STUDIES ON THE GROWTH OF SOYBEANS ON THE DARLING DOWNS, QUEENSLAND

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SUMMARY

Soybean seed yields of up to 1,655 lb per ac were produced over a 3-year period on chernozem type soils at Hermitage Research Station. The highest yielding varieties were Nanda, ECR 973 Congo, and selections from Delsta and Mammoth Biloxi hybrids. Flowering time was accelerated by delayed planting up to the end of December. In a plant population trial, 14, 21, and 28-in. spacings gave higher yields than 42-in. spacing. Where soybeans were grown for the first time, nodulation did not occur even after inoculation of seed. Improved nodulation was noted in second-year soybean ground without further inoculation. Nodulation was also improved through the use of a second strain of Rhizobium on a humus base. Marked response to foliar applications of zinc were observed in some varieties. The need for fungicidal seed dusting at planting was demonstrated.

I. INTRODUCTION

Soybeans have been in limited commercial production in Queensland since 1953-54, mainly in the South Burnett district. Several varieties have been found suitable for grain and forage production, and grain yields of 15-18 bus per ac may be expected under rain-grown conditions. A plant breeding programme conducted by the Department of Primary Industries at Kingaroy resulted in the adaptation of several progenies and varieties, including Nanda (Kerr 1959). Introduction and testing of soybeans have been carried out by the Commonwealth Scientific and Industrial Research Organization in Queensland at Lawes since 1954 and several promising varieties were released for south-eastern Queensland (Byth and Waite 1962).

Soybean investigations at Hermitage Research Station date from 1959. Variety trials were carried out from 1959 to 1962 in a programme of preliminary investigations into the performance of the crop under rain-grown conditions. Field experiments were carried out in 1962-63 on nodulation and seed treatment. A plant population trial was conducted in 1961-62.

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 1575 ft. Mean annual rainfall for the 18 years to 1962 was 28·46 in. Approximately 70 per cent. of this rainfall was of summer incidence. A notable characteristic of the climate at the Station is the relatively short frost-free period, taken as the time between the last spring frost and the first autumn frost, counting a frost as a terrestrial minimum temperature of 30°F or lower. Within the years

* Queensland Department of Primary Industries.

1954 to 1962, the earliest frost occurred on April 11 (1956) and the last on November 4 (1962). The longest and the shortest frost-free periods recorded were 227 and 163 days respectively, and on this basis the normal expectation for the length of frost-free period would be approximately 200 days. The main soil type on the Station is a fertile alluvial, dark-brown, self mulching clay. Soil reaction varies from pH 6·5–7 in the surface foot to above pH 8 in the lower horizons.

II. VARIETIES

Yields of a number of varieties tested in replicated field trials from 1960 to 1962 are shown in Table 1. Progenies prefixed D.E.H. and M.B.H. were selections of Delsta and Mammoth Biloxi hybrids respectively, and were produced by the Department of Primary Industries at Kingaroy. Some varieties were originally introduced for the South Burnett (Mamotan, Yelnando, LZ and Pelican). Other varieties were C.S.I.R.O. introductions (Avoyelles, Batavian Yellow, ECR973 Congo and Mamloxi). Nanda, a commercial variety, was used as the control.

TABLE 1

SOYBEAN YIELDS AT HERMITAGE, 1960–1962

(lb/ac)

Variety or Strain	1960–61	1961–62	1962–63
Nanda	1,070	1,655	679
Mamotan		1,545	
ECR973 Congo	1,196	—	815
D.E.H. 1-2-4-2-3	1,126	—	—
D.E.H. 1-2-4-2-3-4	—	1,488	—
D.E.H. 1-2-4-3-2-1	—	—	922
M.B.H. 7-1-3-1	1,014	—	—
M.B.H. 7-1-3-1-3	—	1,334	—
M.B.H. 7-2-1-1-3	—	—	1,013
Avoyelles Q4792	920	—	903
Batavian Yellow	752	—	372
Yelnando	598	—	635
L.Z.	—	560	—
Pelican	—	100	—
Mamloxi	—	34	—
Means	953·7	959·4	762·7
Necessary differences for significance 5%	209	389	165
Necessary differences for significance 1%	288	533	221

With the exception of several unthrifty varieties described later, soybeans exhibited the capacity to make good vegetative growth and to resist drought. Grain yields varied considerably over the three seasons, mainly through variations in seasonal rainfall. Highest grain yields were recorded in 1961-62, when over 20 in. of rain was received between December and April.

The variety ECR973 Congo and several hybrid selections yielded better than Nanda in two seasons. Of the varieties tested, the M.B.H. selections were superior for harvestability, being erect in growth, with excellent pod ground clearance and resistance to shattering. Varieties LZ, Pelican and Mamloxi appeared much too late in maturity and were subject to severe frost damage towards the end of the 1961-62 season. Several varieties, including Batavian Yellow and Pelican, showed an unthrifty type of growth, characterized by a stunting of growth, reduction in leaf size and severe interveinal chlorosis of leaves leading to necrosis. An experiment in 1963 indicated that these varieties would respond to foliar applications of zinc.

III. TIME OF PLANTING

In view of the possibility of frosts in April, soybean plantings at Hermitage were made before the end of December. Within the midsummer period (November–December), delayed planting accelerated the flowering time of soybeans. This effect may be illustrated with Nanda (Table 2). The time between flowering and maturity appeared to be independent of date of planting. Delayed planting reduced the time to maturity of Nanda, mainly by reduction of the period from planting to flowering. Other varieties tested appeared to react in a similar manner to Nanda, depending on maturity. The latest maturing variety tested, an introduction of Mamloxi, flowered in 113 days when planted in early December, and in 97 days when planted at the end of that month. Excessively drawn-out periods from planting to flowering were noted in all varieties when planted early in summer. For rain-grown conditions, a late-December planting would seem most suitable for varieties of similar maturity to Nanda. Early planting due to lengthening of the vegetative growth stage and exhaustion of soil moisture reserves before flowering would accentuate the effect of subsequent droughts. Soybeans capable of flowering earlier than Nanda may be suitable for early-summer plantings. Preliminary testing of varieties introduced from the southern United States indicated that early flowering varieties were available from this region and a number of these varieties were introduced in 1963 for further testing.

TABLE 2

EFFECT OF PLANTING DATE ON TIME OF FLOWERING AND MATURITY OF NANDA SOYBEAN

Date Planted	Days to Flowering	Days—Flowering to Harvest	Days—Planting to Harvest
8.xi. 60	99	82	181
24.xi. 60	88	77	165
4.xii.61	75	97	172
28.xii.61	64	83	147
28.xii.62	62	90	152

IV. SPACING

A plant population of approximately 40,000 per ac was used in the varietal investigations. Spacing of the rows at 42 in. permitted the entry of standard inter-tillage and spraying equipment. In 1961, a row spacing and plant population trial with Nanda was planted on December 7 to investigate the effect of closer row spacing. The normal 42-in. spacing was compared with 14, 21 and 28 in., using populations of 25,000 and 50,000 plants per ac. Higher populations were not considered on account of the likely effects of drought.

Observations of general growth, yield and seed composition were made. Weeds were controlled by hand-chipping the closer row spacings and cultivation of the 42-in. rows. Seasonal rainfall was good and relatively high yields were obtained.

Yields are shown in Table 3. Higher yields were produced by row spacings closer than 42 in. Plant population had no significant effect on yield, but there was a tendency for the higher population to decrease yield in the close row spacings (14 and 21 in.) and to increase yield in the wider row spacings (28 and 42 in.). It might be inferred that additional yield increases would have been likely with further population increase in the wide row spacing, but not in the closer spacings. There were no significant effects on grain protein and oil content.

TABLE 3

YIELDS IN NANDA SOYBEAN SPACING TRIAL, HERMITAGE, 1961–62

(lb/ac)

Row Spacing (in)	50,000 plants/ac	25,000 plants/ac	Mean
(A) 42	1,526	1,361	1,443
(B) 28	1,741	1,640	1,691
(C) 21	1,634	1,696	1,665
(D) 14	1,735	1,752	1,743
Means	1,659	1,612	1,635

		Row Spacing	Plant Population
Necessary differences for significance	5% ..	154	109
	1% ..	209	148

B, C, D> > A

V. NODULATION

Fixation of nitrogen may be an important function of soybeans, especially when grown in soils low in available nitrogen. Results of numerous experiments in the United States have indicated that nodulation can be a valuable source of nitrogen for soybeans (see Cartter and Hartwig 1962). Fixation of nitrogen would enhance the value of soybeans in crop rotation.

Nodulation of soybeans at Hermitage was found to be erratic. Plantings of inoculated and uninoculated seed in 1960 and 1961 did not exhibit much nodulation. Volunteer plants in the second of these areas in 1962 were found to be well nodulated and plantings on the same area again in 1963 also resulted in well-nodulated plants (Figure 1).

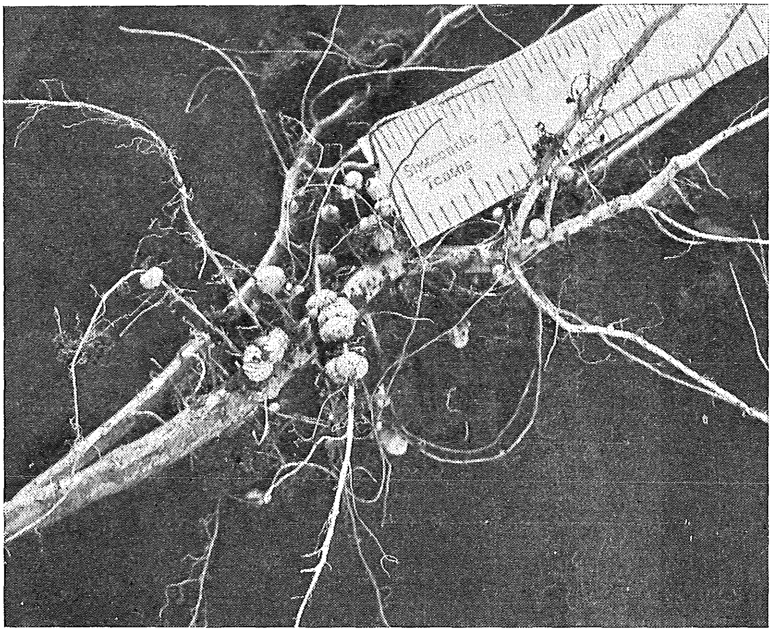

Fig. 1.—Nodulated ECR973 Congo Soybean, sown 1963 without inoculation. Inoculated soybeans grown in the same area in 1961 failed to nodulate.

There was no record of soybeans having been grown at Hermitage prior to 1959 and the absence of suitable strains of Rhizobium in the soils was indicated by the fact that in three separate areas over different seasons, nodulation did not take place in the absence of inoculation.

In 1962 a pot experiment demonstrated the ability of soil in which inoculated soybeans were previously grown to produce well-nodulated plants, subsequently, without further inoculation. At the same time, soybeans failed to nodulate when grown in soil from a site not previously under soybeans. A few nodules were produced with inoculated seed. Results of this pot experiment are set out in Table 4.

In 1962-63, on ground with no previous history of soybeans, an experiment was conducted to investigate the effect on nodulation of a newly released strain of Rhizobium, CB1003. This was applied to seed of Nanda at two rates, using agar and humus base inoculants. Fifty plants were selected from each of four replicate plots per treatment at flowering, and rated for presence or absence of nodulation. Results are shown in Table 5. The degree of infection of plants was increased greatly by the use of heavy rates of inoculation. Use of humus base inoculant was found to be superior to agar culture. Uninoculated seed was again associated with almost complete lack of nodulation.

TABLE 4

NODULATION POT EXPERIMENT, 1962

—	Soil Not Previously Planted with Soybeans		Soil Planted with Inoculated Soybeans 1960–61	
	Seed Inoculated	Seed Uninoculated	Seed Inoculated	Seed Uninoculated
Number of nodules ..	15	nil	144	133
Mean number of nodules per plant	1·3	nil	10·3	7·0

Inoculation with agar culture, Strain QA888.

TABLE 5

EFFECT OF FORM AND RATE OF APPLICATION OF INOCULUM (STRAIN CB1003) ON THE NODULATION OF NANDA SOYBEAN

—	Percentage of Plants Infected	
	Normal Rate of Inoculation	High Rate of Inoculation*
Humus base	88·5	100·0
Agar base	42·0	46·5
Uninoculated	2·5	nil

* Inoculum applied to seed at 5 times the normal or recommended rate.

VI. RESPONSE TO ZINC

Unthrifty growth occurred on each occasion when Batavian Yellow, Pelican and S999 were grown at Hermitage. Symptoms consisted mainly of a reduction in size of plants and leaves, death of leaves, and in severe cases, death of complete plants. In 1963 the symptoms appeared in variety S999 on an area of ground in which linseed had in the past displayed signs of what had come to be known as "zinc deficiency". This was a growth disorder causing a stunting of linseed and which could be corrected by applications of zinc.

Foliar sprays of zinc, potassium and sulphur were applied to the affected plants, the solutions being made up in each case as follows:

Potassium: (*a*) K_2SO_4 20 g per 3 l water.

(*b*) KNO_3 23·5 g per 3 l water.

Zinc: $ZnSO_4$ 18·5 g per 3 l water.

Rapid recovery took place in those plants sprayed with sinc sulphate, and as there was no response to either potassium sulphate or potassium nitrate, it appeared that the S999 soybeans were affected by the same factor causing stunted growth in linseed.

VII. SEED TREATMENT

Two experiments conducted in co-operation with Plant Pathology Branch in 1963 demonstrated the importance of seed treatment in the promotion of field emergence of soybeans. The first of these experiments was sown on heavy clay soil and rainfall was immediate after planting. Organic mercury and captan dusts were both effective in controlling pre-emergence losses under ideal conditions for germination and were superior to thiram ("Thirasan") and chloranil ("Coversan") dusts. A second trial was laid down on a lighter soil type under much drier conditions. Follow-up rainfall was not received until two weeks after planting and initial germination was very uneven. Seed dusting with organic mercury or captan was again, under these conditions, effective in the control of pre-emergence seedling loss.

VIII. ROLE OF INSECTS IN SOYBEAN SEED LOSS

There were several instances of total and near-total crop failure of soybeans at Hermitage following seasons of otherwise normal growth. A variety trial planted in 1959 made good vegetative growth, but failed to produce seed although flowering and pod set appeared quite normal. A similar course of events occurred in 1962, when a variety trial was a near failure. This trial was planted at the same time as an adjacent bulk area of Nanda which yielded over 1,600 lb per ac. Seed harvested from the variety trial was of poor quality (Figure 2) and microscopic examination of malformed seed disclosed indications of insect puncture marks. Two sucking insects commonly found in soybean crops were suspected as possible causes of seed loss. The larger of these was the green vegetable bug

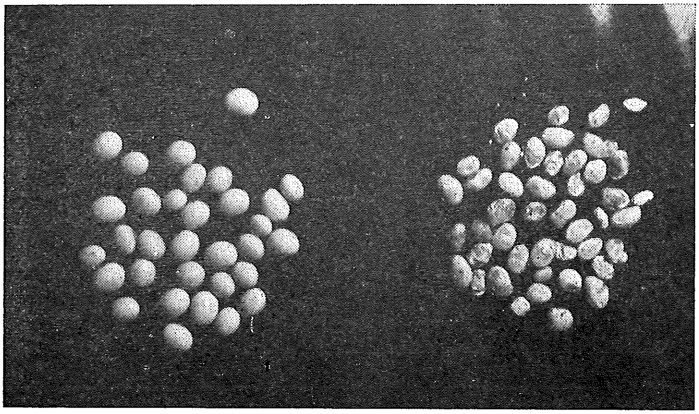

Fig. 2.—Undamaged and damaged seed of Nanda soybean harvested in 1962.

(*Nezara viridula* L. (Pentatomidae)). In the United States, sucking insects of the green stink bug type can cause an almost complete failure of seed production even when present in what would appear to be relatively inconspicuous numbers (H. W. Johnson, personal communication, 1962).

A caging experiment conducted at Hermitage in 1963 provided data on the ability of green vegetable bugs to damage developing seed. Four groups of Eyre soybean plants which were in seed set were surrounded by insect-proof cages (approximately 4 plants per cage). Into each of the cages 25 mature Nezara bugs were released. The plants in the remaining two cages were sprayed with insecticide. After 6 days the cages were removed and all plants treated with insecticide. Seed was rated at maturity for damage. About 34 per cent. of seeds were damaged in the case of plants caged with Nezara bugs, compared with less than 1 per cent. in plants caged without insects.

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