THE EFFECT OF DATES OF PLANTING AND VARIETIES ON YIELD AND OTHER CHARACTERISTICS IN SOYBEANS

By
FAZAL RAHMAN

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FAZAL RAHMAN

Approved:

W. W. Worzella

Wallace W. Worzella: Professor of Agronomy. Advisor.

D. W. Bray

Donald W. Bray: Associate Professor of Plant Genetics and Plant Breeding. Member of Committee.

S. Abu-Shakra

Salah Abu-Shakra: Assistant Professor of Agronomy. Member of Committee.

Adib T. Saad

Adib T. Saad: Assistant Professor of Plant Pathology. Member of Committee.

W. W. Worzella

Wallace W. Worzella: Professor, and Coordinator of Graduate Studies.

Date Thesis is presented:

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Fazal Rahman for M.S. in Agronomy

Title: The effect of dates of planting and varieties on yield and other characteristics in soybeans.

In this experiment, the effects of four dates of planting on yielding capacity, seed composition, time required for flowering and maturity, and other agronomic characters of four soybean varieties were studied.

Plantings made during the later part of April tended to produce the highest seed yields and oil content in the soybeans. Delayed plantings produced seeds with appreciably higher protein content than earlier plantings. For each two-day delay in planting, the flowering and maturity were delayed about one day.

The variety Lindarin produced the highest seed yields, contained the highest protein percentage in the seeds and proved to be the earliest maturing variety. Highest oil content was found to be in the seeds of Clark which was second in yield only to Lindarin. Perry and Wabash, the relatively late varieties, produced the poorest yields in 1966 and 1967 respectively.

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I. INTRODUCTION

The population explosion of many areas of the world demands a constant improvement in the methods of crop production with the object of increasing the yield and quality of cultivated crops. To achieve this objective man has to experiment, observe and evaluate various crops and cultural methods to be able to recommend and combine the best available crops and practices to attain stable and high production. Scientific research in agriculture has proved, beyond doubt, that there is a tremendous scope for improvement of the crops. Man cannot afford to be content with the existing levels of production of agricultural crops for the simple reason that nature itself is in a state of flux. Population increases, varying environmental conditions, genetic changes in crops and their pathogens, ever-changing fertility levels of our soils, etc., all contribute to this instability of natural conditions. Therefore, the best use of scientific investigations is not made by merely following the same standard procedures on the same crops for a long period of time.

One of the easiest and cheapest, although one of the most important too, method of improvement in agricultural production is to learn how to cooperate with the

prevailing environment. Proper time of planting and use of suitable varieties constitute a major part of the procedures leading to cooperation with the environment. In this study these two factors were exploited, in regards to soybeans, at the Agricultural Research and Education Center (AREC) in the Beqa'a Plain, Lebanon.

The soybean plant, Glycine max (L.) Merrill, belongs to sub-family Papilionoideae which in turn is a part of family Leguminosae (38). It is an upright, branching, herbaceous, summer annual legume (67). On the basis of extensive genetic studies, the cultivated soybean is presumed to have been derived from Glycine ussuriensis, which is a wild species growing throughout much of eastern Asia (38, 43).

The soybeans are oleaginous seeds consisting principally of lipids, proteins, carbohydrates and mineral constituents. The seed contains an average of about 21 per cent oil and 40 per cent protein on a dry weight basis (38). The oil of soybeans is highly digestible and of high energy value. The proteins are also very highly digestible (41).

In many areas of the world the importance of this crop has been realized recently through the tremendous increases in area and production of this crop. In United States from 1953 to 1966, plantings of soybeans increased from 5,101,000 hectares to 14,037,000 hectares, while

production increased in the same period from 7,312,000 metric tons to 23,207,000 metric tons. World total production in 1952-53 was 16,000,000 metric tons while in 1965-66 it rose to 36,200,000 metric tons (24).

The general climatic requirements for optimum soybean production are about the same as for that of corn (67). Morse (43) and Weiss (67) reported that it is quite possible to grow soybeans successfully in any region in which there is a five-month period of growth and an annual precipitation of 12 inches. Soybeans succeed on nearly all types of soil, the best results being achieved on mellow, fertile clay or sandy loams (43).

In Middle Eastern countries, relatively little attention has been paid to soybeans. The nutritive potentials of this crop should not be ignored in areas where relatively high nutritive deficiencies exist in the human diets and animal feeds. Soybeans may substitute or supplement other costly sources of oils and proteins since it may be possible to produce soybeans in large quantities in countries with large populations.

Several agronomic studies need to be undertaken to comprehend the actual potentials of this crop in this area. This study was conducted to provide some information on the effects of dates of planting and different varieties on various characteristics of soybeans under irrigated conditions.

II. REVIEW OF LITERATURE

No single cultural factor is more important to soybean production than planting date (14). This is due to the extreme sensitivity of this crop to photoperiodism (29). Soybeans have critical stages in their development when they are most sensitive to adverse environmental conditions, while at other stages they may be affected little (49). Garner and Allard (29) found soybean varieties to differ strikingly in their response to photoperiod. Johnson et al. (37) concluded that the best time to plant a particular variety should be determined on the basis of day length and soil temperature in different areas.

General Environmental Influences

Schutz and Bernard (53) reported the significance of genotype x environment interactions in soybean production. Weiss (67) concluded that locations and years had approximately equal influence on yield, protein and oil contents of the seed. Morse (43) pointed out that time of planting should be adjusted according to particular variety, area and environment. Marvin (40), however, noted that the best performance of an individual variety was limited to a narrow belt only because of the sensitivity of soybean

varieties to even slight changes of the day length. Under practical conditions climate is a more potent factor than soil type in influencing different characteristics of soybeans (28).

According to Weiss (67), minimum requirements for successful soybean production are a five-month-growing period with a total accumulation of 2400°C and an annual precipitation of 300 mm. Fukui et al. (27) reported that the optimum temperature for net photosynthesis in soybeans was 26.2°C. Brown (8) found the best growth and development of soybean plants to occur at 86°F, and the relation between the rate of development and temperature to be curvilinear and parabolic in nature. Weiss (67)obtained maximum flower initiation with day temperatures of 75° to 85°F and night temperatures of 65° to 75°F. Early and Cartter (23) found 22° to 27°C temperatures in the root zone to be most favourable for maximum dry weight production. Runge and Odell (49) observed that precipitation and maximum daily temperatures from June 25 through September 20 explained 68 per cent of the variation in soybean yields at Urbana, Illinois, U.S.A.

Competition with weeds was found to be less in June planted than in earlier planted soybeans by Robinson and Dunham (48). However, Staniforth (60) noted that reduction due to competition with foxtail tended to be small when soil moisture was adequate over the whole season.

Yield

Different planting dates have marked influences on the yield of soybeans. The response of early and late varieties differs considerably in nature (14, 15, 46, 64, 67). Weiss (67), Caviness (15),and Osler and Cartter (46) agree that early varieties, which do not normally require the entire growing season to mature, may be planted considerably later than adapted varieties without incurring significant yield reductions. The yields of relatively late varieties, which normally utilize the entire growing season, may be drastically reduced by any delay following the frost-free date. However, as Caviness (15) has pointed out, yields may be reduced considerably when early varieties are planted extremely late.

Different workers like Abel (1), Cartter (14), Camper and Smith (13), Morse (43) and Gill (32) have associated early planting with higher yields. Feaster (26) found May 10 to be the best date for planting soybeans in southeast Missouri. Smith (57) noted that within the safe range of April 10 to June 15, all the varieties tested gave top yields at the earlier planting dates. Morse (43) reported that in a five-year date-of-planting test at the Iowa Agricultural Experiment Station, using five varieties planted at five different dates from May 1 to June 14, the average yields tended to decrease as the planting was

delayed. Gill (32) observed that delaying the planting from early May to mid-June almost halved the soybean yields. Dimmock and Warren (21) noted that reduced yields from later plantings were caused by a reduction in the number of seeds produced rather than by a decrease in seed size. Smith (58) obtained maximum yields by sowings made on May 20 or June 5 and with the two latest maturing varieties at the Virginia Agricultural Experiment Station. Weiss (67) concluded that differences in yield, attributable to dates of planting, were not great when adapted varieties were planted at successive intervals throughout the first month following the frost-free date. Farhaduddin (25) reported that April 18 planting gave the best yields at AREC in Lebanon out of the four dates of planting studied i.e., April 4, April 18, May 3 and May 18. Badawi (5), at the same location, found that the highest seed yields resulted from the first date of planting, April 10, and decreased successively thereafter. Worzella et al. (69) and Ali (2) found 50 cm spacing between rows to give satisfactory yields under the environmental conditions of the Beqa'a Plain, Lebanon.

Greater light penetration was correlated with higher soybean yields by many workers like Sakamoto and Shaw (51), Shaw and Weber (55), and Sakamoto (50). Sakamoto and Shaw (51) suggested that an increase in yield could possibly be achieved by selecting varieties whose natural inclination

leads to deeper penetration of light to a greater number of leaves. Staniforth (60) found that when soil moisture was adequate until the end of July and severely limiting from then until bean maturity, yield reductions, due to foxtail infestations, averaged four bushels per acre or approximately 14 per cent. Schwab et al. (54) obtained 40 to 50 per cent increases in yield of soybeans resulting from irrigation, at Conesville, Iowa. Uklein (65) noted that the maintenance of soil moisture at 80 per cent of the field moisture capacity throughout the vegetative period provided the best conditions for plant growth and high yields of soybeans.

Protein and Oil

Morse (44) found the chemical composition of the soybean seeds to be influenced by the physiological vigour of the plant as controlled by the environmental conditions during the growing period. Garner et al. (28) noted that maximum oil production in the soybean plant required conditions of nutrition favourable to the accumulation of carbohydrates during the vegetative period, and to the transformation of carbohydrates into oil during the reproductive periods.

Howell and Cartter (35) reported that when soybean seed was produced in the greenhouse at temperatures of 85°, 77°, and 70°F, the average percentage of oil was 23.2, 20.8, and 19.5 per cent, respectively. The oil percentage was

correlated closely with mean maximum temperatures. On the other hand, Donovan et al. (22), reviewing the findings of Viljoen, reported a significantly positive correlation of oil content and a negative correlation of protein content with the mean minimum temperatures. With every degree Fahrenheit increase in the mean minimum temperature, oil content of the beans increased approximately 0.44 per cent and protein content decreased 0.39 per cent. Weiss et al. (68), however, found no appreciable association between temperature and oil content.

Howell and Cartter (34) observed that temperatures exerted greater effect on oil level during the period 20 to 40 days before maturity than during other periods.

Weiss (67) reported that seed of the same variety, grown at 11 widely separated locations at which soil types and climate differed markedly, varied in its oil content from 12.7 to 22.1 per cent and in its protein content from 32.6 to 44.3 per cent within the same year.

Badawi (5), Dimmock and Warren (21), Osler and Cartter (46), Stark (62), Tang (63), Weiss (67), and Weiss et al. (68) all have reported an inverse relationship between oil and protein contents of the seed.

Badawi (5), Dimmock and Warren (21), Osler and Cartter (46), Torrie and Briggs (64) and Weiss (67) have associated relatively early planting with higher oil content and relatively later plantings with lower oil

content of the seeds.

Morse (43) did not find any appreciable effect of the dates of planting on the protein percentage of seeds, while Badawi (5) and Dimmock and Warren (21) associated delayed planting with higher protein content of the seeds.

Tang (63) reported that spring sowing gave higher protein and oil contents than summer or autumn sowings.

Collins and Cartter (19), Feaster (26), and Stark (62) have found oil content, in general, to be associated with the time of planting at which the best yields of the seeds could be achieved.

Farhaduddin (25) did not find any appreciable influence of the dates of planting on the seed composition.

Collins and Cartter (19) found the seeds from the lower portion of the plants to be 0.5 per cent higher in oil and 1.0 per cent lower in protein content than seeds from the upper portions.

Schwab et al. (54) reported that irrigation tended to decrease the oil content of soybeans by four per cent and increase the protein content by 3.3 per cent.

Shaw and Weber (55) noted that greater light penetration resulted in greater oil content of the seeds.

Flowering and Maturity

Garner and Allard (29) recognized the significance of day length in the flowering behaviour of soybeans as early as 1920 and designated this phenomenon by the term photoperiodism. Initiation of flowering is critically associated with the duration of light and dark periods in this crop (6, 29, 31, 43, 67). Garner and Allard (31) found the length of day to be the primary external factor in determining the relative earliness or lateness of a particular variety in an area.

Borthwick and Parker (7) observed that most of the varieties were completely incapable of flowering unless they received ten or more hours of darkness daily. All of the varieties flowered more quickly with daily dark periods of 14 to 16 hours than with short ones. Borthwick and Parker (6) noted that stimulus necessary for the initiation of flower primordia arose in the leaves and then moved towards the growing points. At Washington, D.C., Garner and Allard (29) reported their studies on four varieties which ranged from 27 to 105 days from germination to blossoming under summer day light conditions. When the day length was reduced to 12 hours, all the varieties became early and blossomed within 21 to 28 days after germination. Reduction of photoperiod altered the blossoming time of the earliest variety, Mandarin, only

slightly, while in case of the latest variety, Biloxi, it was radically reduced. Findings of Abel (1), Badawi (5), Brown and Owen (10), Farhaduddin (25), and Weiss (67) showed a similar trend.

Shee (56) reported that Palmetto, a photoperiod sensitive variety, required at least six consecutive short-day cycles of eight hours each to induce flowering, while Shih-Tan, a relatively less sensitive variety, flowered under continuous long days. In both varieties, however, flowering was hastened with more short-day cycles.

Parker and Borthwick (47) noted that in Biloxi variety, pod formation after flower induction required continuation of eight-hour photoperiods, and no pods were formed if these were changed to 14-hours during flowering. Borthwick and Parker (6) reported that a light intensity of at least 100 foot-candles was required for flower induction in Biloxi.

Allard and Garner (3) used different ratios of light to darkness and produced ready flowering with 1:1 ratio and 12-hour alterations. With 7-, 8-, 16-, and 18-hour alterations flowering was totally inhibited. It is evident from these observations that the time of flowering is dependent upon both the ratio of light to darkness and the length of the cycle.

Besides light, temperature also influences the flowering and maturity stages in soybeans. Borthwick and

Parker (7) showed that temperature during the dark period was more important than during light for flower induction in soybeans.

Van Schaik (66) noted that increasing the temperatures from 60° to 90°F, generally caused earlier and more profuse flowering. The appearance of the first pod was hastened by increasing the temperatures from 60° to 70°F.

Marvin (40) considered proper maturity to be the most important of several other factors that influence yield in soybeans. Weiss (67) reviewed the findings of Viljoen which indicated that four to five days delay in planting retarded the maturity of soybeans by one day. Badawi (5) observed that for a delay in planting of each two days there was a corresponding delay of about one day in the maturity of soybean varieties at AREC.

Feaster (26) demonstrated that the time of planting influenced the date of maturity of early varieties more than that of late varieties, and that early maturity could be achieved only by planting genetically early maturing varieties at an early date. Caviness and Walter (18) reported that a month's delay in planting of the early varieties delayed their maturity by 15 to 20 days, while in late varieties by only four to five days. The findings of Abel (1), Cartter and Hartwig (14), Caviness and Smith (16), Garner et al. (28), Morse (43), Osler and Cartter (46), Torrie and Briggs (64), and Weiss (67) are in

close agreement with these results.

Plant Height

A variety may vary considerably in height due to different times of planting. Cartter and Hartwig (14) found mid-season plantings to produce taller plants than earlier or later plantings in Mississippi. Moreover, early varieties tended to gain maximum heights when planted around May 1, whereas, later strains attained maximum heights when planted around June 1 or later. Abel (1) noted that average plant height, in the early May planting, was slightly less than in other May plantings, the tall varieties decreasing more in height than the short ones.

Caviness (15) explained the relative less height of plants resulting from early plantings on the basis of low soil temperatures or short photoperiods, inducing early flowering and hence limiting the height during the life cycle of these plants.

Other workers, however, have reported quite contrasting results. Garner and Allard (31) observed that average heights attained by earlier plantings markedly exceeded those attained by later plantings. Badawi (5), Farhaduddin (25), Morse (43), Osler and Cartter (46) and Torrie and Briggs (64) have reported similar results.

Howell and Cartter (35) noted that increasing the temperature, within reasonable limits, caused an increase

in plant height of soybeans.

Staniforth and Weber (61) reported that presence of weeds in the soybean field decreased their height by two inches.

Shee (56) observed that plant height decreased with increasing numbers of short-day photoperiodic cycles.

Mitrovic (42) reported that average stem height of early varieties, in general, was 53.7 cm, of medium-early varieties 64.1 cm,and of medium-late varieties 77.7 cm.

Number of Pods and Seeds per Plant

Lehman and Lambert (39) noted a marked increase in the number of seeds and pods per plant and number of seeds per pod as spacing between rows was increased from 20 to 40 inches.

Dimmock and Warren (21) observed that delayed planting caused a reduction in the number of seeds produced.

Howell and Cartter (35) found that number of pods and seeds per plant were constant under varying temperature from 70° to 85°F.

Badawi (5) noted that number of pods per plant and number of seeds per pod were only slightly affected by different dates of planting.

Farhaduddin (25), using April 4, April 18, May 3 and May 18 as planting dates, found that the highest average numbers of pods per plant were obtained from

April 18 planting at AREC, Lebanon. Number of seeds per pod was not influenced significantly by different dates of planting in this experiment.

Lodging

Weiss (67) stated that the influence of location on lodging was greater than that of season.

Cartter and Hartwig (14) reported that lodging tended to increase with delayed plantings and genetic lateness of the varieties. The findings of Caviness (15), Farhaduddin (25) and Osler and Cartter (46) are in close agreement with these observations.

On the other hand, Abel (1) found lodging to decrease with late plantings, while Badawi (5) and Torrie and Briggs (64) did not find any effect of planting date on lodging.

Staniforth and Weber (61) found the presence of weeds in the field to increase lodging by two to six per cent.

Seed Weight

Osler and Cartter (46) reported that seed weight was not appreciably affected by different dates of planting. The findings of Abel (1), Badawi (5), Dimmock and Warren (21),and Farhaduddin (25) confirm this observation.

Weiss et al. (68) did not find any association

between seed size and protein and oil content.

Howell and Cartter (35) reported that increasing the temperature from 70° to 85°F, during all or a part of the pod-filling stage, did not affect the 1000-seed weight.

Garner and Allard (30) noted that in Mandarin, an early variety, shortening the light period from long summer days to 12 hours or less reduced the seed size, while in late varieties 12-hour exposures decidedly gave larger seeds than the full day length.

III. MATERIALS AND METHODS

Field trials were conducted to determine the effects of dates of planting and varieties on various characteristics in soybeans. The experiment was carried out during 1966 and 1967 at the Agricultural Research and Education Center (AREC) of the American University of Beirut located in the Beqa'a Plain, Lebanon.

The four varieties included in the experiment were Wabash, Lindarin, Clark, and Perry since they varied in maturity and were found to be adapted in the Beqa'a Plain (69). As regards to maturity, Lindarin has been found to be early, Clark intermediate and Wabash and Perry late at AREC (5, 25, 69). Lindarin was originally derived from a cross between Mandarin and Lincoln and has the reputation of being a high yielding variety with a high oil content (4, 26). Clark is a selection from the backcross Lincoln x (Lincoln x Richland) and has been described to yield fairly high amount of seeds and protein (5, 27, 48).

Each of the four varieties was planted on four different dates with approximately 14-day intervals between two successive plantings. The first planting was made at a date within the safe range of temperature and moisture relationships. Planting dates were April 8, April 23,

May 7, and May 21 for the year 1966, and April 12, April 24, May 8, and May 22 in 1967. The average monthly temperature and rainfall data from March to October for the years 1966 and 1967, along with the 12-year average from 1956 to 1967, as recorded at AREC, are presented in the Appendix (Table 17).

The soils in the central Beqa'a Plain were found to be fine textured, alkaline in reaction (pH 8.0 to 8.3), and high in calcium carbonate. The content of organic matter ranged from 2.03 to 4.62 per cent. Variability in available phosphorus, sufficient exchangeable potassium and high cation exchange capacity was also associated with these soils (52).

The experimental design was a latin square with dates as the main treatments and varieties as sub-plots, arranged within the main treatments, in a randomized complete block pattern. Sub-plots consisted of four rows, each five meters long. The distance between rows was 50 cm. Seeding rates were adjusted, on the basis of germination tests for each variety, so as to obtain a uniform stand of about 165 plants per row. The seeds were inoculated with a standard commercial inoculum shortly before every planting date. Plantings were made at a depth of five cm with a V-belt planter which spaced the seed at a distance of about three cm within a row.

Preplanting fertilizer treatments consisted of

application of 12 kg of nitrogen in the form of ammonium sulfo-nitrate (26.5% N) and 20 kg of P_2O_5 in the form of superphosphate (18% P_2O_5) per dunum. These were disked into the soil during seedbed preparation. Post-planting treatments consisted of four kg and six kg per dunum of nitrogen in May and July, respectively, as side dressings. Sprinkler irrigation was practiced until the plants were about 15 cm tall after which period furrow irrigation was introduced. Irrigation was done at weekly intervals throughout the growing season. The plots were kept free of weeds by hand-hoes or by simple hand pulling. Cut worms caused some damage in the first and second dates of planting in 1966 and were controlled with Endrin.

For data collection, two central rows of each sub-plot were utilized. Dates of flowering were recorded at 50 per cent blooming stage, while dates of maturity were recorded when most of the pods had ripened. At maturity four plants were selected from every sub-plot for determining the number of pods per plant, seeds per pod and plant height. The yield of each sub-plot was determined by harvesting four meters of each of the two central rows, leaving one-half meter on each end to eliminate the border effects. The seed yields and weight of 1000 seeds (in grams) were recorded immediately after threshing. For the determination of protein and oil contents of the seeds, a representative sample from each sub-plot was oven-dried

at 70°C for approximately 72 hours, then ground to pass through a fine mesh screen. For protein content, modified Kjeldahl method (33, pp 12-13) was used, while for that of oil, Dry Extraction method (33) was followed. The percentages of protein and oil were calculated on a dry weight basis. Protein and oil determinations were made only on samples from the 1966 crop.

Analysis of variance tests were conducted to find out the significance of the various results obtained. For this purpose statistical methods applicable to the latin square split-plot design were employed (59). The planting date of April 10 and the variety Wabash were considered as controls in comparing and evaluating the data.

IV. RESULTS AND DISCUSSION

In this experiment the effects of various planting dates on yield, protein and oil percentages of the seeds, number of days from planting to flowering, number of days from planting to maturity, plant height, number of pods per plant, number of seeds per pod and weight of 1000 seeds of four soybean varieties were observed and evaluated. The data and analysis of variance are presented in the Tables 1 through 16 along with L.S.D. values at five per cent and one per cent levels calculated for the treatments found to be significant on the basis of F values.

Grain Yield

The seed yields of the four varieties as affected by different dates of planting in 1966 and 1967 are presented in Table 1 and Table 2, respectively. In both years differences in seed yields due to various dates of planting were not found to be significant. This agrees with the results reported by Badawi (5) and Farhaduddin (25). The varieties, in general, tended to produce their highest yields when planted on April 23, 1966 and April 24, 1967, the second dates of planting. However, Wabash

Table 1. Average seed yield, in kg per dunum, of soybean varieties planted on four dates in 1966 in the Beqa'a Plain, Lebanon.

Variety	Date of planting				Mean
	April 8	April 23	May 7	May 21	
Wabash	220.2	249.9	251.9	226.0	237.0
Lindarin	285.3	314.5	278.4	295.7	293.5**
Perry	189.3	221.2	220.3	172.9	200.9**
Clark	264.5	291.5	255.0	280.5	272.9**
Mean	239.8	269.3	251.4	243.8	

** Indicates significant difference at 1% level.

Analysis of variance

Source	d.f.	M.S.S.	F	L.S.D. 5%	L.S.D. 1%
Rows	3	2992.0	1.64		
Columns	3	3674.8	2.01		
Dates	3	2722.0	1.49		
Error (a)	6	1823.9			
Varieties	3	26555.3	19.36**	26.59	35.63
Dates x varieties	9	896.5	N.S.		
Error (b)	36	1371.8			

** Indicates F values significant at the 1% level.

Table 2. Average seed yield, in kg per dunum, of soybean varieties planted on four dates in 1967 in the Beqa'a Plain, Lebanon.

Variety	Date of planting				Mean
	April 12	April 24	May 8	May 22	
Wabash	161.6	191.3	98.5	121.3	143.2
Lindarin	238.5	258.1	241.0	249.7	246.8**
Perry	184.7	232.8	218.1	166.0	200.4**
Clark	238.5	226.3	193.5	146.3	201.2**
Mean	205.8	227.1	187.8	170.8	

** Indicates significant difference at 1% level.

Analysis of variance

Source	d.f.	M.S.S.	F	L.S.D. 5%	L.S.D. 1%
Rows	3	3938.6	1.83		
Columns	3	1638.0	N.S.		
Dates	3	9351.1	4.35		
Error (a)	6	2148.3			
Varieties	3	28842.9	16.74**	29.80	39.93
Dates x varieties	9	2777.7	1.61		
Error (b)	36	1723.4			

** Indicates F values significant at 1% level.

yielded slightly more when planted on May 7, 1966, and Clark when planted on April 12, 1967.

The differences in yield due to varieties were found to be highly significant. Lindarin gave the highest yields (293.5 kg per dunum in 1966 and 246.8 kg in 1967) in both years, while Perry (200.9 kg) and Wabash (143.2 kg) produced the poorest yields in 1966 and 1967, respectively. Lindarin produced the highest yields at all four planting dates. A similar trend in yield was reported by Farhaduddin (25).

Protein Percentage

The data in Table 3 show that dates of planting greatly affected the protein percentage in soybeans. The seeds produced from the May 7 and May 21 plantings contained significantly higher percentages of protein (35.08 and 34.50) respectively, than those produced from the April 8 or April 23 plantings (32.82 and 33.04), respectively. The percentage protein in the seed from the April plantings did not vary significantly. These results are in close agreement with the findings of Badawi (5), Dimmock and Warren (21), Feaster (26), and Osler and Cartter (46) who associated delayed planting with higher protein content of soybeans.

Varietal differences in protein content were also found to be highly significant. Seeds of Lindarin

Table 3. Average percentage of protein in seeds of soybean varieties planted on four dates in 1966 in the Beqa'a Plain, Lebanon.

Variety	Date of planting				Mean
	April 8	April 23	May 7	May 21	
Wabash	32.71	31.83	35.16	33.82	33.38
Lindarin	34.97	35.65	35.78	35.81	35.55**
Perry	32.19	32.93	34.94	33.89	33.49
Clark	31.41	31.75	34.42	34.46	33.01
Mean	32.82	33.04	35.08**	34.50**	

** Indicates significant difference at 1% level.

Analysis of variance

Source	d.f.	M.S.S.	F	L.S.D. 5%	L.S.D. 1%
Rows	3	5.42	9.85**		
Columns	3	4.23	7.69*		
Dates	3	19.39	35.25**	0.64	0.96
Error (a)	6	0.55			
Varieties	3	21.10	12.79**	0.93	1.25
Dates x varieties	9	2.07	1.25		
Error (b)	36	1.65			

* Indicates F values significant at 5% level.
** Indicates F values significant at 1% level.

contained significantly higher percentages of protein (35.55) than Wabash which contained 33.38 per cent protein. Perry and Clark did not differ significantly in protein percentage from Wabash. The results of Farhaduddin (25) revealed a similar trend in the protein content in soybeans.

Oil Percentage

The oil percentages of soybean seeds, as affected by different dates of planting and varieties, are shown in Table 4. Significant differences in oil content due to dates of planting and varieties were obtained. The April 23 plantings, which gave the highest seed yields, also produced seeds which contained the highest oil percentage (23.7). This is in confirmation of the findings of Collins and Cartter (19), Feaster (26), and Stark (62) who associated highest oil content of the seed with the time of planting at which best yields could be achieved. The seeds of soybeans from plantings made before or after April 23 did not vary significantly in oil content.

Among the varieties studied, the seed of the variety Clark contained a significantly higher percentage of oil in the seed than Wabash. The varieties Lindarin and Perry did not vary in oil percentage from that of Wabash. All the varieties, except Perry, produced seed with highest percentage of oil when planted on April 23.

Table 4. Average percentage of oil in seeds of soybean varieties planted on four dates in 1966 in the Beqa'a Plain, Lebanon.

Variety	Date of planting				
	April 8	April 23	May 7	May 21	Mean
Wabash	20.4	25.2	18.8	19.2	20.9
Lindarin	19.2	22.4	19.7	20.1	20.4
Perry	21.1	20.4	21.3	18.6	20.4
Clark	22.3	26.7	21.8	20.0	22.7*
Mean	20.8	23.7*	20.4	19.5	

* Indicates significant difference at 5% level.

Analysis of variance

Source	d.f.	M.S.S.	F	L.S.D. 5%	L.S.D. 1%
Rows	3	145.6	17.34**		
Columns	3	21.7	2.58		
Dates	3	52.2	6.21*	2.50	3.78
Error (a)	6	8.4			
Varieties	3	19.8	4.04*	1.59	2.14
Dates x varieties	9	9.5	1.94		
Error (b)	36	4.9			

* Indicates F values significant at 5% level.
** Indicates F values significant at 1% level.

Number of Days to Flowering

The number of days from planting to flowering for 1966 and 1967 are reported in Table 5 and Table 6, respectively. Dates of planting influenced the number of days from planting to flowering significantly. As the planting was delayed in 1966 from April 8 to May 21, a delay of 43 days, the average number of days between planting and flowering were reduced by approximately 24 days. Hence, with 43 days delay in planting there was actually only 19 days delay in flowering. In 1967 the delay of 40 days in planting resulted in a delay of 27 days in flowering.

Significant differences were found among varieties in the time required from planting to flowering. The time required to reach flowering stage by Lindarin, Clark and Perry was significantly shorter than that of Wabash in both years. Lindarin required the least number of days for flowering (62 in 1966 and 67.5 in 1967).

Several investigators have reported studies showing a similar trend between dates of planting and flowering (1, 5, 10, 16, 43, 46).

The differential performance in flowering of different varieties when planted on different dates was highly significant in both years of the study. In 1966 for a delay of 43 days in planting there was a corresponding reduction, in the time required from planting to flowering, of 26,

Table 5. Average number of days from planting to flowering of soybean varieties planted on four dates in 1966 in the Beqa'a Plain, Lebanon.

Variety	Date of planting				
	April 8	April 23	May 7	May 21	Mean
Wabash	90.0	77.8	69.5	64.3	75.4
Lindarin	74.3	63.5	58.5	51.8	62.0**
Perry	85.8	76.3	68.5	63.3	73.5**
Clark	81.5	69.5	60.8	56.5	67.1**
Mean	82.9	71.8**	64.3**	59.0**	

** Indicates significant difference at 1% level.

Analysis of variance

Source	d.f.	M.S.S.	F	L.S.D. 5%	L.S.D. 1%
Rows	3	1.83	8.32*		
Columns	3	0.10	0.45		
Dates	3	1719.60	7816.36**	0.42	0.63
Error (a)	6	0.22			
Varieties	3	598.43	1360.07**	0.49	0.65
Dates x varieties	9	4.98	11.32**	1.34	1.80
Error (b)	36	0.44			

* Indicates F values significant at 5% level.
** Indicates F values significant at 1% level.

Table 6. Average number of days from planting to flowering of soybean varieties planted on four dates in 1967 in the Beqa'a Plain, Lebanon.

Variety	Date of planting				
	April 12	April 24	May 8	May 22	Mean
Wabash	88.5	78.3	79.3	77.3	80.9
Lindarin	77.0	69.3	60.5	63.0	67.5**
Perry	87.3	76.0	73.0	76.0	78.1**
Clark	79.3	72.5	65.5	64.8	70.5**
Mean	83.0	74.0**	69.6**	70.1**	

** Indicates significant difference at 1% level.

Analysis of variance

Source	d.f.	M.S.S.	F	L.S.D. 5%	L.S.D. 1%
Rows	3	0.53			
Columns	3	0.07			
Dates	3	611.16	2657.22**	0.42	0.63
Error (a)	6	0.23			
Varieties	3	629.70	1908.18**	0.41	0.55
Dates x varieties	9	18.73	56.76**	1.16	1.55
Error (b)	36	0.33			

** Indicates F values significant at 1% level.

22, 23,and 25 days for Wabash, Lindarin, Perry and Clark, respectively. In 1967 for a 40-day delay in planting, the corresponding reduction was 12, 14, 11,and 14 days for Wabash, Lindarin, Perry,and Clark, respectively.

Number of Days to Maturity

The number of days required by different soybean varieties to mature when planted on different dates in 1966 and 1967 are presented in Tables 7 and 8, respectively. It will be noted that, with only a few exceptions, a delay in planting caused a delay in maturity of each variety. However, the delay in maturity was not commensurate with the delay of planting. For a 43 days delay in planting (April 8 to May 21) in 1966 and 40 days delay (April 12 to May 22) in 1967, the average maturity of the soybeans was delayed about 19 days. In other words, for each delay of two days in planting there was a corresponding delay in maturity of approximately one day. Various workers have reported similar results with different soybean varieties (1, 5, 14, 16, 25, 43, 67).

In both years of the study Lindarin proved to be the earliest maturing variety (114 days in 1966 and 148 in 1967) followed by Clark (135 days in 1966 and 173 in 1967). The varieties Perry and Wabash were late in maturity in both years. These results are in agreement with the findings of Badawi (5) and Farhaduddin (25).

Table 7. Average number of days from planting to maturity of soybean varieties planted on four dates in 1966 in the Beqa'a Plain, Lebanon.

Variety	Date of planting				
	April 8	April 23	May 7	May 21	Mean
Wabash	157.8	147.3	138.5	132.0	143.9
Lindarin	124.0	117.3	113.3	101.3	114.0**
Perry	161.3	155.8	144.3	135.5	149.2**
Clark	147.5	137.8	130.5	126.5	135.6**
Mean	147.7	139.6**	131.7**	123.8**	

** Indicates significant difference at 1% level.

Analysis of variance

Source	d.f.	M.S.S.	F	L.S.D. 5%	L.S.D. 1%
Rows	3	1.50	5.36*		
Columns	3	0.17	0.61		
Dates	3	1677.60	5991.43**	0.47	0.70
Error (a)	6	0.28			
Varieties	3	3852.53	15410.12**	0.37	0.49
Dates x varieties	9	19.84	79.36**	1.02	1.36
Error (b)	36	0.25			

* Indicates F values significant at 5% level.
** Indicates F values significant at 1% level.

Table 8. Average number of days from planting to maturity of soybean varieties planted on four dates in 1967 in the Beqa'a Plain, Lebanon.

Variety	Date of planting				
	April 12	April 24	May 8	May 22	Mean
Wabash	192.5	182.3	186.3	178.8	185.0
Lindarin	159.8	152.5	143.3	136.3	148.0**
Perry	211.8	186.0	193.5	181.3	193.2**
Clark	184.8	175.5	166.5	167.3	173.5**
Mean	187.2	174.1**	172.4**	165.9**	

** Indicates significant difference at 1% level.

Analysis of variance

Source	d.f.	M.S.S.	F	L.S.D. 5%	L.S.D. 1%
Rows	3	4.70	4.70		
Columns	3	1.40	1.40		
Dates	3	1277.40	1277.40**	0.86	1.30
Error (a)	6	1.00			
Varieties	3	6196.5	10327.50**	0.55	0.73
Dates x varieties	9	99.0	165.00**	1.58	2.12
Error (b)	36	0.6			

** Indicates F values significant at 1% level.

Plant Height

The effect of different dates of planting on the height of four soybean varieties grown in 1966 and 1967 is shown in Tables 9 and 10, respectively. The different dates of planting made in 1966 did not influence the average plant heights of soybeans significantly. However, in 1967, as the planting was delayed from April 12 to May 22 there was a consistent increase in the plant height from 138.8 cm to 168.2 cm, respectively. The shortest soybean plants were obtained from the early plantings while the tallest plants were produced from the late plantings. The findings of Abel (1) and Caviness (15) revealed similar trends.

Lindarin produced the shortest plants in both years (138.5 cm in 1966 and 132.1 in 1967). On the other hand, Clark was the tallest variety in 1966 (207.3 cm) while it was near to the short variety Lindarin in plant height in 1967 (143.7 cm). The reason for its excessive height in 1966 seems to be the higher amount of lodging observed in this variety during that year. The varieties Wabash and Perry were intermediate in height.

Number of Pods per Plant

The number of pods per plant of soybeans, as affected by different dates of planting and varieties in

Table 9. Average plant height in cm of soybean varieties planted on four dates in 1966 in the Beqa'a Plain, Lebanon.

Variety	Date of planting				Mean
	April 8	April 23	May 7	May 21	
Wabash	202.0	194.5	200.8	174.0	192.8
Lindarin	129.0	141.5	144.5	138.8	138.5**
Perry	190.5	185.8	202.8	170.5	187.4
Clark	205.0	200.5	221.8	202.0	207.3*
Mean	181.6	180.6	192.5	171.3	

* Indicates significant difference at 5% level.
** Indicates significant difference at 1% level.

Analysis of variance

Source	d.f.	M.S.S.	F	L.S.D. 5%	L.S.D. 1%
Rows	3	2666.6	3.52		
Columns	3	275.6	0.36		
Dates	3	1196.3	1.58		
Error (a)	6	757.4			
Varieties	3	14310.1	53.72**	11.71	15.69
Dates x varieties	9	250.8	0.94		
Error (b)	36	266.4			

** Indicates F values significant at 1% level.

Table 10. Average plant height in cm of soybean varieties planted on four dates in 1967 in the Beqa'a Plain, Lebanon.

Variety	Date of planting				
	April 12	April 24	May 8	May 22	Mean
Wabash	149.5	168.2	167.1	192.5	169.3
Lindarin	122.1	132.1	138.2	135.9	132.1**
Perry	150.4	170.2	174.6	186.3	170.4
Clark	133.3	139.3	144.1	157.9	143.7**
Mean	138.8	152.5	156.0	168.2**	

** Indicates significant difference at 1% level.

Analysis of variance

Source	d.f.	M.S.S.	F	L.S.D. 5%	L.S.D. 1%
Rows	3	970.70	2.33		
Columns	3	200.00	N.S.		
Dates	3	2325.80	5.58*		
Error (a)	6	417.10			
Varieties	3	5817.70	17.13**		
Dates x varieties	9	151.9	N.S.		
Error (b)	36	339.7			

* Indicates F values significant at 5% level.
** Indicates F values significant at 1% level.

1966 and 1967 are reported in Tables 11 and 12, respectively. The various dates of planting did not influence the number of pods per plant.

In 1966 the varieties Lindarin and Perry had fewer pods per plant than did Wabash. In 1967, however, all four varieties of soybeans produced about the same number of pods per plant.

The dates x varieties interaction was found to be highly significant in 1966. Wabash produced the greatest number of pods per plant (48.2) when planted on May 7, while Lindarin (34.0) on May 21, Perry (52.1) on April 23, and Clark (46.1) on April 8.

Number of Seeds per Pod

Tables 13 and 14 show the average number of seeds per pod of soybeans as influenced by planting dates and varieties in 1966 and 1967, respectively. In 1966 mean number of seeds per pod was not influenced significantly by different dates of planting. However, in 1967, April 24 planting, which gave the highest seed yields, produced pods with the highest number of seeds per pod (2.38), while May 22 planting, which gave the lowest yields, had pods with the lowest number of seeds on the average (2.13). Dimmock and Warren (21) also reported that yield differences were closely correlated with number of seeds produced by a particular date of planting.

Table 11. Average number of pods per plant of soybean varieties planted on four dates in 1966 in the Beqa'a Plain, Lebanon.

Variety	Date of planting				
	April 8	April 23	May 7	May 21	Mean
Wabash	48.2	45.3	48.3	44.9	46.7
Lindarin	25.4	28.5	32.1	34.0	30.0**
Perry	44.1	52.1	31.4	25.9	38.4**
Clark	46.1	44.8	39.1	45.0	43.8
Mean	41.0	42.7	37.7	37.5	

** Indicates significant difference at 1% level.

Analysis of variance

Source	d.f.	M.S.S.	F	L.S.D. 5%	L.S.D. 1%
Rows	3	41.4	N.S.		
Columns	3	67.2	1.15		
Dates	3	102.7	1.76		
Error (a)	6	58.3			
Varieties	3	857.6	13.21**	5.79	7.75
Dates x varieties	9	192.1	2.96**	16.36	21.92
Error (b)	36	64.9			

** Indicates F values significant at 1% level.

Table 12. Average number of pods per plant of soybean varieties planted on four dates in 1967 in the Beqa'a Plain, Lebanon.

Variety	Date of planting				
	April 12	April 24	May 8	May 22	Mean
Wabash	47.4	48.1	48.5	44.3	47.1
Lindarin	53.6	39.3	36.5	46.3	43.9
Perry	38.6	49.4	49.7	44.0	45.4
Clark	43.0	51.5	44.5	48.3	46.8
Mean	45.7	47.1	44.8	45.7	

Analysis of variance

Source	d.f.	M.S.S.	F	L.S.D. 5%	L.S.D. 1%
Rows	3	73.4	1.65		
Columns	3	90.5	2.03		
Dates	3	13.9	N.S.		
Error (a)	6	44.5			
Varieties	3	33.9	N.S.		
Dates x varieties	9	134.5	2.62		
Error (b)	36	51.3			

Table 13. Average number of seeds per pod of soybean varieties planted on four dates in 1966 in the Beqa'a Plain, Lebanon.

Variety	Date of planting				
	April 8	April 23	May 7	May 21	Mean
Wabash	2.48	2.48	2.33	2.50	2.45
Lindarin	2.49	2.56	2.58	2.59	2.56**
Perry	2.22	2.22	2.32	2.14	2.23**
Clark	2.57	2.55	2.44	2.56	2.53*
Mean	2.44	2.45	2.42	2.45	

* Indicates significant difference at 5% level.
** Indicates significant difference at 1% level.

Analysis of variance

Source	d.f.	M.S.S.	F	L.S.D. 5%	L.S.D. 1%
Rows	3	0.054	2.16		
Columns	3	0.027	1.08		
Dates	3	0.003	N.S.		
Error (a)	6	0.025			
Varieties	3	0.360	25.71**	0.08	0.11
Dates x varieties	9	0.022	1.57		
Error (b)	36	0.014			

** Indicates F values significant at 1% level.

Table 14. Average number of seeds per pod of soybean varieties planted on four dates in 1967 in the Beqa'a Plain, Lebanon.

Variety	Date of planting				
	April 12	April 24	May 8	May 22	Mean
Wabash	2.37	2.43	2.34	2.09	2.31
Lindarin	2.33	2.39	2.39	2.14	2.31
Perry	2.31	2.19	2.18	1.92	2.15**
Clark	2.45	2.49	2.56	2.37	2.47**
Mean	2.37	2.38**	2.37	2.13**	

** Indicates significant difference at 1% level.

Analysis of variance

Source	d.f.	M.S.S.	F	L.S.D. 5%	L.S.D. 1%
Rows	3	0.020	1.54		
Columns	3	0.023	1.77		
Dates	3	0.230	17.69**	0.004	0.006
Error (a)	6	0.013			
Varieties	3	0.270	18.00**	0.004	0.005
Dates x varieties	9	0.017	1.13		
Error (b)	36	0.015			

** Indicates F values significant at 1% level.

Amongst the varieties, Lindarin and Clark produced the highest number of seeds per pod (2.56 and 2.47) in 1966 and 1967, respectively. Perry produced the lowest number of seeds per pod (2.23 in 1966 and 2.15 in 1967) in both years.

Weight of 1000 Seeds

The weights of 1000 seeds of soybean varieties from various planting dates in 1966 and 1967 are shown in Tables 15 and 16, respectively. The third date of planting (May 7 and 8) produced the largest soybean seeds with an average weight of 189.27 and 189.80 grams per 1000 seeds in 1966 and 1967, respectively. On the other hand, the smallest seeds were obtained from the first date of planting in 1966 and the last planting date in 1967. Soybean seeds intermediate in size were obtained from the other planting dates.

The varieties Lindarin, Perry and Clark had larger seed size than Wabash in both years. With a few exceptions, the variety Perry had the largest seeds while Wabash produced the smallest seeds at all the dates of planting. The findings of Farhaduddin (25) agree with these results.

Lodging

In general as the planting date was delayed, a consistent increase in the number of lodged plants as well

Amongst the varieties, Lindarin and Clark produced the highest number of seeds per pod (2.56 and 2.47) in 1966 and 1967, respectively. Perry produced the lowest number of seeds per pod (2.23 in 1966 and 2.15 in 1967) in both years.

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The varieties Lindarin, Perry and Clark had larger seed size than Wabash in both years. With a few exceptions, the variety Perry had the largest seeds while Wabash produced the smallest seeds at all the dates of planting. The findings of Farhaduddin (25) agree with these results.

Lodging

In general as the planting date was delayed, a consistent increase in the number of lodged plants as well

Table 15. Average 1000-seed weight in grams, of soybean varieties grown at four planting dates in 1966 in the Beqa'a Plain, Lebanon.

Variety	Date of planting				
	April 8	April 23	May 7	May 21	Mean
Wabash	170.75	171.50	176.63	175.69	173.64
Lindarin	183.69	184.06	183.06	176.31	181.78**
Perry	183.13	191.63	205.50	196.44	194.18**
Clark	184.25	177.81	191.88	192.63	186.64**
Mean	180.46	181.25	189.27**	185.27	

** Indicates significant difference at 1% level.

Analysis of variance

Source	d.f.	M.S.S.	F	L.S.D. 5%	L.S.D. 1%
Rows	3	45.17	1.21		
Columns	3	139.25	3.74		
Dates	3	263.77	7.08*	5.29	8.01
Error (a)	6	37.26			
Varieties	3	1187.53	29.38**	4.57	6.12
Dates x varieties	9	123.31	3.05**	12.91	17.30
Error (b)	36	40.42			

* Indicates F values significant at 5% level.
** Indicates F values significant at 1% level.

Table 16. Average 1000-seed weight, in grams of soybean varieties grown at four planting dates in 1967 in the Beqa'a Plain, Lebanon.

Variety	Date of planting				
	April 12	April 24	May 8	May 22	Mean
Wabash	171.69	171.44	175.44	167.81	171.60
Lindarin	188.38	188.38	187.63	172.06	184.11**
Perry	183.50	194.13	204.94	193.19	193.94**
Clark	179.50	179.88	191.19	180.44	182.75**
Mean	180.77	183.46	189.80**	178.38	

** Indicates significant difference at 1% level.

Analysis of variance

Source	d.f.	M.S.S.	F	L.S.D. 5%	L.S.D. 1%
Rows	3	108.81	2.54		
Columns	3	6.62	N.S.		
Dates	3	387.99	9.06**	5.66	8.57
Error (a)	6	42.81			
Varieties	3	1338.59	39.58**	4.16	5.58
Dates x varieties	9	114.62	3.39**	11.79	15.80
Error (b)	36	33.82			

* Indicates F values significant at 5% level.
** Indicates F values significant at 1% level.

as in the degree of lodging was observed in this experiment. Considerable lodging was observed in the plots that were planted on the last date of planting. Plants from these plots produced many seeds that were discolored and moldy. The variety Perry showed the greatest amount of lodging while Lindarin had the least.

Diseases

Seedcoat mottling of the beans was noticed in the variety Clark in 1966 and 1967. When the mottled seed of 1966 was planted in 1967, the ensuing seed had retained the mottled character. Cooper and Kennedy (20) described this disease to be associated with a virus.

Cumulative Day-Degrees

Table 18 (Appendix) shows the cumulative day-degrees received by the soybean varieties during their growing period in 1966 and 1967.

In both years the highest number of day-degrees (2774 in 1966 and 3225 in 1967) was received by the first date of planting. With each subsequent delay in planting, a consistent decrease in the number of day-degrees was observed.

Perry required the highest number of day-degrees on all dates while Lindarin, which produced the best yields, required the lowest.

V. SUMMARY AND CONCLUSIONS

The experiment was carried out for two consecutive years, 1966 and 1967, at the Agricultural Research and Education Center, Beqa'a Plain, Lebanon, to find out the effect of different planting dates and varieties on various characteristics of soybeans.

Four dates of planting - April 8, April 23, May 7 and May 21 in 1966 and April 12, April 24, May 8 and May 22 in 1967 - and four varieties Wabash, Lindarin, Perry and Clark were included in this study.

In both years of study, second date of planting (April 23 and 24) and the variety Lindarin tended to produce the highest seed yields. Perry in 1966 and Wabash in 1967 gave the poorest yields.

Soybeans contained the highest oil content when plantings were made in the latter part of April, while May plantings produced the seeds with higher protein percentages than the earlier plantings. Among the varieties, seeds of Lindarin contained the highest protein content, while those of Clark contained the highest percentage of oil.

For each two-day delay in planting, there was a corresponding delay of approximately one day in maturity. Lindarin was the earliest flowering and maturing variety,

while Wabash and Perry required the longest time to flower and mature.

Plant height was affected only in 1967 in which it increased consistently with the delayed plantings. Plants of Lindarin were found to be the shortest in average height while Clark in 1966, and Perry in 1967, produced the tallest plants.

Lindarin and Perry produced fewer pods than Wabash and Clark in 1966. However, in 1967, different varieties did not differ appreciably in the number of pods per plant. Planting time did not exert any significant influence upon the number of pods per plant in both years of study and upon number of seeds per pod in 1966. Variety Lindarin, in 1966 and Clark in 1967, had the highest number of seeds per pod. Perry contained the lowest number of seeds per pod.

The third date of planting tended to produce seeds with the largest size. Among varieties, Perry possessed the largest seeds.

On the basis of the two-year data fairly satisfactory soybean yields can be obtained in the Beqa'a Plain, Lebanon by planting the early maturing variety, Lindarin, during the later part of April.

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A P P E N D I X

Table 17. Average monthly temperatures and precipitation at the Agricultural Research and Education Center, Beqa'a Plain, Lebanon, from March to October in 1966 and 1967 and twelve years average 1956-1967.

Months	Temperature °C			Rainfall (mm)		
	1966	1967	1956-67	1966	1967	1956-67
March	7.0	5.9	7.9	96.7	167.1	62.0
April	11.8	10.5	11.6	0.0	20.5	23.2
May	14.4	15.1	14.8	2.6	34.5	13.0
June	19.5	17.8	20.4	0.0	0.0	0.8
July	22.8	20.7	22.5	0.0	0.0	0.0
August	23.7	20.5	23.3	0.0	0.0	0.0
September	20.1	18.3	20.3	0.9	0.0	2.7
October	16.1	15.2	16.4	28.0	43.8	15.2

Table 18. Cumulative temperatures (day-degrees C) for the days from planting to maturity of soybeans in 1966 and 1967.

Variety	Date of planting								Mean	
	1966				1967				1966	1967
	April 8	April 23	May 7	May 21	April 12	April 24	May 8	May 22		
Wabash	2994	2897	2834	2774	3361	3250	3179	2967	2875	3189
Lindain	2235	2247	2325	2147	2832	2797	2671	2572	2239	2718
Perry	3094	3078	2935	2838	3468	3311	3179	2967	2986	3231
Clark	2773	2717	2674	2673	3240	3159	3042	2967	2709	3102
Mean	2774	2735	2692	2633	3225	3129	3018	2868		