The Effect of Date of Planting, Rate of Planting, and Width of Row on Two Soybean Varieties

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Virginia has been growing soybeans successfully for over half a century but only in the past fifteen years has the main emphasis been in producing soybeans for grain. Most of the earlier production was planted broadcast or in drill rows for use as forage and green manure. The present soybean acreage is grown primarily for beans and is planted in intertilled rows.

The increase of approximately 300% in soybean acreage in the last fifteen years and consequent production by farmers inexperienced with the crops has increased the demand for information especially on date of seeding, rate of seeding, and width of row. In addition, many farmers grow other intertilled crops and like to plant soybeans early or late before or after their corn, small grains, or other crops. Double cropping with small grain and soybeans has become a common practice in recent years. This necessitates very late planting, especially if wheat is used in the rotation. Adequate information on performance of soybeans planted at different dates is not generally available.

Review of Literature

It has been shown in the Middle West by Burlison et al (1) and in Mississippi by Henson and Carr (5) that relatively early planting over a period of four to five weeks following the frost-free date in spring gives little differences in yield, but successively later plantings give progressively lower yields. Hartwig (3) reported a slight increase in yield for early May seeding over earlier or later seedings in Mississippi, but in Florida considerable decrease was obtained in yield for seedings before or after June 1 for two varieties. Hutchinson (6) reported that late June and early July seedings in eastern Virginia gave reduced yields below early May seeding for several varieties. Wolf (11) had previously reported progressively lower yields for later seedings of two varieties at one to two week intervals from May 11 to June 30 in Virginia.

Hartwig (3) obtained differences in height of different varieties when planted at different dates. In general, the very early dates produced shorter plants than moderately early planting, and later dates gave progressively shorter plants. Osler and Cartter (7) obtained maximum height at the earliest date of planting (May 1) and a progressive decrease in height with delayed planting.

Weiss et al (9) showed that varieties respond differently to date of planting, but in general delayed planting produces less plant height, reduced lodging, and smaller seed size. Delayed planting also delayed maturity to a greater extent in early than late varieties.

1/ In cooperation with the U. S. Department of Agriculture. All chemical analysis were made by the U. S. Regional Soybean Laboratory.

2/ Assistant Professor and Professor of Agronomy, respectively.

Henson and Carr (5) obtained more erect and shorter plants when planting late except for one year when they produced tall plants with lodging equal to earlier plantings - possibly due to favorable rainfall distribution. Osler and Cartter (7) obtained increased lodging with later planting.

Feaster (2) reported that oil content was not appreciably affected by date of planting from April 20 to July 10 except the last date produced beans with the lowest oil content. Weiss et al (9) obtained on the average of several varieties slightly less oil by delayed planting although the decrease was not consistent among varieties. Henson and Carr (5) obtained a slight decrease in oil content of beans from the later plantings.

Data from four Corn Belt states summarized by Weber and Weiss (8) showed that rows spaced 21 inches apart gave higher yields than 7 and 14, or 28 to 42 inch rows. The weeds were not controlled in the 7 and 14 inch drilled rows except for harrowing when plants were small. Wiggins (10) in New York controlled all weeds and obtained progressively higher yields in narrower row spacing with row widths of 8, 12, 16, 24 and 32 inches. However, in spite of the higher yields that can apparently be obtained in the Corn Belt by closer spacing, farmers in that area like to use a wider width similar to that used for corn. Row widths in the South generally range from 36 to 42 inches and there is considerable indication that the wider spacing will generally give yields equal to narrower spacing under southern conditions (4). Apparently the lush and heavier growth of the long season varieties used in the South is able to utilize all the area even when rows are spaced 36 inches or more apart.

EXPERIMENTAL METHODS

This experiment was conducted on sassafras sandy loam of medium fertility at the Eastern Virginia Research Station located in the Northern Coastal Plain. The experiment was initiated in 1951 with two varieties that were planted at four different dates (May 20, June 5, June 20 and July 5); at three row widths (12, 24 and 36 inches); and at three different rates (6, 12 and 18 seeds per foot).

The experiment was revised in 1952 and continued through 1954 with one additional date (May 5). The actual dates of planting varied a few days from year to year due to weather conditions. The seeding rate was also changed in 1952 to 3, 5 and 7 pecks per acre. This rate of planting was adjusted each year to equal a bean size of 16.5 grams per 100 beans which is the average seed size for S-100 and Ogden soybeans grown at three locations in Virginia over several years.

Two varieties were used throughout the experiment - Ogden, a full season variety that is perhaps the most commonly grown variety in the area; and S-100, an earlier variety that is grown on a large acreage in the region. These two varieties probably comprised 90% of the acreage in the surrounding area at the beginning of this experiment. All seed was treated with a fungicide and inoculated just prior to seeding.

Each plot was 12 feet wide and 20 feet long, thus the 1-foot spacing included 12 rows; the 2-foot spacing included 6 rows and the 3-foot spacing included 4 rows per plot. Six rows, each 20 feet long, were harvested from the 1-foot spacing; three rows from the 2-foot spacing and 2 rows from the 3-foot spacing for each replication.

Each variety was planted with four replications in a split-split block design with dates as whole plots, row widths as sub-plots, and rate of seeding as sub-sub-plots with complete randomization of all treatments within blocks. *

The entire area for the experiment was plowed in late winter and fallowed until time for seeding. All weeds were controlled in the fallowed land prior to seeding. Just prior to each seeding date, fertilizer (600 pounds of 0-14-14 per acre) was applied uniformily over the block to be seeded and disked-in followed by slight leveling. Rows were marked with a hand marker, then opened with a garden push plow and seeded by hand. The seed was covered with a garden push plow equipped with two wheels and two hoes to straddle the row, thus covering the seed without moving the soybeans. Since yield as affected by row width, rate of planting and date of planting was the main object of the study, weeds were completely controlled by timely cultivation and hoeing. The two and three foot rows were cultivated with tractor mounted equipment. A small hand plow was used to cultivate the one-foot rows when the beans were small. Later hoes were used to keep the area free of competitive weeds.

Considerable potential damage was caused in some years by insects including the green clover worm, Mexican bean beetles, corn ear worms, army worms, grasshoppers, blister beetles, and leafhoppers. Damage from insects was minimized by use of Dilan in 1952 and 1953, and Malathion in 1954.

All plots were harvested when the beans from each date of planting were mature using a small garden tractor equipped with a mower blade. There was no noticeable loss of beans during harvesting and threshing.

Data were collected for each of the following: Maturity date, plant height, lodging, seed yield, seed size, seed quality, and oil and protein content of the seed. The methods used in obtaining the data were as follows:

Maturity date - Number of days after seeding when most of the pods were dry.

Height - Distance in inches from the ground level to the highest point of the mature plants.

Lodging score -Rated at maturity on a scale of 1 to 5: 1 = most plants erect; 5 = all plants down. A scale of 1 to 7 was used in 1951.

Seed yield - Air-dried, threshed plot weights converted to bushels per acre.

Seed size - Weight of 100 seeds, in grams.

Seed quality Score - Rate on a scale of 1 to 5: 1 = very good; 5 = very poor.

Chemical analyses - Oil and protein content of the seed was determined as percentage on a moisture-free basis. Iodine number was obtained for 1951 only.

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* All statistical treatment of the data was by the Statistical Laboratory, Virginia Agricultural Experiment Station of the Virginia Polytechnic Institute.

RESULTS

Rainfall and Temperature

There was considerable variation in both annual rainfall and rainfall distribution during the growing season for the four years of this experiment. The annual rainfall over the last 35 years at Warsaw has averaged 41.6 inches. The total annual rainfall for the four years of this experiment was respectively 38.8, 42.3, 35.3 and 28.4 inches (Appendix Table 1). The average precipitation during the growing seasons, May through September, was 19.5 inches. Rainfall during the growing season for the 4 years of this experiment was 18.5, 14.9, 13,2 and 10.6 inches, respectively. In addition to the low rainfall, the rainfall distribution during the growing season was very erratic in 1953 and 1954 (Fig. 1). Temperatures were quite variable and tended to be higher during the drier years.

Effect of Planting Date on Stand

Adequate stands were obtained from all dates of planting with both S-100 and Ogden. However, due to the excessive dry seasons in 1953 and 1954, the June and July seedings had slightly poorer stands than for the May seedings.

The actual stand counts (Appendix Table 2) for 1952-54 average show a wide range (from 1.5 to 16.3) in number of plants per foot depending upon seeding rate, row width and date of seeding. However, differences in stand due to date of planting were not considered as sufficient to materially affect performance of the two varieties.

Seed Yield

The wide variation from year to year and the average yield performance of both S-100 and Ogden when seeded at different dates is shown in Figs. 2 and 3. No definite correlation can be made between climatic factors and performance of the soybeans for different dates of seeding and years. The seasonal average yields of S-100 were 28.0, 19.8 and 15.4 bushels per acre, respectively, for 1952 through 1954 and Ogden yields were 29.3, 13.1 and 13.1, respectively, for the same years. Each succeeding year after 1952 had less rainfall, and yielded, on the average, significantly less than the preceding year. These low yields in 1953 and 1954 are apparently due to both inadequate rainfall and poor rainfall distribution.

In spite of the wide differences in performance from year to year, the general trend for both varieties was production of maximum yields at the second or third planting date, and progressively lower yields from later seedings. This tendency for lowered yields from very early or late planting agrees, in general, with data by other workers (1, 3, 5, 6, 11). However, the general trend is not an indication of the year to year results. One exception to this general trend for lowered yields from very early or late plantings appears, at first, to have been obtained in 1951 when significantly lowereyields were obtained for each successively later seeding for both S-100 and Ogden. However, no early (May 5) planting date was included and conclusions on possible yields from an early seeding were not determined. However, the reduction in yield for each later planting is more pronounced than in the following years.

One other exception to this general trend of lower production for later seedings was the 1954 Ogden production. The average yield from the fourth (June 20th)

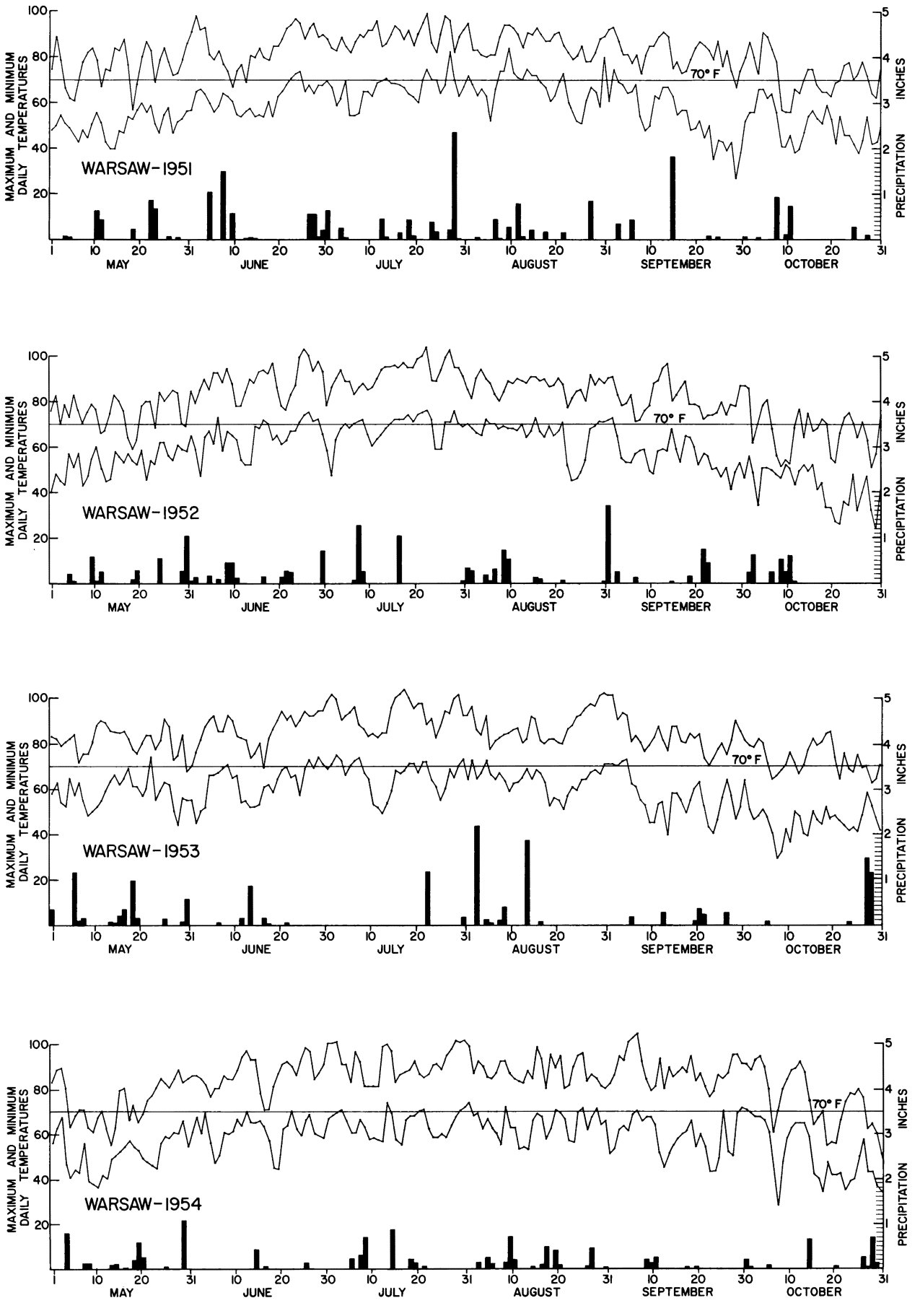

Fig. 1 - Daily precipitation, and maximum and minimum daily temperatures during the growing seasons of 1951 to 1954. Warsaw.

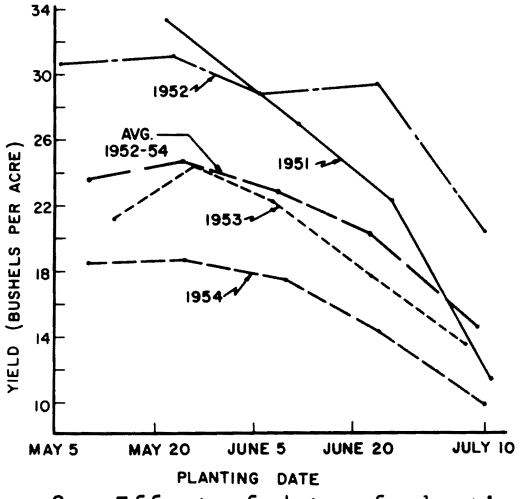

Fig. 2 - Effect of date of planting on yield of S-100 soybeans - 1951 to 1954. Warsaw

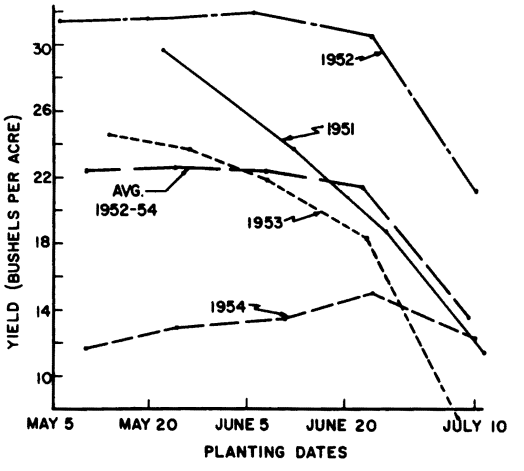

Fig. 3 - Effect of date of planting on yield of Ogden soybeans - 1951 to 1954. Warsaw

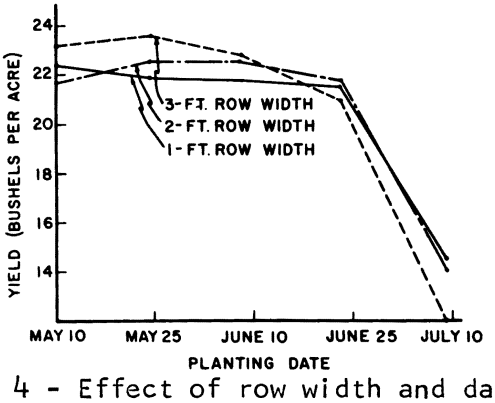

Fig. 4 - Effect of row width and date of planting on yield of Ogden soybeans - Average 1952-54. Warsaw

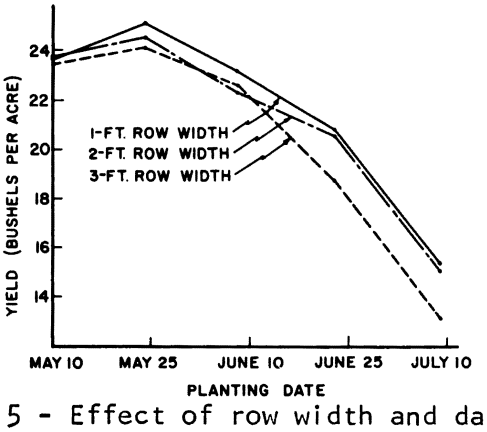

Fig. 5 - Effect of row width and date of planting on yield of S-100 soybeans - Average 1952-54. Warsaw

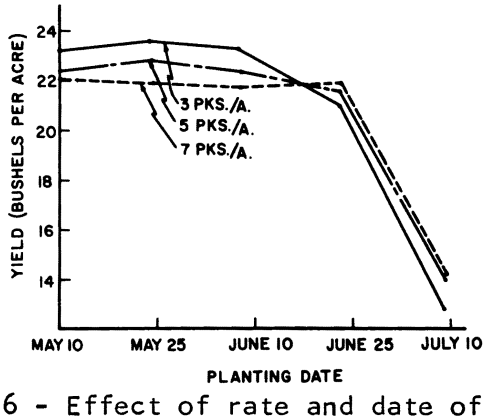

Fig. 6 - Effect of rate and date of planting on yield of S-100 soybeans - Average 1952-54. Warsaw

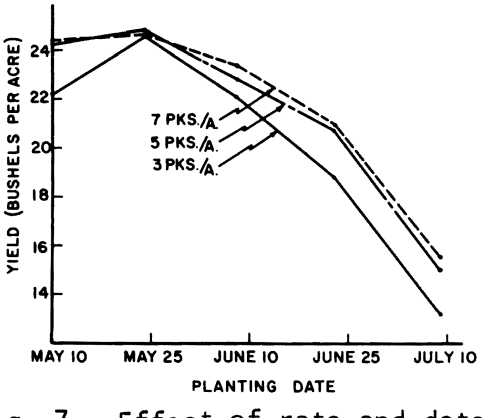

Fig. 7 - Effect of rate and date of planting on yield of Ogden soybeans - Average 1952-54. Warsaw

planting was significantly higher than yields from the other four planting dates, and the average yield from the July 5 seeding was not siginficantly different from the first three dates of planting. No completely satisfactory explanation can be given for this yield performance of the Ogden variety which is so different from previous years and from the S-100 performance in 1954, but it is apparently associated with the moisture-temperature relationship. One of the faults with Ogden is its excessive shedding of flowers during hot dry periods. The plants grown from early seedings possibly produced most of their flowers during periods of stress caused by low moisture and high temperatures which would cause many flowers to drop. In addition, the land on which these experiments were planted was plowed in late winter and fallowed until planting time. All weed growth was controlled during the fallowed period. Thus the areas where seedings were made at the later dates generally had rather favorable moisture at planting time in spite of the low rainfall. Under farm conditions, especially where soybeans follow a small grain, the land would contain much less moisture and germination would be much poorer and possibly delayed until a rain was received. Yields would generally have been lower under farm conditions than were obtained in these experiments.

Under the conditions of these experiments with both S-100 and Ogden varieties, the best seeding dates on the average for maximum yields appear to be approximately May 20, but 15 days earlier or later did not appreciably alter yields. However, extremely late (July) planting gave considerably lower yields than earlier seedings for both varieties in all years except the 1954 yields of the Ogden variety. Ogden tended to maintain on the average a higher percentage of optimum production for late seeding than the S-100 variety. On the other hand, the year to year variations were so great that average yields were no indication of performance that might be obtained in a given year.

The 1952-54 average yield of S-100 was significantly higher for the 12 and 24 inch row spacing (21.7 and 21.2 bushels, respectively) over the 36 inch spacing, (20.2 bushels) but there was no significant difference in average yields of the Ogden variety for different row widths. However, Ogden did give a date x width interaction with early seedings favoring 36 inch width and later seedings favoring closer spacing (Fig. 4). The yield of the 36 inch width of S-100 was appreciably reduced below closer spacings at the two last dates of planting (Fig. 5). But in spite of the higher yields for closer spacing of the later seedings, both Ogden and S-100 yielded appreciably less for the July seeding than for earlier dates of planting regardless of row width.

The 5 and 7 peck rates of seeding of the S-100 variety yielded significantly more (21.5 and 21.6 bushels, respectively) than the 3 pecks per acre (20.1 bushels) for the 1952-54 season average; and also yielded more for four of the five seeding dates (Fig. 6). There was no significant difference between the two higher seeding rates. The Ogden variety averaged 20.7, 20.6 and 20.2 bushels, respecitvely for the 3, 5 and 7 peck rates with a significant difference in favor of the 3 over the 5 peck rate. However, there was a date x rate interaction with the three earlier seedings favoring lower rates and the two later seedings giving more yields for heavier seeding rates (Fig. 7).

Under the conditions of these experiments, the lower rate of seeding (3 pecks per acre) of Ogden gave higher yields for all seedings up until early June, but a heavier rate of 7 pecks gave increased yields for late June and early July seedings. A 5 peck rate was most suitable for S-100 regardless of seeding date.

Height

The height variations from season to season (1951 to 1954) for S-100 (Fig. 8) are more or less correlated with total rainfall and rainfall distribution (Fig. 1). The seasonal height of Ogden was not so closely correlated with moisture supply, especially in 1954, as was the case with S-100 (Fig. 9). Apparently, the decreased yields for earlier seedings of Ogden in 1954 as compared to later seedings, possibly due to excessive flower shedding, did not restrict the plant height to the same extent that was obtained with the better seed set in earlier years.

However, the maximum heights were obtained for both S-100 and Ogden for the second or third planting date in all years except for 1951. This information agrees in general with data by other workers (3, 9). No early seeding was included in 1951 and the height that would have been obtained for an early May seeding in this year cannot be determined.

The wider row spacings of both S-100 and Ogden each produced for the 1952-54 averages significantly taller plants than the narrower spacing. Actual heights for 12, 24 and 36 inch widths were 26.5, 27.5 and 29.2 inches, respectively. The 1952-54 average heights for the 12 and 24 inch spacings of Ogden were significantly shorter than the height of the 36 inch spacing, namely 28.2 and 28.3 as compared to 29.3 inches.

However, differences due to width of row were small as compared to difference due to date of planting (Figs. 10 and 11). There was a significant difference in favor of increased height of S-100 for the 36 inch spacing over both narrower spacings at the first three planting dates and both the 36 and 24 inch spacings produced taller plants for all planting dates than the 12 inch rows (Fig. 10). The plants in the wider rows (36 inches) of Ogden were significantly taller than plants in the narrower rows for the first three seeding dates (Fig. 11), but there was no significant difference in heights between the 24 and 36 inch widths at the two later dates of planting. Plants of both varieties were apparently more competitive in the wider rows when plants were actually closer spaced in the row.

The 3, 5 and 7 pecks per acre seeding rates produced for S-100 and Ogden, for the 1952-54 average, plant heights of 27.2, 27.7 and 28.2, and 27.7, 28.7 and 29.5, respectively. The significant difference in heights due to seeding rates in the case of S-100 were accounted for by the 1st, 4th and 5th dates of seeding with no differences in height at the 2nd and 3rd seeding dates (Fig. 12). Each lower rate of seeding produced shorter plants for all dates of planting for Ogden (Fig. 13). Apparently the height of the Ogden variety with its more profuse vegetative growth, was affected more when crowded in the row than was the case with S-100.

Lodging

There was considerable lodging in 1951 but little during the last three years of the experiment (Appendix Tables 3 and 4). In 1951 when planting rate was based on number of seeds per foot regardless of row width, more lodging was obtained for both S-100 and Ogden with closer spacing in the row. There was little difference in 1951 between the two and three foot row spacing, but increased lodging was produced at the one foot row spacing regardless of seeding rate. The two earliest plantings gave increased lodging over the late June and early July seedings for S-100. On the other hand, Ogden lodged less for June seedings than those made in late May and early July.

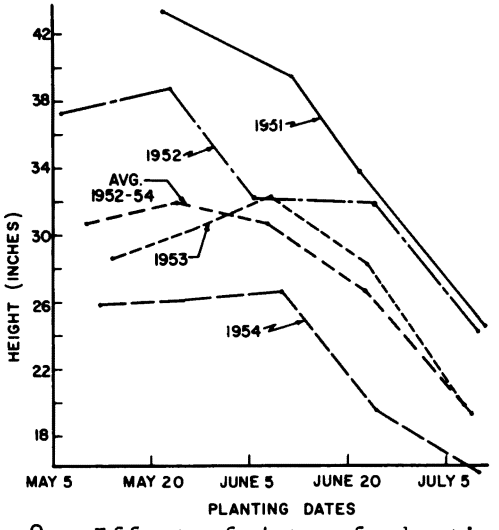

Fig. 8 - Effect of date of planting on height of S-100 soybeans - 1951 to 1954. Warsaw

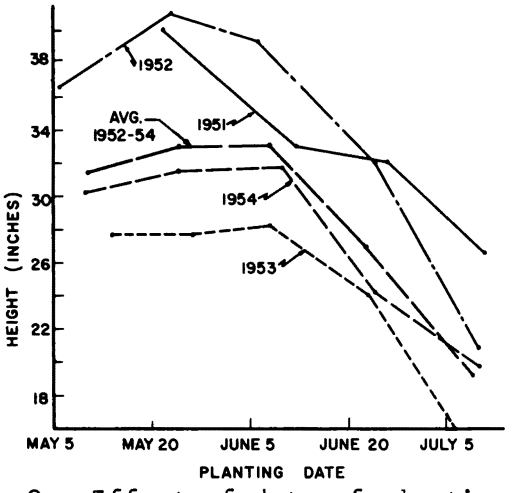

Fig. 9 - Effect of date of planting on height of Ogden soybeans- 1951 to 1954. Warsaw

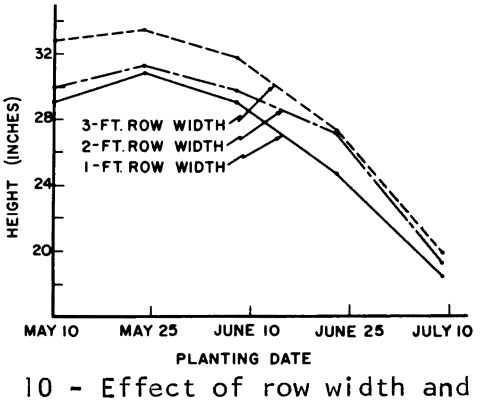

Fig. 10 - Effect of row width and date of planting on height of S-100 soybeans - Average 1952-54. Warsaw

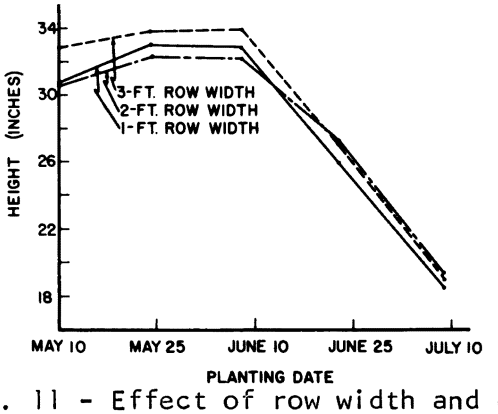

Fig. 11 - Effect of row width and date of planting on height of Ogden soybeans - Average 1952-54. Warsaw

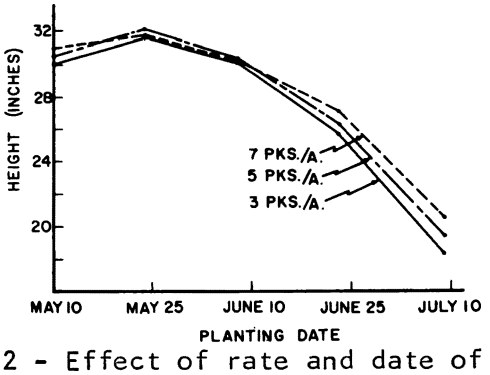

Fig. 12 - Effect of rate and date of planting on height of S-100 soybeans - Average 1952-54. Warsaw

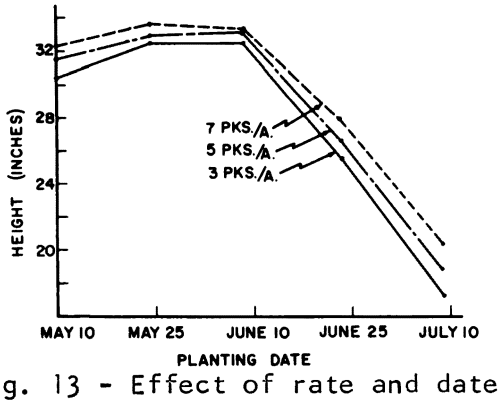

Fig. 13 - Effect of rate and date of planting on height of Ogden soybeans - Average 1952-54. Warsaw

There was more lodging from 1952-1954 for the wider row spacings and heavier planting rates. The closer spacing of plants in the row tended to produce more lodging, regardless of width of row. The three pecks per acre rate gave no appreciable lodging for any date of planting or row width for either variety.

The earlier seeding dates tended to lodge more than later dates although none of the seedings produced excessive lodging. The shorter growth that was produced at the last two dates of planting was apparently one of the main reasons for little lodging for these two later dates of seeding. No lodging was obtained during the three years, 1952-54 for the late June seeding of S-100 and early July seeding of Ogden regardless of seeding rate or row width.

Seed Size

The average seed size of S-100 and Ogden soybeans for 1952 to 1954 was not materially affected by rate of seeding, row width, or date of seeding, except for one planting date (Appendix Table 5). The last average seeding date (July 9) produced beans of a smaller size for Ogden but showed no effect on seed size of S-100. An early frost in two of the 3 years caused premature ripening and is undoubtedly the main cause of the smaller beans for the last planting of Ogden.

Seed Quality

There was no consistent difference in seed quality of either S-100 or Ogden for 1952-54 due to rate of seeding or row width (Appendix Table 6). The date of seeding for the first four dates did not show any consistent effect on seed quality but seed from the last date of planting was definitely poorer than for earlier plantings for both varieties. Much of this poor quality for late plantings was apparently due to immature seed, especially in the case of Ogden.

Chemical Analysis

The average protein content of the seed of both S-100 and Ogden for 1952-54 was not noticeably affected by date of planting (Table 1). Differences due to row width and seeding rate were not determined.

Table 1. Oil and protein content, and iodine number of two soybean varieties - average 1952-54, Warsaw

	S-100			Ogden		
Planting Date	Oil	Protein	Iodine no. of oil*	Oil	Protein	Iodine no. of oil*
	%	%		%	%	
May 10	19.1	43.8	130.4	20.7	42.6	134.1
May 24	19.2	43.2	130.6	20.3	42.5	134.8
June 8	19.2	42.2	131.1	20.2	41.6	136.9
June 23	19.5	42.8	133.0	20.4	41.0	138.1
July 9	18.4	43.9	135.4	18.9	41.7	142.5

* 1952 only.

Date of planting did not materially affect oil content of the seed for the first four planting dates but a lower oil content was obtained for the last planting date for both varieties. This agrees with data obtained by Feaster (2). Immaturity and lower quality seed from later plantings is suggested as probably the main factors responsible for lower oil content.

Iodine number was determined only for the 1952 crop. Both varieties gave a progressively higher iodine number for later plantings.

Date of Maturity

Maturity of soybeans is affected by day length, temperature, moisture and damage to or loss of leaves caused by early frosts or other factors. In these experiments, the S-100 variety matured in 139 days when planted on May 10 and in 119 days when planted July 9 (Table 2). A delay of 60 days in planting thus delayed maturity 20 days. Ogden, for the same planting dates, was delayed 26 days by 60 days later planting. However, if we omit the last date of planting and only consider May 10 to June 23, a delay of 44 days in planting delayed maturity 25 days for S-100 and 22 days for Ogen. The late frosts in two out of three years apparently was the primary factor in delaying maturity of the July planting and had a greater effect upon S-100 than Ogden. Under the conditions of this experiment, S-100 and Ogden are delayed approximately an equal time when planting date is delayed although this delay is not equal for different years or different dates of planting.

Table 2 Number of Days from Seeding to Maturity for Two Soybean Varieties Planted at Different Dates - Average 1952-54, Warsaw, Va.

Variety	Length of Growing Season When Planted on -				
	May 10	May 24	June 8	June 23	July 9
S-100	139	130	121	114	119
Ogden	161	154	148	139	135

SUMMARY

The initial experiment was started at Warsaw in 1951 with two soybean varieties, S-100 and Ogden. Seedings were made at 15 day intervals from May 20 to July 5. Three row spacings (12, 24 and 36 inches) and three rates of seeding (6, 12 and 18 seeds per foot) were included for each date of planting. The experiment was revised in 1952 and continued through 1954 - one additional planting date (May 5) was added, and the planting rate was changed to 3, 5 and 7 pecks per acre.

The following factors were studied: seed yield, plant height, lodging, maturity date, seed size, seed quality, oil and protein content, and iodine number.

Seed yields varied considerably from year to year. Yields were especially low in 1953 and 1954 due to low total rainfall and poor rainfall distribution. Highest seed yields were generally obtained at the second or third date of planting and progressively lower yields were obtained for later seedings. Late June and early July planting materially reduced yields of S-100 for all four years of the experiment, and produced lowered yields of Ogden in three out of four years. Season and date of planting had appreciably more effect on seed yields than any other factors studied.

Both S-100 and Ogden gave higher yields at late planting dates for the one and two foot row spacings than for the three foot spacing. The wider spacing (36 inches) of Ogden gave increased yields over closer spacings at early planting dates.

The three pecks per acre seeding rate gave increased yields of Ogden for May seedings but the heavier seven pecks gave increased yields for late June and early July planting dates. Highest yields of S-100 were obtained with the five and seven peck rate regardless of seeding date.

Maximum heights were obtained at either the May 20 or June 5 planting date for both varieties in all four years, with progressively shorter plants for late seeding. Season and date of planting had considerably more effecton height than any other factors studied. Taller plants were produced on the average in the wider wider rows of Ogden regardless of planting date. The 36 inch spacing of S-100 produced taller plants for early seeding but was not different from the 24 inch spacing at the last two seeding dates. Each lower rate of seeding produced shorter plants for all dates of planting of Ogden, and for the 1st, 4th and 5th planting dates of S-100.

Lodging was heavier for both S-100 and Ogden in 1951 with closer spacing of plants in the row and closer spacing of rows. Both wider rows (consequently closer spacing in the rows) and heavier seeding rates caused increased lodging for both varieties from 1952-54. The earlier seeding dates tended to lodge more than late dates. Little lodging was obtained for late June and early July seedings.

Maturity date was retarded approximately 1 day for each 2 days later planting of S-100 and 1 day for each 2 1/2 days later planting of Ogden, but the amount of delay varied from year to year and also from one planting date to another.

Seed size was not affeceted by date of planting, rate of planting or row width except the last planting of Ogden was smaller than for other seeding dates.

Seed quality showed no consistent differences due to row width or rate of seeding. The July seeding produced a lower quality of seed than was produced for earlier seedings.

Protein content of the seed was not affected by planting date. Oil content of the seed was not appreciably affected by the first four planting dates, but a lower oil content was obtained from the last planting date for both S-100 and Ogden.

Iodine number was progressively higher for later planting dates.

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Appendix Table 1 Precipitation by months for the years 1951-54, Warsaw

Month	Year				
	1951	1952	1953	1954	Mean*
	Inches	Inches	Inches	Inches	Inches
January	1.47	5.40	3.94	3.86	3.06
February	1.69	2.87	3.28	1.20	3.28
March	2.68	3.99	4.38	2.86	3.78
April	3.07	4.67	3.31	2.08	3.32
May	3.04	3.28	4.25	3.58	3.35
June	4.66	2.92	1.40	0.52	4.19
July	5.23	2.62	1.33	2.60	4.56
August	2.91	2.61	4.73	3.29	4.61
September	2.68	3.44	1.50	0.63	2.76
October	2.19	2.53	2.77	2.21	3.09
November	5.27	4.58	1.76	2.67	2.54
December	3.87	3.46	2.68	2.93	3.09
Total	38.76	42.31	35.33	28.42	41.63

* Based on average for 35 year period.

Appendix Table 2 Stand count* of S-100 and Ogden soybean varieties - average 1952-54, Warsaw, Virginia

Seeding rate	S-100 Variety				Ogden Variety			
	Row spacing				Row spacing			
Pecks/a	1 ft.	2 ft.	3 ft.	Avg.	1 ft.	2 ft.	3 ft.	Avg.
			Planting Date - May 10					
3	2.4	4.4	6.2	4.2	2.7	5.6	7.5	5.2
5	3.3	7.1	10.6	7.0	4.0	8.0	11.7	7.9
7	4.8	10.9	15.8	10.5	5.8	11.0	16.3	11.0
Avg.	3.5	7.4	10.9	7.2	4.2	8.2	11.9	8.1
			Planting Date - May 24					
3	2.3	4.3	6.5	4.4	3.4	4.7	8.0	5.3
5	3.6	7.1	10.1	7.0	4.2	7.7	12.1	8.0
7	5.3	9.7	13.7	9.6	6.4	12.8	16.3	11.8
Avg.	3.7	7.1	10.1	7.0	4.7	8.4	12.1	8.4
			Planting Date - June 8					
3	2.2	3.9	5.7	4.0	2.4	4.5	7.0	4.6
5	3.7	6.4	9.2	6.4	3.9	4.5	10.7	6.4
7	4.2	8.4	13.7	8.7	5.7	11.0	15.1	10.6
Avg.	3.3	6.2	9.5	6.3	4.0	6.7	10.9	7.2
			Planting Date - June 23					
3	1.5	2.3	3.9	2.6	1.8	3.5	4.6	3.3
5	2.4	4.2	5.8	4.1	2.7	5.6	7.3	5.2
7	3.3	6.1	8.5	6.0	3.6	7.6	10.3	7.2
Avg.	2.4	4.2	6.1	4.2	2.7	5.6	7.4	5.2
			Planting Date - July 9					
3	1.8	3.3	5.0	3.4	5.2	3.7	5.1	3.7
5	3.1	6.3	6.8	5.4	3.1	6.2	9.2	6.2
7	3.6	8.3	11.6	7.8	4.9	8.4	12.6	8.6
Avg.	2.8	6.0	7.8	5.5	3.4	6.1	9.0	6.2

* Plants per foot.

Appendix Table 3 Lodging* of S-100 and Ogden soybeans, Warsaw, 1951

Planting rate (beans/ft.)	S-100 Row width 1 ft.	2 ft.	3 ft.	Avg.	Ogden Row width 1 ft.	2 ft.	3 ft.	Avg.
Planting Date - May 22								
6	2.1	1.0	1.0	1.4	1.0	1.0	1.0	1.0
12	4.0	3.0	1.9	3.0	3.0	1.2	1.0	1.8
18	6.8	4.2	3.0	4.7	4.7	2.0	1.0	2.6
Avg.	4.3	2.7	2.0	3.0	2.9	1.4	1.0	1.8
Planting Date - June 12								
6	3.0	1.0	1.3	1.8	1.0	1.0	1.0	1.0
12	4.8	2.5	3.0	3.4	1.7	1.0	1.0	1.2
18	5.5	3.8	4.0	4.4	4.2	1.3	1.0	2.2
Avg.	4.4	2.8	2.8	3.3	2.3	1.1	1.0	1.4
Planting Date - June 22								
6	1.8	1.3	1.0	1.4	1.0	1.0	1.0	1.0
12	3.3	1.3	1.8	2.1	2.0	1.2	1.0	1.4
18	5.4	3.3	3.5	4.1	3.0	1.7	1.5	2.1
Avg.	3.5	2.0	2.1	2.5	2.0	1.3	1.2	1.5
Planting Date - July 11								
6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
12	1.5	1.0	1.1	1.2	3.0	1.5	1.2	1.9
18	4.0	1.3	1.3	2.2	5.3	1.7	1.7	2.9
Avg.	2.2	1.1	1.1	1.5	3.1	1.4	1.3	1.9

* Based on a relative scale of 1 to 7 - 1 = very good; 7 = very poor.

Appendix Table 4 Lodging* of S-100 and Ogden soybean varieties average 1952-54, Warsaw

Seeding rate pecks/a	S-100 Row spacing 1 ft.	2 ft.	3 ft.	Avg.	Ogden Row spacing 1 ft.	2 ft.	3 ft.	Avg.
Planting Date - May 10								
3	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.4	1.5	1.3	1.0	1.1	1.4	1.2
7	1.3	1.4	1.6	1.4	1.4	1.9	1.8	1.7
Avg.	1.1	1.3	1.4	1.3	1.1	1.4	1.4	1.3
Planting Date - May 24								
3	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0
5	1.1	1.5	1.9	1.5	1.0	1.1	1.4	1.2
7	1.5	2.1	2.4	2.0	1.9	1.6	1.6	1.7
Avg.	1.2	1.6	1.8	1.5	1.3	1.0	1.3	1.3
Planting Date - June 8								
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.1	1.6	1.3	1.0	1.1	1.4	1.2
7	1.8	1.9	2.4	2.0	1.3	1.3	2.0	1.5
Avg.	1.3	1.3	1.7	1.4	1.1	1.1	1.5	1.2
Planting Date - June 23								
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.0
7	1.0	1.0	1.0	1.0	1.2	1.3	1.3	1.3
Avg.	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.1
Planting Date - July 9								
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.1	1.0	1.0	1.1	1.0	1.0	1.0	1.0
7	1.8	1.1	1.1	1.3	1.0	1.0	1.0	1.0
Avg.	1.3	1.0	1.0	1.1	1.0	1.0	1.0	1.0

* Based on a scale of 1 to 5 - 1 = all plants nearly erect; 5 = all plants nearly prostrate.

Appendix Table 5. Seed size* of S-100 and Ogden soybeans average 1952-54, Warsaw

Seeding rate (pecks/a)	S-100 Variety				Ogden Variety			
	Row spacing				Row spacing			
	1 ft.	2 ft.	3 ft.	Avg.	1 ft.	2 ft.	3 ft.	Avg.
Planting Date - May 10								
3	14.3	14.2	15.4	14.6	15.8	15.9	15.9	15.9
5	14.5	15.5	15.4	15.1	16.2	16.1	16.3	16.2
7	14.3	14.8	15.3	14.8	16.2	16.2	16.4	16.3
Avg.	14.4	14.8	15.4	14.8	16.1	16.1	16.2	16.1
Planting Date - May 24								
3	14.4	14.9	14.9	14.7	16.6	16.3	16.7	16.5
5	14.6	14.4	15.1	14.7	16.6	16.7	16.5	16.6
7	14.2	14.6	15.3	14.7	16.5	16.3	16.4	16.4
Avg.	14.4	14.6	15.1	14.7	16.6	16.4	16.5	16.5
Planting Date - June 8								
3	14.1	14.3	14.7	14.4	15.8	16.0	16.5	16.1
5	13.9	14.2	14.6	14.2	15.8	15.9	16.6	16.1
7	14.3	14.1	14.4	14.3	16.1	16.2	16.3	16.2
Avg.	14.1	14.2	14.6	14.3	15.9	16.0	16.5	16.1
Planting Date - June 23								
3	14.6	14.7	15.3	14.9	15.3	15.5	15.9	15.6
5	14.4	14.2	14.8	14.5	15.7	15.6	15.9	15.7
7	14.4	13.9	14.8	14.4	16.0	15.6	15.6	15.7
Avg.	14.5	14.3	15.0	14.6	15.7	15.6	15.8	15.7
Planting Date - July 9								
3	14.7	14.5	14.8	14.7	13.9	13.5	13.4	13.6
5	14.3	14.2	14.6	14.4	13.2	13.5	13.5	13.4
7	13.8	14.5	14.7	14.3	12.9	13.2	13.5	13.2
Avg.	14.3	14.4	14.7	14.5	13.3	13.4	13.5	13.4

* Grams per 100 seeds.

Appendix Table 6. Seed quality* of S-100 and Ogden soybean varieties average 1952-54, Warsaw

Seeding rate (pecks/a)	S-100 Variety				Ogden Variety			
	Row spacing				Row spacing			
	1 ft.	2 ft.	3 ft.	Avg.	1 ft.	2 ft.	3 ft.	Avg.
			Planting Date - May 10					
3	1.9	2.1	2.0	2.0	1.6	1.9	2.0	1.8
5	1.7	2.2	1.8	1.9	2.2	2.1	1.7	2.0
7	2.0	1.9	2.2	2.0	1.9	2.1	2.1	2.1
Avg.	1.9	2.1	2.0	2.0	1.9	2.1	1.9	2.0
			Planting Date - May 24					
3	1.7	1.6	1.5	1.6	2.0	1.5	1.6	1.7
5	1.8	1.5	1.5	1.6	2.2	1.8	1.8	1.9
7	1.8	1.5	2.1	1.7	2.4	2.0	2.1	2.2
Avg.	1.8	1.5	1.7	1.6	2.2	1.8	1.8	1.9
			Planting Date - June 8					
3	2.0	1.9	1.8	1.9	1.9	2.0	2.2	2.0
5	1.5	1.8	1.7	1.7	1.9	2.0	2.1	2.0
7	1.7	1.9	2.0	1.9	2.3	2.3	2.1	2.2
Avg.	1.7	1.9	1.8	1.9	2.0	2.1	2.1	2.1
			Planting Date - June 23					
3	1.8	1.6	1.8	1.7	1.9	1.8	1.8	1.8
5	1.8	1.7	1.8	1.8	1.8	1.9	1.9	1.9
7	1.8	1.7	2.0	1.9	1.9	1.8	1.9	1.9
Avg.	1.8	1.7	1.9	1.8	1.9	1.8	1.9	1.9
			Planting Date - July 9					
3	2.9	2.9	2.8	2.9	3.3	3.3	3.3	3.3
5	2.9	2.9	2.6	2.8	3.3	3.3	3.3	3.3
7	2.9	2.8	2.9	2.9	3.3	3.3	3.3	3.3
Avg.	2.9	2.9	2.8	2.9	3.3	3.3	3.3	3.3

* Based on a relative scale of 1 to 5 - 1 = very good; 5 = very poor.

Appendix Table 7. Yield in bushels per acre of S-100 and Ogden soybeans Warsaw, 1951

Planting rate (beans/ft.)	S-100 Row width 1 ft.	2 ft.	3 ft.	Avg.	Ogden Row width 1 ft.	2 ft.	3 ft.	Avg.
Planting Date - May 22								
6	33.2	32.9	31.5	32.5	26.7	28.0	26.7	27.1
12	32.1	34.3	33.5	33.3	26.4	28.1	29.5	28.0
18	31.8	35.2	35.2	34.1	27.7	27.5	27.5	27.6
Avg.	32.5	34.1	33.4	33.3	26.9	27.9	27.9	27.5
Planting Date - June 12								
6	27.6	25.9	27.1	26.9	23.5	25.1	24.2	24.3
12	27.6	28.2	26.6	27.5	23.1	24.6	24.9	24.2
18	27.6	24.2	27.2	26.3	22.3	22.6	23.5	22.8
Avg.	27.6	26.1	27.0	26.9	23.0	24.8	24.5	23.7
Planting Date - June 22								
6	22.1	22.1	18.1	20.8	17.4	21.9	14.2	17.8
12	21.6	23.2	22.8	22.9	18.4	21.6	18.3	19.4
18	22.4	24.3	21.9	22.9	15.8	21.4	19.3	18.8
Avg.	22.0	23.2	20.9	22.0	17.2	21.6	17.3	18.6
Planting Date - July 11								
6	10.8	7.7	7.3	8.6	12.0	10.4	7.6	10.0
12	16.2	11.1	7.8	11.7	13.6	12.7	10.2	12.2
18	15.2	13.4	9.3	12.6	13.1	13.1	9.6	11.9
Avg.	14.1	10.7	8.1	10.9	12.9	12.1	9.1	11.3

Mean Yields - S-100[1/]

Planting Date

4th	3rd	2nd	1st
11.2	22.4	26.9	33.3

Row Width

36"	24"	12"
22.4	23.9	24.1

Seeding Rate

6 seeds/ft.	12 seeds/ft.	18 seeds/ft.
22.2	23.9	24.1

Mean Yields - Ogden[1/]

Planting Date

4th	3rd	2nd	1st
11.3	18.7	23.7	27.6

Row Width

36"	24"	12"
19.6	20.0	21.4

Seeding Rate

6 seeds/ft.	18 seeds/ ft.	12 seeds/ft.
19.8	20.3	20.9

(1) The difference between any two means not underscored by the same line is significant at the 5% level.

Appendix Table 8. Yield* in bushels per acre of S-100 and Ogden Soybeans average - 1952-54, Warsaw

Seeding rate (pecks/acre)	S-100 Row spacing 1 ft.	2 ft.	3 ft.	Avg.	Ogden Row spacing 1 ft.	2 ft.	3 ft.	Avg.
Planting Date - May 10								
3	22.2	21.5	22.9	22.2	23.3	22.2	24.0	23.2
5	24.5	24.6	23.9	24.3	22.5	22.0	22.6	22.4
7	24.5	25.1	23.7	24.4	21.4	21.6	23.1	22.1
Avg.	23.7	23.7	23.5	23.6	22.4	21.8	23.2	22.5
Planting Date - May 24								
3	24.5	24.3	24.6	24.5	22.3	23.2	24.8	23.5
5	26.0	24.5	23.8	24.8	21.9	22.8	24.1	22.9
7	24.8	24.8	24.2	24.6	21.6	21.6	22.1	21.8
Avg.	25.1	24.5	24.2	24.6	21.9	22.5	23.7	22.7
Planting Date - June 8								
3	23.0	21.8	21.6	22.1	22.3	23.6	23.6	23.2
5	23.5	23.1	21.7	22.8	21.8	22.5	22.8	22.4
7	23.2	22.1	24.5	23.3	21.2	21.4	21.9	21.5
Avg.	23.2	22.3	22.6	22.7	21.8	22.5	22.8	22.4
Planting Date - June 23								
3	19.9	18.8	17.6	18.8	21.0	21.2	21.0	21.0
5	20.9	21.1	19.5	20.5	21.5	22.0	20.3	21.3
7	21.7	21.8	19.2	20.9	22.0	22.1	21.3	21.8
Avg.	20.8	20.6	18.8	20.1	21.5	21.8	20.9	21.4
Planting Date - July 9								
3	13.4	13.5	12.6	13.2	14.2	12.9	11.0	12.7
5	16.0	15.5	13.1	14.9	14.1	14.6	12.9	13.9
7	16.6	15.6	13.5	15.3	15.5	14.5	12.1	14.1
Avg.	15.3	14.9	13.1	14.5	14.6	14.0	12.0	13.5

* Analysis of variance table on pages 22 and 23.

Appendix Table 8(Cont'd) Analysis of variance for yield of S-100 soybeans average 1952-54, Warsaw

Source of variation	Degrees of freedom	Mean square	F 1/
Replications	9	48.224	6.22**
Dates	4	48.9274	63.08**
Years	2	199.9982	257.83**
Dates x years	8	1.5287	1.97
Error (a)	36	.7757	
Row width	2	2.3504	17.07**
Row width x years	4	.9119	6.62**
Row width x dates	8	.2444	1.77
Row width x dates x years	16	.1806	1.31
Error (b)	90	.1377	
Rates	2	3.0506	27.36**
Rate x years	4	1.0804	9.69**
Rates x dates	8	.3027	2.71**
Rates x dates x years	16	.2581	2.31**
Rates x row width	4	.2147	1.92
Rates x row	8	.0783	.70
Rates x dates x row	16	.0973	.87
Rates x dates x row x years	32	.0260	.23
Error (c)	270	.1115	
Total	539		

1/ * = Significant at 5%
** = Significant at 1%

2/ The difference between any two means not underscored by the same line is significant at the 5% level.

Mean yields - bushels per acre 2/

Planting Date

E	D	C	A	B
14.4	20.0	22.5	23.6	24.6

Year

1954	1953	1952
15.4	19.7	27.9

Row Width

36"	24"	12"
20.3	21.2	21.6

Planting Rate

3 pks.	5 pks.	7 pks.
20.1	21.4	21.5

Appendix Table 8 (Cont'd) Analysis of variance for yield of Odgen soybean average 1952-54, Warsaw

Source	Degrees of freedom	Mean square	F 1/
Replications	9	3.1003	6.14**
Dates	4	45.2367	89.58**
Years	2	330.8912	655.23**
Dates x years	8	12.6824	25.11**
Error (a)	36	.5050	
Row width	2	.0518	-
Row x years	4	1.3900	11.81**
Row x dates	8	.8844	7.51**
Row x dates x years	16	.0297	-
Error (b)	90	.1177	
Rates	2	.3205	3.38**
Rates x years	4	.7812	8.24**
Rates x dates	8	.5419	5.72**
Rates x dates x years	16	.0703	-
Rates x row	4	.0630	-
Rates x rows x years	8	.2082	2.20
Rates x dates x row	16	.0927	-
Rates x dates x row x years	32	.0846	-
Error (c)	270	.0948	
Total	539		

Mean Yields - Bushels per Acre 2/

Planting Date

E	D	C	A	B
13.5	21.4	22.4	22.5	22.7

Years

1954	1953	1952
13.07	19.08	29.3

Planting Rate

7 pks	5 pks	3 pks
20.2	20.6	20.7

1/ * = Significant at 5%
** = Significant at 1%

2/ The difference between any two means not underscored by the same line is significant at the 5% level.

Appendix Table 9. Height in inches of S-100 and Ogden soybeans
Warsaw, 1951

Planting rate (beans/ft.)	S-100 Row width 1 ft.	2 ft.	3 ft.	Avg.	Ogden Row width 1 ft.	2 ft.	3 ft.	Avg.
			Planting Date - May 22					
6	47.0	41.0	40.0	42.6	35.0	36.2	36.2	35.8
12	46.0	46.0	46.0	46.0	48.0	40.0	38.5	42.1
18	46.0	45.0	47.0	46.0	49.0	39.0	40.5	42.8
Avg.	46.3	44.0	44.3	44.8	44.0	38.4	38.4	40.2
			Planting Date - June 12					
6	41.0	35.0	38.0	38.0	32.0	30.0	32.7	31.5
12	43.0	36.0	39.0	39.0	32.0	32.5	33.7	32.7
18	42.0	40.0	40.0	40.6	35.5	34.2	35.0	34.9
Avg.	42.0	37.1	39.0	39.3	33.1	32.2	33.8	33.0
			Planting Date - June 22					
6	33.0	32.0	34.0	33.0	32.0	31.7	28.2	30.6
12	35.0	35.0	36.0	35.3	32.0	33.5	31.7	32.4
18	31.0	32.0	35.0	33.0	31.2	33.7	34.7	33.2
Avg.	33.0	33.0	34.0	33.7	31.7	32.9	31.5	32.0
			Planting Date - July 11					
6	24.0	22.0	22.0	22.6	26.0	21.7	24.2	23.9
12	26.0	22.0	24.0	24.0	29.5	26.0	27.5	27.6
18	29.0	25.0	24.0	26.0	31.2	27.2	26.2	28.2
Avg.	26.3	23.0	27.3	24.2	28.9	24.9	25.9	26.5

Appendix Table 10. Height* in inches of S-100 and Ogden soybean varieties average - 1952-54, Warsaw

Seeding rate (pecks/acre)	S-100 Row spacing 1 ft.	2 ft.	3 ft.	Avg.	Ogden Row spacing 1 ft.	2 ft.	3 ft.	Avg.
			Planting Date - May 10					
3	28.1	28.8	33.0	30.0	29.3	30.2	31.9	30.5
5	28.8	30.3	32.4	30.5	31.0	30.4	33.7	31.7
7	30.0	30.5	32.6	31.0	32.5	31.6	33.2	32.4
Avg.	29.0	29.9	32.7	30.5	30.9	30.7	32.9	31.5
			Planting Date - May 24					
3	30.5	31.0	33.8	31.7	32.5	31.8	33.3	32.5
5	31.3	31.3	33.7	32.1	32.8	32.1	33.8	32.9
7	31.0	31.6	33.1	31.9	33.4	33.1	34.2	33.6
Avg.	30.9	31.3	33.5	31.9	32.9	32.3	33.8	33.0
			Planting Date - June 8					
3	28.8	29.8	32.4	30.2	31.7	31.6	34.3	32.5
5	29.2	29.8	31.9	30.3	33.0	32.2	34.1	33.1
7	29.4	29.9	31.1	30.1	33.7	32.8	33.5	33.3
Avg.	29.1	29.8	31.8	30.2	32.8	32.2	34.0	33.0
			Planting Date - June 23					
3	24.8	25.9	26.4	25.7	24.1	26.2	26.6	25.6
5	24.5	27.2	27.8	26.4	26.1	27.3	26.8	26.7
7	24.9	28.5	28.0	27.1	27.6	28.2	28.1	27.9
Avg.	24.7	27.2	27.4	26.4	25.9	27.2	27.2	26.7
			Planting Date - July 9					
3	17.8	18.3	19.1	18.4	16.6	17.5	18.1	17.3
5	18.7	19.8	19.7	19.4	18.4	19.0	18.9	18.8
7	19.5	19.7	20.1	19.7	20.3	20.9	19.8	20.3
Avg.	18.7	19.3	19.6	19.2	18.4	19.1	18.9	18.8

* Analysis of variance table on pages 26 and 27.

Appendix Table 10 (Cont'd) Analysis of variance for height of S-100 soybeans average 1952-54, Warsaw

Source	Degrees of freedom	Mean square	F[1/]
Replications	9	45.26	2.19
Dates	4	2688.88	129.70**
Years	2	4826.02	233.14**
Dates x years	8	169.98	8.16**
Error (a)	36	20.70	
Row width	2	347.50	91.93**
Rows x years	4	13.03	3.45*
Rows x dates	8	12.48	3.30**
Rows x dates x years	16	4.26	1.13
Error (b)	90	3.78	
Rates	2	45.00	13.89**
Rates x years	4	63.48	19.59**
Rates x dates	8	10.68	3.30**
Rates x dates x years	16	4.64	1.43
Rates x rows	4	1.90	
Rates x dates x rows	16	7.57	2.34**
Rates x rows x years	8	2.61	
Rates x dates x rows x years	32	4.70	1.45
Error (c)	267	3.24	
Total	536		

Mean Height - Inches[2/]

Planting Date

E	D	C	A	B
19.56	26.42	30.25	30.51	31.87

Year

1954	1953	1952
22.65	27.52	33.00

Row Width

12"	24"	36"
26.48	27.47	29.22

Planting Rate

3 pks	5 pks	7 pks
27.22	27.72	28.22

1/ * = Significant at 5%
** = Significant at 1%

2/ The difference between any two means not underscored by the same line is significant at the 5% level.

Appendix Table 10(Cont'd) Analysis of variance for height of Ogden soybeans average 1952-54, Warsaw

Source of variation	Degrees of freedom	Mean square	F [1/]
Replications	9	84.72	5.38**
Dates	4	3948.14	250.00**
Years	2	4114.87	261.00**
Dates x years	8	135.24	8.58**
Error (a)	36	15.76	
Row width	2	70.20	18.90**
Rows x years	4	30.32	7.81**
Rows x dates	8	13.36	3.44**
Rows x dates x years	16	8.50	2.19**
Error (b)	90	3.88	
Rates	2	147.67	47.33**
Rates x years	4	51.46	16.49**
Rates x dates	8	7.29	2.34**
Rates x dates x years	16	2.53	-
Rates x rows	4	12.15	3.89**
Rates x dates x rows	16	2.00	-
Rates x rows x years	8	2.60	-
Rates x dates x rows x years	32	3.66	1.17
Error (c)	270	3.12	
Total	539		

Mean Heights - Inches [2/]

Planting Date

E	D	A	B	C
18.8	26.7	31.5	33.0	33.0

Years

1953	1954	1952
24.7	27.3	33.9

Row Width

12"	24"	36"
28.2	28.3	29.3

Planting Rate

3 pks.	5 pks.	7 pks
27.7	28.7	29.5

1/ * = Significant at 5%

** = Significant at 1%

2/ The difference between any two means not underscored by the same line is significant at the 5% level.