THE EFFECTS OF PLANT SPACINGS AND IRRIGATION ON THE YIELDS OF GREEN PEAS *(Pisum sativum hortense* L.)

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SUMMARY

Victory Freezer peas were grown in all combinations of 10, 20 and 30cm row widths and 2.5, 5.0 and 7.5cm seed spacings within rows during 1969. Yields increased with decreasing row width and/or seed spacing. Substantial yields increases were obtained from sowing rates higher than those currently used commercially. As plant density increased, vine length, pods/plant and peas/pod all decreased. In 1970, five plant spacings were compared at three different waterings. Irrigation at flowering and pod swelling produced a 57% increase in yield as compared with unirrigated treatments. Irrigated plants produced longer vines, more pods and more peas/pod.

INTRODUCTION

The processed pea industry in New Zealand is expanding steadily as export markets are being developed. However, yields of green peas are not high; they average little more than 3900 kg/ha and there is considerable scope for improvement through better agronomic practice (White, 1968).

In New Zealand peas for processing are usually sown in 15 or 18cm rows at 270 kg/ha producing crop densities of about 85 plants/m^2 for the Victory Freezer cultivar. A series of experiments on plant population of peas in England (King, 1966) showed that 20cm was the optimum row width, with little increase in yield where width was reduced to 10cm. The most profitable plant population at 20cm row width was 118 plants/m^2 with the highest gross return at 172 plants/m^2. Other English work (Salter and Williams, 1967) contradicts these results, and indicates that plant densities of 55-65/m^2 should not be exceeded. More recent work with processed peas in Wisconsin (Gritton and Eastin, 1968) compared three row widths of 9,18 and 27cm, each grown at three plant populations, 55, 111 and 166 plants/m^2. Green pea yields increased with increasing population and/or decreasing row spacing. Greatest yields were obtained at 166 plants/m^2 sown in 9cm rows.

Overseas work indicates that the plant populations used in New Zealand may be below optimum for most profitable yields. The objectives in the first year's trial were to acquire information on the effects of various combinations of row width and seed spacing within row on yield and components of yield of green peas.

In the second year the interaction between some of these combinations and three levels of irrigation were examined. Investigations with other crops (Donald, 1963) have shown that optimum plant populations under irrigation may be higher than under dry land conditions, where fewer plants can be maintained to maturity because of water stress. In the Canterbury climate large increases in green pea yields could be expected from irrigation in most years and it is likely to become a regular farm practice in the future.

METHODS

1969/70 Experiment

In the 1969/70 season a factorial trial was established with the following treatments replicated twice.

Row Width: 10, 20, 30cm

Seed spacing within row: 2.5, 5.0, 7.5cm

Phosphate level: 0, 22.4, 67.3 kg/ha P

The trial was carried out on the Lincoln College Research Farm on a Wakanui silt loam (pH 6.2, Truog P 14) previously in six year pasture. Phosphate treatments and basal sulphur were broadcast before sowing. Victory Freezer peas were sown in 2 x 18.3 m plots with a Stanhay precision drill on October 14 and 15. Population counts were made on November 10. In order to overcome water as a factor limiting yield all plots were spray irrigated with 50 mm/ha water at flowering.

Harvesting began on December 28 and finished on December 31, the higher plant populations maturing first. When the tenderometer reading of the green peas was as close as possible to 105 one 3m length, six rows wide was taken at random from each plot and total green weight measured. A 6.8 kg subsample was shelled in a mini-viner for a standard 5 minute period, weight of green peas recorded and tenderometer reading taken.

Twenty-five plants adjacent to the harvest area were taken for the following measurements:

(a) Vine length and length to first pod.

(b) Number of full and flat pods/plant.

(c) Number of peas per pod and per plant.

No weed control was practised as the trial area was completely weed-free but at harvest all plots were scored for weed incidence. Before statistical analyses were computed green pea yields were all corrected to a standard tenderometer reading of 105 using a correction factor derived from a yield/tenderometer reading trial conducted in 1970.

1970/71 Experiment

The trial conducted in 1970/71 compared five of the plant spacings used in 1969 with three different watering treatments in factorial combination. The treatments, replicated three times, were as follows:

Plant Spacings:	10 cm row width	2.5 cm seed spacing
	10 " " "	5.0 " " "
	10 " " "	7.5 " " "
	20 " " "	5.0 " " "
	20 " " "	7.5 " " "
Watering:	Natural rainfall	
	Water stress at flowering and pod filling	
	Adequate water at flowering and pod filling.	

The plot area was adjacent to that used in 1969 and had similar soil analysis figures. Trifluralin (2.1 l/ha) was incorporated into the soil in the later stages of cultivation for weed control, while a basal dressing of 250 kg.ha of superphosphate was broadcast before drilling. The plots measured 2 x 6.1m with a gap of 2m between to avoid border effects from irrigation. Victory Freezer peas were sown on October 14 and 15. Populations counts showed slightly lower figures compared with similar plots sown in 1969.

Early growth of all plots was good following rains of 35 mm immediately after sowing and 45 mm on November 3 and 4. Little effective rain fell from then until harvesting, and unirrigated plots suffered considerable water stress from pre-flowering onwards. Plastic rain shelters for water stress treatments were consequently little used. A trickle irrigation system (Dunn, 1970) supplied water to irrigated treatments to bring soil moisture to near field capacity at flowering and again at pod swelling, two stages of growth which are particularly sensitive to water stress (Salter, 1963).

Plots were harvested between December 29 1970, and January 7 1971, the unirrigated plots maturing 5-7 days before the irrigated plots. Harvesting methods and measurements were similar to those used in 1969/70.

RESULTS

1969/70 Experiment

The plant populations and seeding rates (94% germination) are presented in Table 1.

TABLE 1: Plant Population and SeedingRates

Row Width	Seed spacing within row					
	2.5cm		5.0cm		7.5cm	
	Plants/ m^2	Seeding rate (kg/ha)	Plants/ m^2	Seeding rate (kg/ha)	Plants/ m^2	Seeding rate (kg/ha)
10cm	371	1120	181	560	118	375
20cm	182	560	94	280	58	190
30cm	115	375	59	190	36	120

No significant response was obtained to phosphate application so these treatments were averaged in the results. The lack of response was not surprising as the Truog P figure for the soil was high.

Yields of green peas increased as either row width or seed spacing decreased (Table 2) and were greatest with the highest plant population sown in the narrowest rows.

TABLE 2: Effect of Varying Plant Spacing on Yield of Green Peas (kg/ha).

Row Width	Seed spacing within row			Mean
	2.5cm	5.0cm	7.5cm	
10cm	8830 a	8620 a	7700 b	8380
20cm	8160 ab	7370 bc	5970 d	7170
30cm	6820 c	5520 d	3880 e	5400
Mean	7940	7170	5850	CV 9.6

The increase in yield caused by reduction in row width was greater than when plants were closer in the row. The shelling percentage (shelled pea weight as a percentage of total green weight) tended to increase as plant population increased. It ranged from 15% at the lowest population, to 20% at the 10 x 5cm sowing, dropping back at the very highest population.

The effects of treatments on components of yield and presented in table 3.

TABLE 3: Effect of Spacing on Components of Yield

Row Width x Seed Spacing (cm)	Plants/ m^2	Vine Length (cm)		Pods/plant		Peas/ full pod
		Total	To First Pod	Full	Flat	
10 x 2.5	371	27.7 f	26.7 d	1.7 g	0.2 cd	3.8 g
20 x 2.5	182	35.6 e	32.8 bc	2.8 f	0.1 d	4.4 f
10 x 5.0	181	34.5 e	31.8 c	2.7 f	0.2 cd	4.6 ef
10 x 7.5	118	39.1 d	33.4 bc	3.7 d	0.2 cd	5.2 bcd
30 x 2.5	115	40.9 cd	35.6 b	3.3 e	0.1 d	4.9 de
20 x 5.0	94	42.7 c	35.6 b	4.2 c	0.3 cd	5.1 cd
30 x 5.0	59	48.0 b	37.6 a	4.9 b	0.6 b	5.3 abc
20 x 7.5	58	47.0 b	34.8 b	4.9 b	0.6 bc	5.6 a
30 x 7.5	36	56.1 a	35.6 b	6.0 a	1.2 a	5.5 ab
C.V.		6.2	6.9	9.2	74.7	6.0

These results show that at higher densities vine length was much less than at lower densities; there were fewer pods per plant and the pods were all at the top of the vine. At the lower densities there were more pods, located along the top third of the vine and showing large differences in maturity, the top pod or two being flat and unfilled. The number of peas per pod was not significantly affected by variation in plant population except at high plant densities, where there were fewer peas per pod. Weed incidence decreased as row width or seed spacing within the row decreased, although it was suppressed more in narrower rows.

1970/71 Experiment

Because of the lack of rain in the later stages of the growing period no significant difference occurred between those plots receiving natural rainfall and those subject to water stress. The means of these two treatments are given in the results presented in Table 4.

TABLE 4: Effects of Spacing and Irrigation on Green Pea Yield.

Row Width (cm)	Seed spacing within row (cm)	Plants /m^2	Yield kg/ha	
			Non-Irrigated	Irrigated
10	2.5	348	4950 dc	8040 ab
10	5.0	182	5520 c	8230 a
10	7.5	105	4930 dc	7880 ab
20	5.0	90	4630 d	7270 b
20	7.5	52	3630 e	5560 a
		Mean	4730	7400
		C.V.	8.8	

Yields from the five irrigated plots were slightly less than those from equivalent plots in 1969 but in much the same order. Maximum yield was obtained at a 10 x 5cm spacing although this was not significantly different from the yield at 10 x 2.5 cm spacing, the highest density. In dry land plots yield also increased with increasing density but reached a maximum at 10 x 5cm spacing dropping beyond this.

A highly significant response to irrigation was obtained at all plant densities. The mean yield from irrigated treatments was 57% higher than from dryland plots. Plants on dry land produced shorter vines, with fewer pods, concentrated at the top of the vine (Table 5).

TABLE 5: Effect of Irrigation on Components of Yield of Green Peas (Means of Plant Density Treatments)

	Non Irrigated	Irrigated
Vine length (cm)	36.6	58.9
Length to first pod (cm)	32.5	41.9
Full pods/plant	2.4	3.0
Flat pods/plant	0.2	0.4
Peas/pod	4.2	4.6
Percentage of peas of diam.> 10.9 mm	6.0	13.2

There were also fewer peas per pod and these tended to be smaller particularly at the lower densities. The average shelling percentage of the irrigated plots (18) was less than for dryland treatments (22).

DISCUSSION AND CONCLUSIONS

In these trials the plant population similar to that currently used by processed pea growers in New Zealand was represented by a 20 x 5cm spacing. The substantial yield increases obtained from higher populations than this adds weight to overseas evidence that commercial sowings in this country may be below optimum for economic yields. A green pea yield increase of 17% was obtained in 1969 by reducing row width from 20 to 10cm at 5cm seed spacing. This is equivalent to an extra $76/ha ($31/ac) gross or $37/ha ($15/ac) after the cost of extra seed has been deducted.

There is a closer relationship between seeding rate and yield in peas than in some other crops such as cereals. This is because peas are less able to compensate for variation in plant population by varying the number of stems per plant. Little branching occurred in peas grown at wide spacings in either trial. Highest yields were obtained when spacings approached "on the square" planting. Unfortunately there are difficulties in achieving this in practice. Further plot and paddock scale experiments are planned in which various sowing rates are compared. all in 15cm rows, and under both irrigated and dryland conditions. Results from these trials may allow the most profitable sowing rates to be more precisely determined.

The 1970 irrigation trial confirmed the work of Salter (1963), and Salter and Williams (1967) who showed that irrigation at the beginning of flowering and at pod swelling can give large increases in green pea yields. In the subhumid areas of Canterbury water stress at these stages of growth is very likely in most years. Further work is required on the amounts of water to apply in relation to stage of development and soil type, and methods of application, particularly in relation to crop damage by spray lines and water-logging under border-dyke irrigation. Because irrigation delays the maturity of peas by several days, field officers of processing companies will need to pay special attention to irrigation as a variable when compiling planting date/crop maturity schedules. Irrigation is becoming an increasingly common practice in processed pea crops in Canterbury and, together with the use of higher seeding rates, offers considerable prospects in raising yields in the future.

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