THE INFLUENCE OF PLANTING DATE, VARIETY, SEEDING RATE, AND HARVEST TREATMENT ON FORAGE AND GRAIN YIELDS OF WINTER WHEAT

by

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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INTRODUCTION

Wheat and livestock comprise the largest two components of the agricultural economy of Kansas. The value of hard red winter wheat as one of the food staples of the world is well recognized, as is the ability of the producers of Kansas to supply the wheat demanded. The individual wheat and livestock industries thrive in Kansas, yet they can be interdependent. Many livestock producers graze some of their wheat. In Kansas, up to one third of the wheat established and growing is utilized for forage during the fall.

Many investigators have shown that little or no reduction in the grain yield of wheat will occur when wheat forage is grazed correctly, and efficient gains will be recognized on the livestock.

Some researchers have studied the influence of planting date and planting rate on the grain yield of wheat, others have studied the ability of fall planted cereal grains to supply winter and spring forage. In Kansas, data were needed to evaluate the forage potential of newer varieties of hard red winter wheat and soft red winter wheat.

This study was initiated to gain additional information concerning (1) the best type of forage wheat, (2) the optimum seeding rate and date for forage production, (3) the seasonal distribution of forage, and (4) the influence of time of forage harvest on grain yield.

LITERATURE REVIEW

Many studies have been conducted to evaluate small grain forage. This review will be concerned with the subject of wheat pasture, including cultural practices, projected forage and grain yields, and utilization. The subject has been divided into six sections: planting date, planting rate, forage quality, forage production, grazing management, and problems.

Planting Date

Optimum planting date depends on several factors including geographical location, intended use, and soil water. [Georgia Statewide Committee on Small Grains (1973).] These same factors were mentioned by other experiment stations as they determined their optimum planting date.

Cummins, et al. (1964) and Holt, et al. (1969) studied the effects of planting date on forage production in Georgia and Texas. They concluded that planting near the optimum planting date for grain will produce the most forage. They observed that earlier planting gave better fall forage production, but decreased the season total. In Kansas, Heyne, et al. (1964) observed that early sown wheat is subject to drought and hot winds. Early fall growth and hot winds deplete the soil moisture, and the plants do not harden well. Wheat planted late in Kansas often winterkills and tillers less than wheat planted near the optimum date.

Lundquest (1964) at St. John, Kansas, compared forage yields of five varieties of wheat planted at two dates, and determined that the earlier planting date produced 50% more forage when cut December 3.

Martin (1926) compiled data from eleven experiment stations in the West. An October 1 planting date gave the highest grain yield at Newell, South Dakota; Sheridan, Wyoming; and Hays, Kansas. The Kansas data was a summary of five years with eight planting dates at weekly intervals from September 8 to October 26.

Jardine (1916) and Bhushav (1973) observed that the condition of the seedbed at planting time was important. In Kansas, Jardine noted that planting at the same date in consecutive years may be impossible due to variations in soil moisture and seedbed conditions.

Harper (1961), working with four small grain species in Oklahoma, observed that crops responded differently to fall temperatures. Rye grew better at an average daily temperature of near 50^{O}F, while oats grew more rapidly than rye when the average daily temperature was 64^{O}F. He also noticed that hot weather in September was less damaging to oats and barley than to wheat and rye. His data also indicated twice as much forage was produced from an early September planting date compared to a mid-October date.

Paulsen, et al. (1975) divided Kansas into four zones, generally along lines from northeast to southwest. Zone 1, in the northwest, should be planted from September 10-20; zone 2, from September 10 to October 5; zone 3, from September 25 to October 10; and zone 4, in the southeast corner of Kansas, from October 5-20. These dates are ranges recommended for producers of wheat for grain.

To summarize, the optimum planting date for wheat is determined by location, climate, condition of seedbed, and intended use of the crop.

Planting Rate

Many researchers have studied planting rates in various states. Jardine (1916) found the rates used in Kansas at that time were 3 pecks in the west, increasing to 6 pecks in the eastern part of the state. Another observation was that, ". . . 2 pecks of seed produced as large a yield as 4, 6, or 8 pecks when sown before the last week in September, but after that date heavier seedings produced substantially larger yields almost every year." He concluded that you must not separate planting rate and planting date.

Martin (1926) summarized five years of data from Hays, Kansas. He observed that increasing planting rates from 1 to 4 pecks per acre resulted in a small increase in grain yield.

Lundquest (1964) demonstrated at St. John, Kansas that increased planting rates will produce both higher grain yield and more pounds green matter per acre during the grazing season.

Heyne, et al. (1964) and Paulsen, et al. (1975) recommend a lighter planting rate for western Kansas. They recommend 2 to 3 pecks or 20 to 45 pounds per acre. They observed that the earlier planting of lighter rates will allow the plants to tiller and yields will not suffer. They recommend a heavier planting rate of 6 to 8 pecks or 60 to 90 pounds per acre in the eastern third of Kansas.

Holt (1969), growing wheat for forage in Texas, recommended 64 to 80 pounds per acre. Shipley (1972), working with irrigated wheat, favored the 90 pound per acre planting rate with two fall irrigations.

The Georgia Statewide Committee on Small Grains (1975) recommends a rate of 1-1½ bushels per acre when wheat is grown for grain, and a 2-2½ bushels per acre rate for grazing.

In New Zealand, the optimum planting rate is similar to the midwest. Scott, et al. (1973) observed that rates of 100kg/ha. (121.1 pounds per acre) have higher yields than either 50 or 150kg/ha.

To summarize, Kansas wheat producers must consider planting date and location in the state when selecting a seeding rate for wheat.

Forage Quality

Many researchers, including Anderson (1956), Atkins, et al. (1970), Cummins, et al. (1965), Horn, et al. (1974), Keeney, et al. (1967), Moore, et al. (1971), Shipley and Regier (1972), and Staton and Heller (1949), have determined that the quality of wheat forage is excellent. Since wheat forage regularly contains 20-30% protein on a dry matter basis, Anderson (1956) has stated that protein supplements are needed only in severe weather.

Horn, et al. (1974) reported extensive studies at El Reno, Oklahoma. After analyzing their data, they made six observations concerning the quality of wheat pasture. The two most relevant to this review are: "1. Wheat pasture is very high in a readily available protein. . . 3. The high moisture content of the wheat plant may make it impossible, during some periods of the grazing season, for the animal to satisfy daily dry matter requirements."

Cummins, et al. (1965), working with rye, oats, and ryegrass in Georgia, determined that addition of nitrogen fertilizers will increase the nitrogen content of the forage. They determined that an increase from 75 to 300 pounds per acre increased the percent N in the oven dry forage about one percent.

Holt (1969), working with oats, barley, and ryegrass in Texas, found a similar response to those above. The study examined the effects of split applications of nitrogen on the plant nitrate content. The highest nitrate concentration was produced by application of 60 pounds in October plus 60 pounds in December. Moeller and Thurman (1966) noticed an increase in nitrate content in the plant with increased application of nitrogenous fertilizer. They concluded that application of 100 pounds of N or less should cause no hazardous effects.

Sharma and Rajat (1975) found that the absorption of nitrogen fertilizers is greatest while the plants are in the young vegetative stage, and is slowed as maturity progresses. They note, "This could be ascribed to dilution that occurred due to an excess accumulation." In the excess accumulation of nitrogenous materials, the forage is used as a sink or storage organ. They observed, "This phenomenon of increased N uptake in early stages could be explained on the basis of the fact that plants take enough nutrients from the soil in early stages and accumulate in vegetative parts which is translocated later on to the zone of their requirement. . ."

Singh and Anderson (1973) found that increasing the N rates on wheat increased the dry matter of the plants at all stages of maturity.

Nass, _et al_. (1975) found that increased N fertilization rates to 300 pounds increased crude protein content. In 1972 they observed the _in vitro_ dry matter disappearance (IVDMD) of barley was increased from 50.8% to 56.2% by addition of 300 pounds of N per acre.

In Australia, Lovett and Matheson (1974) measured regrowth one week after harvest and found that wheat and oats grew back more vigorously than barley or rye. They also determined that at the first fall harvest in April the _in vitro_ digestibility averages 85% for all crops. In the second harvest, wheat and oats had dropped to 72.5% and 74.5%. The authors point out that wheat and oats generally have better regrowth following defoliation and more uniform seasonal availability of forage which may be, in commercial practice, more important than total production.

To summarize, wheat forage has high quality, with 20-30% protein on a dry matter basis. This high protein content can be increased slightly with additions of nitrogen fertilizers.

Forage Production

Most investigators agree that a large part of the small grain forage is produced in the spring. Evidence of this seasonal availability is reflected in their harvest patterns, with one fall harvest and several in the spring. [Anderson (1956); Bertrand and Donavin (1973); Brown, et al. (1973); Cummins, et al. (1964); ibid, (1965); Day, et al. (1968); Denholm and Arnold (1970); Elder (1967); Evers (1973); Harper (1961); Holt, et al. (1969); Morey (1961); Peterson (1959); and, Romann, et al. (1975).]

Romann, et al. (1975) noticed little regrowth occurred during January and February. Morey, et al. (1969), working with small grains in Georgia, observed that little regrowth occurs below 40°F.

Harper (1961) noticed that length of day also affects rate of growth. He observed that, "More forage will be produced in late February and early March than in November, although the average daily temperatures are the same."

Day, et al. (1968), working with barley in Texas, noticed that in clipping trials, the plots that were clipped once or twice gave highest and similar grain yields. The plots that were not clipped or that were clipped three times gave significantly lower yields than those clipped once or twice.

The late spring production of forage can be improved by timing of fertilization. Cummins, et al. (1965), working with oats and ryegrass in Florida, observed generally better seasonal distribution of forage was obtained with a split application of N at planting and in February.

Paulsen, et al. (1975) noticed that, in Kansas, under the usual conditions, wheat plants produce 3-6 tillers. However, fewer tillers are produced under drought. Kaase and Seddoway (1975), in Montana, recorded a similar decrease in tiller numbers with drought, and noticed that grazing the leaves after tillering resulted in decreased grain yield.

Army, et al. (1959), Harper (1961), and Lomas and Shaskoua (1973) noticed in their respective areas that winter rainfall was critical to wheat yields. Army, et al., working with grain yield in the Texas high plains, noted that when the October 1 to June 30 rainfall was below five inches, the grain crop was a failure. They noted that for each inch increase in precipitation during that period, two bushels per acre increase was noticed. Harper generalized, ". . . the growth of fall planted small grains will be small when total rainfall November 1 to March 31 is less than eight inches." Lomas and Shaskoua noticed the occurrence of hot dry days with winds made wheat production quite variable.

Cox and Wright (1975) studied winter wheat as a converter of energy. Using irrigation at Bushland, Texas, they noted many interesting facets of growth patterns, in the 246 day growing season. They concluded that the efficiency of net primary production for wheat is low, in the range of 2-4%. This is lower than some other crops and pasture studies.

To summarize, wheat forage production is usually greater in the spring in the midwest. Wheat forage availability may be variable depending on the weather.

Grazing Management

Anderson (1956) observed at Hays, Kansas that wheat may normally be grazed starting November 1, plus or minus 15 days, depending on the year's growth.

Anderson (1956) and Staton and Heller (1949) noticed little effect on production of grain, if grazing is stopped before the jointing stage. Producers interested in grain production must monitor grazing, as most of the forage is generally produced in the spring. Staton and Heller determined that overall forage yield can be tripled by grazing-out the wheat, but the proper variety should be selected. They recorded forage production of 7,742 pounds per acre for hard red winter wheat and 8,171 pounds for soft red winter wheat.

Many workers, including Bertrand and Donavin (1973), Elder (1967), Graham (1959), Harper (1961), Holt, et al. (1969), and Horn, et al. (1974), have measured animal performance when grazing small grain pasture. Bertrand and Donavin report 500 pounds of beef gain per acre for wheat in Florida using calves that weighed approximately 400 pounds in the three year study. Holt, et al. (1969), working with small grains in Texas, warned that the plant should be well established before grazing is commenced. They observed that the grazing season for small grain pasture varied from 141 calendar days in 1964 to 219 days in 1960. Grazing was started as early as November 10, and as late as June 8. Elder (1967) observed that the length of the grazing season in Oklahoma was 195 days. His data indicated that heavy stocking in November and December reduced stocking rates the rest of the year, lowered daily gains, and lowered total gains per acre. Harper reported a maximum of 277 pounds of beef per acre. Elder recorded gains ranging from 227 to 308 pounds per acre. The lowest weight gain resulted from a heavy grazing rate, while highest gain per acre was from the light grazing treatment.

Bertrand and Donavin (1973) determined, in Florida, that wheat pasture produced less beef gains and less grazing days per acre than rye. The average daily gain for wheat pasture was 2.16 pounds per day for wheat, compared with 1.95 pounds for rye.

Ibbetson, et al. (1972) reported gains of 1.75 pounds per day on Parker wheat for a 156 day grazing season. Graham (1959) noted gains of 1.69-1.98 pounds per head on yearlings for a 110-137 day grazing season.

Allden and Whittaker (1970) determined that intake was increased with added plant height when grazing sheep, and that herbage yield and intake were not closely correlated.

Dudley and Wise (1953) determined that use of winter annual forage from small grains in established perennial pastures can aid producers. They listed low pasture establishment cost and less bogging of animals, and less trampling of the forage (compared to small grain pasture) as very important considerations for seeding small grains into permanent warm season pastures.

Viets, et al. (1974) noted wheat's versatility as a food grain, a feed grain, a winter forage, and a silage crop. They expressed the need to develop a wheat for forage during the second half of the frost free period.

To summarize, if producers prevent overgrazing in the fall, there will be more forage in the spring, and an opportunity for good livestock gains.

Problems

Several problems may be encountered when grazing wheat pasture. The first problem encountered by wheat producers in the plains area is planting date. Many experiment stations recommend planting after a fly free date, that is, the date after which the hessian fly is no longer a problem in most years. In Nebraska, Fenster, et al. (1972) stated that similar precautions should be taken to insure minimum damage from the fungi responsible for root and crown rot. Conditions in western Nebraska necessitate a planting date early enough to insure ground cover, but late enough to prevent severe damage by the pathogens.

Many researchers agree that wheat badly infected with the rusts are less palatable. Bertrand and Donavin (1973) noted poor animal gains on rusted wheat in Florida. Williams and Young (1973) found that 64% of the severely rusted plants died upon clipping, while only 4% of the healthy ones died.

Campbell, et al. (1975), in Kansas, and Palmer and Brakke (1975), in Nebraska, have studied the problem of soil borne wheat mosaic virus. This pest is primarily a problem in eastern Kansas. Campbell, et al. (1975) have documented its recent movement into south central Kansas wheat areas. Yield losses of grain range from 44-48%. Reduction of the plants ability to produce tillers is critical. Resistant varieties control the vector.

In Arkansas, Thurman, et al. (1961) observed that wheat is grown mostly in the northern half of the state as loose smut is a problem.

Edmund (1974) noted some hazards in New Zealand when grazing sheep. He cautioned that at high stocking rates, the hooves of animals can have a marked and sustained effect on individual plant performance, botanical composition, and soil aeration and compaction.

Bush, et al. (1974), Meheta, et al. (1974), and Von Gunten, et al. (1975) have extensively studied a problem experienced by dairymen who use wheat as fall, winter, or spring forage. Studies by Meheta at Kansas State University, and Bush at Oklahoma State University determined that 2-10 ppm trimethylamine was detectable and ruined the flavor of milk. The presence of trimethylamine was a problem in milk cows that had grazed wheat forage for some time before milking. Von Gunten, et al., in Oklahoma, determined that cows fed 2% of their body weight in roughage or grain before grazing wheat pasture had a lower concentration of trimethylamine in their milk, probably because they did not eat as much wheat.

Another problem associated with wheat pasture is bloat, more commonly called stockers syndrome, or sudden death syndrome reported by Anderson (1956) and Clay and Croy (1973). Dr. Clay suggests bloat may occur as a result by consumption of feeds containing high levels of nitrates. Anderson suggests the use of dry feeds before turning the animals onto wheat pasture will help prevent bloat.

To summarize, intensive agriculture requires intensive management. A producer expecting to use wheat for forage and grain crop should be cognizant of the potential problems he may encounter.

MATERIALS AND METHODS

The following procedures were used to determine the influence of variety, planting rate, and planting date on forage and grain yield of red winter wheat.

Varieties chosen for this experiment were Arthur 71, Parker, and Centurk. Arthur 71 was selected because it is a soft red winter wheat, and in other studies soft red winter wheats have shown high forage production potential. Parker was chosen because of its tolerance to hessian fly, an important trait for wheat planted before the fly free date. However, it is rated as susceptible to leaf rust and soil borne mosaic virus. Centurk and Parker have yielded similarly in past tests, and are among the five most popular varieties with wheat producers in Kansas.

The second variable studied was the planting rate for forage production. The rates of 60, 90, and 120 pounds of seed per acre were used. That range includes the recommended rates for eastern Kansas as established by the Kansas Agricultural Experiment Station.

To examine the effects of planting date on seasonal distribution of forage, three planting dates were included at Manhattan and two at the Southeast Kansas Agricultural Experiment Station, Mound Valley, Kansas. The three planting dates at Manhattan were August 28, September 20, and October 10. At Mound Valley the two dates were August 22 and October 3.

To determine the seasonal distribution of forage and the effect of time of forage harvest on grain yield, the following harvest schedule was established. A mid-December harvest was made to measure fall accumulation of forage. A second harvest was taken to evaluate early spring forage production. A season-long harvest schedule included a harvest in mid-spring plus clipping at both of the previous harvest dates. The grazeout harvest treatment included the three previous forage harvests plus a late May harvest at Manhattan to determine total forage production. At Mound Valley, the season-long and grazeout harvest treatments were combined because the wheat headed rapidly. The harvest schedules used at Manhattan and Mound Valley are presented in Table 1.

Table 1. Harvest dates for treatments at the Manhattan and Mound Valley locations

Harvest Treatment	Manhattan	Mound Valley
fall-only	Dec. 11	Dec. 22
spring-only	Mar. 22	Feb. 26
season-long	Dec. 11, Mar. 22, Apr. 23	______
grazeout	Dec. 11, Mar. 22, Apr. 23, May 20	Dec. 22, Feb. 26, Apr. 12

The experiment was conducted at the North Agronomy Farm at Manhattan on a Wymore silty clay loam, that is in the Fine Montmorillonitic family of the Mesic, Aquic Argiudolls (Jantz, et al., 1975). The site had been cropped in wheat the previous season. A preplant broadcast application of 40 pounds of N per acre was made in August. The plots were topdressed with 60 pounds of N per acre February 11, 1976.

At Mound Valley the experiment was conducted on a Parsons silt loam soil (Knobel, et al., 1926). The field had been in fallow the previous year. A preplant broadcast application of 200 pounds per acre of a 6-24-24 fertilizer was made August 14, 1975. The plots were topdressed with 60 pounds of actual N per acre on February 13, 1976.

A split-plot design was used at both locations with three replications. Planting dates were the main plots with a complete factorial of varieties by seeding rates as subplots. The harvest treatments were imposed as sub-subplots. The sub-subplot size was 5 rows 7 inches apart x 20 feet at Manhattan, and 4 rows 7 inches apart x 10 feet at Mound Valley.

The forage yield was determined by clipping at a height of 2.5 centimeters. The plots were harvested with a rotary lawnmower or a Carter forage harvester depending upon soil moisture conditions and forage height. A hand grab sample of about 400 grams was selected from each plot and dried at 130°F for seven days to determine percent dry matter.

The wheat was harvested for grain on June 21 at Mound Valley. A sickle-type cutter with an attachment to collect the wheat was used. The wheat was dried for two days at 130°F and then threshed with a Vogel plot thresher. The grain samples were then weighed to determine grain yield.

At Manhattan the plots were cut June 29-30. The plots were cut with a small self-propelled plot combine. The grain was placed in the drier for two days at 125°F. The samples were cleaned with a fan mill, weighed, and grain yield recorded.

Plant height notes were taken at Manhattan June 28. Two observations were made on each plot. The mean plant height for each plot was statistically analyzed.

Statistical analysis of all data was computed by the Aardvark program. This program calculated the treatment means as well as an analysis of variance with the F test. Significant differences were computed at the .05 level of probability.

RESULTS AND DISCUSSION

MANHATTAN LOCATION

Forage Harvests

Fall-only. The means of the variables for the fall harvest are listed in Table 2, and the analysis of variance is shown in Appendix Table 9. The wheat planted August 28 yielded more pounds dry matter per acre (lbs. DM/A) than the wheat planted September 20. The forage production from the 120 pound rate was significantly superior to that of the 60 pound rate, but not different than the 90 pound rate. The differences among varieties were not significant. The October 10 planting was not harvested, as the dry growing condition prohibited enough dry matter production to harvest.

Table 2. Mean forage production (lbs. DM/A) for the fall-only harvest treatment as influenced by planting dates, varieties, and seeding rates

Planting Dates			Varieties			Seeding Rates (lbs/A)		
Aug. 28	Sept. 20	Oct. 10	Arthur 71	Parker	Centurk	60	90	120
1268**	480	0	865	787	970	753b	894ab	975a*

* Treatment means followed by the same letter do not differ significantly at the .05 level of probability.

** Means without designation are not significantly different at the .05 level of probability in this and in subsequent tables.

Spring-only. The spring-only harvest data are the means of the August and September planting dates. The spring-only harvest means are illustrated in Table 3, and the analysis of variance is shown in Appendix Table 10. Only the differences among seeding rates were significant for this harvest. The 90 and

120 pound rates are similar in (lbs. DM/A) produced, and both produced significantly more forage than the 60 pound rate.

Table 3. Mean forage production (lbs. DM/A) for the spring-only harvest treatment as influenced by planting dates, varieties, and seeding rates

Planting Dates			Varieties			Seeding Rates (lbs/A)		
Aug. 28	Sept. 20	Oct. 10	Arthur 71	Parker	Centurk	60	90	120
1088	720	0	804	895	1013	695b*	985a	1033a

* Treatment means followed by the same letter do not differ significantly at the .05 level of probability.

The October 10 planting date had not made sufficient growth to harvest by March 22.

Season-long. The means of the season-long harvest treatment are illustrated in Table 4, and the analysis of variance is shown in Appendix Table 11. These treatment means are composed of the summation of the three component harvests, and the totals analyzed. The differences among planting dates were significant. The forage yield of the October 10 planting was significantly less than the yield of the August 28 and September 20 plantings. The wheat planted October 10 was harvested once. The two earlier dates were harvested three times.

Parker and Centurk yielded similarly, and both produced significantly more (lbs. DM/A) than Arthur 71.

The 90 and 120 pound rates produced similarly and significantly better than the 60 pound rate for forage production.

Table 4. Mean forage production (lbs. DM/A) for the season-long harvest treatment as influenced by planting dates, varieties, and seeding rates

Planting Dates			Varieties			Seeding Rates (lbs/A)		
Aug. 28	Sept. 20	Oct. 10	Arthur 71	Parker	Centurk	60	90	120
3445a*	3881a	1790b	2555b	3082a	3478a	2530b	3306a	3280a

* Treatment means followed by the same letter do not differ significantly at the .05 level of probability.

Grazeout. The means of the variables of the grazeout harvest treatment are illustrated in Table 5, and the analysis of variance is shown in Appendix Table 12. The differences among planting dates were significant. The wheat planted at the September 20 planting date produced significantly more forage than was produced at the other two planting dates. The wheat planted at the August 28 planting date produced significantly more (lbs. DM/A) than the October 10 planting.

Table 5. Mean forage production (lbs. DM/A) for the grazeout harvest treatment as influenced by planting dates, varieties, and seeding rates

Planting Dates			Varieties			Seeding Rates (lbs/A)		
Aug. 28	Sept. 20	Oct. 10	Arthur 71	Parker	Centurk	60	90	120
3813b*	4419a	2382c	2896b	3872a	3845a	3268b	3638a	3708a

* Treatment means followed by the same letter do not differ significantly at the .05 level of probability.

There were differences among varieties. Centurk and Parker yielded similarly, and significantly more (lbs. DM/A) than Arthur 71 yielded.

There were differences among seeding rates, too. The 90 and 120 pound rates yielded similarly and significantly more forage than the 60 pound rate.

Harvest treatment analysis. An analysis was calculated for all forage harvest treatments. The analysis of variance is shown in Appendix Table 13. Examination of Table 13 illustrates significant differences among harvest treatments, planting dates, varieties, and seeding rates. However, the significance of the harvest treatment x planting date, harvest treatment x variety, and the harvest treatment x seeding rate interactions precludes discussion of these factors individually.

Interactions. Three things are apparent from the illustration of the harvest treatment x planting date interaction in Figure 1. They are 1) the August 28 planting date showed a yield advantage at the fall-only and spring-only harvest; 2) the September 20 planting showed a yield advantage for the season-long and grazeout harvests; and 3) the slow start of the October 10 planting date resulted in lower production for the entire season.

The interaction of planting date by harvest treatment is evident when comparing the August 28 and September 20 planting dates. In the fall-only and spring-only harvests, the wheat planted August 28 produced more (lbs. DM/A) than that planted September 20. Conversely, the wheat planted September 20 out-yielded the August 28 planting in the season-long and grazeout harvest treatments. This agrees with the data of Lundquest (1964), Holt, et al. (1969), and Cummins, et al. (1964) who observed that the fall forage production may be increased by planting earlier than optimum date. They also concluded that earlier planting may reduce the season-long total.

The October 10 planting date contributed little to the planting

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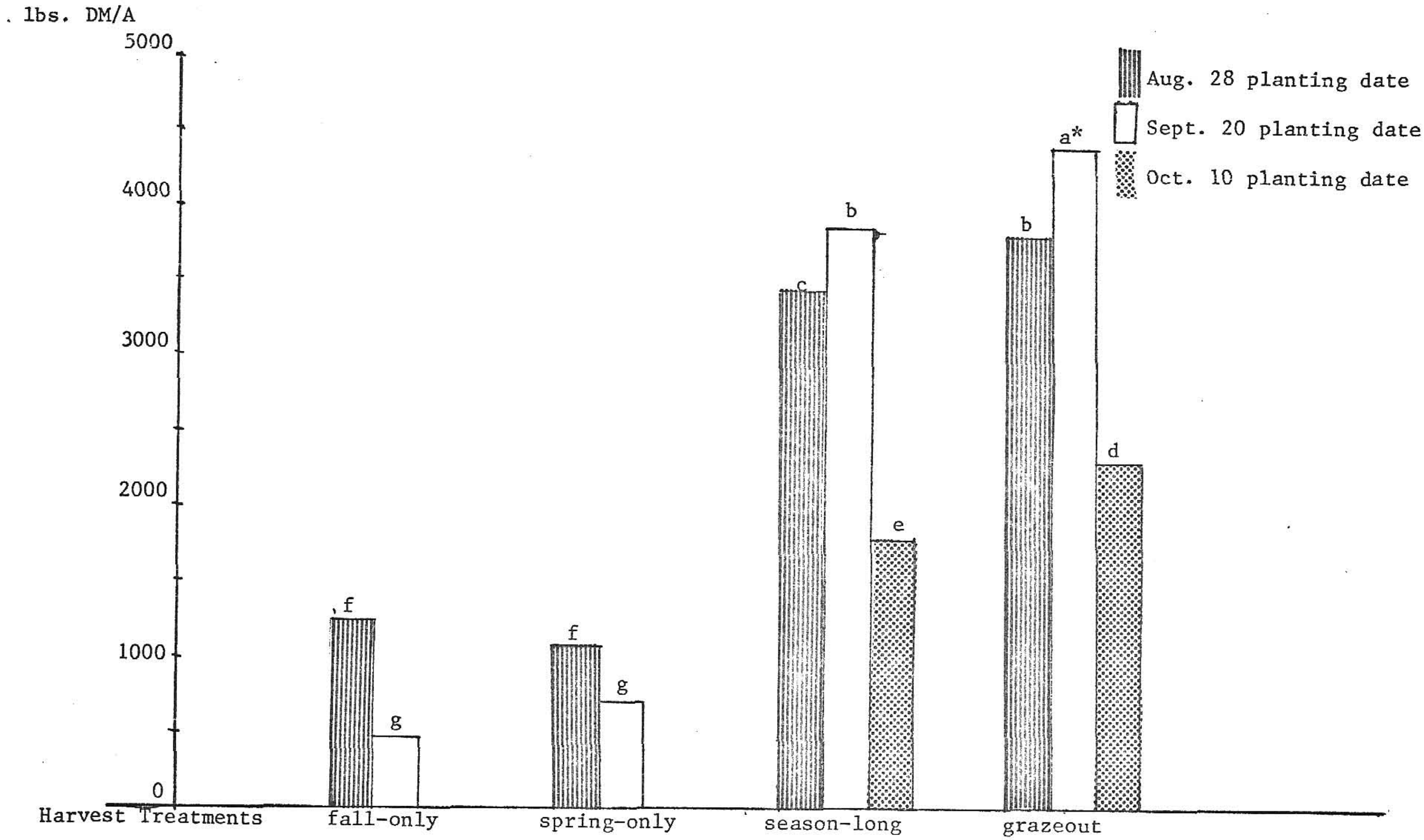

Figure 1. Mean forage yields for planting dates as influenced by harvest treatments

* Bars with common letter are not significantly different (P<.05).

date x harvest treatment interaction, as it was not harvested for the fall-only or spring-only harvest treatments. Emergence was delayed due to drought conditions in late fall.

In the harvest treatment x variety interaction there are no significant differences among varieties for the fall-only or spring-only harvests (Figure 2). Centurk and Parker produced significantly more forage in the season-long and grazeout harvest treatments than did Arthur 71. Centurk produced significantly more forage than Parker at the season-long harvest, but at the grazeout harvest, there was no significant difference between Parker and Centurk.

Of interest is the amount of forage that Parker produced late in the season. Centurk was significantly better at the season-long harvest, but at grazeout, Parker produced as much forage as Centurk.

At both the season-long and grazeout harvests, Arthur 71 yielded significantly less dry matter per acre than the hard red winter wheat varieties. This is in conflict with data of Harper (1949), who found the soft wheat produced more in Oklahoma.

In the harvest treatment x seeding rate interaction (Figure 3), there were no significant differences in forage production among seeding rates at the fall-only and spring-only harvests. Forage production of the 90 and 120 pound rates were similar, and both were significantly better than the 60 pound rate at the season-long and grazeout harvest treatments.

These data suggest that the 90 and 120 pound rates would be best for season-long forage production. These data support the Georgia Statewide Small Grain Committee and others who have recommended higher seeding rates for forage production. If the forage is to be harvested either fall-only or early spring-only, there appears to be no advantage for seeding rates

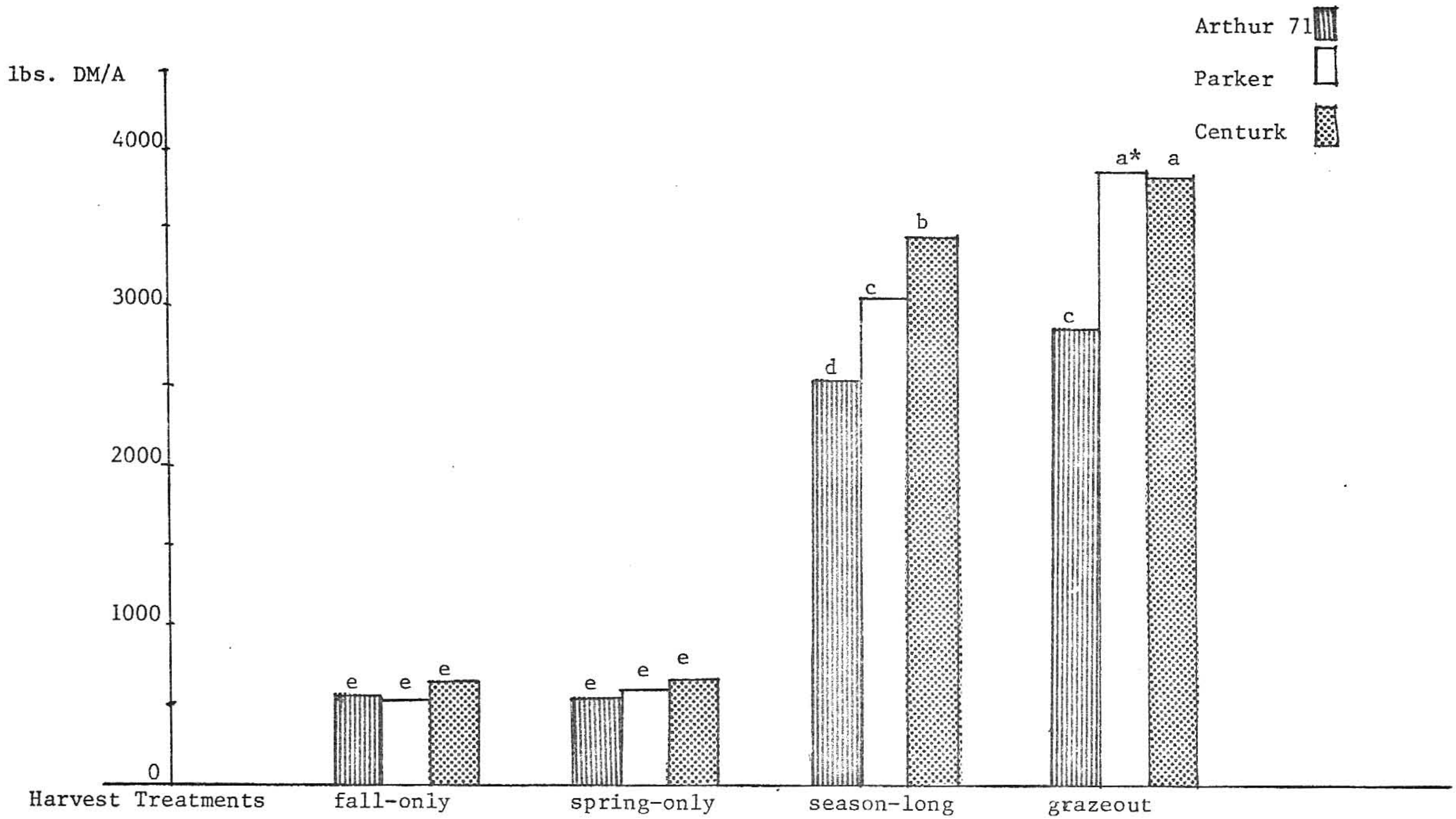

Figure 2. Mean forage yields for varieties as influenced by harvest treatments

* Bars with common letter are not significantly different ($P < .05$).

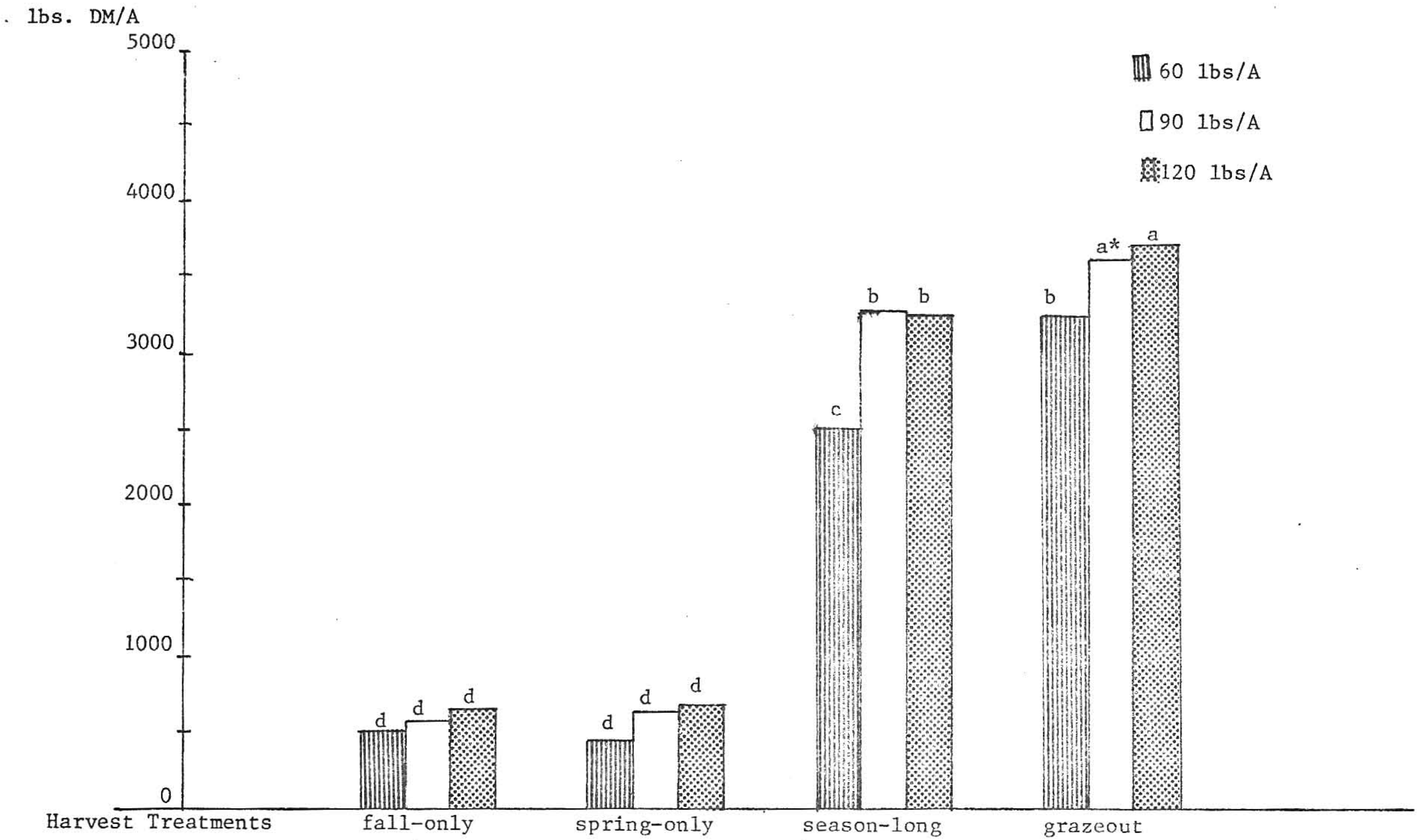

Figure 3. Mean forage yields for seeding rates as influenced by harvest treatments

* Bars with common letter are not significantly different (P<.05).

greater than 60 pounds per acre.

Plant Height

Since the harvest treatment x variety interaction was significant (Figure 4), no conclusions can be made for individual harvests. The analysis of variance is shown in Appendix Table 14. As forage was harvested later in the season, plant heights remained low depending on amount of forage removed. The hard red winter wheats (Parker and Centurk) were significantly taller than the soft red winter wheat (Arthur 71) at the fall-only and spring-only harvest treatments, and the control. Parker and Centurk were not significantly different in height at any harvest. An important component of this interaction was the leveling in plant heights when harvested late in the growing season.

Grain Yield

The highly significant harvest treatment x variety interaction for grain yield is shown in Figure 5, and the analysis of variance is shown in Appendix Table 15. The grain yields of the season-long and grazeout harvest treatments were near zero, and thus depressed the means of the variables and reduced the variation. Varieties differed significantly at the fall-only and spring-only harvest treatments and the control. Varieties ranked consistently in the fall-only and spring-only harvest treatments, and the control. The season-long and grazeout harvest treatments produced very low yields, and would probably be abandoned by the producer.

It appears that Centurk is the superior grain yielding variety. The grain yield of Centurk was reduced slightly by a spring harvest of forage, as opposed to Parker that had a slightly better yield due to spring-only harvest. Arthur 71 was consistently lower than Centurk and Parker in grain yield in this study.

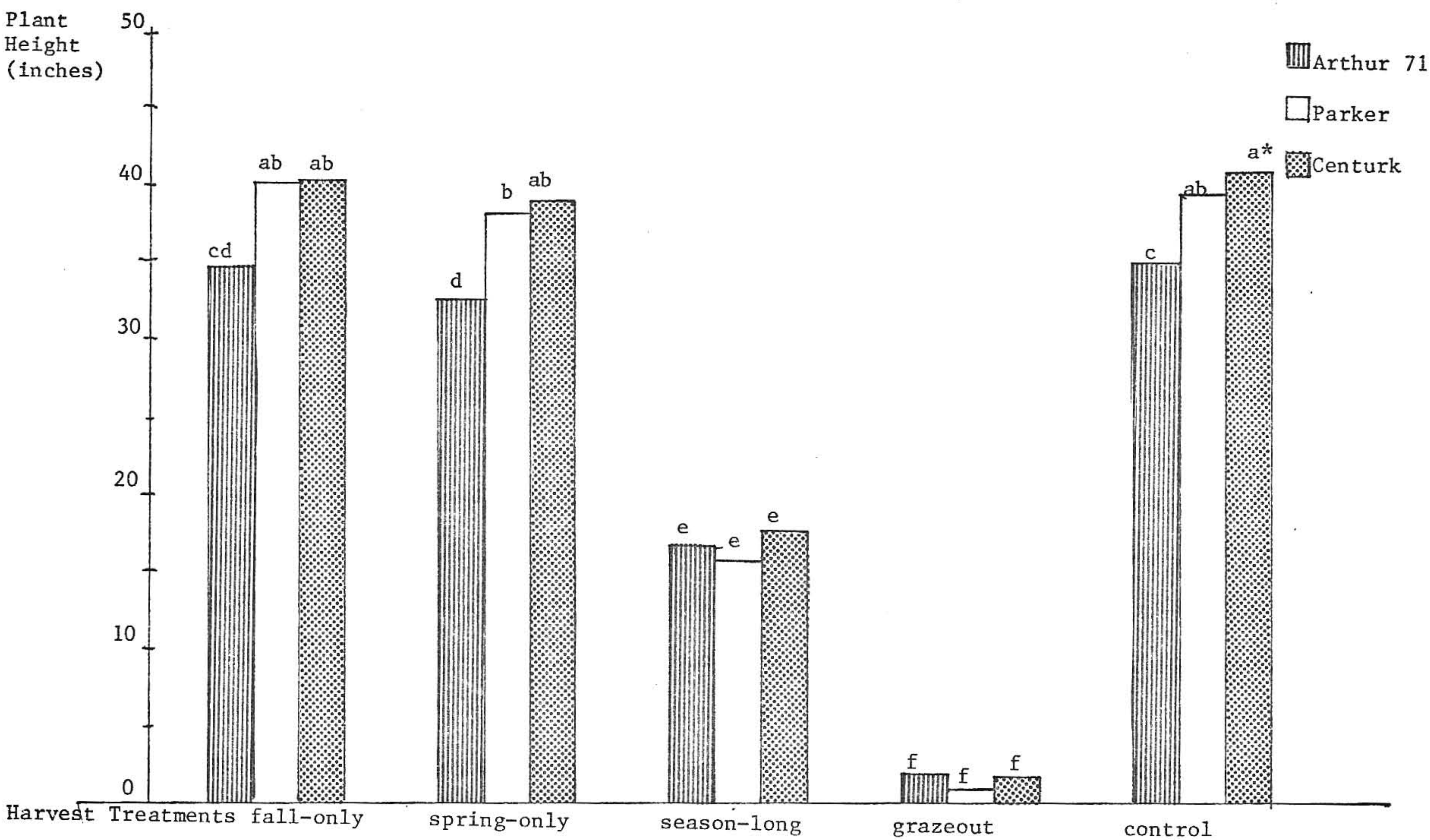

Figure 4. Mean plant heights for varieties as influenced by harvest treatments

* Bars with common letter are not significantly different (P<.05).

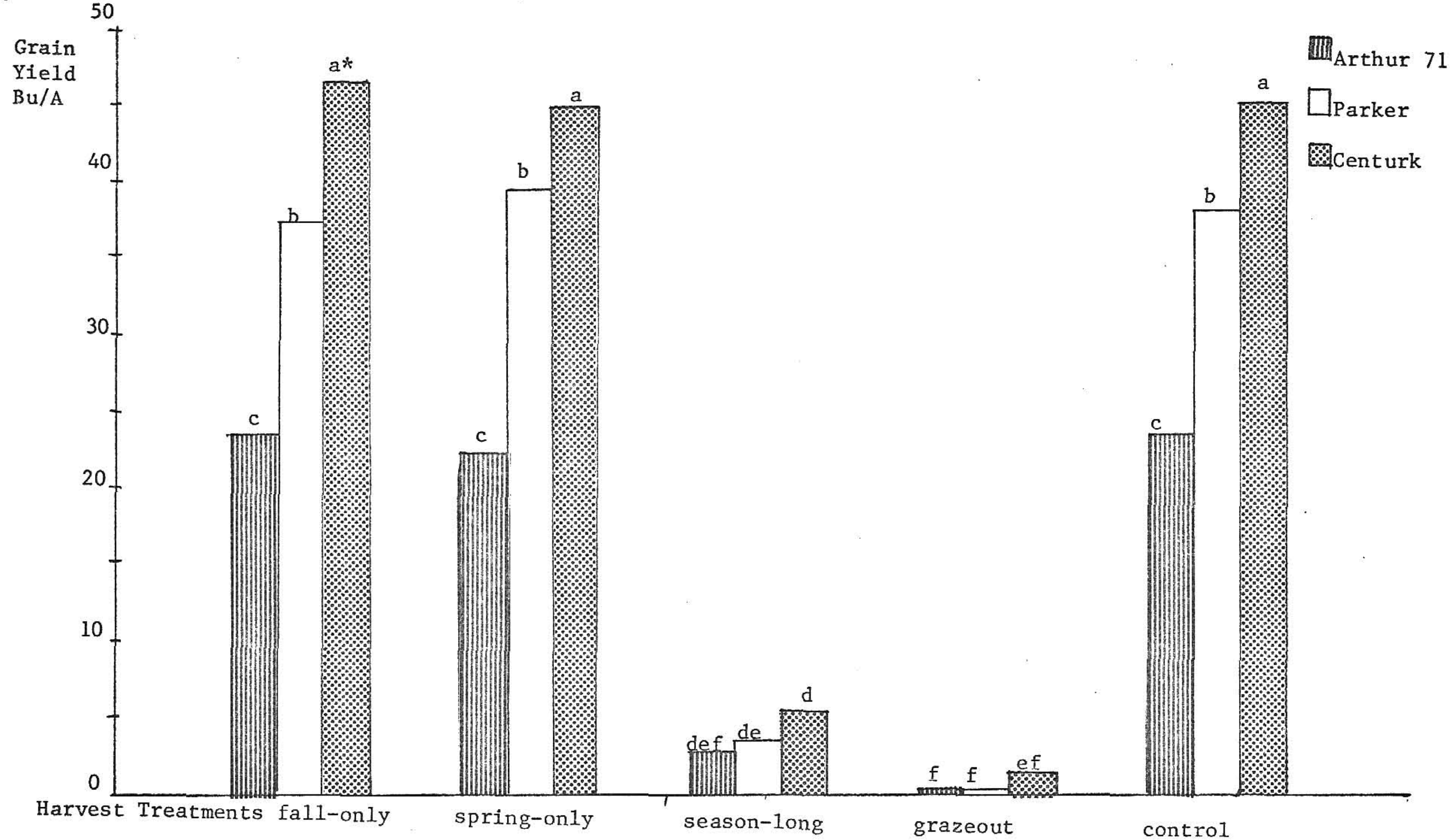

Figure 5. Mean grain yields for varieties as influenced by harvest treatments

* Bars with common letter are not significantly different (P<.05).

The significant interactions for harvest treatment by planting date, planting date x seeding rate, and planting date x variety x harvest treatment are not really meaningful because they include grain yield data from the October 10 plots which were not harvested for forage in the fall or early spring.

These data indicate that harvesting wheat for forage in the fall-only or in the spring-only before jointing has little effect on the grain yield of wheat. This is in agreement with Anderson (1956) who indicated that grain yield can be increased slightly by fall-only grazing or decreased only slightly by an early spring-only grazing.

It is apparent that grazing wheat past the first part of April, as in the season-long treatment, reduces the yield of grain. At the time of the season-long harvest, April 17, the primordia was elongating and was largely harvested for forage. This harvesting treatment severely reduced grain yield.

The grazeout harvest treatment was designed to remove all the usable forage. The last harvest was made near the heading stage and the extremely small grain yields resulted from a few late tillers.

MOUND VALLEY LOCATION

Forage Harvests

Fall-only. The means of the variables for the fall-only harvest for the August 22 planting date are shown in Table 6, and the analysis of variance is shown in Appendix Table 16. The differences in forage production among seeding rates were significant. The forage production of the 120 pound rate is significantly superior to the 60 and 90 pound rates. The lower two seeding rates were not significantly different in forage production.

Table 6. Mean forage production (lbs. DM/A) for the fall-only harvest treatment as influenced by varieties and seeding rates

Varieties			Seeding Rates (lbs/A)		
Arthur 71	Parker	Centurk	60	90	120
1385ab*	1669a	1207b	1217b	1236b	1807a

* Treatment means followed by the same letter do not differ significantly at the .05 level of probability.

There were also significant differences among varieties. Parker yielded significantly more forage (lbs. DM/A) than did Centurk, and Arthur 71 was intermediate and not significantly different than either of the other two varieties.

The October planting date did not make sufficient fall growth for a fall harvest.

Spring-only. The results of the spring-only forage harvest are illustrated in Table 7, and the analysis of variance is shown in Appendix Table 17. There were significant differences among seeding rates, The 120 pound rate produced significantly more forage than the 60 pound rate, and the 90 pound rate was intermediate and not significantly different than the higher and lower rates.

The differences among varieties were not significant. The wheat planted October 3 still had produced little forage and was not harvested at this date.

Table 7. Mean forage production (lbs. DM/A) for the spring-only harvest as influenced by varieties and seeding rates

Varieties			Seeding Rates (lbs/A)		
Arthur 71	Parker	Centurk	60	90	120
2039	2441	2868	1849b*	2412ab	3088a

* Treatment means followed by the same letter do not differ significantly at the .05 level of probability.

<u>Grazeout</u>. The analysis of variance for the grazeout harvest treatment is found in Appendix Table 18. The main effects cannot be discussed, because the planting date x variety and variety x seeding rate interactions were significant.

<u>Interactions</u>. The planting date x variety interaction (Figure 6) illustrates that the wheat planted early gave higher yields than that planted at the later date. This interaction was significant because Centurk produced the least forage when planted early, but the most when planted late.

The variety x seeding rate interaction was also significant (Figure 7). The Parker and Centurk varieties differed significantly for forage yield among seeding rates. Parker, at the 120 pound seeding rate, produced significantly more (lbs. DM/A) than the 60 and 90 pound rates. Centurk, at the 90 and 120 pound rates, was significantly better in forage yield than at the 60 pound

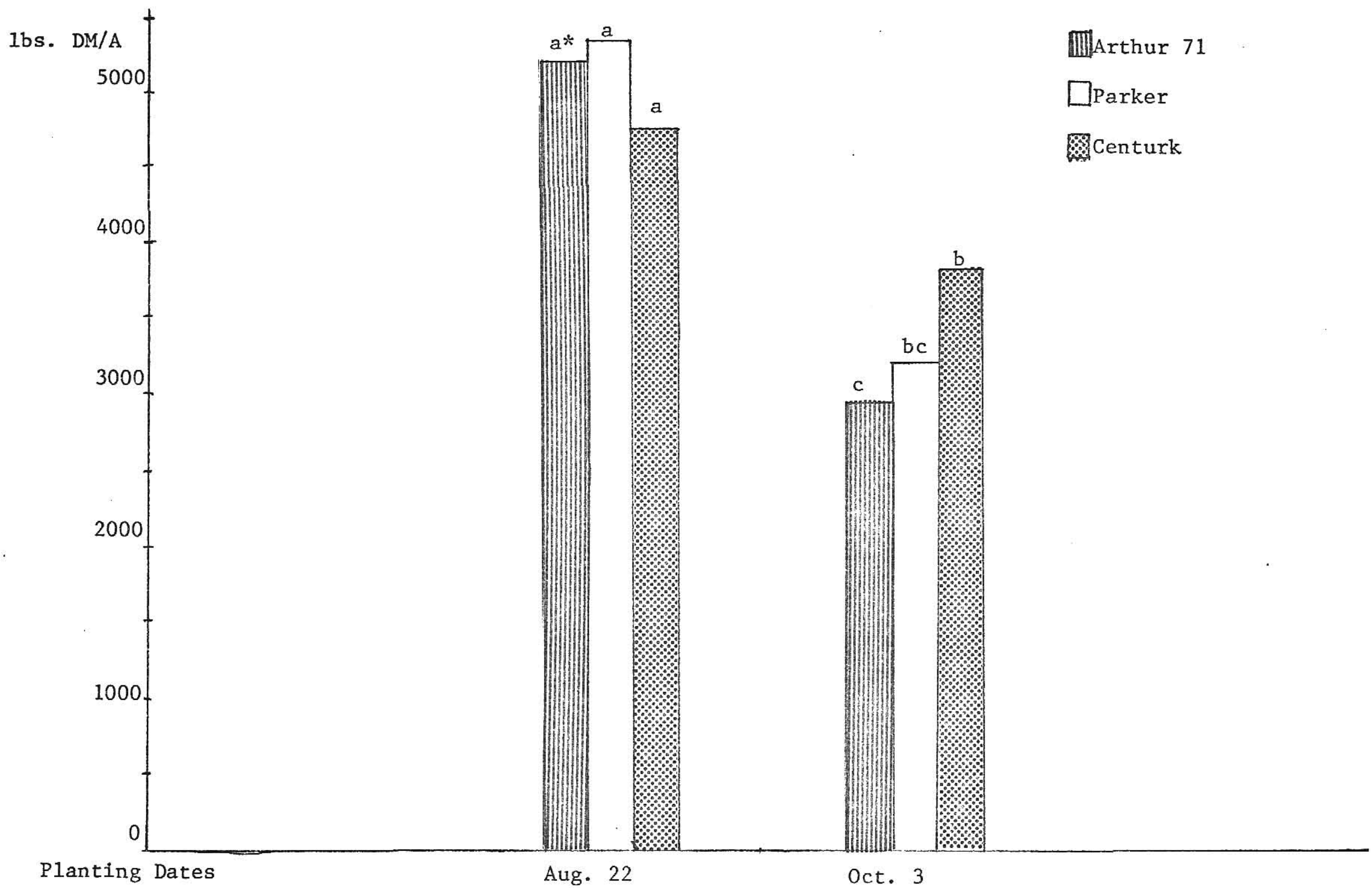

Figure 6. Mean forage yields for varieties as influenced by planting dates

* Bars with common letter are not significantly different (P<.05).

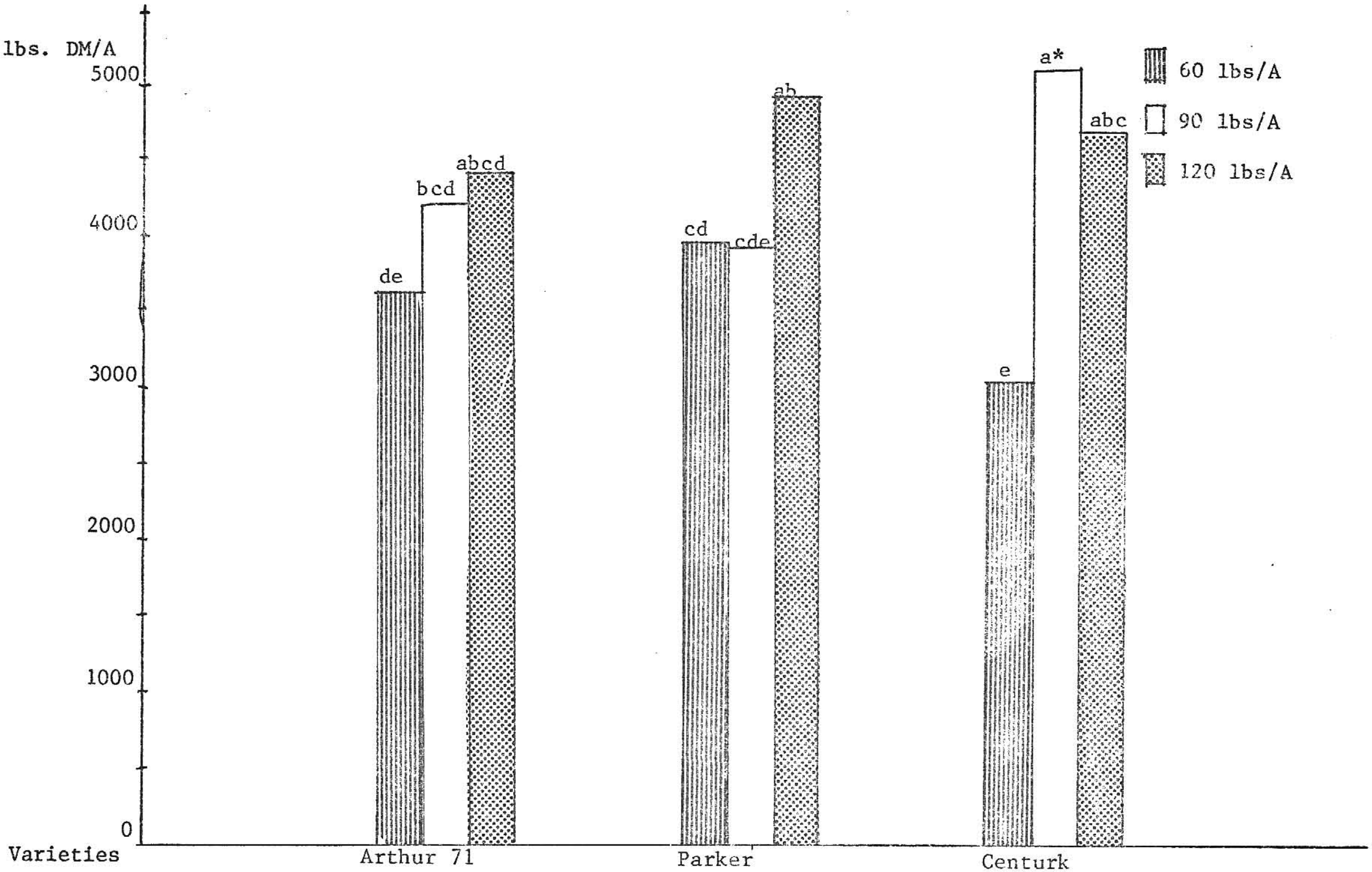

Figure 7. Mean forage yields for seeding rates as influenced by varieties

* Bars with common letter are not significantly different ($P<.05$).

rate. Arthur 71 produced similar forage yields for all three seeding rates.

There was apparently some growth during the winter, because the spring-only yields of forage were generally much greater than the fall-only treatment (Tables 6 and 7). This is in conflict with Romann, et al. (1975), Harper (1961), and Morey, et al. (1969) who noticed little regrowth over the winter.

The 90 and 120 pound seeding rate produced more forage than the 60 pound rate (Figure 7), except for the variety, Parker. This is in agreement with the Statewide Committee on Small Grains (1975), Lundquest (1964), and Holt, et al. (1969) who recommended higher seeding rates for forage production.

Most of the wheat forage (lbs. DM/A) was produced in the spring. Table 6 shows averages of over one half ton per acre in fall-only forage harvest, whereas the mean forage yields in Table 7 for the spring harvest are considerably higher than those of the fall-only harvest (Table 6). This is in agreement with the Manhattan data and with the results of many previous studies. [Anderson (1956); Bertrand and Donavin (1973); Brown, et al. (1973); Cummins, et al. (1964); ibid, (1965); Day, et al. (1968); Denholm and Arnold (1970); Elder (1967); Evers (1973); Harper (1961); Holt, et al. (1969); Morey (1961); Peterson (1959); and Romann, et al. (1975).]

Grain Yield

There were significant differences among varieties in grain yield at each harvest treatment. The grain yield of Centurk was the highest for the fall-only and spring-only harvest treatments. The grain yield of the grazeout harvest treatment was very low and would be abandoned by most producers.

Table 8. Mean grain yields (Bu/A) as influenced by harvest treatments, planting dates, varieties, and seeding rates

Harvest Treatment	Planting Dates		Varieties			Seeding Rates (lbs/A)		
	Aug. 22	Oct. 3	Arthur 71	Parker	Centurk	60	90	120
fall-only	22.3	____	12.0b*	23.5a	31.4a	21.6	25.8	19.5
spring-only	25.4	____	18.7b	22.4b	35.1a	22.3	26.4	27.7
grazeout	0.2b	1.9a	1.6a	0.7b	0.9b	0.8	1.0	1.4
control	21.3b	30.4a	15.7c	24.4b	37.3a	25.2ab	22.9c	29.3a

* Treatment means within harvests followed by the same letter do not differ significantly at the .05 level of probability.

The differences in grain yield among seeding rates were significant only for the control as illustrated in Table 8, and the analyses of variance are shown in Appendix Tables 19, 20, 21, and 22.

Interactions. The analysis of grain yield data resulted in significant interactions for the grazeout forage harvest treatment and the control. Since all grain yields for the grazeout harvest treatment were near zero, these interactions have little meaning. For the control, planting date x variety, planting date x seeding rate, and planting date x variety x seeding rate interactions were significant.

The planting date x variety x seeding rate interaction is illustrated in Figure 8. At both planting dates, the hard red winter wheat varieties, Parker and Centurk, generally yielded better than did Arthur 71. The October planting date generally produced higher grain yields than the August planting date. The trends in grain yield for seeding rates were incon-

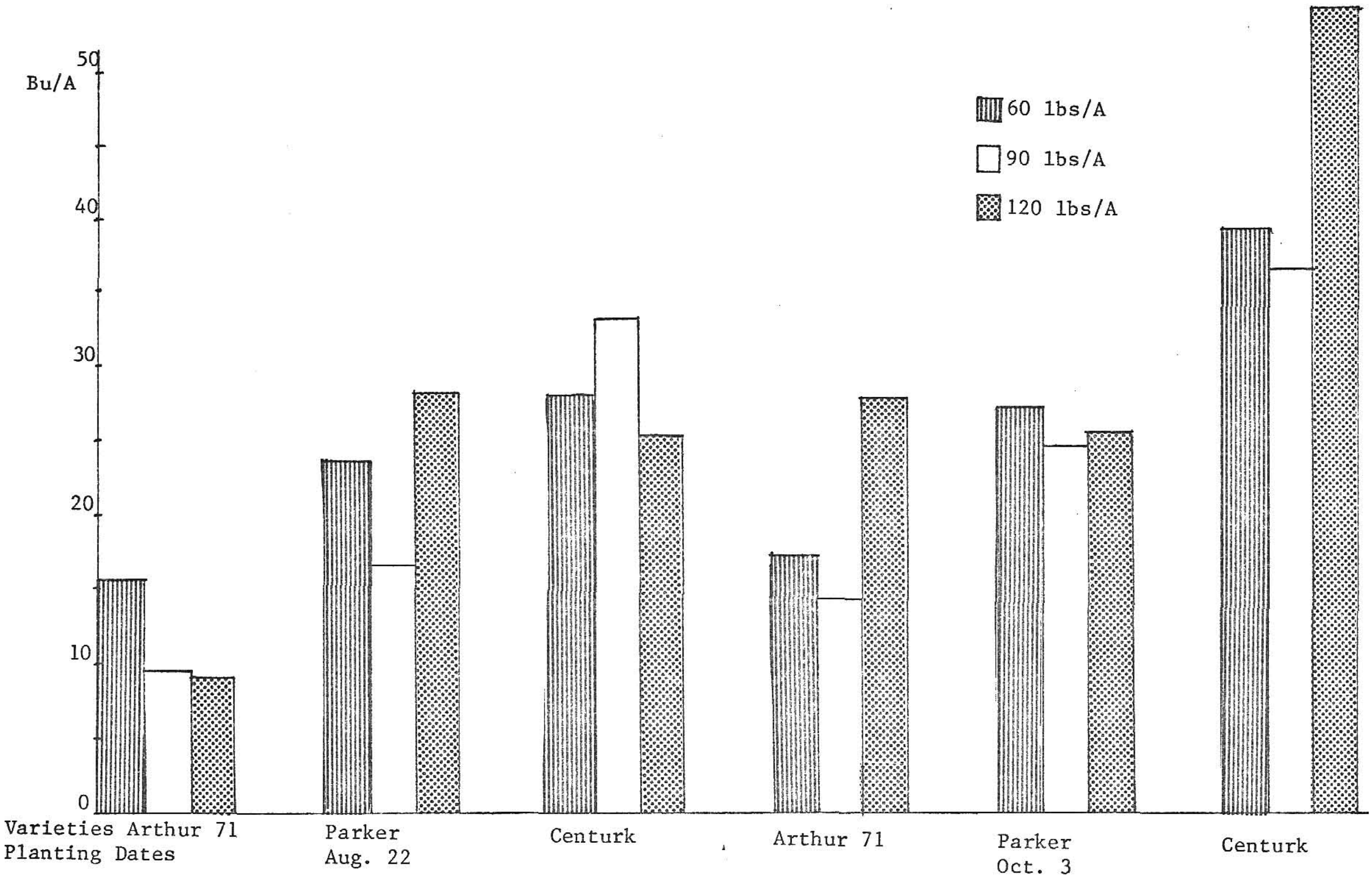

Figure 8. Mean grain yields for seeding rates as influenced by varieties and planting dates

sistent.

Walters (1975) determined that Arthur 71 yielded more grain per acre than Parker or Centurk. These data conflict with his findings, as the hard red winter wheats always yielded better except for the 120 pound seeding rate at the October 3 planting date.

The wheat planted October 3 had not made sufficient growth to harvest at the fall-only and spring-only harvests, therefore, no planting date comparison can be made. The grazeout harvest treatment had grain yields so low that even though the differences were significant, it would not be harvested.

For the control, the later planting date produced significantly more bushels per acre than the earlier planting date. This is in agreement with data of Martin (1926) and Heyne, et al. (1964) who noted planting near optimum date produced the highest grain yield.

CONCLUSIONS

1. There was more forage available in the spring than in the fall, if wheat was planted at the normal planting date. At Manhattan, the August planting produced equal forage yields in the fall-only and spring-only harvests. The September planting date produced 88% of its total forage in the spring, and had a higher total than either the August or October planting dates. The October planting dates produced essentially all their wheat forage in the spring at both Manhattan and Mound Valley.

2. Forage yields were similar for all varieties in the fall-only harvest. The hard red winter wheats (Parker and Centurk) generally produced more (lbs. DM/A) than the soft red winter wheat (Arthur 71) in the spring harvests.

3. Planting date and seeding rate must be considered together for optimum grain yields. The lower seeding rates produced better grain yields at the earlier planting dates. Conversely, the later planting dates produced better yields at the higher seeding rates.

4. Grain yields were greater for the hard red winter wheats (Parker and Centurk) than for the soft red winter wheat (Arthur 71) at both locations.

5. Clipping forage in the fall-only had no adverse effect on grain yield. Early spring clipping reduced yields only slightly at Manhattan, and had no effect on grain yield at Mound Valley. Clipping at jointing reduced grain yield by approximately one-half. Clipping later than jointing prevented grain yields.

6. Plant height was generally unaffected by the fall-only harvest, reduced slightly by the spring-only harvest, and halved by the season-long clipping treatment.

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APPENDIX

Table 9. Analysis of variance for the fall-only forage harvest at Manhattan

Source	df	Mean Square	F Value	$\hat{A}$
Planting Dates (P)	1	8375710	14.89	0.07
Replications	2	803735	1.43	>.10
Error a	2	562456		
Varieties (V)	2	152096	2.89	0.07
Seeding Rates (S)	2	225744	4.30	0.02
V X S	4	20525	.39	*
P X V	2	97491	1.86	0.17
P X S	2	123384	2.35	0.11
P X V X S	4	46407	.88	*
Error b	32	52472		
Total	53			

* Probabilities for F values less than 1.0 have little biological meaning and are not shown.

Table 10. Analysis of variance for the spring-only forage harvest at Manhattan

Source	df	Mean Square	F Value	$\hat{A}$
Planting Dates (P)	1	1827012	1.28	0.10
Replications	2	270744	0.18	*
Error a	2	1430709		
Varieties (V)	2	198007	1.37	0.27
Seeding Rates (S)	2	602331	4.17	0.02
V X S	4	138819		*
P X V	2	155666	1.07	0.35
P X S	2	36178	0.25	*
P X V X S	4	43300	0.30	*
Error b	32	144858		
Total	53			

* Probabilities for F values less than 1.0 have little biological meaning and are not shown.

Table 11. Analysis of variance for the season-long forage harvest treatment at Manhattan

Source	df	Mean Square	F Value	$\hat{A}$
Planting Dates (P)	2	32852240	11.45	0.03
Replications	2	1127244	0.39	*
Error a	4	2870361		
Varieties (V)	2	5793936	8.86	0.00
Seeding Rates (S)	2	5251657	8.03	0.00
V X S	4	761505	1.17	0.34
P X V	4	643219	0.98	*
P X S	4	1131623	1.73	0.16
P X V X S	8	947484	1.45	0.20
Error b	48	653618		
Total	80			

* Probabilities for F values less than 1.0 have little biological meaning and are not shown.

Table 12. Analysis of variance of the grazeout forage harvest treatment at Manhattan

Source	df	Mean Square	F Value	$\hat{A}$
Planting Dates (P)	2	29555872	24.67	0.00
Replications	2	491436	0.41	*
Error a	4	1198143		
Varieties (V)	2	8343544	19.48	0.00
Seeding Rates (S)	2	1511156	3.52	0.04
V X S	4	579312	1.35	0.26
P X V	4	815629	1.90	0.12
P X S	4	766935	1.79	0.14
P X V X S	8	206112	0.48	*
Error b	48	428245		
Total	80			

* Probabilities for F values less than 1.0 have little biological meaning and are not shown.

Table 13. Analysis of variance for all forage harvests at Manhattan

Source	df	Mean Square	F Value	Â
Harvest Treatments (H)	3	199557456	650.18	0.00
Planting Dates (P)	2	65285183	17.61	0.01
H X P	6	5485472	17.87	0.00
Replications	2	2020591	0.54	*
Error a	4	3706839		
Varieties (V)	2	7811640	24.50	0.00
H X V	6	2186408	7.12	0.00
P X V	4	591934	1.86	>.10
H X P X V	12	350613	1.14	0.32
Error b	48	318796		
Seeding Rates (S)	2	5083502	15.95	0.00
H X S	6	743783	2.42	0.03
P X S	4	633619	1.99	0.09
H X P X S	12	494243	1.61	0.09
V X S	4	499543	1.57	>.10
H X V X S	12	315835	1.03	>.10
P X V X S	8	408741	1.28	>.10
H X P X V X S	24	272087	0.89	*
Error c	162	306926		
Total	323			

* Probabilities for F values less than 1.0 have little biological meaning and are not shown.

Table 14. Analysis of variance for plant height at Manhattan

Source	df	Mean Square	F Value	$\hat{A}$
Harvest Treatments (H)	4	22461	440.41	0.00
Planting Dates (P)	2	626	12.24	0.00
H X P	8	411	8.04	0.03
Replications	2	152	2.98	
Error a	4	51		
Varieties (V)	2	466	38.03	0.00
H X V	8	97	7.89	0.00
P X V	4	54	4.38	0.00
H X P X V	16	18	1.46	>.10
Error b	48	12		
Seeding Rates (S)	2	20	1.09	0.34
H X S	8	32	1.70	0.10
P X S	4	11	0.58	*
H X P X S	16	20	1.06	0.40
V X S	4	31	1.66	0.16
H X V X S	16	7	0.35	*
P X V X S	8	20	1.04	0.40
H X P X V X S	32	12	0.62	*
Error c	216	19		
Total	404			

* Probabilities for F values less than 1.0 have little biological meaning and are not shown.

Table 15. Analysis of variance for total grain yield at Manhattan

Source	df	Mean Square	F Value	$\hat{A}$
Harvest Treatments (H)	4	28273	401.29	0.00
Planting Dates (P)	2	3046	43.23	0.00
H X P	8	376	9.89	0.02
Replications	2	54	0.77	*
Error a	4	70		
Varieties (V)	2	7033	118.57	0.00
H X V	8	1010	26.58	0.00
P X V	4	1142	19.26	0.00
H X P X V	16	223	5.86	0.00
Error b	48	59		
Seeding Rates (S)	2	172	4.54	0.02
H X S	8	45	1.17	0.10
P X S	4	191	5.02	0.01
H X P X S	16	52	1.37	>.10
V X S	4	14	0.36	*
H X V X S	16	29	0.74	*
P X V X S	8	51	1.33	>.10
H X P X V X S	32	31	0.85	*
Error c	216	38		
Total	404			

* Probabilities for F values less than 1.0 have little biological meaning and are not shown.

Table 16. Analysis of variance for fall-only forage harvest at Mound Valley

Source	df	Mean Square	F Value	$\hat{A}$
Replications	2	1799277	8.65	0.00
Varieties (V)	2	487105	2.34	0.13
Seeding Rates (S)	2	1012405	4.86	0.02
V X S	4	158391	0.76	*
Error	16	207902		
Total	26			

* Probabilities for F values less than 1.0 have little biological meaning and are not shown.

Table 17. Analysis of variance for spring-only forage harvest at Mound Valley

Source	df	Mean Square	F Value	$\hat{A}$
Replications	2	815108	0.83	*
Varieties (V)	2	1545836	1.58	0.24
Seeding Rates (S)	2	3463347	3.54	0.05
V X S	4	1468116	1.50	0.25
Error	16	977500		
Total	26			

* Probabilities for F values less than 1.0 have little biological meaning and are not shown.

Table 18. Analysis of variance for the grazeout forage harvest treatment at Mound Valley

Source	df	Mean Square	F Value	$\hat{A}$
Planting Dates (P)	1	43121280	7.63	0.00
Error a	4	5652747		
Varieties (V)	2	273280	0.46	*
Seeding Rates (S)	2	6634654	11.26	0.00
V X S	4	1855600	3.15	0.03
P X V	2	2376616	4.03	0.03
P X S	2	223060	0.38	*
P X V X S	4	542283	0.92	*
Error b	32	589087		
Total	53			

* Probabilities for F values less than 1.0 have little biological meaning and are not shown.

Table 19. Analysis of variance for grain yield for the fall-only forage harvest at Mound Valley

Source	df	Mean Square	F Value	$\hat{A}$
Replications	2	216	3.36	0.06
Varieties (V)	2	851	13.20	0.00
Seeding Rates (S)	2	92	1.43	0.27
V X S	4	106	1.65	0.21
Error	16	64		
Total	26			

Table 20. Analysis of variance for grain yield from the spring-only forage harvest treatment at Mound Valley

Source	df	Mean Square	F Value	$\hat{A}$
Replications	2	82	0.96	*
Varieties (V)	2	662	7.82	0.00
Seeding Rates (S)	2	72	0.85	*
V X S	4	164	1.94	0.15
Error	16	85		
Total	26			

* Probabilities for F values less than 1.0 have little biological meaning and are not shown.

Table 21. Analysis of variance of grain yield from the grazeout harvest treatment at Mound Valley

Source	df	Mean Square	F Value	$\hat{A}$
Planting Dates (P)	1	38	9.65	0.00
Replications	2	4	1.17	>.10
Error a	4	4		
Varieties (V)	2	4	4.44	0.02
Seeding Rates (S)	2	1	1.59	0.22
V X S	4	3	3.20	0.03
P X V	2	5	5.44	0.01
P X S	2	2	2.01	0.15
P X V X S	4	3	3.14	0.03
Error b	32	.88		
Total	53			

Table 22. Analysis of variance for grain yield of the control harvest treatment at Mound Valley

Source	df	Mean Square	F Value	$\hat{A}$
Planting Dates (P)	1	1115	12.16	0.00
Replications	2	176	1.91	>.10
Error a	4	92		
Varieties (V)	2	2116	43.70	0.00
Seeding Rates (S)	2	194	4.00	0.03
V X S	4	30	0.62	*
P X V	2	183	3.78	0.03
P X S	2	205	4.24	0.02
P X V X S	4	181	3.73	0.01
Error b	32	48		
Total	53			

* Probabilities for F values less than 1.0 have little biological meaning and are not shown.

Table 23. Forage yields (lbs. DM/A) for harvest treatments, planting dates, varieties, and seeding rates at Manhattan

Harvest Treatments	Planting Dates	Varieties	Seeding Rates (lbs/A) 60	90	120
fall-only	Aug. 28	Arthur 71	1122	1413	1178
		Parker	1074	1086	1199
		Centurk	1478	1393	1466
	Sept. 20	Arthur 71	280	446	753
		Parker	277	409	674
		Centurk	289	615	578
	Oct. 10	*			
spring-only	Aug. 28	Arthur 71	951	1059	1262
		Parker	1041	1164	962
		Centurk	714	1129	1511
	Sept. 20	Arthur 71	291	676	587
		Parker	525	927	749
		Centurk	647	955	1124
	Oct. 10	*			
season-long	Aug. 28	Arthur 71	2929	3743	2876
		Parker	3094	3689	3880
		Centurk	3596	3640	3559
	Sept. 20	Arthur 71	3606	2863	3400
		Parker	3369	4399	4334
		Centurk	3678	4661	4616
	Oct. 10	Arthur 71	348	1834	1396
		Parker	815	2604	1557
		Centurk	1330	2317	3908
grazeout	Aug. 28	Arthur 71	3886	3681	3405
		Parker	4090	4129	4065
		Centurk	4125	3749	3688
	Sept. 20	Arthur 71	3290	3225	3893
		Parker	4245	5077	4966
		Centurk	4757	4890	5427

Table 23. (continued)

Harvest Treatments	Planting Dates	Varieties	Seeding Rates (lbs/A) 60	90	120
grazeout	Oct. 10	Arthur 71	1155	1823	2207
		Parker	1918	3645	2709
		Centurk	2444	2521	3011

* There was insufficient dry matter accumulation for a forage harvest at this time.

Table 24. Grain yields (Bu/A) for harvest treatments, planting dates, varieties, and seeding rates at Manhattan

Harvest Treatments	Planting Dates	Varieties	Seeding Rates (lbs/A) 60	90	120
fall-only	Aug. 28	Arthur 71	34	21	26
		Parker	28	28	23
		Centurk	31	34	30
	Sept. 20	Arthur 71	27	21	25
		Parker	39	44	47
		Centurk	59	60	56
	Oct. 10	Arthur 71	12	21	27
		Parker	35	41	54
		Centurk	49	52	55
spring-only	Aug. 28	Arthur 71	19	22	25
		Parker	30	26	27
		Centurk	33	33	28
	Sept. 20	Arthur 71	18	16	22
		Parker	37	42	44
		Centurk	53	59	54
	Oct. 10	Arthur 71	18	27	34
		Parker	48	49	56
		Centurk	45	41	61
season-long	*				
grazeout	*				
control	Aug. 28	Arthur 71	31	21	25
		Parker	26	29	28
		Centurk	34	26	30
	Sept. 20	Arthur 71	21	21	23
		Parker	31	39	42
		Centurk	60	56	58
	Oct. 10	Arthur 71	22	26	21
		Parker	51	49	50
		Centurk	41	46	59

* Grain yields were usually less than 5 Bu/A for this harvest treatment.

Table 25. Forage yields (lbs. DM/A) for harvest treatments, planting dates, varieties, and seeding rates at Mound Valley

Harvest Treatments	Planting Dates	Varieties	Seeding Rates (lbs/A) 60	90	120
fall-only	Aug. 22	Arthur 71	1272	1353	1529
		Parker	1494	1250	2261
		Centurk	885	1106	1631
	Oct. 3	*			
spring-only	Aug. 22	Arthur 71	1893	2137	2087
		Parker	1571	1834	3918
		Centurk	2082	3264	3258
	Oct. 3	*			
grazeout	Aug. 22	Arthur 71	4436	5560	5661
		Parker	5315	4642	6135
		Centurk	3382	5555	5438
	Oct. 3	Arthur 71	2818	2846	3219
		Parker	2649	3243	3738
		Centurk	2714	4667	4144

* There was insufficient dry matter accumulation for a forage harvest at this time.

Table 26. Grain yields (Bu/A) for harvest treatments, varieties, and seeding rates at Mound Valley

Harvest Treatments	Planting Dates	Varieties	Seeding Rates (lbs/A) 60	90	120
fall-only	Aug. 22	Arthur 71	16	9	11
		Parker	20	27	23
		Centurk	28	41	25
	Oct. 3	*			
spring-only	Aug. 22	Arthur 71	18	19	18
		Parker	22	27	17
		Centurk	26	33	47
	Oct. 3	*			
grazeout	**				
control	Aug. 22	Arthur 71	16	10	9
		Parker	24	17	28
		Centurk	28	35	26
	Oct. 3	Arthur 71	17	15	28
		Parker	27	25	26
		Centurk	39	37	59

* This planting date received neither forage nor grain harvests due to drought.

** Grain yields were usually less than 5 Bu/A for this harvest treatment.

THE INFLUENCE OF PLANTING DATE, VARIETY, SEEDING RATE, AND HARVEST TREATMENT ON FORAGE AND GRAIN YIELDS OF WINTER WHEAT

by

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It is widely known that wheat is a good source of high quality forage, and many producers in Kansas utilize wheat forage in livestock operations. A study was needed to evaluate soft red winter wheats, and newer varieties for forage and grain production in Kansas.

The objectives of this study were to determine: (1) the optimum planting date, seeding rate, and types of wheat for forage, (2) the seasonal distribution of forage production, and (3) the influence of time of forage harvest on the grain yield of wheat.

This experiment was conducted at Manhattan and Mound Valley, Kansas. Wheat was planted August 22 and October 3 at Mound Valley, and August 28, September 20, and October 10 at Manhattan.

A split-plot design was used with planting dates as main plots, variety times seeding rate combinations as sub-plots, and harvest treatments as sub-sub-plots.

To determine seasonal and total dry matter production, harvests were made at mid-December (fall-only), late February at Mound Valley and early March at Manhattan (spring-only), and December, March, and April at Manhattan (season-long). The grazeout treatment was clipped in December, February, and April at Mound Valley, and in December, March, April, and May at Manhattan. Plant height and grain yield were measured at maturity.

Based upon the data collected, the following conclusions were made. (1) There was more forage available in the spring than in the fall, if wheat was planted at the normal planting date. At Manhattan, the August planting produced equal forage yields in the fall-only and spring-only harvests. The September planting date produced 88% of its total forage in the spring, and had a higher total than either the August or October planting dates. The October planting dates produced essentially all their wheat forage in the spring. (2) Forage yields were similar for all varieties in the fall-only harvest. The hard red winter wheats (Parker and Centurk) generally produced more (lbs. DM/A) than the soft red winter wheat (Arthur 71) in the spring harvests. (3) Planting date and seeding rate must be considered together for optimum grain yields. The lower seeding rates produced better grain yields at the earlier planting dates. Conversely, the later planting dates produced better yields at the higher seeding rates. (4) Grain yields were greater for the hard red winter wheats (Parker and Centurk) than for the soft red winter wheat (Arthur 71) at both locations. (5) Clipping forage in the fall-only had no adverse effect on grain yield. Early spring clipping reduced yields only slightly at Manhattan, and had no effect on grain yield at Mound Valley. Clipping at jointing reduced grain yield by approximately one-half. Clipping later than jointing prevented grain yields. (6) Plant height was generally unaffected by the fall-only harvest, reduced slightly by the spring-only harvest, and halved by the season-long clipping treatment.