DENSITY DEPENDENCE OF WEED SEED PRODUCTION IN TWO FIELD CROPS

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SUMMARY

Seed production of three weeds, redroot (*Amaranthus* sp), fathen (*Chenopodium album* agg.) and black nightshade (*Solanum nigrum* complex) was measured in two crops, sweetcorn (*Zea mays*) and green beans (*Phaseolus vulgaris*). Weed seeds were sown in autumn into fumigated soil at six densities from 0 to 20,000/m². Plots were recultivated in the spring before the crops were sown. Weed seedling emergence, green weight and seed production were recorded. Weed seed production per plant was inversely related to weed population resulting in constant production per unit area for weed populations above 10/m², and was in excess of 10⁵ seeds/m².

Keywords: weeds, seed production, redroot, fathen, black nightshade

INTRODUCTION

The value of most weed control is measured by the direct effect of weeds on crop yield. The effect of low weed densities on crop yield may be too low to justify the expense of their control in terms of crop yield increased (Bourdout and Saville 1990). However, uncontrolled weeds affect not only the growth of the current crop but also future weed populations (Auld *et al* 1987).

A series of trials was conducted in 1990-91 at Hawke's Bay Agricultural Research Centre to measure the seed production of three weeds through one cropping cycle of green beans and one weed in supersweet corn.

METHOD

Seeds of redroot, fathen and black nightshade were collected from wild populations in autumn 1990. The seeds of redroot and fathen were collected by cutting mature plants and sun drying them on tarpaulins. The shed seed was sieved over an air draught to remove trash and light seed. Redroot shed as "clean" seed, fathen remained in husk. Black nightshade seed was collected by picking mature berries, crushing them in water, collecting the heavy seed by successive decantation and drying them in the sun.

The trial site was cultivated in April 1990 and the soil fumigated with methyl bromide to control the resident weed population. Each trial of weed by crop was conducted on one fumigated strip 1.7 m wide by 110 m long. Weed seed was sown in mid May and incorporated in the top 100 mm of soil by a single pass with tractor mounted power harrows. As seed establishment rates and critical density of weeds were unknown, a wide range of seed densities were chosen. The weed seeds were sown at six rates:- 0, 50, 200, 1000, 5000 and 20,000/m². Due to limited seed numbers the top rate of black nightshade was only 15,000/m². Treatments were replicated four times in beans and three times in sweetcorn. Main plots were 4.5 m long for beans and 6 m for sweetcorn.

The ground was recultivated (power harrowed), in the reverse direction to reduce seed displacement, immediately prior to sowing the crops in spring. Sweetcorn was drilled into fathen plots on 5/10/90, and beans into fathen, redroot and black nightshade plots on 26/10/90. Three rows of each crop were drilled 600 mm apart. On one half of each main plot two additional crop rows were sown between the drilled rows to give two crop densities as sub-treatments. Few weeds had emerged when the land was cultivated for sweetcorn but weeds were 10-15 cm tall when the land was cultivated for beans.

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Two to three weeks after drilling, weeds were counted on fourteen 150 mm x 250 mm quadrats per sub-plot over the area between two outer crop rows. A geometric weed density series was selected for each weed by crop on the basis of minimum weed numbers available per treatment. Weed populations were then thinned to the desired level and numbers rechecked a week later. No further weed density adjustments were made except "no-weed" plots were kept weed free by hand weeding.

The crops were harvested from the centre row of each sub-plot with all treading kept to one side of the row. After crop harvest, weeds were harvested from one 0.5 m x 0.5 m open ended quadrat slid into the weed jungle to the untrodden side of the centre crop row 1 m into the plot. Where weed density was low, weeds were harvested from several quadrats. Weeds were cut at ground level, lifted carefully and packed into paper rubbish bags or bins (black nightshade). All weeds were counted with no differentiation by size. The weeds were weighed green.

Redroot and fathen bags were hung in a covered area open to the wind for 3-4 weeks. When dry, the bag contents were rubbed through a coarse 10 mm sieve, then through a finer kitchen strainer. The seed was "dressed" and four seed grades retained and weighed. A 0.2-0.5 g sub-sample containing 500-1000 seeds was taken from each bulked grade to establish a conversion factor to convert seed weight to seed number. Small seeds were included in the final total as these would probably have developed fully if the plant had not been harvested.

Black nightshade seed yield was estimated from berry yield. All berries above 2 mm diameter (approx) were cut off the plants, as bunches, and weighed. Five 10 g sub-samples were taken, weighed and berries counted to give an estimate of plot yield as berry numbers. Six randomly selected mature fruit were crushed and seed number counted (mean seed No./berry = 70 S.D. 7.8).

RESULTS AND DISCUSSION

The results are shown in Tables 1-4. Data were collected separately for the two crop densities but for simplicity the mean is shown. There was a trend towards higher weed yield at the lower crop density but this was only significant for low densities of redroot and black nightshade in green beans.

Weed populations tended to level out between initial "adjusted" number and final harvested number. At low densities numbers increased while at high densities they decreased, indicating density-dependent mortality.

Weed biomass (green weight) was not significantly different for all but the lowest population densities for fathen (Tables 1 and 2) and black nightshade (Table 4). Redroot gave similar green weight yield at all weed densities except the highest which is probably an anomalous result (Table 3). The weed seed production was also almost independent of population. Only the lowest density of black nightshade and possibly fathen in sweetcorn failed to reach maximum seed production per unit area (Tables 1 and 4).

TABLE 1: Seed and biomass of fathen at different densities in sweetcorn. Growing period 5/10/90 to 28/1/91 (114 days).

Seeds sown No./m ²	Seedling density (No./m ²)			Green wt (kg/m ²)	Seeds produced No./m ²	Seeds/plant	Multiplication factor
	Emerged*	Adjusted	Final				
50	29	4	8	2.7	334 000	42 000	6700
200	39	15	18	6.1	784 000	44 000	3900
1000	71	60	58	6.6	884 000	15 000	850
5000	270	200	175	6.3	785 000	4 500	160
20000	810	800	352	6.8	832 000	2 400	42
LSD 5%				1.7	476 000		

*15/m² emerged where none sown.

TABLE 2: Seed and biomass production of fathen at different densities in green beans. Growing period 26/10/90 to 23/1/91 (88 days).

Seeds sown No./m ²	Seedling density (No./m ²)			Green wt (kg/m ²)	Seeds produced No./m ²	Seeds/plant	Multiplication factor
	Emerged*	Adjusted	Final				
50	33	4	11	3.9	322 000	30 000	6400
200	37	15	22	4.7	435 000	19 500	2200
1000	80	30	55	6.0	529 000	10 000	530
5000	189	150	140	6.0	520 000	4 000	105
20000	686	600	500	6.2	501 000	2 000	25
LSD 5%				1.6	312 000		

*5/m² emerged where none sown.

TABLE 3: Seed and biomass production of redroot at different densities in green beans. Growing period 26/10/90 to 24/1/91 (89 days).

Seeds sown No./m ²	Seedling density (No./m ²)			Green wt (kg/m ²)	Seeds produced No./m ²	Seeds/plant	Multiplication factor
	Emerged*	Adjusted	Final				
50	51	4	18	4.6	472 000	28 000	9450
200	97	15	45	5.4	398 000	9 000	2150
1000	160	60	65	6.2	471 000	7 000	470
5000	405	250	162	5.6	330 000	2 000	66
20000	1195	1200	316	8.0	418 000	1 500	24
LSD 5%				2.1	226 000		

*28/m² emerged where none sown.

TABLE 4: Seed and biomass production of black nightshade at different densities in green beans. Growing period 26/10/90 to 22/1/91 (87 days).

Seeds sown No./m ²	Seedling density (No./m ²)			Green wt (kg/m ²)	Seeds produced No./m ²	Seeds/plant	Multiplication factor
	Emerged*	Adjusted	Final				
50	18	4	10	0.5	52 000	5 200	1050
200	33	8	14	1.9	185 000	12 700	925
1000	54	20	24	2.2	208 000	8 500	210
5000	108	50	94	2.8	253 000	2 700	51
15000	167	100	106	2.7	203 000	1 900	14
LSD 5%				1.0	121 000		

*17/m² emerged where none sown.

The compensating growth of weeds is shown by the mean seed production per plant. There were significant inverse relationships between the number of weeds/m² and the number of seeds per plant. The following equations were derived from regression analysis of data from all plots.

Fathen in sweetcorn Seeds/plant = 774 000 ÷ weeds/m² R² = 0.93 n = 30
 Fathen in beans Seeds/plant = 406 000 ÷ weeds/m² R² = 0.86 n = 50
 Redroot in beans Seeds/plant = 366 000 ÷ weeds/m² R² = 0.93 n = 39
 Black nightshade in beans Seeds/plant = 157 000 ÷ weeds/m² R² = 0.75 n = 40

The higher seed production of fathen in sweetcorn over that in beans reflects the longer growing period in sweetcorn.

The equations indicate seed production from single plants would be of the order of 10⁵. Over 400,000 seeds have been collected from single redroot plants and 200,000 from fathen (Hartley unpublished) so this magnitude of production is possible. All seed

data must be an underestimate of numbers because mature seeds were shedding when harvested and plants were still flowering.

Further evidence of the compensatory production of weeds is given by the multiplication factor (Tables 1-4). This is the number of seeds produced divided by the number sown per unit area, disregarding the number of emerged seedlings that were removed during population adjustments. Again there were very significant inverse correlations between initial seed numbers and increase in seed return. The regression analysis suggests that where initial seed numbers are low their potential to increase could be of the order of 10^4 .

CONCLUSION

The capacity of low density weed populations to produce compensatingly high seed numbers highlights the risk of not controlling weeds even when the current population may not have an economic effect on crop yield. However, even the lowest weed densities reported here had an effect on yield and control measures may have been economic especially in sweetcorn (in prep. for 1st Int. Weed Congress Melbourne 1992). At the higher weed population densities tested here, the crop was a total failure. Further work is needed to measure the seed production of very low weed populations.

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