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THE EFFECTS OF VARIOUS PLANT POPULATIONS ON AGRONOMIC CHARACTERS OF SEVERAL VARIETIES OF SOYBEAN UNDER RAIN-GROWN CONDITIONS IN SOUTHERN QUEENSLAND

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SUMMARY

Climatic conditions during the growing season had a major influence on the effects of various plant populations of rain-grown soybean varieties during 3 years experimentation. Increased yields of seed were obtained from increased plant populations when available moisture was adequate, but decreased yields resulted when moisture stress developed during growth.

The periods to flowering and maturity lengthened with increase in plant population in the presence of moisture stress. Plant heights decreased and the height of the lowest pod-bearing node increased as plant populations were increased.

As plant populations were increased, seed size was reduced while the oil content of the seed either decreased or showed no variation. Protein content of the seed varied with seasonal conditions and nitrogen availability.

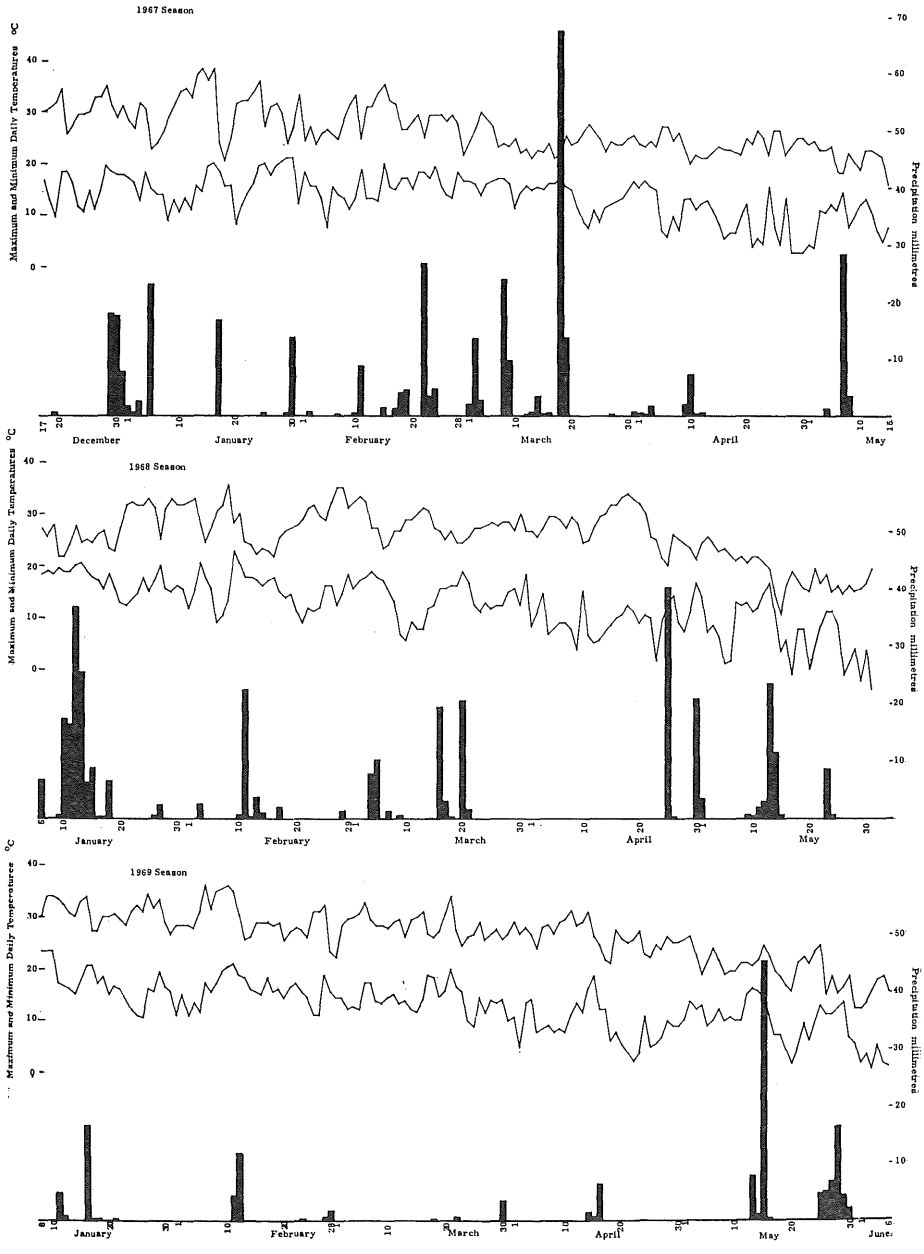
A plant population of about 267 000 per hectare is most suited to the variable climatic conditions which exist in southern Queensland.

Varieties ranging in maturity from Hill and Dorman (early) to Leslie (late) will produce best yields over the range of seasons that can be expected.

I. INTRODUCTION

The effects of varying populations of soybeans have been studied by research workers in the United States of America and Queensland. In the United States, Probst (1945) found that plant spacings of 5·0 to 7·5 cm in the row produced slightly higher yields than 2·5-cm or 10·0-cm spacings. Plants spaced at 2·5 cm in the row matured slightly later than did wider spacings. Smith (1959) found little difference in yield of Ogden soybeans at lower planting rates of 33·6 to 134·4 kg per ha, but yields were reduced at the higher rates of 151·2 and 168·0 kg per ha. If 5 700 seeds per kg is assumed an average

size for the Ogden variety, a field establishment of 80% places the plant populations which showed little difference in yield in the range of 153 000 to 613 000 per ha while higher plant populations of 689 000 and 766 000 per ha gave reduced yields.



In Queensland, Byth and Waite (1962) obtained a linear increase in yield with increased plant populations up to 1 100 000 plants per ha which was the highest population examined. Harty and Bygott (1964) found that, while plant population had no significant effect on yield, there was a tendency for higher populations to decrease yield in close row spacings (36 and 53 cm) and to increase yield in the wider row spacings (71 and 107 cm).

The varying and somewhat contradictory results achieved by these workers led to a study of the effects of varying plant populations in field experiments at the Hermitage Research Station over three seasons 1967 to 1969 inclusive.

Hermitage Research Station is situated in the Swan Creek Valley of the eastern Darling Downs at a latitude of 28.1°S and an altitude of 480 m. The mean annual rainfall is 640 mm of which 66% falls during the summer months October to March inclusive. The first frost normally occurs in late April.

II. MATERIALS AND METHODS

The experimental areas were sited on a flat contour on a fertile, dark-grey, alluvial, self-mulching clay soil with a pH of 7·0, a total N content of 0·14%, available P > 170 p.p.m. and available K of 0·80 m.e. %.

Experiments 1 and 2 followed crops of sorghum in soil with no previous history of soybean cultivation while experiment 3 followed experiment 2.

The seedbeds were prepared by ploughing with a mouldboard plough and cultivating with tines until a medium-fine tilth was obtained. Planting was done by seed drill following suitable planting rains. The three experiments were planted into moist soil which extended to depths of 90, 45 and 35 cm on 14 to 16 December 1966, 3 to 5 January 1968 and 7 January 1969 respectively.

The design of the experiments was a 36 x 3 randomized block. Plant populations were 1 070 000, 535 000, 357 000, 267 000, 214 000, and 178 000 plants per hectare. These populations were obtained by planting at a constant rate within the row and varying the inter-row spacing. In experiment 1, a combination of large seed size and insufficient gearing in the planting machinery resulted in plant populations being only half the intended numbers. No data in respect of the variety Jackson were taken from experiment 2 because of poor establishment.

The number of rows per plot varied with inter-row spacing (Table 1). Plot length was 11 m and plots were trimmed to 10 m before harvest to eliminate end effects. Harvesting was done by auto-header as individual plots matured.

All seed was inoculated with *Rhizobium japonicum* before planting. Strain CB 1003 was used in experiment 1 and the resultant nodulation was poor, as only 7·4% of the plants exhibited nodules. Strain CB 1809, which became available in 1967, was used in experiments 2 and 3. Nodulation in experiment 2 was good, with all varieties exhibiting nodules on at least 90% of the plants. Experiment 3 which was grown in Rhizobia-infested soil produced very good nodulation, with every plant carrying large numbers of nodules.

Weed control was by means of chlorthal applied post-planting, pre-emergence of the crop, at 8·4 kg a.i. per ha. All weeds were effectively controlled by the herbicide except wild cotton (*Hibiscus trionum*), which was removed periodically by hand.

TABLE 1

EXPERIMENTAL DETAILS

(a) PLOT DETAILS (EXPERIMENT 1)

Plant Population per ha	Inter-row Spacing cm	Number of Rows per Plot	Number of Datum Rows per Plot
535 000	18	16	12
267 000	36	8	6
178 000	53	6	4
134 000	71	4	2
107 000	89	4	2
89 000	107	3	1

(b) PLOT DETAILS (EXPERIMENTS 2 AND 3)

Plant Population per ha	Inter-row Spacing cm	Number of Rows per Plot	Number of Datum Rows per Plot
1 070 000	18	16	12
535 000	36	8	6
357 000	53	6	4
267 000	71	4	2
214 000	89	4	2
178 000	107	3	1

Insect pests were present in all three experiments. The principal pest was the green vegetable bug (*Nezara viridula*). The degree of infestation varied with the season, being heaviest in experiment 1 in 1967 and lightest in experiment 3 in 1969. All insects were effectively controlled by timely applications of DDT at 1·12 kg a.i. per ha.

All plant characteristics except oil and protein contents of the seed in experiment 1 were evaluated in individual plots. The oil and protein contents of the seed in experiment 1 were determined from 450 g samples obtained by bulking three replications of each treatment.

The plant characteristics were evaluated in the following manner—

Seed yield was obtained by weighting threshed, air-dried beans and is expressed in kg per ha.

The period to flowering was recorded as the number of days from planting until 25% of the plants in a plot exhibited flowers.

The period to maturity was recorded as the number of days from planting until the leaves had dropped and 95% of the pods were dry.

Plant height was the average height in cm from the base to the tip of the stem at time of maturity and was measured on five plants per plot.

Height of lowest pod-bearing node was the average height in cm from the base of the stem to the first node bearing at least one pod at time of maturity and was measured on five plants per plot.

Seed size was determined as the weight in grams of 100 seeds and was measured on three samples of 100 seeds per plot.

Protein and oil contents of the seed were expressed as percentages of air-dried seed.

III. RESULTS

Details of daily maximum and minimum temperatures and precipitation during the course of the three experiments are shown in Figure 1.

Experiment 1 was subjected to maximum temperatures consistently greater than 27°C from planting until 6 March. Rainfall was adequate and sufficiently well distributed to ensure good growth throughout the season. No apparent moisture stress existed during the flowering, pod-setting and pod-filling periods.

Experiment 2 was exposed to maximum temperatures consistently greater than 27°C from 20 January until 22 April. Rainfall should have been adequate, but distribution was comparatively poorer than in experiment 1. Rainfall was heavy following planting and losses of water occurred from run-off. Moisture stress occurred from 29 March to 24 April which covered part of the pod-setting and pod-filling periods. Rainfall between 25 April and 24 May provided no benefit to the early maturing varieties Bethel and Dorman.

Experiment 3 was exposed to maximum temperatures consistently greater than 27°C from planting until 22 April. Rainfall on this experiment was inadequate and moisture stress was experienced from 16 February until 15 May, by which date the early maturing varieties Dorman and Hill had matured.

The varieties, populations and characteristics evaluated in each of the three experiments are presented in Tables 2 to 9. Treatment, population and variety means and least significant differences for tests between variety means (V), between population means (P) and between individual treatment means (I) are given in each of the tables.

IV. DISCUSSION

When moisture was freely available in the post-flowering period (experiment 1), an increase in plant population was accompanied by an increase in seed yield (Table 2). There was, however, a significant interaction between varieties and populations which modified the population effect on individual varieties. Seed yield of early maturing varieties showed a greater percentage increase with population increase than did the later maturing varieties. When moisture was somewhat limited (experiment 2), very high plant populations produced a significant reduction in seed yield. This effect was not apparent on the two early maturing varieties but was considerable on the later maturing varieties. When moisture was severely restricted throughout most of the season (experiment 3), seed yield of all varieties was depressed to a low level. The effect of increasing plant populations to the highest level examined was to reduce the yield of seed to 150 to 200% of the seed planted. The yield response of rain-grown soybeans to varying plant populations is obviously largely governed by available soil moisture. The yield reductions with large plant populations obtained by Probst (1945) and Smith (1959) could have resulted from a deficiency of available soil moisture during the pod-filling period arising from increased moisture usage during the earlier growth stages. Producers of rain-grown soybeans in southern Queensland should select a plant population which will avoid severe yield losses in any season. The experiments described herein suggest a plant population of 267 000 plants per hectare, and earlier rather than later maturing varities, to ensure consistently better seed yields.

Flowering and maturity of soybeans (Tables 3 and 4) were delayed by increasing plant populations when moisture stress existed and the extent of this delay increased with increase in the stress. All populations of the two latest maturing varieties in experiment 3 matured on the same date following moisture-stress-relieving rainfall in mid May. The delays in maturity of the other varieties are directly attributable to moisture stress. Moisture stress is intensified by

increased plant population. Plant populations of 267 000 per hectare produced delays in maturity longer than 2 days only in the Jackson and Leslie varieties and then only in one year.

Plant heights (Table 5) were significantly reduced by increasing plant populations in experiments 2 and 3, while a similar but non-significant trend occurred in experiment 1. The greatest percentage reduction in plant height with increasing plant population occurred in experiment 3, where moisture stress was most severe and it is considered that variation in plant height was mainly a function of moisture availability.

The height of the lowest pod-bearing node (Table 6) was significantly increased by increasing plant population in each of the three experiments. This effect is of major importance in crops which are to be machine-harvested as pods borne below a level of 10 cm from the ground are frequently left unharvested by the machine.

Seed size (Table 7) was significantly reduced by increased plant populations but, in experiment 2, a significant interaction between varieties and plant populations modified the effect on individual varieties.

Oil content of the seed (Table 8) showed no variation with plant population except in experiment 2, where a significant reduction occurred with increasing plant populations. Protein content of the seed (Table 9) showed an obvious decrease with increase in plant population in experiment 1, a significant increase with increase in population in experiment 2, and no variation in experiment 3. The decrease in protein content in experiment 1 was associated with an increase in seed yield. As nodulation in experiment 1 was not good, it may be that an insufficiency in the nitrogen supply from symbiosis led to a nitrogen dilution effect with increasing seed yield and reduced protein content in the seed.

V. CONCLUSIONS

The production of soybeans under rain-grown conditions in southern Queensland is very dependent on weather conditions which vary tremendously between seasons. The selection of plant population and variety is an important consideration. A plant population of about 267 000 per hectare would be most suitable over the range of seasons which can be expected. Such a plant population would provide a near maximum yield in most seasons. It would not result in inordinate delays in flowering or maturity in dry seasons, especially if an early maturing variety is grown. It would produce a plant of acceptable height carrying its pods sufficiently clear of the ground to permit machine harvesting; and it would produce seed of acceptable size with a suitably balanced chemical content.

The producer of soybeans in southern Queensland will derive most benefit by growing early maturing varieties. However, there would be little point in planting varieties with a shorter period to flowering than Hill and Dorman as yield losses could be expected during wetter seasons. At the other end of the maturity scale, nothing is gained but much is lost from growing varieties later in maturity than Leslie.

VI. ACKNOWLEDGEMENTS

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TABLE 2

SEED YIELD (kg/ha)
(SOYBEAN VARIETY x PLANT POPULATION TRIALS

	Variety	Plant populations						Variety means	S.E.	L.S.D.	
		89 000	107 000	134 000	178 000	267 000	535 000			P < 0·05	P < 0·01
Experiment 1 1967	Bethel	1 245·44	1 236·48	1 275·68	1 566·88	1 450·40	1 986·88	1 460·48	V 61·60	173·60	230·72
	Dorman	1 486·24	1 591·52	1 948·80	1 850·24	2 367·68	1 860·32	1 851·36	P 61·60	173·60	230·72
	Jackson	1 516·48	1 876·00	1 767·36	2 162·72	1 940·96	2 270·24	1 921·92	I 151·20	426·72	566·72
	Leslie	1 995·84	1 770·72	2 076·48	1 554·56	1 822·24	2 215·36	1 906·24			
	Mamroy	1 263·36	1 012·48	1 301·44	1 034·88	1 120·00	1 302·56	1 172·64			
	ECR 973	1 290·24	1 367·52	1 637·44	1 413·44	1 733·76	1 527·68	1 495·20			
	Population means ..	1 466·08	1 476·16	1 667·68	1 597·12	1 739·36	1 860·32				

	Variety	Plant populations						Variety means	S.E.	L.S.D.	
		178 000	214 000	267 000	357 000	535 000	1 070 000			P < 0·05	P < 0·01
Experiment 2 1968	Bethel	844·14	892·08	911·90	758·91	925·46	866·21	866·43	V 40·88	115·58	153·78
	Dorman	1 045·41	864·19	1 132·54	921·54	960·29	1 052·69	966·13	P 44·69	126·56	168·45
	Leslie	1 029·95	906·08	1 016·40	944·72	789·94	384·94	845·38			
	Mamroy	975·74	1 175·55	981·57	933·18	925·46	673·68	944·16			
	ECR 973	813·12	859·60	859·60	689·25	642·77	547·57	735·28			
	Population means ..	941·70	939·46	980·34	849·52	848·74	705·04				
Experiment 3 1969	Dorman	430·53	352·58	394·58	614·99	416·86	325·02	422·46	V 24·30	68·54	91·06
	Hill	737·97	635·49	650·83	649·15	512·51	380·69	594·38	P 24·30	68·54	91·06
	Jackson	574·00	393·57	574·00	519·34	451·02	451·02	493·81	I 59·58	168·00	222·99
	Leslie	512·51	549·36	502·21	813·12	410·03	336·78	520·69			
	Mamroy	423·70	446·88	399·73	396·26	423·70	395·36	414·29			
	ECR 973	259·62	221·42	317·74	348·43	194·77	184·46	254·46			
	Population means ..	489·66	433·22	473·20	556·86	401·41	345·52				

TABLE 3

PERIOD TO FLOWERING (DAYS)
(SOYBEAN VARIETY x PLANT POPULATION TRIALS)

	Variety	Plant populations						Variety means	S.E.	L.S.D.	
		89 000	107 000	134 000	178 000	267 000	535 000			P < 0·05	P < 0·01
Experiment 1 1967	Bethel	47·00	47·00	47·00	46·64	47·00	47·00	46·94	V 0·39	1·11	1·47
	Dorman	61·00	62·33	60·67	61·67	60·67	61·33	61·28	P 0·39	1·11	1·47
	Jackson	65·67	65·33	66·00	66·67	68·33	66·67	66·44			
	Leslie	73·00	72·00	71·67	72·33	73·00	74·33	72·72			
	Mamroy	81·33	81·00	81·67	86·00	86·00	86·00	83·67			
	ECR 973	81·67	81·67	81·33	82·00	81·67	84·00	82·06			
	Population means ..	68·28	68·22	68·06	69·22	69·44	69·89				

	Variety	Plant populations						Variety means	S.E.	L.S.D.	
		178 000	214 000	267 000	357 000	535 000	1 070 000			P < 0·05	P < 0·01
Experiment 2 1968	Bethel	47·00	47·00	47·00	47·00	47·00	47·00	47·00	V 0·12	0·33	0·44
	Dorman	57·00	57·00	57·00	57·00	57·00	57·00	57·00	P 0·13	0·37	0·49
	Leslie	61·00	61·00	61·00	61·00	61·00	61·00	61·00			
	Mamroy	76·67	77·00	77·67	77·67	77·67	78·33	77·50			
	ECR 973	77·33	77·33	78·00	78·00	78·00	78·67	77·89			
	Population means ..	63·80	63·87	64·13	64·13	64·13	64·40				
Experiment 3 1969	Dorman	48·00	48·00	49·00	49·00	50·00	50·67	49·11	V 0·23	0·65	0·86
	Hill	49·67	50·00	50·33	50·33	51·00	51·67	50·50	P 0·23	0·65	0·86
	Jackson	51·67	52·00	52·00	52·00	52·00	54·00	52·28	I 0·56	1·59	2·11
	Leslie	56·00	57·00	57·33	56·00	60·00	62·00	58·06			
	Mamroy	63·67	64·00	65·00	67·33	67·00	69·00	66·00			
	ECR 973	67·33	65·67	68·67	69·00	69·67	72·00	68·72			
	Population means ..	56·06	56·11	57·06	57·28	58·28	59·89				

TABLE 4

PERIOD TO MATURITY (DAYS)
(SOYBEAN VARIETY x PLANT POPULATION TRIALS)

	Variety	Plant populations						Variety means	S.E.		L.S.D.	
		89 000	107 000	134 000	178 000	267 000	535 000				P < 0·05	P < 0·01
Experiment 1 1967	Bethel	130·00	130·00	130·33	130·00	130·00	130·00	130·06	V	0·09	0·26	0·34
	Dorman	130·00	129·67	130·00	130·00	130·00	130·33	130·00				
	Jackson	133·00	133·00	133·00	132·67	133·00	133·33	133·00				
	Leslie	136·00	136·00	135·67	136·00	136·00	136·33	136·00				
	Mamroy	146·00	146·00	146·00	146·00	146·00	146·00	146·00				
	ECR 973	148·00	148·00	148·00	148·00	148·00	148·00	148·00				
	Population means ..	137·17	137·11	137·17	137·11	137·17	137·33					

	Variety	Plant populations						Variety means	S.E.		L.S.D.	
		178 000	214 000	267 000	357 000	535 000	1 070 000				P < 0·05	P < 0·01
Experiment 2 1968	Bethel	115·00	115·00	115·00	115·00	115·00	115·00	115·00	V	0·45	1·26	1·68
	Dorman	114·00	114·00	114·00	114·00	114·00	114·00	114·00	P	0·49	1·38	1·84
	Leslie	124·33	125·67	125·00	125·33	125·67	133·33	126·56	I	1·09	3·09	4·11
	Mamroy	145·33	146·00	146·33	145·67	147·00	149·00	146·56				
	ECR 973	145·00	145·00	145·00	146·67	148·00	150·33	146·67				
	Population means ..	128·73	129·13	129·07	129·33	129·93	132·33					
Experiment 3 1969	Dorman	111·33	111·33	111·67	112·00	115·67	121·67	113·94	V	0·70	1·97	2·61
	Hill	113·00	113·33	114·67	119·33	122·33	128·00	118·44	P	0·70	1·97	2·61
	Jackson	122·00	128·33	127·33	136·00	153·00	153·00	136·61	I	1·71	4·82	6·40
	Leslie	122·00	128·67	136·00	139·00	153·00	153·00	138·61				
	Mamroy	153·00	153·00	153·00	153·00	153·00	153·00	153·00				
	ECR 973	153·00	153·00	153·00	153·00	153·00	153·00	153·00				
	Population means ..	129·06	131·28	132·61	135·39	141·67	143·61					

TABLE 5

PLANT HEIGHTS (cm)
(SOYBEAN VARIETY x PLANT POPULATION TRIALS)

	Variety	Plant populations						Variety means	S.E.		L.S.D.	
		89 000	107 000	134 000	178 000	267 000	535 000				P < 0·05	P < 0·01
Experiment 1 1967	Bethel	58·85	55·45	51·64	58·98	42·75	51·64	53·21	V	2·06	5·82	7·70
	Dorman	67·31	63·93	67·95	66·47	63·50	62·43	65·25				
	Jackson	74·50	76·20	69·85	71·96	67·31	71·12	71·83	I	5·03	14·22	18·87
	Leslie	73·23	66·04	73·66	61·39	66·88	79·17	70·05				
	Mamroy	79·17	78·74	82·55	82·98	82·98	82·55	81·48				
	ECR 973	121·08	99·49	85·93	102·87	106·25	89·33	100·81				
	Population means ..	79·02	73·30	71·93	74·12	71·60	72·69					

	Variety	Plant populations						Variety means	S.E.		L.S.D.	
		178 000	214 000	267 000	357 000	535 000	1 070 000				P < 0·05	P < 0·01
Experiment 2 1968	Bethel	53·85	55·19	49·96	44·20	44·02	39·80	47·83	V	1·14	3·23	4·29
	Dorman	64·52	61·98	61·98	57·58	57·40	56·90	60·05	P	1·24	3·53	4·70
	Leslie	69·27	67·39	67·06	63·68	58·09	59·26	64·11				
	Mamroy	80·95	78·74	71·63	65·02	62·31	57·33	69·32				
	ECR 973	90·93	88·57	76·71	73·99	67·39	65·35	77·17				
	Population means ..	71·91	70·38	65·46	60·88	57·84	55·73					
Experiment 3 1969	Dorman	43·36	36·25	38·94	40·31	31·32	27·76	36·32	V	1·24	3·53	4·67
	Hill	46·05	41·99	37·26	37·26	30·15	23·88	36·09	P	1·24	3·53	4·67
	Jackson	52·65	43·69	49·28	40·64	41·99	35·74	43·99				
	Leslie	45·03	47·75	44·70	45·39	34·72	28·78	41·07				
	Mamroy	50·62	44·88	40·82	40·13	37·77	31·83	41·00				
	ECR 973	59·26	49·78	48·95	35·23	33·71	24·05	41·83				
	Population means ..	49·50	44·04	43·33	39·83	34·95	28·68					

TABLE 6

HEIGHT OF LOWEST POD-BEARING NODE (cm)
(SOYBEAN VARIETY x PLANT POPULATION TRIALS)

	Variety	Plant populations						Variety means	S.E.		L.S.D.	
		89 000	107 000	134 000	178 000	267 000	535 000				P < 0·05	P < 0·01
Experiment 1 1967	Bethel	8·46	8·46	9·32	10·29	9·32	11·43	9·55	V	0·64	1·83	2·41
	Dorman	8·46	9·73	8·89	10·16	12·70	15·24	10·87	P	0·64	1·83	2·41
	Jackson	9·32	12·27	10·16	14·40	13·54	14·81	12·42				
	Leslie	15·24	16·51	16·51	16·51	16·08	22·02	17·15				
	Mamroy	19·05	17·78	21·16	22·86	28·37	32·18	23·57				
	ECR 973	12·70	15·67	13·97	18·21	17·78	20·75	16·51				
	Population means ..	12·22	13·41	13·34	15·39	16·31	19·41					

	Variety	Plant populations						Variety means	S.E.		L.S.D.	
		178 000	214 000	267 000	357 000	535 000	1 070 000				P < 0·05	P < 0·01
Experiment 2 1968	Bethel	7·29	7·37	8·38	8·97	9·32	10·24	8·59	V	0·43	1·19	1·60
	Dorman	6·60	7·44	10·67	11·10	12·27	17·27	10·90	P	0·46	1·32	1·75
	Leslie	9·22	11·68	13·21	13·54	14·15	19·81	13·61	I	1·04	2·92	3·91
	Mamroy	13·54	13·89	17·86	19·56	20·07	25·83	18·47				
	ECR 973	12·19	12·95	15·49	18·47	20·07	22·68	16·97				
	Population means ..	9·78	10·67	13·13	14·33	15·16	19·18					
Experiment 3 1969	Dorman	8·31	6·43	7·95	7·62	10·34	12·70	8·89	V	0·46	1·32	1·75
	Hill	12·19	9·47	9·47	10·85	12·01	15·06	11·51	P	0·46	1·32	1·75
	Jackson	6·78	9·65	9·32	10·85	13·03	15·06	10·77				
	Leslie	8·97	9·32	11·68	11·51	13·03	13·54	11·35				
	Mamroy	13·39	14·91	14·73	14·05	16·08	16·59	14·96				
	ECR 973	12·19	12·52	11·86	13·39	17·45	13·89	13·54				
	Population means ..	10·31	10·39	10·85	11·38	13·67	14·48					

TABLE 7

SEED SIZE (g/100)
(SOYBEAN VARIETY x PLANT POPULATION TRIALS)

	Variety	Plant populations						Variety means	S.E.	L.S.D.	
		89 000	107 000	134 000	178 000	267 000	535 000			P<0·05	P<0·01
Experiment 1 1967	Bethel	19·70	20·06	19·64	19·28	19·24	17·77	19·28	V 0·15	0·42	0·56
	Dorman	16·26	16·25	15·76	15·32	15·96	15·75	15·88	P 0·15	0·42	0·56
	Jackson	16·31	16·01	15·02	15·22	14·36	14·73	15·28			
	Leslie	14·09	13·17	13·57	12·28	12·59	12·87	13·10			
	Mamroy	13·59	12·25	12·88	11·76	11·65	11·96	12·35			
	ECR 973	8·79	8·06	8·63	8·06	7·68	7·80	8·17			
	Population means ..	14·79	14·30	14·25	13·65	13·60	13·48				

	Variety	Plant populations						Variety means	S.E.	L.S.D.	
		178 000	214 000	267 000	357 000	535 000	1 070 000			P<0·05	P<0·01
Experiment 2 1968	Bethel	15·13	15·33	14·47	14·03	13·70	13·00	14·28	V 0·12	0·34	0·45
	Dorman	14·70	14·77	14·17	14·47	13·57	12·87	14·09	P 0·13	0·37	0·49
	Leslie	12·43	11·33	11·63	11·40	10·97	11·70	11·58	I 0·29	0·83	1·11
	Mamroy	14·80	14·97	14·27	14·03	13·10	11·17	13·72			
	ECR 973	8·77	9·03	8·73	8·57	8·27	7·90	8·54			
	Population means ..	13·17	13·09	12·65	12·50	11·92	11·33				
Experiment 3 1969	Dorman	14·53	15·13	14·30	15·03	14·77	14·93	14·78	V 0·12	0·35	0·47
	Hill	12·80	13·27	13·10	13·27	11·90	12·37	12·78			
	Jackson	14·53	14·27	14·67	14·63	14·57	14·23	14·48			
	Leslie	13·57	13·77	14·17	13·83	13·57	13·83	13·79			
	Mamroy	14·77	14·43	13·80	13·50	14·30	13·30	14·02			
	ECR 973	9·03	9·17	8·67	8·97	8·53	8·53	8·82			
	Population means ..	13·21	13·34	13·12	13·21	12·94	12·86				

TABLE 8

OIL CONTENT OF SEED (%)
(SOYBEAN VARIETY x PLANT POPULATION TRIALS)

	Variety	Plant populations						Variety means
		89 000	107 000	134 000	178 000	267 000	535 000	
Experiment 1 1967	Bethel	18·8	18·5	18·2	18·9	18·8	19·3	18·7
	Dorman	18·7	19·5	19·4	19·4	19·2	19·5	19·3
	Jackson	19·5	19·3	18·7	19·9	19·1	19·7	19·4
	Leslie	19·2	19·4	20·2	19·9	19·3	20·4	19·7
	Mamroy	15·6	16·8	16·0	17·0	16·3	16·3	16·3
	ECR 973	16·3	16·7	15·7	16·6	16·8	16·4	16·4
	Population means ..	18·0	18·3	18·0	18·6	18·2	18·6	

	Variety	Plant populations						Variety means	S.E.		L.S.D.	
		178 000	214 000	267 000	357 000	535 000	1 070 000				P < 0·05	P < 0·01
Experiment 2 1968	Bethel	16·67	16·33	16·33	15·67	15·33	15·67	16·00	V	0·13	0·37	0·49
	Dorman	16·67	16·00	16·33	16·00	16·67	16·00	16·28	P	0·14	0·40	0·53
	Leslie	16·09	16·67	16·00	16·33	15·67	15·00	15·96				
	Mamroy	13·33	13·33	12·67	12·33	13·00	13·00	12·94				
	ECR 973	13·67	13·33	13·00	13·00	12·67	12·33	13·00				
	Population means ..	15·28	15·13	14·87	14·67	14·67	14·40					
Experiment 3 1969	Dorman	16·00	16·00	16·00	15·67	15·67	14·67	15·67	V	0·12	0·35	0·47
	Hill	15·33	16·00	16·00	15·67	15·33	15·33	15·61	I	0·31	0·86	1·15
	Jackson	16·33	15·67	16·00	16·00	15·67	15·67	15·89				
	Leslie	15·67	15·33	15·00	15·00	15·00	15·00	15·17				
	Mamroy	12·00	12·67	12·00	11·67	11·33	12·00	11·94				
	ECR 973	12·67	12·00	12·33	12·33	12·33	14·00	12·61				
	Population means ..	14·67	14·61	14·56	14·39	14·22	14·44					

TABLE 9

PROTEIN CONTENT OF SEED (%)
(SOYBEAN VARIETY x PLANT POPULATION TRIALS)

	Variety	Plant populations						Variety means
		89 000	107 000	134 000	178 000	267 000	535 000	
Experiment 1 1967	Bethel	39·37	39·69	39·37	38·44	37·50	35·31	38·28
	Dorman	35·61	34·69	33·75	32·19	33·75	32·19	33·70
	Jackson	34·69	34·37	33·75	34·06	34·37	32·81	34·01
	Leslie	37·50	33·75	33·12	32·69	34·37	31·87	33·88
	Mamroy	40·94	36·25	38·75	35·31	37·19	37·19	37·60
	ECR 973	36·44	38·44	40·19	36·06	34·50	38·12	37·29
	Population means ..	37·43	36·20	36·49	34·79	35·28	34·58	

	Variety	Plant populations						Variety means	S.E.	L.S.D.	
		178 000	214 000	267 000	357 000	535 000	1 070 000			P < 0·05	P < 0·01
Experiment 2 1968	Bethel	38·64	40·63	39·38	39·79	40·63	40·84	39·98	V 0·23	0·64	0·85
	Dorman	38·54	38·75	38·44	39·06	38·96	39·06	38·80	P 0·25	0·70	0·93
	Leslie	38·75	39·58	40·31	41·25	41·15	41·67	40·45			
	Mamroy	40·63	40·00	40·31	40·31	41·36	41·46	40·68			
	ECR 973	39·69	40·52	39·48	41·77	40·42	39·90	40·30			
	Population means ..	39·25	39·90	39·58	40·44	40·50	40·59				
Experiment 3 1969	Dorman	42·17	40·65	41·60	41·38	40·81	41·15	41·29	V 0·29	0·83	1·10
	Hill	41·50	40·94	41·38	42·71	42·27	42·67	41·91			
	Jackson	41·54	41·27	42·67	42·90	42·86	43·40	42·44			
	Leslie	43·06	43·48	42·81	41·25	42·71	43·37	42·78			
	Mamroy	44·10	41·81	44·48	44·06	44·15	43·65	43·71			
	ECR 973	43·69	44·79	43·25	42·94	43·59	43·25	43·59			
	Population means ..	42·68	42·16	42·70	42·54	42·73	42·91				

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