SOYBEAN PRODUCTION IN NORTHLAND

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ABSTRACT

A programme of trial work with soybeans conducted in Northland between 1974 and 1980 is described. Small plot experiments were conducted on cultivars, sowing dates, weed control, seeding rates and row spacing. Grain yields ranged from 1 to 6 t/ha, although a conservative yield expectation with current techniques was considered to be 2.5 t/ha.

INTRODUCTION

Soybeans are not at present a commercially significant crop in Northland. Soybeans have been investigated in New Zealand for over 60 years (Hill, 1914) and many studies have been reported, detailed programmes being conducted by Black and Woodcock (1938), Blair *et al.* (1966), Robb (1968), Gerlach *et al.* (1971), and McCormick (1975,1976). Trial work in Northland by the M.A.F. Research Division began in 1974, stimulated by the Kaipara Co-operative Dairy Company's interest in vegetable oil (Haysmith, 1979). This programme had two main areas of investigation:-

(a) Adaptation of the crop; specifically cultivar choice and sowing date.
(b) Weed control; specifically efficacy of herbicides and canopy competition against weeds.

Limited information was also gathered on soil type differences and pest and disease incidence. This paper summarises all trials in the soybean programme conducted at a range of sites in Northland from 1974 to 1980.

MATERIALS AND METHODS

Although trials were individually designed for specific objectives certain features were common, namely:-

(a) Seedbeds were cultivated.
(b) No nitrogen fertiliser was used and phosphate and potassium fertiliser varied according to soil test although generally 300-500 kg/ha 30% potassic superphosphate was applied in the previous winter with 100-200 kg/ha reverted or serpentine superphosphate being sown with the seed.
(c) Seed was inoculated, and thiram fungicide was lightly dusted onto the seed immediately prior to sowing.
(d) Sowing date was during mid-November (except in sowing date trials).
(e) Row widths were 15 or 30 cm.
(f) Plots were at least 9 rows wide, and at least 5 m long.
(g) Seeding rate aimed for ½ million plants established/ha (except in seeding rate trials).
(h) Linuron (2 kg a.i./ha) plus alachlor (2.5 kg a.i./ha) was applied pre-emergence, and no hand-weeding was conducted (except in herbicide trials).
(i) One or two insecticidal sprayings were made.
(j) Harvest was by hand-pulled quadrats (two 3 or 4 rows x 50cm) sampled from central rows per 5 m length of plot. Samples were threshed by a motorised threshing plant in the field and seed was graded later, seed less than 0.5 cm being discarded.

RESULTS AND DISCUSSION

Climate

In Northland soybeans are sown in November and harvested in April or May. Long-term climatic records (N.Z. Met. Service, 1973) suggest that, between November and May, climatic factors of temperature, rainfall and sunshine hours are similar over the region. For example, comparing the records from Kaitaia Airport in the north, with Albert Park (Auckland) in the south, rainfall and sunshine hours tend to be similar, while Kaitaia has higher mean daily maximum temperatures but lower mean daily minimum temperatures than Auckland.

TABLE 1: Northland climate — long term normals (N.Z. Met. Service, 1973) and 6 year (1974-80) means averaged from Kaitaia Airport and Albert Park, Auckland.

Month	Mean Daily Temperature (°C) Max/Min		Rainfall (mm)		Bright Sunshine (hr)	
	Normal	1974-80	Normal	1974-80	Normal	1974-80
Nov.	20/12	20/12	93	95	206	205
Dec.	22/14	22/14	89	81	220	248
Jan.	23/15	24/16	71	103	231	244
Feb.	24/16	24/16	94	87	191	199
Mar.	23/15	23/16	85	84	188	165
Apr.	20/13	21/13	116	111	158	163

The means for the two sites during 1974-80 are presented in Table 1 (data extracted from *New Zealand Gazette)*. Rainfall in 1976 and 1980 primarily accounted for the greater than normal January rainfall of Table 1, while the higher than normal sunshine of December and January was contributed to by all years except for 1975-76. Each season differed from the normal. 1974-75 was relatively warm and dry, while 1975-76 was cool with heavy (flooding) rain in January and low sunshine hours. The two following years had dry January and February months and higher than normal sunshine. 1978-79 and 1979-80 were marked by wet summers with lower than normal sunshine hours and temperature.

Adaptation

Cultivars In this programme cultivar choice was based on "maturity groups" (Hartwig, 1973). Both temperature and daylength influence soybean phenology (Jones and Laing, 1978) so direct application of maturity groups cannot be made to New Zealand as the summers here are cooler (Gerlach *et al.*,1971). Consequently cultivars selected at about 40°N are theoretically suited to Northland, which spans latitudes 35°S (Kaitaia) and 37°S (Auckland); i.e. cultivars from maturity groups 2 and 3. Phenological studies during this programme (Piggot, *in prep.)* have supported the choice of group 2 and 3 cultivars as those best adapted to the daylength and temperature regime of Northland. A cultivar trial conducted in 1975-76 near Helensville by Turnbull (1976) across groups 00 to 7 found highest grain yield from group 2 and 3 cultivars. The standard cultivars have therefore been Amsoy (group 2 — Weber, 1966) and Wayne (group 3 — Bernard, 1966).

Sowing Date In the U.S.A. sowing date is not critical, within reason, for maximising grain yield of full season cultivars (Pendleton and Hartwig, 1973). However at Hamilton, McCormick (1975, 1976) found significant sowing date effects in full season or late maturing cultivars, the effects being related to the temperature regime both pre-flowering and during the reproductive phase. Turnbull (1976) also found that yield progressively increased when crops were sown on 2, 12, and 22 November during the 1975-76 season near Helensville and related the effect to the temperature regime.

At one site (Otakanini), where crops were sown at 2 or 3 sowing dates in 4 consecutive years (Table 2), sowing earlier than 10 November resulted in significantly lower yielding crops in 2 of the 4 years; while in one year a late sowing also decreased yield. In addition to the effect of temperature on development, plant establishment was affected by early sowing (cold inhibition) or late sowing (drought inhibition). Therefore a mid-November sowing date is favoured regardless of the maturity of the cultivar in Northland.

TABLE 2: The effect of sowing date on soybean yields (t/ha at 10% MC) at Otakanini. Mean of Amsoy and Wayne.

Year	Sowing date			LSD 5%
	Earlier than 10 Nov.	Between 10 & 25 Nov.	later than 25 Nov.	5%
1976-77	2.4	2.4	—	0.4
1977-78	0.9	1.8	—	0.2
1978-79	3.4	4.6	—	0.6
1979-80	5.0	5.3	4.1	0.4

Weed Control

Herbicides In the trial work conducted on herbicides and herbicide combinations (Piggot and Honore, 1977; Rahman *et al.,* 1979) the best herbicide combinations raised yields by an average of 300%. There treatments were pre-emergence linuron plus alachlor, or trifluralin or ethalfluralin (incorporated pre-planting) plus linuron or chloroxuron (pre-emergence). Problem weeds, even where these herbicides were used, were nightshade (*Solanum nigrum* complex), paspalum (*Paspalum dilatatum*), and alligator weed (*Alternanthera philoxeroides*), and sites with these weeds should be avoided unless the weeds can be eliminated prior to sowing soybeans.

Canopy Competition (a) Row Width: Decreasing the row width has the greatest influence on suppression of weeds by the soybean canopy (Felton, 1976). For this reason narrow rows (15 or 30 cm) were used exclusively. Any yield-boosting effect of narrow rows *per se* (Cooper, 1977) was a bonus.

In one trial at Otakanini in 1978-79, a 15 cm row spacing was compared with 30 cm at the same plant population/m^2 in a factorial design with or without herbicidal weed control using cv. Wayne. The results are shown in Table 3. There was no significant row spacing effect except in plots where no weed control was used. Felton (1976) demonstrated the same narrow-row effect using 25cm versus 50 cm rows.

TABLE 3: The effect of 15 or 30 cm row racing and herbicidal weed control on grain yield (t/ha at 10% MC).

Weed Control	Row Spacing (cm)	
	15	30
With	4.1	3.9
Without	2.6	2.2

Interaction NS
LSD 5% 0.4

In commercial scale crops grown in the Helensville district 15 cm row width is now the favoured spacing (B.G. Keene, *pers. comm.*). However, McCormick (1980) has suggested that narrow rows might have been responsible for poor pod set and fungal disease in the Waikato crops in 1979-80. These effects have not, as yet, been observed in Northland.

(b) Plant Population: At a narrow row spacing, plant population has a relatively minor influence on canopy development and grain yield (Felton, 1976; Cooper, 1977). In three trials in Northland (Piggot and Farrell, *in prep.*) grain yield was optimised where seeding rates were chosen to provide about 60 plants/m^2, although the plant popultion optima were not strongly defined.

Disease and Pests

Disease was of minor occurrence in the trial plots but insect pests were a more serious problem. Green vegetable bug (*Nezara viridula*) built up rapidly in most seasons and caused considerable pod damage. Natural control agents (e.g. predaceous soldier bug *Oechalia shellenbergii*) generally proved ineffective at containing green vegetable bug below damaging levels and one or more insecticidal sprays were necessary. No trial work was conducted specifically on insecticidal control of green vegetable but at Otakanini in 1977-78, an unsprayed area produced 0.4 t/ha of grain compared with 1.6 t/ha on sprayed plots, the difference probably being attributable to green vegetable bug control.

Lepidopteran caterpillar damage to leaves, stems and pods was common and occasionally the crops were severely defoliated necessitating insecticidal control. Commonly present were cosmopolitan armyworm (*Leucania separata*), tropical armyworm (*Spodoptera litura*), white butterfly (*Pieris rapae*), corn earworm (*Helicoverpa armigera conferta*), and green looper (*Chrysodeixis erisoma*). Soybeans can withstand considerable defoliation before grain yield is affected (Turnipseed, 1973). Also a number of predators and parasites of these caterpillars appeared to provide effective control of this caterpillar complex, and insecticide sprays applied against green vegetable bug were also found to control caterpillars.

Soils

Northland has a wide range of soil types, although a general classification (Taylor and Sutherland, 1953) recognises 5 major groups; clays, sandy, volcanic, limestone-derived, or alluvial. In general volcanic and sandy soils (with the exception of Te Kopuru sand) are free draining, while the clays, limestones or alluvial soils have tightly structured subsoils with impeded drainage. The influence of soil type on soybean yield was not investigated specifically although trials were conducted on a range of soil types.

Two trial series gave soil type comparisons. From the seeding rate trials (Piggot and Farrell, *in prep*) the grain yields from plots with about 50 plants/m^2 are given in Table 4. Data from a cultivar comparison in 1978-79 and 1979-80 are given in Table 5. The sand site yielded best in these comparisons although the reasons were obscure. In the 1976-77 trials, conducted during a dry summer, intensive soil moisture sampling, dawn measurements of leaf water potential (pressure bomb technique) at the top of the canopy, and sampling of root distribution in the top 80 cm on soil profile showed only minor site differences (*unpubl. data*). Moisture availability is even less likely to account for site differences in 1978-79 or 1979-80 since there was adequate rainfall in these years. The same yield advantage to the sand site was demonstrated in comparisons of summer forage brassica yields (Piggot *et al.,* 1980) although, again, the reasons were obscure.

At this stage the only conclusion that can be drawn is that soybeans were grown successfully on most of the major soil groups in Northland although yields were variable.

TABLE 4: Grain yield (t/ha at 10% MC) for cultivars Amsoy and Wayne in 1976-77 at three sites.

Site	Soil/Soil Type	Amsoy	Wayne	
Otakanini	sand (Whananaki)	2.5	3.4	*
Helensville	alluvial (Kaipara)	2.6	2.5	NS
Dairy Flat	clay (Waikare)	1.1	2.5	*

TABLE 5: Grain yield (t/ha at 10% MC) for 4 cultivars at 2 sites in 1978-79 and 1979-80.

Site	Otakanini		Ruatangata	
Soil	sand		peaty volcanic	
Soil type	Whananaki		Pakotai	
Year	1978-79	1979-80	1978-79	1979-80
Cultivar				
AMT19	—	6.1	2.8	3.2
Amsoy	6.2	5.0	—	—
Wayne	5.1	5.7	4.2	2.8
Fiskeby	3.6	2.0	3.1	2.6
MSD5%	1.3	1.6	1.4	1.3

Grain Yield

Recognising that the harvesting method used in this work involved low losses, the yield data presented here, and in other reports of this work, ranged from 1 to 6 t/ha. Yields of 6 t/ha are at the upper limit of U.S.A. records (Nelson, 1976) and well above previous Gisborne (N.S. Brown, *pers. comm.*) and Waikato (S.J. McCormick, *pers. comm.*) trial results. Factors associated with these high yields were not defined. At the other end of the range, 1 t/ha is poor, although the lowest yields were recorded at early stages of the programme. Whether the information gained during the programme, if applied, will insure against poor yields has yet to be shown.

As a special case, Fiskeby V, which completed development within 4 months, gave satisfactory yields (Table 5) and may have a role in special instances where a quick maturing cultivar is required, e.g. in horticultural fallows.

CONCLUSION

A programme of trial work was conducted with soybeans in Northland between 1974 and 1980. Based on this work soybeans appear suited to soils which have adequate drainage and fertility and which allow seedbed preparation before mid-November. A conservative yield expectation would be 2.5 t/ha based on the following method; cultivated seedbed, mid-November sowing, cv. Amsoy or Wayne, narrow rows, pre-emergent herbicidal weed control, establishment of approximately ½ million plants/ha, green vegetable bug control by insecticide.

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