SOYBEAN - A NEW CROP FOR THE KAIPARA DISTRICT?

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ABSTRACT

During 1975-76 trials were carried out at Helensville to gain some measure of the suitability of available soybean cultivars for growing in the Kaipara district. Twenty cultivars, selected from the maturity groups 00 to 7, were planted at 4 sowing dates, at 10 day intervals from the 2nd November to the 2nd December 1975. Not all cultivars were sown at each sowing date. Cultivars germinated within 6 to 9 days and established populations of 100,000 to 300,000 plants per hectare. Within this range, plant population appeared to have little effect on yield. Yield ranged from 646 kg/ha for Acme sown on the 2/11, to 3272 kg/ha for Wayne sown on the 22/11. In all cultivars, yield increased with delay in planting through November. Yield dependency upon sowing date varied among cultivars. Those from the maturity groups 3 and 4, (i.e. Wayne and SRF 307, 350, 400 and 450) tended to give higher yields over all plantings.

INTRODUCTION

The Kaipara Dairy Company's interest in vegetable oils began with the introduction of polyunsaturated margarine manufacture in 1973. Continuing price escalation and problems of supply led the company to examine the possibility of growing soybeans locally. During 1975-76 trials were carried out at Helensville to gain some measure of the suitability of available soybean cultivars for growing in the district. The necessity for a minimum soil temperature of 15°C at planting, (Turnbull 1974, McCormick 1975) and dry weather during harvesting, set the practical limits of the local growing season as October to April. Cultivars selected were mainly from maturity groups 00 to 4. In earlier studies these had been reported, (Robb 1968, Gerlach **et al.** 1971, McCormick 1975) to respond as early to full season within similar growing limits. These workers suggested that time of sowing was a dominant factor in determining seed yield, with delay in planting frequently giving increased yields. Accdording to Pendleton and Hartwig, 1973, population density also affects crop yield, with varieties reacting differently to planting rate and row width. Previous experience by the author suggested that the optimum population for most of the cultivars in the trial, under narrow row spacing, (30cm), would be met around 250,000 plants per hectare. Cultivar dependency upon sowing date and population density were examined during the Helensville trial.

MATERIALS AND METHODS

The trial was carried out on Kaipara clay, an acidic soil of medium fertility and inherent poor drainage. Originally in pasture, the site had been cropped during 1974 and 1975. Prior to sowing, 44 kg P/ha and 86 kg K/ha, as potassic superphosphate, was applied as an overall dressing. Soil pH was adjusted to 6.0 by addition of 5 tonnes of lime/ha.

A randomised complete block design was used with 4 replications. Plots were 1.3m x 16m in size.

Due to the unseasonal wet weather in October, the first sowing was delayed until November. Twenty cultivars were sown on November 2, 14 on November 12 and 22 and 8 on December 2. (Table 1). Innoculated seed was sown with a Stanhay precision seeder, at a depth of 3cm, 4 rows per plot, 30cm apart. Intra-row spacing was altered according to seed viability to obtain populations as close to 250,000 plants/ha as possible.

Linuron, 1.0 kg/ha a.i. and Alachlor, 3.1 1/ha a.i. were applied immediately after sowing. Plots were handweeded as required during January.

Emergence period, disease incidence, flowering and maturity dates, were recorded for all cultivars for each sowing date.

Plant populations were determined 6 weeks after sowing, from random samples of two 1m lengths per plot.

At maturity each plot was harvested by hand and the total seed yield recorded.

Soil moisture, air and soil temperature were monitored at the trial site.

Data was subjected to an analysis of variance on a per sowing date basis and where possible, cultivars were grouped across sowing dates for pooled analysis. Where heterogeneity invalidated pooling, t tests were used to determine the significance of population means.

Regression analysis was used to determine yield dependency on population density for each cultivar/sowing date and where significant, seed weights were corrected before pooling.

RESULTS AND DISCUSSION

Cultivars emerged in 6 to 9 days. Although small, the variation in cultivar emergence time was significant at all sowing dates ($P < .01$). Low soil temperatures in sowing 1 and soil moisture levels in sowing 4, probably accounted for the slower rates of germination recorded at these sowings.

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TABLE 1: Cultivars, sowing dates, seed yields (kg/ha) at 15% moisture.

	Cultivar Identification	Maturity Group	Sowing Date 2/11	12/11	22/11	2/12
POOL 1	Acme	00	646 L J	967 F	1093 JK J	*
	Soysota x Mandarin	0	672 L J	908 F	1691 GHI J	*
	Comet	0	1516 HIJ CDE	–	2514 DE CDE	–
	Grant x Corsoy (102)	1	1115 JK FGH	–	2112 EFG EFG	–
	Grant x Corsoy (109)	1	1772 GHI BC	–	1816 GH FG	–
	Amsoy x Soysota	1	1757 GHI BCD	–	2623 CDE BCDE	–
	Amsoy x T19	1	1231 J EFJH	1695 CD	2229 EF EF	*
	X-Amsoy x T19	1	1125 JK FGH	–	3059 AB AB	–
	Amsoy	2	1434 IJ DEF	–	2992 ABC ABC	–
	SRF 200	2	721 KL IJ	1017 F	1894 GH FG	–
	Wayne x PI-54-608	2	1336 IJ EF	1663 CD	2492 DE CDE	*
	Wayne	3	2094 EFG AB	2249 AB	3272 A A	*
	SRF 307	3	1517 HIJ CDE	2082 BC	2700 BCD BCD	*
	SRF 350	3	1910 FGH B	2255 AB	2952 ABC ABC	*
POOL 2	SRF 400	4	1816 BC BC	2040 B BC	–	–
	SRF 450	4	2239 AB A	2636 A A	–	–
	Dare	5	1518 CD CDE	1850 BC BCD	–	*
	Hill	5	921 E HIJ	1189 DE EF	–	–
	Ogden	6	988 E GHI	1502 CD DE	–	–
	Bragg	7	1295 DE EFG	1909 BC BCD	–	–

Upper Duncans lettering for horizontal comparisons; lower lettering for vertical comparisons.

– indicates cultivar not sown at this date

* cultivar sown but not harvested due to flooding damage.

Root inspection, one month after sowing, established that nodulation had occurred in all cultivars.

Significant variation ($P<.001$) in plant numbers existed among cultivars at all sowing dates. Population density ranged from 100,000 to 300,000 plants/ha, with an overall mean of 260,000/ha. Time of sowing significantly ($P<.05$) affected population density only in the December sowing. Soil moisture, which delayed germination in this block, was probably the main factor limiting plant establishment. For the 8 cultivars concerned, mean population density was reduced to 75% of that found in their November sowings.

In January, sowing 4 was exluded from the trial due to heavy plant loss following flooding, caused by 180 mm of rain in 7 days.

The relationship between population and crop yield was significant ($P<.05$) only for the cultivars Acme and Amsoy x Soysota in sowing 1. However, as the range of observations available for testing was small, in some cases the true relationship may have been masked by replicate effects which were significant at each sowing. ($P<.001$, sowing 1 and 3; $P<0.05$, sowing 2).

In all cultivars, seed yield increased with delay in sowing. (Table 1). With the exception of Grant x Corsoy (109), the response was significant ($P<.01$) for the 14 early maturing cultivars, (groups 00-3), when compared across sowing 1 and 3 with 20 days between sowings. (Table 1, Pool 1). Of the 6 late maturing cultivars (groups 4-7), in sowing 1 and 2, only Ogden and Bragg were significantly ($P<.01$) affected by the 10 day delay in sowing. (Table 1, Pool 2).

In all comparisons of cultivar groups among sowing dates, sowing 3 yields were significantly greater than those from sowing 1 or 2. This response can be accounted for in terms of plant growth rate and morphological stage, in relation to the prevailing weather conditions.

Following a period of vegetative growth, which varies, dependent upon variety and environmental conditions including daylength and temperature, the plant enters the reproductive stage. The bulk of flower bud formation in the soybean plant is axillary, occuring at node junctions (Carlson, 1973). Growth rate in the pre-flowering phase determines the number of nodes and thus also the number of potential sites available for induction of floral primordia at the onset of the critical photoperiod. (Johnson **et al.** 1960).

Growth rates in sowing 1 and 2 were relatively slow during November, due to low temperatures and sunshine hours. Sowing 3 seedlings, which emerged at the end of November, met improving conditions. Environmental effect on growth rate was reflected in the number of nodes present at the onset of flowering. For cultivars Acme, Soysota x Mandarin, Amsoy x T19, Wayne x PI-54-608 and Wayne, representative of the maturity range present in sowing 3, node numbers at flowering showed significant ($P < .01$) increases of 11% and 19.5% over those in sowings 2 and 1 respectively.

As all cultivars in sowing 3 were indeterminate in growth habit (Bernard, 1972), extension growth and node development continued after onset of flowering. In such plants, as movement into the reproductive state intensifies, pod development dominates and extension growth and node formation taper off. (Egli and Legett, 1973; Turnbull, 1975). Thus the plant's ability to respond to more favourable growth conditions, in terms of additional floral primordial sites, is dependent upon its morphological stage at the time. This effect was clearly shown when, with the onset of warmer weather in January, plants in sowing 3, which were in the early flowering stage, rapidly increased in height with an associated gain in nodes. In the same cultivars in sowing 2, where podding had just begun, observed changes were small and in sowing 1, where pod development was well advanced, virtually no further extension growth occurred.

The yield gain in sowing 3 can therefore be primarily ascribed to the coincidence of growing season maximum temperatures with plant morphogenesis in a favourable transistional state.

Declining temperatures during February would have reduced rate of pod fill in early maturing cultivars and flowering in the determinate, late maturing cultivars Dare, Hill, Ogden and Bragg.

Yield of cultivars Hill and Ogden was affected by a build up of the mites **Tetranychus lambi** and **T. cinnabarinus** during April, which caused premature leaf drop and retarded pod fill. Overall, however, plant growth was relatively free from insect or other pest damage. Levels of lepidopterous larvae, **Pseudaletia separata, Pieris rapae, Plusia chalcites, Heliothus zea** and vegetable bug, **Nezara viridula** damage, were insufficient to warrant spraying.

Predominant diseases noted were bacterial blight, **Pseudamonas glycinea** and soybean mosaic virus. All cultivars appeared to suffer some blight damage, but as with the incidence of mosaic virus, only in sowing 1 were the levels likely to have had any significant effect on seed yield. Acme, Soysota x Mandarin, Wayne x PI-54-608, Hill, Grant x Corsoy (102) and Comet sustained the greatest levels of blight damage. The SRF cultivars 307, 350 and 400 appeared to be most susceptible to mosaic virus. Soysota x Mandarin, Amsoy x T19, Amsoy, Grant x Corsoy (109) and Amsoy x Soysota were scored as 'virus-resistant', in that they expressed no symptoms of the disease.

Expect for the four late maturing cultivars Dare, Hill, Ogden and Bragg, which were harvested in May, all cultivars matured between mid March and mid April.

Although yields were generally lower than expected due to the reduced temperature and radiation levels experienced during the growing season, a number of cultivars were considered to have economic potential. To give financial returns competitive with that from local maize crops of 6000 to 8000 kg/ha, soybeans need to yield 2000 to 2750 kg/ha. (Table 2). On this basis, 12 cultivars, Comet, Grant x Corsoy (102), Amsoy and the three Amsoy crosses, Wayne, Wayne x PI-54-608 and the SRF cultivars 307, 350, 400 and 450, had the yielding ability to give equal or better returns than the average maize crop grown in the Kaipara this season. Under commercial conditions, realisation of such potential would largely be dependent upon the skill of the individual grower.

TABLE 2: Comparison of Maize and Soybean Costs/ Returns Estimated for the 1975-76 season.

a. MAIN COSTS/HA	MAIZE	SOYBEANS
Cultivation	$45:00	$45:00
Seed and Planting	$41:00	$39:00
Fertiliser	$95:00	$44:00
Weed Control	$63:00	$64:00
Harvesting	$65:00	$55:00
TOTAL (excluding transport and insecticide costs)	$309:00	$247:00
b. **RETURNS/KG**		
(after drying costs, 1ct/kg)	7.3 cts.	19 cts.

c. **APPROXIMATE YIELDS REQUIRED TO GIVE COMPARATIVE RETURNS/HA**

	SOYBEANS kg/ha	2000	2350	2750	3150	3500
MAIZE	6000	$130				
	7000		$200			
	8000			$275		
	9000				$350	
	10000					$420

Highest yielding cultivars in the trial were Wayne, followed by X-Amsoy x T19, Amsoy, SRF 350 and 450. As the time of sowing was less critical in determining yield in Wayne and the SRF cultivars

350 and 450, these were considered to be more suited to commercial production than either Amsoy or X-Amsoy x T19.

Under weather conditions more characteristic of the district than those experienced during the trial, the above rankings may alter considerably. Similarly, the trend which suggests that late sowing will give a yield advantage, should be treated with caution. Under average seasonal conditions the area enters its major water stress period in December, with adverse effects on plant establishment.

Further trial work is required, over a number of years and at different locations, to determine soybean cultivars most suited to the diverse soil and weather conditions existing in the Kaipara region.

CONCLUSION

Results from the 1975-76 Helensville trial showed that among the soybean cultivars tested a number of cultivars had the potential to form the basis of a soybean industry in the Kaipara region. As suggested by earlier work, (Robb, 1968; Gerlach **et al.**, 1971: McCormick, 1975), full season varieties from the maturity groups 3 and 4 appear to be most suited for production in this area.

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APPENDIX

Climatological Record for the Trial Period – October 1975 – 1976 May

Met. station site – 36°.42S/174°33E (rainfall, temperature); 36°51S/174°46E (sunshine).
(Trial site – 36° 39S/174°26E).

District averages ( ) – Temperature, 1928-1970
– Rainfall, 1941-1970
– Sunshine, 1935-1955

(i) Temperature (°C) – mean daily

Month	Max.	Min.	Highest Max.	Min.	Lowest Max.	Min.
October	18.4 (7.9)	10.9 (7.9)	28.8 on 30th	14.7 on 15th	15.0 on 10th	3.4 on 32st
November	19.4 (19.4)	10.4 (9.3)	22.7 on 30th	16.8 on 27th	16.5 on 21st	2.9 on 22nd
December	20.9 (21.3)	11.3 (10.9)	24.9 on 18th	18.5 on 19th	17.8 on 26th	5.4 on 27th
January	23.0 (22.7)	14.9 (11.9)	26.8 on 16th	21.0 on 13th	18.3 on 22nd	7.5 on 5th
February	21.6 (23.3)	9.3 (12.4)	23.8 on 5th	17.5 on 7th	17.8 on 7th	5.2 on 29th
March	22.9 (22.2)	13.1 (11.2)	26.1 on 9th	18.5 on 29th	18.8 on 27th	5.5 on 1st
April	20.0 (19.8)	11.7 (9.6)	23.1 on 11th	18.0 on 9th	17.0 on 25th	5.3 on 4th
May	16.7 (17.1)	7.2 (7.2)	18.5 on 4th	14.0 on 7th	13.2 on 23rd	0.2 on 24th

(ii) **Rainfall** (mm)

Month	Total	Highest daily	Total days 0.1 mm or more	Total days 1 mm or more
October	130 (119)	21.5 on 22nd	16	16
November	93 (102)	29.3 on 3rd	10	8
December	41 (97)	15.1 on 24th	11	9
January	163 (81)	69.5 on 12th	11	9
February	21 (99)	14.6 on 6th	5	3
March	22 (104)	7.0 on 27th	8	6
April	92 (102)	35.4 on 29th	12	8
May	92 (155)	16.5 on 1st	13	12

(iii) **Sunshine** (hrs)

Month	Total
October	162 (181)
November	188 (208)
December	212 (227)
January	180 (235)
February	247 (194)
March	180 (191)
April	147 (152)
May	128 (141)