Competition between three weed species and two crops

M J Hartley
Hawkes Bay Agricultural Research Centre
MAF Technology, PO Box 85, Hastings

Summary
Four trials were conducted in Hawkes Bay, New Zealand, to measure the effect of individual weed species on two crops. Fathen (*Chenopodium album*) at four plants m^{-2} reduced yield of sweet corn by 90% and summer grass (*Digitaria sanguinalis*) at five plants m^{-2} reduced yield by one third. Fathen and redroot (*Amaranthus* spp.) at 15 plants m^{-2} halved the yield of green beans.

Introduction
Most weed competition studies reported have been between weeds, especially wild oats (*Avena* spp.) and cereal crops, (eg 1, 6, 7). Cereal yield losses reported are very variable, ranging from 0 - 70% but averaging between 10 and 20%. Less work has been done on weeds in other crops where the effects are generally greater (eg. 3, 4, 10).

This paper reports on a series of four field trials conducted in 1990-1991 in Hawkes Bay, New Zealand to measure the effect of individual weeds on the yield of green beans (*Phaseolus vulgaris* L.) cultivar "Labrador" and supersweet corn (*Zea mays* L.) cultivar "Honey 'n' Pearl". Sweetcorn was planted with either fathen (*Chenopodium album* L.) or summer grass (*Digitaria sanguinalis* (L.) Scop) and beans with either fathen or redroot (*Amaranthus* spp.).

Method
The trial site was cultivated in April 1990 and four strips, 1.7 x 110 m were fumigated with methyl bromide to kill weed seed present. Each strip was used for one trial.

Mature seeds of redroot, fathen and summer grass were collected during the autumn 1990, and sown in mid-May 1990. Seeds were incorporated into the top 100 mm of soil by a single pass with tractor mounted power harrows. Weeds were sown at 0, 50, 200, 1,000, 5,000 and 20,000 seeds m^{-2}. Weed plots were 1.7 x 6 m for sweet corn, and 1.7 x 4.5 m for beans. All treatments were replicated four times except sweetcorn and fathen (three replicates).

The strips were recultivated (power harrowed) in the reverse direction in the spring immediately prior to drilling the crops. No weeds had emerged when cultivating for sweet corn but they were 100 to 150 mm tall when cultivating for beans. On 5 October 1990, after the application of 400 kg of a 12-10-10 NPK fertilizer ha^{-1}, three rows of sweet corn 600 mm apart were drilled through the fathen and summer grass plots (crop x1). On one half of each plot two additional rows of sweet corn were planted between the drilled rows to give a higher crop density (crop x2). After emergence, sweet corn was thinned to 200 mm apart in the rows.

On 26 October 1990, five rows of beans 300 mm apart were drilled through the fathen and redroot plots (crop x2). Two weeks after emergence the 2nd and 4th rows of beans were cut out from one half of each weed plot (crop x1) to give two crop densities.

Two to three weeks after drilling each crop, weed seedlings were counted on fourteen 150 mm x 250 mm quadrats per plot. Weeds were then thinned to the selected level and numbers re-checked and re-adjusted about 2 weeks later. No further weed population adjustments were made except to keep "no-weed" plots free of weed and to remove weeds other than those sown from all plots. The trials were irrigated as necessary to maintain normal plant growth

Beans were harvested from a 2 m section of the centre row of each split-plot on 7-8 January 1991. Fresh weight of pods and plants were recorded. Sweet corn was harvested from a 2.5 m section of the centre row of each split-plot on 28 January 1991. Plants were cut at ground level, stripped of all cobs and weighed. Cobs were graded visually and weight recorded. For both crops the yield data from the centre rows were doubled on the high density sub-plots to give yield from an equivalent area. Weed yields were recorded from one to three 0.25 m^2 quadrats on each sub-plot.

Results

Sweet corn was very sensitive to fathen competition (Table 1). The lowest weed density tested prevented any 1st grade cobs production and reduced marketable yield by nearly 90%. Corn plant weight declined rapidly with increasing weed density (not shown) but plant number was not affected until the weed population excessed 60 m^{-2}. Increasing the sweet corn plant density also reduced the yield of 1st grade cobs by 75% without increasing the marketable yield. Crop density had little effect on weed growth which reached its asymptote at a weed density of about 15 plants m^{-2}.

Table 1. Yield of sweetcorn as affected by *C. album*

Weed No. m^{-2}	Weed FW kg m^{-2}		1st grade yield kg m^{-2}		Marketable yield kg m^{-2}	
	cropx1	cropx2	cropx1	cropx2	cropx1	cropx2
0	0	0	1.4	0.4	1.8	1.5
4	3.3	2.2	0	0	0.2	0.1
15	6.6	5.5	0	0	0.2	0.1
60	6.7	6.6	0	0	0	0
LSD 5%	3.0	2.7	0.3	0.2	0.4	0.3

The effect of summer grass on sweetcorn is shown in Table 2. Marketable cob yield and plant weight (not shown) were significantly depressed by the lowest summer grass density tested. 1st grade cob yield also declined rapidly with increasing weed density. Doubling the corn density halved the 1st grade cob yield. Corn plant number was not affected by summer grass and height was only depressed at the higher summer grass densities.

The responses of bean yields to weed competition are shown in Tables 3 and 4. Fathen and redroot had a very similar depressive effects on bean yield with pod yield approximately halved by 15 weeds m^{-2}. A plot of the square root of weed number against the square root of bean yield showed a negative linear relationship with r^2 values of 0.81 for fathen and 0.72 for redroot. Doubling the crop density increased bean pod yield by 30 - 50% but had little effect on weight of weeds.

Data on weed biomass and seed production have been reported elsewhere (5).

were then thinned to the selected level and numbers re-checked and re-adjusted about 2 weeks later. No further weed population adjustments were made except to keep "no-weed" plots free of weed and to remove weeds other than those sown from all plots. The trials were irrigated as necessary to maintain normal plant growth

Beans were harvested from a 2 m section of the centre row of each split-plot on 7-8 January 1991. Fresh weight of pods and plants were recorded. Sweet corn was harvested from a 2.5 m section of the centre row of each split-plot on 28 January 1991. Plants were cut at ground level, stripped of all cobs and weighed. Cobs were graded visually and weight recorded. For both crops the yield data from the centre rows were doubled on the high density sub-plots to give yield from an equivalent area. Weed yields were recorded from one to three 0.25 m^2 quadrats on each sub-plot.

Results

Sweet corn was very sensitive to fathen competition (Table 1). The lowest weed density tested prevented any 1st grade cobs production and reduced marketable yield by nearly 90%. Corn plant weight declined rapidly with increasing weed density (not shown) but plant number was not affected until the weed population excessed 60 m^{-2}. Increasing the sweet corn plant density also reduced the yield of 1st grade cobs by 75% without increasing the marketable yield. Crop density had little effect on weed growth which reached its asymptote at a weed density of about 15 plants m^{-2}.

Table 1. Yield of sweetcorn as affected by *C. album*

Weed No. m^{-2}	Weed FW kg m^{-2}		1st grade yield kg m^{-2}		Marketable yield kg m^2	
	cropx1	cropx2	cropx1	cropx2	cropx1	cropx2
0	0	0	1.4	0.4	1.8	1.5
4	3.3	2.2	0	0	0.2	0.1
15	6.6	5.5	0	0	0.2	0.1
60	6.7	6.6	0	0	0	0
LSD 5%	3.0	2.7	0.3	0.2	0.4	0.3

The effect of summer grass on sweetcorn is shown in Table 2. Marketable cob yield and plant weight (not shown) were significantly depressed by the lowest summer grass density tested. 1st grade cob yield also declined rapidly with increasing weed density. Doubling the corn density halved the 1st grade cob yield. Corn plant number was not affected by summer grass and height was only depressed at the higher summer grass densities.

The responses of bean yields to weed competition are shown in Tables 3 and 4. Fathen and redroot had a very similar depressive effects on bean yield with pod yield approximately halved by 15 weeds m^{-2}. A plot of the square root of weed number against the square root of bean yield showed a negative linear relationship with r^2 values of 0.81 for fathen and 0.72 for redroot. Doubling the crop density increased bean pod yield by 30 - 50% but had little effect on weight of weeds.

Data on weed biomass and seed production have been reported elsewhere (5).

Table 2 Yield of sweetcorn as affected by *D. sanguinalis*

Weed No. m^{-2}	1st Grade Yield kg m^{-2}		Marketable yield kg m^{-2}	
	cropx1	cropx2	cropx1	cropx2
0	1.6	0.7	2.3	2.8
5	1.1	0.3	1.5	1.3
10	0.5	0.2	1.4	1.3
25	0.5	0.2	1.4	1.1
100	0.1	0.1	0.7	0.5
LSD 5%	0.6	0.7	0.8	0.8

Table 3 Yield of beans as affected by *C. album*

Weed No. m^{-2}	Weed FW kg m^{-2}		Plant FW* kg m^{-2}		Pod yield kg m^{-2}	
	cropx1	cropx2	cropx1	cropx2	cropx1	cropx2
0	0	0	1.8	2.1	1.7	2.4
4	4.1	3.6	1.6	2.3	1.1	2.0
15	3.9	5.4	1.2	2.0	0.8	1.5
30	6.5	5.4	1.0	1.5	0.6	0.7
150	6.5	5.4	0.7	1.0	0.1	0.1
LSD 5%	2.4	1.5	0.1	0.4	0.6	0.6

* excluding pods

Table 4 Yield of beans as affected by *Amaranthus* spp.

Weed No m^{-2}	Weed FW kg m^{-2}		Plant FW* kg m^{-2}		Pod yield kg m^{-2}	
	cropx1	cropx2	cropx1	cropx2	cropx1	cropx2
0	0	0	1.7	2.4	1.9	2.0
4	5.1	4.1	1.5	2.4	1.5	1.7
15	6.1	4.7	1.2	1.9	0.8	1.4
60	7.4	4.9	0.8	1.5	0.2	0.6
250	5.0	6.1	0.5	1.0	0.1	0.1
LSD 5%	2.5	2.6	0.2	0.5	0.4	0.7

* excluding pods

Discussion

Sweet corn proved very sensitive to competition, even from itself, as shown by the depression of 1st grade cobs when the crop density was doubled. However, the effect of the lowest rate of fathen (4 plants m^{-2}) was much greater than the addition of a greater number of corn plants. Caussanel (1) found fathen had a severe effect on maize growth greater than accounted for by competition alone and attributed this to a growth inhibiting leachate.

Qasem and Hill (8) also showed fathen had an allelopathic effect on tomatoes (*Lycopersicon esculentum*). In contrast Vleeshouwers *et al* (9) found fathen relatively non-competitive against peas (*Pisum sativum*). In the work reported here fathen was not as severely depressive of beans as it was of sweet corn. Maybe fathen produces an allelopathic leachate active against sweet corn but not against legumes.

The extension of the weed populations to the high densities, designed to establish the upper limits of competition, limited the number of low density weed plots included on the trial. Further work is needed to measure the effect of weed densities below 4 m^{-2}.

All weeds in these trials germinated simultaneously with the crops. Had the area been hoed once to give the crop a head start results could have been very different.

References

1. Caussanel, J.P., 1979. Effects non competitifs entre le chenopode blanc (*Chenopodium album* L.) et le mais (INRA 258). *Weed Research* 19, 123-135.
2. Chancellor, R.J. and Peters, N.C.B., 1974. The time of the onset of competition between wild oat (*Avena fatua* L.) and spring cereals. *Weed Research* 14, 197-202.
3. Damato, G. and Montemurro, P., 1986. [On competition between black nightshade and transplanted tomatoes] Difesa delle Piante 9, 359-364 (Abstract) *Hort. Abst* (1987) 57 No. 7 abs 5618.
4. Dekker, J. and Meggitt, W.F., 1983. Interference between velvet-leaf (*Abutilon theophrasti* Medi.) and soybean (*Glycine max* (L.) Merr.). II Population dynamics. *Weed Research* 23, 103-107.
5. Hartley, M.J., 1991. Density dependence of weed seed production in two field crops. *Proceeding. 44th NZ Weed and Pest Control Conference.* 125-128.
6. Martin M.P.L.D., and Field, R.J., 1988. Influence of time of emergence of wild oat in competition with wheat. *Weed Research* 28, 111-116.
7. Peters, N.C.B. and Wilson, B.J., 1983. Some studies on the competition between *Avena fatua* L. and spring barley. II Variation in *A. fatua* emergence and development and its influence on crop yield. *Weed Research* 23, 305-311.
8. Qasem, J.R. and Hill, T.A., 1989. Possible role of allelopathy in competition between tomato, *Senecio vulgaris L.* and *Chenopodium album* L.. *Weed Research* 29, 349-356.
9. Vleeshouwers, L.M., Streibig, J.C. and Skovgaard, I., 1989. Assessment of competition between crops and weeds. *Weed Research* 29, 273-280.
10. Zanin, G. and Sattin, M. 1988. Threshold level and seed production of velvetleaf (*Abutilon theophrasti* Medicus) in maize. *Weed Research.* 28, 347-352.