STUDIES ON THE CULTIVATION OF SOYABEAN *(Glycine max* (L.) *Meril.)* IN NEW ZEALAND

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SUMMARY

A number of soyabean cultivars have produced good yields in recent investigations and the crop appears suitable for the districts of Gisborne, Hawkes Bay, Blenheim, Auckland and Waikato.

INTRODUCTION

The soyabean (Glycine Max (L) Merill), domesticated in China around the 11th century B.C., has become one of man's principle food plants. In post-war years world production increased to 44 million tons in 1969/70, harvested from 13.5 million ha in 30 different countries situated between latitudes 52° north and 40° south.

Increasing amounts of soyabean products have been imported into New Zealand in recent years. In 1970 imports were valued at $673,000 and these included 2.3 million litres of oil which was used for preparation of food, paints and plastics.

There is a considerable international trade in soyabeans, Japan and Europe importing large quantities each year.

PREVIOUS RESEARCH

Experiments with soyabeans in New Zealand date back to 1914 and in the twenties and thirties there was considerable interest in research with the crop. This work did not, however, result in its commercial production. More recently Government, Universities and commercial firms all showed a renewed interest in soyabeans and a number of workers were conducting investigations in the years from 1958 onwards.

In summarising earlier work, Black (1939) concluded that the growing of soyabeans could not be recommended in New Zealand because of unsuitable climate and a negligible internal market. Blair, Tan and Palmer (1966) made a re-examination of the

growing of soya beans in arable farming districts, mainly in Canterbury. They concluded that the average yields (of about 25 bushels per acre) obtained in Canterbury would not make the crop a commercial proposition but they believed that the crop should be further investigated especially in areas of higher summer temperatures and rainfalls than occur in Canterbury. Accounts of early work are given by Clifton (1911), Hill (1914), Green (1915), Lonsdale (1916), Black and Woodcock (1938) and of more recent investigations by Blair (1964), Moody and Hastings (1966), Dougherty (1969), Sturrock (1970), Burney (1970), Okereke (1970) and Brown, Watkin, Robinson and Greenwood (1971).

CROP DEVELOPMENT

A provisional study of the main climatic features was used to relate some specific plant requirements to local climatic conditions, which assisted in the selection of the most suitable areas for trial with this crop. A brief enumeration follows of the factors found to be valid under New Zealand conditions.

In the sequence of crop development the following points were found to be of importance:-

For germination a soil moisture content of 50% is required and according to some sources a temperature of 15.5°C. At Rukuhia it was observed that some varieties started germination at 13.3°C (at 9 am).

Under favourable conditions root nodules start to develop after 10-14 days and nitrogen fixation commences a fortnight later. Normal development of the plant occurs at temperatures between 15.5°-32°C. Light intensity influences branching and podset.

The time of flowering depends principally on the latitude for which each variety is developed. The soyabean plant starts flowering when the day-length is below a critical value for each variety. Although it is called a short-day plant, it is in fact the length of the period of darkness that determines the flower initiation. For varieties developed for the lower latitudes (closer to the Equator) floral initiation commences at a shorter day than for those bred for a higher latitude. Each of these groups is adapted to a relatively narrow zone of conditions that exist there. It was found that the division in ten maturity groups (00-VIII) made in the U.S.A. was not directly applicable to conditions here, possibly because our summers are somewhat cooler than those in the soyabean belt of the American

continent. If a variety from a lower latitude is grown at a higher latitude it flowers later in the season and the pods might not all mature in time before the onset of winter. Responses to day length are modified by temperatures. Growth and flowering are promoted by high temperatures, while low temperatures delay floral initiation.

Soil moisture is another factor affecting flowering. Rain or irrigation following a dry spell induces flowering of the mature plant. A series of short dry spells alternated by showers, as may occur in the Waikato, causes repeated flowerings, so that mature and undeveloped pods occur on the same plant.

Temperature and moisture are also of importance for pod and seed development. Droughts of 2-4 weeks after flowering cause flower and pod drop. High temperatures for 3-5 weeks before seed maturity increase the oil content of the seed. Warm and sunny weather promotes ripening and dropping of the leaves at seed maturity.

CURRENT RESEARCH

(a) Inoculation

A large proportion of the nitrogen required by soyabeans is normally supplied through the symbiotic association with the Rhizobium japonicum bacteria. Inoculations with different strains of Rhizobium have, however, given variable results (Blair, Tan and Palmer (1966)). Some new strains specific to variety were introduced last year and when applied in the commercial plantings in Gisborne, appeared to result in well-nodulated crops. Detailed research results with these strains are not available.

(b) Plant Spacing

The spacing of the plants in and between the rows affects the yield. Experiments carried out by Loman (pers. comm.), Brown, et al (1971), Thomson, Nixon, Cumberland (pers. comm.) and Dougherty (1969) show that reducing the spacing between rows to 17.5 cm generally results in higher yields. The reduction in the number of pods per plant is more than compensated by the increase in plant density. However, too close spacing increases fungus infection, and hampers inter-row cultivation, spraying, etc. It is provisionally suggested that on fertile land a spacing from 50-75 cm may be optimal although implements used may require a minimum spacing of 35-45 cm. The wider spacing could have 3-4 plants per 10cm in the row, the narrower 2-3 plants.

(c) Weed Control

Weed control was a major handicap in the first few years of post-war research. Soyabeans are not strong weed competitors and in the seedling stage are easily overgrown by weeds. The research carried out by Burney (1970) has since shown that a combination of weedicides can in most cases give adequate control for the first 6-8 weeks. Thereafter the canopy of the crop, if properly spaced, should close and prevent further development of weeds. The best combinations so far are:-

1) Trifluralin soil-incorporated before sowing followed by linuron as a pre-emergent spray after sowing; 2) Alachlor or propachlor each combined with linuron as a pre-emergence spray; 3) Dinoseb combined with Alachlor as a pre-emergence spray.

(d) Varieties

In the period 1958-1970 38 trials with a total of 29 varieties were harvested, in various districts in both the North and South Island. In addition a number of primary testing trials (of which 16 were harvested) were sown in the South Island. There have been a number of commercial plantings of which the most widespread are those of Fletcher Industries Ltd on farms in the Gisborne and the Hawkes Bay Districts.

It is of interest to note where high yields per variety were produced in the variety trials of the Department of Agriculture. Hawkes Bay, Gisborne and Blenheim districts show above average yields, particularly Hawkes Bay.

TABLE 1: Soyabean Variety Trials: Department of Agriculture. Numbers of occasions when varieties in certain districts gave indicated yields.

District	Numbers of occasions when variety yields kg/ha in districts were			No. of trials in each
	2700-3300	3300-4000	above 4000	District
Auckland	5	3	-	2
Waikato	5	-	-	9
Gisborne	5	3	-	2
Hawkes Bay	7	9	13	6
Manawatu	1	-	-	1
Blenheim	7	4	-	4
Nelson	-	-	-	2
Canterbury	-	-	-	11
Otago	-	-	-	2

Highest yields for New Zealand were obtained in the Wairoa district (part of Hawkes Bay) in the last three years:-

1968	Adams	6500 kg/ha
1969	Wayne	4830 kg/ha
1970	No. 227333	5120 kg/ha

TABLE 2 gives similar information to TABLE 1 in respect of varieties used in these trials.

TABLE 2: Soyabean Variety Trials: Department of Agriculture. Numbers of occasions when varieties gave indicated yields.

Variety	Numbers of occasions when varieties yielded (kg/ha)			Number of trials with these varieties
	2700-3300	3300-4000	above 4000	
Capital	1	-	1	7
Comet	5	1	-	26
Norchief	1	-	1	26
Merit	2	-	-	15
Grant	2	2	1	19
Chippewa	4	1	1	25
Blackhawk	-	1	-	4
Harosoy	4	2	1	25
Hawkeye	1	2	1	17
Lindarin	4	-	1	20
Hark	-	1	-	1
Adams	3	2	1	23
Lincoln	3	2	1	20
Shelby	1	4	-	22
Amsoy	1	1	1	10
Wayne	1	-	2	8
No.227333	-	-	1	1
No. 227334	-	1	-	1
No. 248396	-	1	-	1

This list shows that varieties are available which have a high yielding potential under New Zealand conditions. These fall in the U.S.A. maturity groups 0-III. These groups do well here between 37°-41° latitude south while they are placed in the U.S.A. between 39°-47° north.

TABLE 3, which is based on Tables 1 and 2, indicates in general terms some of the varieties best suited in each district.

TABLE 3: Distribution of high yielding Soyabean Varieties.

Yields (kg/ha)	Auckland	Waikato	Gisborne	Hawkes Bay
2700-3300	Adams Wayne	Comet 2x Norchief Grant Chippewa Harosoy 3x Lindarin Shelby Lincoln 3x	Comet Grant Chippewa Adams Amsoy	Capital Merit Comet Lindarin 2x Hark Adams Lincoln
3300-4000	-	Harosoy Shelby	Harosoy Hawkeye Lincoln Shelby	Grant Chippewa Blackhawk Hawkeye Adams Shelby Amsoy No.227334 No.248396
over 4000	-	-	-	Norchief Grant Chippewa Harosoy Hawkeye Lindarin Adams Lincoln Amsoy Wayne No.227333

Yields (kg/ha)	Manawatu	Blenheim	Canterbury	Otago
2700-3300	Clark	Comet 2x Merit Chippewa Harosoy 2x Hawkeye Lindarin Shelby	-	-
3300-4000	-	Comet Adams Shelby	-	-
over 4000	-	-	-	-

Table 3 confirms the suitability for soyabeans of the East Coast, North Island districts, the Waikato, Auckland and Blenheim. Slightly earlier varieties seem to do better in the Waikato compared with Gisborne and the Hawkes Bay although the Waikato is situated at a higher latitude. This may be caused by slightly lower summer temperatures in the Waikato. The Waikato and Blenheim areas do not show great differences in the list of suitable varieties though Blenheim has a drier climate with less variability in the rainfall.

The commercial trials of Fletcher Industries Ltd in the Gisborne and Hawkes Bay, with plots varying from 2-5 ha seem on the whole to confirm our findings. In 1970/71 some 40 ha were grown in Gisborne with yields between 2800 and 3800 kg/ha.

The results obtained so far leave little doubt that soyabeans can be grown in New Zealand with good yields, provided suitable varieties and areas are selected and adequate weed control is obtained.

CONCLUSIONS

1. The use of crop phenology as a basis of research on the introduction of crops and plants has given worthwhile results.

2. Trial results have shown that the most suitable areas in New Zealand for soyabeans found so far are in the Hawke's Bay, Gisborne and Blenheim districts followed by the Waikato and Auckland districts. It is likely that the Bay of Plenty would also be suitable.

3. Commercial plantings in the Hawke's Bay and Gisborne district seem to be warranted, while for the other districts mentioned further research is needed to determine the most suitable varieties.

4. Further research in the techniques of crop husbandry and development of new soyabean varieties especially adapted and suited to our conditions would be needed to assure regular high yields.

5. As soon as the soyabean is established as a commercial crop further market research is needed to assess what range of soya products would have the best potential overseas.

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