YIELD LOSSES DUE TO WEEDS IN SUPERSWEET CORN AND DWARF BEANS

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SUMMARY

Four trials were conducted in Hawkes Bay to measure the effect of two weed species on two crops. Fathen (*Chenopodium album*) at >1 plant/m² or redroot (*Amaranthus* spp.) at >5 plants/m², emerging with the crop, halved the marketable cob yield of supersweet corn (*Zea mays*). When weed emergence was delayed 5 weeks (fathen) or 8 weeks (redroot) the weeds had no effect on yield. Dwarf bean (*Phaseolus vulgaris*) yield was significantly reduced by 1.25 redroot plants/m² emerging with the crop. Weeds emerging 2 weeks (fathen) or 4 weeks (redroot) after the crop had no effect on bean yield. There were strong negative correlations, between weed weight and crop yield.

Keywords: weed competition, *Zea mays*, *Phaseolus vulgaris*, *Chenopodium album*, *Amaranthus* spp.

INTRODUCTION

Many herbicide trials conducted in New Zealand and elsewhere have measured the effect of weed control measures on crop yield, but very few have measured the effect of weeds per se on crop yield. Most work in this area has been with wild oats (*Avena* spp.) in cereal crops (eg. Chancellor and Peters 1974; Martin and Field 1988; Peters and Wilson 1983) where yield losses averaged 10-20%. Less work has been done on other crops where the effect is generally greater (eg. Damato and Montemurro 1986; Dekker and Meggitt 1983; Zanin and Sattin 1988).

With the current trend towards sustainable weed management and reduced herbicide use it is necessary to know the effect major weeds have on crop production. To this end preliminary trials were conducted in Hawkes Bay in 1990-91 (Hartley 1992) and extended in 1991-92 to measure the effect of fathen and redroot on supersweet corn. Treatments were designed to measure the effect of weed competition:-

- a. Where the weeds, at a range of densities, germinated with the crop.
- b. Where the weeds, at two densities, germinated at intervals after the crop to simulate weed establishment after hoeing.

METHOD

To reduce the problem with unwanted weeds in the soil, strips 110 x 1.7 m were fumigated with methyl bromide in September 1991. Weed plots were 7 x 1.7 m for sweet corn and 3.5 x 1.7 m for beans. All treatments were replicated three times with each fumigated strip comprising one replicate. Sweet corn, cv. "Honey n' Pearl", was sown on 21/11/91 along each corn plot in three rows 600 mm apart, with the centre rows hand sown at an even 200 mm plant spacing. Seeds were sown in multiples and seedlings singled 3-4 weeks later. Dwarf beans, cv. "Labrador", were inoculated with rhizobia and similarly drilled in three rows 500 mm apart on 25/11/91 (fathen) and 2/12/91 (redroot).

Fathen and redroot were seeded at 100/m² on the "density plots", to be thinned to prescribed densities (Table 1) after emergence. This was done 3-4 weeks after sowing and re-checked 1 week later. For the delayed emergence treatment weeds were seeded at 100 or 1000/m² to give a low and high density. They were sown 0, 2, 5 and 8 weeks after the sweet corn and 0, 2, 4 and 6 weeks after the beans. A 10% emergence was expected which would have given 10 or 100 seedlings/m². Weed seeds were weighed

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for each plot, mixed in sawdust to aid even distribution and raked into the top soil. Weeds, other than the sown species, were removed as they appeared.

All sweet corn cobs were harvested on 25/2/92 from the central 5.5 m of the centre row of each plot, graded visually for size and weighed. Plants were cut at ground level and weighed fresh. Weeds were harvested from a 0.5 or 1 m strip across each plot between the guard rows (area 0.6 or 1.2 m²). They were cut at ground level and packed in paper sacks, weighed fresh and dried for seed extraction.

Beans were harvested on 11/2/92 (fathen) and 18/2/92 (redroot) from the central 2 m of the centre row of each plot. Plants were cut at ground level, weighed fresh and stripped of beans. Weeds were harvested as above from the centre 2 m² between the guard rows.

RESULTS

Sweet corn

At all densities fathen and redroot, established with the sweet corn, significantly reduced the marketable yield of sweet corn cobs (Table 1). Weeds also reduced the proportion of first grade cobs. The effects were greater with fathen than with redroot, fathen producing a greater biomass than redroot at low weed densities (Table 1).

TABLE 1: Effect of fathen and redroot on supersweet corn yield (kg/m²) and weed yield (kg/m²)

Initial weed density	Fathen				Redroot			
	Market yield	1st grade cobs	Crop FW	Weed FW	Market yield	1st grade cobs	Crop FW	Weed FW
0	3.2	1.4	3.7	0 d*	3.8	2.4	4.4	0 g*
0.60/m ²	1.8	0.4	2.8	4.7 b	3.3	2.0	3.5	1.7 ef
1.25/m ²	1.1	0.5	2.2	4.9 b	3.0	0.9	3.1	1.8 ef
2.50/m ²	0.5	0	2.2	6.3 ab	2.9	1.2	3.1	3.9 cd
5.00/m ²	0.3	0	1.7	6.5 ab	1.2	0	2.0	4.9 bcd
10.0/m ²	0.2	0	1.6	7.1 ab	0.8	0	1.7	5.0 bcd
Low 0 weeks**	0.1	0	1.3	7.5 ab	0.4	0	1.2	6.7 ab
High 0 weeks	0	0	0.1	8.0 a	0	0	0.1	8.3 a
Low 2 weeks	2.4	0.6	3.0	2.6 c	2.2	0	2.8	5.7 abc
High 2 weeks	0.4	0	2.1	4.8 b	0.1	0	1.6	8.0 a
Low 5 weeks	3.3	2.1	3.4	0.3 d	3.1	1.5	3.6	1.7 ef
High 5 weeks	3.4	2.1	4.0	1.3 c	3.2	1.8	3.8	3.1 de
Low 8 weeks	3.5	1.9	4.0	0.1 d	4.4	2.5	4.6	0.1 g
High 8 weeks	3.6	2.2	3.9	0.1 d	3.5	2.2	4.3	1.0 g
LSD 5%	0.68	0.59	1.05	2.76	0.37	0.63	0.60	1.83

* numbers with no letter in common are significantly different (P<0.05) on ANOVA analysis of square root transformed data

** interval between sowing corn and sowing weeds. FW Fresh weight

Fathen sown 2 weeks after the corn significantly depressed yield, especially of first grade cobs, when sown at low density, and virtually eliminated cob production when sown at high density (Table 1). When sown 5 or 8 weeks after the corn the fathen had no effect at either density. Fathen establishment, when sown with the corn was approximately 10% giving 10 and 100 plants/m² at the low and high densities respectively but this establishment rate and plant size declined rapidly at the later sowings, resulting in a low weed biomass (Table 1).

Redroot significantly reduced sweet corn yield when sown up to 5 weeks after the corn. The redroot established at a higher rate than anticipated (approximately 50%) and hence produced a higher plant density than fathen. When sown 2-5 weeks after the crop it also produced a greater biomass than fathen, an effect that could not be accounted for by plant density alone.

Sweetcorn plant growth was depressed by weed competition though the effect was not as strong as on cobs (Table 1).

There were strong linear relationships between weed weight and all parameters of crop yield, which were not improved by adding a quadratic component to the equations.

Regression analysis, over all plots showed:-

$$(a) \text{ Marketable yield} = 3.2 - 0.4 \times \text{fathen weight} \quad R^2=0.75^{**}$$

$$(b) \text{ Marketable yield} = 3.9 - 0.47 \times \text{redroot weight} \quad R^2=0.78^{**}$$

Beans

Weeds did not have as big an effect on bean yield as they did on sweet corn yield. Although there was a general decline in pod yield with increasing density of fathen, the yield loss did not become statistically significant until there were 10 weeds/m² (Table 2). Redroot, however, produced a significant yield loss at 1.25 plants/m².

TABLE 2: Effect of fathen and redroot on green bean yield (kg/m²) and weed yield (kg/m²)

Initial weed density		Fathen			Redroot		
		Pod yield	Crop FW	Weed FW	Pod yield	Crop FW	Weed FW
0		2.2	1.8	0	2.8	2.0	0
0.60/m ²		1.9	1.5	0.8	2.3	2.0	3.4
1.25/m ²		1.9	1.8	0.9	1.2	1.2	6.9
2.50/m ²		1.9	1.8	1.6	1.7	1.8	6.9
5.00/m ²		1.7	1.7	2.0	1.2	1.3	7.4
10.0/m ²		1.4	1.3	2.0	0.9	1.1	7.2
Low	0 weeks*	2.4	2.2	1.3	0.6	0.7	9.4
High	0 weeks	1.6	1.7	2.6	0.2	0.2	11.6
Low	2 weeks	2.6	2.0	0.3	2.8	2.4	2.0
High	2 weeks	1.9	1.8	1.6	1.0	1.3	5.7
Low	4 weeks	2.6	2.2	0	2.9	2.3	0.2
High	4 weeks	2.5	2.2	0	2.7	2.2	0.8
Low	6 weeks	2.2	1.8	0	—	—	—
High	6 weeks	2.7	2.2	0	—	—	—
LSD 5%		0.73	0.71	1.27	1.12	0.85	3.36

* interval between sowing beans and sowing weeds

FW Fresh weight; - not tested

A high seeding rate of redroot sown 2 weeks after the beans depressed yield but when sown 4 weeks after the crop the weeds had no effect. Fathen had no effect when sown 2 or more weeks after the beans.

There was little difference between pod yield and bean plant weight at any weed density. However, slightly more than half the total weight was in the pods in the absence of weeds and slightly less than half at high weed density (Table 2).

There were significant linear relationships between weed weight and pod yield for both weeds, which was not improved by adding a quadratic component to the

equation.

Regression analysis, overall plots showed:-

$$(a) \text{ Pod yield} = 2.4 - 0.34 \times \text{fathen weight} \quad R^2=0.58^{**}$$

$$(b) \text{ Pod yield} = 2.8 - 0.21 \times \text{redroot weight} \quad R^2=0.65^{**}$$

DISCUSSION

As found in the preliminary trials (Hartley 1992), fathen was very competitive against sweet corn. This led to speculation on allelopathic effects of fathen on corn as suggested by Caussanel (1979). However, trials reported here indicate that redroot, though less competitive on a plant number basis, was equally competitive on a weed biomass basis. This suggests that direct competition is the basis of the effect of both weed species, unless both are allelopathic.

Fathen was only competitive when emerging at the same time as the sweet corn or shortly afterwards whereas redroot had significant effects when sown up to 5 weeks later than the corn. Though fathen ultimately produced larger plants than redroot (Table 1), the initial growth rate of redroot was greater. After the 78 day growth period in the bean trials, redroot had produced 300-400% more biomass than fathen. This rapid initial growth may account for redroot, unlike fathen, being competitive against sweet corn when sown up to 5 weeks later than the corn.

Beans suffered less than sweet corn from weed competition. On a weed numbers basis redroot was the stronger competitor but on weed biomass basis fathen was more aggressive. A comparison of the regression equations for pod yield showed fathen weight to have a significantly greater effect on yield than redroot weight. These results support observations from preliminary trials (Hartley 1992).

In both crops fruit production suffered more than vegetative production from weed competition. This effect was small in beans where even at high weed densities nearly half the total plant biomass was pods. Only in weed free conditions did sweet corn achieve nearly 50% biomass in cobs. The percentage of plant in cobs declined rapidly with increasing weed competition. This was particularly noticeable in the production of first grade cobs, the most important size for the Japanese export trade (John Burgmans pers. comm).

CONCLUSION

Low weed numbers ($<1/m^2$) of fathen or redroot plants emerging with the crop, significantly reduced supersweet corn marketable yield and the proportion of top grade cobs. Beans were not greatly affected by low fathen numbers but yield was significantly reduced by 1.25 redroot plants/ m^2 . Yield losses in both crops were greatly reduced when weeds emerged after the crops and thus could be eliminated by one or possibly two passes with a hoe.

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