EFFECT OF CULTIVATION ON WEED SEED EMERGENCE

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SUMMARY

Seeds of redroot (*Amaranthus* sp.), fathen (*Chenopodium album* agg.), black nightshade (*Solanum nigrum* complex) and summer grass (*Digitaria sanguinalis*) were spread separately on the surface of small plots on clean, bare ground in the autumn. Four cultivation treatments were imposed, autumn and spring, autumn only, spring only and no cultivation. Autumn cultivation increased black nightshade and fathen emergence the following spring almost fourfold and doubled the emergence of summer grass. Spring cultivation doubled the emergence of redroot.

Keywords: redroot, fathen, black nightshade, summer grass, cultivation, emergence

INTRODUCTION

Burial helps the long term survival of weed seeds (Waldron 1904; Goss 1924) and cultivation stimulates the germination of seeds by exposing them to light (Chancellor 1979; Roberts and Potter 1980). In the absence of cultivation few weeds germinate (Roberts 1982; Hartley 1990), but in 'organic' farming, without the aid of herbicides, some cultivation may be necessary for weed control. It may, however, be possible to manipulate the timing of cultivation to assist with weed management. The work reported here measured the effect of autumn and spring cultivation, after surface deposition of weed seeds, on seedling emergence.

METHOD

Ripe seed of redroot, fathen, black nightshade and summer grass was collected during autumn 1990 from natural populations on the Hawke's Bay Agricultural Research Centre.

The black nightshade berries were crushed in water. Seed was collected by repeated decantation and air-dried. The other seeds were sieved over an air current to remove trash and light seeds. Redroot yielded 'clean' seed free of husk, while fathen and summer grass seed remained in husk.

The trial area was cultivated in April 1990, treated with methyl bromide to kill the weed seed present, ventilated and rolled. Seed of each weed species was sown separately in mid May 1990 on 0.5 x 1 m plots. Seed was mixed with untreated sawdust to assist even distribution on the soil surface and sown by hand. Three seeding densities were used, 2,500, 5,000 and 20,000/m², to increase the chance of producing seedling populations suitable for counting and analysis. A nil rate was included to test control of the natural weed population.

After sowing, four cultivation treatments were applied: autumn and spring, autumn only, spring only, none. Autumn cultivation buried a proportion of the seed for the winter. Spring cultivation disturbed the autumn buried seed and buried some previously unburied seed.

Cultivation was done using a hand guided rotary hoe to a depth of 75 mm in a single pass. For plots which were re-cultivated in the spring the direction of travel was reversed. Autumn cultivation was done immediately after sowing. Spring cultivation was done on 26 September 1990. After seedling emergence had been counted on 25 October spring cultivations were repeated on 2 November 1990 while plots not

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cultivated in the spring were sprayed with paraquat to kill emerged seedlings. Seedling counts were repeated on 26 November. Each weed species constituted a separate trial. Each trial was a split plot design with cultivation as main plots and seeding rates as sub-plots. There were four replications.

Plots were assessed visually for weed growth after seeding and before the first spring cultivation. Seedlings were counted either on the whole 0.5 m² plot, if less than 100, or on 2-4 small (150 mm x 250 mm) quadrats and converted to whole plot numbers. Data were analysed after square root transformation.

RESULTS

Inspection over winter showed few seedlings emerged in autumn/winter and those that did were killed by frost. Further inspection prior to spring cultivation showed that black nightshade and fathen seedlings had emerged on all autumn cultivated plots. Black nightshade had also emerged on about 30% of plots not autumn cultivated, but seedlings were smaller than on autumn cultivated plots, indicating later emergence. Fathen had not emerged on any plots not cultivated in the autumn. Redroot and summer grass had not emerged on any plots. Few weeds other than the test species emerged on any plot. Those that did were cut out by hand.

Seedling numbers that emerged after spring cultivation are shown in Table 1. Numbers that emerged on unseeded plots were relatively low and considered unlikely to affect the results, although significantly more resident black nightshade emerged in response to spring cultivation than in absence of spring cultivation. As the 2,500 and 5,000/m² seeding rates gave adequate seedling numbers plots with the high seeding rate were not counted. Both 2,500 and 5,000/m² seeding rates are shown to indicate the uniformity of results. Redroot emergence was increased where spring cultivation

TABLE 1: Number/m² of weed seedlings emerged on 25/10/90 and total for two counts (25/10/90 and 26/11/90).

Time of cultivation	Weed species							
	Redroot		Fathen		Black nightshade		Summer grass	
	25/10	Total	25/10	Total	25/10	Total	25/10	Total
No weed seeds sown								
Autumn and spring	8 a	12 a	44 a	50 a	15 a	18 a	4 a	5 a
Autumn only	2 a	5 ab	14 a	16 a	2 b	2 b	1 a	6 a
Spring only	7 a	9 ab	18 a	22 a	9 a	1 b	1 a	7 a
None	2 a	3 b	10 a	12 a	0 b	0 b	0 a	3 a
Mean	5	7	21	25	6	8	1	5
2500 weed seeds/m²								
Autumn and spring	128 a	214 a	164 a	191 a	184 ab	206 ab	32 b	175 ab
Autumn only	40 b	71 b	130 a	140 a	350 a	370 a	54 a	224 a
Spring only	38 b	125 ab	30 b	41 b	80 bc	82 bc	8 c	78 c
None	38 b	72 b	26 b	30 b	50 c	50 c	2 c	115 bc
Mean	61	120	87	101	165	177	24	148
5000 weed seeds/m²								
Autumn and spring	264 a	388 a	168 a	228 a	264 b	288 b	94 a	350 a
Autumn only	66 b	138 b	154 a	171 a	530 a	577 a	72 ab	304 ab
Spring only	138 ab	197 b	62 b	82 b	174 b	179 b	20 bc	139 b
None	68 b	155 b	50 b	66 b	90 c	97 c	10 c	224 ab
Mean	134	220	108	137	264	280	48	254

Numbers with no letter in common differ at the 5% level of significance.

followed autumn cultivation but not by autumn cultivation alone. Fathen emergence was increased by autumn cultivation but not influenced by spring cultivation. Black nightshade emergence was also increased by autumn cultivation but the effect was reduced by spring cultivation. Summer grass showed some early increase in emergence in response to autumn cultivation but there was little final effect.

Table 2 shows the mean percent of sown seed that emerged from the 2,500 and 5,000 seeds/m² sowing rates. Overall emergence ranged from 3.4% for fathen to 6.3% for the black nightshade. The main effect of autumn cultivation increased black nightshade and fathen emergence by a factor of nearly four and doubled summer grass emergence. Autumn cultivation alone increased black nightshade emergence sixfold compared with no cultivation. Redroot emergence was not increased significantly by autumn cultivation treatments but was doubled by spring cultivation compared with no spring cultivation.

TABLE 2: Percent of sown weed seed emerging as affected by cultivation (mean of 2500 and 5000 seeds/m² — sum of two spring emergences).

Time of cultivation	Weed species			
	Redroot	Fathen	Black nightshade	Summer grass
Autumn and spring	8.1 a	6.1 a	7.0 b	7.0 a
Autumn only	2.8 b	4.5 a	13.0 a	7.5 a
Spring only	4.4 b	1.6 b	3.4 c	3.0 b
None	3.0 b	1.3 b	2.0 c	4.5 b
Main effects				
Autumn cultivation	5.4 a	5.3 a	9.9 a	7.2 a
No autumn cultivation	3.7 a	1.4 b	2.7 b	3.7 b
Spring cultivation	6.3 a	3.9 a	5.2 a	5.0 a
No spring cultivation	2.9 b	2.9 a	7.5 a	6.0 a
Overall mean	4.6	3.4	6.3	5.5

Numbers with no letter in common differ at the 5% level of significance

DISCUSSION

This study only indicates the final outcome of cultivation/no-cultivation on surface sown seed. It did not determine the fate of the seed that did not produce seedlings. Thus seed left on the surface may have been taken by birds, insects, slugs or rendered inviable or dormant by exposure to continuous light or adverse weather. Only redroot seed germination was not increased by autumn cultivation possibly because the very small black seed left on the surface was not found by birds, or fell into cracks in the soil.

Spring cultivation had no additional effect over autumn cultivation on emergence except with redroot. This is surprising as soil disturbance is widely known to stimulate weed seed germination (Roberts and Potter 1980; Hartley and Grbavac 1990). However, these studies were on natural weed populations where seed had been buried for an undetermined period. Other workers (Chancellor 1979; Roberts and Neilson 1980), who followed germination of new seed incorporated into soil did not compare subsequent emergence with and without further soil disturbance. It is possible that new seeds require more than 6 months burial to acquire dormancy and during this period are capable of germinating once temperature conditions are suitable without the additional stimulus of soil disturbance and exposure to light. Wesson and Wareing (1968) found seeds of some weeds had no light requirement for germination for up to 25 weeks after collection but became "light-requiring" after 50 weeks burial. The fact that resident seed of black nightshade responded to the combined autumn and spring cultivation (Table 1) would support this suggestion.

It was observed that a considerable number of black nightshade and fathen seeds had germinated before the first spring cultivation. The apparent reduction in black

nightshade emergence following spring cultivation of autumn cultivated plots may have occurred because the spring cultivation eliminated most of the non-dormant seed population that had already germinated. Black nightshade foliage cultivated into the soil prior to sowing green beans (*Phaseolus vulgaris*) can depress bean emergence significantly (Hartley unpublished). This apparent allelopathic effect may also affect black nightshade seedlings. Seedling foliage incorporated into the soil during cultivation may have affected black nightshade germination.

CONCLUSION

Burying newly shed seeds of redroot, fathen, black nightshade and summer grass in autumn tends to increase the proportion of these seeds that will germinate the following spring. If weed seed has been shed before the harvest of summer crops the subsequent weed problem may be less severe if cultivation were delayed till spring, rather than performed in the autumn.

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