Winter canola dry matter and nutrient accumulation and partitioning and yield formation in northeast Kansas

by

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Abstract

Winter canola (*Brassica napus* L.) in the southern Great Plains offers producers an opportunity to diversify their cropping systems and take advantage of several beneficial aspects of canola. One of the obvious benefits is seed yield. However, due to the indeterminate nature of canola and its ability to adapt to growing conditions, it has been difficult to gain an understanding of dry matter (DM) accumulation, nutrient accumulation, and yield formation. This research was done in an attempt to improve knowledge and understanding of winter canola growth and development in northeast Kansas. Two samplings and two experiments were conducted in Manhattan, Kansas from the spring of 2017 to spring of 2019. Biomass samples were collected along with other potential yield formation data throughout the winter canola growing season. The two samplings (2016-17 and 2017-18) did not have treatment factors. The first experiment (2017-18) had one treatment factor with two levels of plant density. The second experiment (2018-19) had two treatment factors of variety and plant density with two levels each. The first objective of this research was to determine the pattern of dry matter accumulation and partitioning throughout the growing season of winter canola in northeast Kansas at both high and low plant populations, and with open-pollinated (OP) varieties that were bred in Kansas. Plant DM increased quickly and steadily through bolt and the beginning of pod fill. The accumulation rate slowed by the middle of pod fill. Dry matter peaked during ripening in all of the studies. At the end of the season there was 36 to 50% of the DM in vegetative material, 25 to 33% in pod material, and 24 to 34% in the seed. There was generally more DM accumulated in the high plant density than the low density, except in one experiment at harvest when the low density had greater DM than the high density. The varieties accumulated DM similarly to each other. The second objective was to determine the pattern of nutrient accumulation and

partitioning throughout the growing season for winter canola in northeast Kansas at high and low plant populations and with OP varieties. Plant nutrient accumulation generally followed the same trend as the DM accumulation. For nitrogen, 17 to 40% of nitrogen at the end of the season was in vegetative, 13 to 17% in pod, and 44 to 66% in seed material. For phosphorus, 14 to 36% of phosphorus at the end of the season was in vegetative, 7 to 32% in pod, and 35 to 78% in seed material. For potassium, 42 to 50% of potassium at the end of the season was in vegetative, 30 to 37% in pod, and 13 to 26% in seed material. For sulfur, 25 to 37% of sulfur at the end of the season was in vegetative, 35 to 49% in pod, and 21 to 32% in seed material. For iron, 15 to 45% of sulfur at the end of the season was in vegetative, 20 to 27% in pod, and 28 to 65% in seed material. The third objective of this research was to identify yield formation factors that contribute to yield and are potentially useful indicators in predicting yield. Plant DM, seed DM, plant height, and pod count on the main raceme were the most highly correlated measurements to yield at the most sampling dates out of the identified potential yield indicators. For those factors with high correlation values, there were several sampling dates with an r^2 value of 0.5 or above. Determining a pattern of DM accumulation and nutrient accumulation and identifying factors that drive yield formation has contributed to the understanding of winter canola growth and development.

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Chapter 1 - Literature Review

Winter canola in the southern Great Plains

In the 1970s, scientists made improvements upon certain varieties of industrial rapeseed (*Brassica napus* L.) that eventually led to the registration of the term “canola”. Canola seed oil differs from rapeseed oil, though they are produced by the same species, because it has low levels of erucic acid and glucosinolates, less than 2% and less than 30 µmol g^{-1}, respectively, and is safe for human and animal consumption. Animal studies originally raised the concerns of high-erucic acid content (>40%), therefore, high-erucic acid rapeseed oil was only used for industrial purposes and was produced in small quantities in North America. Canadian scientists improved rapeseed quality in 1976, eventually leading to consumable canola varietiess and the registration of the word “canola” in 1979 (Bushong et al., 2018; Lin et al., 2013). The increased demand for canola oil has made it the second most widely consumed vegetable oil in the United States (U.S.), soybean oil being the first. Canola oil-based diets can reduce total and low-density lipoprotein cholesterol levels when compared to the high amount of saturated fatty acids in western diets. When those cholesterol levels are decreased the risk of developing cardiovascular disease is decreased. The health benefits of canola are driving the competition between soybean and canola oil in the market (Lin et al., 2013). The byproduct of producing canola oil is canola meal, which is commonly used as a protein source in livestock diets (USDA, 2012). These are two important demands that will continue to drive the increase of canola production in the United States.

U.S. canola production has been on the rise since the early 1990s. Only 62,726 hectares (ha), or 155,000 acres (ac), of canola were planted in 1991, but the number of hectares planted increased to 719,126 ha (1,777,000 ac) in 2015 and have dropped to 693,631 ha (1,714,000 ac) in

2016 (USDA, 2018). North Dakota has historically produced most of the nation's canola, harvesting 639,403 ha (1,580,000 ac) of spring canola in 2018, which was 85.6% of U.S. production. Oklahoma was the second highest canola producing state until 2018 when it dropped to sixth place. Harvested hectares in Oklahoma continued to rise until 2014 at 62,726 ha (155,000 ac), decreased until 2016, increased in 2017, and decreased in 2018 to its lowest since before 2011 at 21,448 ha (53,000 ac). Oklahoma increased its contribution to U.S canola production until 2013 when it peaked at 9.4% of U.S. production. Due to low winter survival in 2014 production fell to 3.8% and only 57% of the planted area was harvested. In 2018, production decreased to 1.3% in Oklahoma, because there was a low number of hectares planted and harvested, and other states like Montana and Washington increased their canola production (USDA, 2014; USDA, 2017; USDA, 2019). In 2016, U.S. canola oil domestic disappearance was 5,312 million pounds, 3,956 million pounds was imported, and almost 77% of dispersed canola meal was imported (Bushong et al., 2018). Although the southern Great Plains region is not the most important contributor of canola, it has great potential.

The success of winter canola in the southern Great Plains is measured not only in canola yields, but also by how it affects the entire cropping system. Producers have begun to see the benefits of increased diversity in their crop rotations. The southern Great Plains historically has relied heavily on winter wheat in its rotations. Because of this, weeds and diseases became difficult for producers to control (Bushong et al., 2012). Canola has different rooting and canopy architecture, making it more competitive than other crops against some weed species, and it offers the opportunity to use herbicides with alternative modes of action. Winter canola offers producers an alternative crop to include in the rotation, which is one of the main reasons for the increased interest in recent years (Holman et al., 2011). In an Oklahoma study, Bushong et al.

(2012) determined that wheat yields and expected net returns were significantly increased in canola-wheat rotations when compared to continuous wheat rotations. This was likely due to the ability to control the weeds during the canola phase that would have been an issue in the wheat crop. The decreased amount of weeds during the wheat phase reduced the amount of foreign material in the wheat seed that would otherwise lead to a price dock, so the weed control increased the wheat quality (Bushong et al., 2012). Producers are interested in reaping the benefits of including canola in their rotations, but growing winter canola in the southern Great Plains also has its challenges. In the central and southern Great Plains, seed germination and stand establishment can be difficult for canola due to the hot, dry periods that frequent the region. Winter survival is also a risk for producers in the central and southern Great Plains (Holman et al., 2011). Breeding programs have been working to improve winter survival by adapting varieties that tolerate low temperatures as well as rapid temperature fluctuations that are characteristic of the Great Plains (Bushong et al., 2018). Proper agronomic practices must be in place for winter canola to be successful.

Winter canola management practices

Cultural management practices like seeding rate, row spacing, and variety selection play a large role in the success of any crop. Seeding rate and row spacing determine how much space a plant has to grow in, which can affect how the plant will compensate to survive (Christensen and Drabble, 1984; Morrison et al., 1990). Studying the yield components of winter canola can aid in understanding how management and environmental conditions influence growth, development, and yield (Ma et al., 2015). Genetic improvement continues to push for increased yield potential by selecting varieties that will yield better than previous varieties in a given set of environmental conditions (Assefa et al., 2014; Zhang et al., 2016). Producers face some challenging decisions when they prepare to implement winter canola into their rotations. Row spacing, seeding rate, and genotype can greatly affect yield, which makes those choices crucial (Kutcher et al., 2013).

Row spacing

Producers that consider a different crop for their rotations also need to consider how easily they can incorporate those crops. As canola is incorporated into a crop rotation, the need for equipment modifications and different seeding methods should be examined. Small grains producers can easily make that transition to winter canola, because the same equipment, e.g. grain drills and air seeders, can be used (Holman et al., 2011). These articles of equipment differ in row spacing, and the question of optimal row spacing for canola seed quality and yield arises (Johnson and Hanson, 2003). Wider rows are used when commercial grain drills cannot be calibrated to drill 5.6 kilograms hectare^{-1} (kg ha^{-1}), or 5 pounds acre^{-1} (lb ac) in the Great Plains or when producers need greater herbicide coverage on winter annual weeds. However, canola yields may decrease 5 to 15% at row widths greater than 50.8 centimeters (cm), or 20 inches (in.), in dryland conditions (Bushong et al., 2018). Most canola row spacing studies have used spring canola and have produced mixed results for the effect of row spacing on yield. These studies often look at the narrower row widths used for cereal grain crops rather than wide row spacing (Wysocki and Sirovatka, 2009).

There have been inconsistent results from many of the spring canola row spacing experiments. Johnson and Hanson (2003) studied the effect of row spacing using three *Brassica napus* varieties and one *Brassica rapa* variety grown in 15.24 cm (6 in.) and 30.48 cm (12 in.) row spacings at Langdon and Fargo, North Dakota. Seed yields were found to be almost identical for both row spacings. At the University of Manitoba in southern Canada, Morrison et al. (1990)

observed increased yields and a greater number of pods per plant in narrow rows (15.24 cm, 6 in.) versus wide rows (30.48 cm, 12 in.) for all locations when seeding rate was kept constant in summer rape. This was attributed to reduced intra-row competition in the narrower row spacing. The effects of row spacing on plant-to-plant competition has been observed in winter canola as well (Showalter and Roozeboom, 2017). Another three-year spring canola study in Melfort, Saskatchewan, Canada noted that plant density and yield decreased when planted in wide rows (60.96 cm, 24 in.) versus narrow rows (22.86 cm, 9 in.) (Kutcher et al., 2013). These studies suggest further research should be done to understand the effects of row spacing to improve winter canola row spacing recommendations.

Row width experiments were carried out for two years in the Pacific Northwest (PNW) to further explore row spacing effects in winter canola. Wysocki and Sirovatka (2009) believed winter canola might perform better in wider rows than spring canola because of its longer growing season of ten months, as opposed to five months for spring canola, in the PNW. These authors suggested that, in that extra time, plants can branch more and better utilize available space than spring canola. Their experiment consisted of four row widths (15.24, 30.48, 60.96, 76.20 cm; 6, 12, 24, 30 in.) planted at two seeding rates: 5 and 7 lb ac^{-1} (Wysocki and Sirovatka, 2009). The authors observed that the two narrower spacings yielded significantly more than the wider spacings in the first year. In the second year, the 15.24 cm (6 in.), 30.48 cm (12 in.), and 60.96 cm (24 in.) widths produced similar yields, but the 76.20 cm (30 in.) row width yielded about 300 lb ac^{-1} less than the narrower widths. Wysocki and Sirovatka (2009) suggested that the plants were able to compensate in the 60.96 cm (24 in.) rows in the second season because there was more rainfall later in the season and the temperatures were cooler. One problem for wide row spacing is the ability of plant roots to explore the soil and take up available water and nutrients. There may be water in the soil between rows that the roots would not be able to reach in a water-limited environment (Wysocki and Sirovatka, 2009). This study is a good stepping stone for winter canola management practices that can be expanded upon.

Seeding rate

Like row spacing studies, seeding rate studies for winter canola in the southern Great Plains are relatively rare, mostly because of how difficult it is to establish canola in a region of low-rainfall (Young et al., 2014). Both seeding rate and row spacing affect plant density. However, plant density is not closely related to yield, suggesting that seeding rate does not cause a significant yield difference (Christensen and Drabble, 1984; Kutcher et al., 2013; Morrison et al., 1990). Morrison et al., (1990) observed that as seeding rate increased, pods per plant decreased significantly, causing yield to decrease in a summer rapeseed study in southern Canada. However, Brandt et al. (2007) conducted a study at three sites in the Parkland region of Canada and found a positive correlation between seeding rate and yield. This study was set up to test high, medium, and low seeding rates (2.5 lb ac^{-1}, 5 lb ac^{-1}, and 7.5 lb ac^{-1}) and fertilizer rates (67, 100, and 133% of recommended rates) on newer, high-yielding varieties. The authors found a general yield increase with increased seeding rate. The yield increase was more prominent between the low and medium seeding rates than between the medium and high rates (Brandt et al., 2007). Kutcher et al. (2013) conducted a study in Melfort, Canada examining seeding rate and row spacing and determined there was no effect on yield due to seeding rate. However, they did find a linear relationship between seeding rate and plant density. As seeding rate was increased, the plant density was also increased, as would be expected (Kutcher et al., 2013). The yield conclusions drawn from these studies contradict each other, but plant densities increased as seeding rates increased in all of them.

Seeding rate studies do not always find a correlation between seeding rate and yield. A winter canola study conducted in the PNW reported the highest fall and spring plant densities occurred with 6 and 8 lb seed ac^{-1} within each growing season compared to the 2 and 4 lb ac^{-1} rates (Young et al., 2013). Although the highest spring plant densities were associated with the higher seeding rates, Young et al. (2013) reported that the highest rate of winter survival for the first year of the study was 83% in the 2 lb ac^{-1} treatment. The seeding rate with the lowest winter survival (56%) was 6 lb ac^{-1}, which was the highest seeding rate planted that year (Young et al., 2013). Showalter and Roozeboom (2017) also noted that winter survival increased at lower seeding rates in Kansas. An increase in plant population did not result in increased yield (Showalter and Roozeboom, 2017). Morrison et al. (1990) suggested that weed suppression could be a reason for the seeding rate recommendations being so large in summer rapeseed. With greater seeding rates resulting in greater plant densities, the crop could better compete with the weeds during early growth stages (Holman, 2011). Although greater seeding rates may have suppressed weeds, it also increased competition between canola plants and could have decreased overall yield (Morrison et al., 1990). These studies show that seeding rate can be used as a tool to increase winter survival with a low seeding rate, and decrease weed populations with a high seeding rate.

Genotype

Along with management and environment, genetics plays a large role in the advancement of any crop, and winter canola is not an exception. Canola breeders continue to improve performance of hybrid (HYB) and open-pollinated (OP) varieties. However, winter canola hybrids are becoming more popular with producers (Stamm and Ciampitti, 2015). The larger seed size (60,000 to 90,000 seeds lb^{-1}) of hybrid varieties allows the plant to establish and form roots quicker, increasing fall vigor, but it does not always mean an increase in yield (Bushong et al., 2018; Stamm and Ciampitti, 2015). Timeliness is essential when planting winter canola hybrids. If the plants grow too large in the fall, they are more susceptible to winter kill in southern regions. Seed of OP varieties is smaller in size (100,000 to 125,000 seeds lb^{-1}), but the plants can still establish, overwinter, and produce yields that compete with the hybrid yields (Bushong et al., 2018). Recent research in the southern Great Plains supports this conclusion. A study conducted in central Kansas concluded that hybrid and OP varieties performed and yielded similarly (Showalter and Roozeboom, 2017). Brandt et al. (2007) suggested hybrids have a yield advantage over OP varieties of 40 to 72% due to heterosis. High parent heterosis for seed yield is often found in hybrid varieties of *Brassicas*. An increase in number of pods per plant explains the increased yield for hybrid varieties (McVetty, 1995). Based on those early observations, McVetty (1995) predicted a large-scale switch to hybrids in the future.

Research in many countries has tested new varieties of canola to find the best management practices to accommodate the varieties that have the potential to increase yield. A six-year fertility study in western Canada concluded the hybrid varieties yielded more than the OP varieties and covered the cost of hybrid seed. The authors of this study also found that the hybrid variety responded to greater amounts of nitrogen fertilizer than the OP variety because of the increased yield potential (Smith et al., 2010). Kutcher et al. (2013) reported results that contrasted with previous work regarding hybrid and OP varieties. This study included one hybrid and two OP varieties and was conducted in Melfort, Canada. The hybrid had greater plant density, began flowering earlier, had a shorter flowering duration, and produced heavier seed than the OP varieties. Kutcher et al. (2013) suggested that the hybrid was better able to compete with weeds because it produced a taller and more vigorous canopy, allowing it to produce greater yields (Kutcher et al., 2013). Canola production in Australia has risen 300% in the last ten years. It has moved to areas and cropping systems that may not be suitable for some of the new varieties (Zhang et al, 2016). Zhang et al. (2016) determined hybrid seed was only advantageous in high rainfall regions. In the lower rainfall areas of Australia, hybrids do not increase yield over OP varieties and do not justify the extra cost of the seed. However, a previous planting date study conducted in three different regions of Western Australia to test new hybrids and OP varieties showed a general yield increase for hybrid varieties (Amjad and White, 2009). These studies contrast each other so there is still research to be done to determine the higher yielding genotype around the world and in the southern Great Plains.

The United States has also conducted some research on genotypes and their interaction with management. Assefa et al. (2014) studied how winter canola varieties performed in variety trials and in response to different planting dates by analyzing variables like yield potential, winter survival, crown height, and hybrid versus OP varieties for the 2010, 2011, and 2012 harvest years. There were significant yield, survival, and crown height differences between genotypes, but they were not consistent across all years of the study. The hybrids tended to produce greater yields than the OPs unless winter survival was an issue. Assefa et al. (2014) found that yields for the hybrids and OP varieties were similar in the year winter survival was a problem. Based on recent National Winter Canola Variety Trials from 2010 to 2014 at Kansas locations of Manhattan, Belleville, and Hutchinson, the hybrids generally produced greater yields than the OPs. In 2014, drought, below-normal temperatures, late spring freeze events, and precipitation at harvest caused yields to be below average for all genotypes. The OP varieties performed better and yielded more than hybrids that year because of the environmental conditions (Stamm and Dooley, 2010, 2011, 2012, 2013, 2014). Crown height is thought to be a variety characteristic related to winter survival and yield, but Assefa et al. (2014) detected no significant relationships. Holman et al. (2011) also found that earlier planting and a higher crown position did not cause winter injury but rather increased winter survival over the later planted canola in southwest Kansas. Genetics has a hand in how well winter canola performs, but it is a combination of genetics, environment, and management that ultimately determines yields. Data from National Winter Canola Variety Trials in 26 states from 2003 to 2012 determined that environment was responsible for 73% of the yield variability. Assefa et al., (2014) found that canola yields are increased in environments where rainfall is relatively low at planting and establishment, and precipitation was greater from December to June. The authors also observed superior canola yields in environments that were wetter and cooler during reproductive stages than the environments that yielded less. The other 27% of yield variability was attributed to either genetics or the interaction of genetics and environment (Assefa et al., 2014). There were a few genotypes that consistently produced greater yields, but most genotypes had similar yields to one another across years and planting dates (Assefa et al., 2014). The authors suggested that further canola research should strive to identify genotypes and management factors that will increase yield and stand establishment.

Biomass and dry matter

Agronomic crop yield is determined by how well the seed or grain fills, which is dependent upon the yield components: plants ha^{-1}, branches plant^{-1}, pods branch^{-1}, seeds pod^{-1}, and seed weight. Carbohydrates and other photoassimilates are produced in the plant organs that are photosynthetically active, such as leaves and stems. Those molecules are then transported to the seed, and contribute to seed weight and overall seed yield (Heindl and Brun, 1983). This suggests plant biomass can be an indicator of yield. There are several factors, such as precipitation and nutrient availability that affect photoassimilate production and translocation throughout crop growth and development. A lack of resources can cause a reduction in overall biomass and yield components, which is the potential yield, and actual yield (Ma et al., 2014; Wang et al., 2015; Zhang and Flottmann, 2016).

In an Australian study that included OP and HYB canola varieties, biomass production was shown to significantly affect yield (Zhang and Flottmann, 2016). Biomass samples collected at several growth stages and at harvest were used to calculate crop growth rate and to analyze correlations between dry matter, yield components, and yield. Pods m^{-2}, seeds m^{-2}, and seed yield were positively correlated to crop growth rate from budding to podding in high rainfall conditions. Dry matter also was positively correlated to pods m^{-2} and seeds m^{-2} at the eight-leaf stage, podding, and maturity in the same conditions. The authors concluded that in high rainfall conditions, increased biomass, particularly during the vegetative stages, represents an important acquisition of resources that will be turned into yield later. They also stated that a large amount of biomass could exacerbate water stress in dry conditions and be a disadvantage during grain filling (Zhang and Flottmann, 2016). Ma et al. (2014) studied dry matter accumulation in wheat and found that dry matter was translocated to the grain at a greater rate during water stressed conditions than in a non-stressed situation. However, that compensation was not enough to make up for the yield loss incurred by the water stress throughout the growth and development of the wheat. Agronomic management of biomass is key to producing a successful crop in any condition.

One way to manage biomass is through soil nutrient application. Winter canola in the southern Great Plains cannot be allowed to put on a large amount of vegetative biomass in the fall, because it is more likely to be winter-killed. Therefore, a large proportion of nitrogen (N) fertilizer is applied in the late winter or early spring, but only about 25 to 33% of the total N is applied in the fall for seedling establishment. Phosphorus (P) and potassium (K) should be applied before planting to avoid salt and ammonia damage to plants. Sulfur can be applied in the fall or spring. A deficiency in nutrients can cause the plant to grow poorly and reduce pod set, seed quality, and yield (Bushong et al., 2018). A winter oilseed rape study in China compared fertilizer treatments and their effect on dry matter and nutrient uptake (Wang et al., 2015). One treatment included N, P, K fertilizer applications at recommended rates. Three other treatments simulated nutrient deficiencies by excluding one nutrient at a time: N, P, and K. The NPK treatment produced the most dry matter. When compared to the NPK treatment, dry matter was reduced by an average of 60.6, 37.2, and 14.3% when N, P, and K were omitted, respectively. The dry matter uptake trend for the NPK treatment showed rapid dry matter accumulation from planting until the plants went dormant, and dry matter was lost over the winter. From spring stem elongation to pod development, the dry matter accumulation rate increased again, then decreased until harvest. The P deficiency and K deficiency treatments followed a similar trend with overall decreased dry matter accumulation. The N deficiency treatment resulted in a small amount of dry matter accumulation that was stagnant for most of the growing season, and did not follow the same trend as the NPK treatment or the P and K deficiency treatments. The N deficiency did not show any dry matter accumulation peaks as the other treatments did. The nutrient deficiencies caused fewer plants to survive the winter than in the NPK treatment. The reduced amount of dry matter caused the seed yield to be significantly less (Wang et al., 2015). Proper nutrient balance affects plant biomass and the plant’s ability to translocate carbohydrates and other photoassimilates to improve seed yield.

Growing conditions such as precipitation and nutrient availability affect plant growth. Photoassimilates and carbohydrates are translocated from leaves, stems, roots, and other organs to fill the grain. The more resources that are available, the more the plant can translocate to the seed to increase yield (Heindl and Brun, 1983). This means plant biomass is related to yield, so water and soil fertility are two factors that are important to consider throughout the growing season for managing biomass and ultimately yield.

Nutrient content

Soil fertility and plant nutrient availability are important to crop growth and development, because nutrients serve specific roles in plant physiology. Therefore, when there is deficiency of one nutrient, the whole plant can suffer and possibly die (Grant and Bailey, 1993; Ma and Zheng, 2016). This can be catastrophic for a producer's business on a field scale. An understanding of each nutrient's role and its interactions with other nutrients allows crop fertilizer management plans to be balanced and effective in improving crop yields and quality (Grant and Bailey, 1993). Plants need macronutrients (nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur) in large amounts, and micronutrients (iron, boron, chlorine, manganese, zinc, copper, molybdenum, and nickel) in trace amounts. The necessary amounts of these nutrients for crop success varies between species and field conditions.

Canola tends to have a greater nutrient requirement compared to small grain cereals, particularly for nitrogen (N) and sulfur (Bushong et al., 2018; Grant and Bailey, 1993; Ma and Zheng, 2016). Nitrogen is a macronutrient because it is used to build amino acids, proteins, nucleotides, nucleic acids, and chlorophyll, which are all prevalent throughout plant tissues. In canola, an optimal plant N level is 2.5 to 4% during the flowering stage. Nitrogen influences many of the yield contributing factors of canola, such as buds/flowers/pods/seeds per plant, stem length, leaf area index, and number of flowering branches. A deficiency of N causes chlorosis and purpling, and results in small plants with thin stems and few branches (Grant and Bailey, 1993). However, too much N can cause plant lodging and a reduction in seed oil quality by producing more protein (Grant and Bailey, 1993; Ma and Zheng, 2016). Wang et al. (2015) found poor vegetative, pod, and seed growth when N was not applied. This same treatment resulted in low dry matter accumulation and seed yield. Nitrogen has an important role throughout the plant, so it is critical to carefully manage it in any crop.

Phosphorus (P) is another critical macronutrient that is involved in energy transfer. It is also an integral structural component of phospholipids and nucleic acids (Grant and Bailey, 1993). Canola responds to P fertilizer, but it is also a good soil P scavenger. Due to rapeseed's many root hairs, tapering roots, and ability to increase P solubility by adjusting the soil pH of the rhizosphere, it has an increased ability to take up P (Grant and Bailey, 1993). The whole canola plant at flowering should have a P level of 0.25 to 0.5% to be considered sufficient (Grant and Bailey, 1993; Ma and Zheng, 2016). Ma and Zheng (2016) studied the relationship between N and P and found that canola with N and P content between 2.5 and 4, and 0.25 and 0.5%, respectively, had greater yields than canola that had N and P contents below those ranges. Phosphorus deficiency can cause purpling of the leaves, a poor root system, and thin stems with small leaves (Grant and Bailey, 1993). Pods per plant, seeds per pod, and seed weight also are reduced when P is deficient (Wang et al., 2015). Although canola is a good P scavenger it can still suffer from P deficiency.

Potassium (K) is a macronutrient that is not usually limiting because canola-growing regions generally have soils that contain adequate K. Potassium is involved in many plant physiological processes, such as stomatal opening and closing (Grant and Bailey, 1993). Canola growth is poor when K availability is low. Canola will show chlorosis along the leaf margins and between the veins when K is deficient. Leaves can also become necrotic, and the plant is more likely to lodge (Grant and Bailey, 1993). Although canola growth suffers under K deficiency, reductions in growth and yield are not as severe as with N and P deficiencies. Wang et al. (2015) found that dry matter accumulation was less when K fertilizer was omitted, but dry matter accumulation was much less when N or P were omitted. Canola also has no or low response to K fertilizer. For a large yield response to K fertilizer the soil exchangeable K level must be less than 35 parts per million (Grant and Bailey, 1993). Deficiency in K is not typically a problem for producers in the Great Plains, but it can affect plant growth.

Another macronutrient involved with protein synthesis, chlorophyll synthesis, and energy transfer is sulfur (S). It is also critical for volatile oils to create glucosinolates (Grant and Bailey, 1993). Due to its importance in protein synthesis in canola, canola has a greater S requirement than that of small grain cereals. Total plant S content at flowering should be between 0.2 and 0.25%. Sulfur deficiency leads to tissue yellowing, small leaves, reddish-purple discoloration throughout the plant, delayed flowering, and small pods (Grant and Bailey, 1993). The authors reported that increased S rates can increase proteins and undesirable glucosinolates, and decrease the oil content, having an adverse effect on seed quality. Therefore, S fertilizer should be carefully managed at a rate that is consistent with the needs of the crop.

Many other nutrients also perform specific functions within plants that are essential for crop success, though some mechanisms are still unknown. Grant and Bailey (1993) noted that calcium is important to cell integrity and stability, and cell elongation and division. Magnesium is a component of chlorophyll and is integral in enzyme activity. Seed set is reduced when canola is boron deficient. Copper deficiency can result in large leaves and compressed flowers, because it is a component of several enzymes. Copper and manganese tend to antagonize each other at high rates. An application of molybdenum has been known to increase several canola yield components. Zinc is involved with many enzymes and indole acetic acid production in canola (Grant and Bailey, 1993). Iron (Fe) is used in chlorophyll synthesis, a deficiency in Fe can reduce leaf chlorophyll content, and chlorosis in young leaves is observable. This reduces profitability (Ferreira et al., 2019; Jiménez et al., 2019). Iron deficiency becomes more pronounced in high pH soils and semi-arid regions such as western Kansas. This occurs because soluble Fe concentration is much lower due to the speciation of Fe in those soils, meaning there is less plant available Fe (Ferreira et al., 2019). While most of these nutrients are needed only in trace amounts, a deficiency could affect canola growth and seed yields.

A successful crop needs a fertilizer program that is built based on an understanding of macro- and micro-nutrients and their roles within the plant. An effective and balanced program will ensure an improved crop yield and seed quality, and that nutrient deficiency is avoided. If one nutrient is lacking within the plant, it limits the plant's ability to reach its potential yield (Grant and Bailey, 1993; Ma and Zheng, 2016). When the crops nutritive needs are met, the crop can be successful.

Yield formation

Canola is one of the most important oilseed crops grown around the world, but the relationships between yield and yield components are still not fully understood. Researchers have set out to quantify those relationships and to find those agronomic traits that increase yield (Zhang et al., 2011). Fertility also plays a role in increased yield via effects on various yield components. Canola yield components include plant density, branches per plant, pods per plant, seeds per pod, and thousand seed weight. Stressful environments and the timing of stress can cause a canola plant to redirect energy to and from different yield components, which causes factors, like pods per plant and thousand seed weight, which contribute to seed yield to compensate for each other. This is the reason seed yield and yield component results can be so inconsistent from year to year and in different environments (Ma et al., 2015). All of the yield components show plasticity or the ability to adjust to environmental conditions, making the process of determining which component or trait aids the most in estimating yield difficult. However, all yield components are developed after and respond to plant density, making it a critical for determining yield potential.

Canola plants have the ability to compensate and adapt to a given environment. Plant architecture will change to better suit a situation, and this can affect yield and seed quality. A seeding rate study of three different rates in Spain was conducted under ideal growing conditions to evaluate these changes (Jacob et al., 2012). The authors found the component that affected yield the most was the number of pods per plant, though branches per plant increased as seeding rate decreased. The greatest number of pods per plant was observed in the intermediate seeding rate, which resulted in increased seeds per plant, seeds per unit area, and overall yield compared to the lowest and the highest plant densities used in this study. There were also more pods observed on the main inflorescence than on the other branches for all three plant densities, which suggested the main raceme contributed the most to the yield. The intermediate density resulted in the most pods on the main inflorescence and the most total pods compared to the low and high densities (Jacob et al., 2012). Clarke and Simpson (1978) also noted that plant population can greatly influence pods per plant, but did not detect an effect on seeds per pod or seed weight. Many canola yield components can adjust and compensate in less than ideal conditions, but pods per plant seems to be the component that is most closely correlated with yield after a plant density threshold is met for any given environment (Brandt et al., 2007).

Observations from recent research have shown that plant characteristics other than yield components are related to harvested yield. Greater leaf area and plant growth allows the plant to intercept more light and increase photosynthetic activity so more dry matter can accumulate in the plant (Ma et al., 2015). Zhang et al. (2011) determined that greater dry matter production is closely related to greater yields. The number of pods m^{-2} and seeds m^{-2} were found to be correlated to dry matter at maturity, and dry matter was positively correlated to seed yield. This study concluded that there is a closer relationship between pods in an area and seed yield than between seed weight in an area or seeds per pod and seed yield. Furthermore, dry matter at the six-leaf stage was closely related to dry matter at maturity, which would suggest that there is a close relationship between early vigor and yield (Zhang et al., 2011).

A report from Alizadeh and Allameh (2015) is in agreement with Ma et al. (2015), they found that plant height is related to yield. Increased raceme length comes with increased plant height, this produces more flowers, and in turn, pods (Alizadeh and Allameh, 2015). Elongated stems can also indicate a greater potential for vegetative growth than shorter plants. The increased biomass leads to increased photosynthetically active tissues that produce dry matter that can be translocated to the grain (Ma et al., 2015). Alizadeh and Allameh (2015) also believed that the distance between the soil surface and lowest podded branch is another plant characteristic that has a small hand in increased yield. Greater distance between the soil surface and the lowest pods can help minimize seed loss at harvest. The greater distance allows harvest machinery to make in-field adjustments with less difficulty, which decreases pod shatter and increases efficiency (Alizadeh and Allameh, 2015).

Canola is a plant that exhibits great plasticity, making it difficult to estimate yield and the value of different yield components. A low plant density could cause each plant to set more pods than they would at a high plant density, because the plant has more resources available to it. However, this does not always mean there are more pods in a given area at a low density than at a high density or that the densities will have a significant difference in yield. A plant with less pods could allocate more dry matter to each seed than a plant with more pods, which affects the thousand seed weight. To understand the factors of harvested yield, not only are the yield components important to consider, but also other plant characteristics (Alizadeh and Allameh, 2015; Ma et al., 2015; Zhang et al., 2011). The environment can play a large role in determining which of these factors will contribute more than the others from year to year, so the question of canola yield components keeps researchers in pursuit of the answer.

Importance of yield estimation

An accurate estimation of crop yield is essential to a producer's decision-making process and success. For many crops, yield estimation is calculated using yield components such as plants per unit area or number of seeds per flowering structure (Ciampitti, 2019). In the instance of a stressed crop that will not produce enough grain to make it worth its inputs, the crop may be terminated and replanted to a crop more suitable to the environment. If agronomic problems are caught early enough, it may be worth the cost of inputs like irrigation or pesticide applications to improve yield before the end of the growing season. A yield estimation from yield components of the crop would be needed to determine its worth before the crop develops too far and the opportunity to terminate and replant a different crop passes. Crop appraisal is important for insurance purposes as well.

Crop failure in one season can put a producer out of business, so crop insurance exists as a risk management tool that allows producers to recover from a poor season. Methods for crop appraisal that are used by insurance companies often use yield components or other factors that contribute to yield to provide adequate coverage for potential yield losses. For canola appraisal, the sampling procedure requires canola plants from nine square feet of row (USDA, 2013). During the vegetative stages, the loss of leaf area within the sample area is of interest, because it is a plant damage appraisal. From pod set to ripening stages the seed count appraisal is used. Plant damage during these stages is evaluated by the condition of the pods and stems, because the leaves have begun to yellow and senesce. It is also difficult to determine the number of pods that will reach maturity; 40 to 55% of the flowers that are set by the plant become productive pods. The percent plant damage is then correlated to percent yield loss (USDA, 2013). However, it is difficult to make these kinds of estimations in canola because it is a plastic plant that manipulates its architecture to better suit its growing conditions. Once the seed is mature and can be shelled from the pods, the volume of seed per unit area is determined to estimate yield. This method allows for a short window before canola swathing to get a firm yield estimate, which causes a problem for producers when they need to make decisions earlier in the season (USDA, 2013). An improved understanding of canola plant architecture and yield components can improve yield estimation methods earlier in the season.

Research Question and Justification

Canola presents a unique challenge for researchers seeking to develop recommendations for producing a successful crop. Its plasticity allows it to adjust to environmental conditions by shifting its energy to different yield components during periods of stress (Ma et al., 2015). Previous canola research in different environments around the world on row spacing, seeding rate, and genotype have resulted in few conclusions that agree. However, most researchers agree that management of plant nutrition is important to dry matter accumulation, and dry matter availability ultimately drives yield, because it is translocated to the seed (Wang et al., 2015). Winter canola complicates the challenge of production in the southern Great Plains because of winter survival issues.

Most producers understand the benefits of diversifying their crop rotations, but have trouble making management decisions that will help them produce a successful canola crop. Agronomic practices make the difference between mediocre and highly successful crops. Some researchers believe narrower rows will increase yields in winter canola (Wysocki and Sirovatka, 2009). Young et al. (2014) suggested winter survival to be the greatest at low seeding rates, but yield was increased at slightly greater seeding rates. Although hybrid varieties tend to increase yield in ideal growing conditions, they do not overwinter as well as OP varieties when the environment is harsh (Assefa et al., 2014). Grant and Bailey (1993) outlined the importance of each nutrient in canola, and Wang et al. (2015) determined that deficiencies in N, P, and K can decrease dry matter and seed yield. Yield formation and plant architecture are influenced by management practices and stressful conditions, which makes canola yield difficult to predict (Alizadeh and Allameh, 2015; Zhang and Flottmann, 2016). The goal of this research was to assess winter canola dry matter and nutrient accumulation and partitioning patterns and the relationship with yield formation in the southern Great Plains. The overall goal of these studies was to determine how winter canola's growth and development relates to yield.

Specific research goals were:

1. Determine the dry matter and nutrient accumulation and partitioning patterns of winter canola.

Hypothesis: Dry matter and nutrient accumulation will start slowly in the fall and throughout the rosette stage. Accumulation will increase quickly from bolting to pod filling, then accumulation will slow through ripening. The dry matter and nutrients will begin to translocate from vegetative material to pod and seed material from pod set through ripening.

2. Describe dry matter and nutrient accumulation in high and low plant populations of winter canola.

   Hypothesis: Canola is a plastic plant that will branch out when given the space, which allows it to accumulate a similar amount of dry matter and nutrients at contrasting plant densities.

3. Determine yield formation factors that contribute to yield and are potentially useful indicators in predicting yield.

   Hypothesis: Plant DM, pod DM, seed DM, number of pods in a given area, and seed volume in a given area will have strong positive correlations with yield.

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Chapter 2 - The effect of variety and plant density on dry matter accumulation and partitioning of winter canola in northeast Kansas

Abstract

Dry matter accumulation and partitioning in winter canola (*Brassica napus* L.) is not well understood in the southern Great Plains. An understanding of dry matter and the ability to improve accumulation has historically helped in improving crop yields. The objective of this study was to determine the pattern of dry matter accumulation and distribution throughout the growing season of winter canola in northeast Kansas at both high and low plant densities with open-pollinated (OP) varieties bred in Kansas. Dry matter accumulation and partitioning was tracked over three growing seasons. There were two samplings that did not include any treatments, and two experiments that included plant density or plant density and variety treatments. These studies were conducted during the 2016-17, 2017-18, and 2018-19 growing seasons in Manhattan, Kansas. Dry matter accumulation was slow from fall growth to the bolting stage in spring. Then, it increased quickly until the middle of pod fill and the rate of accumulation slowed, leveled off, and in some cases dry matter decreased at the time of swathing. In the Surefire experiment, density had an effect on dry matter accumulation. At most sampling dates, the high plant density accumulated more dry matter than the low density. Plant dry matter at the high density reached a maximum mass of 546.3 g m^{-2}, and the low density reached a maximum mass of 445.8 g m^{-2}. There was also a plant density effect in the Surefire-Wichita experiment. However, there were only three sampling dates when density was significant. Two of the significant dates were early in plant growth where the high density accumulated more dry matter than the low density, and the third was at harvest where the low density was greater than the high density. The high density accumulated a maximum dry matter

mass of 1478.7 g m^{-2} while the low plant density reached a maximum of 1143.4 g m^{-2}. Variety was not significant in the Surefire-Wichita experiment. These mixed results indicate that plant density can have an effect on dry matter accumulation, but growing conditions could be a limiting factor.

Introduction

In most agricultural production systems, increased yield and efficient use of inputs are top priorities. Grain yield can be improved by increasing biomass and harvest index (Liu et al., 2005; Zhang and Flottmann, 2016). Maize (*Zea mays*) and rice (*Oryza sativa*) studies have shown that increased biomass accumulation and partitioning, or harvest index, have increased crop yields over the last several decades. Zhang and Flottmann (2016) estimated that more of that yield increase was due to greater biomass accumulation than improvement in harvest index. Plant biomass accumulation is the basis for yield formation, because it is where sugars and other assimilates are produced and stored until the they are redistributed to the grain (Ao, et al., 2014; Heindl and Brun, 1983). This process is still ambiguous in canola due to its ability to alter plant architecture to adapt to stressful conditions during the growing season.

Producers can manipulate a crop's growing environment by adjusting the seeding rate or row spacing, and these affect plant densities. Wide row spacing versus narrow row spacing studies in canola have mixed yield results. Johnson and Hanson (2003) determined that spring canola seed yield was the same in narrow rows (15.24 cm, 6 in.) as it was in wide rows (30.48 cm, 12 in.). A few other spring and winter canola row spacing studies found that seed yield was greater at the narrower row spacing, and this was attributed to the reduced intra-row plant competition and the extent of soil exploration by roots (Kutcher et al., 2013; Morrison et al., 1990; Wysocki and Sirovatka, 2009). There are also mixed results from canola seeding rate studies. Spring canola studies have found no difference in yields at high and low seeding rates (Kutcher et al., 2013), a general yield increase with increasing seeding rate (Brandt et al., 2007), and yield decreases at increasing seeding rates (Morrison et a., 1990). Winter canola adds complexity to choosing an optimum seeding rate due to its ability to compensate for low plant density and the potential for winter kill. Winter survival tends to increase with decreased seeding rate (Showalter and Roozeboom, 2017; Young et al., 2013). However, there is not a clear trend of seeding rate effect on seed yield (Young et al., 2013). Seeding rate and row spacing determine how close plants are to each other in the field (Kutcher et al., 2013). When plants are close to each other, intra-row competition for resources is increased, and this can affect plant biomass and seed yield (Zhang and Flottmann, 2016).

Genetics play an important role in the performance of plants. Producers could select varieties and varieties that are better suited for specific growing conditions. Genetics play an important role in the performance of plants. Canola hybrids tend to be more vigorous and put on biomass quicker than canola OP varieties. This allows spring canola to grow tall with robust biomass, which can lead to increased yields as long as conditions are ideal (Kutcher et al., 2013; Smith et al., 2010). In the southern Great Plains where winter canola is grown, early growth is not always advantageous. Too much fall growth can lead to greater rates of winter kill in some regions, and the hybrids will perform similarly to OP varieties that do not grow as quickly in the fall as hybrids (Showalter and Roozeboom, 2017; Stamm and Ciampitti, 2015). Variety selection is important to the amount and timing of plant biomass growth that drives plant performance and seed yield in certain conditions.

Studies show that poor growing conditions can affect plant architecture and biomass production throughout the growing season in canola and other indeterminate species. Yield components like seed weight and seeds per pod can be decreased due to a lack of available assimilates from shading of the plant when flowers were at the bud stage or just opening (Kirkegaard et al., 2018). When plant-available phosphorus was low for soybean plants, dry matter was not distributed to the pod and seed material as distinctly as it was in plants that received sufficient phosphorus. This resulted in decreased dry matter in pod material and seed yield, suggesting that dry matter uptake and partitioning is an important factor for yield formation (Ao et al., 2014). Wang et al. (2015) determined that low phosphorus availability in winter canola decreased overall dry matter accumulation throughout the growing season, impeding pod and seed development and decreasing yield. Although phosphorus and potassium deficiencies significantly decreased dry matter production, nitrogen deficiency further decreased dry matter accumulation, and the typical growing season accumulation pattern was not evident. These deficiencies also decreased seed yield and quality (Wang et al., 2015).

Under sufficient resource availability, hybrid (HYB) spring canola with traits for early vigor and increased biomass production yielded more than open-pollinated (OP) canola varieties in southern Australia (Zhang and Flottmann, 2016). The crop growth rate and dry matter uptake from the bud to pod development stage influenced the number of pods, seed set, and ultimately seed yield. The authors also reported a correlation between biomass accumulation during the vegetative stage and seed yield. The general trend across spring canola genotypes and site-years showed that dry matter accumulation increased linearly from bud until pod development. Accumulation continued at a slower rate from pod development until ripening. During a dry year, dry matter accumulation of all genotypes plateaued or slightly decreased after pod development (Zhang and Flottmann, 2016). Soybean plants have also been documented to follow a similar dry matter accumulation pattern. Ao et al. (2014) noted that biomass generally accumulated across phosphorus treatments at one rate from branching until the beginning of seed fill, then the accumulation rate slowed through the remainder of seed fill. Dry matter accumulation plateaued through the maturing stages. The pattern of dry matter distribution was also documented throughout the growing season in the Zhang and Flottmann (2016) study. At budding, HYBs distributed more biomass to the leaves than the stems, and OPs had more biomass in stems than in leaves. At flowering, these proportions reversed for all genotypes. During the beginning of the pod filling stage, HYBs allocated more biomass to stems than to leaves and pods, while the OPs allocated more dry matter to leaves and pods than to stems. At maturity, HYBs had more dry matter invested in stem and pod material than the OPs, therefore the proportion of dry matter in the seed was less in the HYBs than the OPs. This resulted in the HYBs having a lower harvest index than the OPs, but the HYBs had greater yield compared to OPs due to significantly greater total dry matter accumulation (Zhang and Flottmann, 2016). In the soybean study, biomass in stems increased at the branching stage and biomass decreased in the leaves at the same stage. In the high P efficiency variety, pod biomass increased at the moderate and high P treatments during the seed filling stages. Across treatments, dry matter was partitioned to soybean stems, leaves, pods, and seeds at about 30.7, 21, 22.3, and 26%, respectively, at physiological maturity (Ao et al., 2014). The three-year averages canola seed harvest index across genotypes of 30% was greater than the soybean seed harvest index across P treatments (Ao et al., 2014; Zhang and Flottmann, 2016).

An understanding of dry matter uptake and partitioning in canola is crucial to successful production, because one way to increase seed yield is to improve biomass accumulation (Liu et al., 2005; Zhang and Flottmann, 2016). Deficiencies in biomass resources can cause decreases in dry matter production and seed yield (Kirkegaard et al., 2018; Wang et al., 2015). Under normal growing conditions, spring canola will increase in dry matter accumulation at a quick rate until pod filling, then dry matter will continue to increase at a slower rate until ripening. Ultimately, dry matter drives yield because plants with increased biomass can increase yield if the plants are not stressed, but they will not necessarily increase the harvest index (Zhang and Flottmann, 2016). An increased understanding of the pattern of dry matter uptake and distribution in winter canola will allow researchers and producers to continue to improve canola yields. Knowledge of the dry matter accumulation and partitioning pattern allows producers to pinpoint the critical times for certain resources like fertilizers or pest control measures like herbicides. These applications provide ideal growing conditions to increase yields. Dry matter uptake can also differ between spring and winter canola due to the dormancy period and longer growing season in the southern Great Plains (Wysocki and Sirovatka, 2009). This would be important to determine, because there is a lack of information and knowledge that is specific to winter canola in the southern Great Plains.

The objective of this study was to determine the pattern of dry matter accumulation and distribution throughout the growing season of winter canola in northeast Kansas at both high and low plant populations, and with OP varieties that were bred in Kansas. Our hypothesis was that dry matter accumulation would start slowly in the fall and throughout the rosette stage. Accumulation will increase quickly from bolting to pod filling, then accumulation will slow through ripening. The dry matter will begin to translocate from vegetative material to pod and seed material from pod set through ripening. The high and low plant populations will follow this same partitioning trend, but the low plant population will accumulate less dry matter than the high population. The winter canola varieties were expected to perform similarly, because they were suited to the Kansas climate.

Materials and Methods

Samplings and experiments were conducted in the 2016-17, 2017-18, and 2018-19 growing seasons near Manhattan, Kansas at the Kansas State University (KSU) Agronomy

Research Farms. The 2016-17 sampling and the 2018-19 experiment were located at the Agronomy North Farm facility (39.205511, -96.595507). The 2017-18 sampling and experiment were located at the Ashland Bottoms facility (39.124666, -96.613971). The Köppen-Geiger climate classification maps placed these locations in the Dfa class. This class is described as a hot-summer humid continental climate with a cold continental group, without dry season precipitation type, and a hot summer heat level (Beck et al., 2018; Kottek et al., 2006). However, this region is geographically close to a Cfa classification, which is a humid subtropical climate (Beck et al., 2018). The Manhattan area has a mean annual maximum temperature of 19.6°C (67.2°F), a minimum of 5.9°C (42.6°F), and average annual rainfall of 90.4 cm (35.59 in.) (US Climate Data, 2019).

Three open-pollinated (OP) winter canola varieties were used in these studies, and all were developed at Kansas State University in Manhattan, Kansas. Riley (Stamm et al., 2012) and Wichita (Rife et al., 2001) are classified as medium maturity varieties, and Surefire (Stamm et al., 2019) is classified as a medium-to-full maturity variety. Several of the samplings were conducted in fields originally planted for other purposes but in close enough proximity to facilitate weekly sampling. As a result, varieties were not consistent across years or experiments. Therefore, results represent a sampling of potential varieties and environments likely to be encountered in the region. Hereafter, the studies are referred to by the variety used and the type of study: the Riley sampling in 2016-17, the Wichita sampling in 2017-18, the Surefire experiment in 2017-18, and the Surefire-Wichita experiment in 2018-19. The Riley sampling was located at the North Farm, the Wichita sampling at Ashland Bottoms, the Surefire experiment at Ashland Bottoms, and the Surefire-Wichita experiment at the North Farm. The Riley and Wichita samplings were sequential sampling studies, each with one variety at a consistent seeding rate. The Surefire experiment included one variety evaluated at high (294,000 plants ha^{-1}; 119,000 plants ac^{-1}) and low (142,000 plants ha^{-1}; 57,500 plants ac^{-1}) plant populations. These populations were established by hand thinning half of the plots, randomly selected within each replication, to half of the established spring stand. The Surefire-Wichita experiment included the Surefire and Wichita varieties at high (741,000 plants ha^{-1}; 300,000 plants ac^{-1}) and low (370,500 plants ha^{-1}; 150,000 plants ac^{-1}) seeding rates. The spring stands were 558,000 plants ha^{-1} and 378,600 plants ha^{-1}. The plant densities in the Surefire experiment were determined by using an already established winter canola stand and then hand-thinning. The plant densities in the Surefire-Wichita experiment were planted at those densities. Due to the differences in how the plant densities were determined, each experiment had different ranges of high and low densities. However, the recommended seeding rate for OP varieties in the southern Great Plains is 300,000 to 500,000 seeds ac^{-1} (Bushong et al., 2018).

All studies were planted on silt loam or silty clay loam soils (USDA Web Soil Survey, 2019). The Riley sampling was located on a Smolan silt loam, 1 to 3% slopes, fine, smectitic, mesic Pachic Argiustoll (USDA Web Soil Survey, 2019). The Wichita sampling was located on a Rossville silt loam, very rarely flooded, fine-silty, mixed, superactive, mesic Cumulic Hapludoll with 18 to 35% clay and 0 to 20% sand (USDA Web Soil Survey, 2019) soil type. The Surefire experiment was located on a Belvue silt loam, rarely flooded, coarse-silty, mixed, superactive, nonacid, mesic Typic Udifluvent with 5 to 18% clay and 15 to 75% sand (USDA Web Soil Survey, 2019). The Surefire-Wichita site was a Wymore silty clay loam, 1 to 3% slopes, eroded, fine, smectitic, mesic Aquertic Argiudoll with 42 to 55% clay and 0 to 5% sand (USDA Web Soil Survey, 2019).

The equipment used for field operations remained the same across studies. The planter was shop-fabricated with Great Plains 00HD (Great Plains Ag, Salina, KS) row units and Wintersteiger small belted cones (WINTERSTEIGER Inc., Salt Lake City, Utah). In the Riley sampling, the rows were 24.1 cm (9.5 in.) apart and 25.4 cm (10 in.) apart in the other three studies. Each plot was six rows wide. All studies were swathed with a 3.66 meter (m) (5 foot (ft.)) plot swather (Swift Machine and Welding Ltd. Swift Current, SK, Canada) and combine harvested with a Massey Ferguson 8XP plot combine (Kincaid Manufacturing, Haven, KS). This combine was equipped with a Harvest Master Classic GrainGage (Juniper Systems Inc., Logan, UT) and Mirus 3.1 (Juniper Systems Inc., Logan, UT) software.

Crop management practices were implemented to assure success of these studies in field conditions. Seedbed preparation for the Riley sampling and Surefire-Wichita experiment included mechanical tillage with a tandem disk and field cultivator to incorporate trifluralin that was applied by a SpraCoupe sprayer (AGCO, Duluth, GA). The Surefire and Wichita experiments had the same field preparation but were also roller packed to create a firm seedbed. Trifluralin was applied by a RoGator (AGCO, Duluth, GA) for those experiments. Nitrogen, phosphorus, and sulfur fertilizers were applied according to KSU winter canola management recommendations and soil test results for each location (Table 2.1). The plots were monitored for weed competition throughout each growing season, and herbicides were applied as needed (Table 2.1). All in-season herbicide applications and spring nitrogen applications were applied with a 110 gallon three-point sprayer (Ag Spray Equipment Inc., North Sioux City, SD) equipped with Chafer stream bars (Needham Ag Technologies, Calhoun, KY). The study areas were also hand weeded at spring green-up if needed. The most prevalent weeds were volunteer wheat (*Triticum aestivum*), blue mustard (*Chorispora tenella*), and horseweed (*Conyza canadensis*). Other field operations are presented in Table 2.1.

The Riley, Surefire, and Surefire-Wichita studies had similar treatment structures and sampling schemes. Each whole plot was divided into a large machine-harvest subplot and several small biomass-sample subplots. The dimensions differed in each experiment due to different row spacings, bordering considerations, or other constraints (Table 2.2). In the Riley sampling and Surefire experiment, two biomass subsamples were taken from each biomass-sample subplot. Due to the amount of time required to process fresh samples and labor limitations the number of subsamples were reduced in the Wichita sampling and Surefire-Wichita experiment to one biomass sample from each biomass-sample subplot. The sample area of 0.84 m^2 (9 ft^2) remained consistent across all experiments to align with National Crop Insurance Services (NCIS) canola yield estimation procedures. The Wichita sampling was conducted within OP and hybrid variety yield trials (Stamm and Dooley, 2019). Wichita was planted in the borders of the trials, and each trial included three Wichita plots randomly located in each block. The trial plots were used to determine machine-harvest seed yield. Bordered biomass-sample subplots were randomly located and replicated by block in the trial borders for this sampling.

Biomass samples were collected on a weekly or biweekly basis from the biomass sample subplots from spring green-up until swathing. In the Surefire-Wichita experiment, additional biomass samples were collected in the fall and at swathing. The final biomass samples for the Surefire-Wichita experiment were cured in a greenhouse for one week to simulate field swathing conditions. For all studies, plant number, height, developmental stage, and fresh weight were noted in the field at each sample date. Samples were transported to the laboratory where pods were separated from leaf and stem material, and pod number and fresh pod weight were recorded. Subsamples of vegetative matter and pod matter were placed in a forced-air dryer for a minimum of four days at 60°C before dry subsample weights were recorded. At later sample dates, the pod samples were threshed using a small BT14 model ALMACO belt thresher (Nevada, IA) to determine seed volume, weight, and thousand seed weight. Pods were only threshed when the seed was mature and hard enough to be separated from the pod material. Samples could be threshed from the last one or two sample dates in the Riley, Surefire, and Wichita studies. The last five sampling dates in the Surefire-Wichita experiment were threshed. In some cases, there was too much plant material to process in a timely manner, and a subsample was processed in the laboratory. In the Surefire experiment, if there were more than 20 plants per sample, only 20 plants were kept to process. In the Wichita sampling and Surefire-Wichita experiment, if there were more than 30 plants per sample, 30 plants were kept to process. Different plant numbers were used because the Surefire plant populations were lower, and the plants were larger than the plants were in the Wichita and Surefire-Wichita studies. More plants were needed in the Wichita and Surefire-Wichita studies to ensure enough plant dry matter for nutrient analysis. Additional data collected to characterize canopy architecture in the Surefire, Wichita, and Surefire-Wichita studies were: average branch count, raceme length, average pod count on the main raceme, and the representative pod length of pods in the bottom, middle, and top of the pod canopy.

The separation of vegetative matter from pod matter and pod matter from seed matter facilitated analysis of biomass accumulation and partitioning throughout the growing season. The biomass sample dry weight data were analyzed using Statistical Analysis System (SAS) 9.4 (SAS Institute, Cary, NC). Analysis of Variance (ANOVA) was performed using PROC GLIMMIX. The Riley sampling and Wichita sampling data were analyzed with sample date as a fixed effect with repeated measures. The Surefire experiment data were analyzed with sample date and plant density as fixed effects with repeated measures. Sample date, plant density, and variety were fixed effects with repeated measures in the Surefire-Wichita experiment. Both the Surefire and the Surefire-Wichita experiments were also analyzed by date with plant density and variety as fixed effects. Growing degree days (GDD) were calculated for each season from the planting dates to standardize the growing seasons. The equation for daily GDD in °F was

$$\text{GDD} = \left(\frac{\text{maximum daily temperature} + \text{minimum daily temperature}}{2}\right) - 41.$$

Results

Total plant dry matter

All samplings and experiments determined that sampling date affected total plant dry matter (Table 2.3). In all cases, total plant dry matter tended to increase from spring green-up until ripening. For the Riley sampling, plant dry matter accumulated quickly until pod formation. Then, the rate of dry matter accumulation slowed until seed maturity when the rate increased again (Figure 2.1, Table 2.4). The maximum dry matter accumulated was 969.6 g m^{-2}, and that was reached at swathing on 7 June (Table 2.4). Total plant dry matter in the Wichita sampling increased from spring green-up until pod fill. Plant dry matter plateaued briefly at the end of flowering. It increased quickly during plant maturity and plateaued again at seed maturity (Figure 2.2, Table 2.5). The maximum amount of dry matter achieved in the Wichita sampling was 908.3 g m^{-2}, which occurred at ripening, but before swathing (Table 2.5). Plant dry matter for the Surefire experiment across plant densities accumulated steadily from bolting until pod fill. Dry matter accumulation rate decreased from pod fill through ripening and seed maturity. There was a plateau in dry matter accumulation right before seed maturity. The Surefire high plant density reached a maximum plant dry matter of 546.3 g m^{-2} at swathing, and the low density reached 445.8 g m^{-2} at swathing (Table 2.7). For the Surefire-Wichita experiment across variety and plant density treatments, dry matter was maintained through spring green-up. Accumulation steadily increased from bolting to pod fill. Plant dry matter decreased as pod fill was ending then increased as ripening began. As the seed matured and the plants ripened, plant dry matter decreased (Figure 2.9, Table 2.9). In the Surefire-Wichita experiment, maximum dry matter was reached during ripening before swathing on 12 June for both densities (Table 2.10).

In the Surefire and Surefire-Wichita experiments, plant density affected plant dry matter accumulation. There was a date x density interaction in the Surefire experiment, but not the Surefire-Wichita experiment (Table 2.3, Table 2.6, Table 2.8). The Surefire experiment at the low plant density accumulated dry matter at a slower rate than the high plant density. Total plant dry matter was greater at the high density than the low density (Figure 2.3, Figure 2.4, Figure 2.5, Table 2.7). Plant dry matter increased steadily at the low density until pod fill when it increased quickly and plateaued until seed maturity (Figure 2.4). Plant dry matter at the high plant density in the Surefire experiment accumulated more steadily than the low density throughout the season. There was an increase in the rate of accumulation from pod formation to pod fill. Dry matter accumulation plateaued as plant ripening began in the high plant density (Figure 2.3). There were three dates when there was no significant difference between plant densities. These dates corresponded with the beginning of bloom, the end of bloom, and seed maturity (Figure 2.5, Table 2.6). Although both the high and the low plant densities followed the same general trend throughout the growing season in the Surefire-Wichita experiment (Table 2.3, Figure 2.9), dry matter accumulation was less with low plant density about six weeks after planting in the five to six leaf rosette stage, and at spring green-up, but was greater with low plant density at the last sample date (Figure 2.10). Dry matter increased from spring green-up to pod fill, decreased for a brief time at the end of pod fill, increased at the beginning of plant ripening, then decreased during seed maturation (Figure 2.9).

There were no significant variety or interactions with variety effects for total plant dry matter in the Surefire-Wichita experiment across sampling dates (Table 2.3). Within sample dates, total plant dry matter was affected by variety and variety x density on the first sampling date in the fall when plants were at the five- to six-leaf rosette stage. Wichita accumulated a greater amount of dry matter than Surefire at this date. Wichita at the high density had a greater amount of dry matter than Wichita at the low density and Surefire at both densities.

Vegetative dry matter

Vegetative dry matter was affected by sample date in all experiments (Table 2.3). In the Riley sampling, vegetative dry matter accumulated quickly until pod fill began, then dry matter decreased through pod fill. Vegetative dry matter leveled off when the plants ripened, then increased slightly as the seed matured (Figure 2.1, Table 2.4). Maximum vegetative dry matter was reached on 27 April during pod development (Table 2.4). Vegetative dry matter in the Wichita sampling increased until the middle of pod fill, though it increased at a slower rate after pod formation than before pod formation. In the second half of pod fill, vegetative dry matter decreased and plateaued through the end of the season. Maximum vegetative dry matter occurred on 16 May during pod fill (Figure 2.2, Table 2.5). Vegetative dry matter increased steadily in both densities in the Surefire experiment until the first half of pod fill, then accumulation slowed and reached its maximum at the end of bloom and leveled off through seed maturity. Greater plant density resulted in greater vegetative dry matter at most sample dates (Table 2.7). The maximum dry matter in the high plant density occurred on 16 May during pod fill, but reached maximum in the low density a week later, still during pod fill. Vegetative dry matter increased in the Surefire-Wichita experiment until pod fill began (Tables 2.9, 2.10). It leveled off and reached its maximum near the end of bloom. Then, it slowly decreased through the rest of the season with a slight increase at the beginning of ripening. Vegetative dry matter at the high density reached its maximum on 22 May in the middle of pod fill. The low density reached its maximum on 9 May slightly earlier in pod fill (Figure 2.9, Table 2.9, Table 2.10).

There was also a plant density effect in both the Surefire and Surefire-Wichita experiments (Table 2.3, Table 2.6, Table 2.7, Table 2.8). In the Surefire experiment there was a date x density interaction, and there was a variety x density interaction in the Surefire-Wichita experiment. Vegetative dry matter accumulation was different between densities in the Surefire experiment at all dates except for two dates, the beginning of bloom and the end of bloom. When dry matter was different, the high density had greater vegetative dry matter than the low density (Figure 2.6, Table 2.7). In the Surefire-Wichita experiment, dry matter differed between variety x density treatments. Across dates, the Wichita variety at the high plant density was greater than the Wichita at the low density and the Surefire at the high density. However, there was no difference between the Wichita high density and the Surefire low density (Table 2.9).

There were no density, variety, or other interaction effects on vegetative dry matter accumulation across dates, other than the variety x density, in the Surefire-Wichita experiment across dates (Table 2.3). However, there was a significant effect of variety and variety x density at the five to six leaf stage in the fall of 2018. The Wichita variety had accumulated more dry matter by this stage than the Surefire variety. The Wichita at the high density had a greater amount of vegetative dry matter than Wichita at the low density and Surefire at both densities.

Pod dry matter

There was a date effect on pod dry matter accumulation in all samplings and experiments (Table 2.3). Pod dry matter in the Riley sampling steadily increased until it reached its maximum of 475.6 g m^{-2} at the beginning of plant ripening, then it decreased (Figure 2.1, Table 2.4). The Wichita pod dry matter followed a similar trend where it increased until the beginning of ripening and decreased at the end of the season. It reached its maximum on 30 May at the beginning of ripening before swathing (Figure 2.2, Table 2.5). Pod dry matter across treatments in the Surefire experiment increased until the end of pod fill, then decreased and leveled off through ripening. Pod dry matter was maximized for both plant densities on 30 May at the beginning of ripening (Table 2.7). Across treatments in the Surefire-Wichita experiment, pod dry matter increased to its maximum until the end of bloom, then it decreased at the end of pod fill. It increased again until the beginning of ripening, then decreased and plateaued through the end of the season. Pod dry matter reached its maximum on 22 May in the middle of pod fill (Figure 2.9, Table 2.9, Table 2.10).

There was a plant density effect on pod dry matter in the Surefire and Surefire-Wichita experiments (Table 2.3). In both experiments, pod dry matter was greater in the high density across dates. The high density accumulated more dry matter than the low density at each date there was a difference in both experiments. In the Surefire experiment, pod dry matter was the same for both densities only at the end of bloom and at seed maturity (Figure 2.7, Table 2.7). There was also a date x density interaction for the Surefire experiment. Pod dry matter was different between densities only two times during the growing season in the Surefire-Wichita experiment. The first was at spring green-up, and the second in the middle of pod fill. There was not a date x density interaction in the Surefire-Wichita experiment.

There were no significant variety or interactions with variety effects across dates for pod dry matter in the Surefire-Wichita experiment (Table 2.3). There was a variety effect on 2 May during pod formation (Table 2.8) when Surefire had a pod dry matter of 20.5 g m^{-2} and Wichita had a pod dry matter of 12.9 g m^{-2}. Varieties responded differently at the different densities at swathing on 17 June. Wichita at the low density and Surefire at the high density accumulated greater pod dry matter, 313.1 g m^{-2} and 299.1 g m^{-2}, respectively, than Wichita at the high density and Surefire at the low density, 264.0 g m^{-2} and 261.6 g m^{-2}, respectively, on that date.

Seed dry matter

There was only one seed sample date in the Riley and Wichita samplings, so there were no comparisons across dates. There was no date effect or date x density interaction in the Surefire experiment across the two sampling dates, but there was a density effect (Figure 2.8, Table 2.3). The high plant density had a greater amount of seed dry matter than the low density across dates. The maximum seed dry matter for both densities was reached at swathing when the high density had 22 g m^{-2} more seed dry matter than the low density (Table 2.7). There was a date effect for the Surefire-Wichita experiment across the five seed sample dates. Seed dry matter increased from the second half of pod fill to the beginning of plant ripening. Then it decreased and leveled off through the end of the season (Table 2.9). Seed dry matter reached its maximum in both plant densities on 12 June during ripening before swathing (Table 2.10).

There were no variety, density, or interaction effects on seed dry matter in the Surefire-Wichita experiment across dates or at any sample date.

Discussion

Across all the studies plant dry matter generally increased from spring green-up until the middle of pod fill, then leveled off through ripening. The dry matter accumulation rate slightly increased at about the time of pod development, then as pod fill began the rate generally decreased and sometimes the amount of dry matter decreased (Figure 2.1, Figure 2.2, Figure 2.3, Figure 2.4, Figure 2.9). This pattern loosely lined up with the pattern Zhang and Flottmann (2016) observed in spring canola in Australia. In that experiment, dry matter accumulated linearly from bloom until pod development, and accumulation slowed through ripening. This development has also been observed in soybean plants. Dry matter accumulated from vegetative stages to the beginning of seed fill, then the rate of accumulation slowed throughout the maturing stages (Ao et al., 2014). All of the studies reached 100% of their dry matter accumulation during ripening. Vegetative material made up 35 to 50% of the total dry matter when it peaked. Pod material made up 30 to 60% of the total dry matter when it reached 100% of the total dry matter. And seed made up 0 to 40% of the total dry matter when it reached its peak. The Wichita sampling and Surefire-Wichita experiment lost dry matter after accumulating the maximum dry matter, this could be due to pod shatter (Figure 2.2, Figure 2.9). Zhang and Flottman (2016) suggested that increased biomass accumulation could translate to increased yields. They found that hybrid canola produced more biomass, more pods m^{-2}, and had an increased seed yield under ideal conditions than the OP variety. The increased yield was attributed to increased biomass. There was a difference in plant dry matter accumulation between the high and low plant density at most sampling dates in the Surefire experiment (Figure 2.5). The high plant density accumulated significantly more dry matter than the low plant density for seven of the ten sampling dates. However, dry matter was similar for both densities at the final sampling date, which was immediately before swathing. A biomass sample was not taken at harvest in this experiment, so it is unknown if there would have been a difference in plant dry matter between the densities at the very end of the season. However, in the Surefire-Wichita experiment, the densities accumulated the same amount of dry matter for most of the season. On the last sampling date, which was at harvest, the high plant density had less dry matter than the low plant density, which could have been due to a slight delay in plant development in the low plant density plots. This could have signified a difference in senescence between the plant densities as well (Figure 2.10).

Vegetative dry matter increased from spring green-up to the beginning of pod fill in all the studies. Dry matter plateaued or slowly decreased through the rest of the season. At the end of the season, between 36 and 50% of the plant dry matter was in vegetative material (Figure 2.1, Figure 2.2, Figure 2.3, Figure 2.4, Figure 2.9). Generally, pod dry matter increased until seed formation, then it decreased slightly and leveled off through seed ripening. This was more evident in the Surefire and Surefire-Wichita experiments because seed could be separated from the pods at more sample dates than in the other experiments. At the end of the season, pod material made up 25 to 33% of the plant dry matter (Figure 2.1, Figure 2.2, Figure 2.3, Figure 2.4, Figure 2.9). Seed dry matter increased in the Surefire experiment. It increased, then decreased and leveled off in the Surefire-Wichita experiment. This more complicated trend in the Surefire-Wichita experiment could have been due to pod shatter that decreased the seed dry matter at the end of the season. At the end of the season there was 24 to 34% of the plant dry matter in the seeds (Figure 2.1, Figure 2.2, Figure 2.3, Figure 2.4, Figure 2.9). These values are comparable to the partitioning of spring canola reported by Zhang and Flottman (2016) and soybean dry matter reported by Ao et al. (2014). There is less dry matter in the canola vegetative material (36 to 50%) in these studies than there was in the soybean vegetative matter (51.7%), but that dry matter was partitioned to the canola pods and seeds (Ao et al., 2014).

Due to the fast rate of dry matter accumulation during the bolting and bloom stages of development, crop management is important at those stages to set the crop up for greater dry matter accumulation later in the season. Producers should be on the lookout for pests, nutrient stress, and water stress to give the crop the greatest chance for success. There was delayed plant dry matter accumulation in the low plant density of the Surefire experiment, but dry matter amounts were not statistically different between the densities by the end of the season. Irrigation or fertilizer applications could have improved dry matter in those early stages to set the low density up for improved plant performance later in the season.

Conclusions

The objective of this study was to determine the pattern of dry matter accumulation and partitioning throughout the growing season of winter canola in northeast Kansas. Our hypothesis was that dry matter accumulation would start slowly in the fall rosette stage. Accumulation would increase quickly from bolting to pod filling, then accumulation would slow through ripening. Dry matter would begin to translocate from vegetative material to pod and seed material from pod set through ripening. The pattern of dry matter accumulation and partitioning followed our hypothesized trend with slow accumulation during rosette, and increased rate of accumulation from bolt to pod fill, then a slower rate to finish out the season. There was some translocation of dry matter from vegetative material to pod and seed material throughout pod fill. In instances where vegetative material was decreasing but the plant dry matter was still increasing, translocation most likely occurred. The consistency of this pattern is dependent upon the quality of sampling. In the first year of this study, the Wichita sampling, the pod material was not separated from the vegetative material at sampling dates before swathing. This makes the decrease in vegetative matter after pod development more dramatic than it probably was in actuality. In subsequent seasons when seed was separated from pods at more sample dates, vegetative material continued to increase after pod development and then decreased slightly as the pods filled. Plant dry matter accumulation peaked during ripening and translocation occurred throughout pod fill.

The secondary objective of this study was to determine the effect of plant population and variety on the pattern of winter canola dry matter accumulation and partitioning. Our hypothesis was the high and low plant populations will follow this same partitioning trend, but the low plant population will accumulate less dry matter than the high population. The winter canola varieties were expected to perform similarly because they were suited to the Kansas climate. As we hypothesized, the Surefire and Surefire-Wichita experiments generally exhibited greater dry matter accumulation in the high plant densities than in the low densities. On the final sampling date of the Surefire-Wichita experiment, the low density had greater plant dry matter than the high plant density, which could have been due to issues with pod shatter. The high plant density accumulated more dry matter than the low density throughout the majority of the growing season. The Surefire and Wichita varieties accumulated similar amounts of dry matter.

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Figures

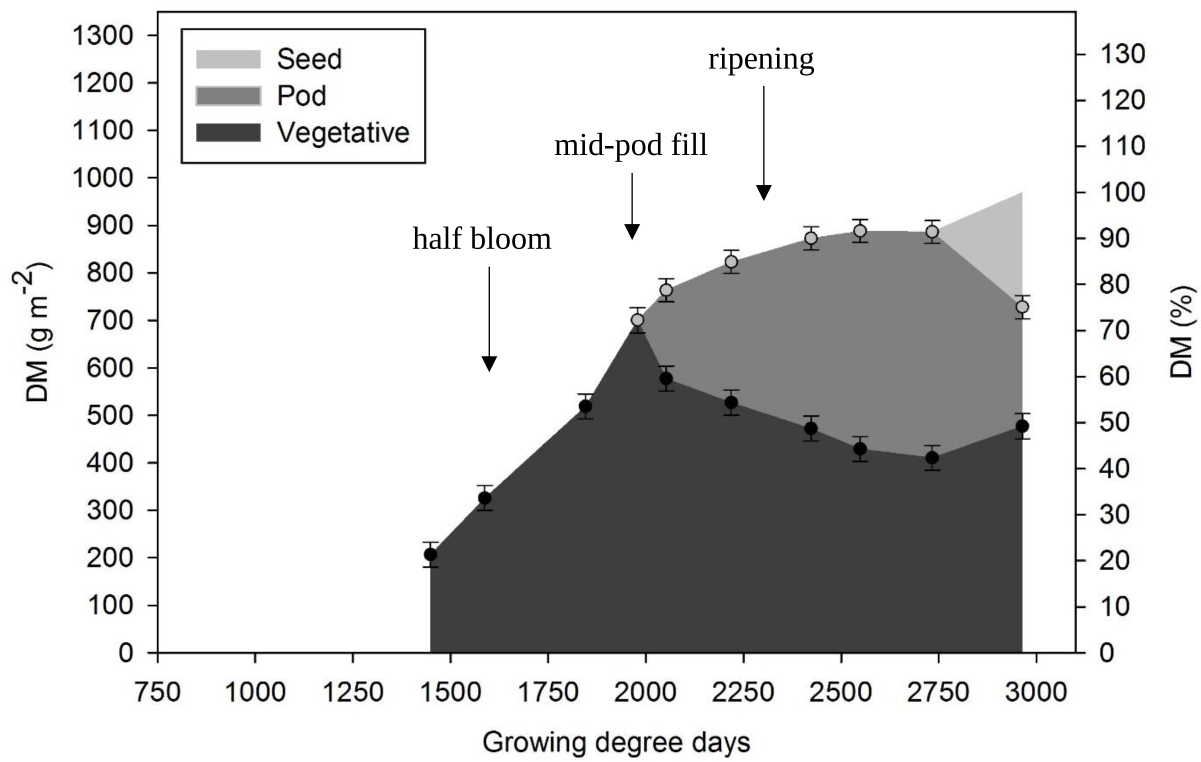

Figure 2.1. Dry matter accumulation and partitioning for the Riley sampling at Manhattan, KS in 2017.

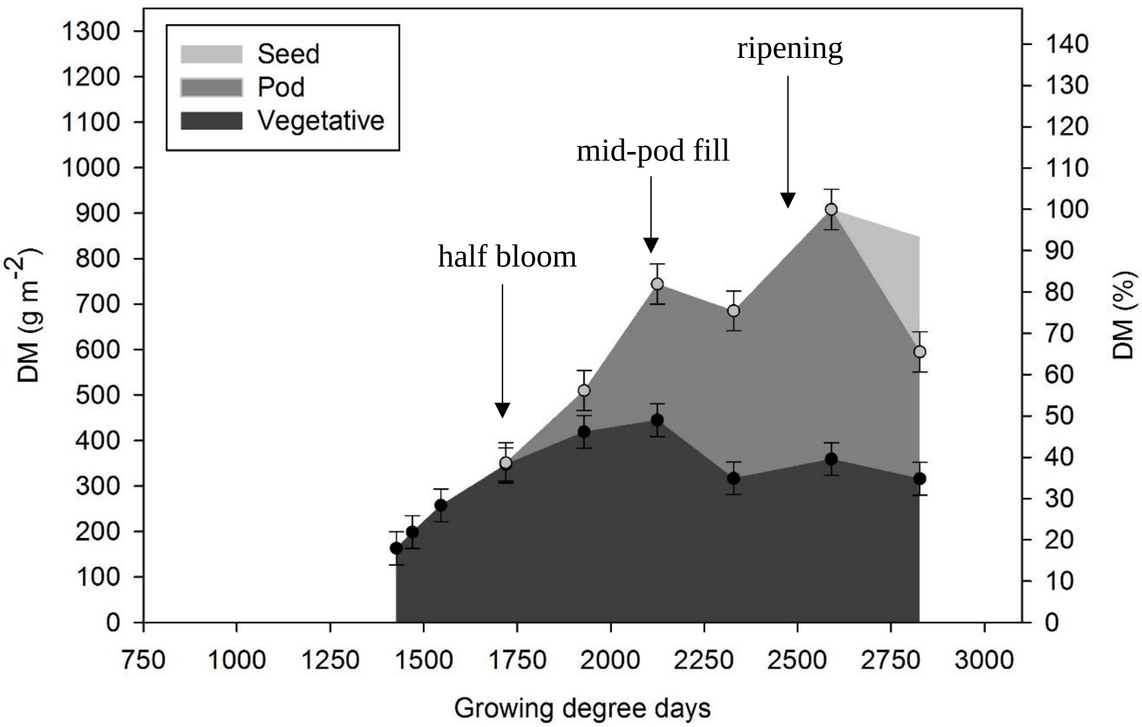

Figure 2.2. Dry matter accumulation and partitioning for the canola variety Wichita sampled near Manhattan, KS in 2018.

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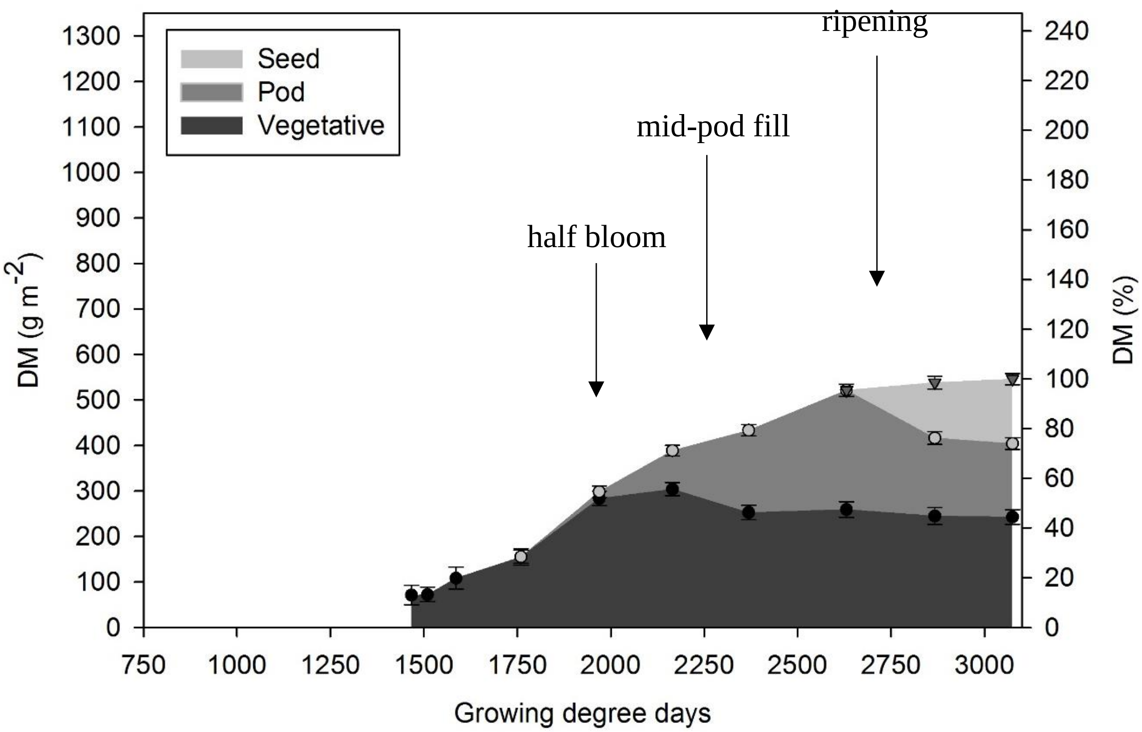

Figure 2.3. Dry matter accumulation and partitioning for the canola variety Surefire at high plant density sampled near Manhattan, KS in 2018.

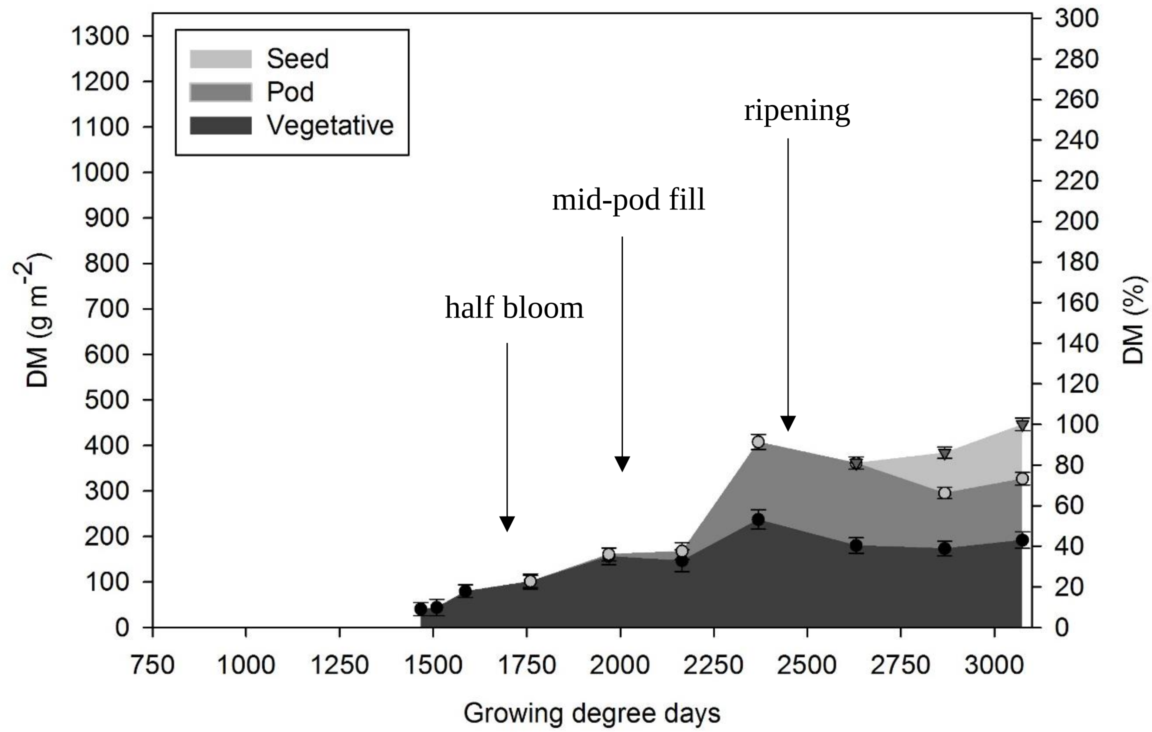

Figure 2.4. Dry matter accumulation and partitioning for the canola variety Surefire at low plant density sampled near Manhattan, KS in 2018.

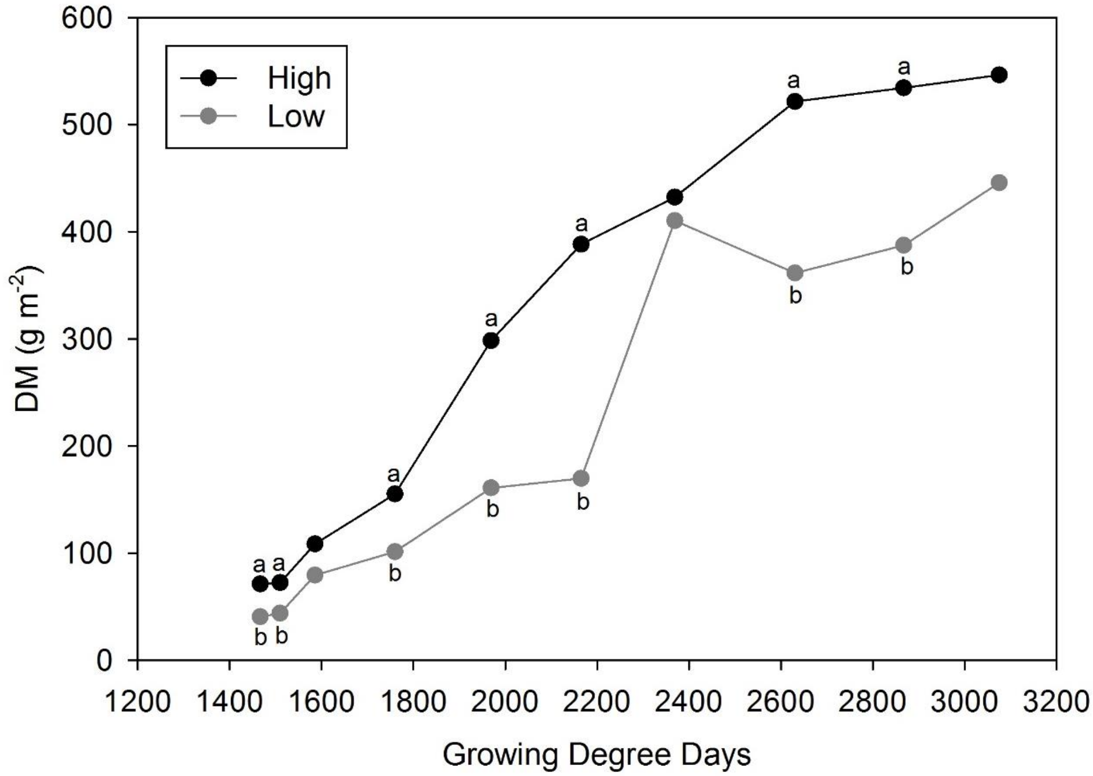

Figure 2.5. Plant dry matter accumulation response to plant density in the Surefire experiment at Manhattan, KS in 2018. Different letters at a sampling date indicate significant differences between densities, α=0.05.

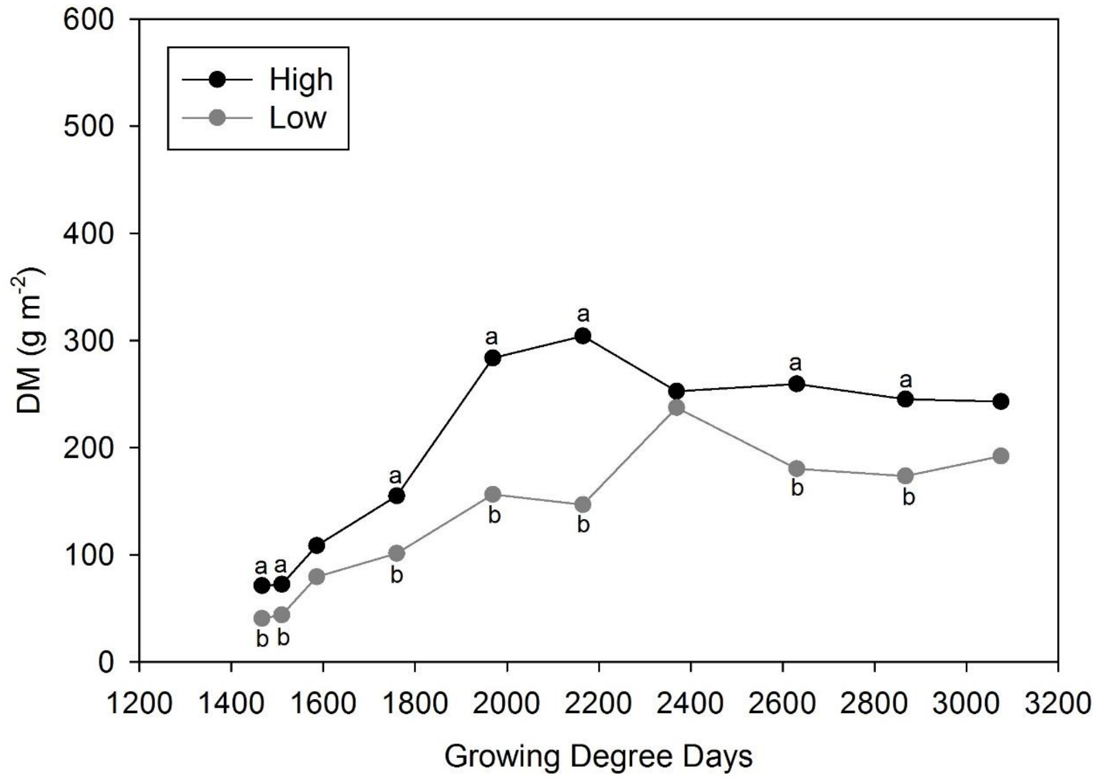

Figure 2.6. Vegetative dry matter accumulation by date for the Surefire experiment at Manhattan, KS in 2018 at high and low plant densities. Different letters at a sampling date indicate significant differences between densities, α=0.05.

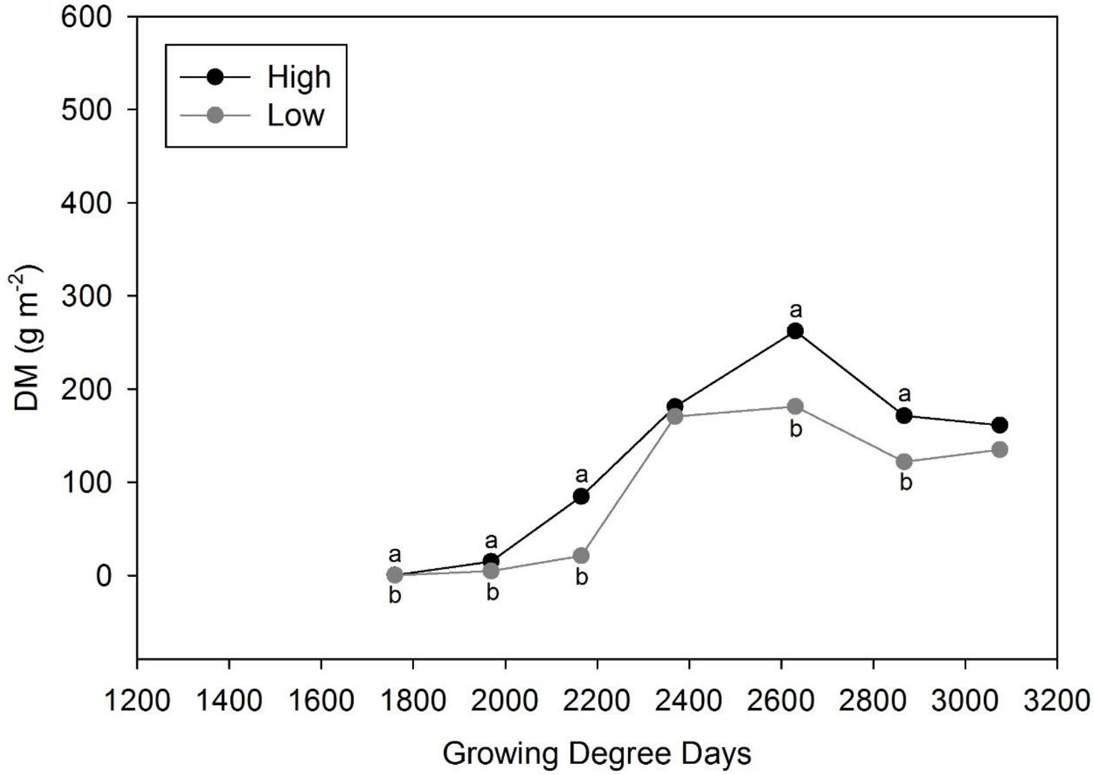

Figure 2.7. Pod dry matter accumulation by date for the Surefire experiment at Manhattan, KS in 2018 at high and low plant densities. Different letters at a sampling date indicate significant differences between densities, α=0.05.

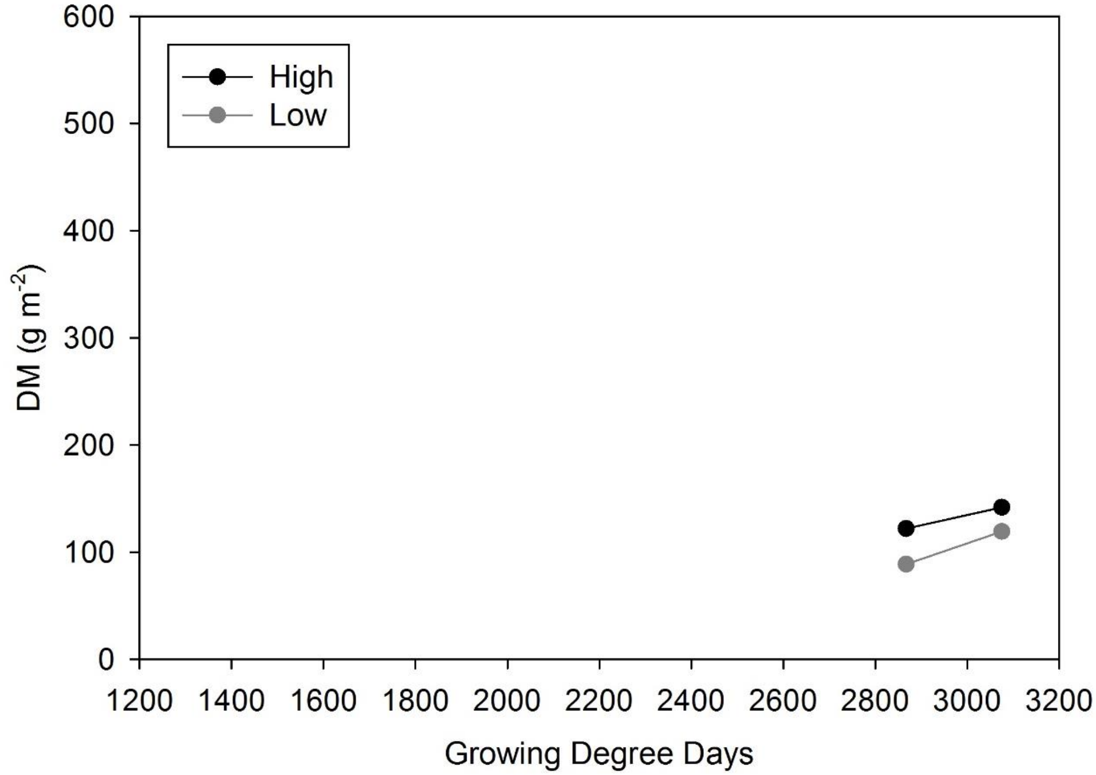

Figure 2.8. Seed dry matter accumulation by date for the Surefire experiment at Manhattan, KS in 2018 at high and low plant densities. Different letters at a sampling date indicate significant differences between densities, α=0.05.

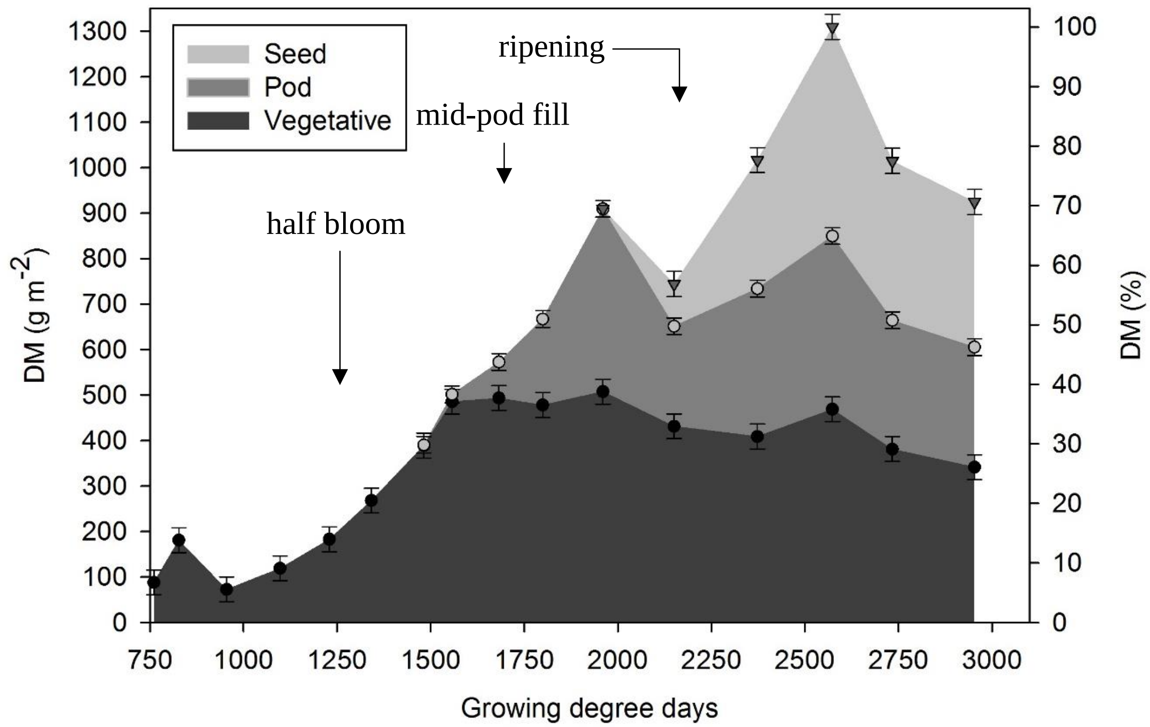

Figure 2.9. Dry matter accumulation and partitioning averaged across varieties and plant densities in the Surefire-Wichita experiment near Manhattan, KS in 2019.

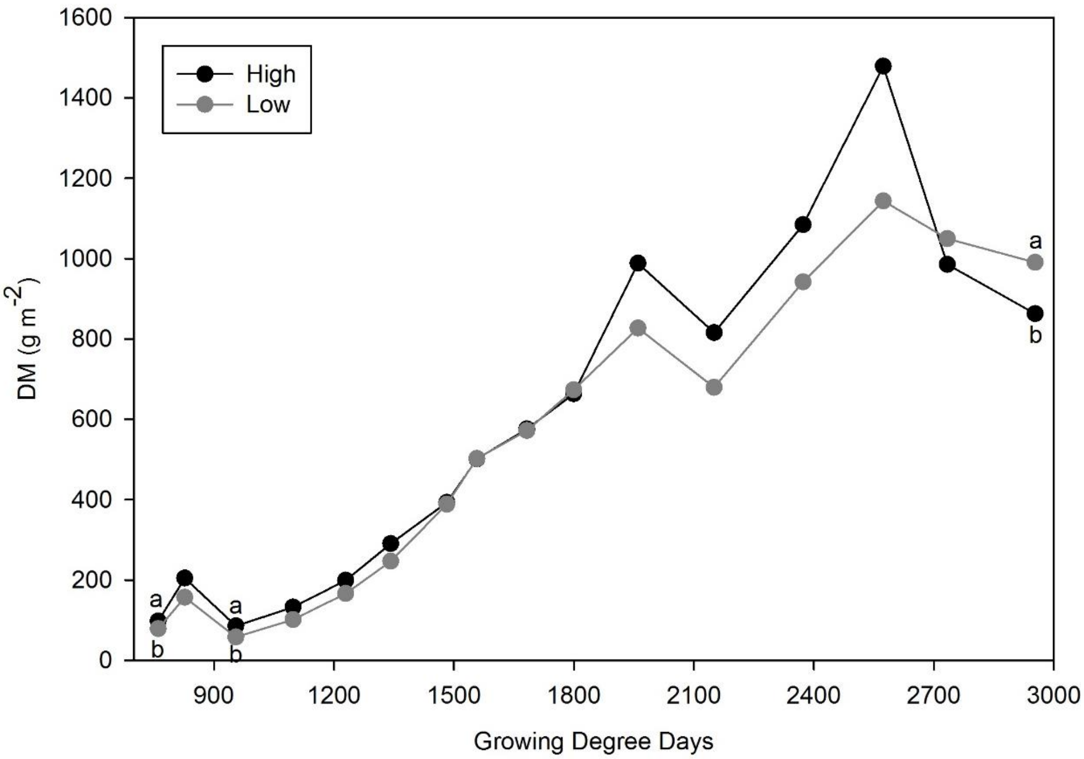

Figure 2.10. Plant dry matter accumulation by date for the Surefire-Wichita experiment at Manhattan, KS in 2019 at high and low plant densities. Different letters at a sampling date indicate significant differences between densities, α=0.05.

Tables

Table 2.1. Field operations for field sampling and experiments conducted to assess canola biomass and nutrient accumulation near Manhattan, KS 2016-2019.

	Sampling		Experiment	
Factor	Riley	Wichita	Surefire	Surefire-Wichita
Fall nitrogen†	39.2 kg ha^{-1} (32-0-0)	39.2 kg ha^{-1} (28-0-0)	39.2 kg ha^{-1} (28-0-0)	15.7 kg ha^{-1} (10-0-0-22)
Fall phosphorus	-	33.6 kg ha^{-1} (10-34-0)	33.6 kg ha^{-1} (10-34-0)	-
Fall sulfur	22.4 kg ha^{-1} (12-0-0-24)	33.6 kg ha^{-1} (10-0-0-22)	33.6 kg ha^{-1} (10-0-0-22)	33.6 kg ha^{-1} (10-0-0-22)
Fall herbicide‡	Treflan 2.8 L ha^{-1} Assure II 730.4 ml ha^{-1} Muster 28.0 g ha^{-1}	Assure II 730.4 ml ha^{-1} Muster 21.0 g ha^{-1} Assure II 584.3 ml ha^{-1}	Assure II 657.3 ml ha^{-1} Muster 21.0 g ha^{-1}	Assure II 730.4 ml ha^{-1} Muster 28.0 g ha^{-1}
Spring nitrogen§	111.0 kg ha^{-1} (32-0-0)	107.6 kg ha^{-1} (32-0-0)	95.3 kg ha^{-1} (32-0-0)	112.1 kg ha^{-1} (28-0-0)
Spring herbicide	Muster 14.0 g ha^{-1} Assure II 657.3 ml ha^{-1}	-	-	-
Planting date	Sep. 29, 2016	Sep. 20, 2017	Sep. 19, 2017	Sep. 18, 2018
Swathing date	Jun. 8, 2017	Jun. 7 & Jun. 11, 2018	Jun. 11, 2018	Jun. 17, 2019
Harvest date	Jun. 16, 2017	Jun. 11 & Jun. 16, 2018	Jun. 13, 2018	Jul. 1, 2019

† All fertilizer applied pre-plant.

‡ Fall herbicide- Treflan [Trifluralin: a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine, 430 g kg-1, Corteva Agriscience (Dow), Wilmington, DE] applied pre-plant; Assure II [Quizalofop-p-ethyl, Ethyl(r)-2-[4-(6-chloroquinoxalin-2-yloxy)-phenoxy]propionate, 103 g kg-1, Corteva Agriscience (DuPont), Wilmington, DE] and Muster (Ethametsulfuron methyl 750 g kg-1, Corteva Agriscience (DuPont), Wilmington, DE]) applied post-emergence.

§ Spring fertilizer and herbicide applied after spring green-up and before canola bolting.

Table 2.2. Experimental details for sampling and experiments conducted to assess canola biomass and nutrient accumulation near Manhattan, KS 2016-2019.

	Sampling		Experiment	
Factor	Riley	Wichita	Surefire	Surefire-Wichita
Whole plot (m)	3.66 x 9.14	-	3.66 x 10.06	3.66 x 13.72
Machine-harvest subplot (m)	1.83 x 9.14	1.83 x 5.79	1.82 x 10.06	1.82 x 13.72
Biomass-sample subplot (m)	0.91 x 0.91	0.76 x 1.10	0.91 x 0.91	0.82 x 1.01
Fall stands	-	-	-	Oct. 19, 2018
Spring stands	Mar. 20, 2017	Mar. 10, 2018	Mar. 10, 2018	Mar. 21, 2019
Fall sampling duration	-	-	-	Nov. 2 to Dec. 17, 2018
Spring sampling duration	Mar. 22 to Jun. 7, 2017	Apr. 12 to Jun. 6, 2018	Mar. 12 to Jun. 11, 2018	Mar. 22 to Jun. 24, 2019
Number of samples	10	9	10	16
Sample order	sequential	random	sequential	sequential
Replications	6	3	4	4

Table 2.3. Tests of significance for dry matter response to main effects of date, density, variety, and their interactions for experiments conducted near Manhattan, KS 2017-2019.

Experiment	Source of variance	Total plant	Vegetative	Pod	Seed
		——probability of > F——			
Riley	Date	<0.0001	<0.0001	<0.0001	
Wichita	Date	<0.0001	<0.0001	<0.0001	
Surefire	Date	<0.0001	<0.0001	<0.0001	0.0551
	Density	<0.0001	<0.0001	<0.0001	0.0455
	Date x Density	0.0060	0.0014	0.0104	0.5529
Surefire-Wichita	Date	<0.0001	<0.0001	<0.0001	<0.0001
	Variety	0.4858	0.3074	0.9403	0.6442
	Density	0.0222	0.1632	0.0003	0.1103
	Date x Variety	0.9800	0.8760	0.9883	0.8641
	Date x Density	0.1140	0.5843	0.0538	0.0510
	Variety x Density	0.0873	0.0013	0.8266	0.9469
	Date x Variety x Density	0.5897	0.5724	0.7128	0.4309

Table 2.4. Accumulation and partitioning of dry matter in the canola variety Riley sampled near Manhattan, KS in 2017.

Date	Growing degree days	Developmental stage	Total plant	Vegetative	Pod†	Seed
			g m^{-2}			
22-Mar-17	1449	rosette/early bolt	207.0 g‡	207.0 h		
6-Apr-17	1587	early bloom	325.8 f	325.8 g		
18-Apr-17	1845	bloom	518.9 e	518.9 cd		
27-Apr-17	1979	pod development	700.5 d	700.5 a		
4-May-17	2052	pod fill	763.4 cd	577.5 b	185.9 d	
10-May-17	2219	pod fill	823.2 bc	526.9 bc	296.4 c	
17-May-17	2423	pod fill	872.9 b	472.4 de	400.5 b	
24-May-17	2549	beginning ripening	888.3 b	429.4 ef	459.0 a	
31-May-17	2733	ripening	886.2 b	410.7 f	475.6 a	
7-Jun-17	2964	swathing	969.6 a	477.2 cde	250.8 c	241.6

† Pods included developing seeds through the 31 May sampling but were separated from seeds for the 7 June sampling.
‡ Values within a column followed by the same letter are not different at α=0.05.

Table 2.5. Accumulation and partitioning of dry matter in the canola variety Wichita sampled near Manhattan, KS in 2018.

Date	Growing degree days	Developmental stage	Total plant	Vegetative	Pod†	Seed
			g m^{-2}			
12-Apr-18	1427	rosette	163.3 f‡	163.3 f		
19-Apr-18	1470	bolt	199.2 f	199.2 ef		
26-Apr-18	1546	beginning bloom	257.8 ef	257.8 de		
3-May-18	1720	pod development	351.4 e	347.5 bc	3.9 c	
10-May-18	1929	pod fill	510.3 d	419.1 ab	91.2 c	
16-May-18	2125	mid-pod fill	744.1 bc	445.1 a	298.9 b	
23-May-18	2329	pod fill	685.1 c	317.1 cd	368.0 b	
30-May-18	2590	ripening	908.3 a	359.3 bc	549.0 a	
6-Jun-18	2827	swathing	847.2 ab	316.0 cd	279.0 b	252.1

† Pods included developing seeds through the 30 May sampling but were separated from seeds for the 6 June sampling.
‡ Values within a column followed by the same letter are not different at α=0.05.

Table 2.6. Tests of significance for plant density effect on dry matter accumulation at each sample date in the Surefire experiment near Manhattan, KS in 2018.

Date	Total plant	Vegetative	Pod	Seed
	probability of > F			
12-Apr-18	0.0082			
19-Apr-18	0.0028			
26-Apr-18	0.0535			
3-May-18	0.0092	0.0093	0.0334	
10-May-18	0.0020	0.0025	0.0058	
16-May-18	0.0067	0.0075	0.0054	
23-May-18	0.6620	0.5971	0.6390	
30-May-18	0.0115	0.0066	0.0227	
6-Jun-18	0.0309	0.0127	0.0322	0.1081
11-Jun-18	0.0555	0.0151	0.1275	0.2149

† Total plant and vegetative values were the same from 2 November until 26 April.

Table 2.7. Accumulation and partitioning of dry matter in the canola variety Surefire at high and low plant densities sampled near Manhattan, KS in 2018.

Date	Growing degree days	Developmental stage	Total plant		Vegetative		Pod†		Seed	
			High	Low	High	Low	High	Low	High	Low
			g m^{-2}							
12-Apr-18	1467	rosette	71.2 a‡	40.6 b	71.2 a	40.6 b				
19-Apr-18	1510	bolt	72.4 a	43.9 b	72.4 a	43.9 b				
26-Apr-18	1586	bloom	108.6	79.5	108.6	79.5				
3-May-18	1760	pod development	155.2 a	101.4 b	155.0 a	101.3 b	0.3 a	0.1 b		
10-May-18	1969	pod fill	298.4 a	160.9 b	283.6 a	156.3 b	14.8 a	4.6 b		
16-May-18	2165	mid-pod fill	388.3 a	169.8 b	304.1 a	146.8 b	84.8 a	21.0 b		
23-May-18	2369	pod fill	432.2	410.3	252.5	237.3	181.0	170.6		
30-May-18	2630	pod fill	521.6 a	361.4 b	259.4 a	180.2 b	262.2 a	181.2 b		
6-Jun-18	2867	ripening	534.2 a	387.3 b	245.1 a	173.5 b	171.3 a	121.9 b	121.9	88.8
11-Jun-18	3075	swathing	546.3	445.8	243.0 a	192.0 b	161.1	134.9	141.8	119.3

† Pods included developing seeds through the 30 May sampling but were separated from seeds for the 6 June and 11 June samplings.
‡ Values within a row and plant part grouping followed by different letters are significantly different for the different plant densities at α=0.05.

Table 2.8. Tests of significance for dry matter response to variety, density, and their interactions for the Surefire-Wichita experiment conducted near Manhattan, KS in 2019.

	Total plant			Vegetative†			Pod			Seed		
Date	Variety	Density	Variety x density	Variety	Density	Variety x density	Variety	Density	Variety x density	Variety	Density	Variety x density
	probability of > F											
2-Nov	0.0320	0.0320	0.0447									
17-Dec	0.2347	0.0668	0.6811									
22-Mar	0.3399	0.0313	0.4544									
5-Apr	0.3308	0.0915	0.7348									
12-Apr	0.6500	0.2592	0.5776									
19-Apr	0.6764	0.3006	0.4093									
26-Apr	0.5951	0.9327	0.9902	0.6163	0.9603	0.9590	0.1447	0.1246	0.0905			
2-May	0.1013	0.9735	0.2261	0.1321	0.8609	0.1833	0.0271	0.101	0.1976			
9-May	0.5513	0.9236	0.2254	0.4606	0.537	0.1346	0.5524	0.0066	0.1350			
15-May	0.4148	0.9067	0.4495	0.3722	0.4279	0.3289	0.5661	0.2087	0.8300			
22-May	0.8402	0.0914	0.4775	0.7508	0.3220	0.3115	0.9273	0.0115	0.9622			
29-May	0.3762	0.2249	0.6215	0.4181	0.3305	0.4756	0.3522	0.1440	0.5870	0.3197	0.1816	0.8364
5-Jun	0.5946	0.2242	0.6439	0.4720	0.5781	0.1957	0.7798	0.1587	0.8232	0.6050	0.0942	0.6381
12-Jun	0.6313	0.1909	0.2629	0.5039	0.3463	0.0962	0.7770	0.1443	0.4059	0.6556	0.1411	0.4313
17-Jun	0.3205	0.4301	0.1393	0.1717	0.3299	0.4242	0.6599	0.7549	0.0405	0.4249	0.4325	0.0794
24-Jun	0.6246	0.0369	0.4182	0.9741	0.0086	0.0988	0.5032	0.2095	0.9410	0.4628	0.0647	0.5989

† Total plant and vegetative values were the same from 2 November until 26 April.

Table 2.9. Date, variety, and plant density effects on accumulation and partitioning of dry matter in the Surefire-Wichita experiment across dates sampled near Manhattan, KS in 2019.

Main effect	Growing degree days	Developmental stage	Total plant		Vegetative		Pod†		Seed	
Date:			g m^{-2}							
2-Nov-18	760	fall rosette	87.2	h‡	88.3	h				
17-Dec-18	827	fall rosette	180.1	gh	181.2	g				
22-Mar-19	955	spring rosette	72.0	h	73.1	h				
5-Apr-19	1098	early bolt	118.1	h	119.2	h				
12-Apr-19	1229	bolt	182.1	gh	183.2	g				
19-Apr-19	1342	beginning bloom	267.2	g	268.3	f				
26-Apr-19	1482	pod development	390.3	f	389.1	de	1.5	f		
2-May-19	1557	pod fill	501.3	ef	485.6	ab	16.0	f		
9-May-19	1682	pod fill	572.5	de	493.6	a	79.2	e		
15-May-19	1799	pod fill	667.2	cd	478.3	ab	189.2	d		
22-May-19	1960	mid-pod fill	909.2	b	507.7	a	401.9	a		
29-May-19	2150	pod fill	745.3	c	431.6	bcd	219.9	d	92.8	d
5-Jun-19	2373	pod fill	1017.6	b	408.9	cd	325.2	b	282.5	c
12-Jun-19	2574	ripening	1310.3	a	468.8	abc	381.0	a	459.5	a
17-Jun-19	2733	swathing	1015.8	b	381.3	de	283.3	bc	350.1	b
24-Jun-19	2953	harvest	925.9	b	341.7	e	263.9	c	319.3	bc
Variety:										
Surefire			552.6		325.6		215.7		295.9	
Wichita			567.7		336.8		216.5		305.8	
Plant density:										
High			585.1	A	338.9		234.8	A	318.2	
Low			535.2	B	323.6		197.4	B	283.5	

† Pods included developing seeds through the 29 May sampling but were separated from seeds for the 5 June through 24 June samplings.

‡ Values within a column followed by the same letter are not different at α=0.05. Lowercase letters are used for date effects. Uppercase letters are used for plant density effects.

Table 2.10. Accumulation and partitioning of dry matter at high and low plant densities in the Surefire-Wichita experiment by date.

Date	Growing degree days	Developmental stage	Total plant High	Total plant Low	Vegetative High	Vegetative Low	Pod† High	Pod† Low	Seed High	Seed Low
			g m^{-2}							
2-Nov-18	760	fall rosette	98.1 a‡	78.9 b	98.1 a	78.9 b				
17-Dec-18	827	fall rosette	204.7	157.0	204.7	157.0				
22-Mar-19	955	spring rosette	86.0 a	58.1 b	86.0 a	58.1 b				
5-Apr-19	1098	early bolt	132.8	101.6	132.8	101.6				
12-Apr-19	1229	bolt	199.6	166.5	199.6	166.5				
19-Apr-19	1342	beginning bloom	290.6	246.8	290.6	246.8				
26-Apr-19	1482	pod development	393.3	388.9	390.1	387.5	3.2	1.4		
2-May-19	1557	pod fill	501.6	502.8	482.2	488.6	19.3	14.1		
9-May-19	1682	pod fill	575.9	571.9	481.5	507.1	94.4 a	64.2 b		
15-May-19	1799	pod fill	663.5	673.4	454.2	501.7	209.3 a	171.9 b		
22-May-19	1960	mid-pod fill	988.4	827.1	536.5	478.1	451.9	344.9		
29-May-19	2150	pod fill	815.7	679.5	461.1	405.3	246.5	195.3	108.2	79.7
5-Jun-19	2373	pod fill	1084.1	941.8	420.0	395.2	351.3	298.9	312.8	246.9
12-Jun-19	2574	ripening	1478.7	1143.4	508.7	428.2	436.5	327.1	533.5	388.2
17-Jun-19	2733	swathing	985.4	1049.5	363.9	399.1	281.5	287.3	340.0	362.6
24-Jun-19	2953	harvest	862.8 b	990.4 a	312.0 b	371.8 a	254.1	275.4	296.7	344.3

† Pods included developing seeds through the 29 May sampling but were separated from seeds for the 5 June through 24 June samplings.
‡ Values within a row and plant part grouping followed by different letters are significantly different for the different plant densities at α=0.05.

Chapter 3 - The effect of variety and plant density on nutrient accumulation and partitioning of winter canola in northeast Kansas

Abstract

Nutrient management is important for all crops because of the specific role each nutrient has in plant growth and development. An understanding of nutrient uptake and partitioning in winter canola (*Brassica napus* L.) can assist producers with their management decisions to improve their cropping systems. The objective of this study was to determine the pattern of nutrient accumulation and partitioning throughout the growing season for winter canola in northeast Kansas at both high and low plant densities with open-pollinated (OP) varieties that were bred in Kansas. Nutrient accumulation and partitioning was tracked over three growing seasons. There were two samplings that did not include any treatments, and two experiments that included plant density or plant density and variety treatments. These studies were conducted during the 2016-17, 2017-18, and 2018-19 growing seasons in Manhattan, Kansas. All plant nutrients accumulated slowly at spring green-up. The rate of accumulation increased during bolting and the beginning of bloom. There was a general decrease in the rate of accumulation after pod development. There was a plateau near the beginning of pod fill in the Surefire experiment. That plateau remained through swathing for nitrogen (N) and sulfur (S) accumulation. Phosphorus (P) accumulation decreased during ripening, and potassium (K) accumulation increased during ripening in the Surefire experiment. Iron (Fe) accumulation peaked during bloom and early pod fill, then decreased and plateaued until the end of the season. In the Wichita sampling and the Surefire-Wichita experiment, N, P, and S accumulation rates remained the same or increased from pod development to early pod fill, then followed the study-specific DM accumulation trends. Peak plant N, P, and S accumulation occurred near the beginning of ripening. Potassium

accumulation peaked during ripening. Nutrient accumulation began to decrease before the middle of pod fill, which means the nutrients were mobilized to other plant parts. There were differences between plant densities in nutrient accumulation at some sampling dates, and typically the high plant density had more nutrient accumulation than the low density. The OP winter canola varieties performed similarly. Nutrient accumulation tended to follow DM accumulation suggesting plant DM is important to nutrient accumulation and crop success.

Introduction

Nutrient availability is key to crop growth and development due to the specific role of each nutrient in plants. When only one nutrient is deficient within the plant, the effects can be devastating for the plant's physiology. In commercial production systems, producers understand the importance of ensuring that crops have enough nutrients throughout the growing season to optimize yield. They create nutrient management plans that suit their land and crops to improve yield (Grant and Bailey, 1993; Ma and Zheng, 2016). Each nutrient's role in the plant and nutrient content in different organs of the plant should be understood to further understand seed yield formation and make effective crop management decisions (Grant and Bailey, 1993; Tamagno et al., 2017).

Some management decisions include seeding rate, row spacing, and genotype or variety selection. Wide row spacing versus narrow row spacing studies in canola (*Brassica napus* L.) have concluded in mixed yield results. Some spring canola studies showed seed yield was the same at narrow and wide rows, while other data determined yield increased at narrower row spacings when compared to wide row spacings (Johnson and Hanson, 2003; Kutcher et al., 2013; Morrison et al., 1990; Wysocki and Sirovatka, 2009). There are also mixed results from canola seeding rate studies. Spring canola studies have found no difference in yields at high and low seeding rates (Kutcher et al., 2013), a general yield increase with increasing seeding rate (Brandt et al., 2007), and yield decreases at increased seeding rates (Morrison et a., 1990). Winter canola adds complexity to choosing an optimum seeding rate due to the potential for winter kill and more time for yield compensation. Winter survival tends to increase with decreased seeding rate (Showalter and Roozeboom, 2017; Young et al., 2013). However, there is not a clear trend of seeding rate effect on seed yield (Young et al., 2013). Seeding rate and row spacing determine how close plants are to each other in the field (Kutcher et al., 2013). Increased plant density increases competition for resources like nutrients, and this can affect plant biomass and seed yield (Zhang and Flottmann, 2016). Wang et al. (2015) determined dry matter production was limited and nutrient uptake was decreased in direct seeded winter oilseed rape when nutrient deficiency treatments were imposed. The seedling stage was affected, and plant tolerance of winter conditions was decreased, so winter survival was decreased. Poor vegetative growth negatively affected yield formation, this in addition to poor stands decreased seed yield (Wang et al., 2015). Genetics play an important role in the performance of plants. Canola hybrids tend to be more vigorous and put on biomass quicker than canola OP varieties. This allows spring canola to grow tall with robust biomass, which can lead to increased yields as long as conditions are ideal (Kutcher et al., 2013; Smith et al., 2010). In the southern Great Plains where winter canola is grown, early growth is not always advantageous. Too much fall growth can lead to greater rates of winter kill and the hybrids will perform similarly to OP varieties that do not grow as quickly in the fall as hybrids (Showalter and Roozeboom, 2017; Stamm and Ciampitti, 2015). A spring canola study determined yield was increased for hybrids when compared to OP varieties. Seed yield response was the same for both genotypes regarding P. However, more N is needed for hybrids due to increased yields. There were inconsistent hybrid and OP variety responses to S and they had low significance (Smith et al., 2010). Variety selection is important for determining the nutrient requirements that will improve plant performance and seed yield.

Nitrogen (N), phosphorus (P), potassium (K), sulfur (S), calcium (Ca), and magnesium (Mg) are macronutrients that are needed in large quantities and make up more than 0.5% by weight of plant dry matter (MacAdam, 2009). These nutrients are used in proteins and chlorophyll, energy transfer, physiological activities, cell integrity, and many other functions

(Grant and Bailey, 1993). A deficiency in any of these nutrients can lead to poor seed yield formation and seed quality (Grant and Bailey, 1993; Ma and Zheng, 2016). Nitrogen deficiency results in small plants and decreased vegetative growth, which in turn decreases total dry matter accumulation. Decreased dry matter means less assimilates and nutrients that can be translocated, and poor pod and seed growth is the result (Wang et al., 2015). Phosphorus deficiency also causes plants to be small and yield components like pods per plant, seeds per pod, and seed weight to be negatively affected (Grant and Bailey, 1993; Wang et al., 2015). Grant and Bailey (1993) and Wang et al. (2015) agree that canola plant growth is poor when K is deficient, but not to the same extent as with a N or P deficiency. Sulfur deficiency can lead to plant discoloration, delayed flowering, and small pods. Calcium and Mg deficiencies decrease cell integrity and enzyme activity, respectively (Grant and Bailey, 1993). Macronutrients have many roles in plant structure and physiology, and deficiencies can reduce plant growth. A soil fertility summary from 2010 described changes in soil tests from 2005 to 2010. It showed that the median Bray P1 soil test levels in Kansas were at 18 parts per million (ppm) in 2010, which is lower than the critical level of 20 ppm. It had dropped three ppm since 2005 (Fixen, 2010). The median K test level in Kansas was 274 ppm in 2010, but it had decreased by 20 ppm since 2005. These values are still well above the critical value, which in this summary ranged from 120 to 200 ppm based on the location of the soil samples (Fixen, 2010). The most soil samples with low S were from the Corn Belt and central Great Plains. Fourteen percent of the soil samples from Kansas tested lower than three ppm S in 2010. This low amount of S could be due the concern for cleaner. With less polluted air in recent years there has been less S deposition. This combined with the continued crop removal of S has led to decreased amount of soil S (Camberato and Casteel, 2017). There was a decreasing amount of these macronutrients from 2005 to 2010, which means there was less available for plant uptake (Fixen, 2010). If this trend continues, producers will need to apply more nutrients to their soils to maintain productivity and crop performance.

The micronutrients that are needed in trace amounts in plants and make up less than 0.5% by weight of plant dry matter include iron (Fe), boron, chlorine, copper, manganese, molybdenum, nickel, and zinc (MacAdam, 2009). Grant and Bailey (1993) noted that canola seed set is reduced when boron is deficient. Copper is used in several enzymes, so a deficiency can cause larger than normal leaves and compressed flower inflorescence (McAndrew et al., 1984). A molybdenum deficiency can result in reduced branches per plant, pods per plant, length of pods, seeds per pod, thousand seed weight, and yield. Zinc is used for synthesis of indole acetic acid, which is involved with canola rosette growth and leaf size. A deficiency can cause changes in the rosette and reduced leaf size (Grant and Bailey, 1993). Iron is involved in chlorophyll synthesis, when it is deficient plant chlorosis can reduce crop profitability. Deficiencies in Fe are exacerbated in high pH soils and semi-arid regions because the Fe speciation causes there to be less plant available Fe in those soils (Ferreira et al., 2019; Jiménez et al., 2019). Although they are not needed in large amounts, micronutrients are important to plant growth, development, and yield potential.

Nutrient availability and uptake are critical to support plant growth, but it is also important to understand nutrient translocation to different plant organs to determine harvest index. Tamagno et al. (2017) suggest an improvement in nutrient accumulation and partitioning as it relates to seed-to-stover nutrient ratios in soybean plants is necessary to continue to increase seed yield and harvest index. The authors reported that the amount of N in vegetative material at beginning pod was correlated to the proportion of N partitioned to seeds at maturity. With a greater harvest index, the plants were limited in their ability to partition P from stover to seed

(Tamagno et al., 2017). Although nutrient uptake and translocation in soybean are well understood, the pattern is still unclear in winter canola.

The objective of this study was to determine the pattern of nutrient accumulation and partitioning throughout the growing season for winter canola in northeast Kansas at high and low plant populations and with OP varieties. Our hypothesis was that nutrient accumulation would start slowly in the fall rosette stage. Accumulation will increase quickly from bolting to pod filling, then accumulation will slow through ripening. The nutrients will begin to translocate from vegetative material to pod and seed material from pod set through the ripening stages. Due to the decreased amount of dry matter accumulated in the low plant density, there will be a decreased amount of nutrients in a given area at a low plant density than in a high plant density. The varieties will accumulate and partition nutrients similarly, because both winter canola varieties were bred in Kansas.

Materials and Methods

Samplings and experiments were conducted in the 2017-18 and 2018-19 growing seasons near Manhattan, Kansas at the Kansas State University (KSU) Agronomy Research Farms. The 2017-18 sampling and experiment were located at the Ashland Bottoms facility (39.124666, -96.613971). The 2018-19 experiment was located at the Agronomy North Farm facility (39.205511, -96.595507). The Köppen-Geiger climate classification maps placed these locations in the Dfa class. This class is described as a hot-summer humid continental climate with a cold continental group, without dry season precipitation type, and a hot summer heat level (Beck et al., 2018; Kottek et al., 2006). However, this region is geographically close to a Cfa classification, which is a humid subtropical climate (Beck et al., 2018). The Manhattan area has a mean annual maximum temperature of 19.6°C (67.2°F), a minimum of 5.9°C (42.6°F), and average annual rainfall of 90.4 cm (35.59 in.) (US Climate Data, 2019).

Two OP winter canola varieties were used in these studies, and both were developed at Kansas State University in Manhattan, Kansas. The Wichita (Rife et al., 2001) variety is classified as a medium maturity variety, and the Surefire (Stamm et al., 2019) variety is classified as a medium-to-full maturity variety. Different varieties were used because they were readily available at the time. Hereafter, the studies are referred to by the variety used and the type of study: the Wichita sampling in 2017-18, the Surefire experiment in 2017-18, and the Surefire-Wichita experiment in 2018-19. The Wichita sampling was located at Ashland Bottoms, the Surefire experiment at Ashland Bottoms, and the Surefire-Wichita experiment at the North Farm. The Wichita sampling was a sampling study with one variety at a consistent seeding rate. The Surefire experiment included one variety at high (294,000 plants ha^{-1}; 119,000 plants ac^{-1}) and low (142,000 plants ha^{-1}; 57,500 plants ac^{-1}) plant populations. These populations were established by hand thinning half of the plots, randomly selected within each replication, to half of the established spring stand. The Surefire-Wichita experiment included the Surefire and Wichita varieties at high (741,000 plants ha^{-1}; 300,000 plants ac^{-1}) and low (370,500 plants ha^{-1}; 150,000 plants ac^{-1}) seeding rates. The spring stands were 558,000 plants ha^{-1} and 378,600 plants ha^{-1}. The plant densities in the Surefire experiment were determined by using an already established winter canola stand and then hand-thinning. The plant densities in the Surefire-Wichita experiment were planted at those densities. Due to the differences in how the plant densities were determined, each experiment had different ranges of high and low densities. However, the recommended seeding rate for OP varieties in the southern Great Plains is 300,000 to 500,000 seeds ac^{-1} (Bushong et al., 2018).

All studies were planted on silt loam or silty clay loam soils (USDA Web Soil Survey, 2019). The Wichita sampling was located on a Rossville silt loam, very rarely flooded, fine-silty, mixed, superactive, mesic Cumulic Hapludoll with 18 to 35% clay and 0 to 20% sand (USDA Web Soil Survey, 2019) soil type. The Surefire experiment was located on a Belvue silt loam, rarely flooded, coarse-silty, mixed, superactive, nonacid, mesic Typic Udifluvent with 5 to 18% clay and 15 to 75% sand (USDA Web Soil Survey, 2019). The Surefire-Wichita site was a Wymore silty clay loam, 1 to 3% slopes, eroded, fine, smectitic, mesic Aquertic Argiudoll with 42 to 55% clay and 0 to 5% sand (USDA Web Soil Survey, 2019).

The equipment used for field operations remained the same across studies. The planter was shop-fabricated with Great Plains 00HD (Great Plains Ag, Salina, KS) row units and Wintersteiger small belted cones (WINTERSTEIGER Inc., Salt Lake City, Utah). The rows were 25.4 cm (10 in.) apart in all three studies. Each plot was six rows wide. All studies were swathed with a 3.66 meter (m) (5 foot (ft.) plot swather (Swift Machine and Welding Ltd. Swift Current, SK, Canada) and combine harvested with a Massey Ferguson 8XP plot combine (Kincaid Manufacturing, Haven, KS). This combine was equipped with a Harvest Master Classic GrainGage (Juniper Systems Inc., Logan, UT) and Mirus 3.1 (Juniper Systems Inc., Logan, UT) software.

Crop management practices were implemented to assure success of these studies in field conditions. Seedbed preparation for the Surefire-Wichita experiment included mechanical tillage with a tandem disk and field cultivator to incorporate trifluralin that was applied by a SpraCoupe sprayer (AGCO, Duluth, GA). The Surefire experiment and the Wichita sampling had the same field preparation but were also roller packed to create a firm seedbed. Trifluralin was applied by a RoGator (AGCO, Duluth, GA) for those studies. Nitrogen, phosphorus, and sulfur fertilizers were applied according to KSU winter canola management recommendations and soil test results for each location (Table 3.1). The plots were monitored for weed competition throughout each growing season, and herbicides were applied as needed (Table 3.1). All in-season herbicide applications and spring nitrogen applications were applied with a 110 gallon three-point sprayer (Ag Spray Equipment Inc., North Sioux City, SD) equipped with Chafer stream bars (Needham Ag Technologies, Calhoun, KY). The study areas were also hand weeded at spring green-up if needed. The most prevalent weeds were volunteer wheat (*Triticum aestivum*), blue mustard (*Chorispora tenella*), and horseweed (*Conyza canadensis*). Other field operations and details are presented in Table 3.1.

The Surefire and Surefire-Wichita experiments had similar treatment structures and sampling schemes. Each whole plot was divided into a large machine-harvest subplot and several small biomass-sample subplots. The dimensions differed in each experiment due to bordering considerations or other constraints (Table 3.2). In the Surefire experiment, two biomass subsamples were taken from each biomass-sample subplot. Due to the amount of time required to process fresh samples and labor limitations the number of subsamples were reduced in the Wichita sampling and Surefire-Wichita experiment to one biomass sample from each biomass-sample subplot. The sample area of 0.84 m^2 (9 ft^2) remained consistent across all experiments to align with National Crop Insurance Services (NCIS) canola yield estimation procedures. The Wichita sampling was conducted within OP and hybrid variety yield trials (Stamm and Dooley, 2019). Wichita was planted in the borders of the trials, and each trial included three Wichita plots randomly located in each block. The trial plots were used to determine machine-harvest seed yield. Bordered biomass-sample subplots were randomly located and replicated by block in the trial borders for this sampling.

Biomass samples were collected on a weekly or biweekly basis from the biomass sample subplots from spring green-up until swathing. In the Surefire-Wichita experiment, additional biomass samples were collected in the fall and at swathing. The final biomass samples for the Surefire-Wichita experiment were cured in a greenhouse for one week to simulate field swathing conditions. For all studies, plant number, height, developmental stage, and fresh weight were noted in the field at each sample date. Samples were transported to the laboratory where pods were separated from leaf and stem material, and pod number and fresh pod weight were recorded. Subsamples of vegetative matter and pod matter were placed in a forced-air dryer for a minimum of four days at 60°C before dry subsample weights were recorded. At later sample dates, the pod samples were threshed using a small BT14 model ALMACO belt thresher (Nevada, IA) to determine seed volume, weight, and thousand seed weight. Pods were only threshed when the seed was mature and hard enough to be separated from the pod material. Samples could be threshed from the last one or two sample dates in the Surefire and Wichita studies. The last five sampling dates in the Surefire-Wichita experiment were threshed. In some cases, there was too much plant material to process in a timely manner, and a subsample was processed in the laboratory. In the Surefire experiment, if there were more than 20 plants per sample, only 20 plants were kept to process. In the Wichita sampling and Surefire-Wichita experiment, if there were more than 30 plants per sample, 30 plants were kept to process. Different plant numbers were used because the Surefire plant populations were lower, and the plants were larger than the plants were in the Wichita and Surefire-Wichita studies. More plants were needed in the Wichita and Surefire-Wichita studies to ensure enough plant dry matter for nutrient analysis. Additional data collected to characterize canopy architecture in the Surefire, Wichita, and Surefire-Wichita studies were: average branch count, raceme length, average pod count on the main raceme, and the representative length of pods in the bottom, middle, and top of the pod canopy.

The separation of vegetative matter from pod matter and pod matter from seed matter facilitated analysis of nutrient accumulation and partitioning throughout the growing season. After dry weight of each sample was recorded for the Surefire, Wichita, and Surefire-Wichita studies, the biomass was ground with a Model 4 Wiley Mill (Swedesboro, NJ) to a maximum particle size of two millimeters. Seed samples from the Surefire-Wichita experiment were ground using a UDY Cyclone Sample Mill (Fort Collins, CO). A representative subsample was kept for nutrient analysis. The samples were analyzed by Waters Agricultural laboratories in Camilla, GA using an Inductively Coupled Argon Plasma Emission Spectrophotometer/Vacuum (ICP) and a DigiBloc 3000 (SCP Science, Baie-D'Urfe, Quebec, Canada) to perform open vessel wet digestion. Nutrients that were analyzed included nitrogen, phosphorus, potassium, magnesium, calcium, sulfur, boron, zinc, manganese, iron, and copper. Only nitrogen, phosphorus, potassium, sulfur, and iron results were summarized. The nutrient uptake and accumulation data were analyzed using SAS 9.4 (SAS Institute, Cary, NC). Analysis of Variance (ANOVA) was performed using PROC GLIMMIX. The Wichita sampling data was analyzed with sample date as a fixed effect with repeated measures. The Surefire experiment data were analyzed with sample date and plant density as fixed effects with repeated measures. Sample date, plant density, and variety were fixed effects with repeated measures in the Surefire-Wichita experiment. Both the Surefire and the Surefire-Wichita experiments were also analyzed by date with plant density and variety as fixed effects. Growing degree days (GDD) were calculated for each season from the planting dates to standardize the growing seasons. The equation for daily GDD in °F was

$$\text{GDD} = \left(\frac{\text{maximum daily temperature} + \text{minimum daily temperature}}{2}\right) - 41.$$

Results

Nitrogen accumulation and partitioning

Plant

The general trend for total plant N accumulation was similar to the plant dry matter accumulation pattern. Nitrogen accumulated quickly from bolt until the beginning of pod fill (Table 3.3). Then in the Wichita sampling, accumulation continued to increase until the middle of pod fill and plateaued for the remainder of the season. One hundred percent of N was reached at the beginning ripening, 6 June (Figure 3.1, Table 3.4). In the Surefire experiment, after pod fill began, N accumulation plateaued through the rest of the growing season. Plant N accumulation in the fall started quickly in the Surefire-Wichita experiment. Nitrogen was lost over the winter, so in the spring N levels were lower than they were in the fall. Nitrogen accumulated until the first half of pod fill, then it decreased for one sampling date. Plant nitrogen accumulation peaked during ripening between 5 June and 12 June (Figure 3.4, Table 3.6).

Across dates, there was a plant density effect on total plant N accumulation in the Surefire experiment, but not in the Surefire-Wichita experiment. Plant N accumulation in the Surefire experiment at the high plant density increased from spring green-up until ripening began where it peaked, then decreased and plateaued until swathing. The low plant density accumulated N until the second half of pod fill, then it plateaued until swathing on 11 June. Nitrogen accumulation in the low plant density started at a similar pace to the high density, but slowed soon after pod fill began and leveled off, then it increased quickly to its peak. The high plant density had more N accumulation than the low density at each date density was significant. There was no difference in plant N accumulation at swathing (Figure 3.2, Figure 3.3, Table 3.5). The high plant density in the Surefire-Wichita experiment had a greater amount of N accumulation at spring green-up than the low density, but the low density had a greater amount of plant N accumulation at harvest than the high plant density. Those were the only times there were differences in N accumulation between the densities. There was a variety x density interaction across dates (Table 3.3). At the first fall sampling date the Wichita variety at the high plant density had greater N accumulation than Surefire at the high density and Wichita at the low density.

Vegetative

Vegetative N generally accumulated from spring green-up until soon after pod development, then it would steadily decrease until the end of the season. In the Wichita sampling, N increased quickly and peaked after pod fill began at 42% of the total N accumulated. Then it plateaued briefly, decreased rapidly, plateaued again, and decreased again at swathing (Figure 3.1, Table 3.4). In the Surefire experiment across plant densities, N accumulated until pod fill began where it peaked at 70% of total N accumulated. Then it decreased until ripening and increased at harvest. In the Surefire-Wichita experiment, N increased in the fall, and decreased during the winter. Nitrogen accumulated quickly from spring green-up until just before the end of bloom where it reached its maximum at 52% of total N accumulation. Then it steadily decreased until harvest (Figure 3.4, Table 3.6).

Plant density across dates affected vegetative N accumulation in the Surefire experiment, but not in the Surefire-Wichita experiment. Both densities in the Surefire experiment followed the same trend of increasing in N until pod development, then it steadily decreased and plateaued until swathing. Again, the high plant density accumulated more N than the low density in the Surefire experiment when there was a significant difference at a sampling date. There were no differences from the end of pod fill to swathing (Figure 3.2, Figure 3.3, Table 3.5). In the

Surefire-Wichita experiment, there was a difference in N accumulation between the densities on three sampling dates. The high plant density had more N at the first fall sampling than the low density, and the low plant density had more N at swathing and harvest than the high density. There was also a variety x density interaction at fall sampling, during ripening, and harvest (Table 3.3). Wichita at the high density had more N than Surefire at the high density and Wichita at the low density at the first fall sampling and during ripening. Surefire at the low density accumulated more N than Wichita at the high density and Surefire at the high density.

Pod

Generally, pod N accumulation increased until the end of pod fill, then decreased until harvest. In the Wichita sampling it increased quickly until ripening, then it increased at a slower rate to its maximum, 70% of total N accumulated, and decreased quickly at swathing (Figure 3.1, Table 3.4). Pod N accumulation in the Surefire experiment increased from pod development to the middle of pod fill, then the accumulation rate slowed until ripening. After ripening began, N accumulation decreased quickly until swathing. From pod development until the middle of pod fill, N accumulation increased quickly in the Surefire-Wichita experiment, then it decreased quickly after bloom ended. Nitrogen began to accumulate again until ripening began, then it steadily decreased until harvest. The maximum amount of N the pods accumulated was at the middle of pod fill when it was 40% of total N accumulation (Figure 3.4, Table 3.6).

Density did affect pod N accumulation in the Surefire and Surefire-Wichita experiments across dates (Table 3.3). When there was a difference between the high and low plant densities in the Surefire experiment, the high plant density accumulated more N at particular sample dates. The peak accumulation was during ripening at 50 to 60% of total N accumulated. There was no significant difference between plant densities in pod N accumulation at swathing (Figure 3.2,

Figure 3.3, Table 3.5). In the Surefire-Wichita experiment, pod N accumulation was different between densities at three sampling dates. At early and mid-pod fill, the high density had more N accumulated than the low density. At harvest, the low plant density accumulated a greater amount of N than the high density. There was also a date x density interaction for both experiments, but no variety effect or other interactions (Table 3.3).

Seed

Due to the differing number of seed samples in each study, it was difficult to illustrate a general seed N accumulation trend. In the Surefire experiment, there was no date or density effect or a date x density interaction across sampling dates (Table 3.3). For the Surefire-Wichita experiment, seed N increased quickly from the middle of pod fill until after ripening began, then it decreased steadily until harvest. The maximum seed N accumulation was 60% of the total N accumulated after ripening began (Figure 3.4, Table 3.6). At the harvest sampling date, the low plant density accumulated more N than the high density.

At swathing, 17% of the plant N was allocated to vegetative material, 17% to pod material, and 66% was in the seed in the Wichita sampling. In the Surefire high plant density, 40% of plant N was in vegetative material, 16% in pod material, and 44% in the seed. In the Surefire low plant density treatment, N was partitioned 35, 16, and 49% to the vegetative, pod, and seed material, respectively. Across treatments in the Surefire-Wichita experiment at harvest, 24, 13, and 63% of plant N was partitioned to vegetative, pod, and seed material, respectively.

Phosphorus accumulation and partitioning

Plant

Plant P accumulation followed a similar trend to plant DM accumulation pattern. Phosphorus accumulation generally increased until the middle of pod fill, then plateaued and decreased at the end of the season (Table 3.7). In the Wichita sampling, P increased from spring green-up until the middle of pod fill and plateaued until swathing. The peak of P accumulation occurred at swathing, 6 June (Figure 3.5, Table 3.8). In the Surefire experiment across densities, P steadily accumulated from green-up until the second half of pod fill when it plateaued. Then, P decreased at swathing (Figure 3.6, Figure 3.7, Table 3.9). Phosphorus in the Surefire-Wichita experiment accumulated in the fall, then decreased over the winter. It began to accumulate again from spring green-up until the middle of pod fill, and at half bloom the rate of P accumulation increased. The amount of P decreased in the second half of pod fill, then increased again until ripening began when it peaked on 12 June. Then, it decreased until harvest (Figure 3.8, Table 3.10).

There was a density effect on plant P accumulation across dates in the Surefire and Surefire-Wichita experiments (Table 3.7). In the Surefire experiment, both plant densities accumulated P at a similar rate until pod development, then the high density increased the rate of P accumulation while the low density slowed accumulation. The high plant density leveled off after pod fill began, and reached its peak of 1.84 g m^{-2} in the second half of pod fill, 30 May. The low density P accumulation plateaued in the beginning of pod fill, then increased quickly to its maximum of at the same time as the high plant density. Phosphorus decreased at harvest for both densities. There were many instances throughout the season where there were differences in plant P accumulation between the high and low densities, and the high density had a greater amount of P than the low density (Figure 3.6, Figure 3.7, Table 3.9). In the Surefire-Wichita experiment, the high plant density had greater plant P accumulation at spring green-up than the low density. At harvest, the low density had a greater amount of P than the high density. There was also a variety x density interaction at the first fall sampling date and at pod development, 3

May (Table 3.7). Wichita at the high density accumulated more P than Surefire at the low density, Wichita at the low density, and Surefire at the high density. At pod development, the Surefire variety at the low density and the Wichita variety at the high density had greater P accumulation than the Wichita variety at the low density.

Vegetative

All the studies followed a similar trend to N accumulation for vegetative P accumulation. Phosphorus increased until pod development, then it steadily decreased and plateaued at the end of the season. In the Wichita sampling, vegetative P accumulation peaked during pod development on 3 May and made up 50% of the total P accumulated (Figure 3.5, Table 3.8). Phosphorus accumulation in the Surefire experiment across plant densities increased until the beginning of pod fill, then decreased and leveled off through plant ripening. In the Surefire-Wichita experiment across treatments, P increased until it reached its peak, 35% of total P accumulated, at the beginning of pod fill, then it decreased and plateaued briefly through the end of bloom. Then, P continued to decrease in vegetative material until ripening when it leveled off again for the rest of the season (Figure 3.8, Table 3.10).

There was a density effect on vegetative P accumulation in the Surefire experiment, but not the Surefire-Wichita experiment (Table 3.7). When there was a difference in the Surefire experiment densities by date, the high density had more P than the low density, and there was no difference between the densities at swathing. The high density reached its peak P accumulation at the beginning of pod fill on 10 May, making up 80% of the total P accumulated. The low density reached its maximum at the same time, making up 50% of total P accumulated (Figure 3.6, Figure 3.7, Table 3.9). In the Surefire-Wichita experiment, the high density had more P accumulated at spring green-up than the low density. There was also a variety x density interaction at the first fall sampling, pod development, and during ripening (Table 3.7).

Pod

For all these studies pod P accumulation increased until the seed was separated from the pods. Pod P accumulation increased quickly in the Wichita sampling until ripening began, then it decreased quickly at swathing. Its peak occurred as ripening began on 30 May when it made up 75% of total P accumulated (Figure 3.5, Table 3.8). The Surefire experiment increased pod P until the end of pod fill when it plateaued and peaked before decreasing during ripening. In the Surefire-Wichita experiment, pod P accumulation increased at the end of bloom and decreased steadily and plateaued at swathing and harvest (Figure 3.8, Table 3.10).

Density had an effect on pod P accumulation across sample dates in the Surefire and the Surefire-Wichita experiments (Table 3.7). The Surefire high and low densities reached their peak at the beginning of ripening. Pod P accumulation at the high density in the Surefire experiment was significantly greater than the low density during the beginning of pod fill (Figure 3.6, Figure 3.7, Table 3.9). In the Surefire-Wichita experiment, both densities reached their peak at the end of bloom. The high plant density accumulated more pod P than the low density at the beginning of pod fill and in the middle of pod fill.

Seed

The seed P in the Wichita sampling was only determined at swathing, and it made up 60% of the total P accumulated (Figure 3.5, Table 3.8). In the Surefire experiment, seed P decreased from ripening to swathing. Seed P accumulation increased quickly from the end of bloom to its peak after ripening began on 12 June, then it decreased and plateaued at swathing and harvest. There was a density effect on seed P across sample dates in the Surefire-Wichita experiment, but not the Surefire experiment (Figure 3.8, Table 3.7). Both plant densities in the Surefire experiment reached their maximums during ripening. There was no difference between the densities at either sample date (Figure 3.6, Figure 3.7, Table 3.9). In the Surefire-Wichita experiment, both densities reached their seed P peaks during ripening, and there were no differences between the densities at any particular sampling dates.

In the Wichita sampling, 14% of P was partitioned to the vegetative material at swathing. The pod material had 24% of the P, and the seed accumulated 62% of P at swathing. In the Surefire experiment, the high plant density had accumulated 36, 28, and 36% of the P in vegetative, pod, and seed material, respectively, at swathing. At the low density in the Surefire experiment, P was partitioned to the vegetative, pod, and seed material at 35, 31, and 34%, respectively. In the Surefire-Wichita experiment at harvest, 15, 7, and 78% of the P had been portioned to the vegetative, pod, and seed material, respectively.

Potassium accumulation and partitioning

Plant

Plant K accumulation followed a similar pattern to the plant DM accumulation. Plant K accumulation started slowly in the Wichita sampling, and the accumulation rate increased when pod fill began on 3 May. Plant K accumulation increased until the middle of pod fill, 16 May, when it plateaued briefly, increased to its peak, and leveled off during ripening until swathing (Figure 3.9, Table 3.12). Across plant densities in the Surefire experiment, plant K accumulation started slowly, and increased more quickly around the time of pod development. Then it leveled off briefly at the beginning of pod fill on 3 May before increasing to its peak at swathing. Similar to N and P accumulation, plant K accumulation in the Surefire-Wichita experiment increased during the fall, decreased over the winter, and increased quickly from spring green-up to the beginning of pod fill. Then plant K plateaued and increased through the first half of pod fill. Plant K decreased in the middle of pod fill, then increased to its maximum during ripening on 12 June, and decreased again through swathing and harvest (Figure 3.12, Table 3.14).

There was a density effect for the Surefire and Surefire-Wichita experiments across sampling dates (Table 3.11). Both plant densities in the Surefire experiment increased in plant K until swathing on 11 June. There were several sample dates in the Surefire experiment when the high plant density accumulated more K than the low density, but there was no difference between the densities at swathing (Figure 3.10, Figure 3.11, Table 3.13). In the Surefire-Wichita experiment, both plant densities reached their peaks during ripening on 12 June. The high plant density accumulated more K at spring green-up than the low density. The low density accumulation more K at harvest than the high density. There was a variety x density interaction on the first sampling date in the fall where Surefire at the low density accumulated more K than Surefire at the high density (Table 3.11).

Vegetative

In all of these studies, vegetative K accumulation started slowly and reached its peak during early to mid-pod fill. In the Wichita sampling, the maximum amount of K in vegetative material was at the beginning of pod fill on 10 May when vegetative material made up 88% of the total K accumulated. Near the end of pod fill, vegetative K decreased quickly, then plateaued through swathing (Figure 3.9, Table 3.12). Vegetative K accumulation in the Surefire experiment reached its peak soon after pod fill began on 10 May, then decreased slightly and leveled off through the rest of pod fill, then decreased and plateaued for the rest of the season. In the Surefire-Wichita experiment, K accumulated in the fall and decreased over the winter. However, K increased quickly from spring green-up to its peak at the beginning of pod fill on 9 May where it leveled off until the middle of pod fill. It decreased and plateaued in the second half of pod fill until harvest (Figure 3.12, Table 3.14).

Density affected vegetative K accumulation in the Surefire experiment, but not in the Surefire-Wichita experiment across dates (Table 3.11). At the high density in the Surefire experiment, K accumulated to its maximum soon after pod development began when it made up 70% of total K accumulated. The low density reached its peak near the middle of pod fill and it made up 55% of total K accumulated. When there were differences in K accumulation between the densities, the high density had more K than the low density. The high density had more K accumulated at swathing than the low plant density (Figure 3.11, Table 3.13). For the Surefire-Wichita experiment, the high density reached its peak at pod development while the low density reached its maximum in early pod fill. They both slowly decreased in vegetative K through harvest. There was also a variety x density interaction across dates (Table 3.11). At the first sample date in the fall, Surefire at the low density accumulated more K than Surefire at the high density.

Pod

For pod K accumulation in the Wichita sampling, it increased quickly from early pod fill to plant ripening on 30 May. It reached its maximum at ripening, making up 45% of total K accumulated (Figure 3.9, Table 3.12). Across the Surefire plant densities, K accumulated quickly until it peaked at ripening, then decreased and plateaued through swathing. The Surefire-Wichita pod K also increased quickly through the first half of pod fill, then it decreased briefly, and increased to its peak during ripening, and it made up 40% of total K accumulated. Then, K decreased and plateaued until harvest (Figure 3.12, Table 3.14).

Plant density affected K accumulation in the Surefire and Surefire-Wichita experiments across sampling dates (Table 3.11). Pod K accumulation was also affected by plant density at several dates in the Surefire experiment (Table 3.13). The high density accumulated more K than the low density whenever it was significant. There was a significant difference at swathing. Both densities followed the same pattern of increasing in pod K until its peak when ripening began, decreasing briefly, then slightly increasing again at swathing. In the Surefire-Wichita experiment, both plant densities reached their maximum K accumulation during ripening on 12 June. The high density had more K accumulated than the low density during the first half of pod fill, but there was no difference between the densities at harvest.

Seed

The seed K accumulation in the Wichita sampling at swathing was 3.63 g m^{-2}, making up 10% of total K accumulated (Figure 3.9, Table 3.12). Seed K accumulation increased through ripening to swathing in the Surefire experiment. In the Surefire-Wichita experiment, seed K increased from the middle of pod fill until after ripening began when it peaked, making up 15% of total K accumulated, then it decreased and plateaued until harvest (Figure 3.12, Table 3.14). Density had an effect on K accumulation across dates in the Surefire and Surefire-Wichita experiments (Table 3.11). In the Surefire experiment, the high plant density had greater K accumulation during ripening than the low density, but there was no difference between the densities at swathing. The high and low plant density seed K accumulations peaked at swathing when they made up 25% of total K accumulated (Figure 3.10, Figure 3.11, Table 3.13). In the Surefire-Wichita experiment, there was a difference between the densities at harvest. The low plant density accumulated more K than the high density.

At swathing, the Wichita sampling had 46, 36, and 18% of the accumulated K in vegetative, pod, and seed material, respectively. The vegetative, pod, and seed material in the Surefire experiment at swathing at the high plant density had 42, 31, and 27% of the K partitioned to them, respectively. At the low density, K was partitioned to the vegetative, pod, and seed material at 42, 30, and 28%, respectively. In the Surefire-Wichita experiment at harvest, K was partitioned at 50, 37, and 13% to the vegetative, pod, and seed material, respectively.

Sulfur accumulation and partitioning

Plant

Overall plant S accumulation followed a similar trend to that of plant DM accumulation. Plant S accumulation increased quickly in the Wichita sampling from spring green-up until early pod fill on 10 May, then the rate of S accumulation slowed until the second half of pod fill around 23 May. Then, the accumulation rate increased until after ripening began and plant S accumulation reached its maximum and leveled off through swathing (Figure 3.13, Table 3.16). In the Surefire experiment across plant densities, S accumulated from green-up until the second half of pod fill on 23 May. Sulfur accumulation plateaued and reached its peak at the beginning of ripening and at swathing. In the Surefire-Wichita experiment, plant S accumulated in the fall, but decreased over the winter. From spring green-up to half bloom, S accumulation increased quickly, then it slowed briefly until pod development. Sulfur continued to accumulate for the first half of pod fill, then it decreased in the middle of pod fill on 29 May, before increasing again. It reached its maximum during ripening before decreasing and leveling off during swathing on 17 June and harvest (Figure 3.16, Table 3.18).

Density had an effect on plant S accumulation in the Surefire and Surefire-Wichita experiments across dates (Table 3.15). In the Surefire experiment, the high density accumulated more S than the low density at all sampling dates. There was a difference in S accumulation between the plant densities at swathing. Both densities reached their peaks near the end of pod fill and plateaued until swathing (Figure 3.14, Figure 3.15, Table 3.17). The same pattern of accumulation occurred for both densities in the Surefire-Wichita experiment as well. They reached their maximums in late pod fill, then slightly decreased and plateaued until harvest. There was also a variety effect across dates in the Surefire-Wichita experiment, but not at any particular sampling date (Table 3.15).

Vegetative

Vegetative S accumulation increased across the studies through the first half of pod fill, then decreased through the rest of the season. In the Wichita sampling, S accumulation started slowly, then increased through the bolting stage until pod development when it reached its peak, making up 55% of total S accumulated on 10 May. After it peaked, S slowly decreased through swathing (Figure 3.13. Table 3.16). In the Surefire experiment, vegetative S accumulation increased steadily to its peak at pod development, making up about 75% of total S accumulated. Then it steadily decreased and leveled off through swathing. Sulfur began to accumulate in the fall for the Surefire-Wichita experiment, but it decreased over the winter. Vegetative S accumulation increased quickly from green-up until pod development on 2 May, then the rate of accumulation slowed through the first half of pod fill when it peaked, making up 50% of total S accumulated. Then, vegetative S decreased through plant ripening and plateaued until harvest (Figure 3.16, Table 3.18).

There was a density effect on vegetative S accumulation for the Surefire experiment, but not the Surefire-Wichita experiment (Table 3.15). Both plant densities followed the same pattern of S accumulation as the trend of S accumulation across densities in the Surefire experiment. The peak of the both densities was at pod development. The high plant density accumulated more vegetative S than the low density at most sampling dates, including the harvest date (Figure 3.14, Figure 3.15, Table 3.17). There was also a variety x density interaction at the first fall sample date and during ripening in the Surefire-Wichita experiment (Table 3.15). Wichita at the high density had more S than the Surefire at the low density, Surefire at the high density, and Wichita at the low density during the fall. During ripening, the Wichita variety at the high plant density accumulated more S than Wichita at the low density and Surefire at the high density.

Pod

Pod S accumulation peaked near the beginning of plant ripening in all of the studies. Accumulation occurred quickly in the Wichita sampling until S peaked during ripening, making up 55% of total S accumulated, then decreased at swathing (Figure 3.13, Table 3.16). Pod S accumulation increased steadily in the Surefire experiment until it plateaued and reached its peak in the second half of pod fill on 30 May, then it decreased and leveled off through ripening and swathing. In the Surefire-Wichita experiment, pod S accumulated quickly through the first half of pod fill, then it decreased in the middle of pod fill, then increased to its peak during ripening on 12 June when pod S made up 45% of plant S. After accumulation peaked, S decreased at swathing and leveled off through harvest (Figure 3.16, Table 3.18).

Plant density had an effect on S accumulation across sampling dates in the Surefire and Surefire-Wichita experiments (Table 3.15). In both experiments, the high and low plant densities followed the same S accumulation trends that were present in the overall pattern across treatments. In the Surefire experiment, the high and low densities reached their maximum S accumulations in the second half of pod fill. The high density accumulated more S in early pod fill and at swathing than the low density (Figure 3.14, Figure 3.15, Table 3.17). In the Surefire-

Wichita experiment, the high plant density had more S than the low density at most sampling dates, but there was no difference in accumulation at harvest.

Seed

Seed material in the Wichita sampling accumulated 1.31 g m^{-2} of S at swathing, which was 25% of total S accumulated (Figure 3.13, Table 3.16). In the Surefire experiment, S accumulation was not significantly different at ripening or swathing, and seed S made up about 25% of total S accumulation. Seed S accumulated quickly from the middle of pod fill to plant ripening in the Surefire-Wichita experiment. It peaked during ripening, making up 25% of total S accumulation, before decreasing and plateauing at swathing and harvest (Figure 3.16, Table 3.18). Plant density affected seed S accumulation across dates in the Surefire-Wichita experiment, but not the Surefire experiment (Table 3.15). In the Surefire-Wichita experiment, the low plant density had greater S accumulation than the high density at harvest. There was also a variety x density interaction at swathing where the Wichita variety at the low density accumulated more S than the Surefire variety at the low density.

Sulfur was partitioned to the vegetative, pod, and seed material at 25, 49, and 26%, respectively, at swathing in the Wichita sampling. At the high plant density in the Surefire experiment, vegetative material had 37, pod material had 37, and seed had 26% of the plant accumulated S at swathing. At the low density, vegetative, pod, and seed material had 34, 35, and 31%, respectively, of the accumulated S at swathing. In the Surefire-Wichita experiment, 36, 43, and 21% of S was partitioned to the vegetative, pod, and seed material, respectively at harvest.

Iron accumulation and partitioning

Plant

Sample date had a significant effect on plant Fe accumulation in all studies. Plant Fe accumulation followed a different trend than plant DM accumulation and other nutrient accumulation trends. Iron content tended to peak at the beginning of bloom or pod fill, then decrease for the remainder of the season. In the Wichita sampling, Fe accumulation peaked at the beginning of bloom, then decreased and leveled off from pod development until the end of the season (Figure 3.17, Table 3.20). In the Surefire experiment across plant densities, plant Fe accumulated quickly during bloom and peaked at pod development, then it decreased at the beginning of pod fill. It slowly increased again until the end of pod fill. Iron accumulation decreased at ripening and increased during swathing (Figure 3.18, Table 3.21). Across plant densities and varieties in the Surefire-Wichita experiment, Fe accumulation was low at the first fall rosette sampling, then it increased quickly and reached its maximum at the second fall rosette sampling. Plant Fe decreased quickly from spring rosette until pod development. It increased briefly during the early pod fill stages before decreasing in the middle of pod fill. Plant Fe slowly decreased through the end of pod fill and leveled off through harvest (Figure 3.19, Table 3.23).

There was a density effect on plant Fe accumulation in the Surefire experiment (Table 3.19). The high plant density had more Fe accumulated than the low plant density at four sample dates corresponding to the rosette, bolt, early pod fill, and swathing stages (Table 3.22).

Vegetative

Sampling date had a significant effect on vegetative Fe accumulation in all studies. Vegetative Fe in the Wichita sampling accumulated quickly from bolting to the beginning of bloom when it peaked, then it continuously decreased until swathing (Figure 3.17, Table 3.20). Across plant densities in the Surefire experiment, vegetative Fe increased to its maximum at the pod development stage, then it decreased and leveled off through pod fill. Iron accumulation decreased at ripening and increased at swathing (Figure 3.18, Table 3.21). Vegetative Fe reached its peak at the second fall rosette sampling stage, then it decreased until pod development across plant densities and varieties in the Surefire-Wichita experiment. During early pod fill, Fe increased briefly, then decreased and leveled off through harvest (Figure 3.19, Table 3.23).

There were also significant density and date x density interaction effects in the Surefire experiment (Table 3.19). The high plant density had more Fe accumulated than the low plant density at four sample dates corresponding to the rosette, bolt, early pod fill, and swathing stages (Table 3.22).

Pod

Sampling date had a significant effect on pod Fe accumulation in all studies (Table 3.19). In the Wichita sampling, pod Fe quickly increased through pod fill, peaking at ripening when it made up 29% of the total Fe accumulation, then decreased at swathing (Figure 3.17, Table 3.20). Across plant densities in the Surefire experiment, pod Fe increased from early pod fill until the end of pod fill when it peaked making up 23% of the total Fe accumulation. Iron decreased during ripening, then increased at swathing (Figure 3.18, Table 3.21). Pod Fe reached its maximum in the middle of pod fill when it made up 7% of the total Fe accumulated in the Surefire-Wichita experiment across plant densities and varieties. Then, it decreased and leveled off through harvest (Figure 3.19, Table 3.23).

Plant density had a significant effect in the Surefire and Surefire-Wichita experiments (Table 3.19). In the Surefire experiment, the high plant density had more Fe accumulated than the low plant density at three sampling dates throughout pod fill (Table 3.22). In the Surefire-Wichita experiment, the high plant density accumulated more pod Fe during the second half of pod fill than the low density (data not shown). There was also a variety x density interaction in the Surefire-Wichita experiment (Table 3.19). Wichita at the high plant density accumulated more iron than Surefire at the high density and Wichita at the low density on 29 May (data not shown).

Seed

Sampling date had a significant effect on seed Fe accumulation in the Surefire-Wichita experiment (Table 3.19). In the Wichita sampling, seed Fe was determined only at swathing when it made up 45% of the total Fe accumulated in that study (Figure 3.17, Table 3.20). In the Surefire experiment across plant densities, seed Fe peaked at swathing when it made up 19% of the total Fe accumulated (Figure 3.18, Table 3.21). Across plant densities and varieties in the Surefire-Wichita experiment, seed Fe increased to its maximum at ripening, making up 9% of the total Fe accumulated in that experiment. Then, Fe decreased and plateaued through swathing and harvest (Figure 3.19, Table 3.23). Plant density had a significant effect on seed Fe in the Surefire experiment, and the date x density interaction was significant in the Surefire-Wichita experiment (Table 3.19).

Iron was partitioned to the vegetative, pod, and seed material at 15, 20, and 65%, respectively, at swathing in the Wichita sampling. In the Surefire experiment, vegetative material had 45, pod material had 27, and seed had 28% of the plant accumulated Fe at swathing. In the Surefire-Wichita experiment, 40, 20, and 40% of Fe was partitioned to the vegetative, pod, and seed material, respectively at swathing.

Discussion

Due to the specific nutrient roles in plants, it is essential that nutrients are present at the appropriate levels in plants. Plant nutrient accumulation patterns across all the studies followed the same trend as plant DM accumulation, with a few exceptions. There was generally less nutrient accumulation in the Surefire experiment than in the Wichita sampling and Surefire-Wichita experiment because there was less DM accumulated in that experiment than the Wichita sampling and Surefire-Wichita experiment.

Nitrogen is an important nutrient in many aspects of plant growth and seed yield. It is used to build proteins, nucleotides, and chlorophyll, which are used throughout plant tissues. Therefore, it influences vegetative material as well as buds, flowers, pods, seeds, and flowering branches (Grant and Bailey, 1993). Wang et al. (2015) found poor plant growth, and a decrease in DM accumulation and seed yield when N was low. There was less N and DM accumulation in both plant densities of the Surefire experiment than in the Wichita sampling and the Surefire-Wichita experiment. For N accumulation, the Wichita sampling and the Surefire experiment increased in N until the second half of pod fill, then leveled off through swathing (Figure 3.1, Figure 3.2, Figure 3.3, Table 3.4, Table 3.5). In the Surefire-Wichita experiment, plant N increased into pod fill, decreased in the middle of pod fill, then increased until after ripening began, then decreased and plateaued at swathing and harvest (Figure 3.4, Table 3.6). These patterns lined up with the DM accumulation trends fairly well. When there was a difference between the plant densities in any of the plant parts, the high density accumulated more N than the low density, except for the harvest date in the Surefire-Wichita experiment. When there was a difference in nutrient accumulation levels between the plant densities at harvest in the Surefire-Wichita experiment, the low plant density had a greater amount than the high density, which reflects increased DM at the low plant density at that sampling date. In most instances, as vegetative material decreased in N, total plant N continued to increase. This illustrates the plant was still taking up N and N was being translocated to different parts of the plant (Figure 3.1, Figure 3.2, Figure 3.3, Figure 3.4). Vegetative N at the end of the season was 17 to 40% of the total plant N accumulated. Nitrogen partitioned to the pod material was between 13 and 17%. The seed N at the last sampling date was 44 to 66% of the total plant N. Therefore, most of the N was partitioned to the seed, a moderate amount to the vegetative material, and, in general, the least amount of N to pod material.

Phosphorus is important for energy transfer and the structure of phospholipids and nucleic acids (Grant and Bailey, 1993). When P is deficient in the plant, there is a reduction in pods per plant, seeds per pod, and seed weight (Wang et al., 2015). Similar to N accumulation, plant P accumulation followed a trend similar to plant DM accumulation. However, plant DM plateaued or increased at swathing in the Surefire experiment, but plant P decreased on that final sampling date. At swathing, the vegetative and pod material P had plateaued, and the seed P decreased, suggesting P was only lost from the seed material (Figure 3.6, Figure 3.7, Table 3.9). The Wichita sampling and the Surefire-Wichita experiment followed the DM patterns more closely than the Surefire experiment. As vegetative P decreased, pod and seed material P increased, meaning P was still being taken up by the plants and it was being translocated throughout the plant (Figure 3.5, Figure 3.8, Table 3.8, Table 3.10). Vegetative material accumulated between 14 and 36% of total P at the final sampling date. The smallest portion of P was found in the pod material at 7 to 31%. Seed P at the end of the season had 34 to 78% of the total plant P.

Potassium is important for physiological processes in plants and when there is a K deficiency, plant growth and yield are reduced (Grant and Bailey, 1993, Wang et al., 2015). Plant K accumulation also followed the plant DM accumulation trends. Generally, K accumulation increased through the bolting stage until the first half of pod fill, then it plateaued. In the Wichita sampling and the Surefire-Wichita experiment, K accumulation peaked around the beginning of ripening and decreased near the end of the season (Figure 3.9, Figure 3.12, Table 3.12, Table 3.14). In the Surefire experiment for both plant densities, K continued to steadily accumulate until swathing (Figure 3.10, Figure 3.11, Table 3.13). In all studies, except for the Surefire experiment at the low plant density, K accumulation in the vegetative material peaked at the beginning of pod fill, then it plateaued and slowly decrease until the final sampling dates. The Surefire experiment at the low density peaked in the middle of pod fill before it decreased and plateaued through ripening (Figure 3.11). The majority of K was partitioned to the vegetative material at the end of the season with 42 to 50% of total accumulated K, which could be due to its importance in physiological processes (Grant and Bailey, 1993). There was 30 to 37% of the total K allocated to pod material at the final sampling dates. The least amount of K was partitioned to the seed material with 13 to 28%.

Sulfur is integral for protein and chlorophyll synthesis, energy transfer, and glucosinolate synthesis. Because moderation of glucosinolate production is important in canola production, it is important to closely manage S (Grant and Bailey, 1993). Sulfur accumulation followed the plant DM trend as well. Less overall S was accumulated in the Surefire experiment than in the Wichita sampling and Surefire-Wichita experiment, because there was less DM accumulated in that experiment. Plant S generally increased until the beginning of ripening where it plateaued (Figure 3.13, Figure 3.14, Figure 3.15, Figure 3.16, Table 3.16, Table 3.17, Table 3.18). In the Surefire-Wichita experiment, S peaked in the first part of ripening, then it decreased at swathing and plateaued through harvest. Vegetative S increased from green-up until the first half of pod fill, then it slowly decreased and plateaued for the remainder of the season (Figure 3.16, Table 3.18). There was 25 to 37% of total plant S in the vegetative material at the final sampling date.

Pod material contained between 35 and 49% of the S. At the end of the season, there was 21 to 31% of the total S in the seed.

Iron also is important for chlorophyll synthesis, which means it is important to manage plant available Fe to optimize plant growth and crop yields. Producers in semi-arid regions with high pH soils should monitor Fe levels closely, because Fe is less plant available at pH levels greater than 7.5 due to Fe speciation (Ferreira et al., 2019; Jiménez et al., 2019). Iron accumulation did not follow the same trend as DM and other nutrient accumulation. In all studies, maximum Fe accumulation occurred early in the season. There was an Fe peak during early bloom to pod fill stages in all studies. In the Surefire-Wichita experiment, maximum Fe accumulation occurred during the fall rosette stage. After the peak during reproductive stages, the amounts of Fe decreased and plateaued through the remainder of the seasons (Figure 3.17, Figure 3.18, Figure 3.19, Table 3.20, Table 3.21, Table 3.23). There was 15 to 45% of total plant Fe in the vegetative material at the final sampling date. Pod material contained between 20 and 27% of the Fe. At the end of the season, there was 28 to 65% of the total Fe in the seed.

Nutrients have specific roles, so the availability of nutrients can determine the performance of a crop. Nitrogen was an important part of the seed material. This means it is important for nutrients to be available early in the season for the plants to use it later in seed formation. The canola plants grew quickly during bolting and blooming. Nitrogen that was taken up during those stages was used for plant growth at that time and used later when it was translocated out of vegetative material. Phosphorus was critical throughout the growing season, but the majority of the plant P ended up in the seed material. The accumulation rate tended to increase during the blooming stages, which means P fertilizer should be available to the plant at this time or prior to it. Potassium accumulation was important in vegetative and pod material.

Availability of K was important during the bolting and early blooming stages because it was needed in the vegetative material early on, then some of it was translocated to the pod and seed material. However, vegetative K did not decrease much, meaning K continued to be taken up in the pod and seed material. This suggests K availability is important through the entirety of the season. Most of the plant S accumulation occurred in the bolting and blooming stages, then slowed through pod fill and ripening. This suggests S should be plant available during early vegetative spring growth. Iron accumulation mostly occurred in the early developmental stages, meaning Fe should be available earlier in the season. Low plant density in the Surefire experiment delayed nutrient uptake more than the high density, meaning crop management early in the season could aid DM and nutrient accumulation to improve plant performance later in the season.

Conclusions

The objective of this study was to determine the pattern of nutrient accumulation and partitioning throughout the growing season for winter canola in northeast Kansas at high and low plant populations with OP varieties. Our hypothesis was that nutrient accumulation would start slowly in the fall rosette stage. Accumulation would increase quickly from bolting to pod filling, then accumulation would slow through ripening. The nutrients would translocate from vegetative material to pod and seed material from pod set through ripening stages.

Due to the decreased amount of dry matter accumulated in the low plant density, there was decreased amounts of nutrients at a low plant density than at a high plant density. The varieties accumulated and partitioned nutrients similarly. As a general rule, nutrient accumulation followed the same pattern as DM accumulation. Nutrient accumulation was slow at spring green-up but increased through bolting and the beginning of bloom. Soon after pod development began there was a decrease in the rate of nutrient accumulation. In the Surefire experiment, there was a plateau at the beginning of pod filling, and it remained level until swathing for N and S accumulation. For P accumulation it decreased during ripening and for K accumulation it increased during ripening.

In the Wichita sampling and the Surefire-Wichita experiment, nutrient accumulation continued into later growth stages, and the N accumulation rate, P accumulation rate, and the S accumulation rate stayed the same or increased from pod development to early pod fill. Plant nutrient accumulation followed the DM accumulation pattern through the rest of the season. Across the studies, all vegetative nutrient accumulation tended to decrease around the middle of pod fill, suggesting the nutrients were being translocated to the pod and seed material. Once seed material was separated from pod material there was a decrease in the amount of nutrients in the pod material, which means nutrients were being moved from pod and vegetative material to seed material.

There was a general difference in nutrient accumulation between the plant densities in the Surefire experiment from green-up until the first half of pod fill. At swathing, P and S accumulation differed between the densities. The high plant density accumulated more nutrients than the low density and this was most likely due to the difference in DM accumulation. In the Surefire-Wichita experiment, nutrient accumulation was different between the densities occasionally. At harvest, the low density had accumulated more nutrients than the high density. There were no differences at any specific date between the varieties used in that experiment.

In several of the studies, most of the nutrients displayed a fast rate of accumulation early in the season, generally through bolting and blooming stages. Then the rate would slow or plateau. Therefore, nutrients need to be available to canola plants during or prior to those early stages. Iron accumulation followed a different trend by accumulating the maximum amount of Fe in the early stages of development. Early nutrient accumulation provides more resources to allocate during later developmental stages.

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Figures

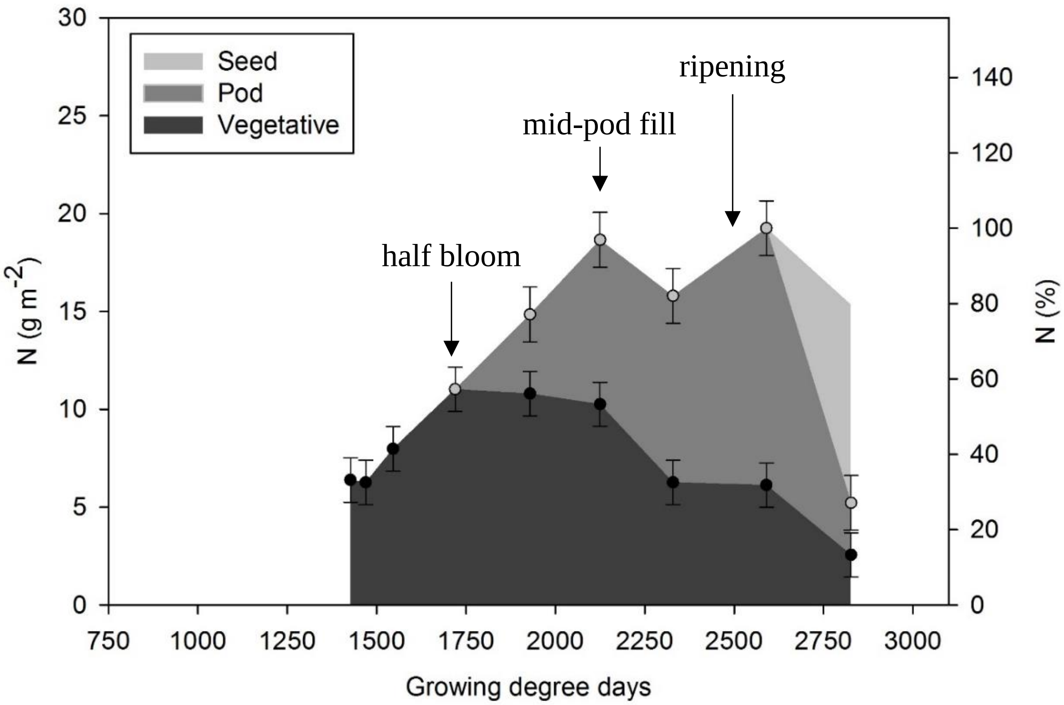

Figure 3.1. Nitrogen accumulation and partitioning for the canola variety Wichita sampled near Manhattan, KS in 2018.

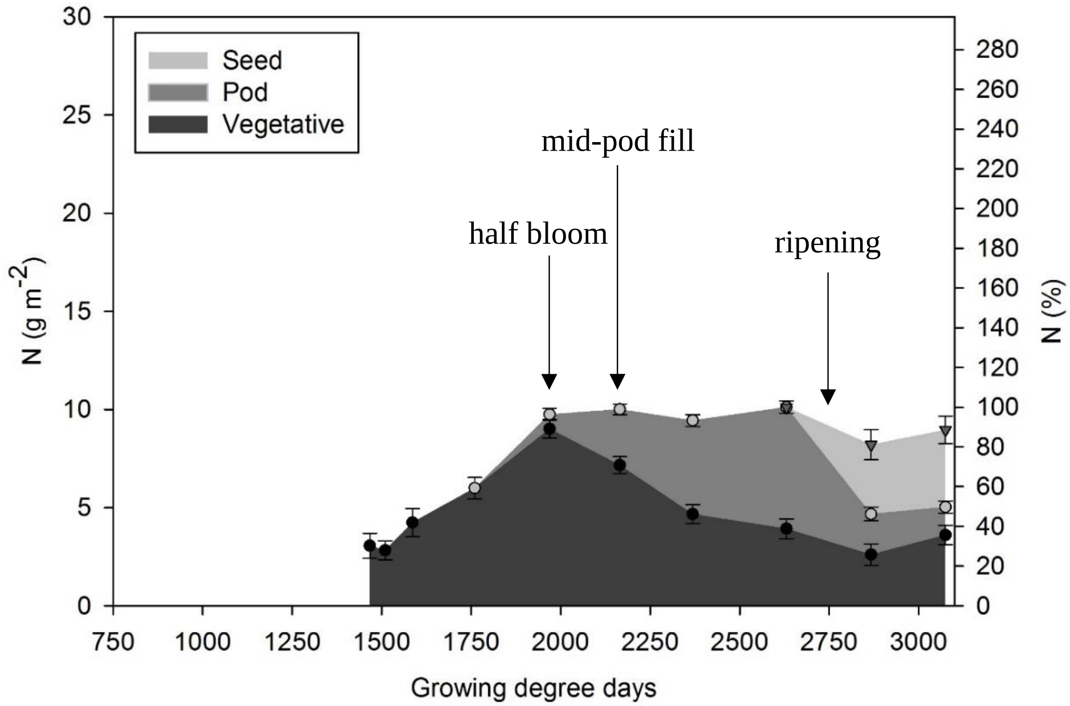

Figure 3.2. Nitrogen accumulation and partitioning for the canola variety Surefire at high plant density sampled near Manhattan, KS in 2018.

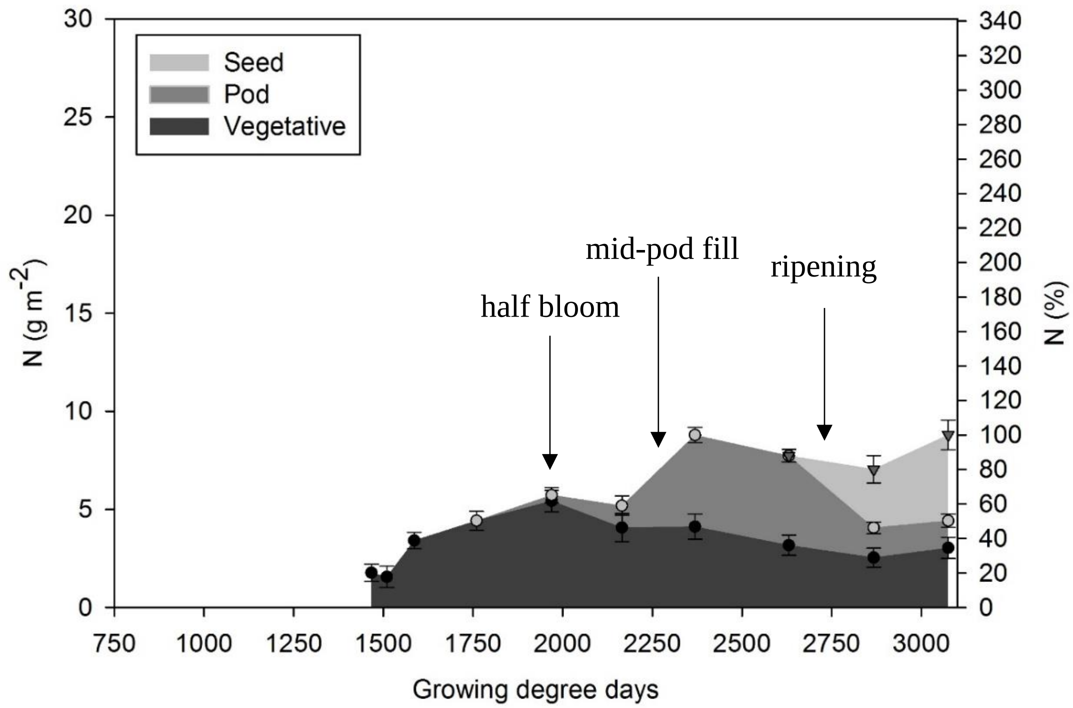

Figure 3.3. Nitrogen accumulation and partitioning for the canola variety Surefire at low plant density sampled near Manhattan, KS in 2018.

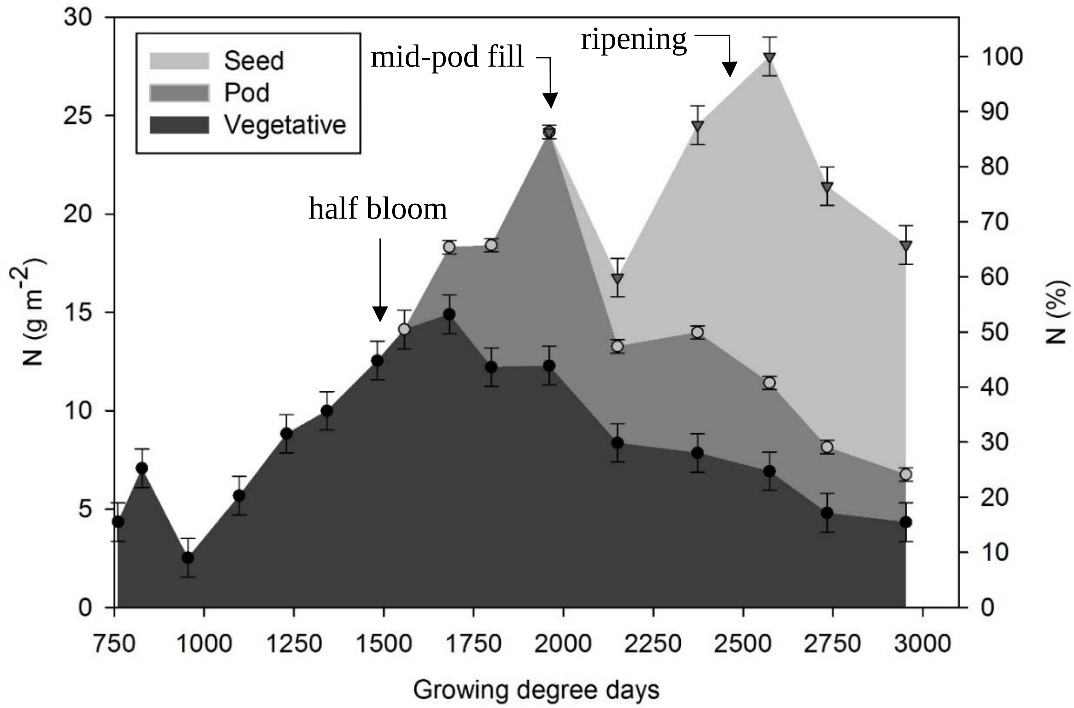

Figure 3.4. Nitrogen accumulation and partitioning averaged across varieties and plant densities in the Surefire-Wichita experiment near Manhattan, KS in 2019.

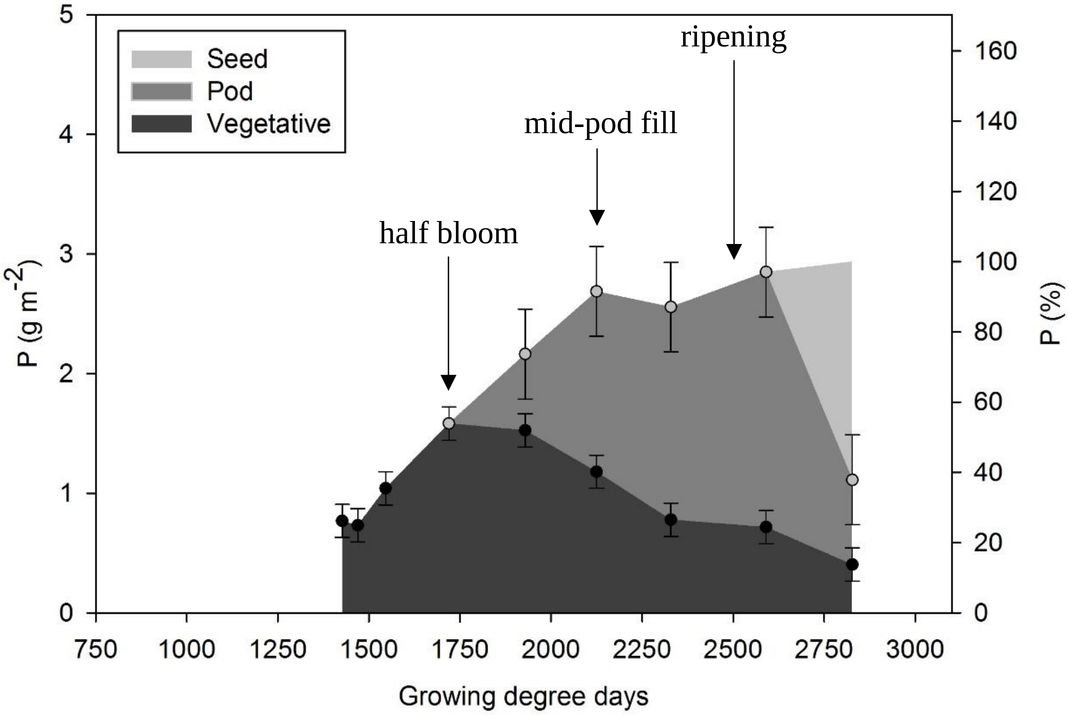

Figure 3.5. Phosphorus accumulation and partitioning for the canola variety Wichita sampled near Manhattan, KS in 2018.

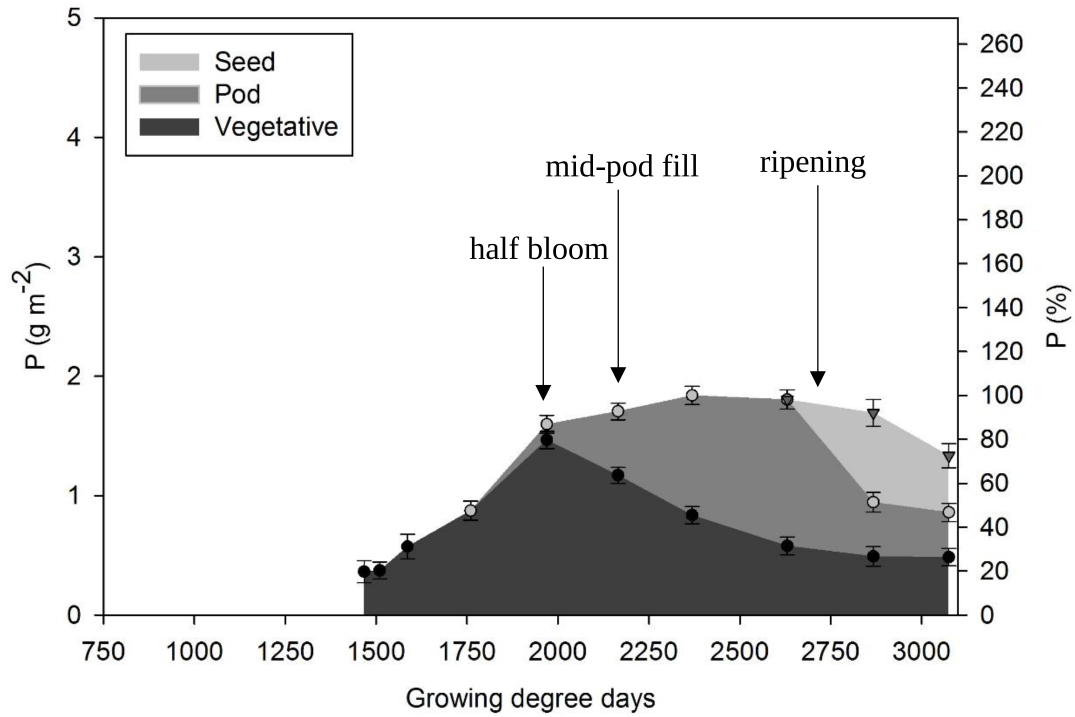

Figure 3.6. Phosphorus accumulation and partitioning for the canola variety Surefire at high plant density sampled near Manhattan, KS in 2018.

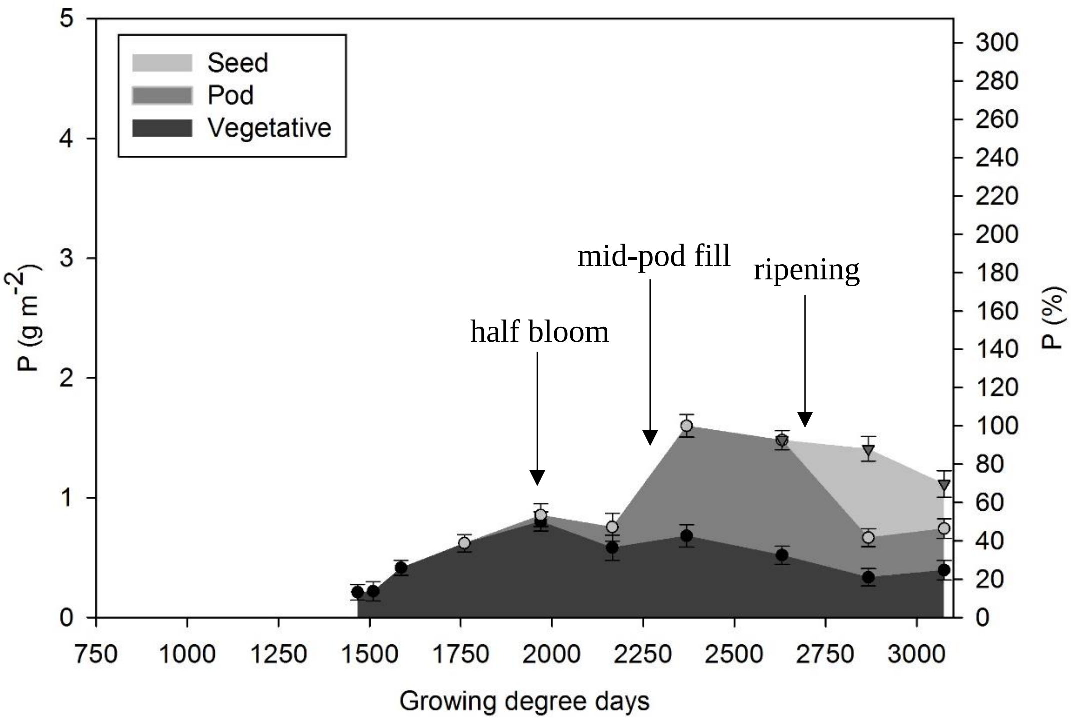

Figure 3.7. Phosphorus accumulation and partitioning for the canola variety Surefire at low plant density sampled near Manhattan, KS in 2018.

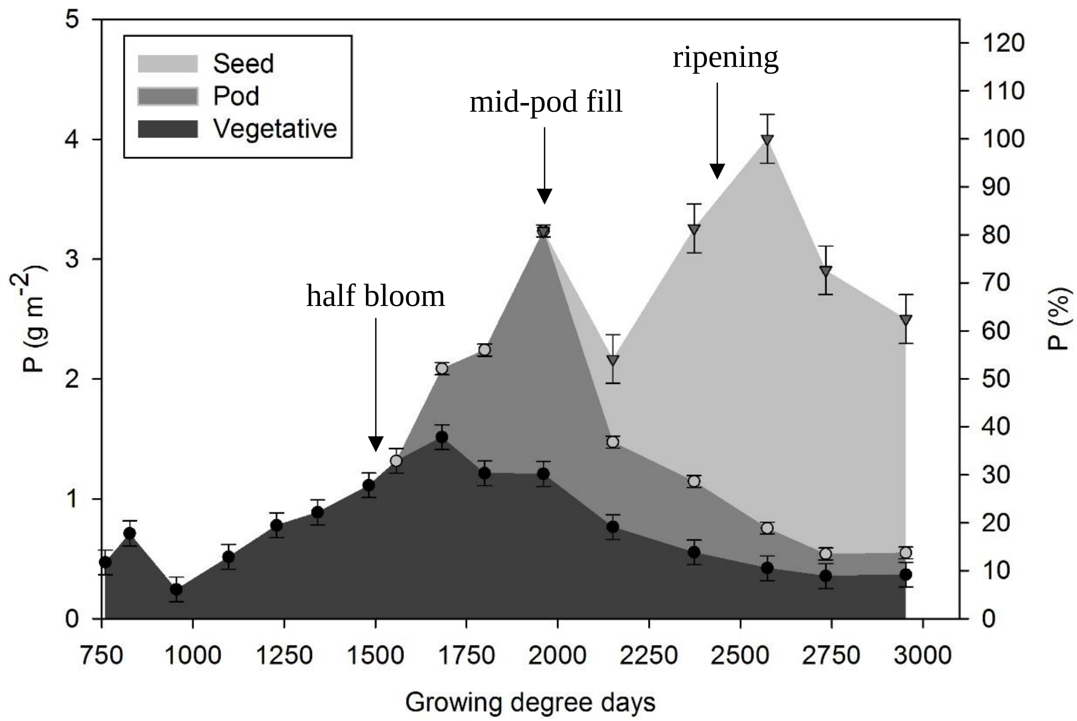

Figure 3.8. Phosphorus accumulation and partitioning averaged across varieties and plant densities in the Surefire-Wichita experiment near Manhattan, KS in 2019.

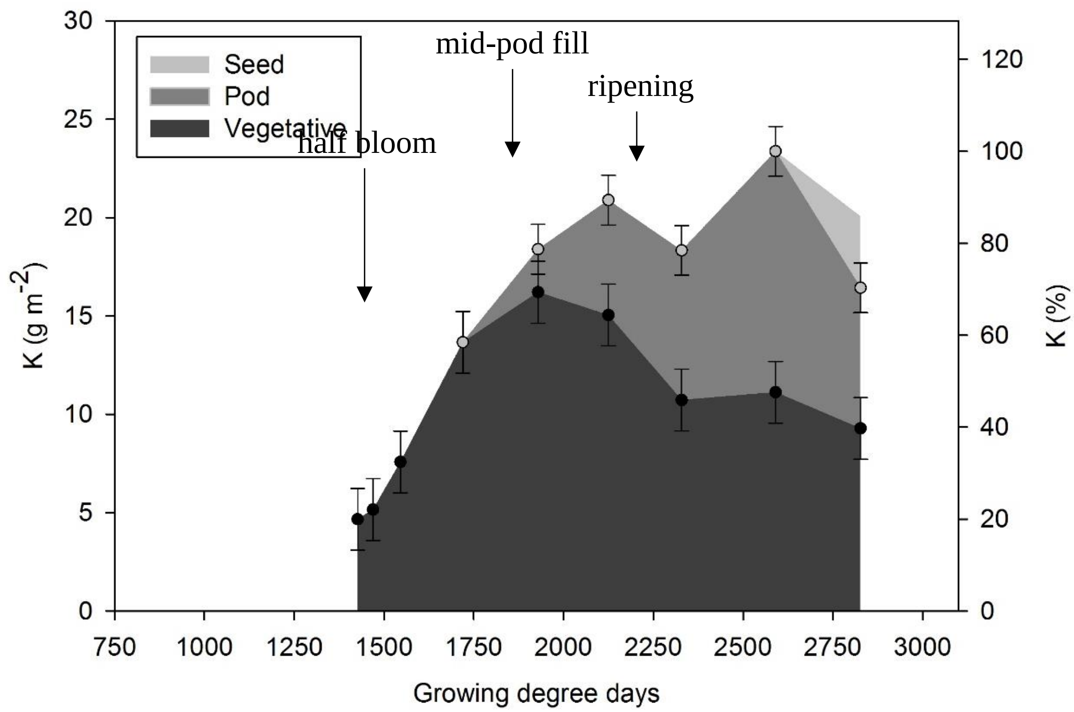

Figure 3.9. Potassium accumulation and partitioning for the canola variety Wichita sampled near Manhattan, KS in 2018.

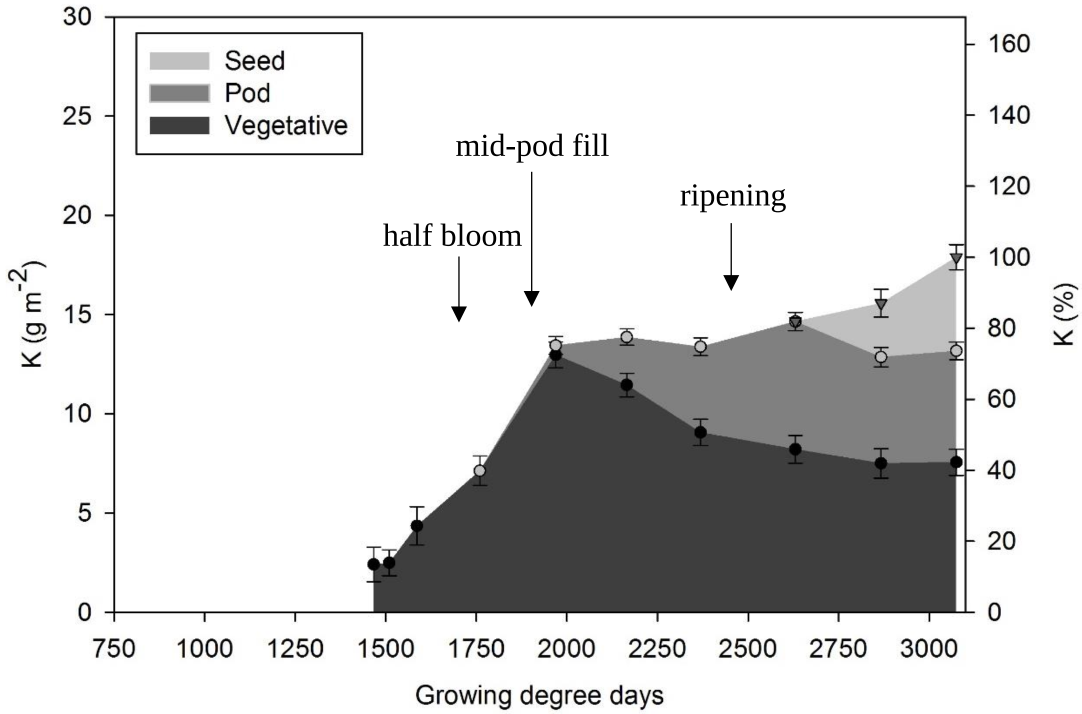

Figure 3.10. Potassium accumulation and partitioning for the canola variety Surefire at high plant density sampled near Manhattan, KS in 2018.

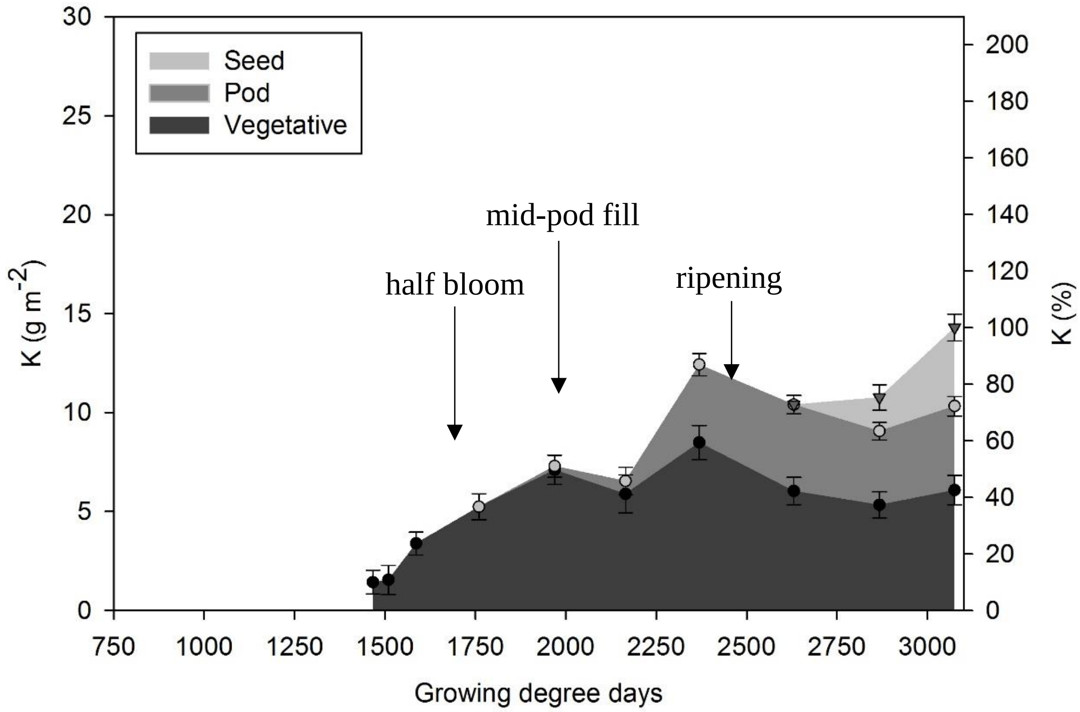

Figure 3.11. Potassium accumulation and partitioning for the canola variety Surefire at low plant density sampled near Manhattan, KS in 2018.

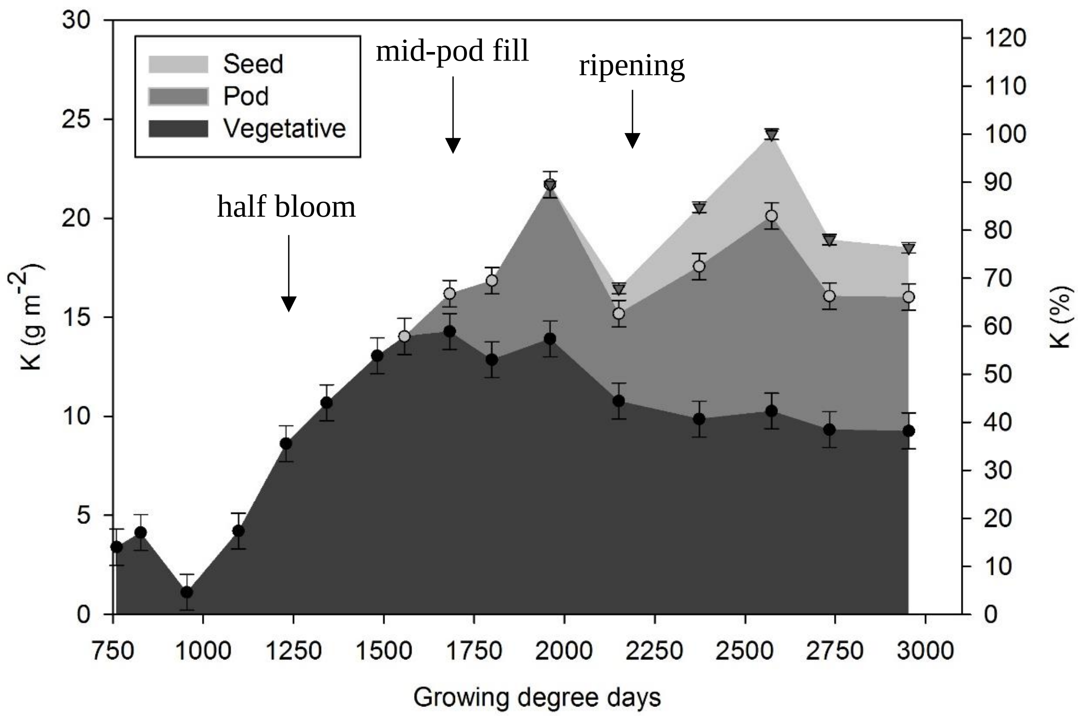

Figure 3.12. Potassium accumulation and partitioning averaged across varieties and plant densities in the Surefire-Wichita experiment near Manhattan, KS in 2019.

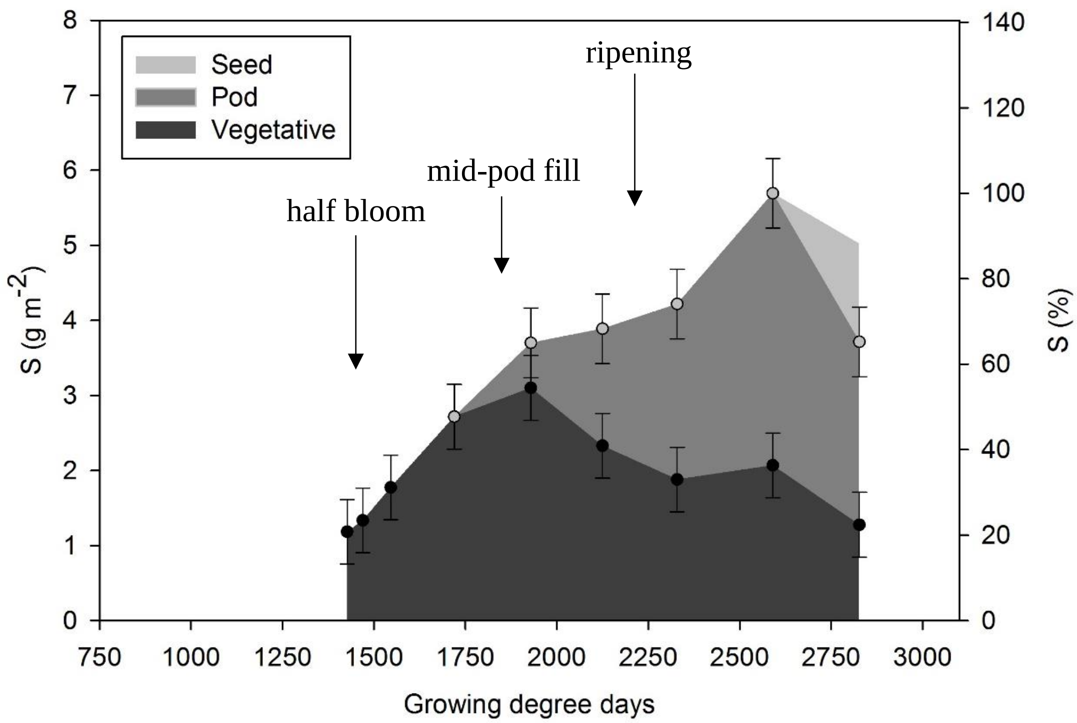

Figure 3.13. Sulfur accumulation and partitioning for the canola variety Wichita sampled near Manhattan, KS in 2018.

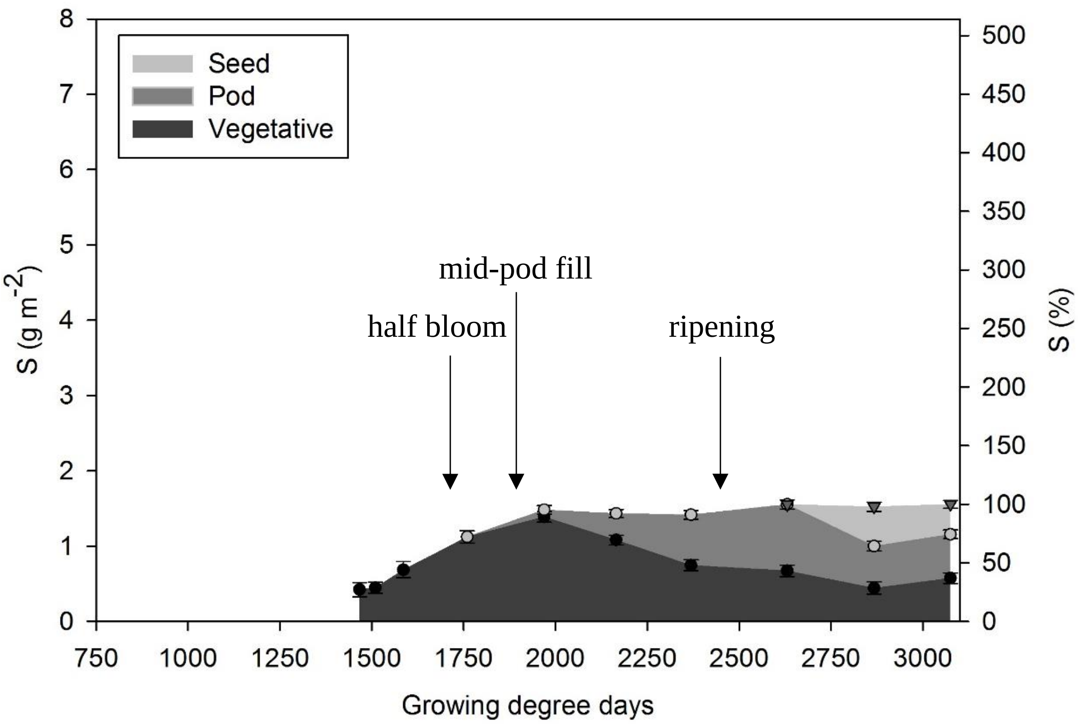

Figure 3.14. Sulfur accumulation and partitioning for the canola variety Surefire at high plant density sampled near Manhattan, KS in 2018.

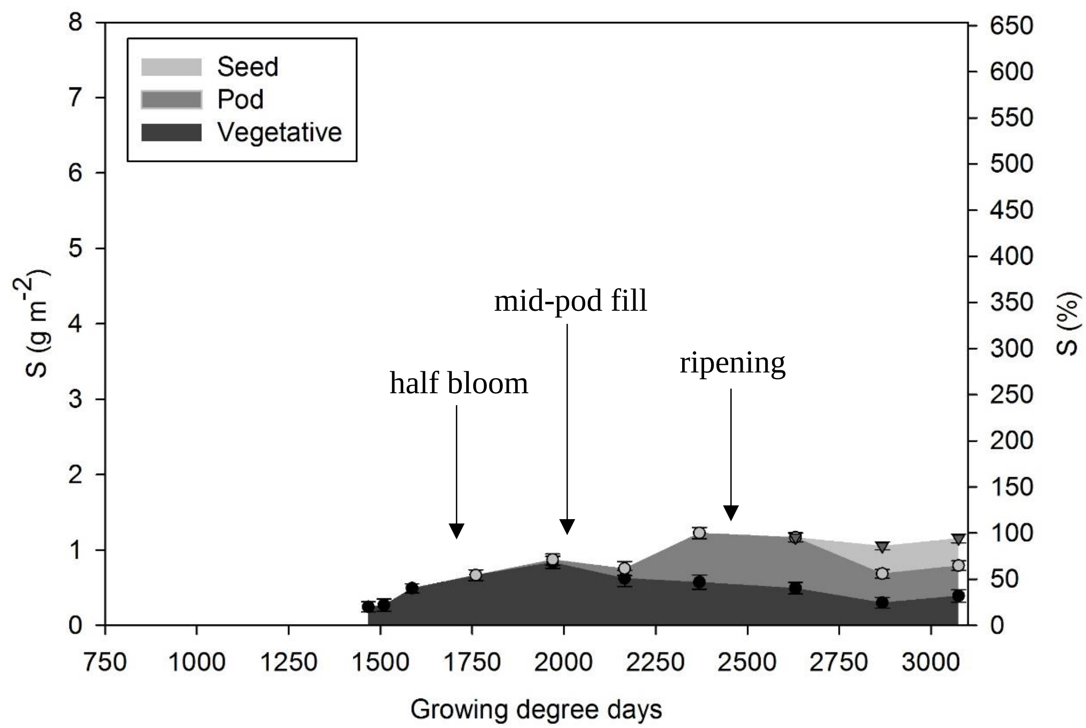

Figure 3.15. Sulfur accumulation and partitioning for the canola variety Surefire at low plant density sampled near Manhattan, KS in 2018.

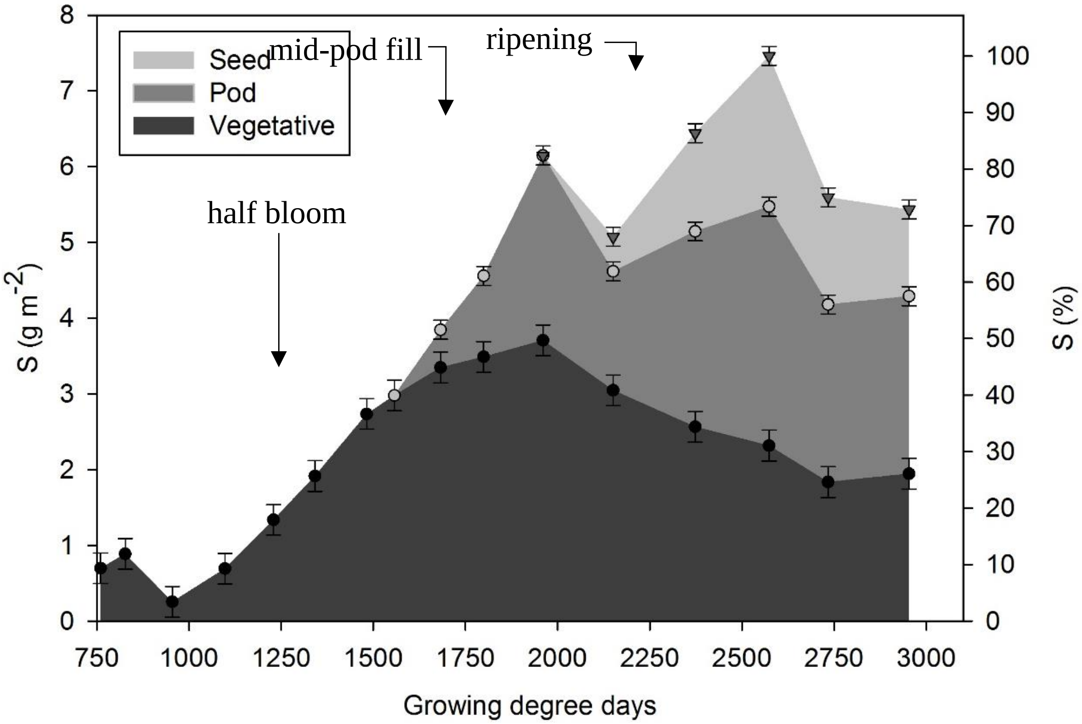

Figure 3.16. Sulfur accumulation and partitioning averaged across varieties and plant densities in the Surefire-Wichita experiment near Manhattan, KS in 2019.

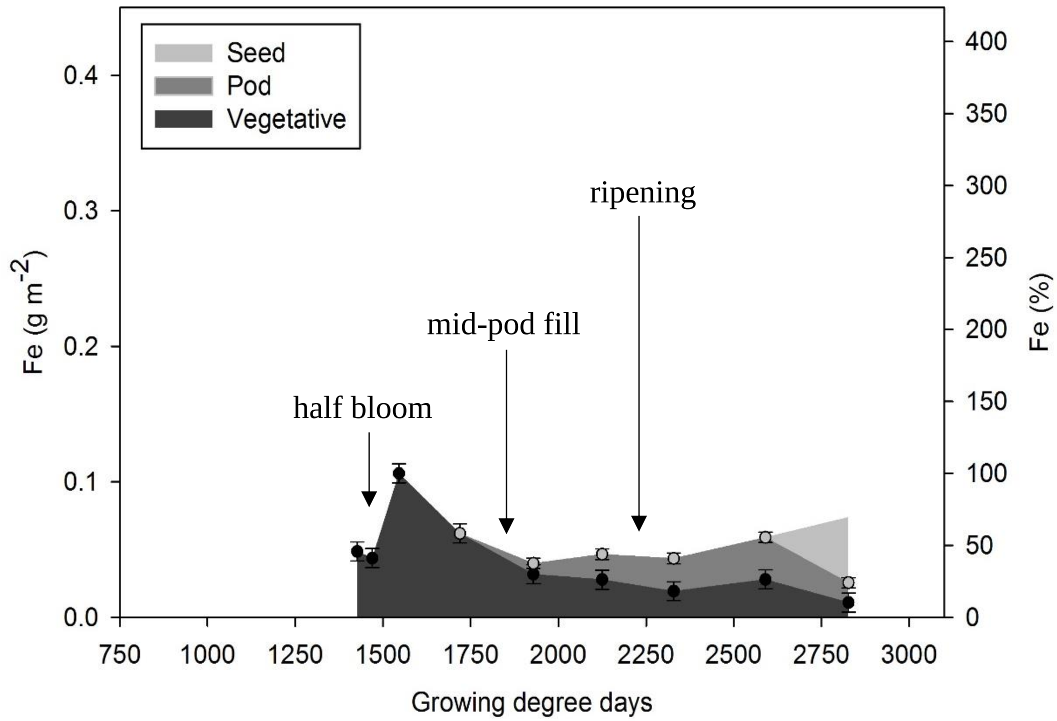

Figure 3.17. Iron accumulation and partitioning for the canola variety Wichita sampled near Manhattan, KS in 2018.

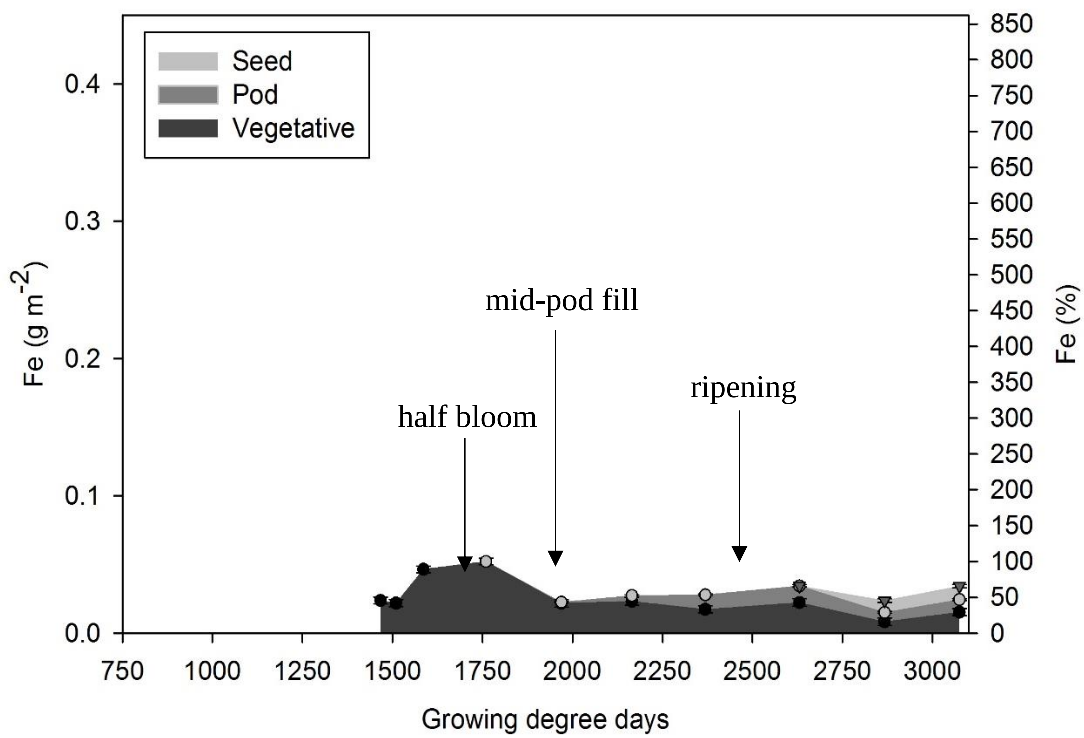

Figure 3.18. Iron accumulation and partitioning averaged across plant densities for the canola variety Surefire sampled near Manhattan, KS in 2018.

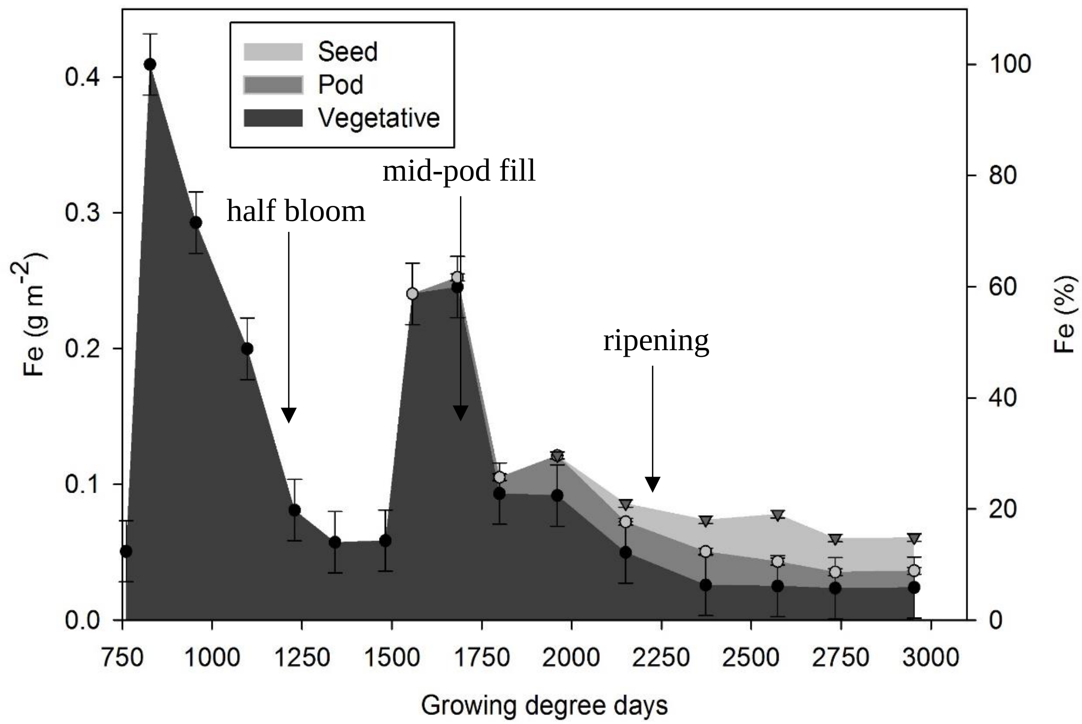

Figure 3.19. Iron accumulation and partitioning averaged across varieties and plant densities in the Surefire-Wichita experiment near Manhattan, KS in 2019.

Tables

Table 3.1. Field operations for field sampling and experiments conducted to assess canola biomass and nutrient accumulation near Manhattan, KS 2016-2019.

	Sampling	Experiment	
Factor	Wichita	Surefire	Surefire-Wichita
Fall nitrogen†	39.2 kg ha^{-1} (28-0-0)	39.2 kg ha^{-1} (28-0-0)	15.7 kg ha^{-1} (10-0-0-22)
Fall phosphorus	33.6 kg ha^{-1} (10-34-0)	33.6 kg ha^{-1} (10-34-0)	-
Fall sulfur	33.6 kg ha^{-1} (10-0-0-22)	33.6 kg ha^{-1} (10-0-0-22)	33.6 kg ha^{-1} (10-0-0-22)
Fall herbicide‡	Assure II 730.4 ml ha^{-1} Muster 21.0 g ha^{-1} Assure II 584.3 ml ha^{-1}	Assure II 657.3 ml ha^{-1} Muster 21.0 g ha^{-1}	Assure II 730.4 ml ha^{-1} Muster 28.0 g ha^{-1}
Spring nitrogen§	107.6 kg ha^{-1} (32-0-0)	95.3 kg ha^{-1} (32-0-0)	112.1 kg ha^{-1} (28-0-0)
Planting date	Sep. 20, 2017	Sep. 19, 2017	Sep. 18, 2018
Swathing date	Jun. 7 & Jun. 11, 2018	Jun. 11, 2018	Jun. 17, 2019
Harvest date	Jun. 11 & Jun. 16, 2018	Jun. 13, 2018	Jul. 1, 2019

† Fall fertilizer applied pre-plant.

‡ Fall herbicide - Assure II [Quizalofop-p-ethyl, Ethyl(r)-2-[4-(6-chloroquinoxalin-2-yloxy)-phenoxy]propionate, 103 g kg-1, Corteva Agriscience (DuPont), Wilmington, DE] and Muster (Ethametsulfuron methyl 750 g kg-1, Corteva Agriscience (DuPont), Wilmington, DE]) applied post-emergence.

§ Spring fertilizer applied after spring green-up and before canola bolting.

Table 3.2. Experimental details for sampling and experiments conducted to assess canola biomass and nutrient accumulation near Manhattan, KS 2016-2019.

	Sampling	Experiment	
Factor	Wichita	Surefire	Surefire-Wichita
Whole plot (m)	-	3.66 x 10.06	3.66 x 13.72
Machine-harvest subplot (m)	1.83 x 5.79	1.82 x 10.06	1.82 x 13.72
Biomass-sample subplot (m)	0.76 x 1.10	0.91 x 0.91	0.82 x 1.01
Fall stands	-	-	Oct. 19, 2018
Spring stands	Mar. 10, 2018	Mar. 10, 2018	Mar. 21, 2019
Fall sampling duration	-	-	Nov. 2 to Dec. 17, 2018
Spring sampling duration	Apr. 12 to Jun. 6, 2018	Mar. 12 to Jun. 11, 2018	Mar. 22 to Jun. 24, 2019
No. of samples	9	10	16
Sample order	random	sequential	sequential
Replications	3	4	4

Table 3.3. Tests of significance for nitrogen response to main effects of date, density, variety, and their interactions for experiments conducted near Manhattan, KS 2017-2019.

Study	Source of variance	Total plant	Vegetative	Pod	Seed
		probability of > F			
Wichita	Date	<0.0001	<0.0001	<0.0001	<0.0001
Surefire	Date	<0.0001	<0.0001	<0.0001	0.1505
	Density	<0.0001	<0.0001	0.0001	0.6672
	Date x Density	0.0334	0.0128	0.0438	0.3720
Surefire-Wichita	Date	<0.0001	<0.0001	<0.0001	<0.0001
	Variety	0.1303	0.2365	0.2918	0.1933
	Date x Variety	0.8915	0.9789	0.8906	0.5321
	Density	0.0582	0.5869	0.0006	0.0710
	Date x Density	0.1085	0.6294	0.0259	0.0125
	Variety x Density	0.0051	0.0002	0.2419	0.8175
	Date x Variety x Density	0.5058	0.5434	0.6763	0.3685

Table 3.4. Accumulation and partitioning of nitrogen in the canola variety Wichita sampled near Manhattan, KS in 2018.

Date	Growing degree days	Developmental stage	Total plant		Vegetative		Pod†		Seed
			g m^{-2}						
12-Apr-18	1427	rosette	6.39	e‡	6.39	c			
19-Apr-18	1470	bolt	6.27	e	6.27	c			
26-Apr-18	1546	beginning bloom	7.98	de	7.98	bc			
3-May-18	1720	pod development	11.02	cd	11.02	a			
10-May-18	1929	pod fill	14.84	bc	10.80	a	4.04	c	
16-May-18	2125	mid-pod fill	18.66	ab	10.26	ab	8.40	b	
23-May-18	2329	pod fill	15.79	ab	6.27	c	9.53	b	
30-May-18	2590	ripening	19.25	a	6.13	c	13.12	a	
6-Jun-18	2827	swathing	15.33	ab	2.56	d	2.66	c	10.11

† Pods included developing seeds through the 30 May sampling but were separated from seeds for the 6 June sampling.
‡ Values within a column followed by the same letter are not different at α=0.05.

Table 3.5. Accumulation and partitioning of nitrogen in the canola variety Surefire at high and low plant densities sampled near Manhattan, KS in 2018.

			Total plant		Vegetative		Pod†		Seed	
Date	Growing degree days	Developmental stage	High	Low	High	Low	High	Low	High	Low
			$g\ m^{-2}$							
12-Apr-18	1467	rosette	3.06 a‡	1.77 b	3.06 a	1.77 b				
19-Apr-18	1510	bolt	2.83 a	1.56 b	2.83 a	1.56 b				
26-Apr-18	1586	bloom	4.24	3.41	4.24	3.41				
3-May-18	1760	pod development	5.99 a	4.42 b	5.99 a	4.42 b				
10-May-18	1969	pod fill	9.74 a	5.65 b	9.01 a	5.42 b	0.73 a	0.30 b		
16-May-18	2165	mid-pod fill	9.97 a	4.97 b	7.16 a	4.07 b	2.85 a	1.12 b		
23-May-18	2369	pod fill	9.39	8.87	4.67	4.12	4.77	4.67		
30-May-18	2630	pod fill	10.16 a	7.69 b	3.92	3.17	6.19 a	4.56 b		
6-Jun-18	2867	ripening	8.45	6.85	2.61	2.54	2.07 a	1.52 b	3.53	2.98
11-Jun-18	3075	swathing	9.04	8.70	3.61	3.04	1.42	1.38	3.93	4.38

† Pods included developing seeds through the 30 May sampling but were separated from seeds for the 6 June and 11 June samplings.
‡ Values within a row and plant part grouping followed by different letters are significantly different at α=0.05.

Table 3.6. Date, variety, and plant density effects on accumulation and partitioning of nitrogen in the Surefire-Wichita experiment across dates sampled near Manhattan, KS in 2019.

Main effect	Growing degree days	Developmental stage	Total plant		Vegetative		Pod†		Seed	
Date:			————	————	————	g m^{-2}	————	————	————	
2-Nov-18	760	fall rosette	4.35	jk‡	4.35	gh				
17-Dec-18	827	fall rosette	7.07	ij	7.07	de				
22-Mar-19	955	spring rosette	2.53	k	2.53	h				
5-Apr-19	1098	early bolt	5.68	j	5.68	efg				
12-Apr-19	1229	bolt	8.83	i	8.83	cd				
19-Apr-19	1342	beginning bloom	9.99	hi	9.99	c				
26-Apr-19	1482	pod development	12.55	gh	12.55	b				
2-May-19	1557	pod fill	14.60	fg	14.13	ab				
9-May-19	1682	pod fill	18.31	e	14.90	a	3.41	d		
15-May-19	1799	pod fill	18.41	de	12.22	b	6.19	b		
22-May-19	1960	mid-pod fill	24.16	bc	12.29	b	11.88	a		
29-May-19	2150	pod fill	16.76	ef	8.36	cd	4.91	c	3.49	d
5-Jun-19	2373	pod fill	24.51	b	7.85	cd	6.12	b	10.53	c
12-Jun-19	2574	ripening	28.00	a	6.92	def	4.49	c	16.59	a
17-Jun-19	2733	swathing	21.41	cd	4.81	fg	3.35	d	13.26	b
24-Jun-19	2953	harvest	18.43	de	4.33	gh	2.42	e	11.67	bc
Variety:										
Surefire			14.31		8.32		5.23		10.63	
Wichita			15.14		8.78		5.46		11.59	
Plant density:										
High			15.24		8.65		5.73	A	11.78	
Low			14.20		8.45		4.96	B	10.44	

† Pods included developing seeds through the 29 May sampling but were separated from seeds for the 5 June through 24 June samplings.
‡ Values within a column followed by the same letter are not different at α=0.05. Lowercase letters are used for date effects. Uppercase letters are used for variety and plant density effects.

Table 3.7. Tests of significance for phosphorus response to main effects of date, density, variety, and their interactions for experiments conducted near Manhattan, KS 2017-2019.

Study	Source of variance	Total plant	Vegetative	Pod	Seed
		————	————probability of > F	————	————
Wichita	Date	<0.0001	<0.0001	0.0021	<0.0001
Surefire	Date	<0.0001	<0.0001	<0.0001	0.0024
	Density	<0.0001	<0.0001	0.0005	0.5340
	Date x Density	0.0163	0.0003	0.2318	0.8422
Surefire-Wichita	Date	<0.0001	<0.0001	<0.0001	<0.0001
	Variety	0.4428	0.6680	0.9694	0.3548
	Date x Variety	0.6952	0.9608	0.6833	0.6106
	Density	0.0476	0.3976	0.0012	0.0293
	Date x Density	0.0636	0.4264	0.0037	0.0329
	Variety x Density	0.0040	<0.0001	0.1989	0.9337
	Date x Variety x Density	0.6068	0.7467	0.5246	0.3998

Table 3.8. Accumulation and partitioning of phosphorus in the canola variety Wichita sampled near Manhattan, KS in 2018.

	Growing degree days	Developmental stage	Total plant		Vegetative		Pod†		Seed
Date			g m^{-2}						
12-Apr-18	1427	rosette	0.77	e‡	0.77	cd			
19-Apr-18	1470	bolt	0.73	e	0.73	d			
26-Apr-18	1546	beginning bloom	1.04	de	1.04	bc			
3-May-18	1720	pod development	1.58	cd	1.58	a			
10-May-18	1929	pod fill	2.16	bc	1.53	a	0.64	b	
16-May-18	2125	mid-pod fill	2.69	ab	1.18	b	1.51	a	
23-May-18	2329	pod fill	2.56	ab	0.78	cd	1.78	a	
30-May-18	2590	ripening	2.85	ab	0.72	d	2.13	a	
6-Jun-18	2827	swathing	2.94	a	0.40	e	0.71	b	1.82

† Pods included developing seeds through the 30 May sampling but were separated from seeds for the 6 June sampling.
‡ Values within a column followed by the same letter are not different at α=0.05.

Table 3.9. Accumulation and partitioning of phosphorus in the canola variety Surefire at high and low plant densities sampled near Manhattan, KS in 2019.

			Total plant		Vegetative		Pod†		Seed	
Date	Growing degree days	Developmental stage	High	Low	High	Low	High	Low	High	Low
			g m⁻²							
12-Apr-18	1467	rosette	0.36 a‡	0.21 b	0.36 a	0.21 b				
19-Apr-18	1510	bolt	0.37 a	0.22 b	0.37 a	0.22 b				
26-Apr-18	1586	bloom	0.57	0.41	0.57	0.41				
3-May-18	1760	pod development	0.87 a	0.62 b	0.87 a	0.62 b				
10-May-18	1969	pod fill	1.60 a	0.84 b	1.47 a	0.80 b	0.13 a	0.05 b		
16-May-18	2165	mid-pod fill	1.70 a	0.72 b	1.17 a	0.58 b	0.53 a	0.17 b		
23-May-18	2369	pod fill	1.84	1.60	0.84	0.68	1.00	0.92		
30-May-18	2630	pod fill	1.80	1.48	0.58	0.52	1.23	0.96		
6-Jun-18	2867	ripening	1.68	1.42	0.49 a	0.34 b	0.45	0.33	0.75	0.74
11-Jun-18	3075	swathing	1.35 a	1.09 b	0.48	0.40	0.38	0.35	0.47	0.37

† Pods included developing seeds through the 30 May sampling but were separated from seeds for the 6 June and 11 June samplings.
‡ Values within a row and plant part grouping followed by different letters are significantly different at α=0.05.

Table 3.10. Date, variety, and plant density effects on accumulation and partitioning of phosphorus in the Surefire-Wichita experiment across dates sampled near Manhattan, KS in 2019.

Main effect	Growing degree days	Developmental stage	Total plant		Vegetative		Pod†		Seed	
Date:			g m^{-2}							
2-Nov-18	760	fall rosette	0.47	hi‡	0.47	fg				
17-Dec-18	827	fall rosette	0.71	gh	0.71	de				
22-Mar-19	955	spring rosette	0.24	i	0.24	h				
5-Apr-19	1098	early bolt	0.52	hi	0.52	fg				
12-Apr-19	1229	bolt	0.78	fgh	0.78	d				
19-Apr-19	1342	beginning bloom	0.89	fg	0.89	d				
26-Apr-19	1482	pod development	1.11	ef	1.11	c				
2-May-19	1557	pod fill	1.39	e	1.32	b				
9-May-19	1682	pod fill	2.09	d	1.51	a	0.57	d		
15-May-19	1799	pod fill	2.24	cd	1.21	bc	1.03	b		
22-May-19	1960	mid-pod fill	3.24	b	1.21	bc	2.03	a		
29-May-19	2150	pod fill	2.17	cd	0.76	d	0.71	c	0.69	c
5-Jun-19	2373	pod fill	3.26	b	0.55	ef	0.59	cd	2.11	b
12-Jun-19	2574	ripening	4.00	a	0.42	fgh	0.33	e	3.25	a
17-Jun-19	2733	swathing	2.91	b	0.36	gh	0.18	f	2.37	b
24-Jun-19	2953	harvest	2.50	c	0.37	fgh	0.18	f	1.95	b
Variety:										
Surefire			1.76		0.77		0.70		2.01	
Wichita			1.81		0.78		0.70		2.14	
Plant density:										
High			1.85	A	0.76		0.76	A	2.24	A
Low			1.72	B	0.79		0.65	B	1.91	B

† Pods included developing seeds through the 29 May sampling but were separated from seeds for the 5 June through 24 June samplings.
‡ Values within a column followed by the same letter are not different at α=0.05. Lowercase letters are used for date effects. Uppercase letters are used for variety and plant density effects.

Table 3.11. Tests of significance for potassium response to main effects of date, density, variety, and their interactions for experiments conducted near Manhattan, KS 2017-2019.

Study	Source of variance	Total plant	Vegetative	Pod	Seed
		probability of > F			
Wichita	Date	<0.0001	<0.0001	<0.0001	0.0181
Surefire	Date	<0.0001	<0.0001	<0.0001	0.0009
	Density	<0.0001	<0.0001	<0.0001	0.0495
	Date x Density	0.0043	0.0004	0.1744	0.5357
Surefire-Wichita	Date	<0.0001	<0.0001	<0.0001	<0.0001
	Variety	0.2702	0.1006	0.6314	0.0737
	Date x Variety	0.9134	0.9313	0.8827	0.3698
	Density	0.0212	0.1893	0.0008	0.0190
	Date x Density	0.1486	0.4854	0.0426	0.0272
	Variety x Density	0.0379	0.0013	0.6690	0.9956
	Date x Variety x Density	0.8700	0.8175	0.8987	0.4132

Table 3.12. Accumulation and partitioning of potassium in the canola variety Wichita sampled near Manhattan, KS in 2018.

Date	Growing degree days	Developmental stage	Total plant		Vegetative		Pod†		Seed
			g m^{-2}						
12-Apr-18	1427	rosette	4.66	d‡	4.66	e			
19-Apr-18	1470	bolt	5.15	d	5.15	e			
26-Apr-18	1546	beginning bloom	7.58	d	7.58	de			
3-May-18	1720	pod development	13.66	c	13.66	ab			
10-May-18	1929	pod fill	18.39	b	16.21	a	2.18	c	
16-May-18	2125	mid-pod fill	20.88	ab	15.04	a	5.85	b	
23-May-18	2329	pod fill	18.33	b	10.72	bcd	7.60	b	
30-May-18	2590	ripening	23.36	a	11.12	bc	12.24	a	
6-Jun-18	2827	swathing	20.06	ab	9.28	cd	7.15	b	3.63

† Pods included developing seeds through the 30 May sampling but were separated from seeds for the 6 June sampling.
‡ Values within a column followed by the same letter are not different at α=0.05.

Table 3.13. Accumulation and partitioning of potassium in the canola variety Surefire at high and low plant densities sampled near Manhattan, KS in 2018.

Date	Growing degree days	Developmental stage	Total plant		Vegetative		Pod†		Seed	
			High	Low	High	Low	High	Low	High	Low
			g m^{-2}							
12-Apr-18	1467	rosette	2.41 a‡	1.43 b	2.41 a	1.43 b				
19-Apr-18	1510	bolt	2.50 a	1.54 b	2.50 a	1.54 b				
26-Apr-18	1586	bloom	4.35	3.39	4.35	3.39				
3-May-18	1760	pod development	7.13	5.24	7.13	5.24				
10-May-18	1969	pod fill	13.45 a	7.24 b	12.97 a	7.10 b	0.48 a	0.19 b		
16-May-18	2165	mid-pod fill	13.79 a	6.48 b	11.46 a	5.89 b	2.41 a	0.65 b		
23-May-18	2369	pod fill	13.32	12.53	9.06	8.48	4.31	3.94		
30-May-18	2630	pod fill	14.65 a	10.40 b	8.21 a	6.03 b	6.44 a	4.37 b		
6-Jun-18	2867	ripening	15.77 a	10.60 b	7.51 a	5.33 b	5.35	3.73	2.71 a	1.70 b
11-Jun-18	3075	swathing	17.86	14.33	7.56 a	6.08 b	5.61 a	4.24 b	4.72	3.97

† Pods included developing seeds through the 30 May sampling but were separated from seeds for the 6 June and 11 June samplings.
‡ Values within a row and plant part grouping followed by different letters are significantly different at α=0.05.

Table 3.14. Date, variety, and plant density effects on accumulation and partitioning of potassium in the Surefire-Wichita experiment across dates sampled near Manhattan, KS in 2019.

Main effect	Growing degree days	Developmental stage	Total plant		Vegetative		Pod†		Seed	
Date:			g m^{-2}							
2-Nov-18	760	fall rosette	3.40	jk‡	3.40	d				
17-Dec-18	827	fall rosette	4.13	j	4.13	d				
22-Mar-19	955	spring rosette	1.11	k	1.11	e				
5-Apr-19	1098	early bolt	4.21	j	4.21	d				
12-Apr-19	1229	bolt	8.62	i	8.62	c				
19-Apr-19	1342	beginning bloom	10.68	hi	10.68	b				
26-Apr-19	1482	pod development	13.05	gh	13.05	a				
2-May-19	1557	pod fill	14.28	fg	14.03	a				
9-May-19	1682	pod fill	16.19	ef	14.28	a	1.91	d		
15-May-19	1799	pod fill	16.85	def	12.85	a	3.99	c		
22-May-19	1960	mid-pod fill	21.69	ab	13.91	a	7.78	b		
29-May-19	2150	pod fill	16.46	def	10.77	b	4.41	c	1.28	c
5-Jun-19	2373	pod fill	20.55	bc	9.86	bc	7.70	b	2.99	b
12-Jun-19	2574	ripening	24.24	a	10.26	bc	9.85	a	4.13	a
17-Jun-19	2733	swathing	18.91	cd	9.32	bc	6.74	b	2.85	b
24-Jun-19	2953	harvest	18.51	cde	9.26	bc	6.76	b	2.50	b
Variety:										
Surefire			13.57		9.63		6.22		2.58	
Wichita			13.04		9.09		6.07		2.92	
Plant density:										
High			13.86	A	9.58		6.67	A	2.98	A
Low			12.75	B	9.14		5.62	B	2.52	B

† Pods included developing seeds through the 29 May sampling but were separated from seeds for the 5 June through 24 June samplings.

‡ Values within a column followed by the same letter are not different at α=0.05. Lowercase letters are used for date effects. Uppercase letters are used for variety and plant density effects.

Table 3.15. Tests of significance for sulfur response to main effects of date, density, variety, and their interactions for experiments conducted near Manhattan, KS 2017-2019.

Study	Source of variance	Total plant	Vegetative	Pod	Seed
		——probability of > F——			
Wichita	Date	<0.0001	0.0004	<0.0001	<0.0001
Surefire	Date	<0.0001	<0.0001	<0.0001	0.3020
	Density	<0.0001	<0.0001	0.0003	0.1092
	Date x Density	0.2280	0.0350	0.3932	0.3506
Surefire-Wichita	Date	<0.0001	<0.0001	<0.0001	<0.0001
	Variety	0.0196	0.0172	0.1346	0.0873
	Date x Variety	0.4092	0.5585	0.6893	0.3539
	Density	0.0050	0.2769	<0.0001	0.0335
	Date x Density	0.0165	0.9414	0.0013	0.0196
	Variety x Density	0.0614	0.0012	0.7742	0.6124
	Date x Variety x Density	0.6386	0.4842	0.7006	0.4400

Table 3.16. Accumulation and partitioning of sulfur in the canola variety Wichita sampled near Manhattan, KS in 2018.

Date	Growing degree days	Developmental stage	Total plant		Vegetative		Pod†		Seed
			g m^{-2}						
12-Apr-18	1427	rosette	1.18	f‡	1.18	e			
19-Apr-18	1470	bolt	1.33	f	1.33	de			
26-Apr-18	1546	beginning bloom	1.77	ef	1.77	cde			
3-May-18	1720	pod development	2.72	de	2.72	ab			
10-May-18	1929	pod fill	3.70	cd	3.10	a	0.60	c	
16-May-18	2125	mid-pod fill	3.89	bcd	2.33	abc	1.56	bc	
23-May-18	2329	pod fill	4.22	bc	1.88	bcde	2.34	b	
30-May-18	2590	ripening	5.69	a	2.07	bcd	3.63	a	
6-Jun-18	2827	swathing	5.02	ab	1.28	de	2.44	b	1.31

† Pods included developing seeds through the 30 May sampling but were separated from seeds for the 6 June sampling.
‡ Values within a column followed by the same letter are not different at α=0.05.

Table 3.17. Accumulation and partitioning of sulfur in the canola variety Surefire at high and low plant densities sampled near Manhattan, KS in 2018.

Date	Growing degree days	Developmental stage	Total plant		Vegetative		Pod†		Seed	
			High	Low	High	Low	High	Low	High	Low
			g m^{-2}							
12-Apr-18	1467	rosette	0.42 a‡	0.24 b	0.42 a	0.24 b				
19-Apr-18	1510	bolt	0.45 a	0.27 b	0.45 a	0.27 b				
26-Apr-18	1586	bloom	0.69 a	0.49 b	0.69 a	0.49 b				
3-May-18	1760	pod development	1.12 a	0.67 b	1.12 a	0.67 b				
10-May-18	1969	pod fill	1.48 a	0.86 b	1.39 a	0.83 b	0.09	0.04		
16-May-18	2165	mid-pod fill	1.43 a	0.73 b	1.08 a	0.62 b	0.35 a	0.13 b		
23-May-18	2369	pod fill	1.42	1.23	0.75	0.57	0.67	0.65		
30-May-18	2630	pod fill	1.55	1.17	0.67	0.49	0.88	0.67		
6-Jun-18	2867	ripening	1.50 a	1.07 b	0.44 a	0.30 b	0.56	0.39	0.52	0.37
11-Jun-18	3075	swathing	1.56 a	1.15 b	0.57 a	0.39 b	0.58 a	0.40 b	0.40	0.36

† Pods included developing seeds through the 30 May sampling but were separated from seeds for the 6 June and 11 June samplings.
‡ Values within a row and plant part grouping followed by different letters are significantly different at α=0.05.

Table 3.18. Date, variety, and plant density effects on accumulation and partitioning of sulfur in the Surefire-Wichita experiment across dates sampled near Manhattan, KS in 2019.

Main effect	Growing degree days	Developmental stage	Total plant		Vegetative		Pod†		Seed	
Date:			g m^{-2}							
2-Nov-18	760	fall rosette	0.70	ij‡	0.70	jk				
17-Dec-18	827	fall rosette	0.89	ij	0.89	ij				
22-Mar-19	955	spring rosette	0.25	j	0.25	k				
5-Apr-19	1098	early bolt	0.69	ij	0.69	jk				
12-Apr-19	1229	bolt	1.34	hi	1.34	i				
19-Apr-19	1342	beginning bloom	1.91	h	1.91	gh				
26-Apr-19	1482	pod development	2.73	g	2.73	def				
2-May-19	1557	pod fill	3.04	g	2.98	cde				
9-May-19	1682	pod fill	3.85	f	3.35	abc	0.50	e		
15-May-19	1799	pod fill	4.56	ef	3.49	ab	1.07	d		
22-May-19	1960	mid-pod fill	6.15	bc	3.71	a	2.44	b		
29-May-19	2150	pod fill	5.07	de	3.05	bcd	1.57	c	0.46	c
5-Jun-19	2373	pod fill	6.44	b	2.57	ef	2.58	b	1.30	b
12-Jun-19	2574	ripening	7.46	a	2.32	fg	3.16	a	1.99	a
17-Jun-19	2733	swathing	5.59	cd	1.83	h	2.34	b	1.42	b
24-Jun-19	2953	harvest	5.43	cd	1.94	gh	2.34	b	1.14	b
Variety:										
Surefire			3.35	B	2.01	B	1.93		1.18	
Wichita			3.66	A	2.21	A	2.07		1.34	
Plant density:										
High			3.69	A	2.15		2.22	A	1.36	A
Low			3.32	B	2.06		1.78	B	1.16	B

† Pods included developing seeds through the 29 May sampling but were separated from seeds for the 5 June through 24 June samplings.

‡ Values within a column followed by the same letter are not different at α=0.05. Lowercase letters are used for date effects. Uppercase letters are used for variety and plant density effects.

Table 3.19. Tests of significance for iron response to main effects of date, density, variety, and their interactions for experiments conducted near Manhattan, KS 2017-2019.

Study	Source of variance	Total plant	Vegetative	Pod	Seed
		probability of > F			
Wichita	Date	0.0116	<0.0001	<0.0001	0.0520
Surefire	Date	<0.0001	<0.0001	<0.0001	0.4071
	Density	<0.0001	<0.0001	<0.0001	0.0165
	Date x Density	0.2565	0.0266	0.2206	0.8124
Surefire-Wichita	Date	<0.0001	<0.0001	<0.0001	<0.0001
	Variety	0.0925	0.1166	0.3317	0.4066
	Date x Variety	0.8788	0.8878	0.2116	0.4495
	Density	0.1836	0.3039	0.0188	0.0898
	Date x Density	0.2601	0.2205	0.6757	0.0320
	Variety x Density	0.0712	0.0944	0.0339	0.5182
	Date x Variety x Density	0.9690	0.9665	0.0698	0.3949

Table 3.20. Accumulation and partitioning of iron in the canola variety Wichita sampled near Manhattan, KS in 2018.

Date	Growing degree days	Developmental stage	Plant		Vegetative		Pod†		Seed
			g m^{-2}						
12-Apr-18	1427	rosette	0.049	b‡	0.049	bc			
19-Apr-18	1470	bolt	0.044	b	0.044	cd			
26-Apr-18	1546	beginning bloom	0.106	a	0.106	a			
3-May-18	1720	pod development	0.062	b	0.062	b			
10-May-18	1929	pod fill	0.040	b	0.032	de	0.008	d	
16-May-18	2125	mid-pod fill	0.047	b	0.028	e	0.019	bc	
23-May-18	2329	pod fill	0.043	b	0.019	ef	0.024	ab	
30-May-18	2590	ripening	0.059	b	0.028	e	0.031	a	
6-Jun-18	2827	swathing	0.074	ab	0.011	f	0.015	cd	0.048

† Pods included developing seeds through the 30 May sampling but were separated from seeds for the 6 June sampling.
‡ Values within a column followed by the same letter are not different at α=0.05.

Table 3.21. Date and plant density effects on accumulation and partitioning of iron in the Surefire experiment across dates sampled near Manhattan, KS in 2018.

Main effect	Growing degree days	Developmental stage	Plant		Vegetative		Pod†		Seed	
Date:			g m^{-2}							
12-Apr-18	1467	rosette	0.024	c‡	0.024	b				
19-Apr-18	1510	bolt	0.022	c	0.022	bc				
26-Apr-18	1586	bloom	0.047	a	0.047	a				
3-May-18	1760	pod development	0.052	a	0.052	a				
10-May-18	1969	pod fill	0.023	c	0.022	bc	0.001	e		
16-May-18	2165	mid-pod fill	0.027	bc	0.023	b	0.004	d		
23-May-18	2369	pod fill	0.028	bc	0.017	bc	0.011	ab		
30-May-18	2630	pod fill	0.034	b	0.022	b	0.012	a		
6-Jun-18	2867	ripening	0.024	c	0.008	d	0.007	c	0.009	
11-Jun-18	3075	swathing	0.034	b	0.015	c	0.009	b	0.010	
Plant density:										
High			0.037	A	0.030	A	0.008	A	0.011	A
Low			0.026	B	0.021	B	0.006	B	0.007	B

† Pods included developing seeds through the 29 May sampling but were separated from seeds for the 6 June through 11 June samplings.
‡ Values within a column followed by the same letter are not different at α=0.05. Lowercase letters are used for date effects. Uppercase letters are used for variety and plant density effects.

Table 3.22. Accumulation and partitioning of iron in the canola variety Surefire at high and low plant densities sampled near Manhattan, KS in 2018.

Date	Growing degree days	Developmental stage	Plant		Vegetative		Pod		Seed	
			High	Low	High	Low	High	Low	High	Low
			g m^{-2}							
12-Apr-18	1467	rosette	0.032 a	0.015 b	0.032 a	0.015 b				
19-Apr-18	1510	bolt	0.028 a	0.016 b	0.028 a	0.016 b				
26-Apr-18	1586	bloom	0.053	0.041	0.053	0.041				
3-May-18	1760	pod development	0.063	0.041	0.063	0.041				
10-May-18	1969	pod fill	0.030 a	0.016 b	0.028 a	0.016 b	0.001 a	0.001 b		
16-May-18	2165	mid-pod fill	0.031	0.023	0.025	0.021	0.006 a	0.002 b		
23-May-18	2369	pod fill	0.029	0.027	0.018	0.016	0.011	0.010		
30-May-18	2630	pod fill	0.035	0.033	0.023	0.021	0.014 a	0.010 b		
6-Jun-18	2867	ripening	0.026	0.021	0.009	0.008	0.007	0.006	0.010	0.007
11-Jun-18	3075	swathing	0.042 a	0.026 b	0.020 a	0.011 b	0.010	0.008	0.012	0.008

† Pods included developing seeds through the 30 May sampling but were separated from seeds for the 6 June and 11 June samplings.
‡ Values within a row and plant part grouping followed by different letters are significantly different at α=0.05.

Table 3.23. Date, variety, and plant density effects on accumulation and partitioning of iron in the Surefire-Wichita experiment across dates sampled near Manhattan, KS in 2019.

Main effect	Growing degree days	Developmental stage	Plant		Vegetative		Pod†		Seed	
Date:			g m^{-2}							
2-Nov-18	760	fall rosette	0.051	f‡	0.051	de				
17-Dec-18	827	fall rosette	0.409	a	0.409	a				
22-Mar-19	955	spring rosette	0.293	b	0.293	b				
5-Apr-19	1098	early bolt	0.200	c	0.200	c				
12-Apr-19	1229	bolt	0.081	def	0.081	d				
19-Apr-19	1342	beginning bloom	0.057	ef	0.057	de				
26-Apr-19	1482	pod development	0.058	ef	0.058	de				
2-May-19	1557	pod fill	0.241	bc	0.240	bc				
9-May-19	1682	pod fill	0.253	bc	0.245	bc	0.007	e		
15-May-19	1799	pod fill	0.105	de	0.093	d	0.012	ed		
22-May-19	1960	mid-pod fill	0.121	d	0.092	d	0.029	a		
29-May-19	2150	pod fill	0.086	def	0.050	de	0.023	cb	0.013	c
5-Jun-19	2373	pod fill	0.074	def	0.026	e	0.025	ab	0.023	b
12-Jun-19	2574	ripening	0.078	def	0.025	e	0.018	cd	0.035	a
17-Jun-19	2733	swathing	0.060	ef	0.024	e	0.012	ed	0.025	b
24-Jun-19	2953	harvest	0.061	ef	0.024	e	0.012	ed	0.024	b
Variety:										
Surefire			0.131		0.116		0.016		0.023	
Wichita			0.147		0.131		0.018		0.025	
Plant density:										
High			0.146		0.128		0.019	A	0.026	
Low			0.133		0.118		0.015	B	0.023	

† Pods included developing seeds through the 29 May sampling but were separated from seeds for the 5 June through 24 June samplings.
‡ Values within a column followed by the same letter are not different at α=0.05. Lowercase letters are used for date effects. Uppercase letters are used for variety and plant density effects.

Chapter 4 - Yield formation factors of winter canola in northeast Kansas

Abstract

The relationship between canola (*Brassica napus* L.) yield and yield forming factors is unclear. Due to canola's ability to adjust its architecture to suit environmental conditions, it is difficult to understand yield relationships and make yield predictions. The objective of this study was to determine yield formation factors that contribute to yield and are potentially useful indicators for predicting yield. Yield predictions can guide in-season production decisions and are required for accurate crop appraisal. Data were collected from 2017 to 2019 in Manhattan, KS. Measurements of dry matter (DM), plant, pod, and seed yield components were recorded at several sampling dates each season. Plant DM was positively correlated to yield with a maximum correlation value of 0.85 at the beginning of ripening. Seed DM was positively correlated yield with a maximum correlation value of 0.82, which also occurred at the beginning of ripening. Plant height was positively and strongly correlated to yield for most of the growing season. Its greatest correlation value was 0.82 at the end of pod fill. Pod number on the main raceme was also positively and strongly correlated with yield from pod fill until the end of ripening, with a maximum correlation value of 0.89 at the end of pod fill. Pods m^{-2} had a strong positive correlation with yield at the end of pod fill and the beginning of ripening. Seed volume was strongly correlated with yield at the beginning of ripening with a value of 0.82. It was also positively correlated through the rest of the season. The earlier indicators of yield like plant DM and height would be useful for producers to make in-season decisions. The mid-season indicators were main raceme pod number and pods m^{-2},

which could still be useful to producers, but would more likely be used for crop appraisal. The late season indicators of seed DM and seed volume likely would be used only for crop appraisal. Although strong correlations with yield were identified, the usefulness of this data could still be based largely upon growing conditions.

Introduction

The relationships between yield components and yield formation factors and yield in canola are still unclear (Zhang et al., 2011). Canola plants have the ability to adjust to environmental conditions by directing resources to different yield components. Components like pods per plant and thousand seed weight could compensate for each other in stressful situations. This results in inconsistent conclusions about the relationship between seed yield and yield components in diverse environments and conditions (Ma et al., 2015). Yield component compensation and inconsistent conclusions about optimum yield formation conditions make it difficult to understand the components that contribute the most to yield in diverse environments and would be the most useful in predicting yields.

Canola plant architecture can change to suit a given situation by adjusting branches per plant, pods per plant, seeds per pod, and thousand seed weight. Jacob et al. (2012) and Clarke and Simpson (1978) agree that high seeding rates are correlated with decreased pods per plant. However, Jacob et al. (2012) found the most pods per plant were associated with an intermediate seeding rate, a medium amount of pods per plant at a low seeding rate, and the fewest pods per plant at a high seeding rate. The authors also found the greater number of pods per plant increased the number of seeds per unit area and seed yield (Jacob et al., 2012). Clarke and Simon (1978) also found the number of pods per plant was decreased with increased seeding rate. Another way plant architecture can change in response to management and environmental conditions is by adjusting the number of branches. The number of branches per plant decreases as seeding rate increases in response to the increased number of plants in an area (Clarke and Simpson, 1978; Jacob et al., 2012). These studies suggest that pods per plant is a yield component that is closely correlated to yield, regardless of other plant architecture changes. Plant density is also determined by row spacing. In wider rows plants are forced closer together and intra-row competition is increased. However, Morrison et al. (1990) found that yield components were not affected by row spacing consistently, but that narrow rows yielded greater than wide rows due to decreased plant competition. These findings are consistent with Young et al. (2013) and Christensen and Drabble (1984); wider rows yielded less than narrow rows. Yield components are fundamental determinants of yield that can be affected by plant density, but there are other yield formation factors to consider.

Plant growth also contributes to yield formation. A plant with greater leaf area can increase photosynthesis because it intercepts more light. Hybrid canola varieties tend to grow more vigorously and robustly than open-pollinated (OP) varieties, putting on vegetative growth more quickly. This works well for spring canola, but it can be a challenge for winter canola, because too much fall growth can increase winter kill in the southern Great Plains (Bushong et al., 2018; Stamm and Ciampitti, 2015). Decreased winter survival in hybrids can cause them to perform similarly to OP varieties (Showalter and Roozeboom, 2017). Greater leaf area means more dry matter can be produced (Ma et al., 2015). Dry matter at the canola six-leaf stage is closely correlated to dry matter at maturity, and dry matter at maturity is correlated to pods m^{-2} and seeds m^{-2} (Zhang et al., 2011). Alizadeh and Allameh (2015) and Ma et al. (2015) found that canola seed yield is related to plant height. Greater height increases the potential for vegetative growth and photosynthetic activity (Ma et al., 2015). The raceme length increases with plant height, and there is more space to set flowers and pods (Alizadeh and Allameh, 2015). Plant growth is a yield formation factor that contributes to yield component performance and seed yield.

Canola's plasticity or ability to adjust its architecture makes it difficult to predict yield and the contributions to yield of the various yield components. The number of pods per plant or per unit area has a strong positive relationship with yield, suggesting it is one of the most important yield components (Clarke and Simpson, 1978; Jacob et al., 2012; Zhang et al., 2011). There are other contributors of yield formation that can also be used as indicators of yield. Greater plant growth, dry matter, and plant height increase the ability of the plant to set seed and fill the seed (Alizadeh and Allameh, 2015; Ma et al., 2015). Growing conditions are different from year to year and location to location, which causes plants to change their architecture to cope with the conditions.

The objective of this study was to determine yield formation factors that contribute to yield and are potentially useful indicators in predicting yield. Our hypothesis was that plant DM, pod DM, seed DM, number of pods in a given area, and seed volume in a given area would have strong positive correlations with yield. If there is more DM accumulated in the plant, that generally means there are more resources to allocate to yield. Therefore, increased DM increases yield, and is the two are positively correlated. In other studies, number of pods has proven to have a strong positive correlation to yield as well. Seed volume should also have a strong relationship with yield. These are the factors that are expected be strong indicators and contributors of yield.

Materials and Methods

Samplings and experiments were conducted in the 2016-17, 2017-18, and 2018-19 growing seasons near Manhattan, Kansas at the Kansas State University (KSU) Agronomy Research Farms. The 2016-17 sampling and the 2018-19 experiment were located at the Agronomy North Farm facility (39.205511, -96.595507). The 2017-18 sampling and experiment were located at the Ashland Bottoms facility (39.124666, -96.613971). The Köppen-Geiger climate classification maps placed these locations in the Dfa class. This class is described as a hot-summer humid continental climate with a cold continental group, without dry season precipitation type, and a hot summer heat level (Beck et al., 2018; Kottek et al., 2006). However, this region is geographically close to a Cfa classification, which is a humid subtropical climate (Beck et al., 2018). The Manhattan area has a mean annual maximum temperature of 19.6°C (67.2°F), a minimum of 5.9°C (42.6°F), and average annual rainfall of 90.4 cm (35.59 in.) (US Climate Data, 2019).

Three OP winter canola varieties were used in these studies, and all were developed at Kansas State University in Manhattan, Kansas. Riley (Stamm et al., 2012) and Wichita (Rife et al., 2001) are classified as medium maturity varieties, and Surefire (Stamm et al., 2019) is classified as a medium-to-full maturity variety. Different varieties were used because they were readily available at the time. Hereafter, the studies are referred to by the variety used and the type of study: the Riley sampling in 2016-17, the Wichita sampling in 2017-18, the Surefire experiment in 2017-18, and the Surefire-Wichita experiment in 2018-19. The Riley sampling was located at the North Farm, the Wichita sampling at Ashland Bottoms, the Surefire experiment at Ashland Bottoms, and the Surefire-Wichita experiment at the North Farm. The Riley and Wichita samplings were sequential sampling studies, each with one variety at a consistent seeding rate. The Surefire experiment included one variety at high (294,000 plants ha^{-1}; 119,000 plants ac^{-1}) and low (142,000 plants ha^{-1}; 57,500 plants ac^{-1}) plant populations. These populations were established by hand thinning half of the plots, randomly selected within each replication, to half of the established spring stand. The Surefire-Wichita experiment included the Surefire and Wichita varieties at high (741,000 plants ha^{-1}; 300,000 plants ac^{-1}) and low (370,500 plants ha^{-1}; 150,000 plants ac^{-1}) seeding rates. The spring stands were 558,000 plants ha^{-1} and 378,600 plants ha^{-1}. The plant densities in the Surefire experiment were determined by using an already established winter canola stand and then hand-thinning. The plant densities in the Surefire-Wichita experiment were planted at those densities. Due to the differences in how the plant densities were determined, each experiment had different ranges of high and low densities. However, the recommended seeding rate for OP varieties in the southern Great Plains is 300,000 to 500,000 seeds ac^{-1} (Bushong et al., 2018).

All studies were planted on silt loam or silty clay loam soils (USDA Web Soil Survey, 2019). The Riley sampling was located on a Smolan silt loam, 1 to 3% slopes, fine, smectitic, mesic Pachic Argiustoll (USDA Web Soil Survey, 2019). The Wichita sampling was located on a Rossville silt loam, very rarely flooded, fine-silty, mixed, superactive, mesic Cumulic Hapludoll with 18 to 35% clay and 0 to 20% sand (USDA Web Soil Survey, 2019) soil type. The Surefire experiment was located on a Belvue silt loam, rarely flooded, coarse-silty, mixed, superactive, nonacid, mesic Typic Udifluvent with 5 to 18% clay and 15 to 75% sand (USDA Web Soil Survey, 2019). The Surefire-Wichita site was a Wymore silty clay loam, 1 to 3% slopes, eroded, fine, smectitic, mesic Aquertic Argiudoll with 42 to 55% clay and 0 to 5% sand (USDA Web Soil Survey, 2019).

The equipment used for field operations remained the same across studies. The planter was shop-fabricated with Great Plains 00HD (Great Plains Ag, Salina, KS) row units and Wintersteiger small belted cones (WINTERSTEIGER Inc., Salt Lake City, Utah). In the Riley sampling, the rows were 24.1 cm (9.5 in.) apart and 25.4 cm (10 in.) apart in the other three studies. Each plot was six rows wide. All studies were swathed with a 3.66 meter (m) (5 foot (ft.)) plot swather (Swift Machine and Welding Ltd. Swift Current, SK, Canada) and combine harvested with a Massey Ferguson 8XP plot combine (Kincaid Manufacturing, Haven, KS). This combine was equipped with a Harvest Master Classic GrainGage (Juniper Systems Inc., Logan, UT) and Mirus 3.1 (Juniper Systems Inc., Logan, UT) software.

Crop management practices were implemented to assure success of these studies in field conditions. Seedbed preparation for the Riley sampling and Surefire-Wichita experiment included mechanical tillage with a tandem disk and field cultivator to incorporate trifluralin that was applied by a SpraCoupe sprayer (AGCO, Duluth, GA). The Surefire and Wichita experiments had the same field preparation but were also roller packed to create a firm seedbed. Trifluralin was applied by a RoGator (AGCO, Duluth, GA) for those experiments. Nitrogen, phosphorus, and sulfur fertilizers were applied according to KSU winter canola management recommendations and soil test results for each location (Table 4.1). The plots were monitored for weed competition throughout each growing season, and herbicides were applied as needed (Table 4.1). All in-season herbicide applications and spring nitrogen applications were applied with a 110 gallon three-point sprayer (Ag Spray Equipment Inc., North Sioux City, SD) equipped with Chafer stream bars (Needham Ag Technologies, Calhoun, KY). The study areas were also hand weeded at spring green-up if needed. The most prevalent weeds were volunteer wheat (*Triticum aestivum*), blue mustard (*Chorispora tenella*), and horseweed (*Conyza canadensis*). Other field operations are presented in Table 4.1.

The Riley, Surefire, and Surefire-Wichita studies had similar treatment structures and sampling schemes. Each whole plot was divided into a large machine-harvest subplot and several small biomass-sample subplots. The dimensions differed in each experiment due to different row spacings, bordering considerations, or other constraints (Table 4.2). In the Riley sampling and Surefire experiment, two biomass subsamples were taken from each biomass-sample subplot.

Due to the amount of time required to process fresh samples and labor limitations the number of subsamples were reduced in the Wichita sampling and Surefire-Wichita experiment to one biomass sample from each biomass-sample subplot. The sample area of 0.84 m^2 (9 ft^2) remained consistent across all experiments to align with National Crop Insurance Services (NCIS) canola yield estimation procedures. The Wichita sampling was conducted within OP and hybrid variety yield trials (Stamm and Dooley, 2019). Wichita was planted in the borders of the trials, and each trial included three Wichita plots randomly located in each block. The trial plots were used to determine machine-harvest seed yield. Bordered biomass-sample subplots were randomly located and replicated by block in the trial borders for this sampling.

The machine-harvest subplots were used to determine machine-harvested seed yield, which was used in conjunction with data collected earlier in the season to analyze relationships between yield components, seed yield, and oil yield. Due to planting and winter weather complications, fall stands were collected only in the machine-harvest subplots for the Surefire-Wichita experiment. Spring stand counts in machine-harvest subplots were recorded in all studies at spring green-up. Stand counts were determined by counting all living plants in the center two rows of the subplots. At harvest, subplot weight, seed moisture, and test weight were collected to calculate seed yield. Thousand seed weight (TSW) was determined for the Surefire, Wichita, and Surefire-Wichita studies by weighing 1000 seeds counted using an International Marketing and Design Corp. seed counter (San Antonio, TX), model 850-3. Seed samples from all studies were sent to the Brassica Breeding and Research program at the University of Idaho for near-infrared spectroscopy (NIRS) oil content estimation.

Biomass samples were collected on a weekly or biweekly basis from the biomass sample subplots from spring green-up until swathing. In the Surefire-Wichita experiment, additional biomass samples were collected in the fall and at swathing. The final biomass samples for the Surefire-Wichita experiment were cured in a greenhouse for one week to simulate field swathing conditions. For all studies, plant number, height, developmental stage, and fresh weight were noted in the field at each sample date. Samples were transported to the laboratory where pods were separated from leaf and stem material, and pod number and fresh pod weight were recorded. Subsamples of vegetative matter and pod matter were placed in a forced-air dryer for a minimum of four days at 60°C before dry subsample weights were recorded. At later sample dates, the pod samples were threshed using a small BT14 model ALMACO belt thresher (Nevada, IA) to determine seed volume, weight, and thousand seed weight. Pods were only threshed when the seed was mature and hard enough to be separated from the pod material. Samples could be threshed from the last one or two sample dates in the Riley, Surefire, and Wichita studies. The last five sampling dates in the Surefire-Wichita experiment were threshed. In some cases, there was too much plant material to process in a timely manner, and a subsample was processed in the laboratory. In the Surefire experiment, if there were more than 20 plants per sample, only 20 plants were kept to process. In the Wichita sampling and Surefire-Wichita experiment, if there were more than 30 plants per sample, 30 plants were kept to process. Different plant numbers were used because the Surefire plant populations were lower, and the plants were larger than the plants were in the Wichita and Surefire-Wichita studies. More plants were needed in the Wichita and Surefire-Wichita studies to ensure enough plant dry matter for nutrient analysis. Additional data were collected to characterize canopy architecture in the Surefire, Wichita, and Surefire-Wichita studies were: average branch count, raceme length, average pod count on the main raceme, and the representative pod length of pods in the bottom, middle, and top of the pod.

The yield component and machine harvest yield data from each plot were used to evaluate winter canola yield formation. The yield components that were evaluated were dry matter in each plant part, plant population, pods per plant, pods per main raceme, pods per unit area, seed volume per unit area, and TSW. Some other yield-forming factors that were considered were plant height, length of the main raceme, pod length, test weight (TW), and branches per plant. Sample dates that were specific in each growing season were standardized into ten sample dates to fit specific growth stages, this made it possible to analyze relationships for all growing seasons. Samples were designated as follows: 0= fall rosette, 1= spring rosette, 2= bolting, 3 = beginning of bloom, 4 = blooming and pod set, 5 = pod fill, 6 = end of pod fill, 7 = beginning of ripening, 8 = ripening 1, 9 = ripening 2, 10 = harvest. Among the growing seasons there were differences in number and timing of samplings, so there were different sample sizes for many of the new sample dates. The Surefire-Wichita experiment was the only data included for the 0 and 10 sample dates, because it was the only study with samples from those stages. Relationships of yield components and other plant characteristics at each date and the machine harvest yield were examined using correlation and regression techniques. Correlation was determined using PROC CORR procedures in SAS 9.4 (SAS Institute, Cary, NC). SigmaPlot 11.0 (Systat Software, Inc., San Jose, CA) was used for the regressions and the r^2 values.

Results

Machine-harvest oil content and TSW did not show strong or consistent correlations with any of the possible yield indicators, so they are not included in these results. Machine-harvest yield data did have strong correlations with several yield indicators. Plant DM, veg DM, pod DM, seed DM, plant height, main raceme length, plant m^{-2}, main raceme pod number, pod length at the bottom of the main raceme, pod m^{-2}, seed volume m^{-2}, TSW, and TW showed stronger and more consistent correlations at several sample dates with yield than the other possible yield indicators. Number of branches, pod length at the middle and top of the main raceme, and pods per plant are not included in these results due to their lack of strong and consistent correlations to yield.

Dry matter

Plant DM had a positive correlation with yield greater than 0.50 from bolting until the beginning of ripening. Correlations were greater than 0.70 at bolting and the end of pod fill. The strongest correlation was at sampling date 7, the beginning of ripening. Plant DM was also positively correlated to yield at spring rosette and through ripening and harvest with correlations between 0.20 and 0.49 (Table 4.3). The strong correlations are illustrated in regression plots presenting the relationships between DM at different stages and seed yield. The r^2 of a linear regression at bolting was 0.50, 0.47 at the beginning of bloom, and 0.72 at the beginning of ripening, which also had the greatest correlation to yield among the plant DM sample dates. The rest of the sample dates were fit to a polynomial curve. The r^2 during bloom and pod set was 0.40, 0.41 during pod fill, 0.52 at the end of pod fill, and 0.60 in the first half of ripening (Figure 4.1, Figure 4.2). Vegetative DM had similar correlation and r^2 values to the plant DM values, especially at early sample dates (Table 4.3). Due to the similarities and the usefulness of the plant material all together, the vegetative correlations to yield are not discussed in detail here.

At most sample dates, pod DM had correlation values greater than 0.20. However, sample date 7 was the only date that the correlation value was greater than 0.50 (Table 4.3). The r^2 value at date 7 was 0.72, and 0.56 at date 8. Both regressions were fit to a polynomial curve where the greatest yields corresponded with a medium amount of pod DM (Figure 4.3).

For seed DM, yield correlation values were greater than 0.50 for three of the five sample dates. Sample date 8, the first half of ripening, and sample date 10, harvest, were 0.54 and 0.53, respectively. Sample date 7, beginning ripening, was strongly and positively correlated to yield with a value of 0.82 (Table 4.3). The regressions at date 7 and 8 were fit to polynomial curves with r^2 values of 0.78 and 0.67, respectively (Figure 4.4).

Plant measurements

Other plant measurements that showed correlations to yield were plant height, main raceme length, and population. Plant height showed positive correlations at all sample dates except spring rosette, which had a very weak negative correlation. At pod set and harvest, the correlations were greater than 0.50. At bolting, pod fill, beginning of ripening, and the first half of ripening, correlations were greater than 0.70. At the end of pod fill, the plant height correlation to yield was the strongest (Table 4.4). The regressions for plant height and yield were linear at bolting, pod fill, end of pod fill, and the beginning of ripening. Through ripening and harvest, the regressions were fit to a polynomial curve. The r^2 values for these regressions ranged from 0.67 at the end of pod fill to 0.32 at harvest (Figure 4.5, Figure 4.6).

The main raceme length was measured from the bottom pod on the main raceme to the top of the main raceme. The correlation value was greater than 0.20 at the beginning of ripening and harvest and was 0.48 in the second half of ripening. The correlation at the end of pod fill was 0.54, and 0.60 at pod fill (Table 4.4). Due to the relatively low correlation values, the main raceme length regressions are not discussed here.

Plant population also had low correlations to yield and were less consistent than other possible indicators. This is because the plant densities were high enough to not be yield limiting. The greatest correlation value was at bolting. The correlations decreased until the end of pod fill when they increased to greater than 0.50 through the first half of ripening. At the fall rosette, second half of ripening, and harvest stages, the plant population correlations to yield were weak and negative (Table 4.4).

Pod measurements

Three pod measurements that showed significant correlation to yield were pod number on the main raceme, length of pods at the bottom of the main raceme, and pods m^{-2}. Of these, pod number on the main raceme was correlated with yield at most dates and had the strongest correlations. The correlation values during pod fill and the second half of ripening were greater than 0.70. The correlation values were greater than 0.80 from the end of pod fill to the first half of ripening (Table 4.5). From pod fill to the end of ripening, the r^2 values for linear regressions describing the relationship between the number of pods on the main raceme and yield ranged from 0.54 in the second half of ripening to 0.79 at the end of pod fill (Figure 4.7).

The length of pods at the bottom of the main raceme were positively correlated to yield from pod fill through ripening. The greatest correlation values were at the end of pod fill and beginning ripening, respectively. There were also correlations greater than 0.50 during pod fill and the second half of ripening (Table 4.5).

Pods m^{-2} also had the greatest correlations with yield at the end of pod fill and the beginning of ripening. Other correlation dates of interest were during pod fill, the first half of ripening, and at harvest, all of which were greater than 0.30 (Table 4.5). From pod fill to the first half of ripening, regressions were fit to polynomial curves. The r^2 values ranged from 0.33 at pod fill to 0.65 at the beginning of ripening. These plots showed yield increasing with pods m^{-2} until about 7,000 pods, then the yield plateaued as pods m^{-2} continued to increase (Figure 4.8).

Seed measurements

Seed measurements included seed volume (mL m^{-2}), TSW, and TW. Seed volume was positively correlated with yield from the end of pod fill to harvest. The greatest correlation was 0.82 at the beginning of ripening. There were also correlations with yield greater than 0.50 in the first half of ripening and at harvest (Table 4.6). The regressions for seed volume fit a polynomial curve with r^2 values at the beginning of ripening and the first half of ripening of 0.79 and 0.65, respectively. Seed yield increased with the volume of seed until about 400 mL, then it plateaued and seed yield stayed constant while seed volume per unit area increased (Figure 4.9).

Thousand seed weight had correlation values greater than 0.30 at the end of pod fill and harvest. Correlation values increased during the first and second half of ripening. There was a weak correlation between TSW and yield at the beginning of ripening (Table 4.6).

Test weight was negatively correlated to yield only in the second half of ripening. The correlation at the end of pod fill, the beginning of ripening, and harvest were 0.29, 0.62, and 0.34, respectively. The strongest positive correlation occurred during the first half of ripening (Table 4.6).

Discussion

The possible yield indicators that had strong correlations with seed yield at several sample dates are discussed here. Ma et al. (2015) suggested greater plant growth allows more DM to accumulate due to an increased amount of photosynthetic activity. An increased amount of plant DM has been proven to be related to greater yields by Zhang et al. (2011). Plant DM in this study also showed a positive correlation to yield, and strong correlations from bolting until the beginning of ripening. The strongest correlation of 0.85 was at the beginning of ripening with an r^2 of 0.72. There were still correlations throughout ripening and harvest, but the correlation values were slightly lower. There was also an unexpectedly strong correlation of plant DM at bolting with yield of 0.71 with an r^2 of 0.50 (Figure 4.1, Figure 4.2, Table 4.3). This information could allow improved yield estimates to be determined by plant DM before pod development and through pod filling. Pod DM also showed positive correlations to yield, but not to the same extent as plant DM and seed DM. At the beginning of ripening, the correlation value was 0.55 with an r^2 value of 0.72 (Figure 4.3, Table 4.3). Seed DM had the strongest correlation, 0.82, with yield at the beginning of ripening with an r^2 value of 0.78. There were also correlations through ripening and at harvest (Figure 4.4, Table 4.3). Plant DM was strongly correlated with yield through vegetative and reproductive growth. Seed DM was more strongly correlated to yield than plant DM near the end of the season. While seed DM is expected to be closely related to yield, it does not serve as a useful predictor of yield, because it is too late in the season to make management decisions that would improve yield. However, the plant DM could be a useful indicator of yield, especially early in the vegetative growth stages when fertilizer, pesticide, and irrigation applications could be made.

Other plant measurements that were correlated to yield were plant height, main raceme length, and population. Plant height and main raceme length increase the amount of vegetative material that produces DM to translocate to grain (Alizadeh and Allameh, 2015; Ma et al., 2015). Alizadeh and Allameh (2015) also suggested an increased main raceme length could increase the number of flowers and pods on the main raceme. Plant height proved to have the strongest correlation with yield at the most sample dates when compared to main raceme length and population. Plant height had a correlation value of 0.73 and r^2 of 0.54 at bolting. There were stronger correlations from pod fill to the first half of ripening with values greater than 0.75. The strongest correlation was 0.82 with an r^2 of 0.67 at the end of pod fill (Figure 4.5, Figure 4.6, Table 4.4). The main raceme length had correlation values of 0.60 and 0.54 during pod fill and at the end of pod fill, respectively. The second half of ripening had a correlation value of 0.48 (Table 4.4). Plant population was positively correlated to yield from spring rosette to the first half of ripening. The strongest correlation was 0.67 at bolting. There were correlation values greater than 0.50 from pod fill through the first half of ripening (Table 4.4). Based on this data, plant height would be the most useful indicator of yield, because it had strong correlations with yield from pod fill through the first part of ripening. There were also decent correlations in earlier vegetative stages. Plant height is also a simple measurement that requires a short amount of time in the field to determine. This would allow producers time to make in-season decisions earlier.

Pod measurements that correlated with yield in this study included the number of pods on the main raceme, the length of pods at the bottom of the main raceme, and pods m^{-2}. Pods per plant did not show strong correlations with yield in this study, which contradicts the finding of Jacob et al. (2012). Due to the low correlation values, the pods per plant yield component is not discussed in detail here. Alizadeh and Allameh (2015) suggested an increase in pod number on the main raceme with an increase in main raceme length. Main raceme pods also contribute more to yield than pods from other branches (Jacob et al., 2012). This may be why there was a strong positive correlation between pod number on the main raceme and yield in this study. From pod fill to the end of ripening, the correlation values between the main raceme pod number and yield were greater than 0.70. The strongest correlation value was 0.89 with an r^2 of 0.79 at the end of pod fill (Figure 4.7, Table 4.5). At all sample dates except for pod set and harvest where there were weak correlations, there was a positive linear trend between pod number on the main raceme and yield. This means as the pod number increases, yield would continue to increase. Pod length at the bottom of the main raceme had a positive correlation to yield from pod fill to the second half of ripening. The greatest values were 0.63 and 0.60 at the end of pod fill and the beginning of ripening (Table 4.5). Pods m^{-2} had the greatest correlations with yield with values of 0.73 and 0.77 at the end of pod fill and the beginning of ripening, respectively. The regressions fit to polynomial curves had an r2 for these sample dates of 0.65 and 0.51, respectively. Since the curve showed a plateau in yield at about 7,000 pods, increasing pod number further would not increase yield drastically (Figure 4.8, Table 4.5). These findings are in agreement with Zhang et al. (2011) who also found that pods in a given area have a close relationship with seed yield. The strongest correlations at the most sampling dates occurred in the correlations between pod number on the main raceme and yield. This yield indicator might be the most useful of the three presented here because of its strong relationship with yield and the logistics of counting pods. Counting pods on the main raceme of several plants would take much less time than counting pods in a given area. While these yield relationships occur later in the season than the time of ideal management applications, they could provide insight for crop appraisals.

In most studies, yield components that included pod measurements were of more interest than yield components with seed measurements, this could be due to the difficulty and inconvenience of handling seed in the field or that pods and seeds are closely correlated. Jacob et al. (2012) found an increase in seeds per unit area and seeds per plant when there was an increase in pods per plant. Zhang et al. (2011) also determined that pods and seeds follow the same trend, and that pods in given area was more closely correlated to yield than seed weight or seeds per pod. Seed measurements in this study that had correlations with yield included seed volume, TSW, and TW. Seed volume was strongly correlated to yield with a correlation value of 0.82 and r^2 value of 0.79 fitted to a polynomial curve at the beginning of ripening. For the rest of the season, there were correlation values greater than 0.40 (Figure 4.9, Table 4.6). Thousand seed weight had correlation values greater than 0.50 at both ripening sample dates, and values greater than 0.30 at the end of pod fill and harvest (Table 4.6). Test weight was strongly correlated to yield in the first half of ripening with a value of 0.82. There were also correlation values of 0.29, 0.62, and 0.34 at the end of pod fill, the beginning of ripening, and harvest, respectively (Table 4.6). Seed volume had stronger correlations at more sampling dates than the TSW and TW. Seed volume would also be less difficult to determine in the field than the other measurements. While these relationships with yield are determined too late in the season to make much of a difference to crop management, they could benefit the work of crop appraisers.

Conclusions

The objective of this study was to determine yield formation factors that contribute to yield and are potentially useful indicators in predicting yield. Our hypothesis was that plant DM, pod DM, seed DM, number of pods in a given area, and the seed volume in a given area would have strong positive correlations with yield. Plant DM proved to be correlated with yield from early vegetative stages. It was most strongly correlated at the beginning of ripening, but the early correlations could allow producers to make in-season management decisions that could improve yields. Pod DM was not as strongly correlated with yield as we had anticipated. It had correlation values greater than 0.40 from the end of pod fill to the first part of ripening, which does not give producers time to make meaningful in-season decisions. Similarly, seed DM was correlated to yield at the end of the season, which does not help producers, but it could help with crop appraisals. Plant height was closely related to yield for most of the growing season with correlation values up to 0.82, which could be valuable for producers and crop appraisals. Unexpectedly, the main raceme pod number showed some of the greatest correlation values out of all the listed possible yield indicators. The greatest correlation value of 0.89 with an r^2 of 0.79 occurred at the end of pod fill. This is not as useful to producers as earlier season indicators, but there could be some yield improvement through management if issues are found early enough. Pods m^{-2} were closely related to yield at the end of pod fill and the beginning of ripening. These correlations are also later in the season than what would be ideal and they are not as strong as some other measurements. Again, seed volume was closely correlated to yield during ripening and harvest, which is too late to improve yield, but it could benefit late season crop appraisal. Useful yield indicators for producers to make management decisions would be plant DM, plant height, and possibly main raceme pod number. A useful indicator at the end of pod fill would be pod m^{-2}. Late season indicators would be seed DM and seed volume.

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Figures

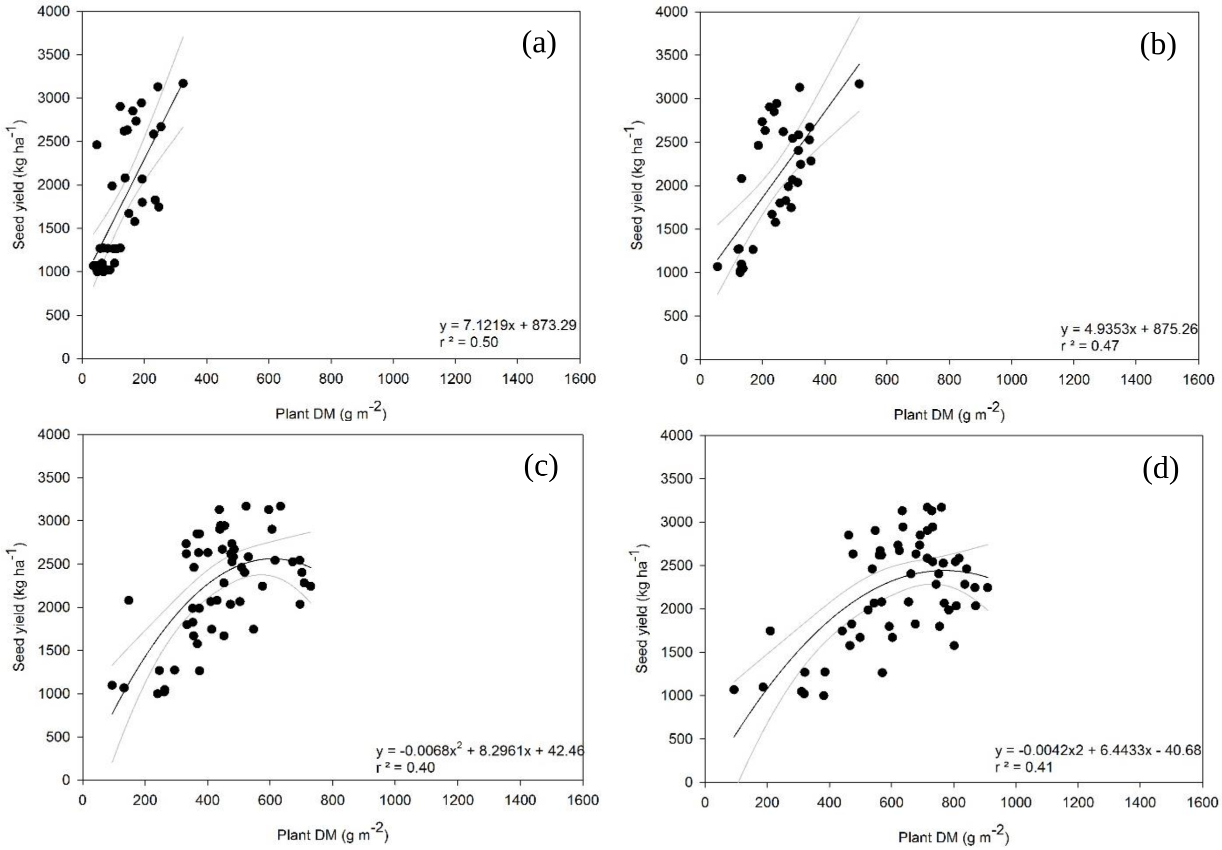


Figure 4.1. Plant DM regressions and r^2 at (a) bolting, (b) beginning of bloom, (c) pod set, and (d) pod fill near Manhattan, KS 2017-2019.

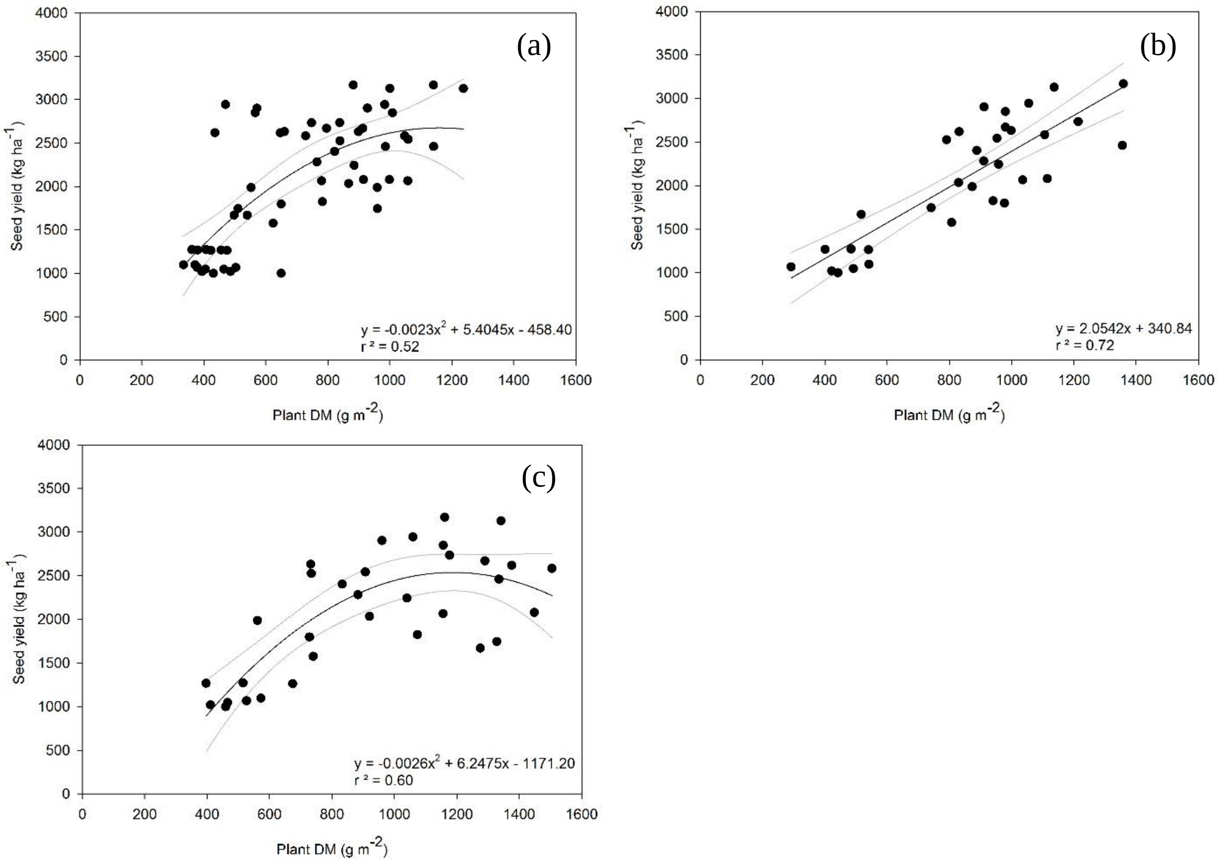


Figure 4.2. Plant DM regressions and r^2 at (a) end of pod fill, (b) beginning of ripening, and (c) first half of ripening near Manhattan, KS 2017-2019.

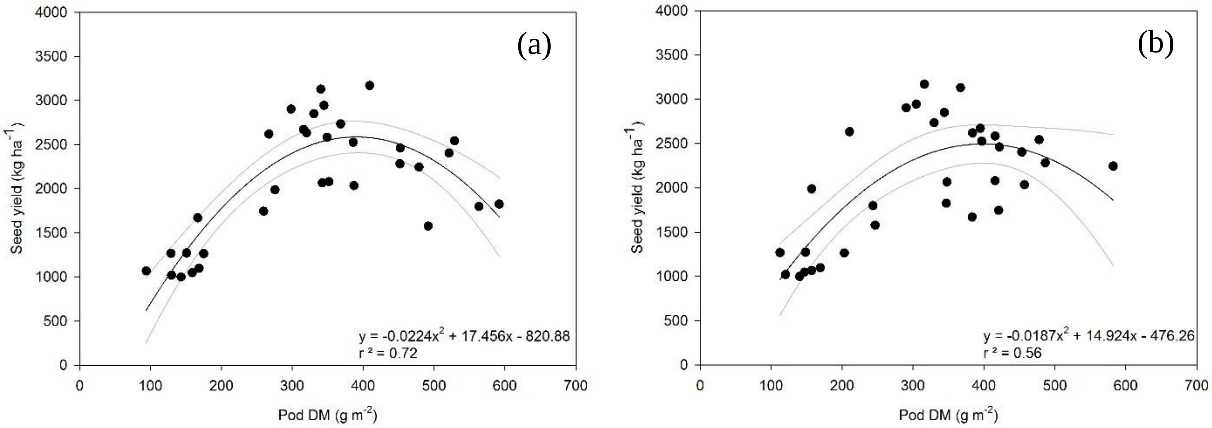


Figure 4.3. Pod DM regressions and r^2 at (a) beginning of ripening and (b) first half of ripening near Manhattan, KS 2017-2019.

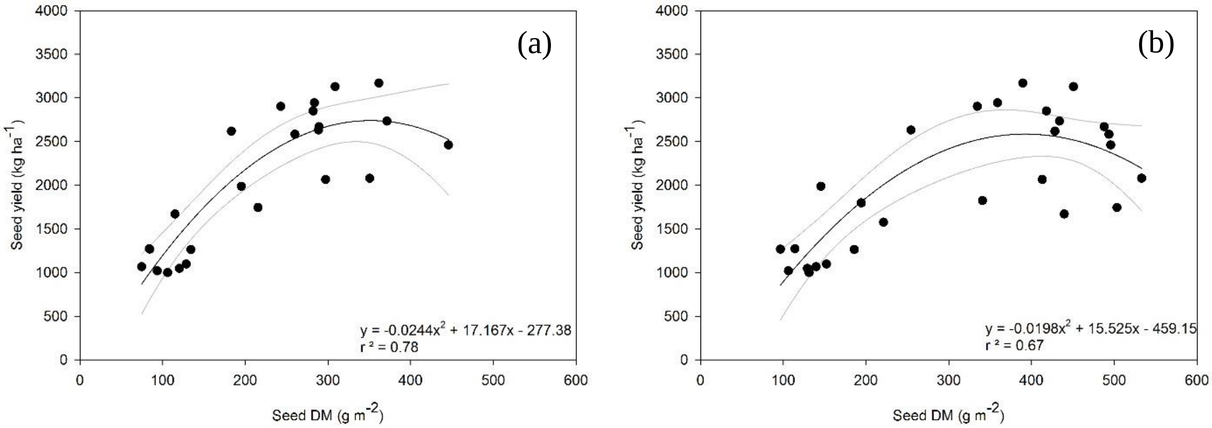


Figure 4.4. Seed DM regressions and r^2 at (a) beginning of ripening and (b) first half of ripening near Manhattan, KS 2017-2019.

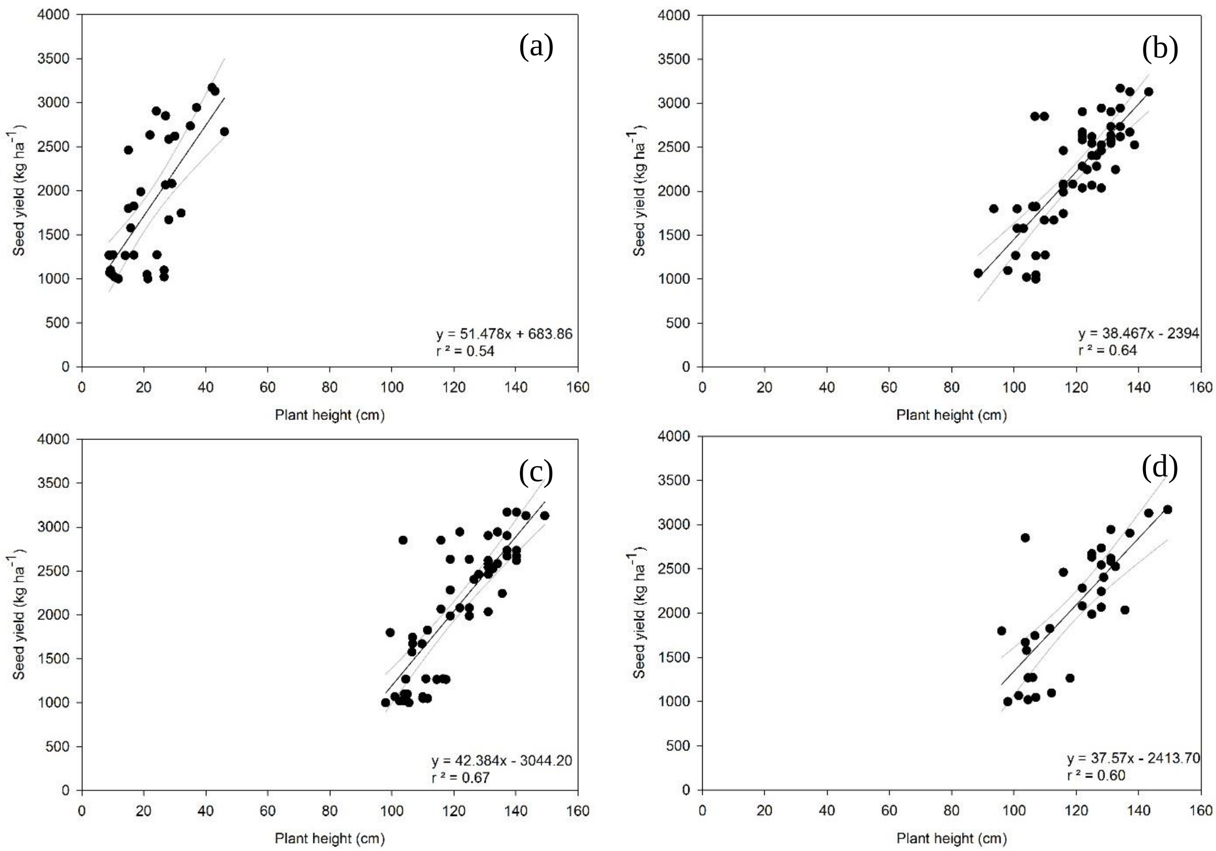


Figure 4.5. Plant height regressions and r^2 at (a) bolting, (b) pod fill, (c) end of pod fill, and (d) beginning of ripening near Manhattan, KS 2017-2019.

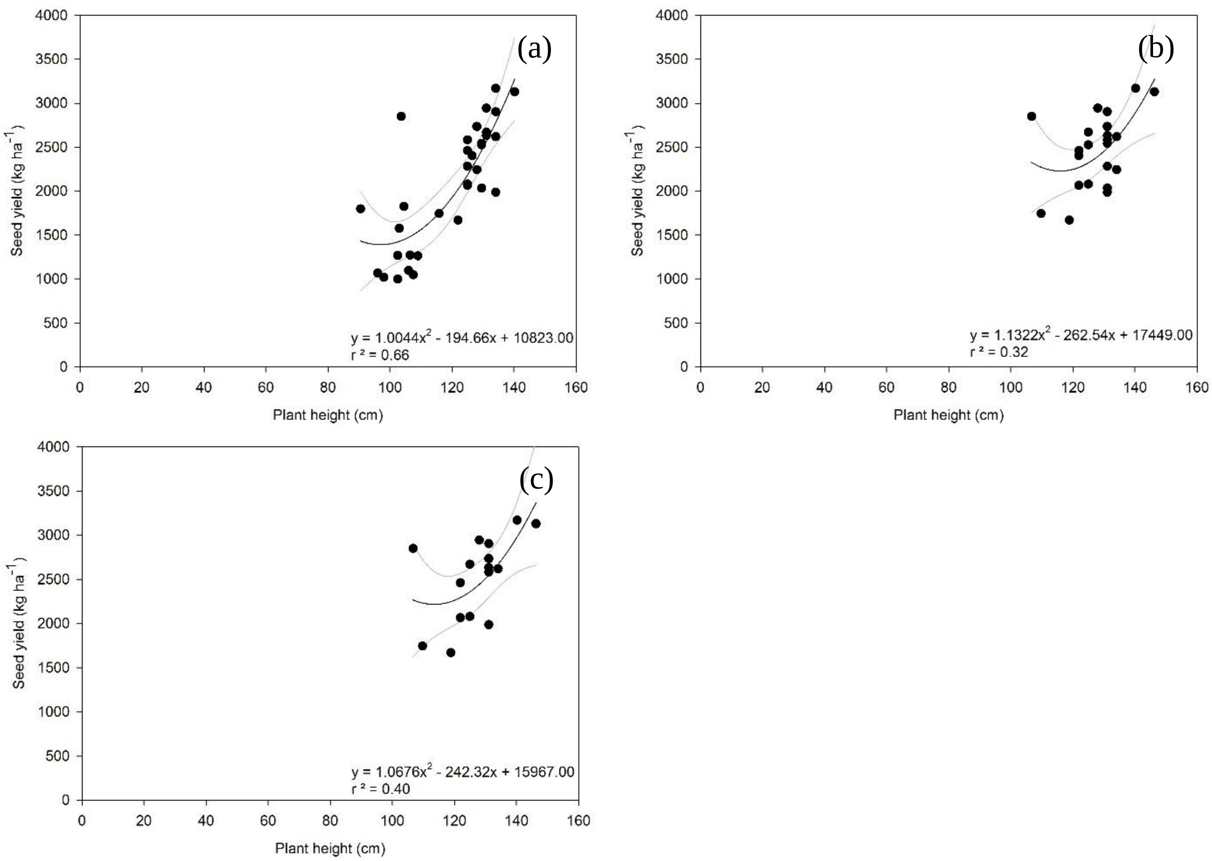


Figure 4.6. Plant height regressions and r^2 at (a) first half of ripening, (b) second half of ripening, and (c) harvest near Manhattan, KS 2017-2019.

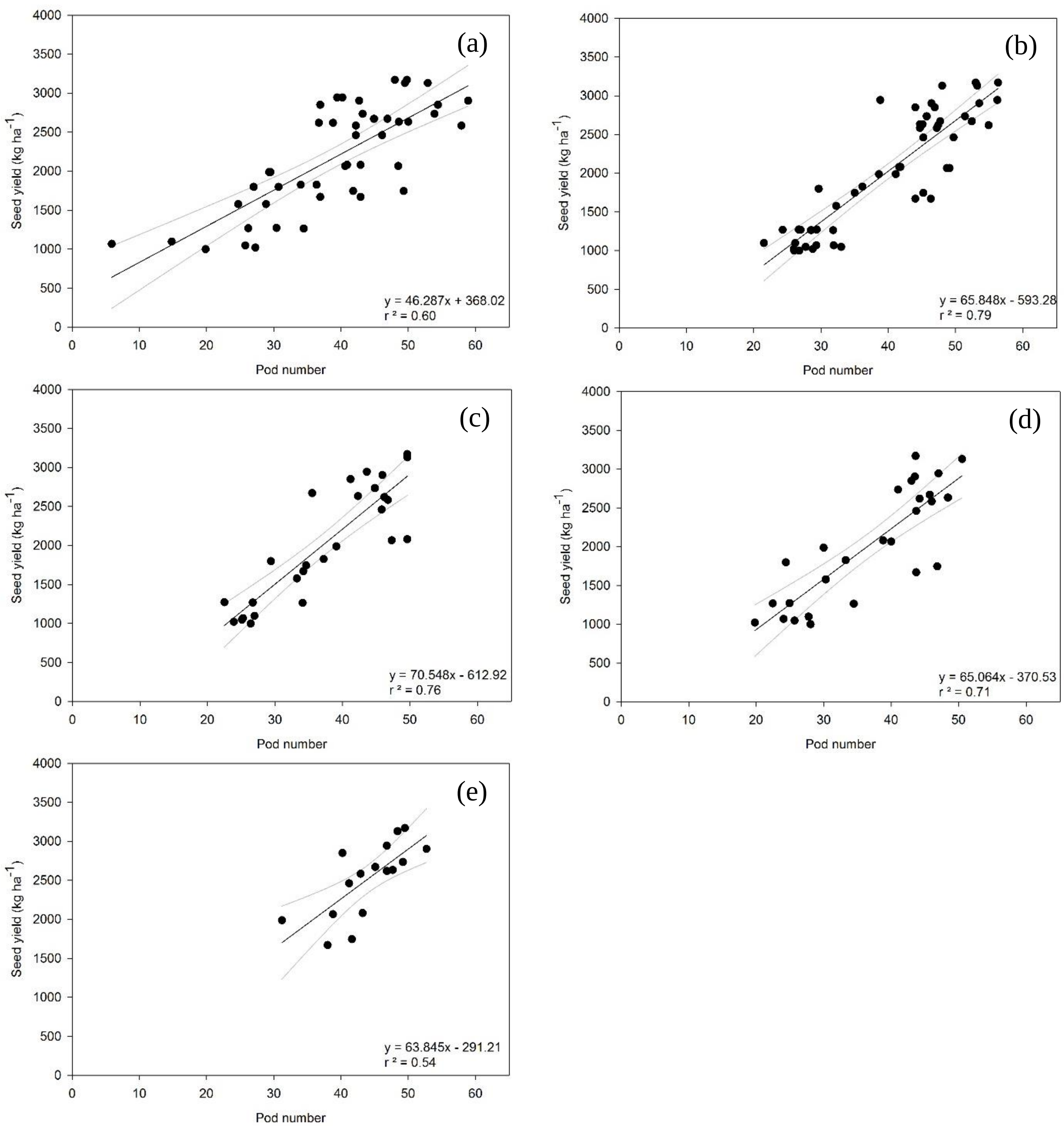


Figure 4.7. Main raceme pod number regressions and r^2 at (a) pod fill, (b) end of pod fill, (c) beginning of ripening, (d) first half of ripening, and (e) second half of ripening near Manhattan, KS 2017-2019.

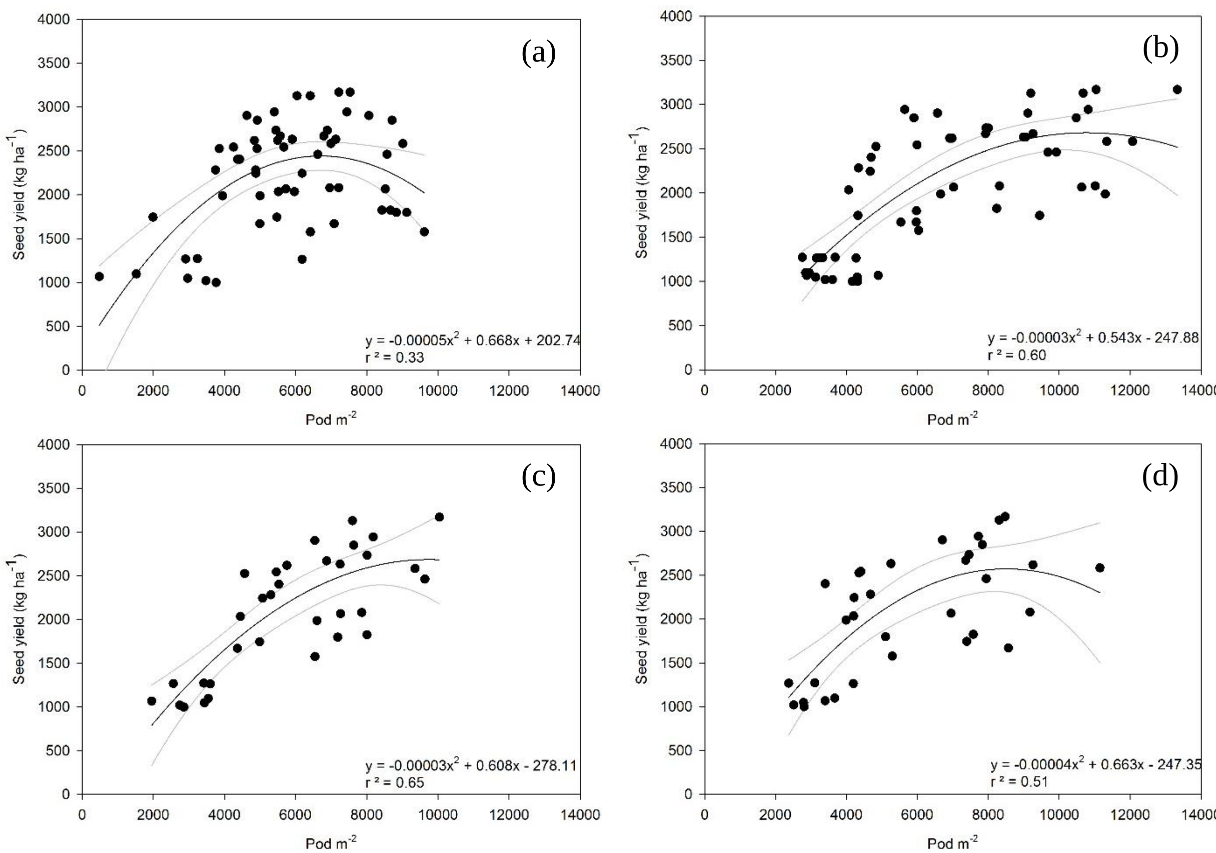
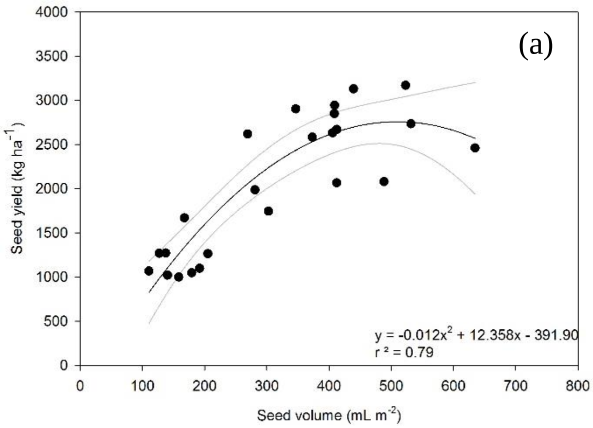


Figure 4.8. Pod m^{-2} regressions and r^2 at (a) pod fill, (b) end of pod fill, (c) beginning of ripening, and (d) first half of ripening near Manhattan, KS 2017-2019.



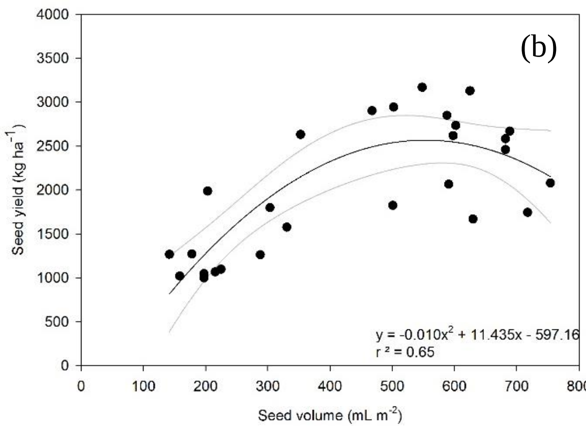


Figure 4.9. Seed volume regressions and r^2 at (a) beginning of ripening and (b) first half of ripening near Manhattan, KS 2017-2019.

Tables

Table 4.1. Field operations for field sampling and experiments conducted to assess canola biomass and nutrient accumulation near Manhattan, KS 2016-2019 near Manhattan, KS 2017-2019.

Factor	Sampling		Experiment	
	Riley	Wichita	Surefire	Surefire-Wichita
Fall† nitrogen	39.2 kg/ha (32-0-0)	39.2 kg/ha (28-0-0)	39.2 kg/ha (28-0-0)	15.7 kg/ha (10-0-0-22)
Fall phosphorus	-	33.6 kg/ha (10-34-0)	33.6 kg/ha (10-34-0)	-
Fall sulfur	22.4 kg/ha (12-0-0-24)	33.6 kg/ha (10-0-0-22)	33.6 kg/ha (10-0-0-22)	33.6 kg/ha (10-0-0-22)
Fall herbicide‡	Treflan 2.8 L/ha Assure II 730.4 ml/ha Muster 28.0 g/ha	Assure II 730.4 ml/ha Muster 21.0 g/ha Assure II 584.3 ml/ha	Assure II 657.3 ml/ha Muster 21.0 g/ha	Assure II 730.4 ml/ha Muster 28.0 g/ha
Spring nitrogen§	111.0 kg/ha (32-0-0)	107.6 kg/ha (32-0-0)	95.3 kg/ha (32-0-0)	112.1 kg/ha (28-0-0)
Spring herbicide	Muster 14.0 g/ha Assure II 657.3 ml/ha	-	-	-
Planting date	Sep. 29, 2016	Sep. 20, 2017	Sep. 19, 2017	Sep. 18, 2018
Swathing date	Jun. 8, 2017	Jun. 7 & Jun. 11, 2018	Jun. 11, 2018	Jun. 17, 2019
Harvest date	Jun. 16, 2017	Jun. 11 & Jun. 16, 2018	Jun. 13, 2018	Jul. 1, 2019

† All fertilizer applied pre-plant.

‡ Fall herbicide- Treflan [Trifluralin: a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine, 430 g kg-1, Corteva Agriscience (Dow), Wilmington, DE] applied pre-plant; Assure II [Quizalofop-p-ethyl, Ethyl(r)-2-[4-(6-chloroquinoxalin-2-yloxy)-phenoxy]propionate, 103 g kg-1, Corteva Agriscience (DuPont), Wilmington, DE] and Muster (Ethametsulfuron methyl 750 g kg-1, Corteva Agriscience (DuPont), Wilmington, DE]) applied post-emergence.

§ Spring fertilizer and herbicide applied after spring green-up and before canola bolting.

Table 4.2. Experimental details for experiments conducted to assess canola biomass and nutrient accumulation near Manhattan, KS 2016-2019 near Manhattan, KS 2017-2019.

Factor	Sampling		Experiment	
	Riley	Wichita	Surefire	Surefire-Wichita
Whole plot (m)	3.66 x 9.14	-	3.66 x 10.06	3.66 x 13.72
Machine-harvest subplot (m)	1.83 x 9.14	1.83 x 5.79	1.82 x 10.06	1.82 x 13.72
Biomass-sample subplot (m)	0.91 x 0.91	0.76 x 1.10	0.91 x 0.91	0.82 x 1.01
Fall stands	-	-	-	Oct. 19, 2018
Spring stands	Mar. 20, 2017	Mar. 10, 2018	Mar. 10, 2018	Mar. 21, 2019
Sampling duration	- Mar. 22 to Jun. 7, 2017	- Apr. 12 to Jun. 6, 2018	- Mar. 12 to Jun. 11, 2018	Nov. 2 to Dec. 17, 2018 Mar. 22 to Jun. 24, 2019
No. of samples	10	9	10	16
Sample order	sequential	random	sequential	sequential
Replications	6	3	4	4

Table 4.3. Values for plant DM, vegetative DM, pod DM, and seed DM correlations to yield at each sample collection stage near Manhattan, KS 2017-2019.

Sample		Plant			Vegetative			Pod			Seed		
		Correlation		N	Correlation		N	Correlation		N	Correlation		N
0	fall rosette	0.09		32	0.09		32						
1	spring rosette	0.29	**	49	0.29	**	49						
2	bolting	0.71	***	35	0.71	***	35						
3	bloom begins	0.69	***	33	0.69	***	33	0.23		8			
4	bloom and pod set	0.55	***	55	0.55	***	55	0.02		43			
5	pod fill	0.57	***	58	0.66	***	58	0.22		58			
6	end of pod fill	0.70	***	57	0.71	***	57	0.43	***	57	0.12		16
7	beginning of ripening	0.85	***	33	0.85	***	33	0.55	***	33	0.82	***	24
8	first half of ripening	0.49	**	33	0.51	**	33	0.50	**	33	0.54	**	27
9	second half of ripening	0.29		22	0.06		22	0.25		22	0.38	*	22
10	harvest	0.46	*	16	0.33		16	0.34		16	0.53	**	16

* significant at α=0.1

** significant at α=0.05

*** significant at α=0.001

Table 4.4. Values for plant height, main raceme length, and plant population correlations to yield at each sample collection stage near Manhattan, KS 2017-2019.

Sample		Plant height		Main raceme length		Plants m^{-2}	
		Correlation	N	Correlation	N	Correlation	N
0	fall rosette	0.30 *	32			0.04	32
1	spring rosette	0.00	49			0.39 **	49
2	bolting	0.73 ***	35			0.67 ***	35
3	bloom begins	0.39 **	33			0.49 **	33
4	bloom and pod set	0.52 ***	55	0.00	43	0.28 **	55
5	pod fill	0.80 ***	58	0.60 ***	46	0.28 **	58
6	end of pod fill	0.82 ***	57	0.54 ***	51	0.60 ***	57
7	beginning of ripening	0.78 ***	33	0.24	27	0.59 ***	33
8	first half of ripening	0.78 ***	33	0.00	27	0.54 **	33
9	second half of ripening	0.46 **	22	0.48 *	16	-0.09	22
10	harvest	0.55 **	16	0.26	16	-0.08	16

* significant at α=0.1
** significant at α=0.05
*** significant at α=0.001

Table 4.5. Values for the number of pods on the main raceme, pod length at the bottom of the main raceme, and pods m^{-2} correlations to yield at each sample collection stage near Manhattan, KS 2017-2019.

Sample		Main raceme pod number		Pod length		Pods m^{-2}	
		Correlation	N	Correlation	N	Correlation	N
3	bloom begins	0.49	8			0.09	8
4	bloom and pod set	0.08	40	-0.05	40	0.04	43
5	pod fill	0.78 ***	46	0.54 ***	46	0.38 **	58
6	end of pod fill	0.89 ***	51	0.63 ***	51	0.73 ***	57
7	beginning of ripening	0.87 ***	27	0.60 ***	27	0.77 ***	33
8	first half of ripening	0.84 ***	27	0.54 **	27	0.48 **	33
9	second half of ripening	0.73 **	16	0.38	16	0.24	16
10	harvest	0.19	16	0.07	16	0.31	16

* significant at α=0.1
** significant at α=0.05
*** significant at α=0.001

Table 4.6. Values for seed volume (mL m^{-2}), thousand seed weight, and test weight (lb bu^{-1}) correlations to yield at each sample collection stage near Manhattan, KS 2017-2019.

Sample		Seed volume m^{-2}		TSW		TW	
		Correlation	N	Correlation	N	Correlation	N
6	end of pod fill	0.11	16	0.33	16	0.29	16
7	beginning of ripening	0.82 ***	24	-0.02	24	0.62 **	24
8	first half of ripening	0.52 **	27	0.57 **	27	0.82 ***	27
9	second half of ripening	0.41 *	22	0.52 **	16	-0.17	22
10	harvest	0.51 **	16	0.36	16	0.34	16

* significant at α=0.1
** significant at α=0.05
*** significant at α=0.001

Appendix A - Raw Data: General sample information

Table A.1. Sampling data key used throughout raw data tables.

Abbreviation	Definition
All chapters:	
Year	year of the study
Study	study the data was collected from, identified by the variety used in the study
Variety	variety used in the study
Seeding_rate	targeted seeding rate of the study
Density	density category of the plot
Plot	plot ID number within a study
Sub	subsample letter within a replication and treatment
Rep	replicate
Sample	sample date number within a study
Date	date of sample collection
Stage	developmental stage
Area	sample area (ft^2)
Chapter2:	
Pt_Ct	plant count
WS_F_VgPdSd_Wt	fresh vegetative, pod, and seed weight (g) of the whole biomass sample
20_Pt_F_Wt	fresh weight of 20 plants (g) or the whole sample if less than 20 plants
30_Pt_F_Wt	fresh weight of 30 plants (g) or the whole sample if less than 30 plants
GHS_Pt_Wt	plant weight (g) after curing in greenhouse
F_Vg_Wt	fresh vegetative weight (g) of number of plants processed
F_Vg_Samp_Wt	fresh vegetative weight (g) of subsample
D_Vg_Samp_Wt	dry vegetative weight (g) of subsample
F_PdSd_Wt	fresh pod and seed weight (g) of number of plants processed
F_PdSd_Samp_Wt	fresh pod and seed weight (g) of subsample
D_PdSd_Samp_Wt	dry pod and seed weight (g) of subsample
D_Pd_Samp_Wt	dry pod weight (g) of subsample

D_Sd_Samp_Wt	dry seed weight (g) of subsample
WS_D_VgPdSd_Wt	whole biomass sample dry vegetative, pod, and seed weight (g); calculated as dry vegetative + dry pod + dry pod weight
D_VgPdSd_g_sqm	dry vegetative, pod, and seed weight (g) per square meter; calculated as (WS_D_VgPdSd_Wt * 10.76) / area of biomass sample
WS_F_Vg_Wt	whole biomass sample fresh vegetative weight (g); calculated as (F_Vg_Wt * Pt_Ct) / number of plants processed
WS_D_Vg_Wt	whole biomass sample dry vegetative weight (g); calculated as WS_F_Vg_Wt * (D_Vg_Samp_Wt / F_Vg_Samp_Wt)
D_Vg_g_sqm	dry vegetative weight (g) per square meter; calculated as (WS_D_Vg_Wt * 10.76) / area of biomass sample
WS_F_PdSd_Wt	whole biomass sample fresh pod and seed weight (g); calculated as (F_PdSd_Wt * Pt_Ct) / number of plants processed
WS_D_PdSd_Wt	whole biomass sample dry pod and seed weight (g); calculated as WS_F_PdSd_Wt * (D_PdSd_Samp_Wt / F_PdSd_Samp_Wt)
D_PdSd_g_sqm	dry pod and seed weight (g) per square meter; calculated as (WS_D_PdSd_Wt * 10.76) / area of biomass sample
WS_D_Pd_Wt	whole biomass sample dry pod weight (g); calculatd as (D_Pd_Wt * Pt_Ct) / number of plants processed
D_Pd_g_sqm	dry pod weight (g) per square meter; calculated as (WS_D_Pd_Wt * 10.76) / area of biomass sample
WS_D_Sd_Wt	whole biomass sample dry seed weight (g); calculated as (D_Sd_Wt * Pt_Ct) / number of plants processed
D_Sd_g_sqm	dry seed weight (g) per square meter; calculated as (WS_D_Sd_Wt * 10.76) / area of biomass sample
Chapter 3:	
Vg N (%)	vegetative N content lab result (%)
Vg_N_gsqm	vegetative N (g) per square meter; calculated as (Vg N (%) * D_Vg_g_sqm) / 100
Vg P (%)	vegetative P content lab result (%)
Vg_P_gsqm	vegetative P (g) per square meter; calculated as (Vg P (%) * D_Vg_g_sqm) / 100
Vg K (%)	vegetative K content lab result (%)
Vg_K_gsqm	vegetative K (g) per square meter; calculated as (Vg K (%) * D_Vg_g_sqm) / 100
Vg Mg (%)	vegetative Mg content lab result (%)
Vg_Mg_gsqm	vegetative Mg (g) per square meter; calculated as (Vg Mg (%) * D_Vg_g_sqm) / 100
Vg Ca (%)	vegetative Ca content lab result (%)
Vg_Ca_gsqm	vegetative Ca (g) per square meter; calculated as (Vg Ca (%) * D_Vg_g_sqm) / 100
Vg S (%)	vegetative S content lab result (%)
Vg_S_gsqm	vegetative S (g) per square meter; calculated as (Vg S (%) * D_Vg_g_sqm) / 100
Vg B (ppm)	vegetative B content lab result (ppm)
Vg_B_gsqm	vegetative B (g) per square meter; calculated as (Vg B (ppm) * D_Vg_g_sqm) / 1000000

Vg Zn (ppm)	vegetative Zn content lab result (ppm)
Vg_Zn_gsqm	vegetative Zn (g) per square meter; calculated as (Vg Zn (ppm) * D_Vg_g_sqm) / 1000000
Vg Mn (ppm)	vegetative Mn content lab result (ppm)
Vg_Mn_gsqm	vegetative Mn (g) per square meter; calculated as (Vg Mn (ppm) * D_Vg_g_sqm) / 1000000
Vg Fe (ppm)	vegetative Fe content lab result (ppm)
Vg_Fe_gsqm	vegetative Fe (g) per square meter; calculated as (Vg Fe (ppm) * D_Vg_g_sqm) / 1000000
Vg Cu (ppm)	vegetative Cu content lab result (ppm)
Vg_Cu_gsqm	vegetative Cu (g) per square meter; calculated as (VgCu (ppm) * D_Vg_g_sqm) / 1000000
Pd N (%)	pod N content lab result (%)
Pd_N_gsqm	pod N (g) per square meter; calculated as (Pd N (%) * D_Pd_g_sqm) / 100
Pd P (%)	pod P content lab result (%)
Pd_P_gsqm	pod P (g) per square meter; calculated as (Pd P (%) * D_Pd_g_sqm) / 100
Pd K (%)	pod K content lab result (%)
Pd_K_gsqm	pod K (g) per square meter; calculated as (Pd K (%) * D_Pd_g_sqm) / 100
Pd Mg (%)	pod Mg content lab result (%)
Pd_Mg_gsqm	pod Mg (g) per square meter; calculated as (Pd Mg (%) * D_Pd_g_sqm) / 100
Pd Ca (%)	pod Ca content lab result (%)
Pd_Ca_gsqm	pod Ca (g) per square meter; calculated as (Pd Ca (%) * D_Pd_g_sqm) / 100
Pd S (%)	pod S content lab result (%)
Pd_S_gsqm	pod S (g) per square meter; calculated as (Pd S (%) * D_Pd_g_sqm) / 100
Pd B (ppm)	pod B content lab result (ppm)
Pd_B_gsqm	pod B (g) per square meter; calculated as (Pd B (ppm) * D_Pd_g_sqm) / 1000000
Pd Zn (ppm)	pod Zn content lab result (ppm)
Pd_Zn_gsqm	pod Zn (g) per square meter; calculated as (Pd B (ppm) * D_Pd_g_sqm) / 1000000
Pd Mn (ppm)	pod Mn content lab result (ppm)
Pd_Mn_gsqm	pod Mn (g) per square meter; calculated as (Pd Mn (ppm) * D_Pd_g_sqm) / 1000000
Pd Fe (ppm)	pod Fe content lab result (ppm)
Pd_Fe_gsqm	pod Fe (g) per square meter; calculated as (Pd Fe (ppm) * D_Pd_g_sqm) / 1000000
Pd Cu (ppm)	pod Cu content lab result (ppm)
Pd_Cu_gsqm	pod Cu (g) per square meter; calculated as (Pd Cu (ppm) * D_Pd_g_sqm) / 1000000
Sd N (%)	seed N content lab result (%)

Sd_N_gsqm	seed N (g) per square meter; calculated as (Sd N (%) * D_Sd_g_sqm) / 100
Sd P (%)	seed P content lab result (%)
Sd_P_gsqm	seed P (g) per square meter; calculated as (Sd P (%) * D_Sd_g_sqm) / 100
Sd K (%)	seed K content lab result (%)
Sd_K_gsqm	seed K (g) per square meter; calculated as (Sd K (%) * D_Sd_g_sqm) / 100
Sd Mg (%)	seed Mg content lab result (%)
Sd_Mg_gsqm	seed Mg (g) per square meter; calculated as (Sd Mg (%) * D_Sd_g_sqm) / 100
Sd Ca (%)	seed Ca content lab result (%)
Sd_Ca_gsqm	seed Ca (g) per square meter; calculated as (Sd Ca (%) * D_Sd_g_sqm) / 100
Sd S (%)	seed S content lab result (%)
Sd_S_gsqm	seed S (g) per square meter; calculated as (Sd S (%) * D_Sd_g_sqm) / 100
Sd B (ppm)	seed B content lab result (ppm)
Sd_B_gsqm	seed B (g) per square meter; calculated as (Sd B (ppm) * D_Sd_g_sqm) / 1000000
Sd Zn (ppm)	seed Zn content lab result (ppm)
Sd_Zn_gsqm	seed Zn (g) per square meter; calculated as (Sd B (ppm) * D_Sd_g_sqm) / 1000000
Sd Mn (ppm)	seed Mn content lab result (ppm)
Sd_Mn_gsqm	seed Mn (g) per square meter; calculated as (Sd Mn (ppm) * D_Sd_g_sqm) / 1000000
Sd Fe (ppm)	seed Fe content lab result (ppm)
Sd_Fe_gsqm	seed Fe (g) per square meter; calculated as (Sd Fe (ppm) * D_Sd_g_sqm) / 1000000
Sd Cu (ppm)	seed Cu content lab result (ppm)
Sd_Cu_gsqm	seed Cu (g) per square meter; calculated as (Sd Cu (ppm) * D_Sd_g_sqm) / 1000000
VgPdSd_N_gsqm	vegetative, pod, and seed N content (g) per square meter; calculated as Vg_N_gsqm + Pd_N_gsqm + Sd_N_gsqm
VgPdSd_P_gsqm	vegetative, pod, and seed P content (g) per square meter; calculated as Vg_P_gsqm + Pd_P_gsqm + Sd_P_gsqm
VgPdSd_K_gsqm	vegetative, pod, and seed K content (g) per square meter; calculated as Vg_K_gsqm + Pd_K_gsqm + Sd_K_gsqm
VgPdSd_Mg_gsqm	vegetative, pod, and seed Mg content (g) per square meter; calculated as Vg_Mg_gsqm + Pd_Mg_gsqm + Sd_Mg_gsqm
VgPdSd_Ca_gsqm	vegetative, pod, and seed Ca content (g) per square meter; calculated as Vg_Ca_gsqm + Pd_Ca_gsqm + Sd_Ca_gsqm
VgPdSd_S_gsqm	vegetative, pod, and seed S content (g) per square meter; calculated as Vg_S_gsqm + Pd_S_gsqm + Sd_S_gsqm
VgPdSd_B_gsqm	vegetative, pod, and seed B content (g) per square meter; calculated as Vg_B_gsqm + Pd_B_gsqm + Sd_B_gsqm
VgPdSd_Zn_gsqm	vegetative, pod, and seed Zn content (g) per square meter; calculated as Vg_Zn_gsqm + Pd_Zn_gsqm + Sd_Zn_gsqm

VgPdSd_Mn_gsqm	vegetative, pod, and seed Mn content (g) per square meter; calculated as Vg_Mn_gsqm + Pd_Mn_gsqm + Sd_Mn_gsqm
VgPdSd_Fe_gsqm	vegetative, pod, and seed Fe content (g) per square meter; calculated as Vg_Fe_gsqm + Pd_Fe_gsqm + Sd_Fe_gsqm
VgPdSd_Cu_gsqm	vegetative, pod, and seed Cu content (g) per square meter; calculated as Vg_Cu_gsqm + Pd_Cu_gsqm + Sd_Cu_gsqm
Chapter 4:	
Pt_Ct	plant count
Ht	plant height (cm)
Pd_Ct	pod count of number of plants processed
Sd_Vol	seed volume (mL) of subsample
Avg_Br_Ct	average branch count
Avg_MR_Lth	average main raceme length (cm)
Pd_Lth_bot	representative bottom pod length (cm)
Pd_Lth_mid	representative middle pod length (cm)
Pd_Lth_top	representative top pod length (cm)
Avg_Pd_Ct_MR	average pod count on main raceme
Pop	population (plants/ha); calculated as (Pt_Ct * 43560 * 2.47) / area of biomass sample
WS_Pd_Ct	whole biomass samle pod count; calculated as (Pd_Ct * Pt_Ct) / number of plants processed
Pd_per_Pt	pods per plant; calculated as WS_Pd_Ct / Pt_Ct
Pd_sqm	pods per square meter; calculated as (WS_Pd_Ct * 10.76) / area of biomass sample
WS_Sd_Vol	whole biomass sample seed volume (mL); calculated as (Sd_Vol * Pt_Ct) / number of plants processed
Avg_TSW	average 1000 seed weight (g)
TW	test weight of seed (lb/bu)
Yield	sample seed yield (kg/ha); calculated as (WS_D_Sd_Wt *43560 * 2.47) / (area of biomass sample * 1000)

Table A.2. Machine harvest data key used throughout raw data tables.

Abbreviation	Definition
Year	year the experiment took place
Study	study the data was collected from, identified by the variety used in the study
Variety	variety used in the study
Density	density category of the plot
Plot	plot ID number within a study
Rep	replicate
Fall_Pt_Ct	fall plant count
Fall_pop	fall population (plants/ha)
Area	whole plot harvest area (ft^2), planter on 6 foot center
Spring_Pt_Ct	spring plant count
Spring_pop	spring population (plants/ha)
Winter_survival	winter plant survival (%)
Plot_Wt	seed weight of whole plot (lb) from combine
Moisture	seed moisture (%) at harvest from combine
TW	seed test weight (lb/bu) from combine
Adj_Wt	whole plot seed weight after moisture adjustment (lb)
Yield	seed yield (kg/ha)
Avg_TSW	average 1000 seed weights (g)
Oil_content	seed oil content (%)

Table A.3. Plot identification used in all studies and throughout all raw data tables.

Year	Study	Variety	Density	Plot	Sub	Rep	Sample	Date	Stage	Area
2017	Riley			101	a	1	1	22-Mar	rosette/ early bolt (30%)	9
2017	Riley			101	b	1	1	22-Mar	rosette/ early bolt (50%)	9
2017	Riley			201	a	2	1	22-Mar	rosette/ early bolt (70%)	9
2017	Riley			201	b	2	1	22-Mar	rosette/ early bolt (70%)	9
2017	Riley			301	a	3	1	22-Mar	rosette/ early bolt (25%)	9
2017	Riley			301	b	3	1	22-Mar	rosette/ early bolt (30%)	9
2017	Riley			401	a	4	1	22-Mar	rosette/ early bolt (35%)	9
2017	Riley			401	b	4	1	22-Mar	rosette/ early bolt (25%)	9
2017	Riley			501	a	5	1	22-Mar	rosette/ early bolt (50%)	9
2017	Riley			501	b	5	1	22-Mar	rosette/ early bolt (50%)	9
2017	Riley			601	a	6	1	22-Mar	rosette/ early bolt (20%)	9
2017	Riley			601	b	6	1	22-Mar	rosette/ early bolt (30%)	9
2017	Riley			102	a	1	2	6-Apr	early bloom (60%)	9
2017	Riley			102	b	1	2	6-Apr	early bloom (40%)	9
2017	Riley			202	a	2	2	6-Apr	early bloom (50%)	9
2017	Riley			202	b	2	2	6-Apr	early bloom (50%)	9
2017	Riley			302	a	3	2	6-Apr	early bloom (40%)	9
2017	Riley			302	b	3	2	6-Apr	early bloom (50%)	9
2017	Riley			402	a	4	2	6-Apr	early bloom (80%)	9
2017	Riley			402	b	4	2	6-Apr	early bloom (50%)	9
2017	Riley			502	a	5	2	6-Apr	early bloom (60%)	9
2017	Riley			502	b	5	2	6-Apr	early bloom (80%)	9
2017	Riley			602	a	6	2	6-Apr	early bloom (40%)	9
2017	Riley			602	b	6	2	6-Apr	early bloom (40%)	9
2017	Riley			103	a	1	3	18-Apr	bloom	9
2017	Riley			103	b	1	3	18-Apr	bloom	9
2017	Riley			203	a	2	3	18-Apr	bloom	9
2017	Riley			203	b	2	3	18-Apr	bloom	9

2017	Riley	303	a	3	3	18-Apr	bloom	9
2017	Riley	303	b	3	3	18-Apr	bloom	9
2017	Riley	403	a	4	3	18-Apr	bloom	9
2017	Riley	403	b	4	3	18-Apr	bloom	9
2017	Riley	503	a	5	3	18-Apr	bloom	9
2017	Riley	503	b	5	3	18-Apr	bloom	9
2017	Riley	603	a	6	3	18-Apr	bloom	9
2017	Riley	603	b	6	3	18-Apr	bloom	9
2017	Riley	104	a	1	4	27-Apr	pod set	9
2017	Riley	104	b	1	4	27-Apr	pod set	9
2017	Riley	204	a	2	4	27-Apr	pod set	9
2017	Riley	204	b	2	4	27-Apr	pod set	9
2017	Riley	304	a	3	4	27-Apr	pod set	9
2017	Riley	304	b	3	4	27-Apr	pod set	9
2017	Riley	404	a	4	4	27-Apr	pod set	9
2017	Riley	404	b	4	4	27-Apr	pod set	9
2017	Riley	504	a	5	4	27-Apr	pod set	9
2017	Riley	504	b	5	4	27-Apr	pod set	9
2017	Riley	604	a	6	4	27-Apr	pod set	9
2017	Riley	604	b	6	4	27-Apr	pod set	9
2017	Riley	105	a	1	5	4-May	pod fill (2/3-3/4 raceme)	9
2017	Riley	105	b	1	5	4-May	pod fill (2/3-3/4 raceme)	9
2017	Riley	205	a	2	5	4-May	pod fill (2/3-3/4 raceme)	9
2017	Riley	205	b	2	5	4-May	pod fill (2/3-3/4 raceme)	9
2017	Riley	305	a	3	5	4-May	pod fill (2/3-3/4 raceme)	9
2017	Riley	305	b	3	5	4-May	pod fill (2/3-3/4 raceme)	9
2017	Riley	405	a	4	5	4-May	pod fill (2/3-3/4 raceme)	9
2017	Riley	405	b	4	5	4-May	pod fill (2/3-3/4 raceme)	9
2017	Riley	505	a	5	5	4-May	pod fill (2/3-3/4 raceme)	9
2017	Riley	505	b	5	5	4-May	pod fill (2/3-3/4 raceme)	9
2017	Riley	605	a	6	5	4-May	pod fill (2/3-3/4 raceme)	9

2017	Riley	605	b	6	5	4-May	pod fill (2/3-3/4 raceme)	9
2017	Riley	106	a	1	6	10-May	Pod fill (50% AY)	9
2017	Riley	106	b	1	6	10-May	Pod fill	9
2017	Riley	206	a	2	6	10-May	Pod fill	9
2017	Riley	206	b	2	6	10-May	Pod fill	9
2017	Riley	306	a	3	6	10-May	Pod fill	9
2017	Riley	306	b	3	6	10-May	Pod fill	9
2017	Riley	406	a	4	6	10-May	Pod fill	9
2017	Riley	406	b	4	6	10-May	Pod fill	9
2017	Riley	506	a	5	6	10-May	Pod fill	9
2017	Riley	506	b	5	6	10-May	Pod fill	9
2017	Riley	606	a	6	6	10-May	Pod fill	9
2017	Riley	606	b	6	6	10-May	Pod fill	9
2017	Riley	107	a	1	7	17-May	Pod fill	9
2017	Riley	107	b	1	7	17-May	Pod fill	9
2017	Riley	207	a	2	7	17-May	Pod fill	9
2017	Riley	207	b	2	7	17-May	Pod fill	9
2017	Riley	307	a	3	7	17-May	Pod fill	9
2017	Riley	307	b	3	7	17-May	Pod fill	9
2017	Riley	407	a	4	7	17-May	Pod fill	9
2017	Riley	407	b	4	7	17-May	Pod fill	9
2017	Riley	507	a	5	7	17-May	Pod fill	9
2017	Riley	507	b	5	7	17-May	Pod fill	9
2017	Riley	607	a	6	7	17-May	Pod fill	9
2017	Riley	607	b	6	7	17-May	Pod fill	9
2017	Riley	108	a	1	8	24-May	Pod fill/beg ripening	9
2017	Riley	108	b	1	8	24-May	Pod fill/beg ripening	9
2017	Riley	208	a	2	8	24-May	Pod fill/beg ripening	9
2017	Riley	208	b	2	8	24-May	Pod fill/beg ripening	9
2017	Riley	308	a	3	8	24-May	Pod fill/beg ripe	9
2017	Riley	308	b	3	8	24-May	Pod fill/beg ripening	9

2017	Riley		408	a	4	8	24-May	Pod fill/beg ripening	9
2017	Riley		408	b	4	8	24-May	Pod fill/beg ripe	9
2017	Riley		508	a	5	8	24-May	Pod fill/beg ripening	9
2017	Riley		508	b	5	8	24-May	Pod fill/beg ripening	9
2017	Riley		608	a	6	8	24-May	Pod fill/beg ripening	9
2017	Riley		608	b	6	8	24-May	Pod fill/beg ripe	9
2017	Riley		109	a	1	9	31-May	Ripening	9
2017	Riley		109	b	1	9	31-May	Ripening	9
2017	Riley		209	a	2	9	31-May	Ripening	9
2017	Riley		209	b	2	9	31-May	Ripening	9
2017	Riley		309	a	3	9	31-May	Ripening	9
2017	Riley		309	b	3	9	31-May	Ripening	9
2017	Riley		409	a	4	9	31-May	Ripening	9
2017	Riley		409	b	4	9	31-May	Ripening	9
2017	Riley		509	a	5	9	31-May	Ripening	9
2017	Riley		509	b	5	9	31-May	Ripening	9
2017	Riley		609	a	6	9	31-May	Ripening	9
2017	Riley		609	b	6	9	31-May	Ripening	9
2017	Riley		110	a	1	10	7-Jun	Dry down	9
2017	Riley		110	b	1	10	7-Jun	Dry down	9
2017	Riley		210	a	2	10	7-Jun	Dry down	9
2017	Riley		210	b	2	10	7-Jun	Dry down	9
2017	Riley		310	a	3	10	7-Jun	Dry down	9
2017	Riley		310	b	3	10	7-Jun	Dry down	9
2017	Riley		410	a	4	10	7-Jun	Dry down	9
2017	Riley		410	b	4	10	7-Jun	Dry down	9
2017	Riley		510	a	5	10	7-Jun	Dry down	9
2017	Riley		510	b	5	10	7-Jun	Dry down	9
2017	Riley		610	a	6	10	7-Jun	Dry down	9
2017	Riley		610	b	6	10	7-Jun	Dry down	9
2018		Wichita	108	a	1	1	12-Apr	rosette 80%, bolt 20%	9

2018	Wichita	118	b	1	1	12-Apr	rosette 90%, bolt 10%	9
2018	Wichita	206	a	2	1	12-Apr	rosette 50%, bolt 50%	9
2018	Wichita	226	b	2	1	12-Apr	rosette 75%, bolt 25%	9
2018	Wichita	306	a	3	1	12-Apr	rosette 40%, bolt 60%	9
2018	Wichita	321	b	3	1	12-Apr	rosette 40%, bolt 60%	9
2018	Wichita	103	a	1	2	19-Apr	rosette 5%, bolt 95%	9
2018	Wichita	104	b	1	2	19-Apr	rosette 10%, bolt 90%	9
2018	Wichita	208	a	2	2	19-Apr	rosette 5%, bolt 95%	9
2018	Wichita	222	b	2	2	19-Apr	rosette 1%, bolt 99%	9
2018	Wichita	317	a	3	2	19-Apr	rosette 1%, bolt 99%	9
2018	Wichita	325	b	3	2	19-Apr	rosette 1%, bolt 99%	9
2018	Wichita	113	a	1	3	26-Apr	bolt 90%, flower 10%	9
2018	Wichita	114	b	1	3	26-Apr	bolt 90%, flower 10%	9
2018	Wichita	201	a	2	3	26-Apr	bolt 95%, flower 5%	9
2018	Wichita	215	b	2	3	26-Apr	bolt 90%, flower 10%	9
2018	Wichita	323	a	3	3	26-Apr	bolt 85%, flower 15%	9
2018	Wichita	324	b	3	3	26-Apr	bolt 90%, flower 10%	9
2018	Wichita	101	a	1	4	3-May	flower 5%, pod set 95%	9
2018	Wichita	119	b	1	4	3-May	pod set 100%	9
2018	Wichita	219	a	2	4	3-May	pod set 100%	9
2018	Wichita	225	b	2	4	3-May	flower 10%, pod set 90%	9
2018	Wichita	308	a	3	4	3-May	bolt 1%, flower 5%, pod set 94%	9
2018	Wichita	320	b	3	4	3-May	flower 5%, pod set 95%	9
2018	Wichita	127	a	1	5	10-May	pod set 100%	9
2018	Wichita	128	b	1	5	10-May	pod set 100%	9
2018	Wichita	202	a	2	5	10-May	pod set 100%	9
2018	Wichita	218	b	2	5	10-May	flower 2%, pod set 98%	9
2018	Wichita	314	a	3	5	10-May	flower 2%, pod set 98%	9
2018	Wichita	318	b	3	5	10-May	pod set 100%	9
2018	Wichita	112	a	1	6	16-May	pod set 25%, pod fill 75%	9
2018	Wichita	123	b	1	6	16-May	pod set 10%, pod fill 90%	9

2018	Wichita		204	a	2	6	16-May	pod set 5%, pod fill 95%	9
2018	Wichita		217	b	2	6	16-May	pod set 15%, pod fill 85%	9
2018	Wichita		302	a	3	6	16-May	pod set 10%, pod fill 90%	9
2018	Wichita		315	b	3	6	16-May	pod set 10%, pod fill 90%	9
2018	Wichita		102	a	1	7	23-May	pod fill and maturity	9
2018	Wichita		120	b	1	7	23-May	pod fill and maturity	9
2018	Wichita		224	a	2	7	23-May	pod fill and maturity	9
2018	Wichita		229	b	2	7	23-May	pod fill and maturity	9
2018	Wichita		313	a	3	7	23-May	pod fill and maturity	9
2018	Wichita		330	b	3	7	23-May	pod fill and maturity	9
2018	Wichita		110	a	1	8	30-May	pod fill and maturity	9
2018	Wichita		130	b	1	8	30-May	pod fill and maturity	9
2018	Wichita		211	a	2	8	30-May	pod fill and maturity	9
2018	Wichita		227	b	2	8	30-May	pod fill and maturity	9
2018	Wichita		319	a	3	8	30-May	pod fill and maturity	9
2018	Wichita		329	b	3	8	30-May	pod fill and maturity	9
2018	Wichita		111	a	1	9	6-Jun	ripening	9
2018	Wichita		116	b	1	9	6-Jun	ripening	9
2018	Wichita		203	a	2	9	6-Jun	ripening	9
2018	Wichita		210	b	2	9	6-Jun	ripening	9
2018	Wichita		305	a	3	9	6-Jun	ripening	9
2018	Wichita		326	b	3	9	6-Jun	ripening	9
2018	Surefire	high	1101	a	1	1	12-Apr	rosette 75%, bolt 25%	9
2018	Surefire	low	1101	b	1	1	12-Apr	rosette 10%, bolt 90%	9
2018	Surefire	low	1201	a	1	1	12-Apr	rosette	9
2018	Surefire	low	1201	b	1	1	12-Apr	rosette	9
2018	Surefire	low	2101	a	2	1	12-Apr	rosette 80%, bolt 20%	9
2018	Surefire	high	2101	b	2	1	12-Apr	rosette 90%, bolt 10%	9
2018	Surefire	high	2201	a	2	1	12-Apr	rosette 55%, bolt 45%	9
2018	Surefire	low	2201	b	2	1	12-Apr	rosette 70%, bolt 30%	9
2018	Surefire	high	3101	a	3	1	12-Apr	rosette 75%, bolt 25%	9

2018	Surefire	high	3101	b	3	1	12-Apr	rosette 85%, bolt 15%	9
2018	Surefire	low	3201	a	3	1	12-Apr	rosette 90%, bolt 10%	9
2018	Surefire	low	3201	b	3	1	12-Apr	rosette 80%, bolt 20%	9
2018	Surefire	low	4101	a	4	1	12-Apr	rosette 75%, bolt 25%	9
2018	Surefire	low	4101	b	4	1	12-Apr	rosette 40%, bolt 60%	9
2018	Surefire	low	4201	a	4	1	12-Apr	rosette 25%, bolt 75%	9
2018	Surefire	low	4201	b	4	1	12-Apr	rosette 20%, bolt 80%	9
2018	Surefire	high	1102	a	1	2	19-Apr	rosette 40%, bolt 60%	9
2018	Surefire	high	1102	b	1	2	19-Apr	rosette 30%, bolt 70%	9
2018	Surefire	low	1202	a	1	2	19-Apr	rosette 80%, bolt 20%	9
2018	Surefire	low	1202	b	1	2	19-Apr	rosette 25%, bolt 75%	9
2018	Surefire	high	2102	a	2	2	19-Apr	rosette 70%, bolt 30%	9
2018	Surefire	high	2102	b	2	2	19-Apr	rosette 65%, bolt 35%	9
2018	Surefire	high	2202	a	2	2	19-Apr	rosette 30%, bolt 70%	9
2018	Surefire	low	2202	b	2	2	19-Apr	rosette 70%, bolt 30%	9
2018	Surefire	high	3102	a	3	2	19-Apr	rosette 60%, bolt 40%	9
2018	Surefire	high	3102	b	3	2	19-Apr	rosette 50%, bolt 50%	9
2018	Surefire	low	3202	a	3	2	19-Apr	rosette 25%, bolt 75%	9
2018	Surefire	low	3202	b	3	2	19-Apr	rosette 25%, bolt 75%	9
2018	Surefire	high	4102	a	4	2	19-Apr	rosette 80%, bolt 20%	9
2018	Surefire	high	4102	b	4	2	19-Apr	rosette 70%, bolt 30%	9
2018	Surefire	low	4202	a	4	2	19-Apr	rosette 20%, bolt 80%	9
2018	Surefire	low	4202	b	4	2	19-Apr	rosette 20%, bolt 80%	9
2018	Surefire	high	1103	a	1	3	26-Apr	rosette 15%, bolt 85%	9
2018	Surefire	low	1103	b	1	3	26-Apr	bolt 95%, flower 5%	9
2018	Surefire	low	1203	a	1	3	26-Apr	rosette 50%, bolt 50%	9
2018	Surefire	low	1203	b	1	3	26-Apr	rosette 50%, bolt 50%	9
2018	Surefire	high	2103	a	2	3	26-Apr	rosette 15%, bolt 85%	9
2018	Surefire	high	2103	b	2	3	26-Apr	rosette 27%, bolt 70%, flower 3%	9
2018	Surefire	low	2203	a	2	3	26-Apr	rosette 10%, bolt 85%, flower 5%	9
2018	Surefire	low	2203	b	2	3	26-Apr	bolt 100%	9

2018	Surefire	low	3103	a	3	3	26-Apr	rosette 7%, bolt 85%, flower 8%	9
2018	Surefire	low	3103	b	3	3	26-Apr	rosette 5%, bolt 95%	9
2018	Surefire	low	3203	a	3	3	26-Apr	bolt 85%, flower 15%	9
2018	Surefire	low	3203	b	3	3	26-Apr	bolt 100%	9
2018	Surefire	high	4103	a	4	3	26-Apr	rosette 50%, bolt 50%	9
2018	Surefire	low	4103	b	4	3	26-Apr	rosette 15%, bolt 85%	9
2018	Surefire	low	4203	a	4	3	26-Apr	bolt 100%	9
2018	Surefire	low	4203	b	4	3	26-Apr	rosette 5%, bolt 95%	9
2018	Surefire	high	1104	a	1	4	3-May	bolt 10%, flower 5%, pod set 85%	9
2018	Surefire	high	1104	b	1	4	3-May	bolt 5%, flower 10%, pod set 85%	9
2018	Surefire	low	1204	a	1	4	3-May	bolt 20%, flower 60%, pod set 20%	9
2018	Surefire	low	1204	b	1	4	3-May	bolt 15%, flower 60%, pod set 25%	9
2018	Surefire	high	2104	a	2	4	3-May	bolt 20%, flower 30%, pod set 50%	9
2018	Surefire	low	2104	b	2	4	3-May	bolt 65%, flower 20%, pod set 15%	9
2018	Surefire	high	2204	a	2	4	3-May	bolt 40%, flower 10%, pod set 50%	9
2018	Surefire	high	2204	b	2	4	3-May	bolt 45%, flower 15%, pod set 40%	9
2018	Surefire	high	3104	a	3	4	3-May	bolt 15%, flower 20%, pod set 65%	9
2018	Surefire	low	3104	b	3	4	3-May	rosette 20%, bolt 20%, flower 10%, pod set 50%	9
2018	Surefire	low	3204	a	3	4	3-May	bolt 15%, flower 50%, pod set 35%	9
2018	Surefire	low	3204	b	3	4	3-May	bolt 25%, flower 60%, pod set 15%	9
2018	Surefire	high	4104	a	4	4	3-May	bolt 25%, flower 15%, pod set 60%	9
2018	Surefire	low	4104	b	4	4	3-May	rosette 40%, bolt 35%, flower 25%	9
2018	Surefire	low	4204	a	4	4	3-May	flower 50%, pod set 50%	9
2018	Surefire	low	4204	b	4	4	3-May	rosette 30%, bolt 10%, flower 10%, pod set 50%	9
2018	Surefire	high	1105	a	1	5	10-May	bolt 10%, pod set 90%	9
2018	Surefire	high	1105	b	1	5	10-May	bolt 2%, pod set 98%	9
2018	Surefire	low	1205	a	1	5	10-May	pod set 100%	9
2018	Surefire	low	1205	b	1	5	10-May	pod set 100%	9
2018	Surefire	high	2105	a	2	5	10-May	pod set 100%	9
2018	Surefire	high	2105	b	2	5	10-May	pod set 100%	9
2018	Surefire	high	2205	a	2	5	10-May	flower 3%, pod set 97%	9

2018	Surefire	high	2205	b	2	5	10-May	bolt 4%, flower 2%, pod set 94%	9
2018	Surefire	low	3105	a	3	5	10-May	flower 50%, pod set 50%	9
2018	Surefire	low	3105	b	3	5	10-May	bolt 40%, flower 25%, pod set 35%	9
2018	Surefire	low	3205	a	3	5	10-May	flower 10%, pod set 90%	9
2018	Surefire	high	3205	b	3	5	10-May	flower 3%, pod set 97%	9
2018	Surefire	high	4105	a	4	5	10-May	bolt 5%, flower 5%, pod set 90%	9
2018	Surefire	low	4105	b	4	5	10-May	bolt 3%, pod set 97%	9
2018	Surefire	high	4205	a	4	5	10-May	bolt 3 %, pod set 97%	9
2018	Surefire	low	4205	b	4	5	10-May	bolt 3%, pod set 97%	9
2018	Surefire	high	1106	a	1	6	16-May	bolt 5%, pod fill 95%	9
2018	Surefire	high	1106	b	1	6	16-May	pod fill 100%	9
2018	Surefire	low	1206	a	1	6	16-May	pod fill 100%	9
2018	Surefire	low	1206	b	1	6	16-May	pod fill 100%	9
2018	Surefire	high	2106	a	2	6	16-May	pod fill 100%	9
2018	Surefire	high	2106	b	2	6	16-May	pod fill 100%	9
2018	Surefire	high	2206	a	2	6	16-May	pod fill 100%	9
2018	Surefire	high	2206	b	2	6	16-May	bolt 5%, pod fill 95%	9
2018	Surefire	low	3106	a	3	6	16-May	pod fill 100%	9
2018	Surefire	high	3206	a	3	6	16-May	pod fill 100%	9
2018	Surefire	high	3206	b	3	6	16-May	pod fill 100%	9
2018	Surefire	high	4106	a	4	6	16-May	pod fill 100%	9
2018	Surefire	low	4106	b	4	6	16-May	pod fill 100%	9
2018	Surefire	high	4206	a	4	6	16-May	pod fill 100%	9
2018	Surefire	high	4206	b	4	6	16-May	pod fill 100%	9
2018	Surefire	low	1107	a	1	7	23-May	pod fill and maturity	9
2018	Surefire	high	1107	b	1	7	23-May	pod fill and maturity	9
2018	Surefire	low	1207	b	1	7	23-May	pod fill and maturity	9
2018	Surefire	high	2107	a	2	7	23-May	pod fill and maturity	9
2018	Surefire	high	2107	b	2	7	23-May	pod fill and maturity	9
2018	Surefire	low	2207	a	2	7	23-May	pod fill and maturity	9
2018	Surefire	high	2207	b	2	7	23-May	pod fill and maturity	9

2018	Surefire	low	3107	a	3	7	23-May	pod fill and maturity	9
2018	Surefire	high	3207	a	3	7	23-May	pod fill and maturity	9
2018	Surefire	high	3207	b	3	7	23-May	pod fill and maturity	9
2018	Surefire	high	4107	a	4	7	23-May	pod fill and maturity	9
2018	Surefire	low	4107	b	4	7	23-May	pod fill and maturity	9
2018	Surefire	high	4207	a	4	7	23-May	pod fill and maturity	9
2018	Surefire	high	4207	b	4	7	23-May	pod fill and maturity	9
2018	Surefire	high	1108	a	1	8	30-May	pod fill and maturity	9
2018	Surefire	low	1108	b	1	8	30-May	pod fill and maturity	9
2018	Surefire	low	1208	a	1	8	30-May	pod fill and maturity	9
2018	Surefire	low	1208	b	1	8	30-May	pod fill and maturity	9
2018	Surefire	high	2108	a	2	8	30-May	pod fill and maturity	9
2018	Surefire	low	2108	b	2	8	30-May	pod fill and maturity	9
2018	Surefire	low	2208	a	2	8	30-May	pod fill and maturity	9
2018	Surefire	low	2208	b	2	8	30-May	pod fill and maturity	9
2018	Surefire	low	3108	a	3	8	30-May	pod fill and maturity	5
2018	Surefire	low	3108	b	3	8	30-May	pod fill and maturity	9
2018	Surefire	high	3208	a	3	8	30-May	pod fill and maturity	9
2018	Surefire	high	3208	b	3	8	30-May	pod fill and maturity	9
2018	Surefire	high	4108	a	4	8	30-May	pod fill and maturity	9
2018	Surefire	high	4108	b	4	8	30-May	pod fill and maturity	9
2018	Surefire	high	4208	a	4	8	30-May	pod fill and maturity	9
2018	Surefire	high	4208	b	4	8	30-May	pod fill and maturity	9
2018	Surefire	low	1109	a	1	9	6-Jun	ripening	9
2018	Surefire	high	1109	b	1	9	6-Jun	ripening	9
2018	Surefire	low	1209	a	1	9	6-Jun	ripening	9
2018	Surefire	low	1209	b	1	9	6-Jun	ripening	9
2018	Surefire	low	2109	a	2	9	6-Jun	ripening	9
2018	Surefire	high	2109	b	2	9	6-Jun	ripening	9
2018	Surefire	low	2209	a	2	9	6-Jun	ripening	9
2018	Surefire	low	2209	b	2	9	6-Jun	ripening	9

2018	Surefire		low	3109	a	3	9	6-Jun	ripening	9
2018	Surefire		high	3109	b	3	9	6-Jun	ripening	9
2018	Surefire		high	3209	a	3	9	6-Jun	ripening	9
2018	Surefire		high	3209	b	3	9	6-Jun	ripening	9
2018	Surefire		high	4109	a	4	9	6-Jun	ripening	9
2018	Surefire		low	4109	b	4	9	6-Jun	ripening	9
2018	Surefire		low	4209	a	4	9	6-Jun	ripening	9
2018	Surefire		high	4209	b	4	9	6-Jun	ripening	9
2018	Surefire		high	1110	a	1	10	11-Jun	ripening	9
2018	Surefire		high	1110	b	1	10	11-Jun	ripening	9
2018	Surefire		low	1210	a	1	10	11-Jun	ripening	9
2018	Surefire		low	1210	b	1	10	11-Jun	ripening	9
2018	Surefire		high	2110	a	2	10	11-Jun	ripening	9
2018	Surefire		high	2110	b	2	10	11-Jun	ripening	9
2018	Surefire		low	2210	a	2	10	11-Jun	ripening	9
2018	Surefire		low	2210	b	2	10	11-Jun	ripening	9
2018	Surefire		high	3110	a	3	10	11-Jun	ripening	9
2018	Surefire		high	3110	b	3	10	11-Jun	ripening	9
2018	Surefire		high	3210	a	3	10	11-Jun	ripening	9
2018	Surefire		high	3210	b	3	10	11-Jun	ripening	9
2018	Surefire		high	4110	a	4	10	11-Jun	ripening	9
2018	Surefire		low	4110	b	4	10	11-Jun	ripening	9
2018	Surefire		low	4210	a	4	10	11-Jun	ripening	9
2018	Surefire		low	4210	b	4	10	11-Jun	ripening	9
2019	Surefire-Wichita	Surefire	high	1101		1	1	2-Nov	5-6 leaf	9
2019	Surefire-Wichita	Wichita	low	1201		1	1	2-Nov	5-6 leaf	9
2019	Surefire-Wichita	Wichita	high	1301		1	1	2-Nov	6-7 leaf	9
2019	Surefire-Wichita	Surefire	low	1401		1	1	2-Nov	5-6 leaf	9
2019	Surefire-Wichita	Surefire	high	2101		2	1	2-Nov	5-6 leaf	9
2019	Surefire-Wichita	Wichita	high	2201		2	1	2-Nov	5-6 leaf	9
2019	Surefire-Wichita	Wichita	low	2301		2	1	2-Nov	5-6 leaf	9

2019	Surefire-Wichita	Surefire	low	2401	2	1	2-Nov	5-6 leaf	9
2019	Surefire-Wichita	Surefire	high	3101	3	1	2-Nov	5-6 leaf	9
2019	Surefire-Wichita	Wichita	high	3201	3	1	2-Nov	6-7 leaf	9
2019	Surefire-Wichita	Wichita	low	3301	3	1	2-Nov	5-6 leaf	9
2019	Surefire-Wichita	Surefire	low	3401	3	1	2-Nov	5-6 leaf	9
2019	Surefire-Wichita	Wichita	low	4101	4	1	2-Nov	5-6 leaf	9
2019	Surefire-Wichita	Surefire	high	4201	4	1	2-Nov	5-6 leaf	9
2019	Surefire-Wichita	Wichita	high	4301	4	1	2-Nov	5-6 leaf	9
2019	Surefire-Wichita	Surefire	high	1102	1	2	17-Dec	6 leaf	9
2019	Surefire-Wichita	Wichita	low	1202	1	2	17-Dec	6 leaf	9
2019	Surefire-Wichita	Wichita	high	1302	1	2	17-Dec	7 leaf	9
2019	Surefire-Wichita	Surefire	low	1402	1	2	17-Dec	7 leaf	9
2019	Surefire-Wichita	Surefire	high	2102	2	2	17-Dec	7 leaf	9
2019	Surefire-Wichita	Wichita	high	2202	2	2	17-Dec	6 leaf	9
2019	Surefire-Wichita	Wichita	low	2302	2	2	17-Dec	7 leaf	9
2019	Surefire-Wichita	Surefire	low	2402	2	2	17-Dec	5 leaf	9
2019	Surefire-Wichita	Surefire	high	3102	3	2	17-Dec	6 leaf	9
2019	Surefire-Wichita	Wichita	high	3202	3	2	17-Dec	7 leaf	9
2019	Surefire-Wichita	Wichita	low	3302	3	2	17-Dec	6 leaf	9
2019	Surefire-Wichita	Surefire	low	3402	3	2	17-Dec	6 leaf	9
2019	Surefire-Wichita	Wichita	low	4102	4	2	17-Dec	6 leaf	9
2019	Surefire-Wichita	Surefire	high	4202	4	2	17-Dec	6 leaf	9
2019	Surefire-Wichita	Wichita	high	4302	4	2	17-Dec	7 leaf	9
2019	Surefire-Wichita	Surefire	high	1103	1	3	22-Mar	6 leaf	9
2019	Surefire-Wichita	Wichita	low	1203	1	3	22-Mar	6 leaf	9
2019	Surefire-Wichita	Wichita	high	1303	1	3	22-Mar	6 leaf	9
2019	Surefire-Wichita	Surefire	low	1403	1	3	22-Mar	6 leaf	9
2019	Surefire-Wichita	Surefire	high	2103	2	3	22-Mar	5 leaf	9
2019	Surefire-Wichita	Wichita	high	2203	2	3	22-Mar	4 leaf	11
2019	Surefire-Wichita	Wichita	low	2303	2	3	22-Mar	7 leaf	14
2019	Surefire-Wichita	Surefire	low	2403	2	3	22-Mar	6 leaf	9

2019	Surefire-Wichita	Surefire	high	3103	3	3	22-Mar	6 leaf	14
2019	Surefire-Wichita	Wichita	high	3203	3	3	22-Mar	7 leaf	9
2019	Surefire-Wichita	Wichita	low	3303	3	3	22-Mar	5 leaf	9
2019	Surefire-Wichita	Surefire	low	3403	3	3	22-Mar	6 leaf	9
2019	Surefire-Wichita	Wichita	low	4103	4	3	22-Mar	5 leaf	9
2019	Surefire-Wichita	Surefire	high	4203	4	3	22-Mar	5 leaf	9
2019	Surefire-Wichita	Wichita	high	4303	4	3	22-Mar	5 leaf	9
2019	Surefire-Wichita	Surefire	high	1104	1	4	5-Apr	early bolt	9
2019	Surefire-Wichita	Wichita	low	1204	1	4	5-Apr	early bolt	9
2019	Surefire-Wichita	Wichita	high	1304	1	4	5-Apr	early bolt	9
2019	Surefire-Wichita	Surefire	low	1404	1	4	5-Apr	early bolt	9
2019	Surefire-Wichita	Surefire	high	2104	2	4	5-Apr	8 leaf	9
2019	Surefire-Wichita	Wichita	high	2204	2	4	5-Apr	early bolt	7
2019	Surefire-Wichita	Wichita	low	2304	2	4	5-Apr	early bolt	9
2019	Surefire-Wichita	Surefire	low	2404	2	4	5-Apr	early bolt	9
2019	Surefire-Wichita	Surefire	high	3104	3	4	5-Apr	early bolt	9
2019	Surefire-Wichita	Wichita	high	3204	3	4	5-Apr	early bolt	9
2019	Surefire-Wichita	Wichita	low	3304	3	4	5-Apr	early bolt	9
2019	Surefire-Wichita	Surefire	low	3404	3	4	5-Apr	12 leaf	9
2019	Surefire-Wichita	Wichita	low	4104	4	4	5-Apr	11 leaf	9
2019	Surefire-Wichita	Surefire	high	4204	4	4	5-Apr	early bolt	9
2019	Surefire-Wichita	Wichita	high	4304	4	4	5-Apr	early bolt	9
2019	Surefire-Wichita	Surefire	high	1105	1	5	12-Apr	bolt	9
2019	Surefire-Wichita	Wichita	low	1205	1	5	12-Apr	bolt	9
2019	Surefire-Wichita	Wichita	high	1305	1	5	12-Apr	bolt	9
2019	Surefire-Wichita	Surefire	low	1405	1	5	12-Apr	bolt	9
2019	Surefire-Wichita	Surefire	high	2105	2	5	12-Apr	bolt	9
2019	Surefire-Wichita	Wichita	high	2205	2	5	12-Apr	bolt	9
2019	Surefire-Wichita	Wichita	low	2305	2	5	12-Apr	bolt	9
2019	Surefire-Wichita	Surefire	low	2405	2	5	12-Apr	bolt	9
2019	Surefire-Wichita	Surefire	high	3105	3	5	12-Apr	bolt	9

2019	Surefire-Wichita	Wichita	high	3205	3	5	12-Apr	bolt	9
2019	Surefire-Wichita	Wichita	low	3305	3	5	12-Apr	bolt	9
2019	Surefire-Wichita	Surefire	low	3405	3	5	12-Apr	bolt	9
2019	Surefire-Wichita	Wichita	low	4105	4	5	12-Apr	bolt	9
2019	Surefire-Wichita	Surefire	high	4205	4	5	12-Apr	bolt	9
2019	Surefire-Wichita	Wichita	high	4305	4	5	12-Apr	bolt	9
2019	Surefire-Wichita	Surefire	high	1106	1	6	19-Apr	5% bolt, 95% flower	9
2019	Surefire-Wichita	Wichita	low	1206	1	6	19-Apr	95% bolt, 5% flower	9
2019	Surefire-Wichita	Wichita	high	1306	1	6	19-Apr	98% bolt, 2% flower	9
2019	Surefire-Wichita	Surefire	low	1406	1	6	19-Apr	100% bolt	9
2019	Surefire-Wichita	Surefire	high	2106	2	6	19-Apr	50% bolt, 50% flower	9
2019	Surefire-Wichita	Wichita	high	2206	2	6	19-Apr	60% bolt, 40% flower	9
2019	Surefire-Wichita	Wichita	low	2306	2	6	19-Apr	98% bolt, 2% flower	9
2019	Surefire-Wichita	Surefire	low	2406	2	6	19-Apr	95% bolt, 5% flower	9
2019	Surefire-Wichita	Surefire	high	3106	3	6	19-Apr	90% bolt, 10% flower	9
2019	Surefire-Wichita	Wichita	high	3206	3	6	19-Apr	90% bolt, 10% flower	9
2019	Surefire-Wichita	Wichita	low	3306	3	6	19-Apr	95% bolt, 5% flower	9
2019	Surefire-Wichita	Surefire	low	3406	3	6	19-Apr	98% bolt, 2% flower	9
2019	Surefire-Wichita	Wichita	low	4106	4	6	19-Apr	85% bolt, 15% flower	9
2019	Surefire-Wichita	Surefire	high	4206	4	6	19-Apr	90% bolt, 10% flower	9
2019	Surefire-Wichita	Wichita	high	4306	4	6	19-Apr	100% bolt	9
2019	Surefire-Wichita	Surefire	high	1107	1	7	26-Apr	flower, 100% pod set	9
2019	Surefire-Wichita	Wichita	low	1207	1	7	26-Apr	flower, 80% pod set	9
2019	Surefire-Wichita	Wichita	high	1307	1	7	26-Apr	flower, 40% pod set	9
2019	Surefire-Wichita	Surefire	low	1407	1	7	26-Apr	flower, 50% pod set	9
2019	Surefire-Wichita	Surefire	high	2107	2	7	26-Apr	flower, 60% pod set	9
2019	Surefire-Wichita	Wichita	high	2207	2	7	26-Apr	1 rosette, 1 bolt, flower, 20% pod set	9
2019	Surefire-Wichita	Wichita	low	2307	2	7	26-Apr	flower, 90% pod set	9
2019	Surefire-Wichita	Surefire	low	2407	2	7	26-Apr	flower, 100% pod set	9
2019	Surefire-Wichita	Surefire	high	3107	3	7	26-Apr	flower, 85% pod set	9
2019	Surefire-Wichita	Wichita	high	3207	3	7	26-Apr	flower, 85% pod set	9

2019	Surefire-Wichita	Wichita	low	3307	3	7	26-Apr	flower, 5% pod set	9
2019	Surefire-Wichita	Surefire	low	3407	3	7	26-Apr	30% bolt, flower, 10% pod set	9
2019	Surefire-Wichita	Wichita	low	4107	4	7	26-Apr	flower, 85% pod set	9
2019	Surefire-Wichita	Surefire	high	4207	4	7	26-Apr	5% bolt, flower, 15% pod set	9
2019	Surefire-Wichita	Wichita	high	4307	4	7	26-Apr	5% bolt, flower, 5% pod set	9
2019	Surefire-Wichita	Surefire	high	1108	1	8	2-May	flower, 100% pod set	9
2019	Surefire-Wichita	Wichita	low	1208	1	8	2-May	flower, 100% pod set	9
2019	Surefire-Wichita	Wichita	high	1308	1	8	2-May	1 bolt, flower, 98% pod set	9
2019	Surefire-Wichita	Surefire	low	1408	1	8	2-May	flower, 100% pod set	9
2019	Surefire-Wichita	Surefire	high	2108	2	8	2-May	flower, 100% pod set	9
2019	Surefire-Wichita	Wichita	high	2208	2	8	2-May	flower, 100% pod set	9
2019	Surefire-Wichita	Wichita	low	2308	2	8	2-May	flower, 100% pod set	9
2019	Surefire-Wichita	Surefire	low	2408	2	8	2-May	flower, 100% pod set	9
2019	Surefire-Wichita	Surefire	high	3108	3	8	2-May	flower, 98% pod set	9
2019	Surefire-Wichita	Wichita	high	3208	3	8	2-May	flower, 100% pod set	9
2019	Surefire-Wichita	Wichita	low	3308	3	8	2-May	flower, 100% pod set	9
2019	Surefire-Wichita	Surefire	low	3408	3	8	2-May	flower, 98% pod set	9
2019	Surefire-Wichita	Wichita	low	4108	4	8	2-May	flower, 100% pod set	9
2019	Surefire-Wichita	Surefire	high	4208	4	8	2-May	flower, 100% pod set	9
2019	Surefire-Wichita	Wichita	high	4308	4	8	2-May	1 bolt, flower, 98% pod set	9
2019	Surefire-Wichita	Surefire	high	1109	1	9	9-May	pod fill, 60% flower	9
2019	Surefire-Wichita	Wichita	low	1209	1	9	9-May	pod fill, 100% flower	9
2019	Surefire-Wichita	Wichita	high	1309	1	9	9-May	pod fill, 100% flower	9
2019	Surefire-Wichita	Surefire	low	1409	1	9	9-May	pod fill, 100% flower	9
2019	Surefire-Wichita	Surefire	high	2109	2	9	9-May	pod fill, 100% flower	9
2019	Surefire-Wichita	Wichita	high	2209	2	9	9-May	pod fill, 100% flower	9
2019	Surefire-Wichita	Wichita	low	2309	2	9	9-May	pod fill, 100% flower	9
2019	Surefire-Wichita	Surefire	low	2409	2	9	9-May	pod fill, 100% flower	9
2019	Surefire-Wichita	Surefire	high	3109	3	9	9-May	pod fill, 80% flower	9
2019	Surefire-Wichita	Wichita	high	3209	3	9	9-May	pod fill, 100% flower	9
2019	Surefire-Wichita	Wichita	low	3309	3	9	9-May	pod fill, 100% flower	9

2019	Surefire-Wichita	Surefire	low	3409	3	9	9-May	pod fill, 100% flower	9
2019	Surefire-Wichita	Wichita	low	4109	4	9	9-May	pod fill, 100% flower	9
2019	Surefire-Wichita	Surefire	high	4209	4	9	9-May	pod fill, 100% flower	9
2019	Surefire-Wichita	Wichita	high	4309	4	9	9-May	pod fill, 100% flower	9
2019	Surefire-Wichita	Surefire	high	1110	1	10	15-May	pod fill, 70% flower	9
2019	Surefire-Wichita	Wichita	low	1210	1	10	15-May	pod fill, 100% flower	9
2019	Surefire-Wichita	Wichita	high	1310	1	10	15-May	pod fill, 90% flower	9
2019	Surefire-Wichita	Surefire	low	1410	1	10	15-May	pod fill, 100% flower	9
2019	Surefire-Wichita	Surefire	high	2110	2	10	15-May	pod fill, 85% flower	9
2019	Surefire-Wichita	Wichita	high	2210	2	10	15-May	pod fill, 90% flower	9
2019	Surefire-Wichita	Wichita	low	2310	2	10	15-May	pod fill, 100% flower	9
2019	Surefire-Wichita	Surefire	low	2410	2	10	15-May	pod fill, 95% flower	9
2019	Surefire-Wichita	Surefire	high	3110	3	10	15-May	pod fill, 95% flower	9
2019	Surefire-Wichita	Wichita	high	3210	3	10	15-May	pod fill, 95% flower	9
2019	Surefire-Wichita	Wichita	low	3310	3	10	15-May	pod fill, 95% flower	9
2019	Surefire-Wichita	Surefire	low	3410	3	10	15-May	pod fill, 95% flower	9
2019	Surefire-Wichita	Wichita	low	4110	4	10	15-May	pod fill, 95% flower	9
2019	Surefire-Wichita	Surefire	high	4210	4	10	15-May	pod fill, 80% flower	9
2019	Surefire-Wichita	Wichita	high	4310	4	10	15-May	pod fill, 100% flower	9
2019	Surefire-Wichita	Surefire	high	1111	1	11	22-May	pod fill, 10% flower	9
2019	Surefire-Wichita	Wichita	low	1211	1	11	22-May	pod fill, 5% flower	9
2019	Surefire-Wichita	Wichita	high	1311	1	11	22-May	pod fill, 5% flower	9
2019	Surefire-Wichita	Surefire	low	1411	1	11	22-May	pod fill, no flowers left	9
2019	Surefire-Wichita	Surefire	high	2111	2	11	22-May	pod fill, 10% flower	9
2019	Surefire-Wichita	Wichita	high	2211	2	11	22-May	pod fill, 2% flower	9
2019	Surefire-Wichita	Wichita	low	2311	2	11	22-May	pod fill, 2% flower	9
2019	Surefire-Wichita	Surefire	low	2411	2	11	22-May	pod fill, 5% flower	9
2019	Surefire-Wichita	Surefire	high	3111	3	11	22-May	pod fill, 15% flower	9
2019	Surefire-Wichita	Wichita	high	3211	3	11	22-May	pod fill, 2% flower	9
2019	Surefire-Wichita	Wichita	low	3311	3	11	22-May	pod fill, 60% flower	9
2019	Surefire-Wichita	Surefire	low	3411	3	11	22-May	pod fill, 10% flower	9

2019	Surefire-Wichita	Wichita	low	4111	4	11	22-May	pod fill, 25% flower	9
2019	Surefire-Wichita	Surefire	high	4211	4	11	22-May	pod fill, 5% flower	9
2019	Surefire-Wichita	Wichita	high	4311	4	11	22-May	pod fill, 25% flower	9
2019	Surefire-Wichita	Surefire	high	1112	1	12	29-May	maturity	9
2019	Surefire-Wichita	Wichita	low	1212	1	12	29-May	maturity	9
2019	Surefire-Wichita	Wichita	high	1312	1	12	29-May	maturity	9
2019	Surefire-Wichita	Surefire	low	1412	1	12	29-May	maturity	9
2019	Surefire-Wichita	Surefire	high	2112	2	12	29-May	maturity	9
2019	Surefire-Wichita	Wichita	high	2212	2	12	29-May	maturity	9
2019	Surefire-Wichita	Wichita	low	2312	2	12	29-May	maturity	9
2019	Surefire-Wichita	Surefire	low	2412	2	12	29-May	maturity	9
2019	Surefire-Wichita	Surefire	high	3112	3	12	29-May	maturity	9
2019	Surefire-Wichita	Wichita	high	3212	3	12	29-May	maturity	9
2019	Surefire-Wichita	Wichita	low	3312	3	12	29-May	maturity	9
2019	Surefire-Wichita	Surefire	low	3412	3	12	29-May	maturity	9
2019	Surefire-Wichita	Wichita	low	4112	4	12	29-May	pod fill, 5% flower	9
2019	Surefire-Wichita	Surefire	high	4212	4	12	29-May	maturity	9
2019	Surefire-Wichita	Wichita	high	4312	4	12	29-May	maturity	9
2019	Surefire-Wichita	Surefire	high	1113	1	13	5-Jun	maturity, beginning ripening	9
2019	Surefire-Wichita	Wichita	low	1213	1	13	5-Jun	maturity, beginning ripening	9
2019	Surefire-Wichita	Wichita	high	1313	1	13	5-Jun	maturity, beginning ripening	9
2019	Surefire-Wichita	Surefire	low	1413	1	13	5-Jun	maturity, beginning ripening	9
2019	Surefire-Wichita	Surefire	high	2113	2	13	5-Jun	maturity, beginning ripening	9
2019	Surefire-Wichita	Wichita	high	2213	2	13	5-Jun	maturity, beginning ripening	9
2019	Surefire-Wichita	Wichita	low	2313	2	13	5-Jun	maturity, beginning ripening	9
2019	Surefire-Wichita	Surefire	low	2413	2	13	5-Jun	maturity, beginning ripening	9
2019	Surefire-Wichita	Surefire	high	3113	3	13	5-Jun	maturity, beginning ripening	9
2019	Surefire-Wichita	Wichita	high	3213	3	13	5-Jun	maturity, beginning ripening	9
2019	Surefire-Wichita	Wichita	low	3313	3	13	5-Jun	maturity, beginning ripening	9
2019	Surefire-Wichita	Surefire	low	3413	3	13	5-Jun	maturity, beginning ripening	9
2019	Surefire-Wichita	Wichita	low	4113	4	13	5-Jun	maturity, beginning ripening	9

2019	Surefire-Wichita	Surefire	high	4213	4	13	5-Jun	maturity, beginning ripening	9
2019	Surefire-Wichita	Wichita	high	4313	4	13	5-Jun	maturity, beginning ripening	9
2019	Surefire-Wichita	Surefire	high	1114	1	14	12-Jun	beginning ripening	9
2019	Surefire-Wichita	Wichita	low	1214	1	14	12-Jun	beginning ripening	9
2019	Surefire-Wichita	Wichita	high	1314	1	14	12-Jun	beginning ripening	9
2019	Surefire-Wichita	Surefire	low	1414	1	14	12-Jun	beginning ripening	9
2019	Surefire-Wichita	Surefire	high	2114	2	14	12-Jun	beginning ripening	9
2019	Surefire-Wichita	Wichita	high	2214	2	14	12-Jun	beginning ripening	9
2019	Surefire-Wichita	Wichita	low	2314	2	14	12-Jun	beginning ripening	9
2019	Surefire-Wichita	Surefire	low	2414	2	14	12-Jun	beginning ripening	9
2019	Surefire-Wichita	Surefire	high	3114	3	14	12-Jun	ripening	9
2019	Surefire-Wichita	Wichita	high	3214	3	14	12-Jun	ripening	9
2019	Surefire-Wichita	Wichita	low	3314	3	14	12-Jun	beginning ripening	9
2019	Surefire-Wichita	Surefire	low	3414	3	14	12-Jun	beginning ripening	9
2019	Surefire-Wichita	Wichita	low	4114	4	14	12-Jun	ripening	9
2019	Surefire-Wichita	Surefire	high	4214	4	14	12-Jun	beginning ripening	9
2019	Surefire-Wichita	Wichita	high	4314	4	14	12-Jun	beginning ripening	9
2019	Surefire-Wichita	Surefire	high	1115	1	15	17-Jun	ripening	9
2019	Surefire-Wichita	Wichita	low	1215	1	15	17-Jun	ripening	9
2019	Surefire-Wichita	Wichita	high	1315	1	15	17-Jun	ripening	9
2019	Surefire-Wichita	Surefire	low	1415	1	15	17-Jun	ripening	9
2019	Surefire-Wichita	Surefire	high	2115	2	15	17-Jun	ripening	9
2019	Surefire-Wichita	Wichita	high	2215	2	15	17-Jun	ripening	9
2019	Surefire-Wichita	Wichita	low	2315	2	15	17-Jun	ripening	9
2019	Surefire-Wichita	Surefire	low	2415	2	15	17-Jun	ripening	9
2019	Surefire-Wichita	Surefire	high	3115	3	15	17-Jun	ripening	9
2019	Surefire-Wichita	Wichita	high	3215	3	15	17-Jun	ripening	9
2019	Surefire-Wichita	Wichita	low	3315	3	15	17-Jun	ripening	9
2019	Surefire-Wichita	Surefire	low	3415	3	15	17-Jun	ripening	9
2019	Surefire-Wichita	Wichita	low	4115	4	15	17-Jun	ripening	9
2019	Surefire-Wichita	Surefire	high	4215	4	15	17-Jun	ripening	9

2019	Surefire-Wichita	Wichita	high	4315	4	15	17-Jun	ripening	9
2019	Surefire-Wichita	Surefire	high	1116	1	16	24-Jun	harvest	9
2019	Surefire-Wichita	Wichita	low	1216	1	16	24-Jun	harvest	9
2019	Surefire-Wichita	Wichita	high	1316	1	16	24-Jun	harvest	9
2019	Surefire-Wichita	Surefire	low	1416	1	16	24-Jun	harvest	9
2019	Surefire-Wichita	Surefire	high	2116	2	16	24-Jun	harvest	9
2019	Surefire-Wichita	Wichita	high	2216	2	16	24-Jun	harvest	9
2019	Surefire-Wichita	Wichita	low	2316	2	16	24-Jun	harvest	9
2019	Surefire-Wichita	Surefire	low	2416	2	16	24-Jun	harvest	9
2019	Surefire-Wichita	Surefire	high	3116	3	16	24-Jun	harvest	9
2019	Surefire-Wichita	Wichita	high	3216	3	16	24-Jun	harvest	9
2019	Surefire-Wichita	Wichita	low	3316	3	16	24-Jun	harvest	9
2019	Surefire-Wichita	Surefire	low	3416	3	16	24-Jun	harvest	9
2019	Surefire-Wichita	Wichita	low	4116	4	16	24-Jun	harvest	9
2019	Surefire-Wichita	Surefire	high	4216	4	16	24-Jun	harvest	9
2019	Surefire-Wichita	Wichita	high	4316	4	16	24-Jun	harvest	9

Appendix B - Raw Data: "The effect of variety and plant density on dry matter accumulation and partitioning of winter canola in northeast Kansas"

Table B.1. Dry matter measurements and calculations for the Riley (2017), Wichita (2018), Surefire (2018), and Surefire-Wichita (2019) studies.

Plot	Sub	Pt_Ct	WS_F_VgPdSd_Wt	20_Pt_F_Wt	30_Pt_F_Wt	GHS_Pt_Wt	F_Vg_Wt	F_Vg_Samp_Wt	D_Vg_Samp_Wt	F_PdSd_Wt	F_PdSd_Samp_Wt	D_PdSd_Samp_Wt	D_Pd_Samp_Wt	D_Sd_Samp_Wt
101	a	27	1209.7				1209.7	501.4	72.0					
101	b	19	1137.6				1137.6	505.1	68.4					
201	a	18	949.1				949.1	502.3	77.2					
201	b	18	1246.7				1246.7	508.6	72.6					
301	a	37	1242.8				1242.8	502.1	75.2					
301	b	35	1401.6				1401.6	503.8	71.3					
401	a	42	1491.4				1491.4	506.2	70.7					
401	b	37	1379.0				1379.0	500.7	68.0					
501	a	24	906.2				906.2	502.6	76.5					
501	b	30	1306.2				1306.2	505.7	72.2					
601	a	17	1041.9				1041.9	503.7	71.6					
601	b	27	1202.5				1202.5	504.9	72.7					
102	a	28	2682.5				2682.5	503.8	51.9					
102	b	23	1881.2				1881.2	501.2	58.7					
202	a	25	2445.0				2445.0	500.9	62.6					
202	b	29	2675.9				2675.9	500.7	54.3					
302	a	88	2265.3				2265.3	502.7	53.2					
302	b	68	2727.5				2727.5	504.8	64.2					
402	a	29	2631.5				2631.5	505.9	46.5					
402	b	43	2755.5				2755.5	503.6	51.4					
502	a	23	2250.0				2250.0	505.1	50.7					
502	b	29	2647.8				2647.8	503.5	57.4					

602 a	22	2277.3	2277.3	502.8	50.1			
602 b	23	2613.5	2613.5	502.8	60.2			
103 a	46	5580.0	5580.0	504.9	59.5			
103 b	28	3430.0	3430.0	506.8	55.0			
203 a	20	4080.0	4080.0	504.7	56.3			
203 b	31	2780.0	2780.0	504.8	54.8			
303 a	24	3500.0	3500.0	506.1	56.7			
303 b	29	3540.0	3540.0	501.9	57.8			
403 a	30	3690.0	3690.0	504.0	61.0			
403 b	25	3510.0	3510.0	503.3	49.5			
503 a	25	3850.0	3850.0	506.9	63.0			
503 b	20	3050.0	3050.0	501.2	63.9			
603 a	27	4710.0	4710.0	507.9	51.7			
603 b	19	4110.0	4110.0	502.5	59.1			
104 a	28	3470.0	3470.0	505.6	75.3			
104 b	35	4000.0	4000.0	503.5	81.2			
204 a	26	4180.0	4180.0	502.9	84.1			
204 b	32	2780.0	2780.0	504.8	88.5			
304 a	38	3700.0	3700.0	505.1	78.4			
304 b	56	3540.0	3540.0	503.2	78.2			
404 a	26	3350.0	3350.0	503.0	89.3			
404 b	28	3340.0	3340.0	504.9	86.0			
504 a	27	3580.0	3580.0	507.5	86.1			
504 b	28	3610.0	3610.0	505.8	79.4			
604 a	47	3990.0	3990.0	504.5	81.6			
604 b	39	3540.0	3540.0	504.6	82.0			
105 a	22	4090.0	3130.0	514.5	82.3	960.0	250.1	46.6
105 b	31	3120.0	2360.0	496.8	83.3	760.0	250.6	49.5
205 a	25	3600.0	2643.0	506.8	96.2	957.0	250.5	46.9
205 b	24	3040.0	2143.0	510.5	94.0	897.0	250.3	47.0
305 a	28	3900.0	3017.0	504.4	81.1	883.0	250.1	45.7

305 b	43	4010.0	3264.0	505.2	77.2	746.0	250.3	45.6
405 a	78	3340.0	2604.3	500.7	107.3	735.7	253.5	49.8
405 b	46	3440.0	2732.7	508.1	95.4	707.3	250.6	48.1
505 a	25	2730.0	1942.9	499.9	109.5	787.1	250.4	49.9
505 b	20	2770.0	2069.1	519.7	97.8	700.9	250.4	48.8
605 a	71	4130.0	3306.6	500.4	88.9	823.4	250.2	48.2
605 b	72	4040.0	3208.6	509.3	86.7	831.4	250.6	48.2
106 a	39	3270.0	2280.4	504.4	99.7	989.6	250.2	48.5
106 b	63	3340.0	2203.9	504.0	109.4	1136.1	250.4	50.0
206 a	39	3070.0	1742.0	501.9	123.6	1328.0	250.4	53.4
206 b	41	2750.0	1590.1	505.7	133.9	1159.9	250.5	57.1
306 a	13	3320.0	1926.6	505.5	114.4	1393.4	250.2	48.1
306 b	20	2460.0	1413.6	501.3	129.7	1046.4	250.5	51.0
406 a	51	3690.0	2363.3	500.8	101.5	1326.7	250.4	46.5
406 b	40	3450.0	2242.5	500.9	111.0	1207.5	250.4	48.5
506 a	39	3180.0	1785.9	508.6	117.6	1394.1	250.4	50.5
506 b	38	2580.0	1588.6	509.0	114.7	991.4	250.7	52.0
606 a	45	3650.0	2254.2	501.9	94.9	1395.8	250.6	48.3
606 b	41	3540.0	2121.5	503.0	126.7	1418.5	250.3	51.4
107 a	21	3910.0	2149.5	505.0	107.0	1760.5	250.7	57.9
107 b	43	4160.0	2399.4	507.1	115.0	1760.6	250.2	52.0
207 a	27	2750.0	1415.2	501.0	109.2	1334.8	250.6	61.4
207 b	42	2930.0	1503.1	502.4	104.0	1426.9	250.6	58.4
307 a	13	3380.0	1992.7	502.9	102.0	1387.3	250.2	55.9
307 b	20	3260.0	1780.9	504.8	101.7	1479.1	250.3	56.0
407 a	39	3030.0	1839.0	500.1	106.4	1191.0	250.0	59.2
407 b	34	3740.0	2251.9	501.0	103.8	1488.1	250.5	52.3
507 a	19	3070.0	1580.6	508.2	104.8	1489.4	250.1	57.3
507 b	22	3390.0	1792.4	504.8	102.3	1597.6	250.1	54.0
607 a	25	3080.0	1677.6	502.3	108.9	1402.4	250.3	55.4
607 b	27	3710.0	2086.1	507.7	109.2	1623.9	250.2	55.1

108 a	15	3260.0	1614.7	500.4	100.5	1645.3	250.1	65.4		
108 b	32	3780.0	2020.8	500.6	95.3	1759.2	250.0	64.6		
208 a	38	3620.0	1969.3	500.5	112.3	1650.7	250.4	61.8		
208 b	40	3060.0	1638.5	499.8	99.2	1421.5	250.5	61.4		
308 a	14	2560.0	1650.9	500.1	99.8	909.1	250.2	61.0		
308 b	17	3220.0	1678.0	500.6	103.8	1542.0	250.1	68.8		
408 a	29	3200.0	1887.1	500.3	99.1	1312.9	250.5	65.3		
408 b	25	3080.0	1804.9	500.9	101.7	1275.1	250.0	59.8		
508 a	32	3600.0	1549.9	502.7	98.6	2050.1	250.2	70.0		
508 b	21	2650.0	1492.0	500.4	103.9	1158.0	250.4	64.5		
608 a	33	3780.0	2089.8	500.6	100.5	1690.2	250.0	63.9		
608 b	30	3500.0	1930.4	500.1	99.1	1569.6	250.1	58.8		
109 a	19	2930.0	1685.9	500.5	122.0	1244.1	250.5	81.6		
109 b	30	2900.0	1554.0	500.0	98.8	1346.0	250.1	73.2		
209 a	41	3060.0	1657.6	500.3	113.8	1402.4	250.1	78.6		
209 b	40	2570.0	1359.1	500.6	105.6	1210.9	250.1	77.0		
309 a	12	2960.0	1540.0	504.4	108.7	1420.0	250.5	73.1		
309 b	19	1900.0	1098.3	500.2	105.4	801.7	250.3	77.9		
409 a	33	3040.0	1769.3	500.1	117.8	1270.7	250.1	84.1		
409 b	26	2920.0	1734.9	500.1	103.3	1185.1	250.2	71.2		
509 a	19	2030.0	998.0	500.6	127.8	1032.0	250.8	85.2		
509 b	29	3010.0	1668.7	500.1	113.9	1341.3	250.0	76.0		
609 a	27	2760.0	1447.3	500.5	117.3	1312.7	250.5	83.5		
609 b	29	3750.0	1990.8	500.0	107.4	1759.2	250.3	76.3		
110 a	31	1310.0	703.4	500.3	234.7	606.6	606.6	407.6	205.2	202.4
110 b	29	1420.0	716.8	500.5	310.0	703.2	703.2	562.4	284.5	277.9
210 a	33	2550.0	1386.4	500.5	153.4	1163.6	1163.6	476.7	244.5	232.2
210 b	39	2440.0	1335.2	500.1	137.4	1104.8	1104.8	465.4	221.2	244.2
310 a	29	1370.0	777.3	500.4	267.4	592.7	592.7	405.8	230.7	175.1
310 b	27	1530.0	1066.9	500.3	213.4	463.1	463.1	264.9	131.6	133.3
410 a	25	1750.0	1046.3	500.1	197.0	703.7	703.7	396.8	199.6	197.2

410 b	28	2520.0		1609.6	500.4	132.5	910.4	910.4	341.2	185.4	155.8
510 a	39	2280.0		1233.8	500.4	142.9	1046.2	1046.2	435.4	221.6	213.8
510 b	43	2180.0		1347.0	500.2	149.7	833.0	833.0	372.0	185.9	186.1
610 a	26	1530.0		913.7	500.6	217.7	616.3	616.3	403.7	207.2	196.5
610 b	32	2250.0		1263.8	500.7	143.5	986.2	986.2	410.3	199.6	210.7
108 a	66	580.5		580.5	580.5	118.3					
118 b	45	787.1		787.1	787.1	137.3					
206 a	40	869.6		869.6	869.6	145.7					
226 b	48	899.2		899.2	899.2	149.2					
306 a	38	740.2		740.2	740.2	125.7					
321 b	62	816.3		816.3	816.3	143.2					
103 a	45	1065.4		1065.4	1065.4	170.8					
104 b	70	945.8		945.8	945.8	153.1					
208 a	53	764.4		764.4	764.4	131.8					
222 b	52	938.0		938.0	938.0	150.9					
317 a	55	1233.2		1233.2	1233.2	195.0					
325 b	71	1223.0		1223.0	1223.0	198.2					
113 a	38	1722.2		1722.2	837.5	101.5					
114 b	44	1790.3		1790.3	835.4	102.8					
201 a	54	1945.2		1945.2	839.8	99.9					
215 b	47	1397.5		1397.5	836.5	103.7					
323 a	57	1945.0		1945.0	829.2	99.3					
324 b	64	1854.5		1854.5	832.6	102.0					
101 a	33	1930.0		1916.8	881.0	100.8	13.2	13.2	2.0		
119 b	44	3060.0		3035.7	863.0	95.0	24.3	24.3	3.7		
219 a	59	2805.0		2761.7	833.3	99.8	43.3	43.3	3.5		
225 b	54	2810.0		2796.8	886.4	88.1	13.2	13.2	2.1		
308 a	80	2590.0		2572.6	897.0	99.3	17.4	17.4	2.6		
320 b	71	2520.0		2501.4	892.0	105.9	18.6	18.6	5.8		
127 a	33	2915.0	1445.0	1115.0	833.7	141.1	243.9	243.9	40.9		
128 b	55	3315.0	1400.0	1150.0	829.0	135.2	212.3	212.3	35.3		

202 a	41	2965.0	1175.0		915.0	819.6	148.2	229.9	229.9	39.7		
218 b	44	2380.0	1070.0		875.0	879.4	142.2	129.1	129.1	22.0		
314 a	37	2465.0	905.0		715.0	725.3	142.3	171.1	171.1	30.2		
318 b	53	3590.0	1080.0		715.0	819.3	158.3	235.1	235.1	40.6		
112 a	70	2270.0	815.0		483.0	483.0	115.7	325.1	316.6	59.9		
123 b	46	3355.0	1505.0		685.0	761.5	167.2	712.3	680.3	122.9		
204 a	68	3095.0	1245.0		600.0	604.3	144.1	613.3	607.6	110.1		
217 b	65	2455.0	730.0		435.0	440.9	96.9	275.4	263.2	48.7		
302 a	62	2715.0	1090.0		540.0	562.1	122.4	416.9	481.7	87.1		
315 b	47	2460.0	1160.0		620.0	642.5	141.7	491.8	483.9	88.7		
102 a	27	2830.0		2640.0	1155.0	858.1	186.9	1401.3	1338.2	277.0		
120 b	38	2610.0		1970.0	815.0	851.0	201.0	1078.8	1036.4	228.1		
224 a	41	2410.0		1575.0	680.0	718.6	159.6	857.9	825.4	160.6		
229 b	50	3225.0		1740.0	740.0	737.6	165.9	968.2	955.2	196.0		
313 a	42	2965.0		1800.0	820.0	817.6	206.1	965.4	955.2	211.8		
330 b	48	3780.0		2150.0	890.0	898.5	203.6	1212.8	1189.8	243.4		
110 a	47	1940.0		1190.0	560.0	567.5	159.1	615.5	500.2	159.9		
130 b	49	4050.0		2270.0	1190.0	858.0	197.0	1506.9	502.7	129.5		
211 a	45	2300.0		1420.0	600.0	596.8	155.1	793.8	566.0	164.2		
227 b	52	2830.0		1660.0	670.0	674.3	170.7	963.8	533.3	152.3		
319 a	55	2710.0		1650.0	620.0	632.1	150.6	947.5	526.5	148.0		
329 b	35	3330.0		2640.0	1070.0	794.0	198.5	1471.4	525.2	153.6		
111 a	44	1440.0		1130.0	560.0	565.3	164.0	522.9	522.9	217.2	125.9	91.3
116 b	61	1630.0		1020.0	430.0	434.3	122.5	548.4	548.4	203.7	109.6	94.1
203 a	45	2310.0		1590.0	670.0	666.0	191.8	860.7	860.7	333.0	172.5	160.5
210 b	34	1470.0		1270.0	520.0	517.1	145.3	704.2	704.2	249.7	135.6	114.1
305 a	56	2500.0		1650.0	690.0	686.9	178.9	886.1	886.1	312.6	157.7	154.9
326 b	43	2780.0		2120.0	850.0	854.5	217.7	1156.7	1156.7	395.6	199.6	196.0
1101 a	30	437.2			437.2	437.2	81.9					
1101 b	14	286.5			286.5	286.5	49.5					
1201 a	5	56.2			56.2	56.2	9.9					

1201 b	12	95.4	95.4	95.4	18.1
2101 a	19	268.4	268.4	268.4	47.1
2101 b	29	514.1	514.1	514.1	81.4
2201 a	24	222.8	222.8	222.8	43.9
2201 b	16	205.3	205.3	205.3	37.8
3101 a	34	300.5	300.5	300.5	55.6
3101 b	27	188.0	188.0	188.0	34.8
3201 a	15	213.7	213.7	213.7	38.0
3201 b	12	202.3	202.3	202.3	36.6
4101 a	13	191.5	191.5	191.5	30.7
4101 b	20	228.0	228.0	228.0	40.5
4201 a	11	238.6	238.6	238.6	40.8
4201 b	10	139.8	139.8	139.8	24.6
1102 a	26	423.6	423.6	423.6	77.0
1102 b	28	609.1	609.1	609.1	92.5
1202 a	13	101.4	101.4	101.4	20.5
1202 b	16	245.9	245.9	245.9	40.7
2102 a	23	261.1	261.1	261.1	44.3
2102 b	28	396.9	396.9	396.9	68.4
2202 a	27	336.2	336.2	336.2	58.6
2202 b	17	209.4	209.4	209.4	35.9
3102 a	28	324.5	324.5	324.5	53.9
3102 b	24	284.6	284.6	284.6	53.0
3202 a	9	229.2	229.2	229.2	40.1
3202 b	11	230.6	230.6	230.6	38.7
4102 a	38	234.5	234.5	234.5	43.0
4102 b	46	324.0	324.0	324.0	53.0
4202 a	7	260.4	260.4	260.4	43.0
4202 b	7	240.5	240.5	240.5	39.4
1103 a	44	716.1	716.1	716.1	90.7
1103 b	17	882.6	882.6	882.6	95.1

1203 a	21	349.4			349.4	349.4	41.0			
1203 b	17	326.6			326.6	326.6	39.2			
2103 a	33	1031.4			1031.4	1031.4	118.3			
2103 b	32	744.5			744.5	744.5	87.6			
2203 a	22	440.4			440.4	440.4	50.4			
2203 b	25	512.3			512.3	512.3	63.5			
3103 a	25	720.2			720.2	720.2	89.1			
3103 b	21	736.3			736.3	736.3	85.4			
3203 a	7	745.3			745.3	745.3	84.9			
3203 b	12	545.0			545.0	545.0	64.3			
4103 a	35	556.3			556.3	556.3	64.1			
4103 b	25	616.2			616.2	616.2	73.3			
4203 a	12	411.2			411.2	411.2	45.6			
4203 b	14	565.0			565.0	565.0	68.3			
1104 a	34	1310.0			1308.6	829.7	80.1	1.4	1.4	0.2
1104 b	25	1785.0			1784.0	899.6	79.2	1.0	1.0	0.2
1204 a	6	565.0			564.7	558.7	49.4	0.3	0.3	0.1
1204 b	9	338.7			338.1	335.3	42.6	0.6	0.6	0.1
2104 a	27	1185.0			1184.3	862.3	88.6	0.7	0.7	0.1
2104 b	13	930.0			929.1	897.8	84.1	0.9	0.9	0.1
2204 a	24	1525.0			1521.7	843.6	74.9	3.3	3.3	0.4
2204 b	22	895.0			894.0	877.3	92.9	1.0	1.0	0.2
3104 a	22	1400.0			1397.8	847.5	87.2	2.2	2.2	0.3
3104 b	14	855.0			854.1	814.3	73.6	0.9	0.9	0.1
3204 a	13	1420.0			1419.6	764.8	75.0	0.4	0.4	0.1
3204 b	11	879.9			879.1	850.7	74.6	0.8	0.8	0.1
4104 a	30	1450.0			1449.2	833.1	90.1	0.8	0.8	0.3
4104 b	11	470.0			470.0	463.3	45.8			
4204 a	17	1350.0			1348.6	898.6	88.7	1.4	1.4	0.3
4204 b	14	732.3			732.0	732.0	81.1	0.3	0.3	0.1
1105 a	40	2085.0	1030.0		965.0	955.4	128.1	43.1	43.1	7.3

1105 b	45	2555.0	1295.0	1205.0	860.8	107.3	40.2	40.2	6.5
1205 a	2	240.0	209.2	200.3	200.3	31.3	7.2	7.2	1.0
1205 b	12	1405.0	1300.0	1250.0	801.3	118.7	26.3	26.3	4.7
2105 a	28	1665.0	1280.0	1135.0	843.5	140.9	106.8	106.8	18.9
2105 b	21	1850.0	1630.0	1550.0	984.9	118.2	32.2	32.2	5.2
2205 a	19	1945.0	1755.0	1655.0	914.8	117.8	53.2	53.2	8.9
2205 b	23	1685.0	1570.0	1490.0	830.6	103.1	24.8	24.8	4.3
3105 a	8	1015.0	960.0	940.0	842.7	105.3	7.9	7.9	1.5
3105 b	4	375.0	335.0	327.2	327.2	38.7	4.2	4.2	0.7
3205 a	14	1970.0	1760.0	1695.0	868.2	106.1	35.6	35.6	5.8
3205 b	19	1925.0	1590.0	1430.0	993.2	147.0	73.5	73.5	12.8
4105 a	19	1665.0	1495.0	1400.0	824.9	125.1	68.3	68.3	12.0
4105 b	13	1435.0	1305.0	1250.0	937.1	136.9	21.5	21.5	4.2
4205 a	21	1870.0	1645.0	1515.0	892.4	127.5	67.5	67.5	11.4
4205 b	15	1210.0	1045.0	955.0	877.7	140.3	53.4	53.4	9.2
1106 a	36	2605.0	1990.0	1410.0	869.1	154.7	467.1	419.8	75.5
1106 b	18	2475.0	2395.0	1755.0	903.4	137.6	526.6	487.3	77.8
1206 a	2	240.0	210.0	206.0	206.0	53.8	3.5	3.5	0.8
1206 b	8	460.0	440.0	369.8	369.8	89.6	56.7	50.8	10.7
2106 a	20	2150.0	2040.0	1595.0	890.0	146.5	362.2	327.0	56.8
2106 b	25	2175.0	1635.0	1325.0	883.6	142.4	234.5	206.3	37.3
2206 a	16	1870.0	1750.0	1350.0	836.6	136.7	316.0	279.4	49.7
2206 b	15	1545.0	1395.0	1060.0	829.0	149.4	273.0	240.2	45.7
3106 a	8	1025.0	920.0	745.0	768.4	136.5	129.0	120.1	22.2
3206 a	22	2150.0	1520.0	1160.0	847.9	152.9	291.1	272.2	48.0
3206 b	18	1610.0	1395.0	1025.0	857.1	162.1	297.9	282.2	49.9
4106 a	16	1730.0	1380.0	995.0	849.2	186.6	325.0	314.6	60.2
4106 b	12	1715.0	1350.0	1120.0	868.2	167.0	212.4	198.7	37.6
4206 a	22	1845.0	1465.0	1135.0	806.5	143.7	269.1	257.0	45.8
4206 b	28	1810.0	1385.0	990.0	888.1	174.6	353.8	322.2	59.4
1107 a	15	1635.0	1570.0	795.0	818.1	162.8	692.9	668.1	123.2

1107 b	27	2710.0	2095.0	1155.0	890.0	164.1	866.3	819.4	154.7		
1207 b	9	2425.0	2350.0	1295.0	833.1	161.1	960.3	907.1	161.1		
2107 a	18	1875.0	1755.0	985.0	827.5	167.4	671.7	634.2	119.2		
2107 b	19	2065.0	1975.0	1040.0	804.1	162.7	788.6	737.3	136.2		
2207 a	15	2515.0	2380.0	1225.0	822.4	162.0	1068.1	1036.5	190.2		
2207 b	19	1800.0	1665.0	853.3	853.3	186.7	776.6	731.8	144.5		
3107 a	11	1475.0	1340.0	785.0	787.5	176.1	536.8	513.2	99.4		
3207 a	26	2250.0	1535.0	885.0	895.8	164.5	599.6	578.6	104.8		
3207 b	20	1730.0	1670.0	1000.0	820.3	160.5	597.1	573.7	107.2		
4107 a	18	1855.0	1740.0	915.0	867.1	184.0	756.0	721.6	142.3		
4107 b	8	1650.0	1420.0	720.0	753.8	174.7	649.2	633.9	122.5		
4207 a	30	2205.0	1460.0	820.0	829.6	178.5	610.3	595.1	114.3		
4207 b	21	1610.0	1540.0	600.0	676.6	162.4	602.4	588.3	120.1		
1108 a	21	2150.0	1700.0	880.0	874.3	177.8	748.1	500.2	122.2		
1108 b	8	1660.0	1580.0	760.0	767.9	155.5	760.7	574.0	131.2		
1208 a	6	1080.0	1000.0	470.0	476.4	100.8	495.0	495.0	108.8		
1208 b	7	2110.0	2020.0	980.0	909.6	193.5	927.6	500.2	117.1		
2108 a	15	2210.0	2040.0	1070.0	855.4	181.3	861.7	500.1	128.3		
2108 b	6	790.0	720.0	350.0	363.2	79.2	324.1	324.1	80.4		
2208 a	9	1500.0	1240.0	650.0	656.3	154.1	562.0	562.0	134.9		
2208 b	12	1960.0	1810.0	860.0	852.9	181.9	854.0	500.1	121.3		
3108 a	5	960.0	880.0	450.0	452.9	102.0	392.3	392.3	102.7		
3108 b	2	1400.0	1150.0	650.0	663.7	152.6	491.3	491.3	105.0		
3208 a	19	2260.0	2030.0	1000.0	864.7	191.3	959.8	524.2	129.5		
3208 b	22	1600.0	1420.0	710.0	720.7	168.8	670.3	542.8	126.4		
4108 a	16	1880.0	1570.0	740.0	745.2	200.7	790.0	503.7	141.6		
4108 b	18	1770.0	1460.0	790.0	800.9	198.8	628.5	500.1	115.8		
4208 a	15	2040.0	1690.0	790.0	786.4	215.3	861.2	500.0	137.5		
4208 b	32	1860.0	1660.0	790.0	792.4	191.2	821.0	515.7	128.9		
1109 a	12	1100.0	1010.0	560.0	566.3	139.5	406.6	406.6	128.6	78.9	49.7
1109 b	29	2250.0	1580.0	680.0	686.6	172.7	821.8	821.8	268.0	147.4	120.6

1209 a	4	690.0	640.0	310.0	313.7	93.7	304.4	304.4	112.8	64.5	48.3
1209 b	4	1070.0	990.0	450.0	454.2	113.6	491.2	491.2	169.2	92.5	76.7
2109 a	13	1240.0	1130.0	640.0	648.2	177.8	433.4	433.4	150.3	90.3	60.0
2109 b	28	1710.0	1340.0	730.0	735.7	173.8	565.6	565.6	173.2	115.8	57.4
2209 a	12	1850.0	1730.0	790.0	786.6	192.9	870.1	870.1	284.1	155.7	128.4
2209 b	10	1380.0	1290.0	680.0	677.0	160.6	561.4	561.4	183.2	110.0	73.2
3109 a	16	1640.0	1520.0	750.0	751.0	197.6	705.1	705.1	245.4	134.8	110.6
3109 b	26	1900.0	1320.0	680.0	679.5	162.8	596.3	596.3	193.4	113.0	80.4
3209 a	19	1620.0	1490.0	760.0	760.4	205.4	653.1	653.1	221.2	130.3	90.9
3209 b	17	1030.0	960.0	480.0	463.2	122.8	463.1	463.1	151.8	86.3	65.5
4109 a	21	1670.0	1450.0	750.0	747.2	205.6	661.7	661.7	235.0	136.9	98.1
4109 b	10	840.0	760.0	400.0	395.0	95.4	340.3	340.3	110.1	71.7	38.4
4209 a	12	1380.0	1230.0	610.0	608.3	162.0	584.2	584.2	202.0	119.1	82.9
4209 b	20	1390.0	1250.0	590.0	589.6	160.1	620.7	620.7	214.8	120.1	94.7
1110 a	18	1750.0	1580.0	787.7	787.7	222.9	733.9	733.9	325.7	170.3	155.4
1110 b	21	1750.0	1640.0	875.4	875.4	241.6	696.1	696.1	309.7	161.5	148.2
1210 a	11	1500.0	1250.0	632.8	632.8	199.6	571.5	571.5	264.1	142.0	122.1
1210 b	14	1390.0	1330.0	700.0	723.1	190.2	547.4	547.4	232.4	120.7	111.7
2110 a	18	1350.0	1230.0	728.7	728.7	203.2	469.6	469.6	194.8	109.0	85.8
2110 b	26	1330.0	1060.0	608.2	608.2	168.5	429.7	429.7	188.0	107.1	80.9
2210 a	9	1300.0	1110.0	527.5	527.5	153.1	541.3	541.3	236.3	126.5	109.8
2210 b	10	1330.0	1210.0	615.4	615.4	163.5	556.1	556.1	225.4	119.0	106.4
3110 a	25	1200.0	950.0	523.2	523.2	141.9	406.0	406.0	192.5	101.7	90.8
3110 b	23	1580.0	1320.0	732.4	732.4	210.4	546.3	546.3	258.4	135.5	122.9
3210 a	18	1160.0	1020.0	537.8	537.8	165.1	448.5	448.5	200.8	106.1	94.7
3210 b	19	980.0	860.0	448.1	448.1	142.6	388.1	388.1	178.1	95.1	83.0
4110 a	22	1360.0	1200.0	590.0	611.2	172.6	530.8	530.8	235.4	119.8	115.6
4110 b	12	700.0	660.0	430.0	430.8	130.5	209.1	209.1	90.9	56.3	34.6
4210 a	10	1290.0	1230.0	585.7	585.7	181.4	589.6	589.6	248.6	131.3	117.3
4210 b	14	1040.0	980.0	460.0	482.3	138.7	466.9	466.9	205.5	103.1	102.4
1101	150	830.2		830.2	830.2	93.4					

1201	80	638.5	638.5	638.5	80.9
1301	116	1167.3	1167.3	1167.3	117.1
1401	72	668.2	668.2	668.2	73.5
2101	79	260.3	260.3	260.3	33.7
2201	118	576.6	576.6	576.6	72.1
2301	75	559.2	559.2	559.2	68.2
2401	56	455.8	455.8	455.8	54.0
3101	121	516.7	516.7	516.7	64.8
3201	103	734.2	734.2	734.2	88.9
3301	68	410.3	410.3	410.3	53.7
3401	63	526.5	526.5	526.5	63.3
4101	74	486.4	486.4	486.4	63.9
4201	107	601.7	601.7	601.7	74.8
4301	98	968.0	968.0	968.0	111.7
1102	97	1032.1	1032.1	1032.1	193.8
1202	37	780.5	780.5	780.5	148.2
1302	102	1282.9	1282.9	1282.9	227.1
1402	67	706.5	706.5	706.5	143.3
2102	49	351.9	351.9	351.9	73.9
2202	90	1028.5	1028.5	1028.5	192.2
2302	57	964.8	964.8	964.8	176.8
2402	34	408.6	408.6	408.6	106.8
3102	71	1011.5	1011.5	1011.5	176.9
3202	87	951.0	951.0	951.0	162.4
3302	50	708.7	708.7	708.7	127.0
3402	33	664.1	664.1	664.1	120.0
4102	60	557.4	557.4	557.4	105.6
4202	74	1181.2	1181.2	1181.2	175.5
4302	70	1096.4	1096.4	1096.4	168.2
1103	139	610.8	610.8	610.8	136.9
1203	42	388.3	388.3	388.3	89.5

1303	91	489.6	489.6	489.6	101.1
1403	41	292.8	292.8	292.8	58.6
2103	60	183.9	183.9	183.9	47.5
2203	54	203.6	203.6	203.6	51.4
2303	73	344.2	344.2	344.2	71.2
2403	46	155.1	155.1	155.1	36.1
3103	92	368.2	368.2	368.2	71.7
3203	62	315.1	315.1	315.1	70.7
3303	39	214.2	214.2	214.2	44.0
3403	21	165.2	165.2	165.2	33.6
4103	32	210.9	210.9	210.9	45.7
4203	67	257.3	257.3	257.3	51.5
4303	54	365.8	365.8	365.8	79.0
1104	100	1296.2	1296.2	1296.2	179.0
1204	40	896.2	896.2	896.2	125.7
1304	75	1346.5	1346.5	1346.5	175.6
1404	43	948.0	948.0	948.0	125.6
2104	22	79.6	79.6	79.6	12.9
2204	40	497.8	497.8	497.8	72.3
2304	37	442.4	442.4	442.4	66.9
2404	37	355.0	355.0	355.0	50.3
3104	94	1080.2	1080.2	1080.2	139.1
3204	72	779.4	779.4	779.4	110.9
3304	40	646.6	646.6	646.6	88.2
3404	23	569.2	569.2	569.2	82.4
4104	71	565.4	565.4	565.4	77.8
4204	48	525.2	525.2	525.2	75.5
4304	48	746.3	746.3	746.3	99.0
1105	92	2030.0	2030.0	2030.0	212.2
1205	33	1370.0	1370.0	1370.0	145.3
1305	76	3040.0	3040.0	3040.0	271.6

1405	49	2140.0	2140.0	2140.0	203.6			
2105	41	330.0	330.0	330.0	39.5			
2205	49	1010.0	1010.0	1010.0	115.3			
2305	44	1070.0	1070.0	1070.0	121.5			
2405	39	990.0	990.0	990.0	102.8			
3105	66	2090.0	2090.0	2090.0	206.3			
3205	65	1080.0	1080.0	1080.0	136.3			
3305	40	1580.0	1580.0	1580.0	159.5			
3405	29	1050.0	1050.0	1050.0	113.1			
4105	34	1150.0	1150.0	1150.0	125.7			
4205	64	1470.0	1470.0	1470.0	161.7			
4305	66	1970.0	1970.0	1970.0	192.5			
1106	86	2270.0	2270.0	1900.0	246.4			
1206	16	1490.0	1490.0	1490.0	166.8			
1306	83	4600.0	4600.0	1900.0	176.5			
1406	44	2690.0	2690.0	1890.0	188.0			
2106	54	1290.0	1290.0	1290.0	156.2			
2206	31	890.0	890.0	890.0	111.2			
2306	29	1520.0	1520.0	1520.0	174.3			
2406	27	1840.0	1840.0	1840.0	186.1			
3106	59	2180.0	2180.0	1910.0	214.3			
3206	58	1520.0	1520.0	1520.0	198.4			
3306	34	1980.0	1980.0	1980.0	205.6			
3406	29	2090.0	2090.0	1890.0	202.1			
4106	28	1630.0	1630.0	1630.0	192.8			
4206	55	2130.0	2130.0	1900.0	221.3			
4306	45	2710.0	2710.0	1920.0	187.2			
1107	82	2420.0	2377.2	1390.0	226.0	42.8	42.8	8.5
1207	23	2180.0	2175.9	1520.0	200.0	4.1	4.1	0.9
1307	63	3800.0	3792.0	1560.0	188.9	8.0	8.0	1.6
1407	43	2980.0	2972.1	1540.0	198.3	7.9	7.9	1.4

2107	51	2190.0	2166.8	1550.0	222.8	23.2	23.2	4.8
2207	19	9100.0	9097.7	830.0	123.1	2.3	2.3	0.5
2307	35	2300.0	2294.5	1540.0	210.7	5.5	5.5	1.2
2407	41	2800.0	2792.4	1440.0	199.0	7.6	7.6	1.4
3107	62	2600.0	2587.6	1560.0	223.0	12.4	12.4	2.4
3207	48	2240.0	2232.6	1530.0	217.0	7.4	7.4	1.5
3307	32	3060.0	3055.1	2010.0	252.5	4.9	4.9	0.9
3407	22	2330.0	2327.5	1540.0	194.3	2.5	2.5	0.4
4107	38	2090.0	2078.8	1480.0	217.3	11.2	11.2	2.3
4207	51	2510.0	2503.3	1520.0	216.5	6.7	6.7	1.3
4307	49	3600.0	3594.5	1390.0	162.5	5.5	5.5	1.0
1108	35	3130.0	2990.3	1480.0	210.9	139.7	139.7	23.7
1208	23	3340.0	3275.5	1480.0	197.8	64.5	64.5	10.7
1308	47	4670.0	4575.4	1400.0	171.5	94.6	94.6	15.4
1408	27	4410.0	4299.6	1480.0	185.6	110.4	110.4	18.1
2108	51	3290.0	3132.4	1480.0	205.6	157.6	157.6	25.5
2208	44	2680.0	2627.1	1440.0	215.9	52.9	52.9	9.0
2308	29	2730.0	2680.6	1430.0	189.2	49.4	49.4	8.4
2408	36	4350.0	4248.6	1410.0	173.2	101.4	101.4	16.9
3108	68	3740.0	3607.7	1480.0	209.2	132.3	132.3	22.1
3208	49	2410.0	2331.2	1490.0	209.6	78.8	78.8	13.1
3308	20	3130.0	3074.1	1460.0	215.4	55.9	55.9	9.8
3408	32	3420.0	3385.3	1410.0	166.5	34.7	34.7	5.6
4108	25	2770.0	2697.6	1280.0	183.0	72.4	72.4	12.3
4208	49	3310.0	3232.1	1430.0	192.9	77.9	77.9	12.6
4308	45	4120.0	4072.3	1460.0	170.1	47.7	47.7	7.9
1109	61	3430.0	2756.2	1300.0	214.8	673.8	673.8	108.0
1209	21	3840.0	3502.8	1100.0	170.1	337.2	337.2	56.8
1309	57	4450.0	3979.4	1070.0	155.9	470.6	470.6	76.2
1409	45	4410.0	3969.5	1300.0	159.8	440.5	440.5	70.9
2109	50	3220.0	2640.5	1270.0	208.1	579.5	579.5	97.5

2209	49	3220.0		2648.2	1380.0	215.4	571.8	571.8	95.7
2309	29	2960.0		2560.9	1360.0	202.6	399.1	399.1	63.1
2409	31	3620.0		3342.1	1340.0	185.1	277.9	277.9	43.5
3109	41	2580.0		2074.9	1390.0	219.7	505.1	505.1	81.5
3209	34	2910.0		2617.4	1320.0	187.3	292.6	292.6	48.6
3309	32	4100.0		3781.7	1440.0	194.9	318.3	318.3	52.1
3409	25	3860.0		3597.2	1390.0	196.3	262.8	262.8	42.7
4109	26	2800.0		2454.1	1180.0	183.0	345.9	345.9	57.2
4209	38	3260.0		2886.0	1470.0	220.3	374.0	374.0	60.8
4309	38	4690.0		4272.5	1340.0	187.4	417.5	417.5	63.5
1110	40	2830.0		2044.5	990.0	195.4	785.5	785.5	139.5
1210	20	3720.0		2865.8	1040.0	193.9	854.2	854.2	145.2
1310	38	4090.0		3138.2	1260.0	243.6	951.8	951.8	162.6
1410	42	3930.0		2982.1	1470.0	265.9	947.9	947.9	159.9
2110	74	4400.0		2919.0	1470.0	281.2	1481.0	1481.0	252.4
2210	68	3180.0		2142.6	1460.0	303.4	1037.4	1037.4	183.9
2310	44	3390.0		2418.5	1480.0	311.5	971.5	971.5	169.5
2410	20	4090.0		3107.4	1480.0	255.9	982.6	982.6	164.4
3110	13	980.0		638.7	540.0	115.8	341.3	341.3	59.7
3210	49	3560.0		2406.8	1380.0	259.0	1153.2	1153.2	203.3
3310	34	4220.0		3395.6	1420.0	240.4	824.4	824.4	135.2
3410	29	3050.0		2548.2	1140.0	189.7	501.8	501.8	87.8
4110	24	2960.0		2141.9	1280.0	264.7	818.1	818.1	142.4
4210	54	4010.0		2805.0	1450.0	265.7	1205.0	1205.0	211.1
4310	50	4790.0		3628.8	1500.0	254.4	1161.2	1161.2	188.3
1111	35	4680.0	4000.0	2070.0	1440.0	253.5	1666.1	851.3	148.2
1211	33	4360.0	3690.0	1710.0	1270.0	250.6	1757.3	846.3	144.5
1311	42	5600.0	4230.0	2250.0	1310.0	232.6	1735.5	859.5	139.6
1411	44	5130.0	3350.0	1680.0	1280.0	237.1	1485.3	860.3	150.3
2111	52	4590.0	2990.0	1430.0	1430.0	283.4	1484.7	853.6	153.8
2211	53	3510.0	2400.0	1060.0	1060.0	215.4	1212.6	850.1	152.8

2311	35	4320.0	3770.0	1710.0	1120.0	216.3	1847.0	845.8	143.9		
2411	32	4800.0	4480.0	2500.0	1400.0	245.3	1796.6	864.4	139.4		
3111	63	3190.0	2080.0	880.0	880.0	198.5	1024.7	854.3	153.3		
3211	56	3520.0	2610.0	1240.0	1240.0	244.2	1222.0	842.3	143.3		
3311	40	4800.0	3940.0	2420.0	1070.0	178.5	1359.0	855.5	134.3		
3411	25	3430.0	3290.0	1940.0	1430.0	241.8	1244.8	850.1	145.5		
4111	21	2460.0	2350.0	1160.0	1160.0	235.6	1074.7	856.9	144.1		
4211	46	3380.0	2240.0	990.0	990.0	216.0	1119.5	850.6	159.1		
4311	52	4780.0	3170.0	1730.0	1360.0	240.4	1227.0	829.9	135.2		
1112	45	5140.0	3560.0	1390.0	1390.0	268.9	1805.8	834.2	174.9	118.4	56.5
1212	41	4190.0	2950.0	1320.0	1320.0	274.6	1460.2	850.5	183.0	122.7	60.3
1312	53	6030.0	4350.0	1490.0	1490.0	259.7	1938.6	855.3	157.9	120.0	37.9
1412	70	5040.0	2620.0	1380.0	1380.0	261.7	1286.3	862.5	182.0	125.0	57.0
2112	58	3950.0	2490.0	1100.0	1100.0	232.6	1300.1	858.6	194.0	128.6	65.4
2212	63	3600.0	2410.0	1040.0	1040.0	217.3	1264.8	848.3	180.6	123.4	57.2
2312	40	4580.0	3630.0	1320.0	1320.0	247.3	1868.1	836.6	166.8	114.4	52.4
2412	34	4200.0	3630.0	1400.0	1400.0	251.7	1712.7	855.2	169.9	121.3	48.6
3112	34	2360.0	1820.0	730.0	730.0	182.5	990.5	848.9	194.3	137.4	56.9
3212	39	2490.0	2030.0	780.0	780.0	187.0	1183.2	825.1	177.1	121.7	55.4
3312	18	2970.0	2530.0	1020.0	1020.0	225.0	1401.9	842.3	167.8	117.7	50.1
3412	29	4220.0	3990.0	1110.0	1110.0	210.0	1686.8	839.6	154.6	120.9	33.7
4112	25	2450.0	2340.0	1060.0	1060.0	281.7	1133.6	840.8	169.8	133.2	36.6
4212	64	4360.0	2710.0	1170.0	1170.0	230.7	1469.2	843.8	184.2	124.3	59.9
4312	45	5140.0	3750.0	1270.0	1270.0	249.9	1700.2	845.6	156.2	115.4	40.8
1113	45	3470.0	2370.0	1060.0	1060.0	209.1	1218.2	1218.2	337.4	176.2	161.2
1213	46	3680.0	2700.0	1230.0	1230.0	258.6	1417.6	1417.6	403.5	200.9	202.6
1313	64	4940.0	2410.0	1170.0	1170.0	230.6	1104.1	1104.1	302.2	160.4	141.8
1413	49	3380.0	2610.0	1310.0	1310.0	249.8	1200.4	1200.4	332.3	174.2	158.1
2113	65	3800.0	2160.0	880.0	880.0	176.7	1211.3	1211.3	346.7	174.6	172.1
2213	57	3800.0	1940.0	840.0	840.0	181.7	1059.0	1059.0	309.1	154.8	154.3
2313	37	3390.0	2870.0	1220.0	1220.0	264.1	1507.9	1507.9	412.8	217.1	195.7

2413	37	3600.0	2820.0	1300.0	1300.0	250.9	1404.5	1404.5	367.1	202.3	164.8
3113	46	2210.0	1540.0	590.0	590.0	145.4	877.5	877.5	259.1	141.6	117.5
3213	50	2590.0	1830.0	720.0	720.0	184.4	1036.8	1036.8	307.4	165.8	141.6
3313	36	4030.0	3340.0	1430.0	1150.0	239.1	1763.9	1763.9	437.9	240.2	197.7
3413	23	3350.0	3270.0	1570.0	990.0	201.0	1553.6	1553.6	376.5	223.3	153.2
4113	21	1680.0	1610.0	680.0	680.0	196.5	874.4	874.4	235.6	139.3	96.3
4213	47	3030.0	2360.0	990.0	990.0	211.3	1253.3	1253.3	341.4	182.7	158.7
4313	36	4250.0	3580.0	1690.0	1220.0	250.0	1723.0	1723.0	424.6	243.3	181.3
1114	54	2960.0	1950.0	790.0	790.0	189.4	1109.7	1109.7	410.2	183.5	226.7
1214	57	3960.0	1740.0	710.0	710.0	181.9	921.8	921.8	336.2	145.2	191.0
1314	55	4290.0	2020.0	950.0	950.0	207.9	964.7	964.7	321.9	144.2	177.7
1414	56	3410.0	2280.0	1140.0	1140.0	234.8	1034.9	1034.9	366.4	164.4	202.0
2114	59	2690.0	1790.0	680.0	680.0	177.6	1058.2	1058.2	390.3	179.4	210.9
2214	101	3750.0	2520.0	1110.0	1110.0	248.3	1322.5	1322.5	471.4	206.5	264.9
2314	29	2520.0	2130.0	910.0	910.0	223.2	1134.5	1134.5	388.8	176.0	212.8
2414	51	3000.0	1850.0	790.0	790.0	164.9	944.8	944.8	307.5	142.9	164.6
3114	60	2560.0	1790.0	700.0	700.0	168.9	1060.0	1060.0	386.5	176.0	210.5
3214	59	2440.0	1650.0	690.0	690.0	167.8	881.5	881.5	324.1	146.3	177.8
3314	40	3790.0	2680.0	1170.0	1170.0	248.4	1304.2	1304.2	416.3	191.1	225.2
3414	50	3920.0	2590.0	1270.0	1270.0	283.0	1143.5	1143.5	407.6	192.6	215.0
4114	40	3480.0	2880.0	1130.0	1130.0	283.8	1522.4	1522.4	516.3	240.5	275.8
4214	52	2680.0	2040.0	890.0	890.0	190.7	1058.0	1058.0	367.1	167.8	199.3
4314	59	4280.0	2680.0	1260.0	1260.0	253.3	1245.3	1245.3	386.8	176.8	210.0
1115	64	2250.0		1222.8	800.0	294.4	1027.2	1027.2	564.5	257.9	306.6
1215	73	3770.0		2217.5	1680.0	490.6	1552.5	1552.5	768.5	333.0	435.5
1315	44	2750.0		1586.2	980.0	317.3	1163.8	1163.8	542.9	234.6	308.3
1415	48	2630.0		1541.2	990.0	321.0	1088.8	1088.8	504.6	223.6	281.0
2115	64	2430.0		1558.5	870.0	289.8	871.5	871.5	582.9	262.4	320.5
2215	89	2120.0		1313.2	970.0	317.2	806.8	806.8	488.6	225.4	263.2
2315	43	2810.0		1531.6	1220.0	348.9	1278.4	1278.4	567.3	241.4	325.9
2415	44	3200.0		2647.0	1240.0	303.1	553.0	553.0	546.3	242.2	304.1

3115	67	1660.0		897.6	650.0	248.2	762.4	762.4	439.0	206.4	232.6
3215	45	1390.0		780.0	490.0	238.1	610.0	610.0	388.1	179.5	208.6
3315	39	2840.0		1422.6	1040.0	336.2	1417.4	1417.4	562.3	244.6	317.7
3415	29	2290.0		1414.5	910.0	272.2	875.5	875.5	416.0	187.9	228.1
4115	41	2230.0		1237.6	870.0	292.8	992.4	992.4	492.8	228.4	264.4
4215	54	2660.0		1427.5	1140.0	347.7	1232.5	1232.5	605.1	274.1	331.0
4315	46	3140.0		2077.9	1280.0	382.1	1062.1	1062.1	547.8	243.6	304.2
1116	74	2200.0	860.0	298.6	290.0	281.3	561.4	561.4	537.1	249.0	288.1
1216	53	2430.0	780.0	278.8	310.0	300.9	501.2	501.2	433.6	197.0	236.6
1316	71	2380.0	800.0	306.6	270.0	281.6	493.4	493.4	476.8	209.7	267.1
1416	63	3350.0	1020.0	364.3	360.0	380.6	655.7	655.7	617.2	266.9	350.3
2116	57	2360.0	820.0	251.5	240.0	245.7	568.5	568.5	535.7	241.7	294.0
2216	65	1760.0	710.0	241.9	200.0	257.0	468.1	468.1	441.9	205.7	236.2
2316	60	2400.0	900.0	310.8	240.0	300.0	589.2	589.2	566.1	253.0	313.1
2416	35	2480.0	820.0	310.2	240.0	261.9	509.8	509.8	484.5	214.3	270.2
3116	87	1360.0	570.0	185.3	170.0	201.0	384.7	384.7	361.6	171.1	190.5
3216	51	1580.0	770.0	264.1	140.0	262.7	505.9	505.9	473.9	216.1	257.8
3316	35	2510.0	860.0	344.0	260.0	296.4	516.0	516.0	493.8	216.3	277.5
3416	28	3010.0	800.0	272.4	340.0	325.0	527.6	527.6	506.7	225.3	281.4
4116	40	2290.0	830.0	294.6	310.0	293.1	535.4	535.4	508.9	234.6	274.3
4216	60	1770.0	700.0	243.1	150.0	260.5	456.9	456.9	433.5	204.8	228.7
4316	30	2480.0	740.0	295.4	330.0	297.9	444.6	444.6	425.3	202.1	223.2

Table B.2. Dry matter measurements and calculations for the Riley (2017), Wichita (2018), Surefire (2018), and Surefire-Wichita (2019) studies continued.

Plot	Sub	WS_D_ VgPdSd_Wt	D_VgPdSd_ g_sqm	WS_F_ Vg_Wt	WS_D_ Vg_Wt	D_Vg_ g_sqm	WS_F_ PdSd_Wt	WS_D_ PdSd_Wt	D_PdSd_ g_sqm	WS_D_ Pd_Wt	D_Pd_ g_sqm	WS_D_ Sd_Wt	D_Sd_ g_sqm
101	a	173.7	207.7	1209.7	173.7	207.7							
101	b	154.1	184.2	1137.6	154.1	184.2							
201	a	145.9	174.4	949.1	145.9	174.4							
201	b	178.0	212.8	1246.7	178.0	212.8							
301	a	186.1	222.5	1242.8	186.1	222.5							
301	b	198.4	237.2	1401.6	198.4	237.2							
401	a	208.3	249.0	1491.4	208.3	249.0							
401	b	187.3	223.9	1379.0	187.3	223.9							
501	a	137.9	164.9	906.2	137.9	164.9							
501	b	186.5	223.0	1306.2	186.5	223.0							
601	a	148.1	177.1	1041.9	148.1	177.1							
601	b	173.1	207.0	1202.5	173.1	207.0							
102	a	276.3	330.4	2682.5	276.3	330.4							
102	b	220.3	263.4	1881.2	220.3	263.4							
202	a	305.6	365.3	2445.0	305.6	365.3							
202	b	290.2	346.9	2675.9	290.2	346.9							
302	a	239.7	286.6	2265.3	239.7	286.6							
302	b	346.9	414.7	2727.5	346.9	414.7							
402	a	241.9	289.2	2631.5	241.9	289.2							
402	b	281.2	336.2	2755.5	281.2	336.2							
502	a	225.8	270.0	2250.0	225.8	270.0							
502	b	301.9	360.9	2647.8	301.9	360.9							
602	a	226.9	271.3	2277.3	226.9	271.3							
602	b	312.9	374.1	2613.5	312.9	374.1							
103	a	657.6	786.2	5580.0	657.6	786.2							
103	b	372.2	445.0	3430.0	372.2	445.0							
203	a	455.1	544.1	4080.0	455.1	544.1							

203 b	301.8	360.8	2780.0	301.8	360.8			
303 a	392.1	468.8	3500.0	392.1	468.8			
303 b	407.7	487.4	3540.0	407.7	487.4			
403 a	446.6	533.9	3690.0	446.6	533.9			
403 b	345.2	412.7	3510.0	345.2	412.7			
503 a	478.5	572.1	3850.0	478.5	572.1			
503 b	388.9	464.9	3050.0	388.9	464.9			
603 a	479.4	573.2	4710.0	479.4	573.2			
603 b	483.4	577.9	4110.0	483.4	577.9			
104 a	516.8	617.9	3470.0	516.8	617.9			
104 b	645.1	771.2	4000.0	645.1	771.2			
204 a	699.0	835.7	4180.0	699.0	835.7			
204 b	487.4	582.7	2780.0	487.4	582.7			
304 a	574.3	686.6	3700.0	574.3	686.6			
304 b	550.1	657.7	3540.0	550.1	657.7			
404 a	594.7	711.0	3350.0	594.7	711.0			
404 b	568.9	680.2	3340.0	568.9	680.2			
504 a	607.4	726.1	3580.0	607.4	726.1			
504 b	566.7	677.5	3610.0	566.7	677.5			
604 a	645.4	771.6	3990.0	645.4	771.6			
604 b	575.3	687.8	3540.0	575.3	687.8			
105 a	679.6	812.4	3130.0	500.7	598.6	960.0	178.9	213.9
105 b	545.8	652.6	2360.0	395.7	473.1	760.0	150.1	179.5
205 a	680.9	814.0	2643.0	501.7	599.8	957.0	179.2	214.2
205 b	563.0	673.1	2143.0	394.6	471.8	897.0	168.4	201.4
305 a	646.4	772.9	3017.0	485.1	580.0	883.0	161.3	192.9
305 b	634.7	758.8	3264.0	498.8	596.3	746.0	135.9	162.5
405 a	702.6	840.0	2604.3	558.1	667.2	735.7	144.5	172.8
405 b	648.8	775.7	2732.7	513.1	613.4	707.3	135.8	162.3
505 a	582.4	696.3	1942.9	425.6	508.8	787.1	156.9	187.5
505 b	526.0	628.8	2069.1	389.4	465.5	700.9	136.6	163.3

605 a	746.1	892.0	3306.6	587.4	702.3	823.4	158.6	189.6
605 b	706.1	844.2	3208.6	546.2	653.0	831.4	159.9	191.2
106 a	642.6	768.2	2280.4	450.7	538.9	989.6	191.8	229.3
106 b	705.2	843.2	2203.9	478.4	571.9	1136.1	226.9	271.2
206 a	712.2	851.5	1742.0	429.0	512.9	1328.0	283.2	338.6
206 b	685.4	819.5	1590.1	421.0	503.4	1159.9	264.4	316.1
306 a	703.9	841.5	1926.6	436.0	521.3	1393.4	267.9	320.3
306 b	578.8	692.0	1413.6	365.7	437.3	1046.4	213.0	254.7
406 a	725.4	867.2	2363.3	479.0	572.7	1326.7	246.4	294.6
406 b	730.8	873.7	2242.5	496.9	594.1	1207.5	233.9	279.6
506 a	694.1	829.8	1785.9	412.9	493.7	1394.1	281.2	336.1
506 b	563.6	673.8	1588.6	358.0	428.0	991.4	205.6	245.8
606 a	695.3	831.2	2254.2	426.2	509.6	1395.8	269.0	321.6
606 b	825.7	987.1	2121.5	534.4	638.9	1418.5	291.3	348.3
107 a	862.0	1030.6	2149.5	455.4	544.5	1760.5	406.6	486.1
107 b	910.0	1088.0	2399.4	544.1	650.5	1760.6	365.9	437.5
207 a	635.5	759.8	1415.2	308.5	368.8	1334.8	327.0	391.0
207 b	643.7	769.6	1503.1	311.2	372.0	1426.9	332.5	397.6
307 a	714.1	853.8	1992.7	404.2	483.2	1387.3	310.0	370.6
307 b	689.7	824.6	1780.9	358.8	429.0	1479.1	330.9	395.6
407 a	673.3	805.0	1839.0	391.3	467.8	1191.0	282.0	337.2
407 b	777.3	929.2	2251.9	466.6	557.8	1488.1	310.7	371.4
507 a	667.2	797.7	1580.6	325.9	389.7	1489.4	341.2	408.0
507 b	708.2	846.7	1792.4	363.2	434.3	1597.6	344.9	412.4
607 a	674.1	805.9	1677.6	363.7	434.8	1402.4	310.4	371.1
607 b	806.3	964.0	2086.1	448.7	536.4	1623.9	357.6	427.6
108 a	754.5	902.1	1614.7	324.3	387.7	1645.3	430.2	514.4
108 b	839.3	1003.4	2020.8	384.7	459.9	1759.2	454.6	543.5
208 a	849.3	1015.3	1969.3	441.9	528.3	1650.7	407.4	487.1
208 b	673.6	805.4	1638.5	325.2	388.8	1421.5	348.4	416.6
308 a	551.1	658.9	1650.9	329.5	393.9	909.1	221.6	265.0

308 b	772.1	923.1	1678.0	347.9	416.0	1542.0	424.2	507.1				
408 a	716.0	856.1	1887.1	373.8	446.9	1312.9	342.2	409.2				
408 b	671.5	802.8	1804.9	366.5	438.1	1275.1	305.0	364.6				
508 a	877.6	1049.2	1549.9	304.0	363.4	2050.1	573.6	685.7				
508 b	608.1	727.0	1492.0	309.8	370.4	1158.0	298.3	356.6				
608 a	851.6	1018.1	2089.8	419.5	501.6	1690.2	432.0	516.5				
608 b	751.6	898.5	1930.4	382.5	457.3	1569.6	369.0	441.2				
109 a	816.2	975.8	1685.9	410.9	491.3	1244.1	405.3	484.5				
109 b	701.0	838.1	1554.0	307.1	367.1	1346.0	394.0	471.0				
209 a	817.8	977.7	1657.6	377.0	450.8	1402.4	440.7	526.9				
209 b	659.5	788.5	1359.1	286.7	342.8	1210.9	372.8	445.7				
309 a	746.3	892.2	1540.0	331.9	396.8	1420.0	414.4	495.4				
309 b	480.9	575.0	1098.3	231.4	276.7	801.7	249.5	298.3				
409 a	844.1	1009.1	1769.3	416.8	498.3	1270.7	427.3	510.9				
409 b	695.6	831.6	1734.9	358.4	428.4	1185.1	337.2	403.2				
509 a	605.4	723.7	998.0	254.8	304.6	1032.0	350.6	419.1				
509 b	787.8	941.9	1668.7	380.1	454.4	1341.3	407.8	487.5				
609 a	776.8	928.7	1447.3	339.2	405.5	1312.7	437.6	523.1				
609 b	963.9	1152.4	1990.8	427.6	511.2	1759.2	536.3	641.1				
110 a	737.6	881.8	703.4	330.0	394.5	606.6	407.6	487.3	205.2	245.3	202.4	242.0
110 b	1006.4	1203.2	716.8	444.0	530.8	703.2	562.4	672.4	284.5	340.1	277.9	332.2
210 a	901.6	1077.9	1386.4	424.9	508.0	1163.6	476.7	569.9	244.5	292.3	232.2	277.6
210 b	832.2	995.0	1335.2	366.8	438.6	1104.8	465.4	556.4	221.2	264.5	244.2	292.0
310 a	821.2	981.8	777.3	415.4	496.6	592.7	405.8	485.2	230.7	275.8	175.1	209.3
310 b	720.0	860.8	1066.9	455.1	544.1	463.1	264.9	316.7	131.6	157.3	133.3	159.4
410 a	809.0	967.2	1046.3	412.2	492.8	703.7	396.8	474.4	199.6	238.6	197.2	235.8
410 b	767.4	917.5	1609.6	426.2	509.5	910.4	341.2	407.9	185.4	221.7	155.8	186.3
510 a	787.7	941.8	1233.8	352.3	421.2	1046.2	435.4	520.5	221.6	264.9	213.8	255.6
510 b	775.1	926.7	1347.0	403.1	482.0	833.0	372.0	444.7	185.9	222.3	186.1	222.5
610 a	801.0	957.7	913.7	397.3	475.1	616.3	403.7	482.6	207.2	247.7	196.5	234.9
610 b	772.5	923.6	1263.8	362.2	433.0	986.2	410.3	490.5	199.6	238.6	210.7	251.9

108 a	118.3	141.4	580.5	118.3	141.4					
118 b	137.3	164.1	787.1	137.3	164.1					
206 a	145.7	174.2	869.6	145.7	174.2					
226 b	149.2	178.4	899.2	149.2	178.4					
306 a	125.7	150.3	740.2	125.7	150.3					
321 b	143.2	171.2	816.3	143.2	171.2					
103 a	170.8	204.2	1065.4	170.8	204.2					
104 b	153.1	183.0	945.8	153.1	183.0					
208 a	131.8	157.6	764.4	131.8	157.6					
222 b	150.9	180.4	938.0	150.9	180.4					
317 a	195.0	233.1	1233.2	195.0	233.1					
325 b	198.2	237.0	1223.0	198.2	237.0					
113 a	208.7	249.5	1722.2	208.7	249.5					
114 b	220.3	263.4	1790.3	220.3	263.4					
201 a	231.4	276.6	1945.2	231.4	276.6					
215 b	173.2	207.1	1397.5	173.2	207.1					
323 a	232.9	278.5	1945.0	232.9	278.5					
324 b	227.2	271.6	1854.5	227.2	271.6					
101 a	221.3	264.6	1916.8	219.3	262.2	13.2	2.0	2.4		2.4
119 b	337.8	403.9	3035.7	334.2	399.5	24.3	3.7	4.4		4.4
219 a	334.2	399.6	2761.7	330.8	395.4	43.3	3.5	4.2		4.2
225 b	280.0	334.8	2796.8	278.0	332.3	13.2	2.1	2.5		2.5
308 a	287.4	343.6	2572.6	284.8	340.5	17.4	2.6	3.1		3.1
320 b	302.8	362.0	2501.4	297.0	355.0	18.6	5.8	6.9		6.9
127 a	378.9	452.9	1839.8	311.4	372.3	402.4	67.5	80.7		80.7
128 b	612.8	732.7	3162.5	515.8	616.6	583.8	97.1	116.1		116.1
202 a	420.6	502.8	1875.8	339.2	405.5	471.3	81.4	97.3		97.3
218 b	359.7	430.0	1925.0	311.3	372.1	284.0	48.4	57.9		57.9
314 a	315.4	377.1	1322.8	259.5	310.3	316.5	55.9	66.8		66.8
318 b	473.7	566.3	1894.8	366.1	437.7	623.0	107.6	128.6		128.6
112 a	620.2	741.5	1690.5	405.0	484.1	1137.9	215.3	257.4		257.4

123 b	641.9	767.4	1575.5	345.9	413.6	1638.3	296.0	353.8		353.8		
204 a	864.3	1033.3	2040.0	486.5	581.6	2085.2	377.9	451.7		451.7		
217 b	476.3	569.5	1413.8	310.7	371.5	895.1	165.6	198.0		198.0		
302 a	598.2	715.2	1674.0	364.5	435.8	1292.4	233.7	279.4		279.4		
315 b	533.2	637.4	1457.0	321.3	384.2	1155.7	211.8	253.3		253.3		
102 a	541.6	647.5	1155.0	251.6	300.8	1401.3	290.1	346.8		346.8		
120 b	544.6	651.1	1032.3	243.8	291.5	1366.5	300.7	359.6		359.6		
224 a	434.5	519.5	929.3	206.4	246.8	1172.5	228.1	272.7		272.7		
229 b	608.5	727.5	1233.3	277.4	331.6	1613.7	331.1	395.9		395.9		
313 a	589.1	704.3	1148.0	289.4	346.0	1351.6	299.7	358.3		358.3		
330 b	719.6	860.4	1424.0	322.7	385.8	1940.5	397.0	474.6		474.6		
110 a	554.2	662.6	877.3	246.0	294.1	964.3	308.3	368.5		368.5		
130 b	1080.3	1291.6	1943.7	446.3	533.5	2461.3	634.0	758.0		758.0		
211 a	579.3	692.6	900.0	233.9	279.6	1190.7	345.4	413.0		413.0		
227 b	771.1	921.9	1161.3	294.0	351.5	1670.6	477.1	570.4		570.4		
319 a	759.1	907.6	1136.7	270.8	323.8	1737.1	488.3	583.8		583.8		
329 b	814.1	973.3	1248.3	312.1	373.1	1716.6	502.0	600.2		600.2		
111 a	556.8	665.7	821.3	238.3	284.9	766.9	318.6	380.9	184.7	220.8	133.9	160.1
116 b	660.8	790.0	874.3	246.6	294.8	1115.1	414.2	495.2	222.9	266.4	191.3	228.8
203 a	788.9	943.2	1005.0	289.4	346.0	1291.1	499.5	597.2	258.8	309.4	240.8	287.8
210 b	448.6	536.3	589.3	165.6	198.0	798.1	283.0	338.3	153.7	183.7	129.3	154.6
305 a	919.0	1098.7	1288.0	335.5	401.1	1654.1	583.5	697.6	294.4	351.9	289.1	345.7
326 b	877.4	1049.0	1218.3	310.4	371.1	1657.9	567.0	677.9	286.1	342.0	280.9	335.9
1101 a	81.9	97.9	437.2	81.9	97.9							
1101 b	49.5	59.2	286.5	49.5	59.2							
1201 a	9.9	11.8	56.2	9.9	11.8							
1201 b	18.1	21.6	95.4	18.1	21.6							
2101 a	47.1	56.3	268.4	47.1	56.3							
2101 b	81.4	97.3	514.1	81.4	97.3							
2201 a	43.9	52.5	222.8	43.9	52.5							
2201 b	37.8	45.2	205.3	37.8	45.2							

3101 a	55.6	66.5	300.5	55.6	66.5
3101 b	34.8	41.6	188.0	34.8	41.6
3201 a	38.0	45.4	213.7	38.0	45.4
3201 b	36.6	43.8	202.3	36.6	43.8
4101 a	30.7	36.7	191.5	30.7	36.7
4101 b	40.5	48.4	228.0	40.5	48.4
4201 a	40.8	48.8	238.6	40.8	48.8
4201 b	24.6	29.4	139.8	24.6	29.4
1102 a	77.0	92.1	423.6	77.0	92.1
1102 b	92.5	110.6	609.1	92.5	110.6
1202 a	20.5	24.5	101.4	20.5	24.5
1202 b	40.7	48.7	245.9	40.7	48.7
2102 a	44.3	53.0	261.1	44.3	53.0
2102 b	68.4	81.8	396.9	68.4	81.8
2202 a	58.6	70.1	336.2	58.6	70.1
2202 b	35.9	42.9	209.4	35.9	42.9
3102 a	53.9	64.4	324.5	53.9	64.4
3102 b	53.0	63.4	284.6	53.0	63.4
3202 a	40.1	47.9	229.2	40.1	47.9
3202 b	38.7	46.3	230.6	38.7	46.3
4102 a	43.0	51.4	234.5	43.0	51.4
4102 b	53.0	63.4	324.0	53.0	63.4
4202 a	43.0	51.4	260.4	43.0	51.4
4202 b	39.4	47.1	240.5	39.4	47.1
1103 a	90.7	108.4	716.1	90.7	108.4
1103 b	95.1	113.7	882.6	95.1	113.7
1203 a	41.0	49.0	349.4	41.0	49.0
1203 b	39.2	46.9	326.6	39.2	46.9
2103 a	118.3	141.4	1031.4	118.3	141.4
2103 b	87.6	104.7	744.5	87.6	104.7
2203 a	50.4	60.3	440.4	50.4	60.3

2203 b	63.5	75.9	512.3	63.5	75.9					
3103 a	89.1	106.5	720.2	89.1	106.5					
3103 b	85.4	102.1	736.3	85.4	102.1					
3203 a	84.9	101.5	745.3	84.9	101.5					
3203 b	64.3	76.9	545.0	64.3	76.9					
4103 a	64.1	76.6	556.3	64.1	76.6					
4103 b	73.3	87.6	616.2	73.3	87.6					
4203 a	45.6	54.5	411.2	45.6	54.5					
4203 b	68.3	81.7	565.0	68.3	81.7					
1104 a	126.5	151.3	1308.6	126.3	151.0	1.4	0.2	0.2		0.2
1104 b	157.2	188.0	1784.0	157.1	187.8	1.0	0.2	0.2		0.2
1204 a	50.0	59.8	564.7	49.9	59.7	0.3	0.1	0.1		0.1
1204 b	43.0	51.4	338.1	43.0	51.4	0.6	0.1	0.1		0.1
2104 a	121.8	145.6	1184.3	121.7	145.5	0.7	0.1	0.1		0.1
2104 b	87.2	104.2	929.1	87.0	104.1	0.9	0.1	0.2		0.2
2204 a	135.5	162.1	1521.7	135.1	161.5	3.3	0.4	0.5		0.5
2204 b	94.8	113.4	894.0	94.7	113.2	1.0	0.2	0.2		0.2
3104 a	144.1	172.3	1397.8	143.8	171.9	2.2	0.3	0.3		0.3
3104 b	77.3	92.5	854.1	77.2	92.3	0.9	0.1	0.2		0.2
3204 a	139.3	166.5	1419.6	139.2	166.4	0.4	0.1	0.1		0.1
3204 b	77.2	92.3	879.1	77.1	92.2	0.8	0.1	0.1		0.1
4104 a	157.0	187.7	1449.2	156.7	187.4	0.8	0.3	0.3		0.3
4104 b	46.5	55.5	470.0	46.5	55.5					
4204 a	133.4	159.5	1348.6	133.1	159.2	1.4	0.3	0.3		0.3
4204 b	81.2	97.0	732.0	81.1	97.0	0.3	0.1	0.1		0.1
1105 a	273.4	326.8	1930.0	258.8	309.4	86.2	14.6	17.5		17.5
1105 b	352.6	421.5	2711.3	338.0	404.1	90.5	14.6	17.5		17.5
1205 a	32.3	38.6	200.3	31.3	37.4	7.2	1.0	1.2		1.2
1205 b	189.9	227.0	1250.0	185.2	221.4	26.3	4.7	5.6		5.6
2105 a	291.9	349.0	1589.0	265.4	317.3	149.5	26.5	31.6		31.6
2105 b	200.8	240.0	1627.5	195.3	233.5	33.8	5.5	6.5		6.5

2205 a	222.0	265.4	1655.0	213.1	254.8	53.2	8.9	10.6	10.6
2205 b	217.6	260.2	1713.5	212.7	254.3	28.5	4.9	5.9	5.9
3105 a	119.0	142.2	940.0	117.5	140.4	7.9	1.5	1.8	1.8
3105 b	39.4	47.1	327.2	38.7	46.3	4.2	0.7	0.8	0.8
3205 a	212.9	254.6	1695.0	207.1	247.6	35.6	5.8	6.9	6.9
3205 b	224.4	268.3	1430.0	211.6	253.0	73.5	12.8	15.3	15.3
4105 a	224.3	268.2	1400.0	212.3	253.8	68.3	12.0	14.3	14.3
4105 b	186.8	223.3	1250.0	182.6	218.3	21.5	4.2	5.0	5.0
4205 a	239.2	286.0	1590.8	227.3	271.7	70.9	12.0	14.3	14.3
4205 b	161.9	193.5	955.0	152.7	182.5	53.4	9.2	11.0	11.0
1106 a	603.0	720.9	2538.0	451.8	540.1	840.8	151.2	180.8	180.8
1106 b	351.4	420.1	1755.0	267.3	319.6	526.6	84.1	100.5	100.5
1206 a	54.6	65.3	206.0	53.8	64.3	3.5	0.8	1.0	1.0
1206 b	101.5	121.4	369.8	89.6	107.1	56.7	11.9	14.3	14.3
2106 a	325.5	389.1	1595.0	262.5	313.9	362.2	62.9	75.2	75.2
2106 b	319.9	382.5	1656.3	266.9	319.1	293.1	53.0	63.4	63.4
2206 a	276.8	330.9	1350.0	220.6	263.7	316.0	56.2	67.2	67.2
2206 b	243.0	290.5	1060.0	191.0	228.4	273.0	51.9	62.1	62.1
3106 a	156.2	186.7	745.0	132.3	158.2	129.0	23.8	28.5	28.5
3206 a	286.6	342.6	1276.0	230.1	275.1	320.2	56.5	67.5	67.5
3206 b	246.5	294.7	1025.0	193.9	231.8	297.9	52.7	63.0	63.0
4106 a	280.8	335.7	995.0	218.6	261.4	325.0	62.2	74.4	74.4
4106 b	255.6	305.6	1120.0	215.4	257.6	212.4	40.2	48.1	48.1
4206 a	275.2	329.0	1248.5	222.5	266.0	296.0	52.8	63.1	63.1
4206 b	363.8	434.9	1386.0	272.5	325.8	495.3	91.3	109.2	109.2
1107 a	286.0	341.9	795.0	158.2	189.1	692.9	127.8	152.8	152.8
1107 b	508.3	607.7	1559.3	287.5	343.7	1169.5	220.8	264.0	264.0
1207 b	421.0	503.3	1295.0	250.4	299.4	960.3	170.5	203.9	203.9
2107 a	325.5	389.2	985.0	199.3	238.2	671.7	126.2	150.9	150.9
2107 b	356.1	425.7	1040.0	210.4	251.6	788.6	145.7	174.2	174.2
2207 a	437.3	522.8	1225.0	241.3	288.5	1068.1	196.0	234.3	234.3

2207 b	340.0	406.5	853.3	186.7	223.2	776.6	153.3	183.3		183.3		
3107 a	279.5	334.2	785.0	175.5	209.9	536.8	104.0	124.3		124.3		
3207 a	352.5	421.4	1150.5	211.3	252.6	779.5	141.2	168.8		168.8		
3207 b	307.2	367.3	1000.0	195.7	233.9	597.1	111.6	133.4		133.4		
4107 a	343.2	410.4	915.0	194.2	232.1	756.0	149.1	178.2		178.2		
4107 b	292.3	349.5	720.0	166.9	199.5	649.2	125.5	150.0		150.0		
4207 a	440.5	526.6	1230.0	264.7	316.4	915.5	175.8	210.2		210.2		
4207 b	280.3	335.2	630.0	151.2	180.8	632.5	129.1	154.4		154.4		
1108 a	379.8	454.1	924.0	187.9	224.7	785.5	191.9	229.4		229.4		
1108 b	327.8	391.9	760.0	153.9	184.0	760.7	173.9	207.9		207.9		
1208 a	208.2	249.0	470.0	99.4	118.9	495.0	108.8	130.1		130.1		
1208 b	425.6	508.9	980.0	208.5	249.2	927.6	217.2	259.6		259.6		
2108 a	447.9	535.4	1070.0	226.8	271.1	861.7	221.1	264.3		264.3		
2108 b	156.7	187.4	350.0	76.3	91.2	324.1	80.4	96.1		96.1		
2208 a	287.5	343.7	650.0	152.6	182.5	562.0	134.9	161.3		161.3		
2208 b	390.6	466.9	860.0	183.4	219.3	854.0	207.1	247.6		247.6		
3108 a	204.0	439.1	450.0	101.3	218.1	392.3	102.7	221.0		221.0		
3108 b	254.5	304.2	650.0	149.5	178.7	491.3	105.0	125.5		125.5		
3208 a	458.3	548.0	1000.0	221.2	264.5	959.8	237.1	283.5		283.5		
3208 b	354.6	424.0	781.0	182.9	218.7	737.3	171.7	205.3		205.3		
4108 a	421.4	503.8	740.0	199.3	238.3	790.0	222.1	265.5		265.5		
4108 b	341.6	408.4	790.0	196.1	234.4	628.5	145.5	174.0		174.0		
4208 a	453.1	541.7	790.0	216.3	258.6	861.2	236.8	283.1		283.1		
4208 b	633.3	757.2	1264.0	305.0	364.6	1313.6	328.3	392.5		392.5		
1109 a	266.5	318.7	560.0	137.9	164.9	406.6	128.6	153.7	78.9	94.3	49.7	59.4
1109 b	636.6	761.1	986.0	248.0	296.5	1191.6	388.6	464.6	213.7	255.5	174.9	209.1
1209 a	205.4	245.6	310.0	92.6	110.7	304.4	112.8	134.9	64.5	77.1	48.3	57.7
1209 b	281.7	336.8	450.0	112.5	134.6	491.2	169.2	202.3	92.5	110.6	76.7	91.7
2109 a	325.9	389.6	640.0	175.6	209.9	433.4	150.3	179.7	90.3	108.0	60.0	71.7
2109 b	483.9	578.5	1022.0	241.4	288.6	791.8	242.5	289.9	162.1	193.8	80.4	96.1
2209 a	477.8	571.3	790.0	193.7	231.6	870.1	284.1	339.7	155.7	186.1	128.4	153.5

2209 b	344.5	411.9	680.0	161.3	192.9	561.4	183.2	219.0	110.0	131.5	73.2	87.5
3109 a	442.7	529.3	750.0	197.3	235.9	705.1	245.4	293.4	134.8	161.2	110.6	132.2
3109 b	463.2	553.8	884.0	211.8	253.2	775.2	251.4	300.6	146.9	175.6	104.5	125.0
3209 a	426.5	509.9	760.0	205.3	245.4	653.1	221.2	264.5	130.3	155.8	90.9	108.7
3209 b	279.1	333.6	480.0	127.3	152.1	463.1	151.8	181.5	86.3	103.2	65.5	78.3
4109 a	463.4	554.1	787.5	216.7	259.1	694.8	246.8	295.0	143.7	171.9	103.0	123.1
4109 b	206.7	247.1	400.0	96.6	115.5	340.3	110.1	131.6	71.7	85.7	38.4	45.9
4209 a	364.5	435.7	610.0	162.5	194.2	584.2	202.0	241.5	119.1	142.4	82.9	99.1
4209 b	375.0	448.3	590.0	160.2	191.5	620.7	214.8	256.8	120.1	143.6	94.7	113.2
1110 a	548.6	655.9	787.7	222.9	266.5	733.9	325.7	389.4	170.3	203.6	155.4	185.8
1110 b	578.9	692.1	919.2	253.7	303.3	730.9	325.2	388.8	169.6	202.7	155.6	186.0
1210 a	463.7	554.4	632.8	199.6	238.6	571.5	264.1	315.7	142.0	169.8	122.1	146.0
1210 b	416.5	498.0	700.0	184.1	220.1	547.4	232.4	277.8	120.7	144.3	111.7	133.5
2110 a	398.0	475.8	728.7	203.2	242.9	469.6	194.8	232.9	109.0	130.3	85.8	102.6
2110 b	463.5	554.1	790.7	219.1	261.9	558.6	244.4	292.2	139.2	166.5	105.2	125.7
2210 a	389.4	465.5	527.5	153.1	183.0	541.3	236.3	282.5	126.5	151.2	109.8	131.3
2210 b	388.9	465.0	615.4	163.5	195.5	556.1	225.4	269.5	119.0	142.3	106.4	127.2
3110 a	418.0	499.7	654.0	177.4	212.1	507.5	240.6	287.7	127.1	152.0	113.5	135.7
3110 b	539.1	644.5	842.3	242.0	289.3	628.2	297.2	355.3	155.8	186.3	141.3	169.0
3210 a	365.9	437.5	537.8	165.1	197.4	448.5	200.8	240.1	106.1	126.8	94.7	113.2
3210 b	320.7	383.4	448.1	142.6	170.5	388.1	178.1	212.9	95.1	113.7	83.0	99.2
4110 a	442.2	528.7	649.0	183.3	219.1	583.9	258.9	309.6	131.8	157.6	127.2	152.0
4110 b	221.2	264.4	430.0	130.3	155.7	209.1	90.9	108.7	56.3	67.3	34.6	41.4
4210 a	430.0	514.1	585.7	181.4	216.9	589.6	248.6	297.2	131.3	157.0	117.3	140.2
4210 b	337.8	403.8	460.0	132.3	158.2	466.9	205.5	245.7	103.1	123.3	102.4	122.4
1101	93.4	111.7	830.2	93.4	111.7							
1201	80.9	96.7	638.5	80.9	96.7							
1301	117.1	140.0	1167.3	117.1	140.0							
1401	73.5	87.9	668.2	73.5	87.9							
2101	33.7	40.3	260.3	33.7	40.3							
2201	72.1	86.2	576.6	72.1	86.2							

2301	68.2	81.5	559.2	68.2	81.5
2401	54.0	64.6	455.8	54.0	64.6
3101	64.8	77.5	516.7	64.8	77.5
3201	88.9	106.3	734.2	88.9	106.3
3301	53.7	64.2	410.3	53.7	64.2
3401	63.3	75.7	526.5	63.3	75.7
4101	63.9	76.4	486.4	63.9	76.4
4201	74.8	89.4	601.7	74.8	89.4
4301	111.7	133.5	968.0	111.7	133.5
1102	193.8	231.7	1032.1	193.8	231.7
1202	148.2	177.2	780.5	148.2	177.2
1302	227.1	271.5	1282.9	227.1	271.5
1402	143.3	171.3	706.5	143.3	171.3
2102	73.9	88.4	351.9	73.9	88.4
2202	192.2	229.8	1028.5	192.2	229.8
2302	176.8	211.4	964.8	176.8	211.4
2402	106.8	127.7	408.6	106.8	127.7
3102	176.9	211.5	1011.5	176.9	211.5
3202	162.4	194.2	951.0	162.4	194.2
3302	127.0	151.8	708.7	127.0	151.8
3402	120.0	143.5	664.1	120.0	143.5
4102	105.6	126.3	557.4	105.6	126.3
4202	175.5	209.8	1181.2	175.5	209.8
4302	168.2	201.1	1096.4	168.2	201.1
1103	136.9	163.7	610.8	136.9	163.7
1203	89.5	107.0	388.3	89.5	107.0
1303	101.1	120.9	489.6	101.1	120.9
1403	58.6	70.1	292.8	58.6	70.1
2103	47.5	56.8	183.9	47.5	56.8
2203	51.4	49.2	203.6	51.4	49.2
2303	71.2	56.7	344.2	71.2	56.7

2403	36.1	43.2	155.1	36.1	43.2
3103	71.7	57.1	368.2	71.7	57.1
3203	70.7	84.5	315.1	70.7	84.5
3303	44.0	52.6	214.2	44.0	52.6
3403	33.6	40.2	165.2	33.6	40.2
4103	45.7	54.6	210.9	45.7	54.6
4203	51.5	61.6	257.3	51.5	61.6
4303	79.0	94.4	365.8	79.0	94.4
1104	179.0	214.0	1296.2	179.0	214.0
1204	125.7	150.3	896.2	125.7	150.3
1304	175.6	209.9	1346.5	175.6	209.9
1404	125.6	150.2	948.0	125.6	150.2
2104	12.9	15.4	79.6	12.9	15.4
2204	72.3	115.3	497.8	72.3	115.3
2304	66.9	80.0	442.4	66.9	80.0
2404	50.3	60.1	355.0	50.3	60.1
3104	139.1	166.3	1080.2	139.1	166.3
3204	110.9	132.6	779.4	110.9	132.6
3304	88.2	105.4	646.6	88.2	105.4
3404	82.4	98.5	569.2	82.4	98.5
4104	77.8	93.0	565.4	77.8	93.0
4204	75.5	90.3	525.2	75.5	90.3
4304	99.0	118.4	746.3	99.0	118.4
1105	212.2	253.7	2030.0	212.2	253.7
1205	145.3	173.7	1370.0	145.3	173.7
1305	271.6	324.7	3040.0	271.6	324.7
1405	203.6	243.4	2140.0	203.6	243.4
2105	39.5	47.2	330.0	39.5	47.2
2205	115.3	137.8	1010.0	115.3	137.8
2305	121.5	145.3	1070.0	121.5	145.3
2405	102.8	122.9	990.0	102.8	122.9

3105	206.3	246.6	2090.0	206.3	246.6					
3205	136.3	163.0	1080.0	136.3	163.0					
3305	159.5	190.7	1580.0	159.5	190.7					
3405	113.1	135.2	1050.0	113.1	135.2					
4105	125.7	150.3	1150.0	125.7	150.3					
4205	161.7	193.3	1470.0	161.7	193.3					
4305	192.5	230.1	1970.0	192.5	230.1					
1106	294.4	352.0	2270.0	294.4	352.0					
1206	166.8	199.4	1490.0	166.8	199.4					
1306	427.3	510.9	4600.0	427.3	510.9					
1406	267.6	319.9	2690.0	267.6	319.9					
2106	156.2	186.7	1290.0	156.2	186.7					
2206	111.2	132.9	890.0	111.2	132.9					
2306	174.3	208.4	1520.0	174.3	208.4					
2406	186.1	222.5	1840.0	186.1	222.5					
3106	244.6	292.4	2180.0	244.6	292.4					
3206	198.4	237.2	1520.0	198.4	237.2					
3306	205.6	245.8	1980.0	205.6	245.8					
3406	223.5	267.2	2090.0	223.5	267.2					
4106	192.8	230.5	1630.0	192.8	230.5					
4206	248.1	296.6	2130.0	248.1	296.6					
4306	264.2	315.9	2710.0	264.2	315.9					
1107	374.3	447.5	2250.0	365.8	437.4	42.8	8.5	10.2		10.2
1207	277.2	331.4	2100.0	276.3	330.4	4.1	0.9	1.1		1.1
1307	437.5	523.1	3600.0	435.9	521.2	8.0	1.6	1.9		1.9
1407	365.8	437.3	2830.0	364.4	435.7	7.9	1.4	1.7		1.7
2107	298.0	356.3	2040.0	293.2	350.6	23.2	4.8	5.7		5.7
2207	123.6	147.8	830.0	123.1	147.2	2.3	0.5	0.6		0.6
2307	310.4	371.1	2260.0	309.2	369.7	5.5	1.2	1.4		1.4
2407	367.6	439.5	2650.0	366.2	437.8	7.6	1.4	1.7		1.7
3107	345.5	413.0	2400.0	343.1	410.2	12.4	2.4	2.9		2.9

3207	306.4	366.4	2150.0	304.9	364.6	7.4	1.5	1.8	1.8
3307	369.0	441.1	2930.0	368.1	440.1	4.9	0.9	1.1	1.1
3407	278.0	332.3	2200.0	277.6	331.9	2.5	0.4	0.5	0.5
4107	297.4	355.6	2010.0	295.1	352.8	11.2	2.3	2.7	2.7
4207	343.1	410.2	2400.0	341.8	408.7	6.7	1.3	1.6	1.6
4307	403.2	482.0	3440.0	402.2	480.8	5.5	1.0	1.2	1.2
1108	405.6	484.9	2680.0	381.9	456.6	139.7	23.7	28.3	28.3
1208	399.6	477.8	2910.0	388.9	465.0	64.5	10.7	12.8	12.8
1308	529.9	633.5	4200.0	514.5	615.1	94.6	15.4	18.4	18.4
1408	498.4	595.9	3830.0	480.3	574.2	110.4	18.1	21.6	21.6
2108	425.6	508.8	2880.0	400.1	478.3	157.6	25.5	30.5	30.5
2208	359.8	430.2	2340.0	350.8	419.4	52.9	9.0	10.8	10.8
2308	335.2	400.8	2470.0	326.8	390.7	49.4	8.4	10.0	10.0
2408	507.0	606.2	3990.0	490.1	586.0	101.4	16.9	20.2	20.2
3108	457.5	546.9	3080.0	435.4	520.5	132.3	22.1	26.4	26.4
3208	312.7	373.9	2130.0	299.6	358.2	78.8	13.1	15.7	15.7
3308	380.1	454.4	2510.0	370.3	442.7	55.9	9.8	11.7	11.7
3408	396.5	474.0	3310.0	390.9	467.3	34.7	5.6	6.7	6.7
4108	378.3	452.3	2560.0	366.0	437.6	72.4	12.3	14.7	14.7
4208	421.3	503.7	3030.0	408.7	488.7	77.9	12.6	15.1	15.1
4308	443.6	530.4	3740.0	435.7	521.0	47.7	7.9	9.4	9.4
1109	522.7	625.0	2510.0	414.7	495.8	673.8	108.0	129.1	129.1
1209	519.2	620.7	2990.0	462.4	552.8	337.2	56.8	67.9	67.9
1309	597.8	714.7	3580.0	521.6	623.6	470.6	76.2	91.1	91.1
1409	530.6	634.4	3740.0	459.7	549.6	440.5	70.9	84.8	84.8
2109	449.8	537.8	2150.0	352.3	421.2	579.5	97.5	116.6	116.6
2209	475.0	567.9	2430.0	379.3	453.5	571.8	95.7	114.4	114.4
2309	398.3	476.2	2250.0	335.2	400.7	399.1	63.1	75.4	75.4
2409	457.9	547.5	3000.0	414.4	495.4	277.9	43.5	52.0	52.0
3109	369.2	441.4	1820.0	287.7	343.9	505.1	81.5	97.4	97.4
3209	386.3	461.9	2380.0	337.7	403.8	292.6	48.6	58.1	58.1

3309	532.6	636.7	3550.0	480.5	574.4	318.3	52.1	62.3	62.3
3409	474.8	567.7	3060.0	432.1	516.7	262.8	42.7	51.1	51.1
4109	417.0	498.5	2320.0	359.8	430.2	345.9	57.2	68.4	68.4
4209	454.9	543.9	2630.0	394.1	471.2	374.0	60.8	72.7	72.7
4309	597.7	714.6	3820.0	534.2	638.7	417.5	63.5	75.9	75.9
1110	471.1	563.2	1680.0	331.6	396.4	785.5	139.5	166.8	166.8
1210	577.7	690.7	2320.0	432.5	517.1	854.2	145.2	173.6	173.6
1310	636.3	760.7	2450.0	473.7	566.3	951.8	162.6	194.4	194.4
1410	610.3	729.7	2490.0	450.4	538.5	947.9	159.9	191.2	191.2
2110	703.9	841.5	2360.0	451.5	539.7	1481.0	252.4	301.8	301.8
2210	547.6	654.7	1750.0	363.7	434.8	1037.4	183.9	219.9	219.9
2310	567.3	678.2	1890.0	397.8	475.6	971.5	169.5	202.6	202.6
2410	598.4	715.4	2510.0	434.0	518.9	982.6	164.4	196.6	196.6
3110	175.5	209.8	540.0	115.8	138.4	341.3	59.7	71.4	71.4
3210	578.7	691.8	2000.0	375.4	448.8	1153.2	203.3	243.1	243.1
3310	612.6	732.4	2820.0	477.4	570.8	824.4	135.2	161.6	161.6
3410	468.9	560.6	2290.0	381.1	455.6	501.8	87.8	105.0	105.0
4110	504.3	602.9	1750.0	361.9	432.7	818.1	142.4	170.2	170.2
4210	643.5	769.4	2360.0	432.4	517.0	1205.0	211.1	252.4	252.4
4310	683.5	817.2	2920.0	495.2	592.1	1161.2	188.3	225.1	225.1
1111	763.5	912.8	2415.0	425.1	508.3	1943.8	338.4	404.6	404.6
1211	701.2	838.4	1881.0	371.2	443.8	1933.0	330.1	394.6	394.6
1311	953.9	1140.5	3150.0	559.3	668.7	2429.7	394.6	471.8	471.8
1411	837.0	1000.7	2464.0	456.4	545.7	2178.4	380.6	455.0	455.0
2111	954.9	1141.7	2478.7	491.2	587.3	2573.5	463.7	554.4	554.4
2211	765.6	915.3	1872.7	380.5	455.0	2142.3	385.1	460.4	460.4
2311	751.9	898.9	1995.0	385.3	460.6	2154.8	366.6	438.3	438.3
2411	776.3	928.1	2666.7	467.2	558.6	1916.4	309.0	369.5	369.5
3111	803.0	960.0	1848.0	416.9	498.4	2151.9	386.1	461.7	461.7
3211	843.9	1009.0	2314.7	455.8	545.0	2281.1	388.1	464.0	464.0
3311	822.7	983.6	3226.7	538.3	643.6	1812.0	284.5	340.1	340.1

3411	541.1	646.9	1940.0	328.0	392.2	1244.8	213.1	254.7		254.7		
4111	416.3	497.7	1160.0	235.6	281.7	1074.7	180.7	216.1		216.1		
4211	652.3	779.8	1518.0	331.2	396.0	1716.6	321.1	383.9		383.9		
4311	876.5	1048.0	2998.7	530.1	633.7	2126.8	346.5	414.2		414.2		
1112	665.7	795.9	2085.0	403.4	482.2	2708.7	567.9	679.0	177.6	212.3	84.8	101.3
1212	625.4	747.7	1804.0	375.3	448.7	1995.6	429.4	513.4	167.7	200.5	82.4	98.5
1312	737.8	882.0	2632.3	458.8	548.5	3424.9	632.3	755.9	212.0	253.5	67.0	80.1
1412	1035.3	1237.8	3220.0	610.6	730.1	3001.4	633.3	757.2	291.7	348.7	133.0	159.0
2112	824.8	986.1	2126.7	449.7	537.6	2513.5	567.9	679.0	248.6	297.2	126.4	151.2
2212	835.6	999.0	2184.0	456.3	545.6	2656.1	565.5	676.1	259.1	309.8	120.1	143.6
2312	552.1	660.1	1760.0	329.7	394.2	2490.8	496.6	593.7	152.5	182.4	69.9	83.5
2412	477.8	571.3	1586.7	285.3	341.0	1941.1	385.6	461.0	137.5	164.4	55.1	65.9
3112	427.0	510.6	827.3	206.8	247.3	1122.6	256.9	307.2	155.7	186.2	64.5	77.1
3212	473.3	565.9	1014.0	243.1	290.6	1538.2	330.2	394.7	158.2	189.2	72.0	86.1
3312	392.8	469.6	1020.0	225.0	269.0	1401.9	279.3	333.9	117.7	140.7	50.1	59.9
3412	364.6	435.9	1110.0	210.0	251.1	1686.8	310.6	371.3	120.9	144.5	33.7	40.3
4112	451.5	539.8	1060.0	281.7	336.8	1133.6	228.9	273.7	133.2	159.2	36.6	43.8
4212	885.1	1058.2	2496.0	492.2	588.4	3134.3	684.2	818.0	265.2	317.0	127.8	152.8
4312	609.2	728.3	1905.0	374.9	448.2	2550.3	471.1	563.2	173.1	207.0	61.2	73.2
1113	819.8	980.1	1590.0	313.7	375.0	1827.3	506.1	605.1	264.3	316.0	241.8	289.1
1213	1015.2	1213.8	1886.0	396.5	474.1	2173.7	618.7	739.7	308.0	368.3	310.7	371.4
1313	1136.6	1358.9	2496.0	491.9	588.2	2355.4	644.7	770.8	342.2	409.1	302.5	361.7
1413	950.8	1136.7	2139.7	408.0	487.8	1960.7	542.8	648.9	284.5	340.2	258.2	308.7
2113	1134.0	1355.8	1906.7	382.9	457.7	2624.5	751.2	898.1	378.3	452.3	372.9	445.8
2213	932.5	1114.9	1596.0	345.2	412.7	2012.1	587.3	702.1	294.1	351.6	293.2	350.5
2313	834.8	998.1	1504.7	325.7	389.4	1859.7	509.1	608.7	267.8	320.1	241.4	288.6
2413	762.2	911.3	1603.3	309.4	370.0	1732.2	452.8	541.3	249.5	298.3	203.3	243.0
3113	620.2	741.5	904.7	222.9	266.5	1345.5	397.3	475.0	217.1	259.6	180.2	215.4
3213	819.7	980.0	1200.0	307.3	367.4	1728.0	512.3	612.5	276.3	330.4	236.0	282.2
3313	882.3	1054.8	1716.0	356.8	426.6	2116.7	525.5	628.2	288.2	344.6	237.2	283.6
3413	695.3	831.2	1570.0	318.8	381.1	1553.6	376.5	450.1	223.3	267.0	153.2	183.2

4113	432.1	516.6	680.0	196.5	234.9	874.4	235.6	281.7	139.3	166.5	96.3	115.1
4213	865.9	1035.2	1551.0	331.0	395.8	1963.5	534.9	639.5	286.2	342.2	248.6	297.3
4313	925.1	1106.0	2028.0	415.6	496.8	2067.6	509.5	609.2	292.0	349.1	217.6	260.1
1114	1079.3	1290.4	1422.0	340.9	407.6	1997.5	738.4	882.8	330.3	394.9	408.1	487.9
1214	984.4	1176.9	1349.0	345.6	413.2	1751.4	638.8	763.7	275.9	329.8	362.9	433.9
1314	971.3	1161.3	1741.7	381.2	455.7	1768.6	590.2	705.6	264.4	316.1	325.8	389.5
1414	1122.2	1341.7	2128.0	438.3	524.0	1931.8	683.9	817.7	306.9	366.9	377.1	450.8
2114	1116.9	1335.3	1337.3	349.3	417.6	2081.1	767.6	917.7	352.8	421.8	414.8	495.9
2214	1211.5	1448.4	1868.5	418.0	499.7	2226.2	793.5	948.7	347.6	415.6	445.9	533.1
2314	612.0	731.7	910.0	223.2	266.9	1134.5	388.8	464.8	176.0	210.4	212.8	254.4
2414	803.1	960.1	1343.0	280.3	335.2	1606.2	522.8	625.0	242.9	290.4	279.8	334.5
3114	1110.8	1328.0	1400.0	337.8	403.9	2120.0	773.0	924.2	352.0	420.8	421.0	503.3
3214	967.4	1156.6	1357.0	330.0	394.5	1733.6	637.4	762.1	287.7	344.0	349.7	418.1
3314	886.3	1059.6	1560.0	331.2	396.0	1738.9	555.1	663.6	254.8	304.6	300.3	359.0
3414	1151.0	1376.1	2116.7	471.7	563.9	1905.8	679.3	812.2	321.0	383.8	358.3	428.4
4114	1066.8	1275.4	1506.7	378.4	452.4	2029.9	688.4	823.0	320.7	383.4	367.7	439.7
4214	966.9	1155.9	1542.7	330.5	395.2	1833.9	636.3	760.7	290.9	347.7	345.5	413.0
4314	1258.9	1505.1	2478.0	498.2	595.6	2449.1	760.7	909.5	347.7	415.7	413.0	493.8
1115	858.9	1026.9	1222.8	294.4	352.0	1027.2	564.5	674.9	257.9	308.3	306.6	366.6
1215	1259.1	1505.3	2217.5	490.6	586.5	1552.5	768.5	918.8	333.0	398.1	435.5	520.7
1315	860.2	1028.4	1586.2	317.3	379.4	1163.8	542.9	649.1	234.6	280.5	308.3	368.6
1415	825.6	987.1	1541.2	321.0	383.8	1088.8	504.6	603.3	223.6	267.3	281.0	336.0
2115	872.7	1043.4	1558.5	289.8	346.5	871.5	582.9	696.9	262.4	313.7	320.5	383.2
2215	805.8	963.4	1313.2	317.2	379.2	806.8	488.6	584.2	225.4	269.5	263.2	314.7
2315	916.2	1095.4	1531.6	348.9	417.1	1278.4	567.3	678.2	241.4	288.6	325.9	389.6
2415	849.4	1015.5	2647.0	303.1	362.4	553.0	546.3	653.1	242.2	289.6	304.1	363.6
3115	687.2	821.6	897.6	248.2	296.7	762.4	439.0	524.9	206.4	246.8	232.6	278.1
3215	626.2	748.7	780.0	238.1	284.7	610.0	388.1	464.0	179.5	214.6	208.6	249.4
3315	898.5	1074.2	1422.6	336.2	401.9	1417.4	562.3	672.3	244.6	292.4	317.7	379.8
3415	688.2	822.8	1414.5	272.2	325.4	875.5	416.0	497.4	187.9	224.6	228.1	272.7
4115	785.6	939.2	1237.6	292.8	350.1	992.4	492.8	589.2	228.4	273.1	264.4	316.1

4215	952.8	1139.1	1427.5	347.7	415.7	1232.5	605.1	723.4	274.1	327.7	331.0	395.7
4315	929.9	1111.8	2077.9	382.1	456.8	1062.1	547.8	654.9	243.6	291.2	304.2	363.7
1116	818.4	978.5	298.6	281.3	336.3	561.4	537.1	642.1	249.0	297.7	288.1	344.4
1216	734.5	878.1	278.8	300.9	359.7	501.2	433.6	518.4	197.0	235.5	236.6	282.9
1316	758.4	906.7	306.6	281.6	336.7	493.4	476.8	570.0	209.7	250.7	267.1	319.3
1416	997.8	1192.9	364.3	380.6	455.0	655.7	617.2	737.9	266.9	319.1	350.3	418.8
2116	781.4	934.2	251.5	245.7	293.8	568.5	535.7	640.5	241.7	289.0	294.0	351.5
2216	698.9	835.6	241.9	257.0	307.3	468.1	441.9	528.3	205.7	245.9	236.2	282.4
2316	866.1	1035.5	310.8	300.0	358.7	589.2	566.1	676.8	253.0	302.5	313.1	374.3
2416	746.4	892.4	310.2	261.9	313.1	509.8	484.5	579.3	214.3	256.2	270.2	323.0
3116	562.6	672.6	185.3	201.0	240.3	384.7	361.6	432.3	171.1	204.6	190.5	227.8
3216	736.6	880.7	264.1	262.7	314.1	505.9	473.9	566.6	216.1	258.4	257.8	308.2
3316	790.2	944.7	344.0	296.4	354.4	516.0	493.8	590.4	216.3	258.6	277.5	331.8
3416	831.7	994.4	272.4	325.0	388.6	527.6	506.7	605.8	225.3	269.4	281.4	336.4
4116	802.0	958.8	294.6	293.1	350.4	535.4	508.9	608.4	234.6	280.5	274.3	327.9
4216	694.0	829.7	243.1	260.5	311.4	456.9	433.5	518.3	204.8	244.9	228.7	273.4
4316	723.2	864.6	295.4	297.9	356.2	444.6	425.3	508.5	202.1	241.6	223.2	266.9

Appendix C - Raw Data: "The effect of variety and plant density on nutrient accumulation and partitioning of winter canola in northeast Kansas"

Table C.1. Nutrient content lab results and calculations for the Wichita (2018), Surefire (2018), and Surefire-Wichita (2019) studies.

Plot	Sub	Vg N (%)	Vg_N_ gsqm	Vg P (%)	Vg_P_ gsqm	Vg K (%)	Vg_K_ gsqm	Vg Mg (%)	Vg_Mg_ gsqm	Vg Ca (%)	Vg_Ca_ gsqm	Vg S (%)	Vg_S_ gsqm
108	a	3.69	5.22	0.46	0.65	2.69	3.80	0.27	0.38	2.07	2.93	0.76	1.07
118	b	3.93	6.45	0.49	0.80	2.87	4.71	0.27	0.44	2.25	3.69	0.76	1.25
206	a	4.05	7.05	0.46	0.80	2.78	4.84	0.25	0.44	1.85	3.22	0.68	1.18
226	b	4.16	7.42	0.46	0.82	2.96	5.28	0.28	0.50	2.05	3.66	0.75	1.34
306	a	3.77	5.67	0.46	0.69	2.92	4.39	0.25	0.38	1.88	2.83	0.70	1.05
321	b	3.80	6.51	0.49	0.84	2.88	4.93	0.27	0.46	1.90	3.25	0.70	1.20
103	a	3.51	7.17	0.35	0.71	2.71	5.53	0.23	0.47	2.14	4.37	0.71	1.45
104	b	3.42	6.26	0.35	0.64	2.76	5.05	0.25	0.46	2.23	4.08	0.69	1.26
208	a	2.96	4.66	0.39	0.61	2.50	3.94	0.25	0.39	2.11	3.32	0.68	1.07
222	b	3.11	5.61	0.35	0.63	2.50	4.51	0.25	0.45	2.11	3.81	0.71	1.28
317	a	2.95	6.88	0.37	0.86	2.52	5.87	0.24	0.56	1.93	4.50	0.62	1.45
325	b	2.96	7.01	0.39	0.92	2.54	6.02	0.25	0.59	1.92	4.55	0.63	1.49
113	a	3.13	7.81	0.41	1.02	2.84	7.09	0.25	0.62	2.10	5.24	0.77	1.92
114	b	2.99	7.88	0.41	1.08	2.91	7.66	0.24	0.63	1.86	4.90	0.74	1.95
201	a	2.88	7.97	0.41	1.13	3.12	8.63	0.23	0.64	1.85	5.12	0.67	1.85
215	b	3.09	6.40	0.35	0.72	2.76	5.72	0.24	0.50	2.11	4.37	0.75	1.55
323	a	3.26	9.08	0.41	1.14	2.93	8.16	0.24	0.67	1.81	5.04	0.59	1.64
324	b	3.22	8.75	0.42	1.14	3.02	8.20	0.25	0.68	1.79	4.86	0.63	1.71
101	a	3.38	8.86	0.41	1.08	3.83	10.04	0.25	0.66	2.19	5.74	0.74	1.94
119	b	3.62	14.46	0.52	2.08	4.23	16.90	0.31	1.24	2.87	11.47	1.00	4.00
219	a	2.95	11.67	0.40	1.58	3.69	14.59	0.27	1.07	2.36	9.33	0.85	3.36
225	b	3.46	11.50	0.48	1.60	4.44	14.76	0.30	1.00	2.36	7.84	0.82	2.73

308 a	2.96	10.08	0.47	1.60	3.81	12.97	0.30	1.02	2.54	8.65	0.60	2.04
320 b	2.69	9.55	0.44	1.56	3.57	12.68	0.26	0.92	2.13	7.56	0.63	2.24
127 a	2.86	10.65	0.33	1.23	3.94	14.67	0.23	0.86	2.38	8.86	0.77	2.87
128 b	2.61	16.09	0.38	2.34	4.33	26.70	0.25	1.54	2.32	14.31	0.80	4.93
202 a	1.80	7.30	0.38	1.54	3.89	15.77	0.20	0.81	1.92	7.79	0.72	2.92
218 b	2.97	11.05	0.36	1.34	3.62	13.47	0.25	0.93	2.67	9.94	0.82	3.05
314 a	2.37	7.35	0.39	1.21	3.43	10.64	0.22	0.68	2.10	6.52	0.67	2.08
318 b	2.82	12.34	0.34	1.49	3.65	15.98	0.23	1.01	2.24	9.80	0.63	2.76
112 a	2.23	10.80	0.22	1.07	3.10	15.01	0.16	0.77	1.50	7.26	0.51	2.47
123 b	2.34	9.68	0.21	0.87	3.50	14.48	0.18	0.74	1.82	7.53	0.61	2.52
204 a	2.84	16.52	0.29	1.69	3.63	21.11	0.18	1.05	2.15	12.50	0.69	4.01
217 b	1.99	7.39	0.22	0.82	3.48	12.93	0.20	0.74	2.16	8.02	0.60	2.23
302 a	2.22	9.67	0.34	1.48	3.36	14.64	0.19	0.83	2.11	9.20	0.62	2.70
315 b	1.95	7.49	0.30	1.15	3.14	12.06	0.18	0.69	1.81	6.95	0.01	0.04
102 a	2.43	7.31	0.30	0.90	3.25	9.77	0.18	0.54	1.85	5.56	0.54	1.62
120 b	2.17	6.33	0.25	0.73	3.15	9.18	0.19	0.55	2.66	7.75	0.72	2.10
224 a	1.52	3.75	0.20	0.49	3.35	8.27	0.14	0.35	1.27	3.13	0.40	0.99
229 b	2.62	8.69	0.20	0.66	3.67	12.17	0.18	0.60	2.29	7.59	0.70	2.32
313 a	1.48	5.12	0.23	0.80	3.22	11.14	0.15	0.52	1.56	5.40	0.49	1.70
330 b	1.66	6.40	0.28	1.08	3.58	13.81	0.15	0.58	1.87	7.21	0.66	2.55
110 a	2.13	6.26	0.15	0.44	2.79	8.20	0.19	0.56	2.18	6.41	0.74	2.18
130 b	1.73	9.23	0.22	1.17	3.06	16.33	0.23	1.23	3.03	16.17	0.89	4.75
211 a	2.03	5.68	0.18	0.50	2.97	8.31	0.18	0.50	1.80	5.03	0.38	1.06
227 b	1.25	4.39	0.19	0.67	3.25	11.42	0.17	0.60	1.80	6.33	0.52	1.83
319 a	1.42	4.60	0.19	0.62	3.09	10.00	0.17	0.55	1.88	6.09	0.36	1.17
329 b	1.77	6.60	0.24	0.90	3.34	12.46	0.14	0.52	1.83	6.83	0.38	1.42
111 a	0.73	2.08	0.19	0.54	3.11	8.86	0.17	0.48	1.22	3.48	0.62	1.77
116 b	1.11	3.27	0.12	0.35	2.87	8.46	0.11	0.32	0.98	2.89	0.51	1.50
203 a	0.76	2.63	0.10	0.35	2.47	8.55	0.08	0.28	0.70	2.42	0.31	1.07
210 b	0.71	1.41	0.09	0.18	2.64	5.23	0.09	0.18	0.77	1.52	0.22	0.44
305 a	0.59	2.37	0.12	0.48	3.37	13.52	0.11	0.44	1.07	4.29	0.42	1.68

326 b	0.97	3.60	0.14	0.52	2.98	11.06	0.08	0.30	0.93	3.45	0.32	1.19
1101 a	4.23	4.14	0.51	0.50	3.72	3.64	0.28	0.27	1.87	1.83	0.57	0.56
1101 b	4.47	2.65	0.57	0.34	3.57	2.11	0.30	0.18	2.14	1.27	0.61	0.36
1201 a	4.91	0.58	0.52	0.06	3.30	0.39	0.29	0.03	1.95	0.23	0.60	0.07
1201 b	4.35	0.94	0.53	0.11	3.65	0.79	0.28	0.06	1.93	0.42	0.63	0.14
2101 a	4.35	2.45	0.57	0.32	3.75	2.11	0.28	0.16	1.82	1.02	0.58	0.33
2101 b	4.36	4.24	0.50	0.49	3.03	2.95	0.27	0.26	1.73	1.68	0.59	0.57
2201 a	4.04	2.12	0.52	0.27	3.36	1.76	0.27	0.14	1.62	0.85	0.60	0.31
2201 b	4.12	1.86	0.53	0.24	3.44	1.55	0.31	0.14	1.91	0.86	0.66	0.30
3101 a	4.42	2.94	0.52	0.35	3.56	2.37	0.31	0.21	1.85	1.23	0.64	0.43
3101 b	4.49	1.87	0.51	0.21	3.23	1.34	0.26	0.11	1.56	0.65	0.56	0.23
3201 a	4.49	2.04	0.52	0.24	3.46	1.57	0.27	0.12	1.67	0.76	0.60	0.27
3201 b	4.31	1.89	0.51	0.22	3.72	1.63	0.30	0.13	1.75	0.77	0.64	0.28
4101 a	4.46	1.64	0.46	0.17	3.43	1.26	0.26	0.10	1.57	0.58	0.56	0.21
4101 b	4.23	2.05	0.52	0.25	3.65	1.77	0.28	0.14	1.66	0.80	0.58	0.28
4201 a	4.23	2.06	0.46	0.22	3.28	1.60	0.26	0.13	1.55	0.76	0.60	0.29
4201 b	4.29	1.26	0.48	0.14	3.07	0.90	0.26	0.08	1.67	0.49	0.57	0.17
1102 a	3.75	3.45	0.53	0.49	3.78	3.48	0.29	0.27	1.81	1.67	0.54	0.50
1102 b	3.88	4.29	0.55	0.61	3.43	3.79	0.32	0.35	2.04	2.26	0.62	0.69
1202 a	3.91	0.96	0.54	0.13	3.32	0.81	0.27	0.07	1.76	0.43	0.61	0.15
1202 b	3.21	1.56	0.51	0.25	3.52	1.71	0.28	0.14	1.88	0.91	0.60	0.29
2102 a	4.10	2.17	0.50	0.26	3.38	1.79	0.26	0.14	1.63	0.86	0.50	0.26
2102 b	4.52	3.70	0.50	0.41	3.15	2.58	0.27	0.22	1.74	1.42	0.57	0.47
2202 a	3.35	2.35	0.54	0.38	3.20	2.24	0.28	0.20	1.71	1.20	0.62	0.43
2202 b	3.50	1.50	0.55	0.24	3.96	1.70	0.28	0.12	1.61	0.69	0.62	0.27
3102 a	3.91	2.52	0.55	0.35	3.63	2.34	0.28	0.18	1.70	1.10	0.70	0.45
3102 b	3.72	2.36	0.48	0.30	3.31	2.10	0.27	0.17	1.71	1.08	0.58	0.37
3202 a	3.45	1.65	0.46	0.22	3.14	1.51	0.24	0.12	1.48	0.71	0.58	0.28
3202 b	3.46	1.60	0.51	0.24	3.51	1.62	0.26	0.12	1.58	0.73	0.64	0.30
4102 a	3.65	1.88	0.47	0.24	3.24	1.67	0.31	0.16	1.89	0.97	0.75	0.39
4102 b	4.11	2.60	0.48	0.30	3.78	2.40	0.32	0.20	1.86	1.18	0.70	0.44

4202 a	3.79	1.95	0.47	0.24	3.48	1.79	0.27	0.14	1.59	0.82	0.58	0.30
4202 b	3.86	1.82	0.48	0.23	3.70	1.74	0.26	0.12	1.57	0.74	0.66	0.31
1103 a	3.29	3.57	0.50	0.54	3.65	3.96	0.30	0.33	1.80	1.95	0.61	0.66
1103 b	3.91	4.45	0.51	0.58	4.18	4.75	0.29	0.33	1.72	1.96	0.55	0.63
1203 a	4.38	2.15	0.53	0.26	4.00	1.96	0.34	0.17	2.22	1.09	0.60	0.29
1203 b	4.35	2.04	0.52	0.24	3.78	1.77	0.32	0.15	2.03	0.95	0.62	0.29
2103 a	3.76	5.32	0.57	0.81	4.10	5.80	0.31	0.44	1.98	2.80	0.69	0.98
2103 b	4.21	4.41	0.53	0.56	4.04	4.23	0.30	0.31	1.97	2.06	0.59	0.62
2203 a	4.42	2.66	0.57	0.34	4.24	2.55	0.36	0.22	2.31	1.39	0.71	0.43
2203 b	4.20	3.19	0.49	0.37	3.82	2.90	0.30	0.23	1.86	1.41	0.63	0.48
3103 a	4.51	4.80	0.57	0.61	4.21	4.48	0.32	0.34	1.95	2.08	0.69	0.74
3103 b	4.51	4.60	0.48	0.49	3.96	4.04	0.28	0.29	1.73	1.77	0.55	0.56
3203 a	4.48	4.55	0.51	0.52	4.62	4.69	0.29	0.29	1.90	1.93	0.61	0.62
3203 b	4.38	3.37	0.59	0.45	4.90	3.77	0.37	0.28	2.13	1.64	0.75	0.58
4103 a	4.16	3.19	0.47	0.36	4.07	3.12	0.32	0.25	1.90	1.46	0.57	0.44
4103 b	4.59	4.02	0.50	0.44	4.34	3.80	0.32	0.28	1.92	1.68	0.60	0.53
4203 a	4.49	2.45	0.52	0.28	4.51	2.46	0.34	0.19	1.99	1.08	0.61	0.33
4203 b	3.90	3.18	0.51	0.42	4.58	3.74	0.32	0.26	1.89	1.54	0.59	0.48
1104 a	3.85	5.81	0.45	0.68	3.79	5.72	0.28	0.42	1.71	2.58	0.57	0.86
1104 b	3.48	6.53	0.53	1.00	4.58	8.60	0.31	0.58	1.83	3.44	0.67	1.26
1204 a	4.51	2.69	0.67	0.40	5.68	3.39	0.34	0.20	2.08	1.24	0.58	0.35
1204 b	4.82	2.48	0.58	0.30	3.94	2.02	0.32	0.16	2.35	1.21	0.68	0.35
2104 a	3.92	5.70	0.69	1.00	5.09	7.40	0.33	0.48	2.20	3.20	0.83	1.21
2104 b	4.57	4.76	0.66	0.69	5.11	5.32	0.32	0.33	2.23	2.32	0.68	0.71
2204 a	3.87	6.25	0.61	0.99	4.88	7.88	0.31	0.50	1.80	2.91	0.66	1.07
2204 b	4.43	5.01	0.61	0.69	4.00	4.53	0.32	0.36	2.09	2.37	0.80	0.91
3104 a	4.11	7.07	0.58	1.00	4.76	8.18	0.29	0.50	1.80	3.10	0.73	1.26
3104 b	4.21	3.89	0.65	0.60	5.59	5.16	0.35	0.32	2.29	2.11	0.77	0.71
3204 a	4.54	7.56	0.64	1.07	5.42	9.02	0.34	0.57	2.06	3.43	0.68	1.13
3204 b	3.80	3.50	0.58	0.53	5.06	4.66	0.31	0.29	2.00	1.84	0.68	0.63
4104 a	3.82	7.16	0.53	0.99	5.04	9.44	0.31	0.58	1.98	3.71	0.69	1.29

4104 b	4.89	2.72	0.54	0.30	5.47	3.04	0.34	0.19	2.14	1.19	0.71	0.39
4204 a	4.17	6.64	0.60	0.95	5.19	8.26	0.33	0.53	1.93	3.07	0.66	1.05
4204 b	4.07	3.95	0.53	0.51	4.54	4.40	0.29	0.28	1.83	1.77	0.70	0.68
1105 a	2.93	9.06	0.49	1.52	4.42	13.67	0.23	0.71	1.30	4.02	0.47	1.45
1105 b	3.67	14.83	0.54	2.18	4.84	19.56	0.26	1.05	1.53	6.18	0.42	1.70
1205 a	4.05	1.52	0.55	0.21	3.96	1.48	0.32	0.12	2.69	1.01	0.59	0.22
1205 b	3.48	7.70	0.52	1.15	4.15	9.19	0.20	0.44	1.56	3.45	0.58	1.28
2105 a	2.61	8.28	0.55	1.75	4.38	13.90	0.24	0.76	1.92	6.09	0.61	1.94
2105 b	3.32	7.75	0.57	1.33	4.91	11.47	0.23	0.54	1.59	3.71	0.43	1.00
2205 a	3.03	7.72	0.46	1.17	4.69	11.95	0.20	0.51	1.03	2.62	0.36	0.92
2205 b	3.43	8.72	0.57	1.45	4.29	10.91	0.25	0.64	1.56	3.97	0.56	1.42
3105 a	3.22	4.52	0.51	0.72	4.81	6.75	0.20	0.28	1.28	1.80	0.50	0.70
3105 b	4.68	2.17	0.59	0.27	5.06	2.34	0.30	0.14	2.21	1.02	0.55	0.25
3205 a	3.40	8.42	0.55	1.36	4.86	12.04	0.25	0.62	1.65	4.09	0.52	1.29
3205 b	3.19	8.07	0.50	1.27	4.44	11.23	0.23	0.58	1.44	3.64	0.54	1.37
4105 a	3.09	7.84	0.46	1.17	4.43	11.24	0.23	0.58	1.32	3.35	0.52	1.32
4105 b	3.86	8.43	0.48	1.05	4.50	9.82	0.23	0.50	1.54	3.36	0.49	1.07
4205 a	3.24	8.80	0.50	1.36	4.71	12.80	0.25	0.68	1.68	4.56	0.51	1.39
4205 b	2.88	5.26	0.47	0.86	4.43	8.09	0.23	0.42	1.47	2.68	0.56	1.02
1106 a	2.24	12.10	0.37	2.00	3.66	19.77	0.18	0.97	1.22	6.59	0.34	1.84
1106 b	2.58	8.25	0.46	1.47	4.29	13.71	0.19	0.61	1.34	4.28	0.35	1.12
1206 a	3.88	2.50	0.59	0.38	4.53	2.91	0.24	0.15	1.91	1.23	0.55	0.35
1206 b	2.77	2.97	0.54	0.58	4.24	4.54	0.19	0.20	1.29	1.38	0.47	0.50
2106 a	2.43	7.63	0.43	1.35	3.81	11.96	0.20	0.63	1.42	4.46	0.36	1.13
2106 b	2.45	7.82	0.42	1.34	3.76	12.00	0.17	0.54	1.39	4.44	0.33	1.05
2206 a	2.25	5.93	0.37	0.98	3.79	10.00	0.16	0.42	1.20	3.16	0.34	0.90
2206 b	2.66	6.08	0.45	1.03	3.80	8.68	0.19	0.43	1.47	3.36	0.47	1.07
3106 a	2.84	4.49	0.41	0.65	4.12	6.52	0.22	0.35	1.46	2.31	0.48	0.76
3206 a	2.18	6.00	0.36	0.99	3.74	10.29	0.19	0.52	1.32	3.63	0.31	0.85
3206 b	2.54	5.89	0.37	0.86	3.47	8.04	0.19	0.44	1.29	2.99	0.34	0.79
4106 a	2.35	6.14	0.32	0.84	3.46	9.04	0.18	0.47	1.36	3.55	0.37	0.97

4106 b	2.45	6.31	0.30	0.77	3.72	9.58	0.18	0.46	1.07	2.76	0.34	0.88
4206 a	2.33	6.20	0.34	0.90	3.77	10.03	0.17	0.45	1.25	3.32	0.29	0.77
4206 b	2.07	6.74	0.34	1.11	3.84	12.51	0.19	0.62	1.53	4.98	0.43	1.40
1107 a	1.49	2.82	0.29	0.55	3.44	6.51	0.11	0.21	0.90	1.70	0.20	0.38
1107 b	2.12	7.29	0.34	1.17	3.76	12.92	0.17	0.58	1.35	4.64	0.24	0.82
1207 b	1.95	5.84	0.34	1.02	3.74	11.20	0.13	0.39	0.84	2.51	0.22	0.66
2107 a	1.91	4.55	0.36	0.86	3.47	8.27	0.15	0.36	1.04	2.48	0.33	0.79
2107 b	1.55	3.90	0.37	0.93	3.80	9.56	0.12	0.30	0.88	2.21	0.20	0.50
2207 a	1.26	3.64	0.30	0.87	3.51	10.13	0.09	0.26	0.75	2.16	0.19	0.55
2207 b	1.62	3.62	0.36	0.80	3.39	7.57	0.16	0.36	1.48	3.30	0.48	1.07
3107 a	2.06	4.32	0.30	0.63	3.71	7.79	0.14	0.29	1.14	2.39	0.35	0.73
3207 a	2.00	5.05	0.33	0.83	3.64	9.19	0.17	0.43	1.39	3.51	0.24	0.61
3207 b	1.36	3.18	0.30	0.70	3.40	7.95	0.13	0.30	0.86	2.01	0.23	0.54
4107 a	1.89	4.39	0.28	0.65	3.51	8.15	0.18	0.42	1.42	3.30	0.44	1.02
4107 b	2.00	3.99	0.22	0.44	3.41	6.80	0.16	0.32	1.40	2.79	0.27	0.54
4207 a	2.46	7.78	0.31	0.98	3.70	11.71	0.20	0.63	1.74	5.51	0.28	0.89
4207 b	1.24	2.24	0.25	0.45	3.45	6.24	0.11	0.20	0.76	1.37	0.26	0.47
1108 a	1.63	3.66	0.28	0.63	3.21	7.21	0.16	0.36	1.43	3.21	0.29	0.65
1108 b	1.53	2.82	0.27	0.50	3.33	6.13	0.14	0.26	1.26	2.32	0.21	0.39
1208 a	2.11	2.51	0.28	0.33	3.30	3.92	0.18	0.21	1.69	2.01	0.20	0.24
1208 b	1.75	4.36	0.27	0.67	3.50	8.72	0.15	0.37	1.38	3.44	0.20	0.50
2108 a	1.41	3.82	0.27	0.73	3.34	9.06	0.12	0.33	1.16	3.15	0.20	0.54
2108 b	1.73	1.58	0.32	0.29	3.40	3.10	0.15	0.14	1.50	1.37	0.27	0.25
2208 a	1.49	2.72	0.35	0.64	3.31	6.04	0.15	0.27	1.41	2.57	0.24	0.44
2208 b	1.28	2.81	0.30	0.66	3.27	7.17	0.14	0.31	1.26	2.76	0.35	0.77
3108 a	1.78	3.88	0.27	0.59	3.38	7.37	0.13	0.28	1.24	2.70	0.28	0.61
3108 b	2.45	4.38	0.27	0.48	3.24	5.79	0.20	0.36	1.80	3.22	0.44	0.79
3208 a	1.75	4.63	0.26	0.69	3.62	9.57	0.23	0.61	2.01	5.32	0.29	0.77
3208 b	1.61	3.52	0.23	0.50	3.06	6.69	0.17	0.37	1.56	3.41	0.33	0.72
4108 a	1.59	3.79	0.19	0.45	3.03	7.22	0.14	0.33	1.26	3.00	0.30	0.71
4108 b	1.79	4.20	0.21	0.49	3.24	7.60	0.17	0.40	1.25	2.93	0.22	0.52

4208 a	1.16	3.00	0.17	0.44	2.97	7.68	0.11	0.28	0.97	2.51	0.14	0.36
4208 b	1.40	5.10	0.19	0.69	2.93	10.68	0.15	0.55	1.33	4.85	0.29	1.06
1109 a	1.16	1.91	0.24	0.40	2.88	4.75	0.10	0.16	0.80	1.32	0.19	0.31
1109 b	0.89	2.64	0.18	0.53	3.15	9.34	0.07	0.21	0.71	2.11	0.16	0.47
1209 a	1.74	1.93	0.24	0.27	2.99	3.31	0.08	0.09	0.80	0.89	0.15	0.17
1209 b	2.14	2.88	0.19	0.26	3.17	4.27	0.09	0.12	0.74	1.00	0.17	0.23
2109 a	1.52	3.19	0.23	0.48	2.84	5.96	0.09	0.19	0.69	1.45	0.19	0.40
2109 b	0.88	2.54	0.26	0.75	3.13	9.03	0.10	0.29	0.72	2.08	0.17	0.49
2209 a	1.24	2.87	0.24	0.56	3.08	7.13	0.09	0.21	0.64	1.48	0.15	0.35
2209 b	1.78	3.43	0.25	0.48	3.42	6.60	0.10	0.19	0.88	1.70	0.25	0.48
3109 a	1.47	3.47	0.15	0.35	2.82	6.65	0.08	0.19	0.65	1.53	0.13	0.31
3109 b	1.87	4.74	0.20	0.51	3.47	8.79	0.11	0.28	0.79	2.00	0.18	0.46
3209 a	1.65	4.05	0.22	0.54	2.95	7.24	0.10	0.25	0.72	1.77	0.12	0.29
3209 b	1.73	2.63	0.17	0.26	3.04	4.63	0.09	0.14	0.72	1.10	0.20	0.30
4109 a	0.55	1.42	0.13	0.34	2.79	7.23	0.08	0.21	0.60	1.55	0.23	0.60
4109 b	0.96	1.11	0.16	0.18	3.30	3.81	0.13	0.15	0.78	0.90	0.24	0.28
4209 a	0.63	1.22	0.14	0.27	3.02	5.87	0.09	0.17	0.77	1.50	0.13	0.25
4209 b	0.55	1.05	0.15	0.29	3.09	5.92	0.08	0.15	0.70	1.34	0.21	0.40
1110 a	0.71	1.89	0.15	0.40	2.83	7.54	0.07	0.19	0.64	1.71	0.13	0.35
1110 b	1.96	5.94	0.22	0.67	3.42	10.37	0.13	0.39	1.18	3.58	0.20	0.61
1210 a	1.93	4.61	0.20	0.48	3.23	7.71	0.11	0.26	0.91	2.17	0.15	0.36
1210 b	1.01	2.22	0.18	0.40	3.37	7.42	0.11	0.24	0.95	2.09	0.22	0.48
2110 a	1.28	3.11	0.33	0.80	3.32	8.07	0.18	0.44	1.44	3.50	0.36	0.87
2110 b	1.06	2.78	0.24	0.63	3.12	8.17	0.13	0.34	1.20	3.14	0.34	0.89
2210 a	1.98	3.62	0.24	0.44	3.11	5.69	0.13	0.24	1.19	2.18	0.26	0.48
2210 b	2.58	5.04	0.33	0.65	2.99	5.84	0.18	0.35	1.55	3.03	0.30	0.59
3110 a	2.17	4.60	0.19	0.40	3.26	6.91	0.11	0.23	0.91	1.93	0.22	0.47
3110 b	2.16	6.25	0.19	0.55	3.14	9.08	0.12	0.35	1.02	2.95	0.18	0.52
3210 a	1.40	2.76	0.21	0.41	2.99	5.90	0.19	0.38	1.49	2.94	0.22	0.43
3210 b	1.40	2.39	0.18	0.31	3.07	5.23	0.13	0.22	1.13	1.93	0.29	0.49
4110 a	1.25	2.74	0.10	0.22	2.83	6.20	0.09	0.20	0.74	1.62	0.18	0.39

4110 b	1.87	2.91	0.22	0.34	3.64	5.67	0.13	0.20	0.80	1.25	0.25	0.39
4210 a	0.74	1.60	0.12	0.26	2.90	6.29	0.09	0.20	0.68	1.47	0.12	0.26
4210 b	0.79	1.25	0.11	0.17	2.83	4.48	0.08	0.13	0.64	1.01	0.19	0.30
1101	4.51	5.04	0.45	0.50	3.66	4.09	0.37	0.41	2.57	2.87	0.84	0.94
1201	3.40	3.29	0.48	0.46	3.65	3.53	0.33	0.32	2.18	2.11	0.74	0.72
1301	5.94	8.32	0.58	0.81	3.48	4.87	0.38	0.53	2.98	4.17	0.87	1.22
1401	5.40	4.75	0.59	0.52	4.00	3.51	0.35	0.31	2.61	2.29	0.85	0.75
2101	5.12	2.06	0.42	0.17	3.72	1.50	0.40	0.16	2.44	0.98	0.83	0.33
2201	3.81	3.28	0.44	0.38	3.99	3.44	0.36	0.31	2.22	1.91	0.73	0.63
2301	4.81	3.92	0.50	0.41	3.52	2.87	0.35	0.29	2.36	1.92	0.69	0.56
2401	5.22	3.37	0.53	0.34	4.69	3.03	0.34	0.22	2.24	1.45	0.72	0.46
3101	3.92	3.04	0.45	0.35	4.08	3.16	0.40	0.31	2.27	1.76	0.74	0.57
3201	4.69	4.98	0.52	0.55	3.42	3.63	0.37	0.39	2.46	2.61	0.80	0.85
3301	4.89	3.14	0.49	0.31	4.08	2.62	0.36	0.23	2.29	1.47	0.69	0.44
3401	5.19	3.93	0.55	0.42	4.78	3.62	0.33	0.25	2.31	1.75	0.75	0.57
4101	4.90	3.74	0.53	0.40	3.34	2.55	0.37	0.28	2.46	1.88	0.75	0.57
4201	4.63	4.14	0.53	0.47	3.51	3.14	0.36	0.32	2.53	2.26	0.81	0.72
4301	5.29	7.06	0.59	0.79	3.28	4.38	0.37	0.49	2.76	3.69	0.75	1.00
1102	3.42	7.92	0.29	0.67	2.00	4.63	0.26	0.60	1.48	3.43	0.40	0.93
1202	3.70	6.56	0.41	0.73	2.18	3.86	0.25	0.44	1.53	2.71	0.50	0.89
1302	4.08	11.08	0.42	1.14	2.91	7.90	0.30	0.81	2.00	5.43	0.56	1.52
1402	3.97	6.80	0.36	0.62	2.18	3.73	0.22	0.38	1.34	2.30	0.45	0.77
2102	3.23	2.85	0.24	0.21	1.46	1.29	0.25	0.22	1.26	1.11	0.34	0.30
2202	3.63	8.34	0.27	0.62	1.62	3.72	0.25	0.57	1.44	3.31	0.38	0.87
2302	4.02	8.50	0.42	0.89	2.32	4.90	0.28	0.59	1.81	3.83	0.53	1.12
2402	2.85	3.64	0.25	0.32	1.38	1.76	0.22	0.28	1.00	1.28	0.29	0.37
3102	3.78	7.99	0.37	0.78	2.17	4.59	0.30	0.63	1.67	3.53	0.51	1.08
3202	3.97	7.71	0.38	0.74	2.19	4.25	0.29	0.56	1.80	3.49	0.52	1.01
3302	4.20	6.38	0.44	0.67	2.27	3.45	0.26	0.39	1.64	2.49	0.50	0.76
3402	4.12	5.91	0.48	0.69	2.56	3.67	0.25	0.36	1.53	2.20	0.51	0.73
4102	3.75	4.73	0.40	0.51	2.11	2.66	0.29	0.37	1.84	2.32	0.52	0.66

4202	4.31	9.04	0.47	0.99	2.71	5.69	0.34	0.71	2.23	4.68	0.58	1.22
4302	4.46	8.97	0.50	1.01	2.61	5.25	0.29	0.58	2.06	4.14	0.55	1.11
1103	3.54	5.79	0.36	0.59	1.57	2.57	0.22	0.36	1.02	1.67	0.39	0.64
1203	2.99	3.20	0.23	0.25	1.19	1.27	0.19	0.20	0.65	0.70	0.27	0.29
1303	3.78	4.57	0.42	0.51	1.97	2.38	0.21	0.25	1.00	1.21	0.41	0.50
1403	4.08	2.86	0.45	0.32	2.26	1.58	0.23	0.16	1.04	0.73	0.49	0.34
2103	2.28	1.29	0.20	0.11	0.89	0.51	0.21	0.12	0.63	0.36	0.24	0.14
2203	2.87	1.41	0.20	0.10	0.95	0.47	0.17	0.08	0.57	0.28	0.23	0.11
2303	3.52	2.00	0.30	0.17	1.45	0.82	0.16	0.09	0.63	0.36	0.31	0.18
2403	2.77	1.20	0.24	0.10	1.12	0.48	0.18	0.08	0.61	0.26	0.26	0.11
3103	4.09	2.34	0.42	0.24	1.98	1.13	0.25	0.14	0.98	0.56	0.48	0.27
3203	3.15	2.66	0.22	0.19	0.92	0.78	0.15	0.13	0.64	0.54	0.24	0.20
3303	4.16	2.19	0.38	0.20	1.70	0.89	0.19	0.10	0.75	0.39	0.38	0.20
3403	3.77	1.51	0.36	0.14	1.49	0.60	0.20	0.08	0.89	0.36	0.35	0.14
4103	3.24	1.77	0.27	0.15	1.14	0.62	0.17	0.09	0.66	0.36	0.30	0.16
4203	3.66	2.25	0.42	0.26	1.82	1.12	0.23	0.14	0.80	0.49	0.40	0.25
4303	3.90	3.68	0.42	0.40	1.78	1.68	0.22	0.21	0.95	0.90	0.38	0.36
1104	4.14	8.86	0.40	0.86	3.74	8.00	0.26	0.56	1.50	3.21	0.61	1.31
1204	4.50	6.76	0.42	0.63	3.53	5.30	0.25	0.38	1.39	2.09	0.58	0.87
1304	4.90	10.29	0.43	0.90	3.65	7.66	0.25	0.52	1.66	3.49	0.57	1.20
1404	5.31	7.97	0.44	0.66	3.63	5.45	0.26	0.39	1.67	2.51	0.60	0.90
2104	4.71	0.73	0.30	0.05	2.91	0.45	0.33	0.05	1.69	0.26	0.49	0.08
2204	4.53	5.22	0.40	0.46	3.08	3.55	0.28	0.32	1.55	1.79	0.56	0.65
2304	4.92	3.94	0.42	0.34	3.34	2.67	0.28	0.22	1.64	1.31	0.57	0.46
2404	5.11	3.07	0.41	0.25	3.43	2.06	0.30	0.18	1.63	0.98	0.55	0.33
3104	5.09	8.46	0.45	0.75	4.13	6.87	0.30	0.50	1.58	2.63	0.61	1.01
3204	4.70	6.23	0.36	0.48	3.27	4.34	0.26	0.34	1.57	2.08	0.54	0.72
3304	5.95	6.27	0.46	0.49	3.50	3.69	0.27	0.28	1.53	1.61	0.57	0.60
3404	3.67	3.62	0.49	0.48	3.65	3.60	0.31	0.31	1.74	1.71	0.59	0.58
4104	5.72	5.32	0.45	0.42	3.39	3.15	0.30	0.28	1.89	1.76	0.65	0.60
4204	5.45	4.92	0.53	0.48	3.47	3.13	0.30	0.27	1.76	1.59	0.66	0.60

4304	5.74	6.79	0.51	0.60	3.68	4.36	0.26	0.31	1.72	2.04	0.61	0.72
1105	5.58	14.16	0.37	0.94	4.73	12.00	0.26	0.66	1.43	3.63	0.61	1.55
1205	4.49	7.80	0.44	0.76	4.93	8.56	0.33	0.57	2.06	3.58	0.80	1.39
1305	4.80	15.59	0.46	1.49	4.74	15.39	0.30	0.97	2.29	7.44	0.79	2.57
1405	5.32	12.95	0.42	1.02	5.18	12.61	0.30	0.73	1.98	4.82	0.70	1.70
2105	2.29	1.08	0.29	0.14	4.55	2.15	0.40	0.19	2.03	0.96	0.53	0.25
2205	3.88	5.35	0.32	0.44	3.94	5.43	0.33	0.45	2.16	2.98	0.67	0.92
2305	5.14	7.47	0.41	0.60	4.63	6.73	0.34	0.49	2.27	3.30	0.69	1.00
2405	5.15	6.33	0.49	0.60	5.60	6.88	0.35	0.43	1.96	2.41	0.73	0.90
3105	4.35	10.73	0.38	0.94	5.70	14.06	0.31	0.76	1.65	4.07	0.73	1.80
3205	4.30	7.01	0.36	0.59	4.18	6.81	0.32	0.52	2.08	3.39	0.77	1.25
3305	5.19	9.90	0.48	0.92	4.79	9.13	0.35	0.67	2.34	4.46	0.82	1.56
3405	5.60	7.57	0.52	0.70	4.55	6.15	0.37	0.50	2.65	3.58	0.82	1.11
4105	5.29	7.95	0.46	0.69	4.16	6.25	0.35	0.53	2.55	3.83	0.79	1.19
4205	5.12	9.90	0.50	0.97	4.83	9.34	0.34	0.66	2.29	4.43	0.81	1.57
4305	5.36	12.34	0.48	1.10	4.64	10.68	0.34	0.78	2.63	6.05	0.79	1.82
1106	2.68	9.43	0.26	0.92	3.81	13.41	0.22	0.77	1.15	4.05	0.47	1.65
1206	3.86	7.70	0.33	0.66	3.89	7.76	0.32	0.64	2.08	4.15	0.75	1.50
1306	4.35	22.22	0.36	1.84	4.37	22.33	0.31	1.58	2.28	11.65	0.69	3.53
1406	3.46	11.07	0.31	0.99	4.33	13.85	0.28	0.90	2.03	6.49	0.71	2.27
2106	3.62	6.76	0.25	0.47	3.73	6.97	0.36	0.67	2.15	4.02	0.67	1.25
2206	3.46	4.60	0.29	0.39	3.00	3.99	0.37	0.49	2.73	3.63	0.87	1.16
2306	3.48	7.25	0.30	0.63	3.72	7.75	0.29	0.60	1.97	4.11	0.68	1.42
2406	3.84	8.54	0.34	0.76	4.46	9.92	0.29	0.65	1.83	4.07	0.68	1.51
3106	3.41	9.97	0.30	0.88	4.23	12.37	0.31	0.91	2.07	6.05	0.71	2.08
3206	3.44	8.16	0.25	0.59	3.36	7.97	0.33	0.78	2.37	5.62	0.78	1.85
3306	3.77	9.27	0.37	0.91	3.78	9.29	0.31	0.76	2.30	5.65	0.79	1.94
3406	4.16	11.12	0.41	1.10	4.21	11.25	0.34	0.91	2.34	6.25	0.74	1.98
4106	2.85	6.57	0.30	0.69	3.52	8.11	0.28	0.65	2.12	4.89	0.72	1.66
4206	3.82	11.33	0.35	1.04	4.03	11.95	0.31	0.92	2.24	6.64	0.74	2.19
4306	4.22	13.33	0.38	1.20	3.91	12.35	0.31	0.98	2.48	7.83	0.77	2.43

1107	2.66	11.63	0.26	1.14	3.31	14.48	0.25	1.09	1.73	7.57	0.62	2.71
1207	3.64	12.02	0.29	0.96	3.23	10.67	0.33	1.09	2.45	8.09	0.80	2.64
1307	3.00	15.64	0.27	1.41	3.75	19.54	0.29	1.51	1.99	10.37	0.60	3.13
1407	2.67	11.63	0.24	1.05	3.79	16.51	0.24	1.05	1.70	7.41	0.60	2.61
2107	3.42	11.99	0.33	1.16	3.49	12.24	0.36	1.26	2.26	7.92	0.78	2.73
2207	3.07	4.52	0.27	0.40	3.08	4.53	0.36	0.53	2.43	3.58	0.76	1.12
2307	3.29	12.16	0.23	0.85	3.23	11.94	0.31	1.15	2.50	9.24	0.75	2.77
2407	3.17	13.88	0.27	1.18	3.65	15.98	0.29	1.27	2.05	8.98	0.68	2.98
3107	2.96	12.14	0.26	1.07	3.49	14.31	0.30	1.23	2.19	8.98	0.70	2.87
3207	3.56	12.98	0.29	1.06	3.05	11.12	0.33	1.20	2.52	9.19	0.81	2.95
3307	3.10	13.64	0.28	1.23	3.15	13.86	0.29	1.28	2.17	9.55	0.69	3.04
3407	4.30	14.27	0.37	1.23	3.14	10.42	0.37	1.23	2.65	8.79	0.82	2.72
4107	2.82	9.95	0.27	0.95	3.02	10.66	0.27	0.95	2.21	7.80	0.72	2.54
4207	3.04	12.42	0.32	1.31	3.55	14.51	0.29	1.19	2.08	8.50	0.74	3.02
4307	3.58	17.21	0.31	1.49	3.46	16.64	0.29	1.39	2.12	10.19	0.64	3.08
1108	2.42	11.05	0.26	1.19	3.00	13.70	0.24	1.10	1.56	7.12	0.54	2.47
1208	2.97	13.81	0.25	1.16	2.94	13.67	0.31	1.44	2.09	9.72	0.60	2.79
1308	2.69	16.55	0.28	1.72	3.14	19.31	0.28	1.72	2.06	12.67	0.62	3.81
1408	2.72	15.62	0.22	1.26	3.18	18.26	0.25	1.44	1.62	9.30	0.53	3.04
2108	2.77	13.25	0.26	1.24	2.92	13.97	0.28	1.34	1.82	8.71	0.61	2.92
2208	3.98	16.69	0.28	1.17	2.61	10.95	0.39	1.64	2.36	9.90	0.70	2.94
2308	2.61	10.20	0.27	1.05	2.58	10.08	0.33	1.29	2.51	9.81	0.74	2.89
2408	2.44	14.30	0.25	1.46	3.14	18.40	0.29	1.70	2.02	11.84	0.63	3.69
3108	3.38	17.59	0.22	1.15	3.20	16.66	0.27	1.41	1.71	8.90	0.54	2.81
3208	2.37	8.49	0.31	1.11	2.90	10.39	0.39	1.40	2.35	8.42	0.74	2.65
3308	4.92	21.78	0.26	1.15	2.97	13.15	0.28	1.24	1.94	8.59	0.59	2.61
3408	2.47	11.54	0.38	1.78	2.77	12.94	0.33	1.54	2.15	10.05	0.67	3.13
4108	3.17	13.87	0.26	1.14	2.58	11.29	0.28	1.23	2.15	9.41	0.65	2.84
4208	3.47	16.96	0.29	1.42	3.11	15.20	0.27	1.32	2.00	9.77	0.67	3.27
4308	3.55	18.49	0.32	1.67	3.05	15.89	0.29	1.51	2.14	11.15	0.64	3.33
1109	4.90	24.30	0.24	1.19	2.93	14.53	0.26	1.29	1.84	9.12	0.62	3.07

1209	3.02	16.69	0.31	1.71	2.64	14.59	0.34	1.88	2.91	16.09	0.73	4.04
1309	2.58	16.09	0.24	1.50	2.75	17.15	0.26	1.62	1.97	12.29	0.55	3.43
1409	2.62	14.40	0.24	1.32	3.09	16.98	0.25	1.37	1.85	10.17	0.55	3.02
2109	1.80	7.58	0.21	0.88	2.85	12.00	0.24	1.01	1.58	6.65	0.54	2.27
2209	2.41	10.93	0.27	1.22	2.39	10.84	0.29	1.32	2.59	11.74	0.77	3.49
2309	2.49	9.98	0.26	1.04	2.66	10.66	0.27	1.08	2.03	8.13	0.64	2.56
2409	2.61	12.93	0.23	1.14	2.99	14.81	0.25	1.24	1.74	8.62	0.55	2.72
3109	2.06	7.08	0.28	0.96	3.04	10.46	0.33	1.13	2.03	6.98	0.69	2.37
3209	2.77	11.18	0.29	1.17	2.52	10.17	0.35	1.41	2.31	9.33	0.67	2.71
3309	3.27	18.78	0.35	2.01	2.63	15.11	0.29	1.67	2.22	12.75	0.61	3.50
3409	2.71	14.00	0.27	1.39	2.89	14.93	0.25	1.29	1.90	9.82	0.60	3.10
4109	2.31	9.94	0.31	1.33	2.67	11.49	0.27	1.16	2.17	9.33	0.67	2.88
4209	3.15	14.84	0.36	1.70	3.15	14.84	0.31	1.46	2.42	11.40	0.81	3.82
4309	3.33	21.27	0.34	2.17	2.95	18.84	0.30	1.92	2.71	17.31	0.77	4.92
1110	1.84	7.29	0.20	0.79	2.92	11.58	0.26	1.03	1.82	7.22	0.53	2.10
1210	2.34	12.10	0.23	1.19	2.58	13.34	0.28	1.45	2.40	12.41	0.64	3.31
1310	3.16	17.90	0.24	1.36	2.40	13.59	0.32	1.81	3.11	17.61	0.85	4.81
1410	2.45	13.19	0.23	1.24	3.29	17.72	0.25	1.35	2.28	12.28	0.70	3.77
2110	1.90	10.26	0.17	0.92	2.84	15.33	0.23	1.24	2.01	10.85	0.64	3.45
2210	2.12	9.22	0.22	0.96	2.29	9.96	0.27	1.17	2.81	12.22	0.77	3.35
2310	2.22	10.56	0.22	1.05	2.55	12.13	0.24	1.14	2.32	11.03	0.71	3.38
2410	2.40	12.45	0.20	1.04	2.99	15.51	0.23	1.19	1.82	9.44	0.56	2.91
3110	2.53	3.50	0.25	0.35	2.81	3.89	0.31	0.43	2.08	2.88	0.69	0.96
3210	2.73	12.25	0.25	1.12	2.55	11.44	0.36	1.62	2.84	12.75	0.82	3.68
3310	2.97	16.95	0.30	1.71	2.69	15.35	0.29	1.66	2.93	16.72	0.84	4.79
3410	2.80	12.76	0.29	1.32	2.63	11.98	0.26	1.18	2.14	9.75	0.65	2.96
4110	2.90	12.55	0.32	1.38	2.44	10.56	0.29	1.25	2.77	11.98	0.85	3.68
4210	2.34	12.10	0.26	1.34	2.80	14.48	0.24	1.24	2.33	12.05	0.79	4.08
4310	2.56	15.16	0.28	1.66	2.65	15.69	0.25	1.48	2.76	16.34	0.81	4.80
1111	1.96	9.96	0.23	1.17	3.02	15.35	0.30	1.52	2.24	11.39	0.72	3.66
1211	1.74	7.72	0.19	0.84	2.53	11.23	0.28	1.24	2.46	10.92	0.63	2.80

1311	3.12	20.86	0.22	1.47	2.53	16.92	0.30	2.01	3.03	20.26	0.90	6.02
1411	2.14	11.68	0.20	1.09	3.19	17.41	0.22	1.20	1.98	10.80	0.69	3.77
2111	2.01	11.80	0.17	1.00	2.67	15.68	0.23	1.35	2.07	12.16	0.65	3.82
2211	1.56	7.10	0.17	0.77	2.50	11.37	0.24	1.09	2.45	11.15	0.60	2.73
2311	1.65	7.60	0.16	0.74	2.50	11.52	0.22	1.01	2.22	10.23	0.65	2.99
2411	2.57	14.36	0.22	1.23	2.87	16.03	0.25	1.40	2.23	12.46	0.67	3.74
3111	1.85	9.22	0.18	0.90	2.62	13.06	0.22	1.10	1.56	7.77	0.55	2.74
3211	2.27	12.37	0.22	1.20	2.52	13.73	0.31	1.69	2.64	14.39	0.82	4.47
3311	3.02	19.44	0.27	1.74	2.65	17.05	0.28	1.80	3.01	19.37	0.83	5.34
3411	2.46	9.65	0.25	0.98	2.79	10.94	0.20	0.78	1.88	7.37	0.62	2.43
4111	2.32	6.53	0.27	0.76	2.38	6.70	0.26	0.73	2.42	6.82	0.76	2.14
4211	2.21	8.75	0.20	0.79	2.83	11.21	0.19	0.75	2.02	8.00	0.62	2.46
4311	2.59	16.41	0.28	1.77	2.66	16.86	0.23	1.46	2.73	17.30	0.77	4.88
1112	1.60	7.72	0.16	0.77	3.06	14.76	0.21	1.01	2.04	9.84	0.53	2.56
1212	1.62	7.27	0.15	0.67	2.33	10.45	0.26	1.17	2.74	12.29	0.73	3.28
1312	2.09	11.46	0.15	0.82	2.43	13.33	0.22	1.21	2.39	13.11	0.72	3.95
1412	1.92	14.02	0.18	1.31	2.86	20.88	0.23	1.68	2.56	18.69	0.85	6.21
2112	2.10	11.29	0.16	0.86	2.43	13.06	0.32	1.72	3.19	17.15	0.96	5.16
2212	1.68	9.17	0.17	0.93	2.29	12.49	0.19	1.04	1.73	9.44	0.50	2.73
2312	1.73	6.82	0.15	0.59	2.59	10.21	0.22	0.87	2.62	10.33	0.72	2.84
2412	1.75	5.97	0.16	0.55	2.72	9.28	0.19	0.65	1.97	6.72	0.65	2.22
3112	1.85	4.57	0.15	0.37	2.57	6.36	0.21	0.52	1.75	4.33	0.60	1.48
3212	1.67	4.85	0.14	0.41	2.43	7.06	0.19	0.55	1.85	5.38	0.66	1.92
3312	2.09	5.62	0.17	0.46	2.36	6.35	0.24	0.65	2.57	6.91	0.75	2.02
3412	2.59	6.50	0.27	0.68	2.46	6.18	0.27	0.68	2.82	7.08	0.80	2.01
4112	1.88	6.33	0.21	0.71	2.12	7.14	0.20	0.67	2.16	7.27	0.67	2.26
4212	1.96	11.53	0.16	0.94	2.56	15.06	0.22	1.29	2.25	13.24	0.76	4.47
4312	2.63	11.79	0.24	1.08	2.55	11.43	0.22	0.99	2.89	12.95	0.81	3.63
1113	1.76	6.60	0.11	0.41	2.65	9.94	0.22	0.82	1.94	7.27	0.60	2.25
1213	1.69	8.01	0.10	0.47	2.14	10.15	0.22	1.04	2.37	11.24	0.67	3.18
1313	2.35	13.82	0.13	0.76	2.34	13.76	0.21	1.24	2.42	14.23	0.74	4.35

1413	1.89	9.22	0.13	0.63	2.74	13.37	0.18	0.88	2.04	9.95	0.66	3.22
2113	1.38	6.32	0.08	0.37	2.27	10.39	0.17	0.78	1.69	7.74	0.53	2.43
2213	1.49	6.15	0.09	0.37	2.27	9.37	0.17	0.70	1.80	7.43	0.54	2.23
2313	1.95	7.59	0.13	0.51	2.45	9.54	0.21	0.82	2.44	9.50	0.72	2.80
2413	2.02	7.47	0.13	0.48	2.52	9.32	0.23	0.85	2.54	9.40	0.68	2.52
3113	1.67	4.45	0.09	0.24	2.62	6.98	0.16	0.43	1.28	3.41	0.52	1.39
3213	1.41	5.18	0.11	0.40	2.39	8.78	0.14	0.51	1.24	4.56	0.48	1.76
3313	1.93	8.23	0.13	0.55	2.49	10.62	0.18	0.77	1.97	8.40	0.62	2.64
3413	2.22	8.46	0.17	0.65	2.63	10.02	0.16	0.61	1.74	6.63	0.53	2.02
4113	2.17	5.10	0.21	0.49	2.32	5.45	0.18	0.42	1.94	4.56	0.70	1.64
4213	1.86	7.36	0.13	0.51	2.54	10.05	0.16	0.63	1.71	6.77	0.63	2.49
4313	2.39	11.87	0.19	0.94	2.17	10.78	0.20	0.99	2.45	12.17	0.73	3.63
1114	1.41	5.75	0.05	0.20	2.37	9.66	0.13	0.53	1.26	5.14	0.43	1.75
1214	1.36	5.62	0.06	0.25	2.16	8.93	0.16	0.66	1.73	7.15	0.49	2.02
1314	1.93	8.79	0.11	0.50	2.29	10.44	0.19	0.87	2.37	10.80	0.71	3.24
1414	1.64	8.59	0.10	0.52	2.63	13.78	0.16	0.84	1.84	9.64	0.62	3.25
2114	1.33	5.55	0.06	0.25	2.24	9.35	0.15	0.63	1.53	6.39	0.48	2.00
2214	1.35	6.75	0.07	0.35	2.05	10.24	0.15	0.75	1.59	7.95	0.49	2.45
2314	1.71	4.56	0.09	0.24	2.20	5.87	0.13	0.35	1.50	4.00	0.45	1.20
2414	1.97	6.60	0.08	0.27	2.52	8.45	0.17	0.57	1.79	6.00	0.57	1.91
3114	1.38	5.57	0.05	0.20	2.26	9.13	0.11	0.44	1.06	4.28	0.36	1.45
3214	1.36	5.37	0.08	0.32	1.96	7.73	0.14	0.55	1.34	5.29	0.49	1.93
3314	1.74	6.89	0.10	0.40	2.09	8.28	0.15	0.59	1.75	6.93	0.51	2.02
3414	1.72	9.70	0.13	0.73	2.41	13.59	0.13	0.73	1.48	8.35	0.45	2.54
4114	1.12	5.07	0.09	0.41	1.94	8.78	0.13	0.59	1.50	6.79	0.50	2.26
4214	1.15	4.54	0.07	0.28	2.39	9.45	0.12	0.47	1.33	5.26	0.49	1.94
4314	1.69	10.07	0.15	0.89	2.44	14.53	0.15	0.89	2.02	12.03	0.57	3.39
1115	0.86	3.03	0.05	0.18	2.57	9.05	0.13	0.46	1.28	4.51	0.38	1.34
1215	1.05	6.16	0.05	0.29	2.37	13.90	0.11	0.65	1.26	7.39	0.37	2.17
1315	1.26	4.78	0.09	0.34	2.42	9.18	0.17	0.64	2.19	8.31	0.60	2.28
1415	1.46	5.60	0.08	0.31	2.81	10.78	0.15	0.58	1.74	6.68	0.54	2.07

2115	0.97	3.36	0.05	0.17	2.53	8.77	0.14	0.49	1.44	4.99	0.45	1.56
2215	0.89	3.38	0.06	0.23	2.25	8.53	0.16	0.61	1.58	5.99	0.42	1.59
2315	1.44	6.01	0.11	0.46	2.39	9.97	0.15	0.63	1.93	8.05	0.49	2.04
2415	1.45	5.25	0.07	0.25	2.81	10.18	0.17	0.62	1.89	6.85	0.55	1.99
3115	1.15	3.41	0.08	0.24	2.67	7.92	0.14	0.42	1.29	3.83	0.40	1.19
3215	0.98	2.79	0.08	0.23	2.07	5.89	0.13	0.37	1.46	4.16	0.47	1.34
3315	1.41	5.67	0.09	0.36	2.35	9.45	0.15	0.60	1.85	7.44	0.57	2.29
3415	1.63	5.30	0.13	0.42	2.54	8.27	0.14	0.46	1.68	5.47	0.45	1.46
4115	1.08	3.78	0.10	0.35	2.19	7.67	0.15	0.53	1.63	5.71	0.48	1.68
4215	1.23	5.11	0.08	0.33	2.71	11.27	0.13	0.54	1.53	6.36	0.53	2.20
4315	1.46	6.67	0.16	0.73	2.47	11.28	0.15	0.69	2.05	9.36	0.52	2.38
1116	0.89	2.99	0.07	0.24	2.75	9.25	0.18	0.61	1.74	5.85	0.54	1.82
1216	1.42	5.11	0.12	0.43	2.78	10.00	0.23	0.83	2.64	9.50	0.67	2.41
1316	1.08	3.64	0.08	0.27	2.52	8.48	0.17	0.57	2.14	7.20	0.62	2.09
1416	1.16	5.28	0.06	0.27	3.12	14.20	0.10	0.46	1.17	5.32	0.39	1.77
2116	0.97	2.85	0.06	0.18	2.85	8.37	0.16	0.47	1.77	5.20	0.54	1.59
2216	1.07	3.29	0.09	0.28	2.19	6.73	0.21	0.65	2.42	7.44	0.61	1.87
2316	0.91	3.26	0.06	0.22	2.82	10.11	0.16	0.57	1.79	6.42	0.51	1.83
2416	1.14	3.57	0.05	0.16	3.01	9.42	0.10	0.31	1.11	3.48	0.36	1.13
3116	0.97	2.33	0.08	0.19	2.88	6.92	0.17	0.41	1.87	4.49	0.53	1.27
3216	0.98	3.08	0.09	0.28	2.50	7.85	0.17	0.53	1.89	5.94	0.54	1.70
3316	1.43	5.07	0.12	0.43	2.72	9.64	0.20	0.71	2.51	8.89	0.77	2.73
3416	1.97	7.65	0.16	0.62	2.76	10.72	0.21	0.82	2.65	10.30	0.70	2.72
4116	1.10	3.85	0.11	0.39	2.10	7.36	0.17	0.60	1.88	6.59	0.57	2.00
4216	1.26	3.92	0.12	0.37	2.73	8.50	0.16	0.50	1.73	5.39	0.59	1.84
4316	1.56	5.56	0.20	0.71	2.56	9.12	0.16	0.57	2.24	7.98	0.54	1.92

Table C.2. Nutrient content lab results and calculations for the Wichita (2018), Surefire (2018), and Surefire-Wichita (2019) studies continued.

Plot Sub	Vg B (ppm)	Vg_B_ gsqm	Vg Zn (ppm)	Vg_Zn_ gsqm	Vg Mn (ppm)	Vg_Mn_ gsqm	Vg Fe (ppm)	Vg_Fe_ gsqm	Vg Cu (ppm)	Vg_Cu_ gsqm
108 a	25.26	0.00	38.70	0.01	84.25	0.01	372.25	0.05	4.71	0.00
118 b	26.32	0.00	36.99	0.01	61.78	0.01	305.25	0.05	4.99	0.00
206 a	26.32	0.00	37.00	0.01	67.41	0.01	328.04	0.06	4.87	0.00
226 b	30.16	0.01	38.14	0.01	69.05	0.01	366.47	0.07	5.35	0.00
306 a	31.36	0.00	37.70	0.01	59.35	0.01	235.18	0.04	4.71	0.00
321 b	31.54	0.01	38.64	0.01	52.12	0.01	180.25	0.03	4.41	0.00
103 a	21.48	0.00	31.89	0.01	60.86	0.01	305.89	0.06	3.85	0.00
104 b	18.92	0.00	31.18	0.01	63.42	0.01	265.06	0.05	4.55	0.00
208 a	27.81	0.00	35.35	0.01	67.08	0.01	303.94	0.05	4.48	0.00
222 b	24.28	0.00	35.45	0.01	57.71	0.01	191.73	0.03	4.14	0.00
317 a	24.45	0.01	33.26	0.01	46.48	0.01	136.39	0.03	3.60	0.00
325 b	26.70	0.01	31.49	0.01	47.03	0.01	155.84	0.04	3.65	0.00
113 a	21.56	0.01	33.13	0.01	59.63	0.01	341.16	0.09	3.91	0.00
114 b	22.39	0.01	34.76	0.01	60.55	0.02	527.38	0.14	4.57	0.00
201 a	22.02	0.01	30.45	0.01	54.30	0.02	536.86	0.15	3.75	0.00
215 b	23.06	0.00	30.69	0.01	56.64	0.01	479.38	0.10	3.91	0.00
323 a	26.05	0.01	32.19	0.01	44.96	0.01	310.43	0.09	3.62	0.00
324 b	28.28	0.01	30.46	0.01	42.01	0.01	289.60	0.08	3.91	0.00
101 a	22.30	0.01	27.74	0.01	50.90	0.01	203.65	0.05	4.38	0.00
119 b	26.74	0.01	37.78	0.02	60.79	0.02	199.98	0.08	4.31	0.00
219 a	25.82	0.01	31.43	0.01	50.89	0.02	162.32	0.06	3.73	0.00
225 b	31.02	0.01	37.23	0.01	59.32	0.02	214.64	0.07	4.87	0.00
308 a	34.73	0.01	30.21	0.01	51.85	0.02	158.39	0.05	4.21	0.00
320 b	29.28	0.01	28.91	0.01	44.93	0.02	136.18	0.05	3.48	0.00
127 a	23.97	0.01	21.22	0.01	54.05	0.02	80.61	0.03	3.17	0.00
128 b	24.18	0.01	21.17	0.01	47.19	0.03	77.16	0.05	3.63	0.00
202 a	21.64	0.01	17.23	0.01	39.32	0.02	72.99	0.03	3.29	0.00

218 b	29.40	0.01	26.47	0.01	55.66	0.02	87.55	0.03	4.50	0.00
314 a	27.27	0.01	22.72	0.01	38.44	0.01	70.72	0.02	3.61	0.00
318 b	22.31	0.01	19.21	0.01	39.87	0.02	67.41	0.03	3.26	0.00
112 a	20.07	0.01	15.47	0.01	36.31	0.02	65.43	0.03	2.89	0.00
123 b	16.70	0.01	18.18	0.01	35.41	0.01	52.63	0.02	2.95	0.00
204 a	20.01	0.01	16.14	0.01	45.75	0.03	59.94	0.03	3.15	0.00
217 b	21.25	0.01	18.57	0.01	43.66	0.02	66.86	0.02	2.90	0.00
302 a	24.78	0.01	16.81	0.01	37.45	0.02	62.42	0.03	3.46	0.00
315 b	21.90	0.01	19.31	0.01	57.12	0.02	68.66	0.03	2.94	0.00
102 a	20.90	0.01	15.48	0.00	35.53	0.01	67.97	0.02	2.82	0.00
120 b	15.83	0.00	14.89	0.00	56.78	0.02	82.70	0.02	3.57	0.00
224 a	16.50	0.00	11.74	0.00	26.91	0.01	50.15	0.01	2.42	0.00
229 b	20.27	0.01	15.43	0.01	44.23	0.01	61.36	0.02	2.80	0.00
313 a	18.77	0.01	11.72	0.00	27.04	0.01	47.26	0.02	3.09	0.00
330 b	20.23	0.01	13.07	0.01	32.49	0.01	57.55	0.02	2.86	0.00
110 a	18.50	0.01	16.54	0.00	50.23	0.01	98.20	0.03	2.93	0.00
130 b	23.02	0.01	15.04	0.01	43.66	0.02	92.53	0.05	3.68	0.00
211 a	18.86	0.01	12.54	0.00	44.31	0.01	56.18	0.02	3.00	0.00
227 b	20.19	0.01	14.22	0.00	41.44	0.01	83.19	0.03	2.77	0.00
319 a	29.61	0.01	11.72	0.00	39.36	0.01	59.68	0.02	3.11	0.00
329 b	24.72	0.01	11.31	0.00	38.95	0.01	67.06	0.03	3.13	0.00
111 a	18.39	0.01	15.06	0.00	34.86	0.01	48.60	0.01	3.34	0.00
116 b	16.04	0.00	10.40	0.00	20.07	0.01	32.59	0.01	2.79	0.00
203 a	15.71	0.01	7.67	0.00	12.67	0.00	27.12	0.01	2.03	0.00
210 b	13.76	0.00	6.91	0.00	20.46	0.00	21.93	0.00	1.66	0.00
305 a	17.58	0.01	8.88	0.00	28.99	0.01	40.40	0.02	3.39	0.00
326 b	17.63	0.01	7.55	0.00	18.58	0.01	32.74	0.01	2.07	0.00
1101 a	22.47	0.00	36.73	0.00	70.22	0.01	471.63	0.05	4.65	0.00
1101 b	17.23	0.00	36.95	0.00	65.36	0.00	297.60	0.02	4.66	0.00
1201 a	22.50	0.00	33.84	0.00	77.98	0.00	360.60	0.00	4.44	0.00
1201 b	24.39	0.00	34.15	0.00	85.47	0.00	380.40	0.01	4.75	0.00

2101 a	30.60	0.00	36.10	0.00	90.49	0.01	371.63	0.02	4.91	0.00
2101 b	24.45	0.00	33.16	0.00	67.04	0.01	487.72	0.05	4.53	0.00
2201 a	22.85	0.00	32.99	0.00	73.60	0.00	421.45	0.02	4.91	0.00
2201 b	26.88	0.00	35.22	0.00	89.33	0.00	388.55	0.02	5.16	0.00
3101 a	24.85	0.00	36.64	0.00	89.35	0.01	478.75	0.03	5.33	0.00
3101 b	22.30	0.00	32.87	0.00	69.04	0.00	352.95	0.01	5.00	0.00
3201 a	24.23	0.00	34.70	0.00	73.71	0.00	382.31	0.02	4.87	0.00
3201 b	19.82	0.00	34.75	0.00	76.01	0.00	349.55	0.02	4.59	0.00
4101 a	19.46	0.00	33.95	0.00	75.89	0.00	446.34	0.02	4.33	0.00
4101 b	18.78	0.00	35.23	0.00	62.54	0.00	324.89	0.02	4.65	0.00
4201 a	18.55	0.00	33.12	0.00	65.18	0.00	436.18	0.02	4.63	0.00
4201 b	25.40	0.00	33.96	0.00	74.57	0.00	458.79	0.01	5.02	0.00
1102 a	22.78	0.00	39.21	0.00	86.86	0.01	471.55	0.04	4.64	0.00
1102 b	20.71	0.00	38.32	0.00	76.13	0.01	397.06	0.04	4.98	0.00
1202 a	21.70	0.00	35.85	0.00	78.03	0.00	325.75	0.01	4.53	0.00
1202 b	23.48	0.00	36.18	0.00	85.77	0.00	347.34	0.02	4.09	0.00
2102 a	25.27	0.00	38.55	0.00	84.05	0.00	326.23	0.02	4.46	0.00
2102 b	21.12	0.00	34.25	0.00	67.31	0.01	271.90	0.02	4.52	0.00
2202 a	21.20	0.00	35.61	0.00	77.37	0.01	381.65	0.03	5.45	0.00
2202 b	24.35	0.00	40.84	0.00	89.90	0.00	344.35	0.01	4.98	0.00
3102 a	23.88	0.00	40.48	0.00	92.90	0.01	360.48	0.02	5.16	0.00
3102 b	23.41	0.00	39.02	0.00	98.17	0.01	492.89	0.03	4.88	0.00
3202 a	23.19	0.00	34.68	0.00	68.12	0.00	330.89	0.02	4.47	0.00
3202 b	22.63	0.00	41.07	0.00	71.95	0.00	378.45	0.02	5.24	0.00
4102 a	21.96	0.00	41.74	0.00	76.67	0.00	369.86	0.02	4.40	0.00
4102 b	20.84	0.00	42.59	0.00	91.83	0.01	314.44	0.02	5.08	0.00
4202 a	17.48	0.00	40.52	0.00	69.31	0.00	496.43	0.03	4.74	0.00
4202 b	18.06	0.00	42.54	0.00	75.09	0.00	326.89	0.02	4.98	0.00
1103 a	23.89	0.00	35.36	0.00	72.89	0.01	512.68	0.06	4.88	0.00
1103 b	21.17	0.00	35.23	0.00	85.19	0.01	577.01	0.07	4.58	0.00
1203 a	19.43	0.00	36.92	0.00	80.59	0.00	739.12	0.04	4.66	0.00

1203 b	20.06	0.00	33.75	0.00	81.50	0.00	650.80	0.03	4.71	0.00
2103 a	27.55	0.00	38.93	0.01	83.53	0.01	466.71	0.07	4.93	0.00
2103 b	21.91	0.00	35.88	0.00	79.72	0.01	414.45	0.04	4.40	0.00
2203 a	22.20	0.00	36.01	0.00	71.28	0.00	390.65	0.02	5.00	0.00
2203 b	20.89	0.00	31.52	0.00	68.50	0.01	461.59	0.04	4.60	0.00
3103 a	23.79	0.00	38.01	0.00	89.92	0.01	492.43	0.05	5.29	0.00
3103 b	21.60	0.00	36.12	0.00	86.97	0.01	424.95	0.04	4.53	0.00
3203 a	19.25	0.00	36.36	0.00	69.61	0.01	418.93	0.04	4.58	0.00
3203 b	23.38	0.00	40.69	0.00	88.54	0.01	691.95	0.05	5.41	0.00
4103 a	17.42	0.00	38.15	0.00	67.68	0.01	582.14	0.04	4.27	0.00
4103 b	15.95	0.00	39.13	0.00	85.17	0.01	512.64	0.04	4.52	0.00
4203 a	17.76	0.00	38.45	0.00	70.49	0.00	595.00	0.03	4.39	0.00
4203 b	18.72	0.00	36.57	0.00	62.59	0.01	358.60	0.03	4.70	0.00
1104 a	16.99	0.00	31.03	0.00	76.56	0.01	717.15	0.11	4.10	0.00
1104 b	26.08	0.00	32.98	0.01	82.70	0.02	374.08	0.07	5.31	0.00
1204 a	26.26	0.00	40.57	0.00	92.05	0.01	462.62	0.03	5.59	0.00
1204 b	20.01	0.00	33.53	0.00	96.40	0.00	762.57	0.04	5.57	0.00
2104 a	31.12	0.00	38.95	0.01	102.18	0.01	364.81	0.05	6.00	0.00
2104 b	23.65	0.00	37.87	0.00	97.22	0.01	435.29	0.05	5.63	0.00
2204 a	22.19	0.00	33.25	0.01	69.48	0.01	380.97	0.06	5.20	0.00
2204 b	23.80	0.00	37.40	0.00	89.94	0.01	489.54	0.06	5.41	0.00
3104 a	25.88	0.00	33.70	0.01	90.95	0.02	249.12	0.04	5.05	0.00
3104 b	24.11	0.00	39.98	0.00	120.25	0.01	471.77	0.04	6.04	0.00
3204 a	24.77	0.00	38.77	0.01	78.66	0.01	509.11	0.08	5.47	0.00
3204 b	23.70	0.00	32.36	0.00	71.30	0.01	274.41	0.03	4.88	0.00
4104 a	20.93	0.00	34.94	0.01	80.95	0.02	273.78	0.05	4.78	0.00
4104 b	18.86	0.00	38.80	0.00	96.08	0.01	455.40	0.03	5.61	0.00
4204 a	25.25	0.00	36.08	0.01	81.94	0.01	320.16	0.05	5.28	0.00
4204 b	22.66	0.00	32.80	0.00	76.37	0.01	288.53	0.03	4.63	0.00
1105 a	27.50	0.01	23.49	0.01	60.38	0.02	82.37	0.03	3.51	0.00
1105 b	26.79	0.01	29.68	0.01	78.28	0.03	111.05	0.04	4.33	0.00

1205 a	21.54	0.00	28.70	0.00	71.33	0.00	133.84	0.01	4.47	0.00
1205 b	18.94	0.00	23.41	0.01	50.53	0.01	77.90	0.02	3.60	0.00
2105 a	30.44	0.01	28.25	0.01	78.44	0.02	100.71	0.03	4.27	0.00
2105 b	26.92	0.01	26.31	0.01	70.06	0.02	124.24	0.03	4.70	0.00
2205 a	19.64	0.01	20.95	0.01	45.93	0.01	72.53	0.02	3.37	0.00
2205 b	36.52	0.01	27.92	0.01	63.56	0.02	116.37	0.03	4.49	0.00
3105 a	22.10	0.00	24.54	0.00	63.32	0.01	118.48	0.02	3.68	0.00
3105 b	25.51	0.00	32.53	0.00	107.30	0.00	171.17	0.01	4.94	0.00
3205 a	26.23	0.01	26.36	0.01	63.80	0.02	88.07	0.02	3.79	0.00
3205 b	22.70	0.01	24.12	0.01	61.96	0.02	96.78	0.02	3.92	0.00
4105 a	21.04	0.01	23.78	0.01	62.15	0.02	74.08	0.02	3.73	0.00
4105 b	22.76	0.00	26.94	0.01	74.21	0.02	113.05	0.02	3.85	0.00
4205 a	24.78	0.01	26.90	0.01	65.33	0.02	94.76	0.03	4.01	0.00
4205 b	22.74	0.00	25.02	0.00	66.37	0.01	96.47	0.02	6.58	0.00
1106 a	24.49	0.01	16.61	0.01	55.63	0.03	65.37	0.04	3.06	0.00
1106 b	25.97	0.01	22.09	0.01	60.83	0.02	95.24	0.03	3.55	0.00
1206 a	26.80	0.00	30.57	0.00	65.66	0.00	259.93	0.02	5.39	0.00
1206 b	20.89	0.00	21.95	0.00	50.91	0.01	140.18	0.02	4.16	0.00
2106 a	24.03	0.01	21.03	0.01	62.75	0.02	91.68	0.03	3.74	0.00
2106 b	25.66	0.01	19.23	0.01	56.17	0.02	80.81	0.03	3.29	0.00
2206 a	20.88	0.01	15.62	0.00	39.84	0.01	70.86	0.02	3.25	0.00
2206 b	23.04	0.01	20.10	0.00	57.07	0.01	101.65	0.02	3.48	0.00
3106 a	19.97	0.00	25.46	0.00	64.44	0.01	152.71	0.02	3.82	0.00
3206 a	20.10	0.01	19.92	0.01	52.12	0.01	93.86	0.03	3.98	0.00
3206 b	26.78	0.01	18.75	0.00	54.30	0.01	97.77	0.02	3.43	0.00
4106 a	19.66	0.01	18.80	0.00	55.02	0.01	74.08	0.02	3.37	0.00
4106 b	14.83	0.00	19.39	0.00	49.39	0.01	110.08	0.03	3.48	0.00
4206 a	19.02	0.01	19.39	0.01	53.51	0.01	71.41	0.02	3.08	0.00
4206 b	20.62	0.01	19.93	0.01	68.24	0.02	81.14	0.03	3.41	0.00
1107 a	18.36	0.00	10.64	0.00	34.28	0.01	50.17	0.01	2.26	0.00
1107 b	20.72	0.01	15.89	0.01	58.06	0.02	62.01	0.02	2.83	0.00

1207 b	18.13	0.01	15.11	0.00	33.27	0.01	55.09	0.02	2.76	0.00
2107 a	21.84	0.01	14.26	0.00	39.36	0.01	63.75	0.02	2.58	0.00
2107 b	17.72	0.00	10.86	0.00	35.96	0.01	57.60	0.01	2.26	0.00
2207 a	15.36	0.00	8.78	0.00	24.91	0.01	51.10	0.01	2.05	0.00
2207 b	18.94	0.00	15.59	0.00	49.98	0.01	112.29	0.03	3.61	0.00
3107 a	17.39	0.00	14.89	0.00	46.78	0.01	100.96	0.02	2.54	0.00
3207 a	19.64	0.00	15.23	0.00	56.34	0.01	72.90	0.02	2.69	0.00
3207 b	18.98	0.00	11.41	0.00	35.71	0.01	71.65	0.02	2.18	0.00
4107 a	15.68	0.00	16.21	0.00	66.64	0.02	65.73	0.02	2.68	0.00
4107 b	14.43	0.00	15.28	0.00	65.07	0.01	98.95	0.02	3.35	0.00
4207 a	20.76	0.01	20.33	0.01	70.37	0.02	87.72	0.03	3.48	0.00
4207 b	13.61	0.00	10.77	0.00	35.91	0.01	44.56	0.01	2.07	0.00
1108 a	24.61	0.01	13.71	0.00	57.62	0.01	62.59	0.01	2.45	0.00
1108 b	18.82	0.00	11.60	0.00	53.89	0.01	107.14	0.02	2.46	0.00
1208 a	20.14	0.00	19.22	0.00	53.44	0.01	146.08	0.02	2.92	0.00
1208 b	21.21	0.01	15.63	0.00	57.67	0.01	109.57	0.03	2.78	0.00
2108 a	20.27	0.01	11.63	0.00	45.73	0.01	76.84	0.02	2.46	0.00
2108 b	22.65	0.00	17.91	0.00	57.12	0.01	165.22	0.02	3.48	0.00
2208 a	18.55	0.00	13.04	0.00	38.64	0.01	87.69	0.02	3.05	0.00
2208 b	20.45	0.00	12.41	0.00	39.07	0.01	78.97	0.02	2.36	0.00
3108 a	21.98	0.00	15.18	0.00	58.18	0.01	119.72	0.03	2.69	0.00
3108 b	19.72	0.00	29.58	0.01	91.02	0.02	233.56	0.04	4.20	0.00
3208 a	23.47	0.01	16.50	0.00	69.17	0.02	82.90	0.02	3.51	0.00
3208 b	22.06	0.00	14.90	0.00	58.65	0.01	115.70	0.03	3.07	0.00
4108 a	16.80	0.00	12.60	0.00	51.63	0.01	100.01	0.02	2.63	0.00
4108 b	15.35	0.00	14.20	0.00	56.26	0.01	91.11	0.02	2.74	0.00
4208 a	14.66	0.00	9.79	0.00	33.61	0.01	60.34	0.02	1.93	0.00
4208 b	27.31	0.01	12.18	0.00	53.68	0.02	90.77	0.03	2.74	0.00
1109 a	15.46	0.00	9.15	0.00	36.26	0.01	60.66	0.01	2.12	0.00
1109 b	16.41	0.00	6.96	0.00	27.31	0.01	27.62	0.01	2.02	0.00
1209 a	24.31	0.00	10.52	0.00	27.85	0.00	55.31	0.01	2.19	0.00

1209 b	15.46	0.00	8.53	0.00	25.44	0.00	38.84	0.01	1.94	0.00
2109 a	14.73	0.00	8.55	0.00	24.72	0.01	45.54	0.01	1.88	0.00
2109 b	13.51	0.00	9.32	0.00	25.72	0.01	30.18	0.01	1.84	0.00
2209 a	11.52	0.00	11.74	0.00	18.92	0.00	29.11	0.01	2.47	0.00
2209 b	16.84	0.00	10.36	0.00	29.24	0.01	62.95	0.01	2.10	0.00
3109 a	11.95	0.00	8.03	0.00	25.79	0.01	28.18	0.01	2.13	0.00
3109 b	16.50	0.00	12.91	0.00	36.91	0.01	37.68	0.01	2.53	0.00
3209 a	13.32	0.00	9.18	0.00	28.99	0.01	38.99	0.01	2.42	0.00
3209 b	15.88	0.00	8.24	0.00	24.94	0.00	30.35	0.00	1.89	0.00
4109 a	10.79	0.00	9.60	0.00	27.77	0.01	33.47	0.01	1.86	0.00
4109 b	15.64	0.00	15.96	0.00	43.63	0.01	45.36	0.01	2.69	0.00
4209 a	15.91	0.00	8.57	0.00	27.76	0.01	48.12	0.01	1.94	0.00
4209 b	13.52	0.00	11.42	0.00	29.37	0.01	57.77	0.01	2.16	0.00
1110 a	14.67	0.00	6.32	0.00	25.84	0.01	44.42	0.01	2.22	0.00
1110 b	29.83	0.01	13.28	0.00	53.78	0.02	90.44	0.03	2.61	0.00
1210 a	17.99	0.00	10.20	0.00	26.99	0.01	53.12	0.01	1.89	0.00
1210 b	24.24	0.01	10.13	0.00	36.77	0.01	50.61	0.01	2.27	0.00
2110 a	32.93	0.01	16.46	0.00	61.23	0.01	99.91	0.02	3.13	0.00
2110 b	23.56	0.01	12.41	0.00	36.35	0.01	113.84	0.03	2.71	0.00
2210 a	26.08	0.00	12.36	0.00	37.98	0.01	75.50	0.01	2.56	0.00
2210 b	43.58	0.01	15.72	0.00	63.58	0.01	98.73	0.02	2.84	0.00
3110 a	20.45	0.00	12.20	0.00	39.76	0.01	55.92	0.01	2.59	0.00
3110 b	34.99	0.01	12.29	0.00	56.98	0.02	62.70	0.02	2.20	0.00
3210 a	25.00	0.00	15.12	0.00	55.11	0.01	84.43	0.02	2.89	0.00
3210 b	23.47	0.00	13.01	0.00	44.34	0.01	118.37	0.02	2.24	0.00
4110 a	20.99	0.00	11.24	0.00	37.15	0.01	56.76	0.01	2.25	0.00
4110 b	18.16	0.00	13.60	0.00	44.10	0.01	59.65	0.01	2.33	0.00
4210 a	15.24	0.00	8.21	0.00	29.87	0.01	35.95	0.01	1.60	0.00
4210 b	13.77	0.00	8.00	0.00	24.40	0.00	33.19	0.01	1.92	0.00
1101	26.00	0.00	34.00	0.00	74.00	0.01	531.00	0.06	5.00	0.00
1201	24.00	0.00	30.00	0.00	59.00	0.01	640.00	0.06	3.00	0.00

1301	24.00	0.00	36.00	0.01	90.00	0.01	470.00	0.07	4.00	0.00
1401	26.00	0.00	34.00	0.00	80.00	0.01	542.00	0.05	5.00	0.00
2101	22.00	0.00	30.00	0.00	65.00	0.00	532.00	0.02	4.00	0.00
2201	25.00	0.00	28.00	0.00	47.00	0.00	366.00	0.03	3.00	0.00
2301	25.00	0.00	29.00	0.00	70.00	0.01	1029.00	0.08	3.00	0.00
2401	25.00	0.00	33.00	0.00	52.00	0.00	287.00	0.02	4.00	0.00
3101	24.00	0.00	32.00	0.00	78.00	0.01	861.00	0.07	4.00	0.00
3201	27.00	0.00	32.00	0.00	60.00	0.01	570.00	0.06	4.00	0.00
3301	25.00	0.00	33.00	0.00	60.00	0.00	728.00	0.05	5.00	0.00
3401	24.00	0.00	34.00	0.00	58.00	0.00	263.00	0.02	5.00	0.00
4101	26.00	0.00	33.00	0.00	51.00	0.00	341.00	0.03	4.00	0.00
4201	26.00	0.00	30.00	0.00	84.00	0.01	615.00	0.05	5.00	0.00
4301	26.00	0.00	35.00	0.00	77.00	0.01	733.00	0.10	5.00	0.00
1102	18.00	0.00	24.00	0.01	118.00	0.03	2689.00	0.62	5.00	0.00
1202	21.00	0.00	26.00	0.00	105.00	0.02	2350.00	0.42	5.00	0.00
1302	19.00	0.01	35.00	0.01	148.00	0.04	2850.00	0.77	6.00	0.00
1402	17.00	0.00	26.00	0.00	130.00	0.02	2231.00	0.38	5.00	0.00
2102	15.00	0.00	21.00	0.00	113.00	0.01	2696.00	0.24	4.00	0.00
2202	16.00	0.00	22.00	0.01	120.00	0.03	2924.00	0.67	4.00	0.00
2302	24.00	0.01	29.00	0.01	110.00	0.02	2218.00	0.47	5.00	0.00
2402	13.00	0.00	27.00	0.00	186.00	0.02	4651.00	0.59	4.00	0.00
3102	22.00	0.00	25.00	0.01	117.00	0.02	2344.00	0.50	5.00	0.00
3202	25.00	0.00	25.00	0.00	100.00	0.02	2059.00	0.40	4.00	0.00
3302	25.00	0.00	29.00	0.00	81.00	0.01	1557.00	0.24	5.00	0.00
3402	24.00	0.00	34.00	0.00	93.00	0.01	1389.00	0.20	6.00	0.00
4102	22.00	0.00	28.00	0.00	115.00	0.01	2536.00	0.32	5.00	0.00
4202	27.00	0.01	28.00	0.01	106.00	0.02	1620.00	0.34	5.00	0.00
4302	29.00	0.01	31.00	0.01	79.00	0.02	1309.00	0.26	5.00	0.00
1103	28.00	0.00	31.00	0.01	129.00	0.02	3114.00	0.51	6.00	0.00
1203	13.00	0.00	28.00	0.00	212.00	0.02	5636.00	0.60	6.00	0.00
1303	23.00	0.00	32.00	0.00	167.00	0.02	3419.00	0.41	6.00	0.00

1403	31.00	0.00	32.00	0.00	182.00	0.01	3124.00	0.22	7.00	0.00
2103	21.00	0.00	25.00	0.00	201.00	0.01	5478.00	0.31	5.00	0.00
2203	13.00	0.00	23.00	0.00	195.00	0.01	5287.00	0.26	5.00	0.00
2303	17.00	0.00	23.00	0.00	136.00	0.01	3194.00	0.18	5.00	0.00
2403	19.00	0.00	26.00	0.00	198.00	0.01	4356.00	0.19	6.00	0.00
3103	29.00	0.00	28.00	0.00	132.00	0.01	2954.00	0.17	7.00	0.00
3203	14.00	0.00	23.00	0.00	138.00	0.01	3450.00	0.29	4.00	0.00
3303	25.00	0.00	28.00	0.00	110.00	0.01	2713.00	0.14	5.00	0.00
3403	20.00	0.00	32.00	0.00	151.00	0.01	3181.00	0.13	6.00	0.00
4103	16.00	0.00	22.00	0.00	147.00	0.01	3558.00	0.19	5.00	0.00
4203	25.00	0.00	35.00	0.00	189.00	0.01	4074.00	0.25	7.00	0.00
4303	27.00	0.00	40.00	0.00	174.00	0.02	4642.00	0.44	7.00	0.00
1104	30.00	0.01	32.00	0.01	91.00	0.02	1156.00	0.25	5.00	0.00
1204	28.00	0.00	32.00	0.00	121.00	0.02	2140.00	0.32	5.00	0.00
1304	28.00	0.01	32.00	0.01	120.00	0.03	1710.00	0.36	5.00	0.00
1404	29.00	0.00	34.00	0.01	115.00	0.02	1501.00	0.23	5.00	0.00
2104	22.00	0.00	32.00	0.00	116.00	0.00	2262.00	0.03	6.00	0.00
2204	27.00	0.00	32.00	0.00	109.00	0.01	2155.00	0.25	6.00	0.00
2304	27.00	0.00	34.00	0.00	131.00	0.01	2172.00	0.17	5.00	0.00
2404	25.00	0.00	35.00	0.00	132.00	0.01	2207.00	0.13	5.00	0.00
3104	31.00	0.01	35.00	0.01	106.00	0.02	1551.00	0.26	6.00	0.00
3204	29.00	0.00	28.00	0.00	82.00	0.01	1322.00	0.18	5.00	0.00
3304	29.00	0.00	37.00	0.00	120.00	0.01	1964.00	0.21	5.00	0.00
3404	28.00	0.00	40.00	0.00	125.00	0.01	2237.00	0.22	6.00	0.00
4104	29.00	0.00	34.00	0.00	101.00	0.01	1698.00	0.16	6.00	0.00
4204	30.00	0.00	39.00	0.00	141.00	0.01	1859.00	0.17	7.00	0.00
4304	33.00	0.00	38.00	0.00	92.00	0.01	1380.00	0.16	5.00	0.00
1105	31.00	0.01	27.00	0.01	67.00	0.02	465.00	0.12	4.00	0.00
1205	32.00	0.01	32.00	0.01	67.00	0.01	396.00	0.07	4.00	0.00
1305	36.00	0.01	31.00	0.01	87.00	0.03	598.00	0.19	4.00	0.00
1405	33.00	0.01	31.00	0.01	76.00	0.02	624.00	0.15	5.00	0.00

2105	28.00	0.00	33.00	0.00	67.00	0.00	490.00	0.02	6.00	0.00
2205	33.00	0.00	27.00	0.00	52.00	0.01	446.00	0.06	4.00	0.00
2305	32.00	0.00	35.00	0.01	78.00	0.01	602.00	0.09	5.00	0.00
2405	32.00	0.00	33.00	0.00	73.00	0.01	454.00	0.06	5.00	0.00
3105	32.00	0.01	30.00	0.01	58.00	0.01	260.00	0.06	4.00	0.00
3205	35.00	0.01	31.00	0.01	65.00	0.01	518.00	0.08	4.00	0.00
3305	37.00	0.01	35.00	0.01	64.00	0.01	356.00	0.07	5.00	0.00
3405	34.00	0.00	39.00	0.01	78.00	0.01	390.00	0.05	5.00	0.00
4105	35.00	0.01	35.00	0.01	75.00	0.01	542.00	0.08	4.00	0.00
4205	35.00	0.01	33.00	0.01	70.00	0.01	349.00	0.07	5.00	0.00
4305	37.00	0.01	35.00	0.01	68.00	0.02	403.00	0.09	4.00	0.00
1106	27.00	0.01	23.00	0.01	43.00	0.02	120.00	0.04	3.00	0.00
1206	30.00	0.01	33.00	0.01	51.00	0.01	268.00	0.05	3.00	0.00
1306	36.00	0.02	32.00	0.02	67.00	0.03	317.00	0.16	4.00	0.00
1406	35.00	0.01	29.00	0.01	61.00	0.02	241.00	0.08	4.00	0.00
2106	33.00	0.01	24.00	0.00	59.00	0.01	193.00	0.04	5.00	0.00
2206	37.00	0.00	29.00	0.00	55.00	0.01	327.00	0.04	5.00	0.00
2306	34.00	0.01	29.00	0.01	51.00	0.01	209.00	0.04	4.00	0.00
2406	33.00	0.01	29.00	0.01	60.00	0.01	205.00	0.05	4.00	0.00
3106	36.00	0.01	28.00	0.01	66.00	0.02	208.00	0.06	4.00	0.00
3206	35.00	0.01	30.00	0.01	51.00	0.01	190.00	0.05	4.00	0.00
3306	39.00	0.01	33.00	0.01	51.00	0.01	161.00	0.04	4.00	0.00
3406	34.00	0.01	43.00	0.01	59.00	0.02	192.00	0.05	4.00	0.00
4106	37.00	0.01	26.00	0.01	44.00	0.01	162.00	0.04	3.00	0.00
4206	35.00	0.01	31.00	0.01	62.00	0.02	172.00	0.05	4.00	0.00
4306	37.00	0.01	32.00	0.01	48.00	0.02	194.00	0.06	3.00	0.00
1107	30.00	0.01	23.00	0.01	55.00	0.02	165.00	0.07	4.00	0.00
1207	34.00	0.01	29.00	0.01	47.00	0.02	200.00	0.07	4.00	0.00
1307	32.00	0.02	23.00	0.01	46.00	0.02	212.00	0.11	3.00	0.00
1407	30.00	0.01	20.00	0.01	45.00	0.02	110.00	0.05	3.00	0.00
2107	39.00	0.01	25.00	0.01	64.00	0.02	189.00	0.07	4.00	0.00

2207	32.00	0.00	22.00	0.00	38.00	0.01	137.00	0.02	4.00	0.00
2307	34.00	0.01	25.00	0.01	41.00	0.02	134.00	0.05	3.00	0.00
2407	33.00	0.01	25.00	0.01	54.00	0.02	175.00	0.08	4.00	0.00
3107	33.00	0.01	31.00	0.01	53.00	0.02	171.00	0.07	4.00	0.00
3207	41.00	0.01	27.00	0.01	42.00	0.02	140.00	0.05	4.00	0.00
3307	37.00	0.02	31.00	0.01	34.00	0.01	127.00	0.06	3.00	0.00
3407	33.00	0.01	33.00	0.01	53.00	0.02	130.00	0.04	4.00	0.00
4107	36.00	0.01	21.00	0.01	38.00	0.01	108.00	0.04	3.00	0.00
4207	36.00	0.01	26.00	0.01	49.00	0.02	159.00	0.06	4.00	0.00
4307	33.00	0.02	27.00	0.01	31.00	0.01	105.00	0.05	3.00	0.00
1108	28.00	0.01	20.00	0.01	52.00	0.02	660.00	0.30	4.00	0.00
1208	28.00	0.01	23.00	0.01	52.00	0.02	687.00	0.32	4.00	0.00
1308	32.00	0.02	22.00	0.01	49.00	0.03	436.00	0.27	4.00	0.00
1408	25.00	0.01	20.00	0.01	59.00	0.03	666.00	0.38	4.00	0.00
2108	29.00	0.01	17.00	0.01	50.00	0.02	506.00	0.24	4.00	0.00
2208	27.00	0.01	18.00	0.01	46.00	0.02	598.00	0.25	4.00	0.00
2308	31.00	0.01	26.00	0.01	54.00	0.02	608.00	0.24	4.00	0.00
2408	27.00	0.02	23.00	0.01	47.00	0.03	332.00	0.19	4.00	0.00
3108	27.00	0.01	16.00	0.01	34.00	0.02	285.00	0.15	3.00	0.00
3208	33.00	0.01	19.00	0.01	39.00	0.01	346.00	0.12	4.00	0.00
3308	28.00	0.01	24.00	0.01	36.00	0.02	388.00	0.17	3.00	0.00
3408	29.00	0.01	31.00	0.01	52.00	0.02	426.00	0.20	6.00	0.00
4108	29.00	0.01	19.00	0.01	44.00	0.02	597.00	0.26	4.00	0.00
4208	31.00	0.02	24.00	0.01	50.00	0.02	472.00	0.23	5.00	0.00
4308	32.00	0.02	26.00	0.01	46.00	0.02	678.00	0.35	5.00	0.00
1109	23.00	0.01	17.00	0.01	46.00	0.02	374.00	0.19	4.00	0.00
1209	31.00	0.02	22.00	0.01	49.00	0.03	487.00	0.27	4.00	0.00
1309	26.00	0.02	18.00	0.01	43.00	0.03	482.00	0.30	4.00	0.00
1409	22.00	0.01	19.00	0.01	47.00	0.03	265.00	0.15	4.00	0.00
2109	23.00	0.01	12.00	0.01	37.00	0.02	243.00	0.10	3.00	0.00
2209	26.00	0.01	18.00	0.01	48.00	0.02	627.00	0.28	6.00	0.00

2309	26.00	0.01	18.00	0.01	47.00	0.02	641.00	0.26	3.00	0.00
2409	23.00	0.01	17.00	0.01	49.00	0.02	555.00	0.27	4.00	0.00
3109	24.00	0.01	17.00	0.01	45.00	0.02	376.00	0.13	5.00	0.00
3209	28.00	0.01	16.00	0.01	39.00	0.02	444.00	0.18	4.00	0.00
3309	26.00	0.01	26.00	0.01	43.00	0.02	445.00	0.26	5.00	0.00
3409	26.00	0.01	21.00	0.01	34.00	0.02	359.00	0.19	4.00	0.00
4109	25.00	0.01	18.00	0.01	39.00	0.02	378.00	0.16	4.00	0.00
4209	34.00	0.02	24.00	0.01	64.00	0.03	523.00	0.25	5.00	0.00
4309	32.00	0.02	29.00	0.02	43.00	0.03	511.00	0.33	5.00	0.00
1110	23.00	0.01	13.00	0.01	38.00	0.02	141.00	0.06	3.00	0.00
1210	24.00	0.01	17.00	0.01	35.00	0.02	137.00	0.07	3.00	0.00
1310	30.00	0.02	19.00	0.01	73.00	0.04	459.00	0.26	4.00	0.00
1410	25.00	0.01	17.00	0.01	61.00	0.03	189.00	0.10	4.00	0.00
2110	26.00	0.01	11.00	0.01	41.00	0.02	94.00	0.05	3.00	0.00
2210	26.00	0.01	15.00	0.01	43.00	0.02	178.00	0.08	3.00	0.00
2310	28.00	0.01	15.00	0.01	40.00	0.02	164.00	0.08	3.00	0.00
2410	21.00	0.01	13.00	0.01	43.00	0.02	103.00	0.05	3.00	0.00
3110	26.00	0.00	14.00	0.00	48.00	0.01	163.00	0.02	4.00	0.00
3210	31.00	0.01	17.00	0.01	44.00	0.02	133.00	0.06	4.00	0.00
3310	34.00	0.02	23.00	0.01	38.00	0.02	268.00	0.15	4.00	0.00
3410	24.00	0.01	23.00	0.01	33.00	0.02	142.00	0.06	4.00	0.00
4110	29.00	0.01	21.00	0.01	49.00	0.02	321.00	0.14	4.00	0.00
4210	32.00	0.02	15.00	0.01	44.00	0.02	171.00	0.09	3.00	0.00
4310	31.00	0.02	21.00	0.01	33.00	0.02	199.00	0.12	4.00	0.00
1111	25.00	0.01	15.00	0.01	50.00	0.03	129.00	0.07	3.00	0.00
1211	23.00	0.01	14.00	0.01	40.00	0.02	172.00	0.08	3.00	0.00
1311	26.00	0.02	16.00	0.01	68.00	0.05	184.00	0.12	3.00	0.00
1411	20.00	0.01	15.00	0.01	64.00	0.03	143.00	0.08	3.00	0.00
2111	22.00	0.01	11.00	0.01	45.00	0.03	151.00	0.09	3.00	0.00
2211	21.00	0.01	12.00	0.01	38.00	0.02	80.00	0.04	2.00	0.00
2311	23.00	0.01	15.00	0.01	35.00	0.02	110.00	0.05	3.00	0.00

2411	21.00	0.01	17.00	0.01	48.00	0.03	111.00	0.06	3.00	0.00
3111	19.00	0.01	10.00	0.00	34.00	0.02	74.00	0.04	3.00	0.00
3211	25.00	0.01	13.00	0.01	40.00	0.02	104.00	0.06	3.00	0.00
3311	34.00	0.02	19.00	0.01	43.00	0.03	140.00	0.09	4.00	0.00
3411	20.00	0.01	16.00	0.01	38.00	0.01	165.00	0.06	4.00	0.00
4111	22.00	0.01	14.00	0.00	36.00	0.01	174.00	0.05	3.00	0.00
4211	26.00	0.01	11.00	0.00	39.00	0.02	161.00	0.06	3.00	0.00
4311	28.00	0.02	17.00	0.01	32.00	0.02	112.00	0.07	4.00	0.00
1112	24.00	0.01	9.00	0.00	39.00	0.02	116.00	0.06	3.00	0.00
1212	23.00	0.01	12.00	0.01	46.00	0.02	117.00	0.05	2.00	0.00
1312	21.00	0.01	12.00	0.01	61.00	0.03	99.00	0.05	3.00	0.00
1412	22.00	0.02	14.00	0.01	71.00	0.05	115.00	0.08	3.00	0.00
2112	29.00	0.02	13.00	0.01	66.00	0.04	177.00	0.10	4.00	0.00
2212	22.00	0.01	10.00	0.01	29.00	0.02	54.00	0.03	2.00	0.00
2312	25.00	0.01	11.00	0.00	38.00	0.01	109.00	0.04	2.00	0.00
2412	20.00	0.01	10.00	0.00	51.00	0.02	92.00	0.03	2.00	0.00
3112	22.00	0.01	11.00	0.00	43.00	0.01	187.00	0.05	4.00	0.00
3212	19.00	0.01	10.00	0.00	37.00	0.01	81.00	0.02	3.00	0.00
3312	23.00	0.01	14.00	0.00	46.00	0.01	140.00	0.04	3.00	0.00
3412	24.00	0.01	19.00	0.00	57.00	0.01	301.00	0.08	4.00	0.00
4112	20.00	0.01	11.00	0.00	36.00	0.01	101.00	0.03	3.00	0.00
4212	24.00	0.01	12.00	0.01	47.00	0.03	95.00	0.06	3.00	0.00
4312	27.00	0.01	15.00	0.01	32.00	0.01	120.00	0.05	3.00	0.00
1113	23.00	0.01	9.00	0.00	41.00	0.02	65.00	0.02	2.00	0.00
1213	25.00	0.01	9.00	0.00	42.00	0.02	64.00	0.03	3.00	0.00
1313	27.00	0.02	9.00	0.01	62.00	0.04	79.00	0.05	2.00	0.00
1413	22.00	0.01	11.00	0.01	58.00	0.03	76.00	0.04	2.00	0.00
2113	20.00	0.01	6.00	0.00	30.00	0.01	43.00	0.02	2.00	0.00
2213	19.00	0.01	8.00	0.00	32.00	0.01	45.00	0.02	2.00	0.00
2313	26.00	0.01	12.00	0.00	45.00	0.02	69.00	0.03	2.00	0.00
2413	23.00	0.01	11.00	0.00	59.00	0.02	70.00	0.03	3.00	0.00

3113	19.00	0.01	9.00	0.00	34.00	0.01	53.00	0.01	3.00	0.00
3213	16.00	0.01	8.00	0.00	27.00	0.01	40.00	0.01	2.00	0.00
3313	21.00	0.01	10.00	0.00	43.00	0.02	64.00	0.03	2.00	0.00
3413	20.00	0.01	10.00	0.00	32.00	0.01	64.00	0.02	2.00	0.00
4113	22.00	0.01	12.00	0.00	35.00	0.01	65.00	0.02	3.00	0.00
4213	21.00	0.01	9.00	0.00	38.00	0.02	52.00	0.02	3.00	0.00
4313	22.00	0.01	14.00	0.01	25.00	0.01	67.00	0.03	3.00	0.00
1114	16.00	0.01	6.00	0.00	27.00	0.01	40.00	0.02	2.00	0.00
1214	19.00	0.01	7.00	0.00	35.00	0.01	47.00	0.02	1.00	0.00
1314	26.00	0.01	9.00	0.00	58.00	0.03	80.00	0.04	2.00	0.00
1414	21.00	0.01	10.00	0.01	59.00	0.03	69.00	0.04	3.00	0.00
2114	18.00	0.01	6.00	0.00	35.00	0.01	52.00	0.02	2.00	0.00
2214	18.00	0.01	8.00	0.00	32.00	0.02	45.00	0.02	1.00	0.00
2314	18.00	0.00	8.00	0.00	28.00	0.01	52.00	0.01	2.00	0.00
2414	20.00	0.01	9.00	0.00	49.00	0.02	66.00	0.02	2.00	0.00
3114	15.00	0.01	7.00	0.00	23.00	0.01	37.00	0.01	2.00	0.00
3214	16.00	0.01	8.00	0.00	24.00	0.01	41.00	0.02	2.00	0.00
3314	19.00	0.01	10.00	0.00	41.00	0.02	67.00	0.03	2.00	0.00
3414	19.00	0.01	10.00	0.01	28.00	0.02	60.00	0.03	2.00	0.00
4114	16.00	0.01	9.00	0.00	26.00	0.01	41.00	0.02	2.00	0.00
4214	17.00	0.01	7.00	0.00	28.00	0.01	48.00	0.02	2.00	0.00
4314	20.00	0.01	12.00	0.01	21.00	0.01	60.00	0.04	3.00	0.00
1115	16.00	0.01	6.00	0.00	24.00	0.01	39.00	0.01	2.00	0.00
1215	16.00	0.01	6.00	0.00	26.00	0.02	65.00	0.04	2.00	0.00
1315	24.00	0.01	10.00	0.00	63.00	0.02	71.00	0.03	2.00	0.00
1415	20.00	0.01	7.00	0.00	51.00	0.02	76.00	0.03	2.00	0.00
2115	19.00	0.01	5.00	0.00	31.00	0.01	58.00	0.02	3.00	0.00
2215	19.00	0.01	6.00	0.00	32.00	0.01	45.00	0.02	2.00	0.00
2315	23.00	0.01	10.00	0.00	32.00	0.01	74.00	0.03	3.00	0.00
2415	22.00	0.01	8.00	0.00	49.00	0.02	73.00	0.03	2.00	0.00
3115	17.00	0.01	6.00	0.00	22.00	0.01	49.00	0.01	3.00	0.00

3215	17.00	0.00	6.00	0.00	28.00	0.01	54.00	0.02	3.00	0.00
3315	20.00	0.01	10.00	0.00	37.00	0.01	56.00	0.02	2.00	0.00
3415	18.00	0.01	9.00	0.00	29.00	0.01	70.00	0.02	3.00	0.00
4115	17.00	0.01	8.00	0.00	24.00	0.01	46.00	0.02	2.00	0.00
4215	20.00	0.01	9.00	0.00	35.00	0.01	62.00	0.03	2.00	0.00
4315	20.00	0.01	11.00	0.01	25.00	0.01	73.00	0.03	2.00	0.00
1116	25.00	0.01	7.00	0.00	34.00	0.01	50.00	0.02	2.00	0.00
1216	37.00	0.01	12.00	0.00	55.00	0.02	99.00	0.04	2.00	0.00
1316	29.00	0.01	7.00	0.00	50.00	0.02	61.00	0.02	2.00	0.00
1416	17.00	0.01	7.00	0.00	31.00	0.01	48.00	0.02	2.00	0.00
2116	28.00	0.01	6.00	0.00	40.00	0.01	53.00	0.02	2.00	0.00
2216	31.00	0.01	9.00	0.00	44.00	0.01	79.00	0.02	3.00	0.00
2316	22.00	0.01	7.00	0.00	40.00	0.01	61.00	0.02	1.00	0.00
2416	16.00	0.01	6.00	0.00	33.00	0.01	43.00	0.01	2.00	0.00
3116	27.00	0.01	8.00	0.00	37.00	0.01	63.00	0.02	2.00	0.00
3216	26.00	0.01	8.00	0.00	42.00	0.01	91.00	0.03	2.00	0.00
3316	33.00	0.01	12.00	0.00	56.00	0.02	74.00	0.03	2.00	0.00
3416	31.00	0.01	14.00	0.01	45.00	0.02	89.00	0.03	3.00	0.00
4116	21.00	0.01	8.00	0.00	26.00	0.01	51.00	0.02	2.00	0.00
4216	26.00	0.01	11.00	0.00	46.00	0.01	87.00	0.03	3.00	0.00
4316	23.00	0.01	11.00	0.00	27.00	0.01	67.00	0.02	3.00	0.00

Table C.3. Nutrient content lab results and calculations for the Wichita (2018), Surefire (2018), and Surefire-Wichita (2019) studies continued.

Plot	Sub	Pd N (%)	Pd_N_ gsqm	Pd P (%)	Pd_P_ gsqm	Pd K (%)	Pd_K_ gsqm	Pd Mg (%)	Pd_Mg_ gsqm	Pd Ca (%)	Pd_Ca_ gsqm	Pd S (%)	Pd_S_ gsqm
127	a	4.66	3.76	0.79	0.64	2.48	2.00	0.31	0.25	1.53	1.23	0.71	0.57
128	b	4.57	5.30	0.78	0.91	2.72	3.16	0.33	0.38	1.50	1.74	0.78	0.91
202	a	4.36	4.24	0.75	0.73	2.44	2.37	0.31	0.30	1.45	1.41	0.68	0.66
218	b	4.59	2.66	0.74	0.43	2.43	1.41	0.31	0.18	1.42	0.82	0.62	0.36
314	a	4.22	2.82	0.74	0.49	2.62	1.75	0.33	0.22	1.45	0.97	0.60	0.40
318	b	4.25	5.47	0.49	0.63	1.88	2.42	0.24	0.31	1.30	1.67	0.54	0.69
112	a	2.88	7.41	0.47	1.21	1.86	4.79	0.24	0.62	1.31	3.37	0.52	1.34
123	b	2.87	10.16	0.48	1.70	1.89	6.69	0.24	0.85	1.37	4.85	0.49	1.73
204	a	2.70	12.20	0.52	2.35	2.03	9.17	0.27	1.22	1.40	6.32	0.51	2.30
217	b	2.83	5.60	0.53	1.05	1.93	3.82	0.25	0.49	1.43	2.83	0.48	0.95
302	a	2.75	7.68	0.51	1.42	1.94	5.42	0.25	0.70	1.29	3.60	0.46	1.29
315	b	2.90	7.35	0.52	1.32	2.05	5.19	0.26	0.66	1.94	4.91	0.69	1.75
102	a	2.73	9.47	0.51	1.77	2.13	7.39	0.26	0.90	1.73	6.00	0.64	2.22
120	b	2.54	9.13	0.50	1.80	2.02	7.26	0.28	1.01	1.47	5.29	0.53	1.91
224	a	2.52	6.87	0.47	1.28	2.14	5.84	0.27	0.74	1.82	4.96	0.66	1.80
229	b	2.60	10.29	0.53	2.10	2.02	8.00	0.28	1.11	1.60	6.33	0.57	2.26
313	a	2.42	8.67	0.51	1.83	2.00	7.17	0.27	0.97	1.63	5.84	0.60	2.15
330	b	2.68	12.72	0.40	1.90	2.10	9.97	0.26	1.23	2.16	10.25	0.78	3.70
110	a	2.23	8.22	0.45	1.66	2.23	8.22	0.26	0.96	2.08	7.67	0.81	2.99
130	b	2.76	20.92	0.46	3.49	1.96	14.86	0.27	2.05	1.82	13.80	0.50	3.79
211	a	2.15	8.88	0.43	1.78	2.12	8.76	0.28	1.16	1.90	7.85	0.67	2.77
227	b	2.38	13.58	0.39	2.22	2.21	12.61	0.23	1.31	1.74	9.92	0.41	2.34
319	a	2.16	12.61	0.45	2.63	2.38	13.89	0.23	1.34	1.66	9.69	0.50	2.92
329	b	2.42	14.53	0.17	1.02	2.52	15.13	0.21	1.26	3.17	19.03	1.16	6.96
111	a	0.91	2.01	0.14	0.31	2.71	5.98	0.19	0.42	3.26	7.20	1.31	2.89
116	b	0.95	2.53	0.10	0.27	2.79	7.43	0.17	0.45	3.25	8.66	1.09	2.90
203	a	0.80	2.47	0.16	0.49	3.06	9.47	0.22	0.68	2.80	8.66	0.59	1.83

210 b	0.94	1.73	0.12	0.22	2.98	5.48	0.21	0.39	3.14	5.77	0.92	1.69
305 a	1.00	3.52	0.12	0.42	3.18	11.19	0.17	0.60	2.73	9.61	0.86	3.03
326 b	1.08	3.69	0.74	2.53	0.98	3.35	0.30	1.03	0.71	2.43	0.67	2.29
1105 a	4.76	0.83	0.88	0.15	3.34	0.58	0.33	0.06	0.80	0.14	0.62	0.11
1105 b	5.24	0.92	0.85	0.15	3.27	0.57	0.32	0.06	0.73	0.13	0.50	0.09
1205 a	5.40	0.06	0.80	0.01	2.80	0.03	0.30	0.00	1.15	0.01	0.63	0.01
1205 b	5.02	0.28	0.94	0.05	3.27	0.18	0.26	0.01	0.80	0.04	0.71	0.04
2105 a	4.73	1.50	0.94	0.30	3.00	0.95	0.33	0.10	1.00	0.32	0.72	0.23
2105 b	5.09	0.33	0.93	0.06	3.35	0.22	0.31	0.02	0.76	0.05	0.57	0.04
2205 a	5.02	0.53	0.90	0.10	3.15	0.34	0.31	0.03	0.79	0.08	0.63	0.07
2205 b	5.06	0.30	0.92	0.05	3.31	0.20	0.31	0.02	0.76	0.04	0.70	0.04
3205 a	5.49	0.38	0.98	0.07	3.39	0.24	0.35	0.02	0.73	0.05	0.60	0.04
3205 b	5.12	0.78	0.91	0.14	3.48	0.53	0.33	0.05	0.82	0.13	0.63	0.10
4105 a	5.00	0.72	0.80	0.11	2.96	0.42	0.31	0.04	0.73	0.10	0.60	0.09
4105 b	5.46	0.27	0.82	0.04	2.96	0.15	0.27	0.01	0.69	0.03	0.59	0.03
4205 a	4.81	0.69	0.89	0.13	3.31	0.47	0.32	0.05	0.70	0.10	0.54	0.08
4205 b	4.65	0.51	0.84	0.09	3.30	0.36	0.31	0.03	0.81	0.09	0.56	0.06
1106 a	3.29	5.95	0.60	1.08	2.47	4.47	0.28	0.51	0.86	1.55	0.38	0.69
1106 b	3.68	3.70	0.69	0.69	3.03	3.05	0.30	0.30	0.98	0.99	0.43	0.43
1206 b	4.48	0.64	0.72	0.10	2.60	0.37	0.20	0.03	0.48	0.07	0.51	0.07
2106 a	3.57	2.69	0.69	0.52	2.75	2.07	0.30	0.23	1.14	0.86	0.47	0.35
2106 b	3.80	2.41	0.69	0.44	2.77	1.76	0.28	0.18	0.87	0.55	0.42	0.27
2206 a	3.67	2.47	0.62	0.42	2.45	1.65	0.26	0.17	0.81	0.54	0.41	0.28
2206 b	3.33	2.07	0.64	0.40	2.50	1.55	0.25	0.16	0.90	0.56	0.41	0.25
3106 a	3.84	1.09	0.69	0.20	2.69	0.77	0.28	0.08	0.80	0.23	0.47	0.13
3206 a	2.22	1.50	0.38	0.26	3.86	2.61	0.19	0.13	1.25	0.84	0.35	0.24
3206 b	3.36	2.12	0.65	0.41	2.78	1.75	0.27	0.17	0.83	0.52	0.38	0.24
4106 a	3.32	2.47	0.64	0.48	2.68	1.99	0.28	0.21	0.93	0.69	0.47	0.35
4106 b	3.90	1.87	0.56	0.27	2.56	1.23	0.26	0.12	0.75	0.36	0.44	0.21
4206 a	3.44	2.17	0.67	0.42	2.96	1.87	0.29	0.18	0.84	0.53	0.38	0.24
4206 b	3.05	3.33	0.61	0.67	2.67	2.91	0.28	0.31	0.89	0.97	0.44	0.48

1107 a	2.48	3.79	0.56	0.86	2.43	3.71	0.26	0.40	1.05	1.60	0.35	0.53
1107 b	2.65	7.00	0.51	1.35	2.29	6.05	0.23	0.61	0.92	2.43	0.29	0.77
1207 b	3.12	6.36	0.59	1.20	2.60	5.30	0.26	0.53	1.07	2.18	0.42	0.86
2107 a	2.82	4.26	0.58	0.88	2.29	3.46	0.24	0.36	1.03	1.55	0.41	0.62
2107 b	2.80	4.88	0.62	1.08	2.39	4.16	0.26	0.45	1.11	1.93	0.38	0.66
2207 a	2.51	5.88	0.54	1.27	2.18	5.11	0.23	0.54	1.04	2.44	0.36	0.84
2207 b	2.47	4.53	0.63	1.16	2.50	4.58	0.27	0.50	1.25	2.29	0.51	0.94
3107 a	2.92	3.63	0.54	0.67	2.26	2.81	0.24	0.30	1.05	1.31	0.43	0.53
3207 a	2.64	4.46	0.52	0.88	2.34	3.95	0.25	0.42	0.99	1.67	0.31	0.52
3207 b	2.45	3.27	0.51	0.68	2.16	2.88	0.25	0.33	1.00	1.33	0.36	0.48
4107 a	2.64	4.71	0.51	0.91	2.21	3.94	0.27	0.48	1.07	1.91	0.41	0.73
4107 b	2.73	4.09	0.48	0.72	2.20	3.30	0.25	0.37	1.03	1.54	0.35	0.52
4207 a	2.69	5.65	0.55	1.16	2.59	5.44	0.25	0.53	1.01	2.12	0.34	0.71
4207 b	2.44	3.77	0.54	0.83	2.48	3.83	0.27	0.42	1.02	1.57	0.40	0.62
1108 a	2.32	5.32	0.47	1.08	2.58	5.92	0.23	0.53	1.27	2.91	0.33	0.76
1108 b	2.44	5.07	0.53	1.10	2.64	5.49	0.26	0.54	1.20	2.49	0.31	0.64
1208 a	2.74	3.56	0.51	0.66	2.33	3.03	0.24	0.31	1.12	1.46	0.31	0.40
1208 b	2.47	6.41	0.55	1.43	2.51	6.52	0.24	0.62	1.06	2.75	0.33	0.86
2108 a	2.35	6.21	0.51	1.35	2.33	6.16	0.24	0.63	1.28	3.38	0.34	0.90
2108 b	2.48	2.38	0.56	0.54	2.29	2.20	0.24	0.23	1.22	1.17	0.38	0.37
2208 a	2.63	4.24	0.58	0.94	2.32	3.74	0.26	0.42	1.43	2.31	0.37	0.60
2208 b	2.31	5.72	0.58	1.44	2.41	5.97	0.26	0.64	1.36	3.37	0.46	1.14
3108 a	2.37	5.24	0.42	0.93	2.25	4.97	0.20	0.44	1.16	2.56	0.35	0.77
3108 b	3.07	3.85	0.52	0.65	2.42	3.04	0.26	0.33	1.25	1.57	0.49	0.62
3208 a	2.45	6.95	0.47	1.33	2.45	6.95	0.25	0.71	1.22	3.46	0.30	0.85
3208 b	2.29	4.70	0.46	0.94	2.54	5.21	0.25	0.51	1.30	2.67	0.37	0.76
4108 a	2.34	6.21	0.45	1.19	2.61	6.93	0.24	0.64	1.23	3.27	0.39	1.04
4108 b	2.92	5.08	0.45	0.78	2.32	4.04	0.27	0.47	1.17	2.04	0.34	0.59
4208 a	2.30	6.51	0.48	1.36	2.36	6.68	0.25	0.71	1.12	3.17	0.29	0.82
4208 b	2.18	8.56	0.45	1.77	2.45	9.62	0.25	0.98	1.17	4.59	0.34	1.33
1109 a	1.32	1.25	0.34	0.32	3.19	3.01	0.19	0.18	1.68	1.58	0.31	0.29

1109 b	1.18	3.02	0.25	0.64	3.57	9.12	0.16	0.41	1.88	4.80	0.34	0.87
1209 a	1.40	1.08	0.29	0.22	2.96	2.28	0.15	0.12	1.65	1.27	0.22	0.17
1209 b	1.23	1.36	0.29	0.32	3.26	3.61	0.19	0.21	1.85	2.05	0.25	0.28
2109 a	1.26	1.36	0.34	0.37	2.90	3.13	0.20	0.22	2.08	2.25	0.38	0.41
2109 b	1.26	2.44	0.35	0.68	2.80	5.43	0.18	0.35	1.83	3.55	0.31	0.60
2209 a	1.17	2.18	0.29	0.54	3.11	5.79	0.16	0.30	2.05	3.82	0.33	0.61
2209 b	1.26	1.66	0.35	0.46	3.04	4.00	0.21	0.28	2.30	3.02	0.48	0.63
3109 a	1.16	1.87	0.24	0.39	3.21	5.17	0.17	0.27	1.97	3.17	0.29	0.47
3109 b	1.42	2.49	0.22	0.39	3.01	5.29	0.19	0.33	2.09	3.67	0.33	0.58
3209 a	1.26	1.96	0.26	0.41	3.04	4.74	0.20	0.31	1.76	2.74	0.22	0.34
3209 b	1.21	1.25	0.23	0.24	3.08	3.18	0.19	0.20	1.82	1.88	0.39	0.40
4109 a	1.11	1.91	0.19	0.33	3.06	5.26	0.17	0.29	1.52	2.61	0.37	0.64
4109 b	1.66	1.42	0.23	0.20	2.64	2.26	0.23	0.20	1.78	1.53	0.38	0.33
4209 a	1.08	1.54	0.24	0.34	3.02	4.30	0.20	0.28	2.01	2.86	0.23	0.33
4209 b	0.98	1.41	0.22	0.32	3.08	4.42	0.18	0.26	1.74	2.50	0.29	0.42
1110 a	0.78	1.59	0.24	0.49	3.82	7.78	0.18	0.37	2.06	4.19	0.28	0.57
1110 b	0.89	1.80	0.27	0.55	3.91	7.93	0.21	0.43	2.16	4.38	0.32	0.65
1210 a	1.00	1.70	0.26	0.44	3.38	5.74	0.17	0.29	2.24	3.80	0.23	0.39
1210 b	0.86	1.24	0.28	0.40	3.55	5.12	0.19	0.27	2.32	3.35	0.33	0.48
2110 a	0.83	1.08	0.29	0.38	3.00	3.91	0.20	0.26	2.24	2.92	0.43	0.56
2110 b	0.90	1.50	0.33	0.55	3.66	6.09	0.22	0.37	2.77	4.61	0.60	1.00
2210 a	0.98	1.48	0.31	0.47	2.93	4.43	0.19	0.29	2.28	3.45	0.36	0.54
2210 b	1.02	1.45	0.33	0.47	2.94	4.18	0.18	0.26	2.18	3.10	0.33	0.47
3110 a	0.91	1.38	0.20	0.30	3.08	4.68	0.16	0.24	2.06	3.13	0.36	0.55
3110 b	1.00	1.86	0.20	0.37	3.23	6.02	0.18	0.34	2.12	3.95	0.28	0.52
3210 a	0.98	1.24	0.20	0.25	3.29	4.17	0.23	0.29	2.26	2.87	0.27	0.34
3210 b	0.85	0.97	0.20	0.23	2.96	3.37	0.21	0.24	2.25	2.56	0.35	0.40
4110 a	0.87	1.37	0.14	0.22	3.29	5.18	0.20	0.32	2.08	3.28	0.30	0.47
4110 b	1.95	1.31	0.23	0.15	3.09	2.08	0.21	0.14	2.01	1.35	0.41	0.28
4210 a	0.94	1.48	0.20	0.31	3.24	5.09	0.20	0.31	2.07	3.25	0.23	0.36
4210 b	0.81	1.00	0.18	0.22	3.57	4.40	0.16	0.20	2.00	2.47	0.38	0.47

1108	4.75	1.35	0.78	0.22	2.72	0.77	0.41	0.12	1.35	0.38	0.64	0.18
1308	5.49	1.01	0.87	0.16	2.68	0.49	0.37	0.07	1.16	0.21	0.68	0.13
1408	5.47	1.18	0.89	0.19	2.77	0.60	0.40	0.09	1.10	0.24	0.68	0.15
2108	4.92	1.50	0.81	0.25	2.72	0.83	0.42	0.13	1.39	0.42	0.71	0.22
2408	5.41	1.09	0.83	0.17	2.65	0.54	0.40	0.08	1.15	0.23	0.68	0.14
3108	5.20	1.37	0.84	0.22	2.76	0.73	0.42	0.11	1.34	0.35	0.74	0.20
1109	3.69	4.76	0.67	0.87	2.42	3.12	0.39	0.50	1.40	1.81	0.56	0.72
1209	4.51	3.06	0.77	0.52	2.37	1.61	0.36	0.24	1.23	0.84	0.63	0.43
1309	4.54	4.14	0.72	0.66	2.46	2.24	0.34	0.31	1.35	1.23	0.67	0.61
1409	4.59	3.89	0.76	0.64	2.66	2.25	0.39	0.33	1.18	1.00	0.60	0.51
2109	3.81	4.44	0.65	0.76	2.39	2.79	0.36	0.42	1.30	1.52	0.60	0.70
2209	3.64	4.16	0.64	0.73	2.27	2.60	0.32	0.37	1.41	1.61	0.56	0.64
2309	4.37	3.30	0.70	0.53	2.42	1.83	0.34	0.26	1.36	1.03	0.67	0.51
2409	4.87	2.53	0.79	0.41	2.62	1.36	0.39	0.20	1.27	0.66	0.64	0.33
3109	4.03	3.93	0.70	0.68	2.37	2.31	0.37	0.36	1.29	1.26	0.63	0.61
3209	4.48	2.60	0.70	0.41	2.24	1.30	0.34	0.20	1.29	0.75	0.74	0.43
3309	4.74	2.95	0.77	0.48	2.38	1.48	0.33	0.21	1.30	0.81	0.68	0.42
3409	5.15	2.63	0.86	0.44	2.58	1.32	0.38	0.19	1.35	0.69	0.70	0.36
4109	4.34	2.97	0.73	0.50	2.29	1.57	0.31	0.21	1.25	0.85	0.63	0.43
4209	4.60	3.34	0.77	0.56	2.58	1.88	0.34	0.25	1.19	0.87	0.64	0.47
4309	4.72	3.58	0.74	0.56	2.39	1.81	0.34	0.26	1.36	1.03	0.67	0.51
1110	3.25	5.42	0.57	0.95	2.25	3.75	0.36	0.60	1.52	2.54	0.54	0.90
1210	3.44	5.97	0.55	0.95	2.16	3.75	0.32	0.56	1.38	2.40	0.55	0.95
1310	3.63	7.06	0.55	1.07	2.22	4.32	0.32	0.62	1.55	3.01	0.61	1.19
1410	3.45	6.60	0.57	1.09	2.45	4.68	0.33	0.63	1.35	2.58	0.57	1.09
2110	2.99	9.02	0.51	1.54	2.10	6.34	0.32	0.97	1.45	4.38	0.52	1.57
2210	2.87	6.31	0.51	1.12	2.03	4.46	0.28	0.62	1.49	3.28	0.49	1.08
2310	3.08	6.24	0.52	1.05	2.15	4.36	0.29	0.59	1.40	2.84	0.54	1.09
2410	3.91	7.69	0.61	1.20	2.52	4.95	0.34	0.67	1.52	2.99	0.60	1.18
3110	3.93	2.81	0.64	0.46	2.24	1.60	0.32	0.23	1.64	1.17	0.65	0.46
3210	3.29	8.00	0.53	1.29	2.05	4.98	0.33	0.80	1.57	3.82	0.62	1.51

3310	3.49	5.64	0.69	1.12	2.22	3.59	0.35	0.57	1.64	2.65	0.72	1.16
3410	4.14	4.35	0.55	0.58	2.13	2.24	0.28	0.29	1.45	1.52	0.61	0.64
4110	3.38	5.75	0.56	0.95	2.12	3.61	0.28	0.48	1.45	2.47	0.61	1.04
4210	3.26	8.23	0.55	1.39	2.14	5.40	0.30	0.76	1.52	3.84	0.61	1.54
4310	3.53	7.95	0.60	1.35	2.18	4.91	0.31	0.70	1.58	3.56	0.63	1.42
1111	2.89	11.69	0.53	2.14	2.02	8.17	0.38	1.54	1.51	6.11	0.57	2.31
1211	2.77	10.93	0.50	1.97	1.88	7.42	0.33	1.30	1.50	5.92	0.55	2.17
1311	3.14	14.81	0.50	2.36	1.98	9.34	0.31	1.46	1.58	7.45	0.66	3.11
1411	2.86	13.01	0.51	2.32	2.10	9.56	0.33	1.50	1.49	6.78	0.60	2.73
2111	2.81	15.58	0.49	2.72	2.01	11.14	0.34	1.88	1.57	8.70	0.58	3.22
2211	2.58	11.88	0.47	2.16	1.86	8.56	0.30	1.38	1.56	7.18	0.52	2.39
2311	2.76	12.10	0.47	2.06	1.90	8.33	0.30	1.31	1.55	6.79	0.57	2.50
2411	3.52	13.01	0.57	2.11	2.27	8.39	0.35	1.29	1.70	6.28	0.67	2.48
3111	2.96	13.67	0.49	2.26	2.01	9.28	0.32	1.48	1.51	6.97	0.62	2.86
3211	2.93	13.59	0.47	2.18	1.83	8.49	0.32	1.48	1.59	7.38	0.66	3.06
3311	3.43	11.66	0.54	1.84	1.97	6.70	0.30	1.02	1.57	5.34	0.64	2.18
3411	3.26	8.30	0.57	1.45	2.00	5.09	0.32	0.82	1.64	4.18	0.67	1.71
4111	3.18	6.87	0.53	1.15	1.98	4.28	0.29	0.63	1.67	3.61	0.70	1.51
4211	2.91	11.17	0.52	2.00	1.90	7.29	0.30	1.15	1.63	6.26	0.68	2.61
4311	3.11	12.88	0.54	2.24	1.88	7.79	0.29	1.20	1.55	6.42	0.63	2.61
1112	1.81	3.84	0.29	0.62	2.04	4.33	0.29	0.62	2.06	4.37	0.65	1.38
1212	1.98	3.97	0.29	0.58	1.93	3.87	0.26	0.52	2.19	4.39	0.63	1.26
1312	2.64	6.69	0.36	0.91	1.92	4.87	0.26	0.66	1.94	4.92	0.76	1.93
1412	2.14	7.46	0.32	1.12	2.23	7.78	0.25	0.87	1.95	6.80	0.67	2.34
2112	1.93	5.74	0.26	0.77	2.15	6.39	0.29	0.86	2.37	7.04	0.69	2.05
2212	1.87	5.79	0.29	0.90	1.90	5.89	0.25	0.77	2.28	7.06	0.68	2.11
2312	2.12	3.87	0.29	0.53	2.08	3.79	0.24	0.44	2.08	3.79	0.66	1.20
2412	2.18	3.58	0.32	0.53	2.12	3.48	0.25	0.41	1.92	3.16	0.69	1.13
3112	2.36	4.39	0.31	0.58	2.10	3.91	0.26	0.48	1.90	3.54	0.71	1.32
3212	2.41	4.56	0.32	0.61	2.02	3.82	0.26	0.49	2.26	4.27	0.84	1.59
3312	2.37	3.34	0.28	0.39	2.07	2.91	0.22	0.31	2.06	2.90	0.74	1.04

3412	2.62	3.79	0.46	0.66	2.12	3.06	0.28	0.40	1.89	2.73	0.72	1.04
4112	2.74	4.36	0.40	0.64	1.84	2.93	0.23	0.37	1.73	2.76	0.72	1.15
4212	1.88	5.96	0.27	0.86	2.10	6.66	0.24	0.76	2.21	7.01	0.83	2.63
4312	2.77	5.73	0.38	0.79	1.92	3.97	0.23	0.48	2.08	4.30	0.80	1.66
1113	1.71	5.40	0.16	0.51	2.50	7.90	0.26	0.82	2.57	8.12	0.77	2.43
1213	1.67	6.15	0.14	0.52	2.53	9.32	0.22	0.81	2.88	10.61	0.78	2.87
1313	1.95	7.98	0.18	0.74	2.40	9.82	0.22	0.90	2.77	11.33	0.87	3.56
1413	1.90	6.46	0.17	0.58	2.90	9.86	0.20	0.68	2.49	8.47	0.76	2.59
2113	1.56	7.06	0.12	0.54	2.72	12.30	0.25	1.13	2.76	12.48	0.79	3.57
2213	1.59	5.59	0.14	0.49	2.62	9.21	0.21	0.74	2.82	9.92	0.79	2.78
2313	1.97	6.31	0.18	0.58	2.61	8.36	0.20	0.64	2.67	8.55	0.77	2.46
2413	1.96	5.85	0.18	0.54	2.42	7.22	0.21	0.63	2.42	7.22	0.64	1.91
3113	2.19	5.68	0.20	0.52	2.24	5.81	0.18	0.47	2.56	6.65	0.80	2.08
3213	1.86	6.14	0.18	0.59	1.98	6.54	0.20	0.66	2.66	8.79	0.93	3.07
3313	1.93	6.65	0.17	0.59	2.22	7.65	0.23	0.79	2.29	7.89	0.80	2.76
3413	2.23	5.95	0.26	0.69	2.12	5.66	0.19	0.51	2.15	5.74	0.65	1.74
4113	2.38	3.96	0.24	0.40	2.19	3.65	0.17	0.28	2.42	4.03	0.87	1.45
4213	1.59	5.44	0.17	0.58	2.31	7.90	0.21	0.72	2.67	9.14	0.90	3.08
4313	2.17	7.57	0.24	0.84	1.92	6.70	0.17	0.59	2.49	8.69	0.85	2.97
1114	0.95	3.75	0.06	0.24	2.82	11.14	0.21	0.83	2.81	11.10	0.81	3.20
1214	1.12	3.69	0.08	0.26	2.92	9.63	0.18	0.59	3.02	9.96	0.78	2.57
1314	1.24	3.92	0.11	0.35	2.81	8.88	0.18	0.57	2.92	9.23	0.93	2.94
1414	1.14	4.18	0.09	0.33	2.95	10.82	0.15	0.55	2.60	9.54	0.80	2.94
2114	1.01	4.26	0.06	0.25	2.74	11.56	0.21	0.89	2.91	12.27	0.81	3.42
2214	0.91	3.78	0.06	0.25	2.67	11.10	0.17	0.71	3.11	12.92	0.76	3.16
2314	1.38	2.90	0.11	0.23	2.84	5.98	0.14	0.29	2.75	5.79	0.76	1.60
2414	1.39	4.04	0.10	0.29	3.12	9.06	0.20	0.58	2.80	8.13	0.86	2.50
3114	1.04	4.38	0.07	0.29	2.65	11.15	0.23	0.97	3.08	12.96	0.90	3.79
3214	1.12	3.85	0.07	0.24	2.39	8.22	0.17	0.58	3.12	10.73	1.05	3.61
3314	1.37	4.17	0.09	0.27	2.62	7.98	0.16	0.49	3.02	9.20	0.88	2.68
3414	1.34	5.14	0.14	0.54	2.54	9.75	0.14	0.54	2.50	9.59	0.74	2.84

4114	1.29	4.95	0.10	0.38	2.27	8.70	0.13	0.50	3.06	11.73	0.92	3.53
4214	1.33	4.62	0.08	0.28	2.64	9.18	0.17	0.59	2.82	9.81	0.96	3.34
4314	1.72	7.15	0.13	0.54	2.45	10.18	0.12	0.50	2.89	12.01	0.94	3.91
1115	1.12	3.45	0.05	0.15	2.57	7.92	0.19	0.59	2.61	8.05	0.69	2.13
1215	1.29	5.14	0.05	0.20	2.46	9.79	0.15	0.60	2.72	10.83	0.71	2.83
1315	1.24	3.48	0.06	0.17	2.59	7.26	0.13	0.36	2.76	7.74	0.78	2.19
1415	1.24	3.31	0.05	0.13	2.82	7.54	0.15	0.40	2.64	7.06	0.80	2.14
2115	1.04	3.26	0.04	0.13	2.53	7.94	0.19	0.60	2.68	8.41	0.79	2.48
2215	1.26	3.40	0.05	0.13	2.27	6.12	0.17	0.46	3.03	8.17	0.77	2.08
2315	1.45	4.18	0.07	0.20	2.39	6.90	0.11	0.32	2.59	7.47	0.80	2.31
2415	1.23	3.56	0.06	0.17	2.87	8.31	0.18	0.52	2.88	8.34	0.88	2.55
3115	1.29	3.18	0.07	0.17	2.27	5.60	0.21	0.52	2.84	7.01	0.82	2.02
3215	1.37	2.94	0.06	0.13	1.96	4.21	0.16	0.34	2.84	6.09	0.94	2.02
3315	1.48	4.33	0.06	0.18	2.29	6.70	0.14	0.41	3.11	9.09	1.02	2.98
3415	1.11	2.49	0.09	0.20	2.49	5.59	0.13	0.29	2.52	5.66	0.77	1.73
4115	0.89	2.43	0.08	0.22	2.11	5.76	0.12	0.33	2.86	7.81	0.88	2.40
4215	0.84	2.75	0.05	0.16	2.35	7.70	0.17	0.56	2.84	9.31	1.00	3.28
4315	1.05	3.06	0.09	0.26	2.31	6.73	0.10	0.29	2.94	8.56	0.89	2.59
1116	0.74	2.20	0.05	0.15	2.77	8.25	0.22	0.65	2.94	8.75	0.81	2.41
1216	1.04	2.45	0.07	0.16	2.62	6.17	0.16	0.38	2.96	6.97	0.76	1.79
1316	0.80	2.01	0.05	0.13	2.85	7.15	0.14	0.35	3.17	7.95	0.90	2.26
1416	0.80	2.55	0.05	0.16	3.08	9.83	0.16	0.51	2.95	9.41	0.85	2.71
2116	0.77	2.23	0.05	0.14	2.97	8.58	0.22	0.64	2.95	8.52	0.95	2.75
2216	0.72	1.77	0.05	0.12	2.10	5.16	0.17	0.42	3.26	8.02	0.80	1.97
2316	0.73	2.21	0.05	0.15	2.65	8.02	0.17	0.51	3.38	10.22	0.91	2.75
2416	0.88	2.25	0.05	0.13	2.82	7.23	0.17	0.44	2.65	6.79	0.78	2.00
3116	0.76	1.55	0.06	0.12	2.37	4.85	0.18	0.37	2.79	5.71	0.77	1.58
3216	0.80	2.07	0.05	0.13	2.27	5.86	0.15	0.39	2.90	7.49	0.93	2.40
3316	1.09	2.82	0.07	0.18	2.74	7.09	0.12	0.31	3.21	8.30	1.05	2.72
3416	1.18	3.18	0.08	0.22	2.63	7.08	0.14	0.38	2.81	7.57	0.88	2.37
4116	1.03	2.89	0.09	0.25	2.05	5.75	0.12	0.34	2.91	8.16	0.98	2.75

4216	1.00	2.45	0.08	0.20	2.32	5.68	0.17	0.42	2.87	7.03	0.98	2.40
4316	1.28	3.09	0.13	0.31	2.22	5.36	0.09	0.22	3.03	7.32	0.92	2.22

Table C.4. Nutrient content lab results and calculations for the Wichita (2018), Surefire (2018), and Surefire-Wichita (2019) studies continued.

Plot	Sub	Pd B (ppm)	Pd_B_ gsqm	Pd Zn (ppm)	Pd_Zn_ gsqm	Pd Mn (ppm)	Pd_Mn_ gsqm	Pd Fe (ppm)	Pd_Fe_ gsqm	Pd Cu (ppm)	Pd_Cu_ gsqm
127	a	46.43	0.00	53.74	0.00	50.70	0.00	99.01	0.01	6.73	0.00
128	b	43.63	0.01	52.18	0.01	44.12	0.01	99.70	0.01	6.17	0.00
202	a	43.10	0.00	46.29	0.00	44.63	0.00	84.37	0.01	6.12	0.00
218	b	45.74	0.00	47.77	0.00	36.03	0.00	87.13	0.01	5.10	0.00
314	a	44.34	0.00	46.36	0.00	37.40	0.00	89.53	0.01	5.23	0.00
318	b	25.54	0.00	35.28	0.00	42.64	0.01	71.04	0.01	4.30	0.00
112	a	27.30	0.01	33.22	0.01	34.87	0.01	67.02	0.02	3.54	0.00
123	b	30.65	0.01	29.38	0.01	36.22	0.01	59.20	0.02	3.78	0.00
204	a	28.05	0.01	32.86	0.01	37.75	0.02	60.50	0.03	3.91	0.00
217	b	30.79	0.01	30.18	0.01	29.31	0.01	61.27	0.01	3.77	0.00
302	a	31.86	0.01	29.49	0.01	31.22	0.01	63.73	0.02	3.23	0.00
315	b	22.82	0.01	25.11	0.01	46.82	0.01	68.39	0.02	3.86	0.00
102	a	26.07	0.01	32.96	0.01	34.97	0.01	65.50	0.02	3.75	0.00
120	b	26.35	0.01	25.18	0.01	37.67	0.01	57.09	0.02	3.43	0.00
224	a	27.87	0.01	27.42	0.01	38.44	0.01	60.51	0.02	4.14	0.00
229	b	31.48	0.01	25.79	0.01	31.63	0.01	61.54	0.02	4.09	0.00
313	a	28.10	0.01	26.15	0.01	31.47	0.01	60.46	0.02	3.07	0.00
330	b	27.30	0.01	25.90	0.01	50.15	0.02	82.57	0.04	4.01	0.00
110	a	35.09	0.01	25.63	0.01	33.60	0.01	60.94	0.02	4.06	0.00
130	b	28.20	0.02	23.86	0.02	48.51	0.04	60.74	0.05	3.66	0.00
211	a	28.89	0.01	22.75	0.01	43.65	0.02	65.52	0.03	4.18	0.00
227	b	27.53	0.02	18.55	0.01	31.87	0.02	48.62	0.03	3.42	0.00
319	a	27.97	0.02	21.33	0.01	34.52	0.02	60.54	0.04	3.78	0.00
329	b	31.46	0.02	10.03	0.01	59.37	0.04	46.39	0.03	5.24	0.00
111	a	29.19	0.01	8.52	0.00	43.26	0.01	45.67	0.01	4.40	0.00
116	b	28.79	0.01	6.98	0.00	31.53	0.01	38.19	0.01	3.74	0.00
203	a	32.81	0.01	8.21	0.00	48.52	0.02	39.94	0.01	4.93	0.00

210 b	42.83	0.01	8.28	0.00	39.42	0.01	46.62	0.01	4.97	0.00
305 a	34.88	0.01	7.68	0.00	25.30	0.01	41.35	0.01	3.58	0.00
326 b	17.88	0.01	43.64	0.01	45.29	0.02	93.27	0.03	3.26	0.00
1105 a	41.90	0.00	51.97	0.00	53.41	0.00	94.34	0.00	5.67	0.00
1105 b	39.82	0.00	55.64	0.00	54.09	0.00	98.77	0.00	5.95	0.00
1205 a	36.69	0.00	49.16	0.00	42.51	0.00	104.57	0.00	5.11	0.00
1205 b	36.04	0.00	57.13	0.00	44.90	0.00	119.22	0.00	5.58	0.00
2105 a	41.72	0.00	54.81	0.00	56.08	0.00	81.24	0.00	5.78	0.00
2105 b	43.50	0.00	58.95	0.00	52.77	0.00	94.55	0.00	5.38	0.00
2205 a	38.67	0.00	56.31	0.00	50.13	0.00	87.96	0.00	5.35	0.00
2205 b	37.81	0.00	58.84	0.00	49.94	0.00	123.67	0.00	5.71	0.00
3205 a	42.59	0.00	61.21	0.00	51.12	0.00	106.61	0.00	6.00	0.00
3205 b	37.86	0.00	57.80	0.00	52.05	0.00	97.36	0.00	5.62	0.00
4105 a	33.06	0.00	52.01	0.00	52.21	0.00	86.76	0.00	5.41	0.00
4105 b	30.28	0.00	54.41	0.00	54.16	0.00	87.20	0.00	5.63	0.00
4205 a	37.26	0.00	55.31	0.00	51.26	0.00	92.15	0.00	5.38	0.00
4205 b	32.75	0.00	51.11	0.00	56.23	0.00	77.26	0.00	4.95	0.00
1106 a	30.93	0.01	30.83	0.01	48.34	0.01	61.87	0.01	3.45	0.00
1106 b	33.64	0.00	37.24	0.00	52.59	0.01	77.78	0.01	4.45	0.00
1206 b	33.03	0.00	42.00	0.00	36.39	0.00	77.81	0.00	4.33	0.00
2106 a	34.16	0.00	37.70	0.00	50.87	0.00	71.15	0.01	4.01	0.00
2106 b	33.55	0.00	35.43	0.00	47.80	0.00	72.44	0.00	4.06	0.00
2206 a	29.22	0.00	33.73	0.00	39.74	0.00	62.92	0.00	4.00	0.00
2206 b	24.85	0.00	33.01	0.00	43.69	0.00	70.07	0.00	3.63	0.00
3106 a	27.33	0.00	38.47	0.00	51.26	0.00	78.31	0.00	4.58	0.00
3206 a	24.83	0.00	18.20	0.00	51.31	0.00	126.62	0.01	2.91	0.00
3206 b	28.05	0.00	33.58	0.00	48.26	0.00	74.62	0.00	3.94	0.00
4106 a	23.73	0.00	40.38	0.00	47.84	0.00	71.20	0.01	3.95	0.00
4106 b	18.26	0.00	35.72	0.00	46.15	0.00	73.64	0.00	4.18	0.00
4206 a	28.39	0.00	38.69	0.00	50.08	0.00	75.46	0.00	4.13	0.00
4206 b	24.65	0.00	34.33	0.00	52.13	0.01	63.33	0.01	3.78	0.00

1107 a	31.36	0.00	23.09	0.00	50.05	0.01	58.77	0.01	3.24	0.00
1107 b	27.35	0.01	23.78	0.01	42.56	0.01	58.97	0.02	3.61	0.00
1207 b	25.90	0.01	27.35	0.01	51.06	0.01	64.76	0.01	3.68	0.00
2107 a	26.87	0.00	24.25	0.00	52.14	0.01	56.16	0.01	3.17	0.00
2107 b	31.49	0.01	27.45	0.00	51.89	0.01	64.38	0.01	3.53	0.00
2207 a	29.40	0.01	23.42	0.01	39.21	0.01	56.12	0.01	3.57	0.00
2207 b	27.54	0.01	26.79	0.00	49.74	0.01	65.01	0.01	3.88	0.00
3107 a	24.38	0.00	27.88	0.00	50.07	0.01	62.71	0.01	3.81	0.00
3207 a	28.06	0.00	24.98	0.00	46.29	0.01	61.10	0.01	3.50	0.00
3207 b	28.20	0.00	22.59	0.00	48.34	0.01	52.63	0.01	2.91	0.00
4107 a	17.23	0.00	24.97	0.00	54.41	0.01	61.27	0.01	3.58	0.00
4107 b	19.32	0.00	24.80	0.00	55.21	0.01	65.78	0.01	4.24	0.00
4207 a	22.53	0.00	27.95	0.01	50.21	0.01	64.77	0.01	3.63	0.00
4207 b	21.56	0.00	24.82	0.00	55.54	0.01	55.60	0.01	3.01	0.00
1108 a	32.70	0.01	19.49	0.00	56.04	0.01	55.95	0.01	3.46	0.00
1108 b	29.68	0.01	24.51	0.01	56.43	0.01	59.91	0.01	3.46	0.00
1208 a	26.23	0.00	24.86	0.00	45.40	0.01	57.59	0.01	3.04	0.00
1208 b	27.43	0.01	24.85	0.01	51.06	0.01	58.28	0.02	3.36	0.00
2108 a	30.96	0.01	21.88	0.01	53.84	0.01	57.06	0.02	3.76	0.00
2108 b	30.41	0.00	24.43	0.00	52.70	0.01	57.39	0.01	3.77	0.00
2208 a	27.53	0.00	24.08	0.00	49.99	0.01	58.90	0.01	3.57	0.00
2208 b	28.82	0.01	23.89	0.01	48.13	0.01	51.83	0.01	3.29	0.00
3108 a	27.58	0.01	22.31	0.00	56.39	0.01	53.93	0.01	3.06	0.00
3108 b	26.69	0.00	35.50	0.00	69.02	0.01	72.32	0.01	4.38	0.00
3208 a	25.57	0.01	21.57	0.01	52.98	0.02	54.55	0.02	3.12	0.00
3208 b	26.20	0.01	20.56	0.00	53.43	0.01	51.31	0.01	3.23	0.00
4108 a	21.23	0.01	21.11	0.01	57.01	0.02	50.82	0.01	3.53	0.00
4108 b	22.54	0.00	26.01	0.00	61.70	0.01	63.28	0.01	4.22	0.00
4208 a	22.88	0.01	23.44	0.01	48.64	0.01	49.02	0.01	3.08	0.00
4208 b	22.47	0.01	20.30	0.01	52.54	0.02	46.06	0.02	3.40	0.00
1109 a	40.39	0.00	11.30	0.00	56.73	0.01	49.91	0.00	3.88	0.00

1109 b	40.45	0.01	8.07	0.00	57.89	0.01	41.09	0.01	3.73	0.00
1209 a	39.42	0.00	11.64	0.00	50.09	0.00	56.80	0.00	3.89	0.00
1209 b	39.88	0.00	9.79	0.00	65.55	0.01	56.12	0.01	4.46	0.00
2109 a	46.85	0.01	11.26	0.00	60.99	0.01	51.12	0.01	3.71	0.00
2109 b	40.40	0.01	10.28	0.00	52.69	0.01	44.45	0.01	3.59	0.00
2209 a	39.55	0.01	9.10	0.00	44.88	0.01	45.75	0.01	4.20	0.00
2209 b	39.04	0.01	11.09	0.00	54.12	0.01	52.56	0.01	4.31	0.00
3109 a	37.09	0.01	10.38	0.00	60.69	0.01	45.35	0.01	4.29	0.00
3109 b	45.73	0.01	12.02	0.00	72.87	0.01	52.93	0.01	4.51	0.00
3209 a	33.68	0.01	10.13	0.00	52.30	0.01	40.81	0.01	4.10	0.00
3209 b	31.44	0.00	9.21	0.00	54.79	0.01	39.51	0.00	3.50	0.00
4109 a	21.87	0.00	9.40	0.00	54.82	0.01	44.39	0.01	3.63	0.00
4109 b	28.22	0.00	14.58	0.00	74.09	0.01	58.77	0.01	4.31	0.00
4209 a	32.08	0.00	10.06	0.00	70.11	0.01	44.95	0.01	3.79	0.00
4209 b	30.68	0.00	9.34	0.00	70.08	0.01	40.60	0.01	3.63	0.00
1110 a	48.62	0.01	7.02	0.00	64.28	0.01	66.88	0.01	3.59	0.00
1110 b	61.24	0.01	8.88	0.00	80.04	0.02	70.21	0.01	4.39	0.00
1210 a	50.08	0.01	8.21	0.00	51.47	0.01	66.68	0.01	4.17	0.00
1210 b	55.09	0.01	8.91	0.00	67.69	0.01	57.33	0.01	4.54	0.00
2110 a	52.15	0.01	9.35	0.00	76.00	0.01	52.07	0.01	4.66	0.00
2110 b	52.19	0.01	9.64	0.00	61.31	0.01	67.29	0.01	5.14	0.00
2210 a	46.26	0.01	9.78	0.00	52.95	0.01	56.22	0.01	4.14	0.00
2210 b	52.02	0.01	8.48	0.00	60.41	0.01	51.79	0.01	4.13	0.00
3110 a	48.69	0.01	7.35	0.00	60.24	0.01	57.69	0.01	3.87	0.00
3110 b	52.37	0.01	9.05	0.00	84.33	0.02	59.85	0.01	4.64	0.00
3210 a	47.74	0.01	8.50	0.00	71.53	0.01	77.15	0.01	4.75	0.00
3210 b	43.74	0.00	7.81	0.00	66.91	0.01	49.49	0.01	3.51	0.00
4110 a	38.93	0.01	8.03	0.00	75.28	0.01	61.57	0.01	3.97	0.00
4110 b	61.13	0.00	14.05	0.00	86.70	0.01	88.77	0.01	5.78	0.00
4210 a	38.61	0.01	8.37	0.00	77.53	0.01	62.61	0.01	4.07	0.00
4210 b	40.34	0.00	6.99	0.00	64.80	0.01	52.43	0.01	3.74	0.00

1108	42.00	0.00	54.00	0.00	46.00	0.00	98.00	0.00	8.00	0.00
1308	51.00	0.00	67.00	0.00	41.00	0.00	152.00	0.00	7.00	0.00
1408	46.00	0.00	66.00	0.00	50.00	0.00	117.00	0.00	9.00	0.00
2108	43.00	0.00	49.00	0.00	44.00	0.00	130.00	0.00	8.00	0.00
2408	45.00	0.00	69.00	0.00	45.00	0.00	123.00	0.00	7.00	0.00
3108	44.00	0.00	58.00	0.00	41.00	0.00	112.00	0.00	8.00	0.00
1109	39.00	0.01	38.00	0.00	40.00	0.01	76.00	0.01	7.00	0.00
1209	43.00	0.00	49.00	0.00	32.00	0.00	97.00	0.01	7.00	0.00
1309	45.00	0.00	44.00	0.00	34.00	0.00	86.00	0.01	6.00	0.00
1409	40.00	0.00	47.00	0.00	51.00	0.00	96.00	0.01	8.00	0.00
2109	38.00	0.00	35.00	0.00	39.00	0.00	81.00	0.01	7.00	0.00
2209	39.00	0.00	36.00	0.00	30.00	0.00	72.00	0.01	5.00	0.00
2309	41.00	0.00	41.00	0.00	34.00	0.00	92.00	0.01	6.00	0.00
2409	43.00	0.00	54.00	0.00	43.00	0.00	98.00	0.01	7.00	0.00
3109	38.00	0.00	38.00	0.00	38.00	0.00	82.00	0.01	7.00	0.00
3209	40.00	0.00	34.00	0.00	32.00	0.00	91.00	0.01	6.00	0.00
3309	44.00	0.00	55.00	0.00	32.00	0.00	108.00	0.01	6.00	0.00
3409	41.00	0.00	62.00	0.00	42.00	0.00	121.00	0.01	8.00	0.00
4109	40.00	0.00	42.00	0.00	34.00	0.00	114.00	0.01	6.00	0.00
4209	42.00	0.00	48.00	0.00	39.00	0.00	92.00	0.01	7.00	0.00
4309	42.00	0.00	54.00	0.00	31.00	0.00	100.00	0.01	7.00	0.00
1110	36.00	0.01	30.00	0.01	50.00	0.01	70.00	0.01	6.00	0.00
1210	38.00	0.01	33.00	0.01	39.00	0.01	69.00	0.01	5.00	0.00
1310	39.00	0.01	29.00	0.01	50.00	0.01	67.00	0.01	5.00	0.00
1410	36.00	0.01	36.00	0.01	56.00	0.01	68.00	0.01	5.00	0.00
2110	36.00	0.01	23.00	0.01	44.00	0.01	60.00	0.02	5.00	0.00
2210	37.00	0.01	26.00	0.01	35.00	0.01	50.00	0.01	5.00	0.00
2310	38.00	0.01	28.00	0.01	39.00	0.01	58.00	0.01	4.00	0.00
2410	37.00	0.01	36.00	0.01	58.00	0.01	71.00	0.01	6.00	0.00
3110	43.00	0.00	41.00	0.00	35.00	0.00	68.00	0.00	6.00	0.00
3210	39.00	0.01	28.00	0.01	38.00	0.01	69.00	0.02	5.00	0.00

3310	40.00	0.01	43.00	0.01	41.00	0.01	88.00	0.01	6.00	0.00
3410	37.00	0.00	30.00	0.00	39.00	0.00	64.00	0.01	4.00	0.00
4110	38.00	0.01	30.00	0.01	39.00	0.01	64.00	0.01	4.00	0.00
4210	37.00	0.01	31.00	0.01	43.00	0.01	64.00	0.02	5.00	0.00
4310	40.00	0.01	37.00	0.01	31.00	0.01	61.00	0.01	5.00	0.00
1111	33.00	0.01	27.00	0.01	57.00	0.02	77.00	0.03	5.00	0.00
1211	35.00	0.01	28.00	0.01	47.00	0.02	66.00	0.03	5.00	0.00
1311	35.00	0.02	29.00	0.01	71.00	0.03	83.00	0.04	5.00	0.00
1411	33.00	0.02	31.00	0.01	77.00	0.04	83.00	0.04	5.00	0.00
2111	34.00	0.02	26.00	0.01	55.00	0.03	72.00	0.04	5.00	0.00
2211	32.00	0.01	25.00	0.01	49.00	0.02	58.00	0.03	4.00	0.00
2311	35.00	0.02	25.00	0.01	45.00	0.02	65.00	0.03	4.00	0.00
2411	33.00	0.01	31.00	0.01	74.00	0.03	82.00	0.03	5.00	0.00
3111	33.00	0.02	25.00	0.01	55.00	0.03	66.00	0.03	4.00	0.00
3211	35.00	0.02	26.00	0.01	44.00	0.02	79.00	0.04	4.00	0.00
3311	38.00	0.01	33.00	0.01	45.00	0.02	66.00	0.02	5.00	0.00
3411	36.00	0.01	36.00	0.01	53.00	0.01	90.00	0.02	6.00	0.00
4111	35.00	0.01	29.00	0.01	45.00	0.01	63.00	0.01	5.00	0.00
4211	33.00	0.01	29.00	0.01	51.00	0.02	77.00	0.03	5.00	0.00
4311	36.00	0.01	34.00	0.01	37.00	0.02	73.00	0.03	5.00	0.00
1112	39.00	0.01	17.00	0.00	55.00	0.01	71.00	0.02	5.00	0.00
1212	45.00	0.01	18.00	0.00	52.00	0.01	60.00	0.01	4.00	0.00
1312	40.00	0.01	26.00	0.01	84.00	0.02	157.00	0.04	5.00	0.00
1412	39.00	0.01	21.00	0.01	76.00	0.03	100.00	0.03	4.00	0.00
2112	42.00	0.01	17.00	0.01	62.00	0.02	73.00	0.02	4.00	0.00
2212	42.00	0.01	16.00	0.00	51.00	0.02	140.00	0.04	4.00	0.00
2312	44.00	0.01	18.00	0.00	47.00	0.01	65.00	0.01	4.00	0.00
2412	38.00	0.01	22.00	0.00	85.00	0.01	272.00	0.04	6.00	0.00
3112	39.00	0.01	16.00	0.00	61.00	0.01	70.00	0.01	4.00	0.00
3212	44.00	0.01	27.00	0.01	62.00	0.01	167.00	0.03	4.00	0.00
3312	41.00	0.01	15.00	0.00	52.00	0.01	53.00	0.01	4.00	0.00

3412	40.00	0.01	25.00	0.00	56.00	0.01	65.00	0.01	6.00	0.00
4112	39.00	0.01	20.00	0.00	45.00	0.01	56.00	0.01	3.00	0.00
4212	44.00	0.01	19.00	0.01	64.00	0.02	67.00	0.02	5.00	0.00
4312	41.00	0.01	23.00	0.00	35.00	0.01	143.00	0.03	4.00	0.00
1113	49.00	0.02	11.00	0.00	57.00	0.02	48.00	0.02	4.00	0.00
1213	57.00	0.02	11.00	0.00	53.00	0.02	45.00	0.02	5.00	0.00
1313	57.00	0.02	12.00	0.00	93.00	0.04	63.00	0.03	5.00	0.00
1413	48.00	0.02	13.00	0.00	87.00	0.03	66.00	0.02	4.00	0.00
2113	59.00	0.03	10.00	0.00	61.00	0.03	50.00	0.02	5.00	0.00
2213	54.00	0.02	13.00	0.00	50.00	0.02	273.00	0.10	4.00	0.00
2313	55.00	0.02	13.00	0.00	54.00	0.02	43.00	0.01	5.00	0.00
2413	50.00	0.01	13.00	0.00	87.00	0.03	59.00	0.02	5.00	0.00
3113	51.00	0.01	13.00	0.00	63.00	0.02	56.00	0.01	4.00	0.00
3213	52.00	0.02	12.00	0.00	57.00	0.02	51.00	0.02	4.00	0.00
3313	49.00	0.02	12.00	0.00	66.00	0.02	168.00	0.06	4.00	0.00
3413	45.00	0.01	14.00	0.00	49.00	0.01	60.00	0.02	5.00	0.00
4113	49.00	0.01	16.00	0.00	43.00	0.01	57.00	0.01	4.00	0.00
4213	51.00	0.02	13.00	0.00	67.00	0.02	49.00	0.02	5.00	0.00
4313	46.00	0.02	15.00	0.01	25.00	0.01	46.00	0.02	5.00	0.00
1114	50.00	0.02	6.00	0.00	48.00	0.02	43.00	0.02	5.00	0.00
1214	57.00	0.02	8.00	0.00	55.00	0.02	57.00	0.02	5.00	0.00
1314	59.00	0.02	10.00	0.00	81.00	0.03	64.00	0.02	6.00	0.00
1414	51.00	0.02	7.00	0.00	85.00	0.03	46.00	0.02	5.00	0.00
2114	54.00	0.02	6.00	0.00	66.00	0.03	45.00	0.02	5.00	0.00
2214	55.00	0.02	8.00	0.00	51.00	0.02	50.00	0.02	5.00	0.00
2314	56.00	0.01	11.00	0.00	50.00	0.01	47.00	0.01	5.00	0.00
2414	50.00	0.01	10.00	0.00	100.00	0.03	64.00	0.02	6.00	0.00
3114	52.00	0.02	8.00	0.00	62.00	0.03	50.00	0.02	4.00	0.00
3214	55.00	0.02	8.00	0.00	46.00	0.02	44.00	0.02	5.00	0.00
3314	59.00	0.02	9.00	0.00	77.00	0.02	44.00	0.01	5.00	0.00
3414	52.00	0.02	9.00	0.00	46.00	0.02	49.00	0.02	6.00	0.00

4114	56.00	0.02	9.00	0.00	43.00	0.02	43.00	0.02	4.00	0.00
4214	53.00	0.02	7.00	0.00	57.00	0.02	51.00	0.02	5.00	0.00
4314	52.00	0.02	10.00	0.00	26.00	0.01	39.00	0.02	5.00	0.00
1115	49.00	0.02	5.00	0.00	42.00	0.01	36.00	0.01	5.00	0.00
1215	54.00	0.02	6.00	0.00	45.00	0.02	39.00	0.02	5.00	0.00
1315	55.00	0.02	8.00	0.00	77.00	0.02	41.00	0.01	5.00	0.00
1415	52.00	0.01	6.00	0.00	71.00	0.02	44.00	0.01	5.00	0.00
2115	54.00	0.02	5.00	0.00	54.00	0.02	43.00	0.01	5.00	0.00
2215	53.00	0.01	6.00	0.00	51.00	0.01	35.00	0.01	5.00	0.00
2315	56.00	0.02	7.00	0.00	35.00	0.01	40.00	0.01	6.00	0.00
2415	53.00	0.02	7.00	0.00	89.00	0.03	48.00	0.01	6.00	0.00
3115	55.00	0.01	7.00	0.00	48.00	0.01	46.00	0.01	4.00	0.00
3215	49.00	0.01	6.00	0.00	53.00	0.01	38.00	0.01	4.00	0.00
3315	57.00	0.02	8.00	0.00	55.00	0.02	46.00	0.01	5.00	0.00
3415	53.00	0.01	8.00	0.00	37.00	0.01	50.00	0.01	5.00	0.00
4115	52.00	0.01	6.00	0.00	30.00	0.01	36.00	0.01	4.00	0.00
4215	51.00	0.02	6.00	0.00	66.00	0.02	45.00	0.01	4.00	0.00
4315	56.00	0.02	8.00	0.00	26.00	0.01	43.00	0.01	4.00	0.00
1116	52.00	0.02	5.00	0.00	47.00	0.01	44.00	0.01	5.00	0.00
1216	57.00	0.01	9.00	0.00	43.00	0.01	42.00	0.01	5.00	0.00
1316	59.00	0.01	7.00	0.00	66.00	0.02	44.00	0.01	5.00	0.00
1416	56.00	0.02	7.00	0.00	67.00	0.02	54.00	0.02	5.00	0.00
2116	49.00	0.01	6.00	0.00	66.00	0.02	47.00	0.01	5.00	0.00
2216	56.00	0.01	6.00	0.00	50.00	0.01	41.00	0.01	5.00	0.00
2316	58.00	0.02	8.00	0.00	78.00	0.02	41.00	0.01	5.00	0.00
2416	54.00	0.01	7.00	0.00	100.00	0.03	51.00	0.01	5.00	0.00
3116	56.00	0.01	5.00	0.00	53.00	0.01	41.00	0.01	4.00	0.00
3216	48.00	0.01	6.00	0.00	52.00	0.01	37.00	0.01	4.00	0.00
3316	63.00	0.02	8.00	0.00	63.00	0.02	49.00	0.01	5.00	0.00
3416	50.00	0.01	7.00	0.00	42.00	0.01	47.00	0.01	6.00	0.00
4116	54.00	0.02	8.00	0.00	35.00	0.01	40.00	0.01	4.00	0.00

4216	56.00	0.01	8.00	0.00	72.00	0.02	68.00	0.02	5.00	0.00
4316	58.00	0.01	11.00	0.00	30.00	0.01	52.00	0.01	5.00	0.00

Table C.5. Nutrient content lab results and calculations for the Wichita (2018), Surefire (2018), and Surefire-Wichita (2019) studies continued.

Plot	Sub	Sd N (%)	Sd_N_ gsqm	Sd P (%)	Sd_P_ gsqm	Sd K (%)	Sd_K_ gsqm	Sd Mg (%)	Sd_Mg_ gsqm	Sd Ca (%)	Sd_Ca_ gsqm	Sd S (%)	Sd_S_ gsqm
111	a	4.12	6.60	0.75	1.20	0.86	1.38	0.30	0.48	0.54	0.86	0.58	0.93
116	b	4.10	9.38	0.76	1.74	0.86	1.97	0.32	0.73	0.50	1.14	0.52	1.19
203	a	3.88	11.17	0.87	2.50	1.00	2.88	0.36	1.04	0.47	1.35	0.56	1.61
210	b	4.06	6.28	0.73	1.13	0.89	1.38	0.33	0.51	0.46	0.71	0.46	0.71
305	a	3.98	13.76	0.78	2.70	0.90	3.11	0.35	1.21	0.44	1.52	0.41	1.42
326	b	4.01	13.47	0.50	1.68	3.29	11.05	0.28	0.94	1.64	5.51	0.59	1.98
1109	a	3.86	2.29	0.82	0.49	1.13	0.67	0.33	0.20	0.50	0.30	0.49	0.29
1109	b	3.74	7.82	0.76	1.59	1.13	2.36	0.32	0.67	0.56	1.17	0.47	0.98
1209	a	4.16	2.40	0.81	0.47	1.14	0.66	0.30	0.17	0.40	0.23	0.38	0.22
1209	b	3.64	3.34	0.73	0.67	1.02	0.94	0.29	0.27	0.49	0.45	0.41	0.38
2109	a	3.81	2.73	0.93	0.67	1.06	0.76	0.35	0.25	0.47	0.34	0.46	0.33
2109	b	4.09	3.93	0.92	0.88	1.14	1.10	0.34	0.33	0.58	0.56	0.44	0.42
2209	a	3.70	5.68	0.76	1.17	1.12	1.72	0.30	0.46	0.55	0.84	0.44	0.68
2209	b	3.12	2.73	0.80	0.70	1.20	1.05	0.35	0.31	0.65	0.57	0.42	0.37
3109	a	2.82	3.73	0.95	1.26	2.29	3.03	0.25	0.33	0.75	0.99	0.41	0.54
3109	b	2.50	3.12	0.35	0.44	3.10	3.87	0.26	0.32	0.85	1.06	0.38	0.47
3209	a	2.65	2.88	0.54	0.59	3.65	3.97	0.31	0.34	1.10	1.20	0.36	0.39
3209	b	2.35	1.84	0.63	0.49	2.97	2.33	0.22	0.17	1.25	0.98	0.51	0.40
4109	a	0.80	0.99	0.60	0.74	2.85	3.51	0.25	0.31	0.87	1.07	0.43	0.53
4109	b	0.95	0.44	0.75	0.34	3.45	1.58	0.30	0.14	0.99	0.45	0.31	0.14
4209	a	3.65	3.62	0.92	0.91	3.16	3.13	0.28	0.28	1.00	0.99	0.36	0.36
4209	b	3.54	4.01	0.45	0.51	3.21	3.63	0.27	0.31	0.98	1.11	0.41	0.46
1110	a	2.55	4.74	0.48	0.89	2.20	4.09	0.25	0.46	1.03	1.91	0.35	0.65
1110	b	2.01	3.74	0.28	0.52	4.18	7.78	0.33	0.61	1.87	3.48	0.19	0.35
1210	a	4.15	6.06	0.29	0.42	2.28	3.33	0.40	0.58	1.21	1.77	0.29	0.42
1210	b	2.84	3.79	0.33	0.44	5.25	7.01	0.44	0.59	1.90	2.54	0.22	0.29
2110	a	3.25	3.33	0.37	0.38	2.49	2.55	0.44	0.45	1.39	1.43	0.31	0.32

2110 b	2.88	3.62	0.25	0.31	4.45	5.60	0.38	0.48	1.84	2.31	0.17	0.21
2210 a	4.36	5.72	0.35	0.46	2.14	2.81	0.39	0.51	1.31	1.72	0.28	0.37
2210 b	2.57	3.27	0.25	0.32	4.38	5.57	0.39	0.50	1.95	2.48	0.17	0.22
3110 a	4.94	6.70	0.35	0.47	2.22	3.01	0.41	0.56	1.38	1.87	0.28	0.38
3110 b	2.14	3.62	0.26	0.44	4.45	7.52	0.38	0.64	1.73	2.92	0.24	0.41
3210 a	2.58	2.92	0.36	0.41	2.28	2.58	0.47	0.53	1.52	1.72	0.30	0.34
3210 b	2.92	2.90	0.22	0.22	4.52	4.49	0.35	0.35	1.78	1.77	0.45	0.45
4110 a	3.15	4.79	0.38	0.58	2.46	3.74	0.48	0.73	1.60	2.43	0.32	0.49
4110 b	3.03	1.25	0.22	0.09	4.54	1.88	0.39	0.16	1.76	0.73	0.48	0.20
4210 a	4.95	6.94	0.38	0.53	2.47	3.46	0.44	0.62	1.52	2.13	0.31	0.43
4210 b	2.18	2.67	0.31	0.38	4.00	4.90	0.36	0.44	1.78	2.18	0.50	0.61
1112	3.85	3.90	0.80	0.81	1.52	1.54	0.37	0.37	0.39	0.40	0.49	0.50
1212	3.85	3.79	0.79	0.78	1.28	1.26	0.38	0.37	0.39	0.38	0.48	0.47
1312	3.94	3.15	0.76	0.61	1.44	1.15	0.37	0.30	0.37	0.30	0.51	0.41
1412	3.78	6.01	0.77	1.22	1.48	2.35	0.36	0.57	0.40	0.64	0.49	0.78
2112	3.82	5.77	0.73	1.10	1.35	2.04	0.35	0.53	0.38	0.57	0.48	0.73
2212	3.80	5.46	0.76	1.09	1.48	2.13	0.38	0.55	0.38	0.55	0.50	0.72
2312	3.86	3.22	0.77	0.64	1.35	1.13	0.37	0.31	0.36	0.30	0.51	0.43
2412	3.88	2.56	0.81	0.53	1.42	0.94	0.36	0.24	0.42	0.28	0.51	0.34
3112	3.96	3.05	0.76	0.59	1.37	1.06	0.34	0.26	0.45	0.35	0.58	0.45
3212	3.86	3.32	0.71	0.61	1.54	1.33	0.35	0.30	0.39	0.34	0.57	0.49
3312	3.94	2.36	0.75	0.45	1.41	0.84	0.37	0.22	0.38	0.23	0.49	0.29
3412	3.92	1.58	0.79	0.32	1.40	0.56	0.33	0.13	0.44	0.18	0.47	0.19
4112	3.90	1.71	0.77	0.34	1.40	0.61	0.31	0.14	0.40	0.18	0.55	0.24
4212	3.86	5.90	0.76	1.16	1.33	2.03	0.35	0.53	0.40	0.61	0.51	0.78
4312	3.96	2.90	0.79	0.58	1.42	1.04	0.36	0.26	0.38	0.28	0.49	0.36
1113	3.70	10.70	0.80	2.31	1.01	2.92	0.37	1.07	0.39	1.13	0.44	1.27
1213	3.57	13.26	0.71	2.64	1.03	3.83	0.35	1.30	0.36	1.34	0.45	1.67
1313	3.72	13.45	0.73	2.64	1.09	3.94	0.36	1.30	0.34	1.23	0.46	1.66
1413	3.78	11.67	0.76	2.35	1.03	3.18	0.36	1.11	0.38	1.17	0.45	1.39
2113	3.59	16.00	0.74	3.30	1.00	4.46	0.36	1.60	0.39	1.74	0.43	1.92

2213	3.49	12.23	0.72	2.52	1.04	3.65	0.35	1.23	0.35	1.23	0.41	1.44
2313	3.85	11.11	0.75	2.16	1.10	3.17	0.37	1.07	0.39	1.13	0.48	1.39
2413	3.84	9.33	0.76	1.85	1.06	2.58	0.37	0.90	0.39	0.95	0.47	1.14
3113	3.76	8.10	0.71	1.53	1.00	2.15	0.34	0.73	0.41	0.88	0.48	1.03
3213	3.66	10.33	0.72	2.03	1.12	3.16	0.34	0.96	0.41	1.16	0.48	1.35
3313	3.94	11.18	0.74	2.10	1.10	3.12	0.36	1.02	0.41	1.16	0.49	1.39
3413	3.96	7.25	0.81	1.48	1.16	2.12	0.36	0.66	0.40	0.73	0.48	0.88
4113	4.02	4.63	0.79	0.91	1.17	1.35	0.35	0.40	0.39	0.45	0.53	0.61
4213	3.77	11.21	0.79	2.35	1.09	3.24	0.37	1.10	0.42	1.25	0.48	1.43
4313	3.99	10.38	0.78	2.03	1.12	2.91	0.36	0.94	0.40	1.04	0.50	1.30
1114	3.52	17.17	0.74	3.61	0.87	4.24	0.35	1.71	0.41	2.00	0.40	1.95
1214	3.61	15.66	0.69	2.99	0.91	3.95	0.34	1.48	0.33	1.43	0.45	1.95
1314	3.86	15.03	0.74	2.88	0.96	3.74	0.36	1.40	0.35	1.36	0.45	1.75
1414	3.74	16.86	0.76	3.43	0.90	4.06	0.35	1.58	0.39	1.76	0.44	1.98
2114	3.58	17.75	0.68	3.37	0.85	4.22	0.34	1.69	0.37	1.83	0.42	2.08
2214	3.60	19.19	0.72	3.84	0.94	5.01	0.35	1.87	0.32	1.71	0.46	2.45
2314	3.85	9.80	0.71	1.81	0.96	2.44	0.35	0.89	0.34	0.87	0.48	1.22
2414	3.99	13.35	0.76	2.54	0.94	3.14	0.36	1.20	0.36	1.20	0.45	1.51
3114	3.62	18.22	0.66	3.32	0.83	4.18	0.32	1.61	0.43	2.16	0.44	2.21
3214	3.68	15.38	0.73	3.05	1.00	4.18	0.34	1.42	0.38	1.59	0.46	1.92
3314	3.96	14.22	0.75	2.69	0.97	3.48	0.36	1.29	0.37	1.33	0.48	1.72
3414	3.84	16.45	0.78	3.34	0.96	4.11	0.35	1.50	0.42	1.80	0.42	1.80
4114	3.76	16.53	0.74	3.25	0.96	4.22	0.34	1.49	0.38	1.67	0.46	2.02
4214	3.62	14.95	0.74	3.06	0.91	3.76	0.34	1.40	0.43	1.78	0.44	1.82
4314	3.97	19.60	0.75	3.70	0.98	4.84	0.34	1.68	0.37	1.83	0.47	2.32
1115	3.61	13.23	0.72	2.64	0.83	3.04	0.34	1.25	0.41	1.50	0.41	1.50
1215	3.83	19.94	0.70	3.64	0.88	4.58	0.34	1.77	0.38	1.98	0.44	2.29
1315	3.82	14.08	0.72	2.65	0.90	3.32	0.34	1.25	0.35	1.29	0.43	1.58
1415	3.93	13.20	0.72	2.42	0.82	2.75	0.33	1.11	0.40	1.34	0.43	1.44
2115	3.62	13.87	0.70	2.68	0.79	3.03	0.34	1.30	0.40	1.53	0.43	1.65
2215	3.69	11.61	0.74	2.33	0.91	2.86	0.35	1.10	0.37	1.16	0.44	1.38

2315	4.05	15.78	0.71	2.77	0.91	3.55	0.32	1.25	0.34	1.32	0.43	1.68
2415	3.96	14.40	0.66	2.40	0.76	2.76	0.32	1.16	0.34	1.24	0.39	1.42
3115	3.83	10.65	0.67	1.86	0.81	2.25	0.32	0.89	0.39	1.08	0.40	1.11
3215	3.90	9.73	0.66	1.65	0.87	2.17	0.31	0.77	0.33	0.82	0.44	1.10
3315	4.06	15.42	0.63	2.39	0.78	2.96	0.30	1.14	0.32	1.22	0.43	1.63
3415	3.91	10.66	0.68	1.85	0.81	2.21	0.31	0.85	0.37	1.01	0.36	0.98
4115	3.89	12.30	0.68	2.15	0.83	2.62	0.31	0.98	0.35	1.11	0.40	1.26
4215	3.82	15.12	0.64	2.53	0.75	2.97	0.30	1.19	0.35	1.39	0.38	1.50
4315	4.03	14.66	0.70	2.55	0.83	3.02	0.30	1.09	0.34	1.24	0.40	1.45
1116	3.46	11.92	0.62	2.14	0.72	2.48	0.30	1.03	0.41	1.41	0.33	1.14
1216	3.92	11.09	0.61	1.73	0.77	2.18	0.29	0.82	0.33	0.93	0.40	1.13
1316	3.70	11.82	0.65	2.08	0.81	2.59	0.31	0.99	0.31	0.99	0.34	1.09
1416	3.66	15.33	0.60	2.51	0.75	3.14	0.28	1.17	0.38	1.59	0.35	1.47
2116	3.41	11.99	0.56	1.97	0.73	2.57	0.29	1.02	0.44	1.55	0.34	1.20
2216	3.72	10.51	0.64	1.81	0.82	2.32	0.31	0.88	0.31	0.88	0.36	1.02
2316	3.53	13.21	0.61	2.28	0.79	2.96	0.29	1.09	0.37	1.39	0.38	1.42
2416	3.67	11.86	0.59	1.91	0.77	2.49	0.30	0.97	0.39	1.26	0.37	1.20
3116	3.58	8.15	0.63	1.43	0.79	1.80	0.29	0.66	0.42	0.96	0.35	0.80
3216	3.54	10.91	0.57	1.76	0.79	2.43	0.27	0.83	0.36	1.11	0.35	1.08
3316	3.83	12.71	0.61	2.02	0.87	2.89	0.29	0.96	0.38	1.26	0.37	1.23
3416	4.04	13.59	0.70	2.36	0.81	2.73	0.32	1.08	0.32	1.08	0.39	1.31
4116	3.70	12.13	0.60	1.97	0.82	2.69	0.27	0.89	0.40	1.31	0.37	1.21
4216	3.65	9.98	0.63	1.72	0.77	2.11	0.29	0.79	0.41	1.12	0.37	1.01
4316	3.91	10.43	0.64	1.71	0.83	2.21	0.26	0.69	0.40	1.07	0.37	0.99

Table C.6. Nutrient content lab results and calculations for the Wichita (2018), Surefire (2018), and Surefire-Wichita (2019) studies continued.

Plot	Sub	Sd B (ppm)	Sd_B_ gsqm	Sd Zn (ppm)	Sd_Zn_ gsqm	Sd Mn (ppm)	Sd_Mn_ gsqm	Sd Fe (ppm)	Sd_Fe_ gsqm	Sd Cu (ppm)	Sd_Cu_ gsqm
111	a	15.14	0.00	41.88	0.01	38.46	0.01	86.50	0.01	3.02	0.00
116	b	14.19	0.00	35.88	0.01	38.67	0.01	94.87	0.02	2.63	0.00
203	a	14.45	0.00	38.48	0.01	40.26	0.01	84.33	0.02	3.11	0.00
210	b	15.29	0.00	34.13	0.01	39.26	0.01	93.69	0.01	2.96	0.00
305	a	17.22	0.01	33.88	0.01	36.97	0.01	85.80	0.03	2.58	0.00
326	b	24.15	0.01	33.15	0.01	73.20	0.02	552.37	0.19	4.61	0.00
1109	a	14.28	0.00	37.34	0.00	41.34	0.00	95.57	0.01	3.74	0.00
1109	b	16.06	0.00	36.40	0.01	42.98	0.01	87.67	0.02	3.63	0.00
1209	a	10.73	0.00	37.48	0.00	30.83	0.00	77.19	0.00	2.74	0.00
1209	b	12.01	0.00	34.12	0.00	36.24	0.00	77.18	0.01	3.45	0.00
2109	a	11.13	0.00	38.77	0.00	38.73	0.00	87.53	0.01	3.01	0.00
2109	b	14.87	0.00	41.57	0.00	40.20	0.00	86.53	0.01	3.70	0.00
2209	a	17.12	0.00	35.47	0.01	39.62	0.01	120.21	0.02	3.90	0.00
2209	b	25.90	0.00	27.35	0.00	51.06	0.00	64.76	0.01	0.95	0.00
3109	a	26.87	0.00	24.25	0.00	52.14	0.01	56.16	0.01	4.15	0.00
3109	b	31.49	0.00	27.45	0.00	51.89	0.01	75.15	0.01	5.00	0.00
3209	a	29.40	0.00	23.42	0.00	39.21	0.00	89.00	0.01	3.57	0.00
3209	b	27.54	0.00	26.79	0.00	49.74	0.00	65.01	0.01	3.25	0.00
4109	a	24.38	0.00	27.88	0.00	50.07	0.01	71.25	0.01	4.25	0.00
4109	b	28.06	0.00	24.98	0.00	46.29	0.00	61.10	0.00	4.15	0.00
4209	a	28.20	0.00	22.59	0.00	48.34	0.00	62.61	0.01	3.51	0.00
4209	b	17.23	0.00	24.97	0.00	54.41	0.01	88.15	0.01	3.58	0.00
1110	a	19.32	0.00	24.80	0.00	55.21	0.01	65.78	0.01	4.24	0.00
1110	b	41.69	0.01	27.16	0.01	58.60	0.01	119.00	0.02	10.42	0.00
1210	a	42.57	0.01	38.10	0.01	95.18	0.01	78.25	0.01	11.10	0.00
1210	b	43.03	0.01	45.31	0.01	37.40	0.00	80.15	0.01	15.86	0.00
2110	a	54.19	0.01	47.28	0.00	73.85	0.01	95.75	0.01	12.90	0.00

2110 b	39.34	0.00	30.76	0.00	37.51	0.00	115.00	0.01	13.19	0.00
2210 a	53.86	0.01	41.09	0.01	42.15	0.01	44.25	0.01	12.86	0.00
2210 b	41.93	0.01	28.22	0.00	36.26	0.00	54.75	0.01	11.56	0.00
3110 a	57.11	0.01	47.03	0.01	55.65	0.01	62.05	0.01	12.43	0.00
3110 b	41.50	0.01	28.55	0.00	45.11	0.01	98.05	0.02	10.09	0.00
3210 a	45.08	0.01	36.72	0.00	76.54	0.01	71.15	0.01	11.94	0.00
3210 b	46.11	0.00	34.12	0.00	56.24	0.01	63.50	0.01	11.70	0.00
4110 a	60.69	0.01	41.50	0.01	76.15	0.01	55.14	0.01	12.13	0.00
4110 b	40.82	0.00	30.32	0.00	48.46	0.00	47.65	0.00	8.86	0.00
4210 a	76.17	0.01	43.14	0.01	65.25	0.01	70.35	0.01	11.60	0.00
4210 b	50.74	0.01	32.92	0.00	37.99	0.00	65.15	0.01	11.79	0.00
1112	19.00	0.00	44.00	0.00	42.00	0.00	151.00	0.02	6.00	0.00
1212	18.00	0.00	48.00	0.00	45.00	0.00	134.00	0.01	5.00	0.00
1312	20.00	0.00	51.00	0.00	50.00	0.00	180.00	0.01	6.00	0.00
1412	19.00	0.00	48.00	0.01	44.00	0.01	119.00	0.02	6.00	0.00
2112	19.00	0.00	39.00	0.01	41.00	0.01	130.00	0.02	6.00	0.00
2212	21.00	0.00	38.00	0.01	40.00	0.01	110.00	0.02	5.00	0.00
2312	18.00	0.00	48.00	0.00	44.00	0.00	209.00	0.02	4.00	0.00
2412	19.00	0.00	54.00	0.00	48.00	0.00	209.00	0.01	6.00	0.00
3112	19.00	0.00	43.00	0.00	42.00	0.00	102.00	0.01	5.00	0.00
3212	23.00	0.00	39.00	0.00	41.00	0.00	144.00	0.01	5.00	0.00
3312	20.00	0.00	50.00	0.00	46.00	0.00	101.00	0.01	5.00	0.00
3412	21.00	0.00	57.00	0.00	42.00	0.00	198.00	0.01	7.00	0.00
4112	20.00	0.00	43.00	0.00	40.00	0.00	128.00	0.01	4.00	0.00
4212	18.00	0.00	43.00	0.01	43.00	0.01	208.00	0.03	5.00	0.00
4312	22.00	0.00	54.00	0.00	38.00	0.00	94.00	0.01	6.00	0.00
1113	15.00	0.00	41.00	0.01	49.00	0.01	87.00	0.03	5.00	0.00
1213	18.00	0.01	36.00	0.01	45.00	0.02	79.00	0.03	4.00	0.00
1313	18.00	0.01	40.00	0.01	54.00	0.02	89.00	0.03	4.00	0.00
1413	16.00	0.00	42.00	0.01	51.00	0.02	81.00	0.03	4.00	0.00
2113	14.00	0.01	33.00	0.01	47.00	0.02	81.00	0.04	4.00	0.00

2213	14.00	0.00	33.00	0.01	45.00	0.02	73.00	0.03	4.00	0.00
2313	19.00	0.01	38.00	0.01	51.00	0.01	79.00	0.02	4.00	0.00
2413	15.00	0.00	43.00	0.01	52.00	0.01	97.00	0.02	4.00	0.00
3113	13.00	0.00	35.00	0.01	48.00	0.01	83.00	0.02	4.00	0.00
3213	19.00	0.01	34.00	0.01	48.00	0.01	90.00	0.03	4.00	0.00
3313	22.00	0.01	43.00	0.01	55.00	0.02	85.00	0.02	5.00	0.00
3413	17.00	0.00	43.00	0.01	44.00	0.01	83.00	0.02	5.00	0.00
4113	14.00	0.00	35.00	0.00	44.00	0.01	82.00	0.01	3.00	0.00
4213	15.00	0.00	39.00	0.01	55.00	0.02	88.00	0.03	4.00	0.00
4313	18.00	0.00	45.00	0.01	42.00	0.01	84.00	0.02	4.00	0.00
1114	12.00	0.01	32.00	0.02	48.00	0.02	76.00	0.04	3.00	0.00
1214	12.00	0.01	34.00	0.01	46.00	0.02	80.00	0.03	3.00	0.00
1314	13.00	0.01	37.00	0.01	53.00	0.02	80.00	0.03	4.00	0.00
1414	12.00	0.01	39.00	0.02	54.00	0.02	86.00	0.04	4.00	0.00
2114	11.00	0.01	31.00	0.02	49.00	0.02	77.00	0.04	3.00	0.00
2214	12.00	0.01	35.00	0.02	45.00	0.02	80.00	0.04	3.00	0.00
2314	12.00	0.00	36.00	0.01	48.00	0.01	74.00	0.02	3.00	0.00
2414	11.00	0.00	40.00	0.01	56.00	0.02	81.00	0.03	3.00	0.00
3114	11.00	0.01	30.00	0.02	48.00	0.02	70.00	0.04	3.00	0.00
3214	13.00	0.01	31.00	0.01	47.00	0.02	75.00	0.03	3.00	0.00
3314	14.00	0.01	38.00	0.01	55.00	0.02	87.00	0.03	3.00	0.00
3414	12.00	0.01	38.00	0.02	49.00	0.02	82.00	0.04	4.00	0.00
4114	15.00	0.01	33.00	0.01	45.00	0.02	75.00	0.03	2.00	0.00
4214	13.00	0.01	33.00	0.01	52.00	0.02	74.00	0.03	3.00	0.00
4314	13.00	0.01	37.00	0.02	42.00	0.02	80.00	0.04	3.00	0.00
1115	12.00	0.00	31.00	0.01	47.00	0.02	74.00	0.03	3.00	0.00
1215	12.00	0.01	33.00	0.02	50.00	0.03	81.00	0.04	3.00	0.00
1315	14.00	0.01	33.00	0.01	55.00	0.02	78.00	0.03	3.00	0.00
1415	10.00	0.00	37.00	0.01	53.00	0.02	86.00	0.03	3.00	0.00
2115	12.00	0.00	30.00	0.01	50.00	0.02	76.00	0.03	3.00	0.00
2215	14.00	0.00	35.00	0.01	47.00	0.01	74.00	0.02	3.00	0.00

2315	12.00	0.00	35.00	0.01	44.00	0.02	73.00	0.03	4.00	0.00
2415	10.00	0.00	35.00	0.01	49.00	0.02	71.00	0.03	3.00	0.00
3115	12.00	0.00	30.00	0.01	47.00	0.01	72.00	0.02	3.00	0.00
3215	11.00	0.00	28.00	0.01	44.00	0.01	63.00	0.02	3.00	0.00
3315	11.00	0.00	34.00	0.01	43.00	0.02	66.00	0.03	3.00	0.00
3415	10.00	0.00	33.00	0.01	42.00	0.01	64.00	0.02	4.00	0.00
4115	11.00	0.00	35.00	0.01	41.00	0.01	85.00	0.03	13.00	0.00
4215	12.00	0.00	30.00	0.01	46.00	0.02	66.00	0.03	3.00	0.00
4315	11.00	0.00	33.00	0.01	37.00	0.01	67.00	0.02	3.00	0.00
1116	12.00	0.00	27.00	0.01	43.00	0.01	79.00	0.03	3.00	0.00
1216	12.00	0.00	33.00	0.01	39.00	0.01	90.00	0.03	3.00	0.00
1316	10.00	0.00	30.00	0.01	45.00	0.01	87.00	0.03	3.00	0.00
1416	15.00	0.01	33.00	0.01	45.00	0.02	94.00	0.04	3.00	0.00
2116	12.00	0.00	25.00	0.01	47.00	0.02	66.00	0.02	4.00	0.00
2216	11.00	0.00	30.00	0.01	42.00	0.01	81.00	0.02	3.00	0.00
2316	12.00	0.00	29.00	0.01	47.00	0.02	87.00	0.03	3.00	0.00
2416	12.00	0.00	30.00	0.01	53.00	0.02	74.00	0.02	4.00	0.00
3116	12.00	0.00	28.00	0.01	45.00	0.01	70.00	0.02	3.00	0.00
3216	11.00	0.00	23.00	0.01	42.00	0.01	59.00	0.02	2.00	0.00
3316	14.00	0.00	31.00	0.01	48.00	0.02	102.00	0.03	3.00	0.00
3416	9.00	0.00	36.00	0.01	39.00	0.01	68.00	0.02	3.00	0.00
4116	13.00	0.00	27.00	0.01	40.00	0.01	61.00	0.02	3.00	0.00
4216	10.00	0.00	28.00	0.01	47.00	0.01	82.00	0.02	3.00	0.00
4316	12.00	0.00	27.00	0.01	36.00	0.01	60.00	0.02	3.00	0.00

Table C.7. Nutrient content lab results and calculations for the Wichita (2018), Surefire (2018), and Surefire-Wichita (2019) studies continued.

Plot	Sub	VgPdSd_ N_gsqm	VgPdSd_ P_gsqm	VgPdSd_ K_gsqm	VgPdSd_ Mg_gsqm	VgPdSd_ Ca_gsqm	VgPdSd_ S_gsqm	VgPdSd_ B_gsqm	VgPdSd_ Zn_gsqm	VgPdSd_ Mn_gsqm	VgPdSd_ Fe_gsqm	VgPdSd_ Cu_gsqm
108	a	5.22	0.65	3.80	0.38	2.93	1.07	0.00	0.01	0.01	0.05	0.00
118	b	6.45	0.80	4.71	0.44	3.69	1.25	0.00	0.01	0.01	0.05	0.00
206	a	7.05	0.80	4.84	0.44	3.22	1.18	0.00	0.01	0.01	0.06	0.00
226	b	7.42	0.82	5.28	0.50	3.66	1.34	0.01	0.01	0.01	0.07	0.00
306	a	5.67	0.69	4.39	0.38	2.83	1.05	0.00	0.01	0.01	0.04	0.00
321	b	6.51	0.84	4.93	0.46	3.25	1.20	0.01	0.01	0.01	0.03	0.00
103	a	7.17	0.71	5.53	0.47	4.37	1.45	0.00	0.01	0.01	0.06	0.00
104	b	6.26	0.64	5.05	0.46	4.08	1.26	0.00	0.01	0.01	0.05	0.00
208	a	4.66	0.61	3.94	0.39	3.32	1.07	0.00	0.01	0.01	0.05	0.00
222	b	5.61	0.63	4.51	0.45	3.81	1.28	0.00	0.01	0.01	0.03	0.00
317	a	6.88	0.86	5.87	0.56	4.50	1.45	0.01	0.01	0.01	0.03	0.00
325	b	7.01	0.92	6.02	0.59	4.55	1.49	0.01	0.01	0.01	0.04	0.00
113	a	7.81	1.02	7.09	0.62	5.24	1.92	0.01	0.01	0.01	0.09	0.00
114	b	7.88	1.08	7.66	0.63	4.90	1.95	0.01	0.01	0.02	0.14	0.00
201	a	7.97	1.13	8.63	0.64	5.12	1.85	0.01	0.01	0.02	0.15	0.00
215	b	6.40	0.72	5.72	0.50	4.37	1.55	0.00	0.01	0.01	0.10	0.00
323	a	9.08	1.14	8.16	0.67	5.04	1.64	0.01	0.01	0.01	0.09	0.00
324	b	8.75	1.14	8.20	0.68	4.86	1.71	0.01	0.01	0.01	0.08	0.00
101	a	8.86	1.08	10.04	0.66	5.74	1.94	0.01	0.01	0.01	0.05	0.00
119	b	14.46	2.08	16.90	1.24	11.47	4.00	0.01	0.02	0.02	0.08	0.00
219	a	11.67	1.58	14.59	1.07	9.33	3.36	0.01	0.01	0.02	0.06	0.00
225	b	11.50	1.60	14.76	1.00	7.84	2.73	0.01	0.01	0.02	0.07	0.00
308	a	10.08	1.60	12.97	1.02	8.65	2.04	0.01	0.01	0.02	0.05	0.00
320	b	9.55	1.56	12.68	0.92	7.56	2.24	0.01	0.01	0.02	0.05	0.00
127	a	14.41	1.87	16.67	1.11	10.09	3.44	0.01	0.01	0.02	0.04	0.00
128	b	21.40	3.25	29.86	1.92	16.05	5.84	0.02	0.02	0.03	0.06	0.00
202	a	11.54	2.27	18.15	1.11	9.20	3.58	0.01	0.01	0.02	0.04	0.00

218 b	13.71	1.77	14.88	1.11	10.76	3.41	0.01	0.01	0.02	0.04	0.00
314 a	10.17	1.70	12.39	0.90	7.48	2.48	0.01	0.01	0.01	0.03	0.00
318 b	17.81	2.12	18.39	1.32	11.48	3.45	0.01	0.01	0.02	0.04	0.00
112 a	18.21	2.27	19.80	1.39	10.63	3.81	0.02	0.02	0.03	0.05	0.00
123 b	19.83	2.57	21.16	1.59	12.37	4.26	0.02	0.02	0.03	0.04	0.00
204 a	28.71	4.04	30.28	2.27	18.83	6.32	0.02	0.02	0.04	0.06	0.00
217 b	13.00	1.87	16.75	1.24	10.86	3.18	0.01	0.01	0.02	0.04	0.00
302 a	17.36	2.91	20.06	1.53	12.80	3.99	0.02	0.02	0.03	0.05	0.00
315 b	14.84	2.47	17.26	1.35	11.87	1.79	0.01	0.01	0.03	0.04	0.00
102 a	16.78	2.67	17.16	1.44	11.56	3.84	0.02	0.02	0.02	0.04	0.00
120 b	15.46	2.53	16.45	1.56	13.04	4.00	0.01	0.01	0.03	0.04	0.00
224 a	10.62	1.78	14.10	1.08	8.10	2.79	0.01	0.01	0.02	0.03	0.00
229 b	18.98	2.76	20.17	1.71	13.93	4.58	0.02	0.02	0.03	0.04	0.00
313 a	13.79	2.62	18.31	1.49	11.24	3.85	0.02	0.01	0.02	0.04	0.00
330 b	19.12	2.98	23.78	1.81	17.47	6.25	0.02	0.02	0.04	0.06	0.00
110 a	14.48	2.10	16.42	1.52	14.08	5.16	0.02	0.01	0.03	0.05	0.00
130 b	30.15	4.66	31.18	3.27	29.96	8.54	0.03	0.03	0.06	0.10	0.00
211 a	14.56	2.28	17.06	1.66	12.88	3.83	0.02	0.01	0.03	0.04	0.00
227 b	17.97	2.89	24.03	1.91	16.25	4.17	0.02	0.02	0.03	0.06	0.00
319 a	17.21	3.24	23.90	1.89	15.78	4.08	0.03	0.02	0.03	0.05	0.00
329 b	21.13	1.92	27.59	1.78	25.86	8.38	0.03	0.01	0.05	0.05	0.00
111 a	10.68	2.05	16.22	1.38	11.54	5.59	0.01	0.01	0.03	0.04	0.00
116 b	15.18	2.36	17.86	1.51	12.69	5.60	0.02	0.01	0.02	0.04	0.00
203 a	16.27	3.35	20.89	1.99	12.44	4.51	0.02	0.02	0.03	0.05	0.00
210 b	9.41	1.53	12.08	1.07	8.00	2.84	0.01	0.01	0.02	0.03	0.00
305 a	19.64	3.60	27.82	2.25	15.42	6.13	0.03	0.02	0.03	0.06	0.00
326 b	20.76	4.73	25.46	2.26	11.39	5.46	0.02	0.03	0.05	0.23	0.00
1101 a	4.14	0.50	3.64	0.27	1.83	0.56	0.00	0.00	0.01	0.05	0.00
1101 b	2.65	0.34	2.11	0.18	1.27	0.36	0.00	0.00	0.00	0.02	0.00
1201 a	0.58	0.06	0.39	0.03	0.23	0.07	0.00	0.00	0.00	0.00	0.00
1201 b	0.94	0.11	0.79	0.06	0.42	0.14	0.00	0.00	0.00	0.01	0.00

2101 a	2.45	0.32	2.11	0.16	1.02	0.33	0.00	0.00	0.01	0.02	0.00
2101 b	4.24	0.49	2.95	0.26	1.68	0.57	0.00	0.00	0.01	0.05	0.00
2201 a	2.12	0.27	1.76	0.14	0.85	0.31	0.00	0.00	0.00	0.02	0.00
2201 b	1.86	0.24	1.55	0.14	0.86	0.30	0.00	0.00	0.00	0.02	0.00
3101 a	2.94	0.35	2.37	0.21	1.23	0.43	0.00	0.00	0.01	0.03	0.00
3101 b	1.87	0.21	1.34	0.11	0.65	0.23	0.00	0.00	0.00	0.01	0.00
3201 a	2.04	0.24	1.57	0.12	0.76	0.27	0.00	0.00	0.00	0.02	0.00
3201 b	1.89	0.22	1.63	0.13	0.77	0.28	0.00	0.00	0.00	0.02	0.00
4101 a	1.64	0.17	1.26	0.10	0.58	0.21	0.00	0.00	0.00	0.02	0.00
4101 b	2.05	0.25	1.77	0.14	0.80	0.28	0.00	0.00	0.00	0.02	0.00
4201 a	2.06	0.22	1.60	0.13	0.76	0.29	0.00	0.00	0.00	0.02	0.00
4201 b	1.26	0.14	0.90	0.08	0.49	0.17	0.00	0.00	0.00	0.01	0.00
1102 a	3.45	0.49	3.48	0.27	1.67	0.50	0.00	0.00	0.01	0.04	0.00
1102 b	4.29	0.61	3.79	0.35	2.26	0.69	0.00	0.00	0.01	0.04	0.00
1202 a	0.96	0.13	0.81	0.07	0.43	0.15	0.00	0.00	0.00	0.01	0.00
1202 b	1.56	0.25	1.71	0.14	0.91	0.29	0.00	0.00	0.00	0.02	0.00
2102 a	2.17	0.26	1.79	0.14	0.86	0.26	0.00	0.00	0.00	0.02	0.00
2102 b	3.70	0.41	2.58	0.22	1.42	0.47	0.00	0.00	0.01	0.02	0.00
2202 a	2.35	0.38	2.24	0.20	1.20	0.43	0.00	0.00	0.01	0.03	0.00
2202 b	1.50	0.24	1.70	0.12	0.69	0.27	0.00	0.00	0.00	0.01	0.00
3102 a	2.52	0.35	2.34	0.18	1.10	0.45	0.00	0.00	0.01	0.02	0.00
3102 b	2.36	0.30	2.10	0.17	1.08	0.37	0.00	0.00	0.01	0.03	0.00
3202 a	1.65	0.22	1.51	0.12	0.71	0.28	0.00	0.00	0.00	0.02	0.00
3202 b	1.60	0.24	1.62	0.12	0.73	0.30	0.00	0.00	0.00	0.02	0.00
4102 a	1.88	0.24	1.67	0.16	0.97	0.39	0.00	0.00	0.00	0.02	0.00
4102 b	2.60	0.30	2.40	0.20	1.18	0.44	0.00	0.00	0.01	0.02	0.00
4202 a	1.95	0.24	1.79	0.14	0.82	0.30	0.00	0.00	0.00	0.03	0.00
4202 b	1.82	0.23	1.74	0.12	0.74	0.31	0.00	0.00	0.00	0.02	0.00
1103 a	3.57	0.54	3.96	0.33	1.95	0.66	0.00	0.00	0.01	0.06	0.00
1103 b	4.45	0.58	4.75	0.33	1.96	0.63	0.00	0.00	0.01	0.07	0.00
1203 a	2.15	0.26	1.96	0.17	1.09	0.29	0.00	0.00	0.00	0.04	0.00

1203 b	2.04	0.24	1.77	0.15	0.95	0.29	0.00	0.00	0.00	0.03	0.00
2103 a	5.32	0.81	5.80	0.44	2.80	0.98	0.00	0.01	0.01	0.07	0.00
2103 b	4.41	0.56	4.23	0.31	2.06	0.62	0.00	0.00	0.01	0.04	0.00
2203 a	2.66	0.34	2.55	0.22	1.39	0.43	0.00	0.00	0.00	0.02	0.00
2203 b	3.19	0.37	2.90	0.23	1.41	0.48	0.00	0.00	0.01	0.04	0.00
3103 a	4.80	0.61	4.48	0.34	2.08	0.74	0.00	0.00	0.01	0.05	0.00
3103 b	4.60	0.49	4.04	0.29	1.77	0.56	0.00	0.00	0.01	0.04	0.00
3203 a	4.55	0.52	4.69	0.29	1.93	0.62	0.00	0.00	0.01	0.04	0.00
3203 b	3.37	0.45	3.77	0.28	1.64	0.58	0.00	0.00	0.01	0.05	0.00
4103 a	3.19	0.36	3.12	0.25	1.46	0.44	0.00	0.00	0.01	0.04	0.00
4103 b	4.02	0.44	3.80	0.28	1.68	0.53	0.00	0.00	0.01	0.04	0.00
4203 a	2.45	0.28	2.46	0.19	1.08	0.33	0.00	0.00	0.00	0.03	0.00
4203 b	3.18	0.42	3.74	0.26	1.54	0.48	0.00	0.00	0.01	0.03	0.00
1104 a	5.81	0.68	5.72	0.42	2.58	0.86	0.00	0.00	0.01	0.11	0.00
1104 b	6.53	1.00	8.60	0.58	3.44	1.26	0.00	0.01	0.02	0.07	0.00
1204 a	2.69	0.40	3.39	0.20	1.24	0.35	0.00	0.00	0.01	0.03	0.00
1204 b	2.48	0.30	2.02	0.16	1.21	0.35	0.00	0.00	0.00	0.04	0.00
2104 a	5.70	1.00	7.40	0.48	3.20	1.21	0.00	0.01	0.01	0.05	0.00
2104 b	4.76	0.69	5.32	0.33	2.32	0.71	0.00	0.00	0.01	0.05	0.00
2204 a	6.25	0.99	7.88	0.50	2.91	1.07	0.00	0.01	0.01	0.06	0.00
2204 b	5.01	0.69	4.53	0.36	2.37	0.91	0.00	0.00	0.01	0.06	0.00
3104 a	7.07	1.00	8.18	0.50	3.10	1.26	0.00	0.01	0.02	0.04	0.00
3104 b	3.89	0.60	5.16	0.32	2.11	0.71	0.00	0.00	0.01	0.04	0.00
3204 a	7.56	1.07	9.02	0.57	3.43	1.13	0.00	0.01	0.01	0.08	0.00
3204 b	3.50	0.53	4.66	0.29	1.84	0.63	0.00	0.00	0.01	0.03	0.00
4104 a	7.16	0.99	9.44	0.58	3.71	1.29	0.00	0.01	0.02	0.05	0.00
4104 b	2.72	0.30	3.04	0.19	1.19	0.39	0.00	0.00	0.01	0.03	0.00
4204 a	6.64	0.95	8.26	0.53	3.07	1.05	0.00	0.01	0.01	0.05	0.00
4204 b	3.95	0.51	4.40	0.28	1.77	0.68	0.00	0.00	0.01	0.03	0.00
1105 a	9.90	1.67	14.26	0.77	4.16	1.56	0.01	0.01	0.02	0.03	0.00
1105 b	15.74	2.33	20.13	1.11	6.31	1.78	0.01	0.01	0.03	0.05	0.00

1205 a	1.58	0.22	1.52	0.12	1.02	0.23	0.00	0.00	0.00	0.01	0.00
1205 b	7.99	1.20	9.37	0.46	3.50	1.32	0.00	0.01	0.01	0.02	0.00
2105 a	9.78	2.04	14.85	0.87	6.41	2.16	0.01	0.01	0.03	0.03	0.00
2105 b	8.08	1.39	11.68	0.56	3.76	1.04	0.01	0.01	0.02	0.03	0.00
2205 a	8.25	1.27	12.28	0.54	2.71	0.98	0.01	0.01	0.01	0.02	0.00
2205 b	9.02	1.50	11.10	0.65	4.01	1.47	0.01	0.01	0.02	0.03	0.00
3105 a	4.52	0.72	6.75	0.28	1.80	0.70	0.00	0.00	0.01	0.02	0.00
3105 b	2.17	0.27	2.34	0.14	1.02	0.25	0.00	0.00	0.00	0.01	0.00
3205 a	8.80	1.43	12.27	0.64	4.14	1.33	0.01	0.01	0.02	0.02	0.00
3205 b	8.86	1.40	11.77	0.63	3.77	1.46	0.01	0.01	0.02	0.03	0.00
4105 a	8.56	1.28	11.67	0.63	3.46	1.41	0.01	0.01	0.02	0.02	0.00
4105 b	8.70	1.09	9.97	0.52	3.40	1.10	0.01	0.01	0.02	0.03	0.00
4205 a	9.49	1.49	13.27	0.73	4.67	1.46	0.01	0.01	0.02	0.03	0.00
4205 b	5.77	0.95	8.45	0.45	2.77	1.08	0.00	0.01	0.01	0.02	0.00
1106 a	18.05	3.08	24.23	1.48	8.14	2.52	0.02	0.01	0.04	0.05	0.00
1106 b	11.94	2.16	16.76	0.91	5.27	1.55	0.01	0.01	0.02	0.04	0.00
1206 a	2.50	0.38	2.91	0.15	1.23	0.35	0.00	0.00	0.00	0.02	0.00
1206 b	3.61	0.68	4.91	0.23	1.45	0.58	0.00	0.00	0.01	0.02	0.00
2106 a	10.31	1.87	14.03	0.85	5.31	1.48	0.01	0.01	0.02	0.03	0.00
2106 b	10.23	1.78	13.75	0.72	4.99	1.32	0.01	0.01	0.02	0.03	0.00
2206 a	8.40	1.39	11.64	0.60	3.71	1.17	0.01	0.01	0.01	0.02	0.00
2206 b	8.14	1.43	10.23	0.59	3.92	1.33	0.01	0.01	0.02	0.03	0.00
3106 a	5.59	0.85	7.29	0.43	2.54	0.89	0.00	0.01	0.01	0.03	0.00
3206 a	7.50	1.25	12.89	0.65	4.48	1.09	0.01	0.01	0.02	0.03	0.00
3206 b	8.00	1.27	9.79	0.61	3.51	1.03	0.01	0.01	0.02	0.03	0.00
4106 a	8.61	1.31	11.04	0.68	4.25	1.32	0.01	0.01	0.02	0.02	0.00
4106 b	8.18	1.04	10.81	0.59	3.12	1.09	0.00	0.01	0.01	0.03	0.00
4206 a	8.37	1.33	11.89	0.64	3.85	1.01	0.01	0.01	0.02	0.02	0.00
4206 b	10.07	1.77	15.42	0.92	5.96	1.88	0.01	0.01	0.03	0.03	0.00
1107 a	6.61	1.40	10.22	0.61	3.31	0.91	0.01	0.01	0.01	0.02	0.00
1107 b	14.28	2.51	18.97	1.19	7.07	1.59	0.01	0.01	0.03	0.04	0.00

1207 b	12.20	2.22	16.50	0.92	4.70	1.52	0.01	0.01	0.02	0.03	0.00
2107 a	8.81	1.73	11.72	0.72	4.03	1.40	0.01	0.01	0.02	0.02	0.00
2107 b	8.78	2.01	13.72	0.75	4.15	1.16	0.01	0.01	0.02	0.03	0.00
2207 a	9.52	2.13	15.23	0.80	4.60	1.39	0.01	0.01	0.02	0.03	0.00
2207 b	8.14	1.96	12.15	0.85	5.60	2.01	0.01	0.01	0.02	0.04	0.00
3107 a	7.95	1.30	10.60	0.59	3.70	1.27	0.01	0.01	0.02	0.03	0.00
3207 a	9.51	1.71	13.14	0.85	5.18	1.13	0.01	0.01	0.02	0.03	0.00
3207 b	6.45	1.38	10.83	0.64	3.35	1.02	0.01	0.01	0.01	0.02	0.00
4107 a	9.09	1.56	12.09	0.90	5.20	1.75	0.01	0.01	0.03	0.03	0.00
4107 b	8.08	1.16	10.10	0.69	4.34	1.06	0.01	0.01	0.02	0.03	0.00
4207 a	13.44	2.14	17.15	1.16	7.63	1.60	0.01	0.01	0.03	0.04	0.00
4207 b	6.01	1.29	10.07	0.62	2.95	1.09	0.01	0.01	0.02	0.02	0.00
1108 a	8.98	1.71	13.13	0.89	6.13	1.41	0.01	0.01	0.03	0.03	0.00
1108 b	7.89	1.60	11.62	0.80	4.81	1.03	0.01	0.01	0.02	0.03	0.00
1208 a	6.07	1.00	6.95	0.53	3.47	0.64	0.01	0.01	0.01	0.02	0.00
1208 b	10.77	2.10	15.24	1.00	6.19	1.36	0.01	0.01	0.03	0.04	0.00
2108 a	10.03	2.08	15.21	0.96	6.53	1.44	0.01	0.01	0.03	0.04	0.00
2108 b	3.96	0.83	5.30	0.37	2.54	0.61	0.00	0.00	0.01	0.02	0.00
2208 a	6.96	1.57	9.78	0.69	4.88	1.03	0.01	0.01	0.02	0.03	0.00
2208 b	8.53	2.09	13.14	0.95	6.13	1.91	0.01	0.01	0.02	0.03	0.00
3108 a	9.12	1.52	12.34	0.73	5.27	1.38	0.01	0.01	0.03	0.04	0.00
3108 b	8.23	1.14	8.83	0.68	4.79	1.40	0.01	0.01	0.02	0.05	0.00
3208 a	11.57	2.02	16.52	1.32	8.77	1.62	0.01	0.01	0.03	0.04	0.00
3208 b	8.22	1.45	11.91	0.88	6.08	1.48	0.01	0.01	0.02	0.04	0.00
4108 a	10.00	1.65	14.15	0.97	6.27	1.75	0.01	0.01	0.03	0.04	0.00
4108 b	9.28	1.28	11.63	0.87	4.97	1.11	0.01	0.01	0.02	0.03	0.00
4208 a	9.51	1.80	14.36	0.99	5.68	1.18	0.01	0.01	0.02	0.03	0.00
4208 b	13.66	2.46	20.30	1.53	9.44	2.39	0.02	0.01	0.04	0.05	0.00
1109 a	5.45	1.20	8.43	0.54	3.20	0.90	0.01	0.00	0.01	0.02	0.00
1109 b	13.47	2.76	20.82	1.29	8.08	2.33	0.02	0.01	0.03	0.04	0.00
1209 a	5.41	0.96	6.25	0.38	2.39	0.56	0.01	0.00	0.01	0.01	0.00

1209 b	7.58	1.25	8.81	0.60	3.49	0.88	0.01	0.01	0.01	0.02	0.00
2109 a	7.28	1.52	9.85	0.66	4.03	1.14	0.01	0.01	0.01	0.02	0.00
2109 b	8.91	2.31	15.56	0.96	6.18	1.51	0.01	0.01	0.02	0.03	0.00
2209 a	10.73	2.26	14.64	0.97	6.14	1.64	0.01	0.01	0.02	0.03	0.00
2209 b	7.82	1.64	11.64	0.78	5.29	1.48	0.01	0.01	0.02	0.02	0.00
3109 a	9.07	2.00	14.85	0.79	5.70	1.32	0.01	0.01	0.02	0.02	0.00
3109 b	10.35	1.33	17.95	0.94	6.73	1.51	0.02	0.01	0.03	0.03	0.00
3209 a	8.89	1.53	15.94	0.89	5.70	1.03	0.01	0.01	0.02	0.03	0.00
3209 b	5.72	0.99	10.13	0.51	3.95	1.11	0.01	0.00	0.01	0.01	0.00
4109 a	4.32	1.40	16.00	0.81	5.24	1.76	0.01	0.01	0.02	0.03	0.00
4109 b	2.97	0.73	7.66	0.49	2.88	0.75	0.01	0.00	0.01	0.01	0.00
4209 a	6.38	1.53	13.30	0.74	5.35	0.94	0.01	0.01	0.02	0.02	0.00
4209 b	6.47	1.11	13.98	0.72	4.95	1.28	0.01	0.01	0.02	0.03	0.00
1110 a	8.22	1.78	19.41	1.02	7.81	1.57	0.02	0.01	0.03	0.04	0.00
1110 b	11.49	1.74	26.08	1.43	11.44	1.61	0.03	0.01	0.04	0.06	0.00
1210 a	12.36	1.34	16.77	1.14	7.74	1.17	0.02	0.01	0.03	0.04	0.00
1210 b	7.26	1.24	19.55	1.10	7.98	1.25	0.02	0.01	0.02	0.03	0.00
2110 a	7.53	1.56	14.53	1.15	7.84	1.75	0.02	0.01	0.03	0.04	0.00
2110 b	7.90	1.49	19.86	1.18	10.07	2.10	0.02	0.01	0.02	0.06	0.00
2210 a	10.83	1.37	12.93	1.04	7.35	1.39	0.02	0.01	0.02	0.03	0.00
2210 b	9.76	1.43	15.60	1.10	8.61	1.27	0.02	0.01	0.03	0.03	0.00
3110 a	12.69	1.18	14.61	1.03	6.93	1.39	0.02	0.01	0.03	0.03	0.00
3110 b	11.73	1.36	22.62	1.32	9.82	1.45	0.03	0.01	0.04	0.05	0.00
3210 a	6.93	1.08	12.66	1.20	7.53	1.12	0.02	0.01	0.03	0.03	0.00
3210 b	6.25	0.75	13.08	0.81	6.25	1.34	0.01	0.01	0.02	0.03	0.00
4110 a	8.90	1.02	15.12	1.24	7.33	1.35	0.02	0.01	0.03	0.03	0.00
4110 b	5.48	0.59	9.63	0.51	3.33	0.86	0.01	0.00	0.01	0.02	0.00
4210 a	10.02	1.11	14.84	1.13	6.86	1.06	0.02	0.01	0.03	0.03	0.00
4210 b	4.92	0.78	13.77	0.76	5.66	1.38	0.01	0.01	0.02	0.02	0.00
1101	5.04	0.50	4.09	0.41	2.87	0.94	0.00	0.00	0.01	0.06	0.00
1201	3.29	0.46	3.53	0.32	2.11	0.72	0.00	0.00	0.01	0.06	0.00

1301	8.32	0.81	4.87	0.53	4.17	1.22	0.00	0.01	0.01	0.07	0.00
1401	4.75	0.52	3.51	0.31	2.29	0.75	0.00	0.00	0.01	0.05	0.00
2101	2.06	0.17	1.50	0.16	0.98	0.33	0.00	0.00	0.00	0.02	0.00
2201	3.28	0.38	3.44	0.31	1.91	0.63	0.00	0.00	0.00	0.03	0.00
2301	3.92	0.41	2.87	0.29	1.92	0.56	0.00	0.00	0.01	0.08	0.00
2401	3.37	0.34	3.03	0.22	1.45	0.46	0.00	0.00	0.00	0.02	0.00
3101	3.04	0.35	3.16	0.31	1.76	0.57	0.00	0.00	0.01	0.07	0.00
3201	4.98	0.55	3.63	0.39	2.61	0.85	0.00	0.00	0.01	0.06	0.00
3301	3.14	0.31	2.62	0.23	1.47	0.44	0.00	0.00	0.00	0.05	0.00
3401	3.93	0.42	3.62	0.25	1.75	0.57	0.00	0.00	0.00	0.02	0.00
4101	3.74	0.40	2.55	0.28	1.88	0.57	0.00	0.00	0.00	0.03	0.00
4201	4.14	0.47	3.14	0.32	2.26	0.72	0.00	0.00	0.01	0.05	0.00
4301	7.06	0.79	4.38	0.49	3.69	1.00	0.00	0.00	0.01	0.10	0.00
1102	7.92	0.67	4.63	0.60	3.43	0.93	0.00	0.01	0.03	0.62	0.00
1202	6.56	0.73	3.86	0.44	2.71	0.89	0.00	0.00	0.02	0.42	0.00
1302	11.08	1.14	7.90	0.81	5.43	1.52	0.01	0.01	0.04	0.77	0.00
1402	6.80	0.62	3.73	0.38	2.30	0.77	0.00	0.00	0.02	0.38	0.00
2102	2.85	0.21	1.29	0.22	1.11	0.30	0.00	0.00	0.01	0.24	0.00
2202	8.34	0.62	3.72	0.57	3.31	0.87	0.00	0.01	0.03	0.67	0.00
2302	8.50	0.89	4.90	0.59	3.83	1.12	0.01	0.01	0.02	0.47	0.00
2402	3.64	0.32	1.76	0.28	1.28	0.37	0.00	0.00	0.02	0.59	0.00
3102	7.99	0.78	4.59	0.63	3.53	1.08	0.00	0.01	0.02	0.50	0.00
3202	7.71	0.74	4.25	0.56	3.49	1.01	0.00	0.00	0.02	0.40	0.00
3302	6.38	0.67	3.45	0.39	2.49	0.76	0.00	0.00	0.01	0.24	0.00
3402	5.91	0.69	3.67	0.36	2.20	0.73	0.00	0.00	0.01	0.20	0.00
4102	4.73	0.51	2.66	0.37	2.32	0.66	0.00	0.00	0.01	0.32	0.00
4202	9.04	0.99	5.69	0.71	4.68	1.22	0.01	0.01	0.02	0.34	0.00
4302	8.97	1.01	5.25	0.58	4.14	1.11	0.01	0.01	0.02	0.26	0.00
1103	5.79	0.59	2.57	0.36	1.67	0.64	0.00	0.01	0.02	0.51	0.00
1203	3.20	0.25	1.27	0.20	0.70	0.29	0.00	0.00	0.02	0.60	0.00
1303	4.57	0.51	2.38	0.25	1.21	0.50	0.00	0.00	0.02	0.41	0.00

1403	2.86	0.32	1.58	0.16	0.73	0.34	0.00	0.00	0.01	0.22	0.00
2103	1.29	0.11	0.51	0.12	0.36	0.14	0.00	0.00	0.01	0.31	0.00
2203	1.41	0.10	0.47	0.08	0.28	0.11	0.00	0.00	0.01	0.26	0.00
2303	2.00	0.17	0.82	0.09	0.36	0.18	0.00	0.00	0.01	0.18	0.00
2403	1.20	0.10	0.48	0.08	0.26	0.11	0.00	0.00	0.01	0.19	0.00
3103	2.34	0.24	1.13	0.14	0.56	0.27	0.00	0.00	0.01	0.17	0.00
3203	2.66	0.19	0.78	0.13	0.54	0.20	0.00	0.00	0.01	0.29	0.00
3303	2.19	0.20	0.89	0.10	0.39	0.20	0.00	0.00	0.01	0.14	0.00
3403	1.51	0.14	0.60	0.08	0.36	0.14	0.00	0.00	0.01	0.13	0.00
4103	1.77	0.15	0.62	0.09	0.36	0.16	0.00	0.00	0.01	0.19	0.00
4203	2.25	0.26	1.12	0.14	0.49	0.25	0.00	0.00	0.01	0.25	0.00
4303	3.68	0.40	1.68	0.21	0.90	0.36	0.00	0.00	0.02	0.44	0.00
1104	8.86	0.86	8.00	0.56	3.21	1.31	0.01	0.01	0.02	0.25	0.00
1204	6.76	0.63	5.30	0.38	2.09	0.87	0.00	0.00	0.02	0.32	0.00
1304	10.29	0.90	7.66	0.52	3.49	1.20	0.01	0.01	0.03	0.36	0.00
1404	7.97	0.66	5.45	0.39	2.51	0.90	0.00	0.01	0.02	0.23	0.00
2104	0.73	0.05	0.45	0.05	0.26	0.08	0.00	0.00	0.00	0.03	0.00
2204	5.22	0.46	3.55	0.32	1.79	0.65	0.00	0.00	0.01	0.25	0.00
2304	3.94	0.34	2.67	0.22	1.31	0.46	0.00	0.00	0.01	0.17	0.00
2404	3.07	0.25	2.06	0.18	0.98	0.33	0.00	0.00	0.01	0.13	0.00
3104	8.46	0.75	6.87	0.50	2.63	1.01	0.01	0.01	0.02	0.26	0.00
3204	6.23	0.48	4.34	0.34	2.08	0.72	0.00	0.00	0.01	0.18	0.00
3304	6.27	0.49	3.69	0.28	1.61	0.60	0.00	0.00	0.01	0.21	0.00
3404	3.62	0.48	3.60	0.31	1.71	0.58	0.00	0.00	0.01	0.22	0.00
4104	5.32	0.42	3.15	0.28	1.76	0.60	0.00	0.00	0.01	0.16	0.00
4204	4.92	0.48	3.13	0.27	1.59	0.60	0.00	0.00	0.01	0.17	0.00
4304	6.79	0.60	4.36	0.31	2.04	0.72	0.00	0.00	0.01	0.16	0.00
1105	14.16	0.94	12.00	0.66	3.63	1.55	0.01	0.01	0.02	0.12	0.00
1205	7.80	0.76	8.56	0.57	3.58	1.39	0.01	0.01	0.01	0.07	0.00
1305	15.59	1.49	15.39	0.97	7.44	2.57	0.01	0.01	0.03	0.19	0.00
1405	12.95	1.02	12.61	0.73	4.82	1.70	0.01	0.01	0.02	0.15	0.00

2105	1.08	0.14	2.15	0.19	0.96	0.25	0.00	0.00	0.00	0.02	0.00
2205	5.35	0.44	5.43	0.45	2.98	0.92	0.00	0.00	0.01	0.06	0.00
2305	7.47	0.60	6.73	0.49	3.30	1.00	0.00	0.01	0.01	0.09	0.00
2405	6.33	0.60	6.88	0.43	2.41	0.90	0.00	0.00	0.01	0.06	0.00
3105	10.73	0.94	14.06	0.76	4.07	1.80	0.01	0.01	0.01	0.06	0.00
3205	7.01	0.59	6.81	0.52	3.39	1.25	0.01	0.01	0.01	0.08	0.00
3305	9.90	0.92	9.13	0.67	4.46	1.56	0.01	0.01	0.01	0.07	0.00
3405	7.57	0.70	6.15	0.50	3.58	1.11	0.00	0.01	0.01	0.05	0.00
4105	7.95	0.69	6.25	0.53	3.83	1.19	0.01	0.01	0.01	0.08	0.00
4205	9.90	0.97	9.34	0.66	4.43	1.57	0.01	0.01	0.01	0.07	0.00
4305	12.34	1.10	10.68	0.78	6.05	1.82	0.01	0.01	0.02	0.09	0.00
1106	9.43	0.92	13.41	0.77	4.05	1.65	0.01	0.01	0.02	0.04	0.00
1206	7.70	0.66	7.76	0.64	4.15	1.50	0.01	0.01	0.01	0.05	0.00
1306	22.22	1.84	22.33	1.58	11.65	3.53	0.02	0.02	0.03	0.16	0.00
1406	11.07	0.99	13.85	0.90	6.49	2.27	0.01	0.01	0.02	0.08	0.00
2106	6.76	0.47	6.97	0.67	4.02	1.25	0.01	0.00	0.01	0.04	0.00
2206	4.60	0.39	3.99	0.49	3.63	1.16	0.00	0.00	0.01	0.04	0.00
2306	7.25	0.63	7.75	0.60	4.11	1.42	0.01	0.01	0.01	0.04	0.00
2406	8.54	0.76	9.92	0.65	4.07	1.51	0.01	0.01	0.01	0.05	0.00
3106	9.97	0.88	12.37	0.91	6.05	2.08	0.01	0.01	0.02	0.06	0.00
3206	8.16	0.59	7.97	0.78	5.62	1.85	0.01	0.01	0.01	0.05	0.00
3306	9.27	0.91	9.29	0.76	5.65	1.94	0.01	0.01	0.01	0.04	0.00
3406	11.12	1.10	11.25	0.91	6.25	1.98	0.01	0.01	0.02	0.05	0.00
4106	6.57	0.69	8.11	0.65	4.89	1.66	0.01	0.01	0.01	0.04	0.00
4206	11.33	1.04	11.95	0.92	6.64	2.19	0.01	0.01	0.02	0.05	0.00
4306	13.33	1.20	12.35	0.98	7.83	2.43	0.01	0.01	0.02	0.06	0.00
1107	11.63	1.14	14.48	1.09	7.57	2.71	0.01	0.01	0.02	0.07	0.00
1207	12.02	0.96	10.67	1.09	8.09	2.64	0.01	0.01	0.02	0.07	0.00
1307	15.64	1.41	19.54	1.51	10.37	3.13	0.02	0.01	0.02	0.11	0.00
1407	11.63	1.05	16.51	1.05	7.41	2.61	0.01	0.01	0.02	0.05	0.00
2107	11.99	1.16	12.24	1.26	7.92	2.73	0.01	0.01	0.02	0.07	0.00

2207	4.52	0.40	4.53	0.53	3.58	1.12	0.00	0.00	0.01	0.02	0.00
2307	12.16	0.85	11.94	1.15	9.24	2.77	0.01	0.01	0.02	0.05	0.00
2407	13.88	1.18	15.98	1.27	8.98	2.98	0.01	0.01	0.02	0.08	0.00
3107	12.14	1.07	14.31	1.23	8.98	2.87	0.01	0.01	0.02	0.07	0.00
3207	12.98	1.06	11.12	1.20	9.19	2.95	0.01	0.01	0.02	0.05	0.00
3307	13.64	1.23	13.86	1.28	9.55	3.04	0.02	0.01	0.01	0.06	0.00
3407	14.27	1.23	10.42	1.23	8.79	2.72	0.01	0.01	0.02	0.04	0.00
4107	9.95	0.95	10.66	0.95	7.80	2.54	0.01	0.01	0.01	0.04	0.00
4207	12.42	1.31	14.51	1.19	8.50	3.02	0.01	0.01	0.02	0.06	0.00
4307	17.21	1.49	16.64	1.39	10.19	3.08	0.02	0.01	0.01	0.05	0.00
1108	12.40	1.41	14.47	1.21	7.51	2.65	0.01	0.01	0.03	0.30	0.00
1208	13.81	1.16	13.67	1.44	9.72	2.79	0.01	0.01	0.02	0.32	0.00
1308	17.56	1.88	19.81	1.79	12.89	3.94	0.02	0.01	0.03	0.27	0.00
1408	16.80	1.46	18.86	1.52	9.54	3.19	0.02	0.01	0.03	0.38	0.00
2108	14.75	1.49	14.80	1.47	9.13	3.13	0.02	0.01	0.03	0.25	0.00
2208	16.69	1.17	10.95	1.64	9.90	2.94	0.01	0.01	0.02	0.25	0.00
2308	10.20	1.05	10.08	1.29	9.81	2.89	0.01	0.01	0.02	0.24	0.00
2408	15.39	1.63	18.93	1.78	12.07	3.83	0.02	0.01	0.03	0.20	0.00
3108	18.97	1.37	17.39	1.52	9.25	3.01	0.02	0.01	0.02	0.15	0.00
3208	8.49	1.11	10.39	1.40	8.42	2.65	0.01	0.01	0.01	0.12	0.00
3308	21.78	1.15	13.15	1.24	8.59	2.61	0.01	0.01	0.02	0.17	0.00
3408	11.54	1.78	12.94	1.54	10.05	3.13	0.01	0.01	0.02	0.20	0.00
4108	13.87	1.14	11.29	1.23	9.41	2.84	0.01	0.01	0.02	0.26	0.00
4208	16.96	1.42	15.20	1.32	9.77	3.27	0.02	0.01	0.02	0.23	0.00
4308	18.49	1.67	15.89	1.51	11.15	3.33	0.02	0.01	0.02	0.35	0.00
1109	29.06	2.06	17.65	1.79	10.93	3.80	0.02	0.01	0.03	0.20	0.00
1209	19.76	2.24	16.20	2.12	16.92	4.46	0.02	0.02	0.03	0.28	0.00
1309	20.23	2.15	19.39	1.93	13.52	4.04	0.02	0.02	0.03	0.31	0.00
1409	18.29	1.96	19.24	1.70	11.17	3.53	0.02	0.01	0.03	0.15	0.00
2109	12.02	1.64	14.79	1.43	8.17	2.97	0.01	0.01	0.02	0.11	0.00
2209	15.09	1.96	13.44	1.68	13.36	4.13	0.02	0.01	0.03	0.29	0.00

2309	13.28	1.57	12.49	1.34	9.16	3.07	0.01	0.01	0.02	0.26	0.00
2409	15.46	1.55	16.18	1.44	9.28	3.06	0.01	0.01	0.03	0.28	0.00
3109	11.01	1.65	12.76	1.50	8.24	2.99	0.01	0.01	0.02	0.14	0.00
3209	13.79	1.58	11.48	1.61	10.08	3.14	0.01	0.01	0.02	0.18	0.00
3309	21.74	2.49	16.59	1.87	13.56	3.93	0.02	0.02	0.03	0.26	0.00
3409	16.63	1.83	16.25	1.49	10.51	3.46	0.02	0.01	0.02	0.19	0.00
4109	12.90	1.83	13.05	1.37	10.19	3.31	0.01	0.01	0.02	0.17	0.00
4209	18.19	2.26	16.72	1.71	12.27	4.28	0.02	0.01	0.03	0.25	0.00
4309	24.85	2.73	20.66	2.17	18.34	5.43	0.02	0.02	0.03	0.33	0.00
1110	12.71	1.74	15.33	1.63	9.75	3.00	0.02	0.01	0.02	0.07	0.00
1210	18.07	2.14	17.09	2.00	14.81	4.26	0.02	0.01	0.02	0.08	0.00
1310	24.95	2.43	17.91	2.43	20.63	6.00	0.02	0.02	0.05	0.27	0.00
1410	19.79	2.33	22.40	1.98	14.86	4.86	0.02	0.02	0.04	0.11	0.00
2110	19.28	2.46	21.67	2.21	15.22	5.02	0.02	0.01	0.04	0.07	0.00
2210	15.53	2.08	14.42	1.79	15.49	4.43	0.02	0.01	0.03	0.09	0.00
2310	16.80	2.10	16.48	1.73	13.87	4.47	0.02	0.01	0.03	0.09	0.00
2410	20.14	2.24	20.47	1.86	12.43	4.08	0.02	0.01	0.03	0.07	0.00
3110	6.31	0.80	5.49	0.66	4.05	1.42	0.01	0.00	0.01	0.03	0.00
3210	20.25	2.41	16.43	2.42	16.56	5.19	0.02	0.01	0.03	0.08	0.00
3310	22.59	2.83	18.94	2.22	19.37	5.96	0.03	0.02	0.03	0.17	0.00
3410	17.10	1.90	14.22	1.48	11.27	3.60	0.01	0.01	0.02	0.07	0.00
4110	18.30	2.34	14.17	1.73	14.45	4.72	0.02	0.01	0.03	0.15	0.00
4210	20.33	2.73	19.88	2.00	15.88	5.62	0.03	0.02	0.03	0.10	0.00
4310	23.10	3.01	20.60	2.18	19.90	6.21	0.03	0.02	0.03	0.13	0.00
1111	21.65	3.31	23.52	3.06	17.49	5.97	0.03	0.02	0.05	0.10	0.00
1211	18.65	2.82	18.65	2.54	16.84	4.97	0.02	0.02	0.04	0.10	0.00
1311	35.68	3.83	26.26	3.47	27.72	9.13	0.03	0.02	0.08	0.16	0.00
1411	24.69	3.41	26.96	2.70	17.58	6.50	0.03	0.02	0.07	0.12	0.00
2111	27.38	3.71	26.82	3.24	20.86	7.03	0.03	0.02	0.06	0.13	0.00
2211	18.97	2.94	19.94	2.47	18.33	5.12	0.02	0.02	0.04	0.06	0.00
2311	19.70	2.80	19.84	2.33	17.02	5.49	0.03	0.02	0.04	0.08	0.00

2411	27.36	3.34	24.42	2.69	18.74	6.22	0.02	0.02	0.05	0.09	0.00
3111	22.89	3.16	22.34	2.57	14.75	5.60	0.02	0.02	0.04	0.07	0.00
3211	25.97	3.38	22.22	3.17	21.76	7.53	0.03	0.02	0.04	0.09	0.00
3311	31.10	3.57	23.75	2.82	24.71	7.52	0.03	0.02	0.04	0.11	0.00
3411	17.95	2.43	16.04	1.60	11.55	4.14	0.02	0.02	0.03	0.09	0.00
4111	13.41	1.91	10.98	1.36	10.42	3.65	0.01	0.01	0.02	0.06	0.00
4211	19.92	2.79	18.50	1.90	14.26	5.07	0.02	0.02	0.04	0.09	0.00
4311	29.30	4.01	24.64	2.66	23.72	7.49	0.03	0.02	0.04	0.10	0.00
1112	15.46	2.20	20.63	2.00	14.61	4.43	0.02	0.01	0.03	0.09	0.00
1212	15.03	2.03	15.58	2.06	17.07	5.01	0.02	0.01	0.04	0.08	0.00
1312	21.31	2.34	19.35	2.16	18.32	6.28	0.02	0.02	0.06	0.11	0.00
1412	27.49	3.65	31.01	3.12	26.13	9.32	0.03	0.03	0.09	0.14	0.00
2112	22.80	2.74	21.50	3.11	24.77	7.94	0.03	0.02	0.06	0.14	0.00
2212	20.42	2.92	20.51	2.36	17.05	5.55	0.03	0.02	0.04	0.09	0.00
2312	13.91	1.76	15.13	1.61	14.42	4.47	0.02	0.01	0.03	0.07	0.00
2412	12.11	1.61	13.70	1.30	10.15	3.69	0.01	0.01	0.03	0.09	0.00
3112	12.02	1.53	11.32	1.27	8.21	3.25	0.01	0.01	0.03	0.07	0.00
3212	12.74	1.62	12.21	1.35	9.99	4.00	0.02	0.01	0.03	0.07	0.00
3312	11.32	1.30	10.11	1.18	10.04	3.35	0.01	0.01	0.02	0.05	0.00
3412	11.87	1.66	9.80	1.22	9.99	3.24	0.01	0.01	0.02	0.09	0.00
4112	12.40	1.68	10.68	1.18	10.20	3.64	0.01	0.01	0.02	0.05	0.00
4212	23.39	2.96	23.75	2.59	20.86	7.88	0.03	0.02	0.05	0.11	0.00
4312	20.42	2.44	16.44	1.73	17.53	5.64	0.02	0.02	0.02	0.09	0.00
1113	22.70	3.23	20.76	2.72	16.52	5.96	0.03	0.02	0.05	0.06	0.00
1213	27.42	3.63	23.29	3.15	23.18	7.72	0.04	0.02	0.06	0.08	0.00
1313	35.25	4.14	27.52	3.44	26.80	9.58	0.05	0.02	0.09	0.10	0.00
1413	27.35	3.56	26.41	2.67	19.59	7.19	0.03	0.02	0.07	0.08	0.00
2113	29.38	4.21	27.15	3.51	21.96	7.92	0.04	0.02	0.06	0.08	0.00
2213	23.97	3.39	22.23	2.67	18.57	6.44	0.03	0.02	0.05	0.14	0.00
2313	25.01	3.25	21.07	2.53	19.17	6.65	0.03	0.02	0.05	0.06	0.00
2413	22.65	2.86	19.12	2.38	17.56	5.57	0.03	0.02	0.06	0.07	0.00

3113	18.24	2.29	14.95	1.63	10.94	4.50	0.02	0.01	0.04	0.05	0.00
3213	21.65	3.03	18.48	2.13	14.50	6.19	0.03	0.02	0.04	0.06	0.00
3313	26.06	3.24	21.39	2.58	17.46	6.79	0.03	0.02	0.06	0.11	0.00
3413	21.67	2.83	17.81	1.78	13.10	4.63	0.02	0.02	0.03	0.06	0.00
4113	13.69	1.80	10.44	1.11	9.04	3.70	0.01	0.01	0.02	0.03	0.00
4213	24.01	3.44	21.20	2.45	17.15	7.00	0.03	0.02	0.05	0.06	0.00
4313	29.83	3.81	20.40	2.52	21.90	7.89	0.03	0.02	0.03	0.07	0.00
1114	26.67	4.05	25.04	3.07	18.23	6.90	0.03	0.02	0.05	0.07	0.00
1214	24.98	3.51	22.50	2.73	18.54	6.55	0.03	0.02	0.05	0.07	0.00
1314	27.75	3.73	23.06	2.84	21.39	7.93	0.04	0.02	0.07	0.09	0.00
1414	29.64	4.28	28.66	2.97	20.94	8.17	0.04	0.03	0.09	0.09	0.01
2114	27.57	3.88	25.13	3.20	20.50	7.50	0.04	0.02	0.07	0.08	0.00
2214	59.44	8.88	52.70	6.64	45.15	16.12	0.08	0.05	0.12	0.17	0.01
2314	17.26	2.28	14.29	1.53	10.65	4.02	0.02	0.01	0.03	0.04	0.00
2414	23.99	3.10	20.65	2.35	15.34	5.91	0.02	0.02	0.06	0.07	0.00
3114	28.17	3.82	24.46	3.02	19.41	7.46	0.03	0.02	0.06	0.07	0.00
3214	24.60	3.61	20.14	2.56	17.61	7.47	0.03	0.02	0.04	0.06	0.00
3314	25.28	3.36	19.74	2.37	17.46	6.42	0.03	0.02	0.06	0.07	0.00
3414	31.29	4.61	27.45	2.77	19.74	7.18	0.04	0.03	0.05	0.09	0.01
4114	26.54	4.04	21.70	2.58	20.19	7.81	0.04	0.02	0.05	0.07	0.00
4214	24.12	3.61	22.38	2.47	16.84	7.09	0.03	0.02	0.05	0.07	0.00
4314	36.82	5.14	29.56	3.07	25.87	9.62	0.04	0.03	0.04	0.09	0.01
1115	19.71	2.97	20.01	2.29	14.06	4.97	0.03	0.02	0.04	0.05	0.00
1215	31.24	4.14	28.28	3.01	20.20	7.29	0.04	0.02	0.06	0.10	0.00
1315	22.34	3.16	19.76	2.26	17.34	6.05	0.03	0.02	0.07	0.07	0.00
1415	22.12	2.86	21.08	2.09	15.08	5.66	0.02	0.02	0.06	0.07	0.00
2115	20.49	2.98	19.73	2.38	14.93	5.69	0.03	0.01	0.05	0.06	0.00
2215	18.38	2.69	17.51	2.17	15.32	5.05	0.03	0.01	0.04	0.05	0.00
2315	25.97	3.43	20.41	2.19	16.85	6.03	0.03	0.02	0.04	0.07	0.00
2415	23.21	2.83	21.26	2.30	16.42	5.96	0.03	0.02	0.06	0.07	0.00
3115	17.25	2.27	15.78	1.82	11.92	4.32	0.02	0.01	0.03	0.05	0.00

3215	15.46	2.00	12.27	1.49	11.07	4.45	0.02	0.01	0.03	0.04	0.00
3315	25.42	2.93	19.11	2.15	17.75	6.91	0.03	0.02	0.05	0.06	0.00
3415	18.46	2.48	16.07	1.59	12.14	4.18	0.02	0.01	0.03	0.05	0.00
4115	18.51	2.72	16.05	1.83	14.62	5.35	0.02	0.02	0.03	0.05	0.01
4215	22.98	3.03	21.93	2.28	17.05	6.98	0.03	0.02	0.05	0.07	0.00
4315	24.38	3.54	21.03	2.07	19.16	6.42	0.03	0.02	0.03	0.07	0.00
1116	17.11	2.52	19.97	2.29	16.02	5.36	0.03	0.01	0.04	0.06	0.00
1216	18.65	2.32	18.35	2.02	17.40	5.33	0.03	0.02	0.04	0.07	0.00
1316	17.46	2.47	18.22	1.91	16.14	5.43	0.03	0.01	0.05	0.06	0.00
1416	23.16	2.95	27.17	2.14	16.33	5.95	0.03	0.02	0.05	0.08	0.00
2116	17.06	2.29	19.52	2.13	15.27	5.53	0.03	0.01	0.05	0.05	0.00
2216	15.56	2.21	14.21	1.94	16.33	4.86	0.03	0.01	0.04	0.06	0.00
2316	18.69	2.65	21.09	2.17	18.03	6.00	0.03	0.02	0.06	0.07	0.00
2416	17.68	2.19	19.14	1.72	11.53	4.32	0.02	0.01	0.05	0.05	0.00
3116	12.04	1.75	13.57	1.44	11.16	3.65	0.02	0.01	0.03	0.04	0.00
3216	16.06	2.17	16.15	1.75	14.54	5.18	0.02	0.01	0.04	0.06	0.00
3316	20.59	2.63	19.61	1.98	18.46	6.67	0.03	0.02	0.05	0.07	0.00
3416	24.42	3.19	20.53	2.27	18.94	6.40	0.03	0.02	0.04	0.07	0.00
4116	18.88	2.61	15.80	1.82	16.06	5.96	0.03	0.01	0.03	0.05	0.00
4216	16.35	2.29	16.29	1.71	13.54	5.25	0.02	0.01	0.04	0.07	0.00
4316	19.08	2.73	16.70	1.48	16.37	5.13	0.03	0.01	0.03	0.05	0.00

Appendix D - Raw Data: "Yield formation factors of winter canola in northeast Kansas"

Table D.1. Yield formation data and calculations for the Riley (2017), Wichita (2018), Surefire (2018), and Surefire-Wichita (2019) studies.

Plot	Sub	Pt_Ct	Ht	Pd_Ct	Sd_Vol	Avg_Br_Ct	Avg_MR_Lth	Pd_Lth_bot	Pd_Lth_mid	Pd_Lth_top	Avg_Pd_Ct_MR	Pop
101	a	27	18									322780
101	b	19	20									227141
201	a	18	19									215186
201	b	18	17									215186
301	a	37	18									442328
301	b	35	18									418418
401	a	42	19									502102
401	b	37	20									442328
501	a	24	15									286915
501	b	30	17									358644
601	a	17	20									203232
601	b	27	18									322780
102	a	28	72									334734
102	b	23	67									274960
202	a	25	70									298870
202	b	29	69									346689
302	a	88	68									1052022
302	b	68	67									812926
402	a	29	70									346689
402	b	43	70									514056
502	a	23	74									274960
502	b	29	72									346689
602	a	22	72									263006
602	b	23	70									274960
103	a	46	123									549921

103 b	28	120		334734
203 a	20	119		239096
203 b	31	117		370599
303 a	24	116		286915
303 b	29	110		346689
403 a	30	113		358644
403 b	25	119		298870
503 a	25	116		298870
503 b	20	116		239096
603 a	27	119		322780
603 b	19	120		227141
104 a	28	128		334734
104 b	35	119		418418
204 a	26	128		310825
204 b	32	122		382554
304 a	38	116		454282
304 b	56	113		669469
404 a	26	125		310825
404 b	28	125		334734
504 a	27	125		322780
504 b	28	119		334734
604 a	47	122		561876
604 b	39	122		466237
105 a	22	131		263006
105 b	31	131	3558	370599
205 a	25	128		298870
205 b	24	125	3133	286915
305 a	28	131		334734
305 b	43	125	3223	514056
405 a	78	119	5367	932474
405 b	46	125	4617	549921

505 a	25	128	3918	298870
505 b	20	122	3390	239096
605 a	71	125		848791
605 b	72	122	4084	860746
106 a	39	122		466237
106 b	63	128	4743	753152
206 a	39	122		466237
206 b	41	122	4074	490147
306 a	13	140		155412
306 b	20	137	4111	239096
406 a	51	128		609695
406 b	40	128	4612	478192
506 a	39	128		466237
506 b	38	125	3700	454282
606 a	45	131		537966
606 b	41	134	5169	490147
107 a	21	131	5010	251051
107 b	43	131		514056
207 a	27	119	3631	322780
207 b	42	119		502102
307 a	13	131	4041	155412
307 b	20	134		239096
407 a	39	134	3395	466237
407 b	34	128		406463
507 a	19	128	3927	227141
507 b	22	125		263006
607 a	25	134	3904	298870
607 b	27	137		322780
108 a	15	131	4564	179322
108 b	32	125		382554
208 a	38	122	4435	454282

208 b	40	122			478192
308 a	14	131			167367
308 b	17	134	3820		203232
408 a	29	134	3720		346689
408 b	25	137			298870
508 a	32	130	4625		382554
508 b	21	128			251051
608 a	33	131	4241		394508
608 b	30	125			358644
109 a	19	131	3686		227141
109 b	30	128			358644
209 a	41	128	3913		490147
209 b	40	122			478192
309 a	12	131	3638		143458
309 b	19	128			227141
409 a	33	131	3511		394508
409 b	26	128			310825
509 a	19	125	2845		227141
509 b	29	128			346689
609 a	27	128	3526		322780
609 b	29	128			346689
110 a	31	128		310	370599
110 b	29	134		420	346689
210 a	33	134		360	394508
210 b	39	128		380	466237
310 a	29	125		265	346689
310 b	27	125		200	322780
410 a	25	137		300	298870
410 b	28	125		245	334734
510 a	39	125		325	466237
510 b	43	119		280	514056

610 a	26	140		275							310825
610 b	32	128		325							382554
108 a	66	9									789017
118 b	45	10									537966
206 a	40	10									478192
226 b	48	10									573830
306 a	38	12									454282
321 b	62	11									741198
103 a	45	16									537966
104 b	70	14									836836
208 a	53	17									633604
222 b	52	15									621650
317 a	55	18									657514
325 b	71	16									848791
113 a	38	43									454282
114 b	44	43									526011
201 a	54	45									645559
215 b	47	44									561876
323 a	57	46									681424
324 b	64	45									765107
101 a	33	77	523		9.0	8.00		2.2			394508
119 b	44	82	961		6.0	24.00		2.0			526011
219 a	59	84	1049		7.0	21.00		2.0			705333
225 b	54	83	636		6.0	11.00		2.1			645559
308 a	80	78	750		6.0	28.00		2.3			956384
320 b	71	85	811		9.0	18.00		2.5			848791
127 a	33	94	3826		8.8	35.32	5.8	5.5	2.7	35	394508
128 b	55	93	3253		7.6	25.94	7.1	4.5	2.9	26	657514
202 a	41	111	3150		7.8	33.40	9.1	5.0	5.3	35	490147
218 b	44	91	1943		6.4	31.51	7.5	6.2	3.2	23	526011
314 a	37	107	2593		7.0	42.88	5.4	4.8	4.3	38	442328

318 b	53	107	3511		7.4	37.78	8.0	6.1	5.5	35	633604
112 a	70	98	1908		4.9	30.61	8.6	8.7	6.6	20	836836
123 b	46	104	3520		7.2	39.67	9.0	7.1	6.2	35	549921
204 a	68	108	3085		7.2	38.71	8.4	9.4	7.9	31	812926
217 b	65	98	1723		4.2	29.61	9.8	7.9	4.8	18	777062
302 a	62	105	2448		8.0	40.89	8.0	8.6	7.6	36	741198
315 b	47	107	2939		6.8	42.67	8.0	8.0	8.0	32	561876
102 a	27	101	5108		7.8	33.62	8.9	8.0	7.0	29	322780
120 b	38	98	3856		6.8	30.12	8.2	8.3	7.4	30	454282
224 a	41	105	2935		5.4	38.33	10.5	9.5	7.5	29	490147
229 b	50	108	3650		6.1	42.50	9.5	8.3	7.2	36	597740
313 a	42	110	3994		7.2	41.20	9.5	9.4	7.0	31	502102
330 b	48	113	5118		7.4	43.65	9.9	9.7	6.3	41	573830
110 a	47	85	2345		5.9	29.25	8.5	7.7	6.8	28	561876
130 b	49	107	5104		6.7	31.47	8.2	9.5	8.9	31	585785
211 a	45	107	3060		6.1	31.36	9.1	9.2	8.2	27	537966
227 b	52	101	3666		5.7	44.14	9.4	8.2	6.5	39	621650
319 a	55	116	3507		5.7	40.93	10.0	9.3	6.8	38	657514
329 b	35	107	5968		7.0	41.29	7.5	7.7	7.4	37	418418
111 a	44	88	2541	145	6.6	36.61	9.5	8.6	7.7	26	526011
116 b	61	93	2364	145	6.6	37.40	7.4	9.1	8.3	23	729243
203 a	45	107	3827	240	6.4	40.80	7.2	8.5	6.7	32	537966
210 b	34	99	2742	170	4.5	43.70	8.6	10.2	8.0	29	406463
305 a	56	102	3630	230	7.1	40.20	9.7	9.7	8.1	33	669469
326 b	43	107	4114	285	7.0	43.10	8.0	10.0	9.4	34	514056
1101 a	30	9									358644
1101 b	14	8									167367
1201 a	5	7									59774
1201 b	12	7									143458
2101 a	19	8									227141
2101 b	29	9									346689

2201 a	24	9	286915
2201 b	16	8	191277
3101 a	34	8	406463
3101 b	27	8	322780
3201 a	15	8	179322
3201 b	12	9	143458
4101 a	13	9	155412
4101 b	20	7	239096
4201 a	11	8	131503
4201 b	10	9	119548
1102 a	26	9	310825
1102 b	28	10	334734
1202 a	13	9	155412
1202 b	16	10	191277
2102 a	23	10	274960
2102 b	28	11	334734
2202 a	27	10	322780
2202 b	17	10	203232
3102 a	28	10	334734
3102 b	24	9	286915
3202 a	9	10	107593
3202 b	11	11	131503
4102 a	38	9	454282
4102 b	46	9	549921
4202 a	7	12	83684
4202 b	7	12	83684
1103 a	44	14	526011
1103 b	17	14	203232
1203 a	21	9	251051
1203 b	17	9	203232
2103 a	33	23	394508

2103 b	32	26								382554
2203 a	22	18								263006
2203 b	25	24								298870
3103 a	25	26								298870
3103 b	21	27								251051
3203 a	7	29								83684
3203 b	12	24								143458
4103 a	35	16								418418
4103 b	25	18								298870
4203 a	12	18								143458
4203 b	14	25								167367
1104 a	34	50	80	5.0			1.5		9	406463
1104 b	25	66	59	7.0			1.4		9	298870
1204 a	6	37	18	1.0			1.4		7	71729
1204 b	9	37	30	12.0			1.5		1	107593
2104 a	27	61	43	11.0			1.5		4	322780
2104 b	13	54	38	8.0			1.5		6	155412
2204 a	24	58	187	9.0			1.6		15	286915
2204 b	22	62	67	7.0			1.5		11	263006
3104 a	22	72	115	10.0			1.4		8	263006
3104 b	14	58	49	7.0			1.6		10	167367
3204 a	13	74	42	7.0			1.5		1	155412
3204 b	11	61	28	13.0			1.2		0	131503
4104 a	30	55	105	13.0			1.3		17	358644
4104 b	11	42		5.0						131503
4204 a	17	66	107	10.0			1.0		3	203232
4204 b	14	47	25	12.0			1.2		3	167367
1105 a	40	101	731	5.1	36.20	6.5	8.2	4.8	14	478192
1105 b	45	90	702	5.2	31.60	10.1	7.6	4.0	18	537966
1205 a	2	49	153	12.0	22.50	6.4	6.6	2.0	19	23910
1205 b	12	81	648	5.5	17.25	8.9	5.5	3.0	11	143458

2105 a	28	94	1976	7.8	37.61	5.0	6.0	4.0	25	334734
2105 b	21	105	525	5.9	33.49	7.0	4.5	3.5	20	251051
2205 a	19	91	1017	7.5	28.65	7.2	5.4	3.3	14	227141
2205 b	23	90	566	5.2	21.47	5.7	4.6	2.7	9	274960
3105 a	8	72	179	8.9	19.43	5.6	3.1	3.2	10	95638
3105 b	4	67	74	6.3	16.38	5.3	3.3	2.0	10	47819
3205 a	14	90	703	8.0	32.98	8.0	6.2	3.2	18	167367
3205 b	19	87	1587	7.7	35.59	6.5	5.0	2.8	27	227141
4105 a	19	104	1175	8.4	33.90	8.0	5.5	5.5	30	227141
4105 b	13	82	385	6.6	25.32	8.7	5.9	3.2	15	155412
4205 a	21	88	1348	8.8	39.04	7.7	6.9	3.6	23	251051
4205 b	15	93	1010	7.4	28.38	7.3	5.1	3.4	18	179322
1106 a	36	104	3203	6.7	40.93	8.0	5.8	3.0	31	430373
1106 b	18	110	4574	6.4	47.99	7.5	8.5	4.0	38	215186
1206 a	2	70	131	7.5	9.05	5.4	3.8	3.2	7	23910
1206 b	8	107	671	8.3	10.86	6.5	5.7	3.8	5	95638
2106 a	20	110	2971	6.6	44.77	10.0	7.6	3.8	33	239096
2106 b	25	110	1957	5.5	46.90	9.5	8.2	4.3	28	298870
2206 a	16	110	2650	7.3	39.67	8.4	8.5	4.5	28	191277
2206 b	15	104	2310	7.4	34.15	8.7	5.8	3.1	24	179322
3106 a	8	98	1273	6.6	21.36	9.0	7.3	3.2	15	95638
3206 a	22	107	3044	5.1	39.45	8.9	7.0	3.5	25	263006
3206 b	18	101	2472	8.0	47.62	9.8	7.2	4.0	30	215186
4106 a	16	107	2615	7.2	32.02	9.0	7.1	8.2	25	191277
4106 b	12	94	2243	5.6	41.31	9.4	8.7	5.2	27	143458
4206 a	22	107	2396	6.1	34.25	9.2	7.2	4.3	19	263006
4206 b	28	107	2614	6.4	33.44	8.7	8.1	3.0	21	334734
1107 a	15	113	2682	5.2	44.15	8.9	10.2	6.8	27	179322
1107 b	27	116	3306	4.5	45.70	11.0	10.5	6.9	37	322780
1207 b	9	110	4093	9.8	41.55	8.7	8.1	7.1	29	107593
2107 a	18	111	2940	5.1	46.17	10.1	8.2	7.9	30	215186

2107 b	19	111	3219		8.5	42.14	9.1	7.6	6.3	29	227141
2207 a	15	116	4260		8.6	46.90	10.0	7.9	5.8	35	179322
2207 b	19	107	2935		6.5	40.08	10.1	6.8	4.5	31	227141
3107 a	11	105	2464		8.1	29.42	9.2	9.1	6.0	22	131503
3207 a	26	107	2528		5.0	45.69	9.0	9.7	7.0	33	310825
3207 b	20	101	2744		5.7	40.32	9.6	10.2	7.0	25	239096
4107 a	18	104	2933		6.4	39.31	7.0	9.3	7.0	27	215186
4107 b	8	105	2458		8.3	35.50	12.0	9.5	8.5	27	95638
4207 a	30	104	2761		5.7	42.00	11.0	7.1	6.5	27	358644
4207 b	21	107	2692		5.0	41.60	8.2	10.2	7.0	26	251051
1108 a	21	113	2873		6.4	44.70	9.6	8.6	7.5	28	251051
1108 b	8	122	2251		5.3	49.38	9.0	8.1	5.3	29	95638
1208 a	6	101	1566		7.3	44.80	8.5	9.1	7.3	30	71729
1208 b	7	101	3255		10.0	49.87	9.1	6.3	6.6	33	83684
2108 a	15	122	3419		5.6	48.47	7.9	10.5	7.9	34	179322
2108 b	6	111	1184		7.2	32.61	12.1	11.3	5.1	20	71729
2208 a	9	107	2264		8.2	31.72	8.6	9.7	6.9	21	107593
2208 b	12	113	2967		6.6	51.10	9.2	8.8	6.6	34	143458
3108 a	5	104	1430		9.2	35.78	9.3	8.1	5.2	30	107593
3108 b	2	104	2181		13.0	30.30	11.3	9.1	6.6	23	23910
3208 a	19	107	3180		6.1	52.50	9.3	9.8	6.7	27	227141
3208 b	22	98	2278		5.9	38.20	8.2	8.9	7.3	25	263006
4108 a	16	105	2937		6.6	40.22	8.8	8.7	6.0	28	191277
4108 b	18	104	2628		4.5	36.69	7.4	8.5	6.2	21	215186
4208 a	15	98	2919		7.5	43.19	8.0	9.0	8.2	28	179322
4208 b	32	98	2684		5.8	37.26	9.5	8.7	8.1	26	382554
1109 a	12	119	1750	75	4.9	51.50	10.4	9.6	7.3	26	143458
1109 b	29	117	2946	185	5.0	54.45	8.5	9.0	8.0	42	346689
1209 a	4	102	1220	70	7.5	33.43	10.0	7.1	5.7	21	47819
1209 b	4	101	2046	115	12.3	39.95	6.5	8.1	7.1	29	47819
2109 a	13	104	2159	90	6.7	27.51	8.6	10.5	8.7	20	155412

2109 b	28	108	2542	100	5.9	46.70	10.4	9.4	8.4	25	334734
2209 a	12	110	3236	190	9.2	51.10	9.2	9.5	7.9	32	143458
2209 b	10	104	2510	110	7.8	41.40	8.0	8.5	8.0	19	119548
3109 a	16	114	2775	165	5.8	41.90	10.3	9.5	8.6	27	191277
3109 b	26	110	2426	120	5.1	39.32	10.4	9.4	5.5	27	310825
3209 a	19	105	2658	135	5.4	48.20	9.5	8.7	7.5	27	227141
3209 b	17	104	1929	100	3.7	42.80	9.6	8.0	5.3	21	203232
4109 a	21	107	2662	145	5.7	51.00	8.7	7.8	8.0	29	251051
4109 b	10	102	1489	60	4.8	45.80	12.1	8.5	9.2	25	119548
4209 a	12	108	2368	125	7.3	47.15	8.3	8.8	7.5	30	143458
4209 b	20	88	2412	140	6.7	33.13	6.6	8.7	6.6	23	239096
1110 a	18	110	3599	240	7.0	49.89	9.0	10.0	5.5	39	215186
1110 b	21	108	3255	230	6.3	43.98	9.5	10.3	8.5	30	251051
1210 a	11	94	2945	195	8.3	44.60	8.2	7.7	7.2	24	131503
1210 b	14	98	2734	165	7.4	41.90	9.3	8.8	8.7	24	167367
2110 a	18	105	2208	135	5.4	44.60	8.0	8.5	7.1	25	215186
2110 b	26	108	2299	125	4.3	46.80	9.7	9.0	8.1	25	310825
2210 a	9	105	2357	170	6.9	41.83	10.5	9.1	8.1	26	107593
2210 b	10	110	2310	160	8.5	43.11	9.1	9.5	7.5	25	119548
3110 a	25	105	2325	135	5.7	44.45	10.5	8.5	8.8	26	298870
3110 b	23	107	2809	180	5.1	54.60	5.8	9.6	9.1	30	274960
3210 a	18	98	2175	140	5.6	44.76	9.1	7.5	7.6	20	215186
3210 b	19	98	2026	125	5.6	36.20	8.5	8.3	6.3	20	227141
4110 a	22	98	2376	170	5.1	43.00	9.8	9.6	7.9	23	263006
4110 b	12	107	1349	50	4.9	42.10	10.5	9.8	8.8	22	143458
4210 a	10	104	2565	175	6.8	49.60	9.5	7.2	8.0	27	119548
4210 b	14	101	2121	155	7.7	49.80	9.3	9.4	6.5	29	167367
1101	150	15									1793238
1201	80	14									956394
1301	116	19									1386771
1401	72	12									860754

2101	79	12	944439
2201	118	11	1410681
2301	75	11	896619
2401	56	12	669475
3101	121	9	1446545
3201	103	12	1231357
3301	68	12	812935
3401	63	13	753160
4101	74	12	884664
4201	107	11	1279176
4301	98	13	1171582
1102	97	11	1159627
1202	37	8	442332
1302	102	11	1219402
1402	67	7	800980
2102	49	7	585791
2202	90	9	1075943
2302	57	9	681430
2402	34	6	406467
3102	71	7	848799
3202	87	7	1040078
3302	50	8	597746
3402	33	6	394512
4102	60	6	717295
4202	74	8	884664
4302	70	8	836844
1103	139	4	1661734
1203	42	4	502107
1303	91	5	1087898
1403	41	4	490152
2103	60	4	717295

2203	54	3	516443
2303	73	4	581800
2403	46	4	549926
3103	92	4	733228
3203	62	5	741205
3303	39	3	466242
3403	21	5	251053
4103	32	4	382557
4203	67	4	800980
4303	54	4	645566
1104	100	11	1195492
1204	40	12	478197
1304	75	14	896619
1404	43	11	514062
2104	22	6	263008
2204	40	9	637589
2304	37	8	442332
2404	37	8	442332
3104	94	10	1123762
3204	72	10	860754
3304	40	11	478197
3404	23	12	274963
4104	71	10	848799
4204	48	10	573836
4304	48	9	573836
1105	92	46	1099853
1205	33	35	394512
1305	76	42	908574
1405	49	43	585791
2105	41	15	490152
2205	49	29	585791

2305	44	22							526016
2405	39	24							466242
3105	66	32							789025
3205	65	27							777070
3305	40	37							478197
3405	29	30							346693
4105	34	28							406467
4205	64	27							765115
4305	66	28							789025
1106	86	71							1028123
1206	16	63							191279
1306	83	72							992258
1406	44	62							526016
2106	54	53							645566
2206	31	55							370603
2306	29	62							346693
2406	27	60							322783
3106	59	68							705340
3206	58	57							693385
3306	34	66							406467
3406	29	54							346693
4106	28	62							334738
4206	55	65							657521
4306	45	61							537971
1107	82	101	933	6.1	18.54	4.5	3.0	13	980303
1207	23	101	128	7.5	21.09	4.5	3.5	10	274963
1307	63	107	234	7.7	20.06	4.0	3.0	9	753160
1407	43	104	209	6.9	21.49	4.0	3.5	9	514062
2107	51	91	543	6.1	22.17	6.5	4.0	18	609701
2207	19	94	79	6.1	18.72	4.5	3.0	8	227143
2307	35	98	167	7.7	25.35	6.0	4.0	10	418422

2407	41	94	216	6.3	14.76	4.0	3.5		8	490152
3107	62	91	394	5.7	19.15	4.5	3.8		13	741205
3207	48	88	229	7.9	18.11	4.0	3.5		9	573836
3307	32	98	188	8.1	20.90	4.5	3.2		7	382557
3407	22	98	80	8.2	14.76	4.5	3.5		7	263008
4107	38	98	319	7.6	25.58	4.0	3.0		17	454287
4207	51	98	171	8.2	17.08	4.5	3.5		5	609701
4307	49	98	181	7.5	14.48	3.8	2.8		6	585791
1108	35	116	1739	5.5	35.47	10.0	5.0	3.0	36	418422
1208	23	116	1586	7.9	33.31	10.0	4.5	3.0	26	274963
1308	47	119	2238	6.3	31.26	8.5	3.8	2.5	27	561881
1408	27	119	2220	6.9	36.98	9.0	5.0	3.0	33	322783
2108	51	107	2871	5.8	34.07	10.0	6.5	3.5	34	609701
2208	44	101	1401	6.2	29.88	7.0	3.5	3.0	18	526016
2308	29	107	1185	7.7	34.65	8.5	5.0	3.0	31	346693
2408	36	116	2067	7.7	35.02	9.5	5.5	3.5	33	430377
3108	68	113	2628	6.0	28.11	12.0	5.5	3.5	28	812935
3208	49	104	1909	6.9	32.69	6.5	4.0	3.0	31	585791
3308	20	104	1206	8.0	31.44	10.5	6.5	3.5	22	239098
3408	32	113	800	8.5	34.76	8.5	7.0	3.5	25	382557
4108	25	107	1765	7.8	30.42	7.5	4.5	3.0	23	298873
4208	49	104	1863	7.6	30.93	8.0	4.5	3.0	33	585791
4308	45	110	1280	7.6	28.88	7.0	3.5	3.0	26	537971
1109	61	122	5679	5.8	42.37	12.5	8.5	3.0	47	729250
1209	21	131	4555	7.5	45.65	11.0	6.0	3.5	43	251053
1309	57	134	6035	7.1	45.06	9.5	7.5	3.0	50	681430
1409	45	137	5055	6.3	42.15	10.5	7.3	3.0	50	537971
2109	50	116	5535	5.9	40.43	9.5	7.0	3.0	42	597746
2209	49	116	6031	6.4	44.64	11.5	9.0	3.0	43	585791
2309	29	122	4937	6.9	45.88	10.3	7.0	3.0	49	346693
2409	31	122	3869	6.2	43.33	11.5	9.5	3.3	43	370603

3109	41	116	4581	7.6	40.62	10.5	8.5	3.0	49	490152
3209	34	107	4116	8.0	39.92	10.3	8.0	3.5	37	406467
3309	32	128	4517	8.2	43.28	11.3	9.5	2.5	40	382557
3409	25	125	4048	8.1	39.31	9.8	6.0	3.0	39	298873
4109	26	113	4175	7.1	41.68	10.3	7.5	2.5	43	310828
4209	38	116	4788	8.0	37.98	8.8	6.0	3.5	41	454287
4309	38	122	5843	8.8	41.13	11.0	8.5	4.0	42	454287
1110	40	137	4656	5.9	44.85	12.0	10.0	3.8	45	478197
1210	20	134	5763	6.6	54.63	10.3	10.8	5.0	54	239098
1310	38	134	6298	5.9	48.24	9.5	9.0	3.3	48	454287
1410	42	143	5362	6.1	50.60	11.0	10.0	5.0	53	502107
2110	74	128	7168	6.4	41.15	11.5	10.3	7.0	46	884664
2210	68	119	5817	6.4	41.13	9.5	8.0	4.0	41	812935
2310	44	131	5961	7.0	47.05	11.0	9.3	6.3	50	526016
2410	20	131	6741	7.6	53.96	10.5	9.0	3.5	59	239098
3110	13	116	1662	7.7	40.41	12.3	10.5	4.5	42	155414
3210	49	110	7285	7.6	44.01	10.5	9.5	3.5	54	585791
3310	34	134	6223	7.5	43.79	11.0	8.5	3.3	39	406467
3410	29	134	4596	7.6	40.86	10.0	8.3	5.3	37	346693
4110	24	110	5924	7.7	37.75	11.0	9.8	4.3	37	286918
4210	54	125	7127	7.3	41.34	10.3	10.0	7.3	49	645566
4310	50	131	7541	7.3	45.65	10.5	9.0	3.0	58	597746
1111	35	140	5678	6.7	45.41	10.0	9.3	4.3	48	418422
1211	33	140	6027	7.2	49.09	12.0	11.0	8.5	51	394512
1311	42	137	6597	6.7	50.07	10.5	9.0	6.0	56	502107
1411	44	149	5247	5.4	48.04	10.3	9.0	8.0	53	526016
2111	52	128	4786	6.5	43.34	11.8	10.0	4.0	50	621656
2211	53	122	3936	5.9	40.47	10.3	9.5	6.0	42	633611
2311	35	119	6445	7.6	45.13	11.5	9.0	9.0	45	418422
2411	32	131	7146	6.7	48.63	10.3	8.5	5.3	54	382557
3111	63	107	3763	6.7	38.67	10.0	10.0	6.0	45	753160

3211	56	116	4696		7.1	40.21	11.3	9.5	5.5	44	669475
3311	40	134	6785		6.0	45.15	10.5	9.5	6.5	39	478197
3411	25	131	5779		7.9	48.41	12.0	10.8	6.5	55	298873
4111	21	110	4628		8.0	39.05	9.0	8.5	7.3	44	251053
4211	46	116	3830		6.0	40.37	12.0	11.5	8.0	49	549926
4311	52	131	5823		7.2	45.12	9.0	8.3	6.0	45	621656
1112	45	137	5164	80	5.8	50.13	11.0	9.0	6.5	52	537971
1212	41	137	4895	90	6.2	46.32	9.8	8.5	7.0	46	490152
1312	53	140	6311	60	6.8	49.87	11.8	9.3	6.5	53	633611
1412	70	143	3828	80	5.7	46.51	11.5	10.3	6.3	48	836844
2112	58	131	4187	95	5.7	40.76	10.0	9.5	7.8	45	693385
2212	63	125	4388	85	6.1	42.29	10.0	9.5	6.3	42	753160
2312	40	125	5678	80	7.4	43.45	9.5	10.0	6.8	45	478197
2412	34	137	4846	75	6.3	44.60	11.5	9.0	7.5	46	406467
3112	34	107	3189	90	6.3	33.20	8.5	11.0	9.0	35	406467
3212	39	104	3796	80	6.8	41.91	10.5	10.0	7.0	47	466242
3312	18	122	4719	80	8.4	56.09	11.5	10.0	8.0	56	215189
3412	29	140	5838	55	8.2	47.83	11.3	10.3	8.3	47	346693
4112	25	107	4993	60	6.7	45.16	11.0	9.3	7.0	46	298873
4212	64	116	4169	85	7.5	39.89	10.3	10.0	6.5	49	765115
4312	45	134	6324	65	6.2	46.65	10.3	8.8	7.5	47	537971
1113	45	125	3832	230	4.9	39.04	11.5	9.5	6.5	36	537971
1213	46	128	4368	290	5.6	44.24	11.0	10.0	8.0	45	549926
1313	64	149	3938	205	6.4	43.42	10.8	9.5	7.3	50	765115
1413	49	143	3890	225	6.5	46.17	11.0	10.0	6.0	50	585791
2113	65	116	3719	245	5.4	43.72	10.5	9.8	6.5	46	777070
2213	57	122	3459	215	5.7	47.22	8.5	9.0	8.0	50	681430
2313	37	125	4916	275	6.5	43.10	9.5	8.8	6.5	42	442332
2413	37	137	4433	235	6.0	43.86	10.5	11.0	7.0	46	442332
3113	46	107	2720	165	5.3	32.01	11.0	9.8	8.0	35	549926
3213	50	104	3830	205	5.7	46.42	10.5	9.5	8.0	41	597746

3313	36	131	5702	285	7.8	47.87	10.3	9.0	7.0	44	430377
3413	23	131	4810	225	7.0	46.22	9.8	9.5	7.5	46	274963
4113	21	104	3648	140	7.1	38.34	9.5	10.0	6.5	34	251053
4213	47	128	3877	220	5.9	42.76	11.0	10.8	6.5	47	561881
4313	36	131	6521	260	6.9	46.50	10.8	8.0	6.8	47	430377
1114	54	131	3421	320	5.5	41.26	10.5	10.0	7.0	46	645566
1214	57	128	3281	265	4.7	41.24	9.5	7.5	7.0	41	681430
1314	55	134	3866	250	6.6	43.21	10.5	9.0	6.0	44	657521
1414	56	140	3722	280	6.0	45.77	10.5	10.0	9.0	51	669475
2114	59	125	3378	290	5.8	39.96	10.8	9.5	8.5	44	705340
2214	101	125	4560	375	5.1	38.26	11.3	9.5	8.0	39	1207447
2314	29	131	4396	295	5.1	57.23	9.5	9.5	8.0	48	346693
2414	51	134	3298	230	6.0	41.63	10.8	10.0	5.0	44	609701
3114	60	116	3092	300	6.0	44.57	10.5	7.8	6.3	47	717295
3214	59	104	3330	250	5.6	40.36	9.0	9.8	7.0	43	705340
3314	40	131	4843	315	5.7	48.79	10.5	9.3	7.0	47	478197
3414	50	134	4646	300	6.3	46.80	10.5	10.5	8.0	44	597746
4114	40	122	5374	395	5.5	45.27	10.5	8.5	5.3	44	478197
4214	52	125	3353	285	5.7	41.61	10.5	9.0	7.3	40	621656
4314	59	125	4741	290	6.2	45.27	10.5	9.0	6.0	46	705340
1115	64	125	5148	450	4.4	41.40	10.8	10.5	9.0	45	765115
1215	73	131	7500	630	5.6	46.76	11.0	7.0	7.0	49	872709
1315	44	140	4992	450	6.3	44.38	10.3	9.0	8.0	50	526016
1415	48	146	4716	395	5.7	46.28	9.5	9.3	7.5	48	573836
2115	64	122	5334	470	5.0	40.27	9.0	7.3	6.0	41	765115
2215	89	125	4861	390	4.9	43.60	10.8	8.3	7.8	43	1063988
2315	43	131	5841	470	5.4	52.62	9.0	9.5	5.8	48	514062
2415	44	131	5158	480	5.2	54.06	9.5	9.8	7.5	53	526016
3115	67	110	4135	340	5.3	41.65	9.3	10.3	7.5	42	800980
3215	45	107	4483	295	5.3	41.82	11.5	11.0	6.5	40	537971
3315	39	128	6243	450	5.3	48.89	10.5	8.0	7.0	47	466242

3415	29	134	4492	320	5.6	48.97	11.5	9.0	7.0	47	346693
4115	41	119	5386	335	6.6	44.30	9.5	9.0	7.5	38	490152
4215	54	122	5778	480	5.1	39.02	9.0	8.5	7.3	39	645566
4315	46	131	6259	435	5.6	45.00	10.0	8.0	7.0	43	549926
1116	74	125	4671	425	4.9	43.71	10.5	8.0	10.0	40	884664
1216	53	131	4463	340	5.5	45.66	10.3	9.5	7.5	41	633611
1316	71	140	4329	385	6.1	34.39	11.0	10.0	6.0	35	848799
1416	63	146	5278	510	6.3	45.15	10.5	8.5	6.8	40	753160
2116	57	122	4538	430	4.6	40.17	10.8	11.0	7.5	43	681430
2216	65	125	4456	345	4.9	36.14	9.5	9.0	8.5	36	777070
2316	60	131	5046	455	5.5	40.08	9.0	7.8	8.0	39	717295
2416	35	131	4259	390	5.3	45.40	10.5	9.0	7.0	46	418422
3116	87	110	3439	280	4.1	33.76	10.5	10.0	7.0	39	1040078
3216	51	107	4434	375	6.4	33.85	10.5	9.5	7.5	36	609701
3316	35	128	4987	400	6.9	47.28	10.5	9.0	7.0	44	418422
3416	28	134	5137	410	7.2	49.18	9.8	8.5	5.5	45	334738
4116	40	119	4994	400	5.8	42.23	10.8	8.5	7.5	35	478197
4216	60	122	4154	330	5.6	41.06	11.5	10.0	8.0	44	717295
4316	30	131	4650	320	6.1	47.86	11.0	9.5	9.0	43	358648

Table D.2. Yield formation data and calculations for the Riley (2017), Wichita (2018), Surefire (2018), and Surefire-Wichita (2019) studies continued.

Plot	Sub	WS_Pd_Ct	Pd_per_Pt	Pd_sqm	WS_Sd_Vol	Avg_TSW	TW	Yield
105	b	3558	115	4254				
205	b	3133	131	3746				
305	b	3223	75	3853				
405	a	5367	69	6417				
405	b	4617	100	5520				
505	a	3918	157	4684				
505	b	3390	170	4053				
605	b	4084	57	4883				
106	b	4743	75	5671				
206	b	4074	99	4871				
306	b	4111	206	4915				
406	b	4612	115	5514				
506	b	3700	97	4424				
606	b	5169	126	6180				
107	a	5010	239	5990				
207	a	3631	134	4341				
307	a	4041	311	4831				
407	a	3395	87	4059				
507	a	3927	207	4695				
607	a	3904	156	4667				
108	a	4564	304	5457				
208	a	4435	117	5302				
308	b	3820	225	4567				
408	a	3720	128	4447				
508	a	4625	145	5529				
608	a	4241	129	5070				
109	a	3686	194	4407				

209 a	3913	95	4678			
309 a	3638	303	4349			
409 a	3511	106	4198			
509 a	2845	150	3401			
609 a	3526	131	4216			
110 a				310	50.68	2420
110 b				420	51.36	3322
210 a				360	50.06	2776
210 b				380	49.88	2919
310 a				265	51.29	2093
310 b				200	51.73	1594
410 a				300	51.02	2357
410 b				245	49.36	1863
510 a				325	51.06	2556
510 b				280	51.59	2225
610 a				275	55.46	2349
610 b				325	50.32	2519
101 a	523	16	625			
119 b	961	22	1149			
219 a	1049	18	1254			
225 b	636	12	760			
308 a	750	9	897			
320 b	811	11	970			
127 a	6313	191	7547			
128 b	8946	163	10695			
202 a	6458	158	7720			
218 b	4275	97	5111			
314 a	4797	130	5735			
318 b	9304	176	11124			
112 a	6678	95	7984			
123 b	8096	176	9679			

204 a	10489	154	12540				
217 b	5600	86	6695				
302 a	7589	122	9073				
315 b	6907	147	8257				
102 a	5108	189	6107				
120 b	4884	129	5839				
224 a	4011	98	4796				
229 b	6083	122	7273				
313 a	5592	133	6685				
330 b	8189	171	9790				
110 a	3674	78	4392				
130 b	8337	170	9967				
211 a	4590	102	5488				
227 b	6354	122	7597				
319 a	6430	117	7687				
329 b	6963	199	8324				
111 a	3727	85	4456	213	2.82	48.87	1601
116 b	4807	79	5747	295	2.66	50.37	2287
203 a	5741	128	6863	360	3.08	51.91	2878
210 b	3108	91	3715	193	2.50	52.10	1546
305 a	6776	121	8101	429	2.78	52.27	3457
326 b	5897	137	7050	409	2.92	53.38	3359
1104 a	80	2	96				
1104 b	59	2	71				
1204 a	18	3	22				
1204 b	30	3	36				
2104 a	43	2	51				
2104 b	38	3	45				
2204 a	187	8	224				
2204 b	67	3	80				
3104 a	115	5	137				

3104 b	49	4	59
3204 a	42	3	50
3204 b	28	3	33
4104 a	105	4	126
4104 b			
4204 a	107	6	128
4204 b	25	2	30
1105 a	1462	37	1748
1105 b	1580	35	1888
1205 a	153	77	183
1205 b	648	54	775
2105 a	2766	99	3307
2105 b	551	26	659
2205 a	1017	54	1216
2205 b	651	28	778
3105 a	179	22	214
3105 b	74	19	88
3205 a	703	50	840
3205 b	1587	84	1897
4105 a	1175	62	1405
4105 b	385	30	460
4205 a	1415	67	1692
4205 b	1010	67	1208
1106 a	5765	160	6893
1106 b	4574	254	5468
1206 a	131	66	157
1206 b	671	84	802
2106 a	2971	149	3552
2106 b	2446	98	2925
2206 a	2650	166	3168
2206 b	2310	154	2762

3106 a	1273	159	1522
3206 a	3348	152	4003
3206 b	2472	137	2955
4106 a	2615	163	3126
4106 b	2243	187	2682
4206 a	2636	120	3151
4206 b	3660	131	4375
1107 a	2682	179	3206
1107 b	4463	165	5336
1207 b	4093	455	4893
2107 a	2940	163	3515
2107 b	3219	169	3848
2207 a	4260	284	5093
2207 b	2935	154	3509
3107 a	2464	224	2946
3207 a	3286	126	3929
3207 b	2744	137	3281
4107 a	2933	163	3507
4107 b	2458	307	2939
4207 a	4142	138	4951
4207 b	2827	135	3379
1108 a	3017	144	3607
1108 b	2251	281	2691
1208 a	1566	261	1872
1208 b	3255	465	3892
2108 a	3419	228	4088
2108 b	1184	197	1416
2208 a	2264	252	2707
2208 b	2967	247	3547
3108 a	1430	286	3077
3108 b	2181	1091	2608

3208 a	3180	167	3802				
3208 b	2506	114	2996				
4108 a	2937	184	3511				
4108 b	2628	146	3142				
4208 a	2919	195	3490				
4208 b	4294	134	5134				
1109 a	1750	146	2092	75	2.43	51.44	594
1109 b	4272	147	5107	268	2.80	50.60	2091
1209 a	1220	305	1459	70	2.46	53.56	577
1209 b	2046	512	2446	115	2.59	51.77	917
2109 a	2159	166	2581	90	2.60	51.75	717
2109 b	3559	127	4255	140	1.89	44.55	961
2209 a	3236	270	3869	190	2.68	52.45	1535
2209 b	2510	251	3001	110	2.48	51.65	875
3109 a	2775	173	3318	165	2.57	52.03	1322
3109 b	3154	121	3771	156	2.58	52.00	1250
3209 a	2658	140	3178	135	2.61	52.26	1087
3209 b	1929	113	2306	100	2.60	50.84	783
4109 a	2795	133	3342	152	2.90	52.51	1231
4109 b	1489	149	1780	60	2.58	49.68	459
4209 a	2368	197	2831	125	2.66	51.48	991
4209 b	2412	121	2884	140	2.79	52.50	1132
1110 a	3599	200	4303	240	2.77	50.26	1858
1110 b	3418	163	4086	242	2.93	50.01	1860
1210 a	2945	268	3521	195	2.92	48.60	1460
1210 b	2734	195	3269	165	2.90	52.55	1335
2110 a	2208	123	2640	135	2.93	49.33	1026
2110 b	2989	115	3573	163	2.55	50.23	1257
2210 a	2357	262	2818	170	3.02	50.13	1313
2210 b	2310	231	2762	160	2.89	51.62	1272
3110 a	2906	116	3475	169	2.92	52.21	1357

3110 b	3230	140	3862	207	2.91	53.00	1690
3210 a	2175	121	2600	140	2.85	52.50	1132
3210 b	2026	107	2422	125	3.00	51.54	992
4110 a	2614	119	3125	187	3.07	52.78	1520
4110 b	1349	112	1613	50	2.56	53.71	414
4210 a	2565	257	3067	175	3.09	52.03	1402
4210 b	2121	152	2536	155	2.96	51.28	1224
1107	933	11	1115				
1207	128	6	153				
1307	234	4	280				
1407	209	5	250				
2107	543	11	649				
2207	79	4	94				
2307	167	5	200				
2407	216	5	258				
3107	394	6	471				
3207	229	5	274				
3307	188	6	225				
3407	80	4	96				
4107	319	8	381				
4207	171	3	204				
4307	181	4	216				
1108	1739	50	2079				
1208	1586	69	1896				
1308	2238	48	2676				
1408	2220	82	2654				
2108	2871	56	3432				
2208	1401	32	1675				
2308	1185	41	1417				
2408	2067	57	2471				
3108	2628	39	3142				

3208	1909	39	2282
3308	1206	60	1442
3408	800	25	956
4108	1765	71	2110
4208	1863	38	2227
4308	1280	28	1530
1109	5679	93	6790
1209	4555	217	5446
1309	6035	106	7215
1409	5055	112	6044
2109	5535	111	6617
2209	6031	123	7210
2309	4937	170	5903
2409	3869	125	4626
3109	4581	112	5477
3209	4116	121	4921
3309	4517	141	5400
3409	4048	162	4840
4109	4175	161	4991
4209	4788	126	5724
4309	5843	154	6986
1110	4656	116	5567
1210	5763	288	6890
1310	6298	166	7530
1410	5362	128	6411
2110	7168	97	8570
2210	5817	86	6955
2310	5961	135	7127
2410	6741	337	8059
3110	1662	128	1987
3210	7285	149	8710

3310	6223	183	7440				
3410	4596	158	5495				
4110	5924	247	7083				
4210	7127	132	8521				
4310	7541	151	9016				
1111	6624	189	7920				
1211	6630	201	7926				
1311	9236	220	11042				
1411	7696	175	9201				
2111	8296	160	9918				
2211	6954	131	8313				
2311	7519	215	8990				
2411	7622	238	9113				
3111	7902	125	9448				
3211	8766	157	10480				
3311	9047	226	10816				
3411	5779	231	6909				
4111	4628	220	5533				
4211	5873	128	7021				
4311	10093	194	12067				
1112	7746	172	9261	120	1.73	54.82	1013
1212	6690	163	7998	123	1.60	52.00	985
1312	11149	210	13330	106	1.40	49.03	800
1412	8932	128	10679	187	1.63	55.30	1590
2112	8095	140	9678	184	1.73	53.43	1512
2212	9215	146	11017	179	1.53	52.23	1436
2312	7571	189	9051	107	1.53	50.84	835
2412	5492	162	6566	85	1.47	50.30	658
3112	3614	106	4321	102	1.33	49.07	771
3212	4935	127	5900	104	1.50	53.75	861
3312	4719	262	5642	80	1.07	48.61	599

3412	5838	201	6980	55	1.17	47.56	403
4112	4993	200	5969	60	0.83	47.35	438
4212	8894	139	10633	181	1.77	54.70	1528
4312	9486	211	11341	98	1.33	48.72	732
1113	5748	128	6872	345	2.90	54.40	2891
1213	6698	146	8007	445	2.87	54.23	3714
1313	8401	131	10044	437	2.60	53.69	3616
1413	6354	130	7596	368	2.87	54.54	3087
2113	8058	124	9634	531	2.90	54.52	4458
2213	6572	115	7857	409	2.80	55.71	3505
2313	6063	164	7249	339	2.47	55.24	2885
2413	5467	148	6537	290	2.37	54.43	2430
3113	4171	91	4986	253	2.53	55.27	2154
3213	6383	128	7632	342	2.37	53.61	2821
3313	6842	190	8181	342	2.30	53.84	2836
3413	4810	209	5751	225	2.30	52.85	1831
4113	3648	174	4361	140	2.23	53.39	1151
4213	6074	129	7262	345	2.53	55.99	2972
4313	7825	217	9356	312	2.07	54.12	2601
1114	6158	114	7362	576	3.67	54.99	4878
1214	6234	109	7453	504	3.60	55.94	4338
1314	7088	129	8474	458	3.53	55.17	3895
1414	6948	124	8306	523	3.40	56.00	4508
2114	6643	113	7943	570	3.70	56.45	4959
2214	7676	76	9177	631	3.77	54.83	5331
2314	4396	152	5256	295	3.13	55.99	2544
2414	5607	110	6703	391	3.37	55.55	3345
3114	6184	103	7393	600	3.30	54.46	5033
3214	6549	111	7830	492	3.10	55.20	4180
3314	6457	161	7720	420	3.13	55.49	3590
3414	7743	155	9258	500	2.80	55.63	4284

4114	7165	179	8567	527	2.97	54.20	4396
4214	5812	112	6948	494	3.20	54.28	4130
4314	9324	158	11147	570	2.93	56.21	4937
1115	5148	80	6155	450	3.27	52.88	3665
1215	7500	103	8967	630	3.40	53.66	5206
1315	4992	113	5968	450	3.60	53.18	3686
1415	4716	98	5638	395	3.57	55.22	3359
2115	5334	83	6377	470	3.33	52.93	3832
2215	4861	55	5812	390	3.47	52.38	3147
2315	5841	136	6983	470	3.20	53.82	3896
2415	5158	117	6167	480	3.60	49.17	3635
3115	4135	62	4944	340	3.20	53.10	2781
3215	4483	100	5360	295	3.27	54.89	2494
3315	6243	160	7464	450	3.40	54.80	3798
3415	4492	155	5370	320	3.13	55.33	2727
4115	5386	131	6439	335	3.27	61.26	3161
4215	5778	107	6908	480	3.43	53.52	3957
4315	6259	136	7483	435	3.27	54.28	3637
1116	4671	63	5584	425	3.53	52.62	3444
1216	4463	84	5336	340	3.60	54.01	2829
1316	4329	61	5176	385	3.57	53.85	3193
1416	5278	84	6310	510	3.77	53.31	4188
2116	4538	80	5425	430	3.23	53.07	3515
2216	4456	69	5327	345	3.47	53.14	2824
2316	5046	84	6033	455	3.67	53.41	3743
2416	4259	122	5092	390	3.60	53.78	3230
3116	3439	40	4112	280	3.40	52.81	2277
3216	4434	87	5301	375	3.43	53.36	3082
3316	4987	142	5962	400	3.50	53.85	3317
3416	5137	183	6142	410	3.47	53.27	3364
4116	4994	125	5971	400	3.60	53.23	3279

4216	4154	69	4966	330	3.30	53.79	2734
4316	4650	155	5559	320	3.13	54.14	2668

Table D.3. Machine harvest data and calculations for the Riley (2017), Wichita (2018), Surefire (2018), and Surefire-Wichita (2019) studies.

Year	Study	Variety	Density	Plot	Rep	Fall_Pt_Ct	Fall_pop	Area	Spring_Pt_Ct	Spring_pop	Winter_survival
2017	Riley	Riley		100	1			180	198	448588	
2017	Riley	Riley		200	2			180	147	333043	
2017	Riley	Riley		300	3			180	213	482572	
2017	Riley	Riley		400	4			180	216	489369	
2017	Riley	Riley		500	5			180	288	652492	
2017	Riley	Riley		600	6			180	141	319449	
2018	Wichita	Wichita		111	1			115	149	499981	
2018	Wichita	Wichita		209	2			116	130	431728	
2018	Wichita	Wichita		303	3			113	190	651125	
2018	Wichita	Wichita		103	1			120	163	525081	
2018	Wichita	Wichita		219	2			111	171	595515	
2018	Wichita	Wichita		305	3			115	200	671115	
2018	Surefire	Surefire	high	1100	1			198	163	318231	
2018	Surefire	Surefire	low	1200	1			198	89	173758	
2018	Surefire	Surefire	high	2100	2			198	190	370944	
2018	Surefire	Surefire	low	2200	2			198	105	204995	
2018	Surefire	Surefire	high	3100	3			198	182	355325	
2018	Surefire	Surefire	low	3200	3			198	100	195234	
2018	Surefire	Surefire	high	4100	4			198	186	363134	
2018	Surefire	Surefire	low	4200	4			198	107	208900	
2019	Surefire-Wichita	Surefire	high	1100	1	710	975335	281	605	831095	85
2019	Surefire-Wichita	Wichita	low	1200	1	432	605054	276	386	540627	89
2019	Surefire-Wichita	Wichita	high	1300	1	588	821760	277	414	578586	70
2019	Surefire-Wichita	Surefire	low	1400	1	433	599934	279	393	544513	91
2019	Surefire-Wichita	Surefire	high	2100	2	539	746800	279	403	558368	75
2019	Surefire-Wichita	Wichita	high	2200	2	544	750499	280	328	452507	60
2019	Surefire-Wichita	Wichita	low	2300	2	321	459580	270	219	313545	68

2019	Surefire-Wichita	Surefire	low	2400	2	359	506112	274	264	372183	74
2019	Surefire-Wichita	Surefire	high	3100	3	566	782526	280	379	523988	67
2019	Surefire-Wichita	Wichita	high	3200	3	549	767255	277	384	536659	70
2019	Surefire-Wichita	Wichita	low	3300	3	334	487951	265	203	296569	61
2019	Surefire-Wichita	Surefire	low	3400	3	294	412670	275	242	339681	82
2019	Surefire-Wichita	Wichita	low	4100	4	282	407364	268	223	322135	79
2019	Surefire-Wichita	Surefire	high	4200	4	483	670652	278	375	520693	78
2019	Surefire-Wichita	Wichita	high	4300	4	462	647072	276	324	453791	70
2019	Surefire-Wichita	Surefire	low	4400	4	264	383080	266	208	301820	79

Table D.4. Machine harvest data and calculations for the Riley (2017), Wichita (2018), Surefire (2018), and Surefire-Wichita (2019) studies continued.

Year	Study	Variety	Density	Plot	Rep	Plot_Wt	Moisture	TW	Adj_Wt	Yield	Avg_TSW	Oil_content
2017	Riley	Riley		100	1	9.91	5.45	45.7	9.37	2543		39.7
2017	Riley	Riley		200	2	8.90	5.49	45.4	8.41	2283		40.8
2017	Riley	Riley		300	3	9.90	5.98	43.6	9.31	2526		40.2
2017	Riley	Riley		400	4	7.92	5.35	43.5	7.50	2034		40.1
2017	Riley	Riley		500	5	9.38	5.56	43.8	8.86	2404		39.4
2017	Riley	Riley		600	6	8.89	6.98	46.0	8.27	2244		39.7
2018	Wichita	Wichita		111	1	4.27	3.96	45.9	4.10	1739	2.9	35.7
2018	Wichita	Wichita		209	2	3.06	3.95	45.3	2.94	1233	3.3	34.6
2018	Wichita	Wichita		303	3	3.95	3.47	45.6	3.81	1651		
2018	Wichita	Wichita		103	1	4.81	5.19	48.4	4.56	1856	3.3	37.9
2018	Wichita	Wichita		219	2	4.58	4.81	48.7	4.36	1919	3.4	39.1
2018	Wichita	Wichita		305	3	4.94	4.59	49.7	4.71	1999		
2018	Surefire	Surefire	high	1100	1	5.59	8.39	45.9	5.12	1263	3.1	38.1
2018	Surefire	Surefire	low	1200	1	4.98	13.10	49.4	4.33	1068	3.5	37.9
2018	Surefire	Surefire	high	2100	2	5.72	9.90	49.4	5.15	1271	3.7	38.2
2018	Surefire	Surefire	low	2200	2	4.89	13.20	48.8	4.24	1047	3.5	36.7
2018	Surefire	Surefire	high	3100	3	4.99	10.90	49.4	4.45	1097	3.7	38.6
2018	Surefire	Surefire	low	3200	3	4.82	14.20	48.8	4.14	1020	3.5	38.5
2018	Surefire	Surefire	high	4100	4	5.69	9.66	49.7	5.14	1268	3.7	38.6
2018	Surefire	Surefire	low	4200	4	4.72	14.20	49.0	4.05	999	3.5	37.7
2019	Surefire-Wichita	Surefire	high	1100	1	16.15	4.75	51.0	15.38	2670	3.6	38.77
2019	Surefire-Wichita	Wichita	low	1200	1	16.30	5.21	50.2	15.45	2735	3.6	40.07
2019	Surefire-Wichita	Wichita	high	1300	1	18.90	5.04	49.5	17.95	3170	3.7	40.41
2019	Surefire-Wichita	Surefire	low	1400	1	18.90	5.44	50.9	17.87	3129	3.7	38.03
2019	Surefire-Wichita	Surefire	high	2100	2	14.82	5.15	50.7	14.06	2461	3.5	40.45
2019	Surefire-Wichita	Wichita	high	2200	2	12.54	4.85	51.3	11.93	2080	3.5	39.83
2019	Surefire-Wichita	Wichita	low	2300	2	15.33	5.10	50.2	14.55	2632	3.7	39.68

2019	Surefire-Wichita	Surefire	low	2400	2	17.18	5.15	50.0	16.30	2903	3.6	38.84
2019	Surefire-Wichita	Surefire	high	3100	3	10.50	4.87	51.4	9.99	1745	3.6	37.8
2019	Surefire-Wichita	Wichita	high	3200	3	16.95	4.81	51.0	16.13	2849	3.6	38.98
2019	Surefire-Wichita	Wichita	low	3300	3	16.78	4.97	51.0	15.95	2944	3.6	38.8
2019	Surefire-Wichita	Surefire	low	3400	3	15.57	5.17	51.1	14.77	2619	3.4	35.33
2019	Surefire-Wichita	Wichita	low	4100	4	9.62	4.90	52.1	9.15	1670	3.2	38.28
2019	Surefire-Wichita	Surefire	high	4200	4	12.48	5.68	50.0	11.77	2065	3.1	36.52
2019	Surefire-Wichita	Wichita	high	4300	4	15.43	5.40	50.4	14.60	2583	3.3	40.03
2019	Surefire-Wichita	Surefire	low	4400	4	11.50	5.73	51.3	10.84	1988	3.4	37.03