RESPONSE OF TWO SOYBEAN VARIETIES TO ROW WIDTHS AND PLANT POPULATIONS

By

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ROW WIDTHS AND PLANT POPULATIONS

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CHAPTER I

INTRODUCTION

The world's food and fuel requirements continue to demand greater yields from the grain and forage grown by producers. Soybeans Glycine max (L.) Merrill can play an important role in bringing the shortage of food and fuel under more manageable levels. The soybean has many important uses. The two main products derived from soybeans are soybean oil and soybean meal. Soybean oil is used in motor fuel, soap, plastics, paint, and in many foods (16). Soybean meal is a very important livestock feed. Soy protein is used as a food additive to increase protein content and to improve nutritive value (1).

The recent rise in the popularity of soybeans is one of the most striking agricultural developments in the last fifty years (16). In the North Central states, soybean acreage nearly doubled during the 1960's. Also, an increase in soybean acreage occurred in the Southwest. Oklahoma soybean acreage has increased from 260,000 planted acres in 1976 to 350,000 planted acres in 1979. Yields have increased along with the acreage. In the United States soybean yields increased by approximately 30% between 1939 and 1971 (23). Still, improved soybean production technology is needed.

Any production practice that helps to increase the yield potential of the soybean would be considered a great asset. The effects of lodging, plant population, seed size, and row width are a few factors which

have been investigated.

The yield of soybeans is determined by the genetic potential and the interaction of a wide range of environmental factors and management practices (28). Row width and plant population are two major factors in any management practice.

This study dealt with three row widths, four plant populations, and two varieties. The objectives of this study were to evaluate the response of two soybean varieties to row widths and plant populations and to determine which combination of treatments yielded highest.

CHAPTER II

REVIEW OF LITERATURE

Soybeans are the most important cash crop in the United States (31). The United States soybean crop contributes more protein and oil to our food economy than any other single source (31). The recent interest in developing protein foods from soybeans is one practical approach to solving food shortage problems.

Soybean cultivars are classified as having a determinate or indeterminate growth habit. Bernard (2) defined a determinate type as one in which the stem growth terminated abruptly at the onset of flowering, while in the indeterminate type, stem growth, node, and leaf production continued for several weeks after flowering began. Bernard pointed out that there are graduations in determinacy. Westermann and Crothers (35) found that the determinate plant is subject to less competitive stress than the indeterminate plant type at higher plant populations. In a 1977 study, Green et al. (12) found that indeterminate lines yielded 4.5% higher than determinate lines and stated that the longer reproductive period of the indeterminate lines may have contributed to the yield increase. They also found that seed size was significantly affected by growth habits, with the indeterminate lines having 4% heavier seed.

A system of classification has been developed so that each new variety of soybeans is assigned to a maturity group, based upon the

length of time from planting to maturity (3). The system consists of ten maturity groups, 00 to VIII, running from earlier to later maturity characteristics.

The grain yield of soybeans is the result of many plant growth processes which are ultimately expressed in the yield components of plants per unit area, pods per plant, seeds per pod, and grams per seed (35). The highest yields are obtained when all the yield components are maximized.

Soybean yields in the United States increased nearly 30% between 1939 and 1971 (23). Improved management practice and the development of new, higher yielding cultivars have contributed to this increase in yield. Pendleton and Hartwig (21) stated in 1973 that the differences in average soybean yields from community, state, or region and the yields from either research stations or outstanding growers therein is primarily due to management practices.

One management practice investigated by numerous researchers is the effect of variation in row width. Increases in grain yield due to planting soybeans in narrow rows (less than 20 inches) rather than wide rows (greater than 30 inches) have been well documented (1, 4, 6, 12, 17, 18, 25, 26, 30, 36).

In 1939 Wiggans (36) concluded that the nearer the arrangement of plants on a given area approaches a uniform distribution, the greater will be the yield. Costa et al. (10) studied the response of soybean cultivars to planting patterns. They found that planting soybeans in narrower than conventionally spaced rows (30 to 40 inches) is one way of obtaining a more uniform plant distribution. Shibles and Weber (30) in 1966 concluded that increased yields from narrow rows are attributed,

in part, to improved plant distribution for a given area. They also concluded that plant distribution is more uniform in narrow rows and that plants more quickly occupy the aerial environment than do plants in wide row spacings.

In 1960, Lehman and Lambert (18) found that 20-inch rows generally outyielded 40-inch rows. Cartter and Hartwig (8) noted that maximum grain yields from soybeans grown in a short season will be obtained from narrow rows. They also noted that the row width which will result in maximum yields depends on the growth habit of the soybean, length of growing season, soil fertility, and location. In the northern and central regions of the United States, studies showed soybeans planted in narrow rows consistently yield more than those grown in traditional 40-inch rows (1). Research in the North Central states generally showed soybean yields in narrow rows superior to those in wide rows (18, 22). In a series of studies initiated in 1970, Ryder and Beuerlein (25, 26, 27) concluded that varieties generally produce larger yields in narrow rows than in wide rows. They showed that 30-inch rows outyielded 40-inch rows by 6 bushels per acre and that 15-inch rows outyielded 30-inch rows by 3.8 bushels per acre. For maximum yields, their results showed that the row width should be no wider than 15 inches. Kueneman et al. (17) found that narrow row spacings conferred significantly higher yields. They concluded that for a given density, planting soybeans in narrow rows at more equidistant spacing will, on the average, result in higher yields than planting in wider rows that provide a more rectangular arrangement of plants. Green et al. (12) contributed increased grain yields from narrow rows to greater photosynthetically active radiation interception.

Hicks et al. (14) found that planting soybeans in 25 versus 76 centimeter rows had no effect on seed yield in 1966 and increased yield 6.5 percent in 1967. In 1968 Oswalt et al. (20) conducted a row spacing study using three soybean cultivars and row widths of 14, 21, and 28 inches. Their results indicated that yields were highest for all three cultivars when they were planted in the 21-inch row width. Weber et al. (34) found that seed yields were highest when soybeans were planted in 10-inch rows when compared to 4, 20, and 40-inch row widths. In addition, they found that seeds per plant were maximized at the 10-inch row width and consistently decreased with increasing plant population.

The major problem growers face when using narrow rows is controlling weeds. Aldrich and Scott (1) reported that acceptance of narrow rows by growers has been slow due to the problem of controlling weeds. In 1977 Burnside and Moomaw (6) stated that planting soybeans in wide rows (35 to 41 inches) is simply traditional. They continued to state that present day dependence on cultivation for partial weed control necessitates planting soybeans in wide rows rather than narrow rows. The use of improved herbicides can help to eliminate the dependence on cultivation for weed control. Soybeans are most vulnerable to weeds during their early growth stages (6). If kept weed-free for 30 days after planting, when soybeans have become established, later emerging weeds will cause little yield loss since established soybeans compete well with weeds (5). Burnside (5), Wax (33), and Burnside and Moomaw (6) found that narrow row soybeans provide competition to weeds at an earlier stage of growth than those in wide rows by better distribution of roots and by earlier and more complete shading of the soil surface.

Taylor (32) found that under optimal soil moisture availability

narrow row soybeans outyielded those grown in wider rows, but during drought conditions, row width had no effect on soybean yields. He suggested that during drought years, the increased interception of solar radiation, caused by the more evenly distributed plants growing in narrow rows, resulted in more water being used during the early growing season and less water remaining for use during the pod-filling stage. The effect of moisture stress on soybean plants is complex and dependent on the stage of development. Doss et al. (11), Runge and Odell (24), and Shaw and Laing (29) concluded that the pod-filling stage was the most critical period for adequate moisture to obtain maximum yields.

Wax (33) noted that soybeans grown in narrow rows without cultivation would likely be easier to harvest than in wider rows where the soil was ridged by cultivation. The absence of cultivation ridges permits a lower cutting height. Cartter and Hartwig (8) stated that harvest losses may be reduced in soybeans grown in narrow rows, as changes in the microclimate tend to increase plant height and raise the height of the first pods. Plant height increases with narrower row spacings, according to Hicks et al. (14). Costa et al. (10) found that with the more uniform distribution in closely spaced rows, the harvest cutting area is spread over the entire length of the combine cutter bar, giving more uniform feeding of plants into the machine. As a result, combine efficiency is increased and harvest losses are reduced.

In 1966 Weber et al. (34) reported that maturity date, plant height, and lodging were relatively unaffected by row width. Cooper (9) in 1977 studied the response of soybean cultivars to narrow rows and planting rates under weed-free conditions. He observed that as row widths

were narrowed, lodging tended to increase. Green et al. (12) found lodging was not significantly affected by row width but averaged 0.3 units higher in the indeterminate lines.

Aldrich and Scott (1) stated that shorter and earlier varieties benefit more from the use of narrow rows than taller, later varieties. In 1979, Carter and Boerma (7) found that indeterminate cultivars yield 10% to 50% more in narrow rows (arbitrarily 26 inches or less) than wide rows over a range of planting dates. They noted that determinate cultivars also show yield response to narrow rows although these responses usually occur in late plantings (after June 15) rather than in early plantings.

Another management practice investigated by numerous workers is the effect of variation in plant population within the row. In 1939 Wiggans (36) found that the soybean plant has the ability to make wide adjustments to space and that the optimum plant population for soybeans should be determined not only for the various soybean producing areas but also for the cultivars to be grown. Pendleton and Hartwig (21) included row width, date of planting, seed germination, seed size, and weed species and numbers, along with variety and location, in determining the optimum plant population for soybeans.

Results of studies in the regions where narrow rows are used indicated that optimum plant populations are 6 to 8 plants per foot of row at harvest time in 36-inch rows, 4 to 6 plants in 20-inch rows, and 3 to 4 plants in rows 10 inches or narrower (1). Aldrich and Scott (1) and Ryder and Beuerlein (26) stated that planting too much seed is probably more common than planting too little.

Westermann and Crothers (35) studied plant population effects on

seed yield of two determinate and two indeterminate cultivars of beans. They reported that increasing plant populations causes greater interplant competition, which could further increase the intraplant competition for assimilates. They stated that this effect may be larger for indeterminate plants where there is a potential for greater competition between vegetative and reproductive growth.

Lodging is the character most often affected by an excessive plant population. According to Cooper (9), proper plant population helps to prevent lodging. Weber et al. (34) studied the effect of plant population and row spacing on soybeans using four row widths (5, 10, 20, and 40 inches) and four plant populations (26, 52, 104, and 209 thousands of plants per acre). They concluded that plants produced at higher densities were taller, more sparsely branched, lodged more, and set fewer pods and seeds than those plants at lower densities. Hicks et al. (14) also found plant height to increase with higher plant populations. They found pod set to be higher as a result of taller plants. Height of the pods is important because low pod height causes harvesting difficulties and losses.

Lehman and Lambert (18) found yield differences due to plant populations to be inconclusive when using plant populations of 4, 8, 16, and 24 plants per foot of row and row widths of 20 and 40 inches. In 1979 Ryder and Beuerlein (26) stated that, in general, many producers plant more soybeans per acre than are needed. Their results showed that natural thinning due to competition at the higher plant populations reduces yields, often as much as 50%.

CHAPTER III

MATERIALS AND METHODS

This study consisted of two soybean varieties, three row widths, and four plant populations. The effects of row width and plant population on two soybean varieties were investigated in the 1980 growing season.

Varieties

The two varieties used were Forrest and Crawford. Forrest originated as an F_5 line selected from the cross 'Dyer' X 'Bragg' (13). It was developed in a cooperative program of the Agricultural Research Service, U.S.D.A., and the Mississippi and Tennessee Agricultural Experiment Stations. Forrest has white flowers, tawny pubescence, tan pods, yellow seedcoats, and black hila. It is highly resistant to races 1 and 3 of the soybean cyst nematode and to the root-knot nematode. Forrest has a determinate growth type and belongs to maturity Group V. Crawford originated as an F_4 selection from a cross, 'Williams' X 'Columbus', made at the Kansas Agricultural Experiment Station (19). Crawford is characterized as having purple flowers, tawny pubescence, brown pods, light yellow seedcoats, and black hila. It is moderately resistant to races 1 and 2 of Phytophthora rot. Crawford has an indeterminate growth type and belongs to maturity Group IV. Both varieties were selected because of their adaptability to Oklahoma.

Row Widths

The row widths used were 12, 24, and 36 inch row spacings. These spacings were the distance between rows of plants. The 12-inch row width is generally considered a narrow row width and the 36-inch row width is considered a wide row width.

Plant Populations

The plant populations used were 1, 2, 3, and 4 plants per linear foot of row. The plant populations were chosed to represent a range of populations used by soybean growers.

Design and Field Layout

The study was planted on a Teller loam soil on the Agronomy Research Station near Perkins, Oklahoma. The soybeans were planted with a four cone planter on June 3, 1980. Nitrogen fixing bacteria, Rhizobium japonicum, were applied to the seed prior to planting. Hitbold et al. (15) stated that effective inoculation with Rhizobium japonicum is essential for nitrogen fixation and economic yield of soybeans. The factorial arrangement of the varieties, row widths, and plant populations was layed out in a randomized complete-block design having four replications. Each replication consisted of 24 entries.

Due to the extremely hot and dry conditions during the course of this study, irrigation had to be used to maintain the crop. The study was irrigated six times between planting and harvest. A total of approximately 10 inches of irrigation water was applied through the sprinkler system.

Throughout the growing season the study was scouted for weeds, insects, and diseases. The plots were hand-hoed as needed to control weeds. Insect damage and disease damage were determined to be at levels too low to warrant treatment of any kind.

Characters Evaluated

The following characters were observed and measured on all plots: grain yield, plant height, shattering, lodging, 100 seed weight, plants per plot, and seeds per plant.

Grain Yield

Prior to harvest the plots were hand shortened to eight feet to eliminate end-of-plot bias. The plots were harvested by hand and threshed in the field with a plot thresher. Crawford was harvested and threshed on October 17, 1980. Forrest was harvested and threshed on October 31, 1980. The center rows were harvested in all plots. The plots with the 12-inch row width had the center six rows harvested. Plots having rows 24 inches apart had the center three rows harvested. The plots with the 36-inch row width had the center two rows harvested. The same area (48 square feet) was harvested from each plot. When the threshed soybeans were dried to a uniform moisture content they were cleaned and weighed. The weight was recorded as grams per plot and then converted to bushels per acre.

Plant Height

Plant heights were taken at maturity and corresponded to the distance in inches from the soil surface to the top of the main stem. This

character was expressed as an average over the entire plot.

Shattering

The amount of soybean shattering was measured visually prior to harvest of each variety. Each plot was rated on a scale of 1 to 5 depending on the amount of shattering that had occurred, with 1 equal to "no shattering" and 5 equal to "over 20% shattering."

Lodging

The amount of plants that had lodged was measured visually prior to harvest. Each was rated on a scale of 1 to 5 depending on the amount of lodging that had occurred, with 1 equal to "no lodging" and 5 equal to "over 20% lodged."

100 Seed Weight

A random sample of 100 whole, clean seeds was taken from each plot and weighed to determine 100 seed weight.

Plants Per Plot

The number of plants per plot was counted just prior to harvest. Only those plants in the rows to be harvested were counted.

Seeds Per Plant

The number of seeds per plant was calculated for each plot by dividing the number of seeds per plot by the number of plants per plot. The number of seeds per plot was calculated by dividing the number of grams per plot by the 100 seed weight and multiplying the quotient by

100. These calculations were computed by the Oklahoma State University Computer Center.

Statistical Analyses

The statistical analyses of variance for the data collected were computed by the Statistical Analysis System at the Oklahoma State University Computer Center. An analysis of variance was computed for each character.

CHAPTER IV

RESULTS AND DISCUSSION

Grain Yield

The analyses of variance for grain yield and its components are presented in Table I. This table indicates that there was a significant difference due to row width for grain yield at 0.01 level of probability. The average grain yield for the two varieties in different row widths and different plant populations is presented in Table II. The mean grain yield was highest for both varieties when they were grown in 24-inch rows. The 36-inch row width was outyielded by the 12-inch and 24-inch row width in both varieties. There was a row width-linear effect and a row width-quadratic effect on grain yield, both significant at the 0.01 level of probability. The linear and quadratic effects are seen by the increase in yield then decrease in yield when going from the 12-inch to 24-inch to 36-inch row width. The increase in yield from 12-inch to 24-inch row width (Tables II and III) suggests that plant competition for water and nutrients was too great at the 12-inch row width to obtain maximum yields. Other researchers (1, 4, 6, 12, 17, 18, 25, 26, 30, 36) have also found that narrow rows tend to outyield wider rows. Table III shows the average effect of row width and plant population on grain yield. This table also shows mean grain yield to be highest when plants were grown in 24-inch rows. There

TABLE I

MEAN SQUARES FOR GRAIN YIELD, PLANT HEIGHT, SHATTERING, LODGING, 100 SEED WEIGHT, PLANTS PER PLOT, AND SEEDS PER PLANT

Source of Variation	d. f.	Grain Yield	Height	Shat.	Lodg.	100 Seed Wt.	Plants Per Plot	Seeds Per Plant
Var	1	48.25	392.04**	.84*	.04	388.86**	49.59	102907.08**
Row Width	2	774.76**	7.13	.04	.01	.43	21527.32**	149891.18**
Var. x Row Width	2	24.89	15.04*	.00	.01	.77	54.78	2239.46
Plt. Popl.	3	45.76	25.26**	.18	.04	.77	10242.48**	238864.74**
Var. x Plt. Popl.	3	37.69	5.04	.01	.04	3.73*	659.04*	1246.21
Row Width x Plt. Popl.	6	72.84	10.22*	.13	.01	1.04	715.25**	5698.47
Var. x Row Width x Popl.	6	54.32	2.33	.17	.01	1.29	620.27**	7078.63*
Error	69	44.40	3.48	.14	.02	1.09	177.54	2997.79

*Significant at the 0.05 level of probability.
**Significant at the 0.01 level of probability.

TABLE II

AVERAGE EFFECT OF ROW WIDTH AND PLANT POPULATION ON THE GRAIN YIELD OF TWO SOYBEAN VARIETIES

Variety	Row Width (in.)	Plant Population (plt./linear ft.)	Grain Yield (bu./ac.)	Mean Grain Yield (bu./ac.)
Crawford	12	1	35.4	32.8
		2	30.9	
		3	40.5	
		4	23.7	
	24	1	36.7	36.3
		2	34.7	
		3	33.9	
		4	39.8	
	36	1	28.6	27.5
		2	29.9	
		3	28.8	
		4	22.7	
Forrest	12	1	37.7	35.9
		2	37.5	
		3	35.5	
		4	32.8	
	24	1	36.5	37.5
		2	41.3	
		3	35.0	
		4	37.3	
	36	1	25.7	27.3
		2	25.6	
		3	29.3	
		4	28.5	

TABLE III

AVERAGE EFFECT OF ROW WIDTH
AND PLANT POPULATION ON
GRAIN YIELD

Row Width (in.)	Plant Population (plt./linear ft.)				Mean Grain Yield (bu./ac.)
	1	2	3	4	
12	36.6	34.2	38.0	28.2	34.2
24	36.6	38.0	34.5	38.6	36.9
36	27.1	27.7	29.0	25.6	27.4
Mean Grain Yield (bu./ac.)	33.4	33.3	33.8	30.8	

was no significant difference between plant populations for grain yield. The lack of a yield response to change in plant population demonstrates the ability of a soybean plant to make adjustments to available space. No significant difference between plant populations suggest that it would be more economical to plant at the lowest plant population used in this study. There was no significant difference between the two varieties for grain yield. Crawford's mean yield over all plots was 32.1 bu./ac. and Forrest's mean yield over all plots was 33.6 bu./ac.

Plant Height

A highly significant difference was found between the two varieties for plant height (Table I). The mean plant height for the two varieties is compared in Table IV. There was a variety X row width interaction which was significant at the 0.05 level of probability (Table I). This interaction can be explained by using the data in Table V. Table V shows Crawford's mean plant height increased then decreased when going from 12-inch to 24-inch to 36-inch row width. Table V shows Forrest's mean plant height decreased as row width increased. There was also a row width X plant population interaction which was significant at the 0.05 level of probability. This interaction can be explained by using the data in Table VI. Table VI shows that in the 12-inch row width plant height increased as plant population increased to 3 plants per linear foot, but plant height decreased when going from 3 to 4 plants per linear foot. Table VI shows that in the 24-inch row width plant height increased, then decreased, and increased as plant population increased. Table VI shows that in the 36-inch row

TABLE IV

AVERAGE EFFECT OF PLANT POPULATION
AND VARIETY ON PLANT HEIGHT

Variety	Plant Population (plt./linear ft.)				Mean Plant Height (in.)
	1	2	3	4	
Crawford	22.9	24.2	24.7	24.1	24.0
Forrest	18.0	19.9	20.4	21.3	20.0
Mean Plant Height (in.)	20.5	22.0	22.5	22.7	

TABLE V

AVERAGE EFFECT OF ROW WIDTH AND PLANT POPULATION ON THE HEIGHT OF TWO SOYBEAN VARIETIES

Variety	Row Width (in.)	Plant Population (plt./linear ft.)	Plant Height (in.)	Mean Plant Height (in.)
Crawford	12	1	23.0	23.1
		2	23.0	
		3	24.8	
		4	21.8	
	24	1	23.5	25.0
		2	26.5	
		3	24.5	
		4	25.5	
	36	1	22.3	23.8
		2	23.0	
		3	24.8	
		4	25.0	
Forrest	12	1	20.3	20.6
		2	21.0	
		3	20.8	
		4	20.5	
	24	1	17.8	19.9
		2	19.8	
		3	20.0	
		4	22.0	
	36	1	16.0	19.3
		2	19.0	
		3	20.5	
		4	21.5	

TABLE VI

AVERAGE EFFECT OF ROW WIDTH
AND PLANT POPULATION ON
PLANT HEIGHT

Row Width (in.)	Plant Population (plt./linear ft.)				Mean Plant Height (in.)
	1	2	3	4	
12	21.6	22.0	22.8	21.1	21.9
24	20.6	23.1	22.3	23.8	22.4
36	19.1	21.0	22.6	23.3	21.5
Mean Plant Height (in.)	20.5	22.0	22.5	22.7	

width plant height increased as plant population increased. A highly significant difference was found among the plant populations for plant height (Table I). Mean plant height increased as plant population increased (Table VI). Hicks et al. (14) also reported plant height increased as plant population increased. Greater competition for water and nutrients occurs between plants when the row width decreases and plant population increases. This greater competition tends to cause height to increase.

Shattering

The variety effect on shattering was significant at the 0.05 level of probability (Table I). The Forrest variety averaged slightly higher in shattering percentage than did the Crawford variety. The amount of shattering was not high enough to significantly influence grain yield of either variety. There was no effect on shattering by row width or plant population.

Lodging

Table I indicates that there was no effect due to lodging. Aldrich and Scott (1) stated that lodging is the character most often affected by increasing plant population. Plant population did not have a significant effect on lodging in this study. Green et al. (12) and Weber et al. (34) found that lodging was not significantly affected by row width. Row width did not have a significant effect on lodging in this study either.

100 Seed Weight

The variety effect on 100 seed weight was significant at the 0.01

level of probability (Table I). Crawford, indeterminate in growth habit, averaged 15.2 g/100 seed and Forrest, determinate in growth habit, averaged 11.2 g/100 seed (Table VII). Green et al. (12) found that seed size was significantly affected by growth habits, with the indeterminate varieties having heavier seed. Row width and plant population had no effect on the 100 seed weight of either variety. There was a variety X plant population interaction which was significant at the 0.05 level of probability (Table I). This interaction can be explained by using the data in Table VII. Table VII shows Crawford's 100 seed weight increased as plant population increased to 3 plants per linear foot, but 100 seed weight decreased when going from 3 to 4 plants per linear foot. Table VII shows Forrest's 100 seed weight decreased when going from 1 to 2 plants per linear foot and when going from 2 to 3 plants per linear foot. Forrest's 100 seed weight increased when going from 3 to 4 plants per linear foot.

Plants Per Plot

A highly significant difference was found among row widths, and a highly significant difference was found among plant populations for the number of plants per plot (Table I). The significant difference can be expected because the number of seeds planted per plot increased when the row width narrowed or the plant population increased. There was a variety X row width X plant population interaction and a row width X plant population interaction. Both of these interactions were significant at the 0.01 level of probability (Table I). The three-factor interaction can be explained by using the data in Table VIII. Table VIII shows that both varieties increased in the number of plants

TABLE VII

AVERAGE EFFECT OF PLANT POPULATION
AND VARIETY ON 100 SEED WEIGHT

Variety	Plant Population (plt./linear ft.)				Mean 100 Seed Weight (g/100 seed)
	1	2	3	4	
Crawford	14.9	15.2	15.7	15.1	15.2
Forrest	11.9	11.2	10.7	10.9	11.2
Mean 100 Seed Weight (g/100 seed)	13.4	13.2	13.2	13.0	

TABLE VIII

AVERAGE EFFECT OF ROW WIDTH AND PLANT POPULATION ON THE NUMBER OF PLANTS PER PLOT OF TWO SOYBEAN VARIETIES

Variety	Row Width (in.)	Plant Population (plt./linear ft.)	Plants Per Plot
Crawford	12	1	43.3
		2	63.3
		3	106.5
		4	114.0
	24	1	20.5
		2	40.3
		3	56.5
		4	63.8
	36	1	14.0
		2	26.8
		3	43.3
		4	50.3
Forrest	12	1	34.3
		2	92.5
		3	92.8
		4	106.5
	24	1	24.3
		2	38.8
		3	47.0
		4	72.5
	36	1	14.8
		2	24.5
		3	33.5
		4	43.8

per plot as plant population increased and row width decreased. The row width X plant population interaction can be explained by using the data in Table IX. Table IX shows that within all three row widths the number of plants per plot increased as plant population increased. There was also a variety X plant population interaction which was significant at the 0.05 level of probability (Table I). Both varieties showed an increase in the number of plants per plot as plant population increased (Table VIII).

Seeds Per Plant

A highly significant difference was found between varieties, row widths, and plant populations for the numbers of seeds per plant (Table I). Crawford averaged 167.9 seeds per plant over all plots. Forrest averaged 233.4 seeds per plant over all plots. Mean seeds per plant increased as row width increased (Table X). Seeds per plant decreased as plant population increased (Table X). There was a variety X row width X plant population interaction which was significant at the 0.05 level of probability (Table I). This interaction can be explained by using the data in Table XI. Table XI shows that within each row width Crawford's number of seeds per plant decreased as plant population increased. Table XI shows that within the 24-inch and 36-inch row width Forrest's number of seeds per plant decreased as plant population increased. However, in the 12-inch row width of Forrest there was a decrease, a slight increase, and a decrease as plant population increased.

The effect of variety, row width, and plant population on seven agronomic characters can be seen in Table XII.

TABLE IX

AVERAGE EFFECT OF ROW WIDTH
AND PLANT POPULATION ON
THE NUMBER OF PLANTS
PER PLOT

Row Width (in.)	Plant Population (plt./linear ft.)				Mean Plants Per Plot
	1	2	3	4	
12	38.8	84.9	99.6	103.3	81.6
24	22.4	39.5	51.8	68.1	45.4
36	14.4	25.6	38.4	47.0	31.3
Mean Seeds Per Plot	25.2	50.0	63.3	72.8	

TABLE X

AVERAGE EFFECT OF ROW WIDTH AND PLANT POPULATION ON THE NUMBER OF SEEDS PER PLANT

Row Width (in.)	Plant Population (plt./linear ft.)				Mean Seeds Per Plant
	1	2	3	4	
12	235.2	99.5	88.9	70.9	123.6
24	370.6	222.3	165.2	136.9	223.7
36	422.0	257.1	199.0	139.9	254.5
Mean Seeds Per Plant	342.6	192.9	150.0	115.9	

TABLE XI

AVERAGE EFFECT OF ROW WIDTH AND PLANT POPULATION ON THE NUMBER OF SEEDS PER PLANT OF TWO SOYBEAN VARIETIES

Variety	Row Width (in.)	Plant Population (plt./linear ft.)	Seeds Per Plant
Crawford	12	1	169.0
		2	99.5
		3	74.0
		4	46.7
	24	1	363.6
		2	170.0
		3	122.7
		4	120.0
	36	1	410.8
		2	220.3
		3	128.6
		4	89.5
Forrest	12	1	301.4
		2	99.4
		3	103.9
		4	95.1
	24	1	377.1
		2	274.5
		3	210.3
		4	151.1
	36	1	433.3
		2	293.9
		3	269.4
		4	190.3

TABLE XII

AVERAGE EFFECT OF ROW WIDTH AND PLANT POPULATION ON SEVEN AGRONOMIC CHARACTERS OF TWO SOYBEAN VARIETIES

Variety	Row (in.)	Plant Popl. (plt./lin.ft.)	Grain Yield (bu./ac.)	Height (in.)	Shat.	Lodging	100 Seed Wt. (g)	Plants Per Plot	Seeds Per Plant
Crawford	12	1	35.4	23.0	1.3	1.0	14.7	43.3	169.0
		2	30.9	23.0	1.0	1.0	14.8	63.3	99.5
		3	40.5	24.8	1.0	1.0	15.7	106.5	74.0
		4	23.7	21.8	1.0	1.0	14.8	114.0	46.7
	24	1	36.7	23.5	1.0	1.0	14.9	20.5	363.6
		2	34.7	26.5	1.0	1.0	15.4	40.3	170.0
		3	33.9	24.5	1.3	1.0	15.2	56.5	122.7
		4	39.9	25.5	1.3	1.0	15.4	63.8	120.0
	36	1	28.6	22.3	1.0	1.0	15.2	14.0	410.8
		2	29.9	23.0	1.0	1.0	15.4	26.8	220.3
		3	28.8	24.8	1.0	1.0	16.1	43.3	128.6
		4	22.8	25.0	1.3	1.0	15.1	50.3	89.5
Forrest	12	1	37.7	20.3	1.3	1.3	11.0	34.3	301.4
		2	37.5	21.0	1.0	1.0	11.1	92.5	99.4
		3	35.5	20.8	1.3	1.0	11.0	92.8	103.9
		4	32.8	20.5	1.5	1.0	11.5	106.5	95.1
	24	1	36.5	17.8	1.0	1.0	12.3	24.3	377.7
		2	41.3	19.8	1.5	1.0	11.9	38.8	274.5
		3	35.0	20.0	1.3	1.0	11.0	47.0	210.3
		4	37.3	22.0	1.5	1.0	10.3	72.5	151.1
	36	1	25.7	16.0	1.5	1.3	12.4	14.8	433.3
		2	25.6	19.0	1.0	1.0	10.7	24.5	293.9
		3	29.3	20.5	1.3	1.0	10.3	33.5	269.4
		4	28.5	21.5	1.3	1.0	10.8	43.8	190.3

CHAPTER V

SUMMARY AND CONCLUSIONS

The objectives of this study were to evaluate and determine the response of two soybean varieties to row widths and plant populations and to determine which combination of treatments yielded highest. This study dealt with two soybean varieties (Crawford and Forrest), three row widths (12-inch, 24-inch, and 36-inch), and four plant populations (1, 2, 3, and 4 plants/linear foot of row). The factorial arrangement of varieties, row widths, and plant populations was layed out in a randomized complete-block design having four replications.

Characters analyzed were grain yield, plant height, shattering, lodging, 100 seed weight, plants per plot, and seeds per plant. An analysis of variance was conducted for each character to provide information on the effects of variety, row width, and plant population on these characters.

There was a significant difference due to row width for grain yield at the 0.01 level of probability. The grain yield was highest for both varieties when they were grown in 24-inch rows. The 36-inch row width was outyielded by the 12-inch and 24-inch row width in both varieties. There was no significant difference between the two varieties for grain yield. There was also no significant difference between plant populations for grain yield.

A highly significant difference was found between the two varieties

for plant height. Crawford's mean plant height was 24.0 inches and Forrest's mean plant height was 20.0 inches. Crawford's mean plant height increased then decreased when going from 12-inch to 24-inch to 36-inch row width, whereas Forrest's mean plant height steadily increased as row width narrowed. The plant population effect on plant height was highly significant. In general, mean plant height increased as plant population increased.

The variety effect of shattering was significant at the 0.05 level of probability. Forrest averaged slightly higher in shattering than did Crawford. Lodging was not affected by variety, row width, or plant population.

The variety effect on 100 seed weight was significant at the 0.01 level of probability. Crawford averaged 15.2 g/100 seed and Forrest averaged 11.2 g/100 seed. Row width or plant population had no effect on the 100 seed weight.

A highly significant difference was found among row widths, and a highly significant difference was found among plant populations for the number of plants per plot. Plants per plot increased as row width narrowed and as plant population increased.

A highly significant difference was found between varieties, row widths, and plant populations for the number of seeds per plant. Crawford averaged 167.9 seeds per plant over all plots. Forrest averaged 233.4 seeds per plant over all plots. Mean seeds per plant increased as row width increased. Seeds per plant decreased as plant population increased.

In conclusion, the results of this study indicated that soybeans yielded highest when grown in 24-inch rows. The results also indicated

that there was no significant difference between the plant populations for grain yield. However, these results are from a one year study only. The results were consistent with the results of other researchers who have studied the response of soybeans to row widths and plant populations. More research of this kind will need to be done to further determine optimum row width and optimum plant population for Oklahoma grown soybeans.

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