EFFECT OF VARIABILITY IN INTRA-ROW SPACING
ON CORN (ZEA MAYS L.) YIELD

by 613-8302

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Dedicated to the memory of my mother, OMOSEBI ESECHIE

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INTRODUCTION

While such farming practices as the efficient use of fertilizers, herbicides and irrigation play a major role in increasing corn yield, the effect of planting pattern cannot be underestimated.

The western part of Kansas, an area with a third of the state's corn acreage, produces over half of the state's total output of corn for grain, and one of the reasons for this has been attributed to efficient planting. Efficient or precision planting is a method whereby corn plants are uniformly spaced within the row. Evenly and properly spaced corn plants have plenty of room to grow and make efficient use of water and plant food. Also, there is more access for sunlight to penetrate and activate the growth processes.

With the different types of planters now in use it is difficult, if not impossible, to space corn plants evenly within the row. However, it is possible to achieve a planting very close to uniformity but this would require a well-calibrated planter and a very careful operator. Is the yield advantage of uniformly spaced over non-uniformly spaced corn plants worth the trouble of striving towards uniformity?

This study investigated the effect of intra-row spacing variability on corn yield. Hand and machine plantings were used to create a range of intra-row spacing variability.

REVIEW OF LITERATURE

Although many yield comparisons between different corn planting patterns have been made, the superiority of any one planting pattern has not been fully established. As of date, no work has been done on the effect of intra-row spacing variability on corn yield. But many experiments have been conducted in which a comparison was made between drilled and hilled corn. Since hill-planting is more or less an extreme form of unequal intra-row spacings, this review would be primarily a comparison between drill and hill methods of corn planting.

Morrow and Hunt (12) found that check-row planting out-yielded drill-row corn, but the authors attributed the larger yields to fewer weeds. In later tests in Indiana, Kohnke and Miles (10) noted that drilling scored better in 2 out of 5 points, yield and suckering, but uniform spacing showed no advantage over drilling. While hilling gave the lowest yields, it resulted in the least lodging and least suckering. They did not recommend uniform spacing. They concluded that a compromise between drilling and hilling might be best. This could be achieved by planting two kernels every 45.72 or 50.80 cm in rows spaced 101.60 cm apart.

In other states including Kentucky, Roberts and Kinney (15); Ohio, Williams and Welton (19); Nebraska, Kiesselbach, Anderson, and Lyness (9) and Michigan, Rounds, et al (16), the average yield from comparable populations was in favor of the drill method of planting. Dungan, Lang, and Pendleton (6) reported that results from seven corn growing states covering a total of 39 station-years showed a weighted average yield for drilled corn that was 100.4 kg/ha or 3% above checked corn, but this figure was hardly significant economically or statistically.

Dungan (5) reported that single plant distribution was favored over multiple plant hills. The average of 7-year tests showed a 200.8 kg/ha advantage for single plant distribution, but this was barely significant. He noted that conditions which particularly favored the crop grown in single plant distribution were apparently a combination of (a) a soil of medium-high productivity and (b) plentiful and well distributed rainfall.

In Nebraska, Kiesselbach, et al (9) conducted extensive tests with irregular number of plants per hill but with the same population per hectare. They found that a uniform stand of 3 plants per hill produced a 14-year average of 3132.5 kg/ha. Stands of 2 and 4 per hill alternating regularly gave a yield of 3176.5 kg/ha; 1,3 and 5 plants per hill yielded 3094.9 kg/ha; and 1, 2, 3, 4 and 5 plants per hill in regular sequence gave a yield of 3138.8 kg/ha.

Roberts and Kinney (15) obtained higher yields for 3 stalks per hill planting than 2 stalks per hill, using equal plant population. They noted that corn planted in hills tended to yield better than drilled corn, under dry conditions. However, Colville and McGill (3) reported that yields of drilled corn were superior to both hill dropped and checked methods of planting. Yield increases due to drilled as compared to hilled corn ranged from 616.3 to 1406.2 kg/ha.

In Iowa, Bryan, Eckhardt, and Sprague (1) reported the results of a four-year test in which plants grown at 4 per hill in 106.6 cm rows were compared with plants grown 1 per hill in rows 53.30 cm apart in both directions. The population was 35,148 plants per hectare. Average grain yield per hectare was 5048.1 kg. for the 53.3 cm spacing and 4852.3 kg. for 106.6 cm spacing. They concluded that no consistent and material advantage would result from spacings closer than the traditional 106.6 x 106.6 cm. However, Pfister (14) reported that the ideal spacing appeared to be 50.8 cm apart in each direction.

Collins and Shedd (2) obtained 439.4 kg/ha or 9.2% yield advantage for 53.3 x 53.3 cm single kernel hills over 106.6 x 106.6 cm four kernel hills. Also at Ibadan, Nigeria, Fayemi (7) observed that corn at a population of 47,840 plants per hectare spaced at 22.9 cm apart in the row gave consistently, though not significantly, higher yields than the same population spaced at 45.8 or 91.6 cm in the row.

Other conditions being equal, reported Hoff and Mederski (8), the production of high corn yields is dependent largely on an adequate soil moisture supply. In initiating their investigation these workers theorized that an equidistant pattern may reduce competition between roots of adjacent plants for water and nutrients and thereby increase grain yield. Equidistant planting also provides a uniform vegetative canopy early in the season and may reduce soil erosion. They noted that equidistant planting produced more ears and fewer nubbins, but did not have a marked effect on ear weight. An increase in mean yield by 345.3 kg/ha by equidistant planting was obtained in this experiment.

Dungan (5) also noted that spacing plants singly and equidistant in all directions from other plants should provide less competition than any other method of distributing the same number of plants per hectare. He added, however, that there was not much likelihood that anyone would want to grow a commercial crop by this method. Yet if tests of this distribution showed a significant advantage, practical modifications of it could be readily devised.

EXPERIMENTAL PROCEDURE

1971 Experiment

Five corn hybrids were planted at 39,536 plants per hectare by both hand and machine planting at the Kansas River Valley Irrigation Experiment Field. Hand planted sections (four 30.5-meter rows) were planted in a bulk area of machine planted corn.

DeKalb variety XL-390 was machine planted on May 25, 1971 and hand planted three days later. DeKalb variety 901, PAG variety 644, PAG variety SX-70 and PAG variety 17525 were all machine planted on June 1, 1971; hand planting took place on June 4, 1971.

Weed control was attained by a broadcast application of 4.5 kg/ha (active material) of atrazine after planting.

Individual between plant spacings were measured prior to harvest in 3.05-meter long plots from the middle rows of the four 30.5-meter row hand planted sections and also from the adjacent machine planted bulk area. There were a total of thirty-five hand planted plots and thirty-five machine planted plots.

Grain yields were generally poor because of lack of irrigation and yield data were therefore of no practical significance. However, results of "standard deviation" of spacings calculated according to Snedecor and Cochran (17) showed that there was a higher variability in spacings in the machine planted corn than in hand planted corn.

1972 Experiments

The study was conducted at three irrigated locations: Kansas

River Valley Experiment Field at Silver Lake, Sandyland Irrigation Experiment Field at St. John and Irrigation Experiment Field at Scandia.

In all three locations bulk areas were planted by machine, leaving sections of four 30.5-meter long rows for hand planting.

Sandyland Experiment Field experiment was planted on May 14, 1972 to Pioneer variety 3390. Six sections comprising four 30.5-meter long rows were planted by hand in a bulk area of machine-planted corn. The Irrigation Experiment Field experiment was planted on May 20, 1972 to Pioneer variety 3149. There were five hand-planted sections in a machine planted bulk area. Stull variety 850 WSX (white corn) was planted by machine at the Kansas River Valley Experiment Field on May 20, 1972; four sections were hand-planted within this bulk area of machine planting two days later.

In all locations five plots (4.57-meter long single row) were taken from the middle rows of each hand-planted section and five were taken from four adjacent rows of machine planted corn. There were thirty each of hand and machine planted plots at the Sandyland Irrigation Experiment Field; twenty-five each of hand and machine planted plots at the Irrigation Experiment Field, and twenty each of hand and machine planted plots at the Kansas River Valley Irrigation Experiment Field.

Individual plant spacings were measured in all plots prior to harvest, and from these measurements "standard deviation" of spacing and "coefficient of variation" of spacing were calculated according to Snedecor and Cochran (17); these represented measures of spacing variability. All plots were hand-harvested and grain yields were calculated at 14.5% moisture. The intended plant population for this study was 64,246 plants per hectare at all locations. While hand planting came very close to this planting rate, much disparity was observed in machine planting. Therefore, adjusting yield for population at each location based on the average plant population for that location was necessary.

RESULTS AND DISCUSSION

Kansas River Valley Experiment: The intended planting rate of 64,246 plants per hectare was obtained neither in hand planting nor in machine planting. Plant populations for hand planted corn ranged from 54,538 to 68,890 plants per hectare; machine planting ranged from 45,926 to 60,278 plants per hectare (Appendix Table 5).

Table 1. Kansas River Valley Experiment (1972): Simple Correlations among grain yield, yield components and variability of spacing

	Yield (unadjusted)	Ear number	Ear weight	Plants/ha	Yield (adjusted)	Standard deviation of spacing
Ear number	0.339*[1]					
Ear weight	0.888**	0.198				
Plants/ha	-0.311*	-0.492**	-0.541**			
Yield (adjusted)	0.950**	0.195	0.752**	0.000		
Standard deviation of spacing	0.354*	0.359*	0.546**	-0.831**	0.100	
Coefficient of variation of spacing	0.369*	0.295	0.533**	-0.737**	0.147	0.984**

Grain yield and plant population were negatively and significantly correlated, indicating that grain yield tended to fall as plant population increased (Table 1). Plots with fewer number of plants were

[1]One asterisk (*) indicates significance at the 5% level. A double asterisk (**) indicates significance at the 1% level.

therefore likely to have a yield advantage over plots with higher number of plants. Since grain yield was the response being studied in this experiment it was necessary to eliminate factors which would tend to obscure yield results. Grain yields from all plots were adjusted to the average population for this location, 59,561 plants per hectare (Appendix Table 8). These yield adjustments eliminated population effects, thus creating a justifiable basis for comparing grain yields as affected by intra-row spacing variability as measured by standard deviation.

Adjusted grain yield ranged from 2,710 kg/ha to 7,427 kg/ha; average grain yield was 5,363 kg/ha. Unadjusted grain yield ranged from 2,491 kg/ha to 7,388 kg/ha (Appendix Table 5). Standard deviation of spacing ranged from 1.66 cm to 9.68 cm for hand planted corn and 5.20 to 14.20 cm for machine planted corn.

Correlation of adjusted grain yield and standard deviation of spacing was not significant, indicating that no relationship existed between grain yield and intra-row spacing variability (as measured by standard deviation). However, a significant positive correlation existed between standard deviation of spacing and number of ears per plant. Also, ear weight was highly positively correlated with standard deviation of spacing. It should be recalled that plant population and unadjusted grain yield were negatively correlated. Therefore, although ear number and ear weight (two yield components) were positively and significantly correlated to intra-row spacing variability, the negative and significant correlation between plant population (a yield component) and intra-row spacing variability was sufficient to offset the positive and significant correlation between intra-row spacing variability and the other two yield components. This explains why there was no significant correlation between adjusted grain yield and intra-row spacing variability, even when a linear relationship existed between intra-row spacing variability and two yield components.

Coefficient of variation, which is a measure of "relative" variation, should be an effective measure of intra-row spacing variability where there is disparity in plant population. This "statistic" was calculated by dividing standard deviation of intra-row spacing by the average intra-row spacing. Coefficient of variation ranged from 0.08 to 0.32 for hand planted corn and 0.24 to 0.64 for machine planted corn (Appendix Table 5). Unadjusted grain yield and coefficient of variation were positively correlated (Table 1). Correlation of ear number and standard deviation of spacing was not significant, but ear weight and coefficient of variation were highly correlated.

A significant correlation between unadjusted grain yield and coefficient of variation of spacing, indicating a linear relationship between these two variables, is noteworthy. It should be recalled that there was no linear relationship between adjusted grain yield and standard deviation of spacing. This important information about linearity between grain yield and variability may have been lost in the process of yield adjustments for population. Maintaining a uniform planting rate would have alleviated this problem.

Sandyland Irrigation Experiment: Plant population for hand planted corn ranged from 57,408 to 68,890 plants per hectare; machine planting ranged from 48,797 to 80,271 plants per hectare. Grain yield and plant population were positively and highly significantly correlated (Table 2).

Table 2. Sandyland Irrigation Experiment (1972): Simple Correlations among grain yield, yield components and variability of spacing

	Yield (unadjusted)	Ear number	Ear weight	Plants/ha	Yield (adjusted)	Standard deviation of spacing
Ear number	0.086					
Ear weight	0.308*	-0.420**				
Plants/ha	0.429**	-0.218	-0.436**			
Yield (adjusted)	0.903**	0.199	0.548**	-0.000		
Standard deviation of spacing	-0.169	0.225	-0.274*	0.047	-0.209	
Coefficient of variation of spacing	-0.061	0.180	-0.373**	0.278*	-0.199	0.968**

An attempt was made to eliminate this population effect by adjusting grain yield on the basis of the average plant population for this experimental site, which was 63,340 plants per hectare (Appendix Table 8).

Adjusted grain yield was 12,689 kg/ha on the average, the range being 10,441 kg/ha to 14,374 kg/ha. Standard deviation of spacing for hand planted corn ranged from 1.77 cm to 9.55 cm; 5.06 cm to 11.70 cm was the range of standard deviation for machine planted corn.

Adjusted grain yield and standard deviation of spacing gave a negative correlation, showing that grain yield tended to decrease as intra-row spacing variability increased. However, the correlation coefficient (-0.209) was not significant. Correlation for ear number and standard deviation of spacing was not significant. Ear weight and standard deviation of spacing gave a negative and significant correlation (Table 2). This showed that ear weight tended to decrease as intra-row spacing variability increased.

Neither unadjusted grain yield nor ear number were significantly correlated to coefficient of variation. Ear weight and coefficient of variation were negatively and highly significantly correlated.

Results for both measures of variability tend to agree--a negative but nonsignificant correlation between variability and grain yield, a positive but nonsignificant correlation between ear number and variability, and a negative and significant correlation between ear weight and variability. Ear number was probably compensating for ear weight such that as ear weight tended to decrease with increase in variability, ear number tended to increase. This compensating effect between two yield components might have been responsible for the lack of significant correlation between grain yield and intra-row spacing variability.

Irrigation Experiment (Scandia): No relationship was found between grain yield and plant population. However, it was obvious from the range in plant population (57,408 to 71,760 plants per hectare for hand planted corn and 43,056 to 60,278 plants per hectare for machine planted corn) that there was some disparity in planting rate. Average plant population for this location was 57,465 plants per hectare. Yield adjustments were made as in the other locations in an attempt to remove population effects (Appendix Table 8).

Standard deviation of intra-row spacing was highest at this location. For hand planted corn the range was 2.15 cm to 8.23 cm; for machine planted corn the range was 9.27 cm to 15.70 cm. Coefficient of variation was, however, not highest at this location. Hand planted corn had a range of 0.11 to 0.36, while 0.33 to 0.60 was the range for machine planted corn.

Table 3. Irrigation Experiment, Scandia (1972): Simple Correlations among grain yield, yield components and variability of spacing

	Yield (unadjusted)	Ear number	Ear weight	Plants/ha	Yield (adjusted)	Standard deviation of spacing
Ear number	-0.152					
Ear weight	-0.422**	0.201				
Plants/ha	0.069	-0.724**	-0.669**			
Yield (adjusted)	1.000**	-0.149	-0.419**	0.064		
Standard deviation of spacing	-0.049	0.650**	0.503**	-0.829**	-0.045	
Coefficient of variation of spacing	-0.044	0.546**	0.396**	-0.686**	-0.041	0.968**

Standard deviation of spacing was not significantly correlated to adjusted grain yield; similarly, there was no significant correlation between unadjusted grain yield and coefficient of variation of spacing. These results indicated that there was no linear relationship between grain yield and intra-row spacing variability. The two measures of variability were, however, positively and highly correlated to two yield components (Table 3), showing that ear number and ear weight increased as intra-row spacing variability increased.

Plant population and intra-row spacing variability were negatively and highly significantly correlated. The negative and highly significant correlation between plant population and variability was probably negating the correlation between variability and ear number and between variability and ear weight, such that no linear relationship was found between grain yield and intra-row spacing variability.

Partial Correlations

Partial correlation between intra-row spacing variability and unadjusted grain yield was used to measure that correlation between variability and grain yield that was not simply a reflection of their relationship to plant population.

Table 4. Partial Correlations between grain yield and variability of spacing

	Kansas River Valley Experiment	Sandyland Irrigation Experiment	Irrigation Experiment (Scandia)
$r_{12.4}$[1]	0.181	-0.210	0.015
$r_{13.4}$	0.218	-0.240	0.005

[1] 1 = Unadjusted grain yield
2 = Standard deviation
3 = Coefficient of variation
4 = Plant population

Table 4 shows the partial correlations for each experiment. There was no significant partial correlation between yield and intra-row spacing variability which is in agreement with the correlations between adjusted grain yield and intra-row spacing variability.

SUMMARY AND CONCLUSIONS

No relationship was found between grain yield and intra-row spacing variability, except at the Kansas River Valley Irrigation Experiment Field. Intra-row spacing variability was significantly correlated to yield components in almost all cases. At the Kansas River Valley Irrigation Experiment Field and Irrigation Experiment Field (Scandia) yield components (ear weight and ears per plant) tended to increase as intra-row spacing variability increased. But at the Sandyland Irrigation Experiment Field, ear weight (a yield component) tended to decrease as intra-row spacing variability increased.

It was established that intra-row spacing variability tended to decrease as plant population increased; such results whereby a positive linear relationship existed between variability and two yield components (ear number and ear weight) and no such relationship between grain yield and variability were attributed to this population effect.

Results indicate that intra-row spacing variability had more effect on yield components than on grain yield. Grain yield was found to be affected more by plant population than intra-row spacing variability. It should be noted, however, that the range of variability, 1.45 cm to 15.70 cm (as measured standard deviation) obtained in this study may be much lower than the range in farmers' fields. It is possible that higher levels of variability may give different results. The farmer's field should be a more appropriate site for future studies on intra-row spacing variability. Maintaining a uniform planting rate should enhance precision, because there would then be no need to adjust grain yield for plant population.

It would be premature at this stage of study of intra-row spacing variability to make a general statement on what effect it would have on grain yield. In fact, until all the possible ranges of intra-row spacing variability have been explored any conclusion arrived at should be open to question. It is hoped, however, that the results obtained in this study could serve as a guide to future studies on intra-row spacing variability.

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APPENDIX

CORN STUDY 1972: SUMMARY OF GRAIN YIELD, PLANT POPULATION, STANDARD DEVIATION OF SPACING AND COEFFICIENT OF VARIATION OF SPACING

Table 5. Location: Kansas River Valley Irrigation Experiment Field, Silver Lake
Variety: Stull 850 WSx

Plants/ha	Unadjusted Yield (Kg/ha)	Adjusted Yield (Kg/ha)	Standard Deviation of Spacing (cm)	Coefficient of Variation of Spacing
Hand Planted Corn				
66,019	5,008	5,407	1.74	0.08
66,019	5,573	5,972	3.19	0.16
66,019	5,724	6,123	3.15	0.16
63,149	5,030	5,249	2.92	0.14
54,538	6,354	6,034	9.68	0.40
63,149	2,491	2,710	1.66	0.08
63,149	2,732	2,951	4.30	0.20
63,149	3,173	3,393	4.93	0.23
68,890	2,521	3,100	3.07	0.16
63,149	3,657	3,876	4.22	0.20
63,149	6,102	6,321	6.10	0.29
66,019	5,457	5,855	3.12	0.15
63,149	5,470	5,689	3.15	0.15
60,278	5,463	5,503	5.67	0.26
66,019	6,209	6,608	4.83	0.24
66,019	5,133	5,532	5.95	0.30
66,019	4,929	5,327	6.46	0.32
68,890	5,132	5,710	4.27	0.22
60,278	6,380	6,420	5.08	0.24
63,149	6,877	7,096	4.02	0.19

Table 5 (cont.).

Plants/ha	Unadjusted Yield (Kg/ha)	Adjusted Yield (kg/ha)	Standard Deviation of Spacing (cm)	Coefficient of Variation of Spacing
Machine Planted Corn				
57,408	7,153	7,013	9.03	0.40
60,278	4,532	4,572	6.31	0.29
60,278	5,122	5,161	5.20	0.24
51,667	5,266	4,767	11.00	0.42
48,797	4,981	4,302	13.80	0.51
51,667	6,300	5,800	9.25	0.36
54,538	4,908	4,588	11.00	0.46
57,408	4,451	4,311	8.77	0.38
45,926	6,424	5,566	11.70	0.42
60,278	5,287	5,326	14.20	0.64
60,278	7,388	7,427	6.78	0.30
54,538	6,635	6,315	11.20	0.46
54,538	6,103	5,784	10.60	0.45
57,408	6,758	6,618	12.10	0.49
54,538	5,784	5,465	8.12	0.34
57,408	6,052	5,912	9.91	0.44
60,278	6,289	6,329	9.39	0.42
54,538	5,588	5,269	8.41	0.35
48,767	4,776	4,097	13.60	0.50
51,667	5,519	5,020	12.20	0.47

Table 6. Location: Sandyland Irrigation Experiment Field, St. John
Variety: Pioneer 3390

Plants/ha	Unadjusted Yield (Kg/ha)	Adjusted Yield (Kg/ha)	Standard Deviation of Spacing (cm)	Coefficient of Variation of Spacing
Hand Planted Corn				
60,278	13,264	13,504	6.05	0.27
63,149	12,738	12,753	3.63	0.17
60,278	11,029	11,269	2.87	0.14
66,019	13,484	13,274	2.48	0.12
63,149	13,548	13,563	5.15	0.24
60,278	12,577	12,817	5.78	0.26
57,408	12,358	12,823	4.77	0.22
63,149	12,819	12,834	2.32	0.11
63,149	13,281	13,296	3.52	0.17
63,149	13,287	13,302	3.07	0.15
68,890	14,284	13,849	5.22	0.27
63,149	13,363	13,378	4.86	0.23
63,149	12,782	12,797	1.45	0.07
66,019	14,584	14,374	1.77	0.09
63,149	13,335	13,350	5.74	0.27
63,149	12,738	12,753	4.41	0.21
63,149	11,464	11,479	2.14	0.11
57,408	10,697	11,162	9.55	0.41
57,408	11,723	12,189	8.78	0.40
57,408	11,703	12,168	7.03	0.31
60,278	12,999	13,239	5.38	0.25

Table 6 (cont.).

Plants/ha	Unadjusted Yield (Kg/ha)	Adjusted Yield (Kg/ha)	Standard Deviation of Spacing (cm)	Coefficient of Variation of Spacing
Hand Planted Corn (cont.)				
68,890	12,553	12,118	4.63	0.24
63,149	13,291	13,306	4.54	0.22
57,408	11,214	11,679	6.94	0.29
68,890	13,768	13,332	8.29	0.43
63,149	14,246	14,261	4.38	0.20
60,278	12,820	13,060	3.49	0.16
63,149	13,731	13,746	5.27	0.25
66,019	12,473	12,262	2.69	0.14
60,278	12,178	12,418	6.83	0.31
Machine Planted Corn				
68,890	13,490	13,055	8.37	0.43
68,890	13,218	12,783	7.21	0.37
68,890	13,736	13,301	11.70	0.60
77,501	11,552	10,441	6.42	0.37
60,278	11,869	12,109	7.21	0.32
66,019	11,823	11,613	9.41	0.49
71,760	13,775	13,114	8.76	0.48
57,408	11,485	11,951	11.40	0.49
60,278	12,871	13,111	6.10	0.28
60,278	12,662	12,903	7.58	0.35
60,278	13,085	13,325	7.03	0.31

Table 6 (cont.).

Plants/ha	Unadjusted Yield (Kg/ha)	Adjusted Yield (Kg/ha)	Standard Deviation of Spacing (cm)	Coefficient of Variation of Spacing
Machine Planted Corn (cont.)				
60,278	12,973	13,214	9.09	0.42
57,408	12,419	12,885	10.70	0.47
57,408	11,983	12,449	8.43	0.37
66,019	12,240	12,030	7.07	0.36
48,797	10,247	11,388	8.02	0.30
60,278	12,784	13,025	8.35	0.38
66,019	14,565	14,355	9.15	0.46
54,539	10,868	11,559	7.51	0.31
68,890	13,713	13,278	7.73	0.41
57,408	12,879	13,344	8.15	0.36
60,278	13,841	14,081	5.10	0.23
66,019	12,802	12,592	7.03	0.36
60,278	10,486	10,726	6.47	0.30
66,019	12,707	12,497	11.70	0.60
68,890	11,849	11,413	10.30	0.52
71,760	13,466	12,806	10.30	0.57
80,371	12,414	11,078	8.92	0.54
66,019	12,604	12,394	5.06	0.25
68,890	12,628	12,193	7.54	0.35

Table 7. Location: Irrigation Experiment Field, Scandia
Variety: Pioneer 3149

Plants/ha	Unadjusted Yield (Kg/ha)	Adjusted Yield (Kg/ha)	Standard Deviation of Spacing (cm)	Coefficient of Variation of Spacing
Hand Planted Corn				
66,019	11,080	11,058	4.63	0.24
60,278	10,220	10,213	8.20	0.37
68,890	10,986	10,957	3.96	0.20
63,149	10,927	10,912	7.03	0.33
60,278	10,399	10,392	6.68	0.31
66,019	10,190	10,168	3.36	0.17
63,149	11,823	11,809	4.58	0.22
68,890	9,757	9,728	3.16	0.16
57,408	9,434	9,435	8.23	0.35
63,148	10,427	10,412	5.12	0.24
71,760	10,538	10,502	4.69	0.26
63,149	10,565	10,551	7.43	0.36
66,019	9,471	9,449	6.81	0.34
63,149	9,198	9,184	5.24	0.25
66,019	9,876	9,855	5.67	0.28
66,019	11,701	11,680	6.87	0.33
66,019	10,750	10,729	2.65	0.14
57,408	9,614	9,614	8.15	0.35
63,149	8,775	8,761	2.15	0.11
66,019	10,863	10,842	7.39	0.35
60,278	9,933	9,926	4.47	0.21

Table 7 (cont.).

Plants/ha	Unadjusted Yield (Kg/ha)	Adjusted Yield (Kg/ha)	Standard Deviation of Spacing (cm)	Coefficient of Variation of Spacing
Hand Planted Corn (cont.)				
66,019	11,261	11,239	3.55	0.18
68,890	10,538	10,509	3.95	0.21
68,890	9,982	9,954	4.17	0.21
60,278	10,953	10,946	7.13	0.32
Machine Planted Corn				
45,926	10,326	10,355	10.20	0.36
51,667	10,742	10,757	10.80	0.44
51,667	9,118	9,133	11.40	0.46
60,278	9,880	9,873	12.10	0.57
48,797	10,414	10,436	12.90	0.49
51,667	10,579	10,594	13.10	0.56
48,797	11,526	11,549	10.70	0.41
45,926	10,415	10,445	11.80	0.44
60,278	11,099	11,092	12.80	0.60
54,538	10,203	10,211	10.20	0.43
48,797	10,658	10,680	15.70	0.58
43,056	10,835	10,872	13.70	0.46
51,667	11,631	11,646	11.10	0.41
51,667	9,857	9,872	11.60	0.45
51,667	10,155	10,170	14.10	0.57
48,797	10,495	10,518	11.40	0.43

Table 7 (cont.).

Plants/ha	Unadjusted Yield (Kg/ha)	Adjusted Yield (Kg/ha)	Standard Deviation of Spacing (cm)	Coefficient of Variation of Spacing
Machine Planted Corn (cont.)				
45,926	10,455	10,484	9.74	0.34
51,667	10,639	10,654	11.60	0.46
54,538	9,959	9,966	12.20	0.49
51,667	10,989	10,004	9.27	0.37
48,797	9,920	9,942	15.10	0.58
43,056	9,620	9,657	9.99	0.33
48,797	9,614	9,636	15.00	0.56
51,667	11,052	11,067	13.60	0.50
51,667	10,676	10,691	11.00	0.45

Table 8. Linear regression between grain yield and plant population

Location	Average Plants/ha	Slope	Intercept
Kansas River Valley Irrigation Experiment	59,561	-0.06255	9,094
Sandyland Irrigation Experiment	63,340	0.07844	7,721
Irrigation Experiment	57,465	0.00256	10,255

Yield adjustments based on equation: $Y\ (\text{corrected}) = Y - b(X - \bar{X})$

where Y (corrected) = adjusted yield

Y = actual yield

b = slope

X = actual plant population

$\bar{X}$ = average plant population

EFFECT OF VARIABILITY IN INTRA-ROW SPACING
ON CORN (_ZEA_ _MAYS_ L.) YIELD

by

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B. Sc. (Hons.), University of Ibadan, Nigeria, 1970

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A study was carried out at the Kansas River Valley Irrigation Experiment Field in 1971 to investigate the effect of intra-row spacing variability on yield of corn (*Zea mays* L.). Grain yields were generally poor because of lack of irrigation and, therefore, yield data were of no practical significance.

The study was repeated in 1972 at three irrigated locations, namely, Kansas River Valley Irrigation Experiment Field at Silver Lake, Sandyland Irrigation Experiment Field at St. John and Irrigation Experiment Field at Scandia. In all three locations, areas were planted by machine, leaving four 30.5 meter-long rows for hand planting. There were twenty each of hand and machine planted plots at the Kansas River Valley Irrigation Experiment; thirty each of hand and machine planted plots at the Sandyland Irrigation Experiment, and twenty-five each of hand and machine planted plots at the Irrigation Experiment.

Individual plant spacings were measured in all plots prior to harvest and "standard deviation" and "coefficient of variation" were calculated from these; both represented measures of intra-row spacing variability.

The intended plant population of 64,246 plants per hectare was not uniformly attained in any of the three locations. Yield adjustments for population were made, based on the average plant population for each location.

No relationship was found between grain yield and intra-row spacing variability, except at the Kansas River Valley Irrigation Experiment, where grain yield tended to increase as variability increased. Intra-row spacing variability was positively correlated to ear weight and ear number in almost all cases. A negative and significant correlation between plant population and variability was thought to have a negating effect on the relationship between the other two yield components and variability. This explains why no relationship was found to exist between grain yield and variability.

Results indicated that grain yield was affected more by plant population than by intra-row spacing variability. However, all possible ranges of intra-row spacing variability need to be explored before a general statement could be made. Maintaining a uniform plant population should enhance precision, since yield adjustments for population would then be unnecessary.