WEED EMERGENCE AND CROP PRODUCTION UNDER DIFFERENCT CULTIVATION REGIMES

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SUMMARY

A trial was established in autumn 1989 to study the effect of cultivation systems on weed emergence. Seasonal weed emergence and crop production over the first 3 years of this continuing trial are presented. Black nightshade (*Solanum nigrum*) and fathen (*Chenopodium album*) emergence was strongly stimulated by spring cultivation and declined significantly from year 1 in the absence of cultivation. Redroot (*Amaranthus* spp.) emergence was affected less strongly and summer grass (*Digitaria sanguinalis*) very little by cultivation. Scrambling speedwell (*Veronica persica*) emergence was stimulated by autumn cultivation but more germinated, in the spring, without cultivation. Cultivation systems had very little effect on crop production.

Keywords: weed emergence, cultivation, crop production.

INTRODUCTION

The availability of selective herbicides over the past 50 years has provided such effective weed control, in most situations, that there has been little need to consider other methods. However, with current trends towards sustainable agriculture and public desires to reduce pesticide use we must learn, or re-learn, other techniques to manage weeds. One technique is cultivation which can be used to sever and/or bury weeds. However, burial of weed seeds is known to prolong their survival (Chepil 1946; Goss 1924) and cultivation also stimulates weed germination (Roberts and Potter 1980; Chancellor 1979). Thus cultivation may both cure and cause weed problems.

Hartley (1990) reported on weed population changes that occurred in a long term cultivation systems trial, started in 1983, at the East Coast Technology Centre. Unfortunately, weed dynamics were not recorded for the first 3 years of that trial. In 1989 a new cultivation systems trial was set up to monitor early changes in weed populations in a vegetable cropping situation in response to different cultivation programmes and measure the effect of these changes on crop production. The first 3 years of this trial are reported here.

METHOD

The trial was conducted on a Mangateretere silt loam which had been under cultivation for 3 years. It was cultivated as one unit in April 1989.

Five cultivation treatments were established as main plot treatments on plots 3x10 m, arranged in a Latin square and replicated five times.

1. No cultivation
2. Deep cultivation, each spring (October/November) and autumn (April) (first year rotary hoed by tractor, subsequently dug by hand to 150 mm depth).
3. Deep cultivation, as above, spring only.
4. Deep cultivation, as above, autumn only.
5. Shallow cultivation spring and autumn (hand guided rotary hoe to 50 mm).

Shortly before each cultivation all plots were sprayed with paraquat or glyphosate. Weed debris on uncultivated plots were mulched and left on the plot.

Three sub-treatment plots were placed on each main plot. Sub-treatment plots were 1.5 x 1.5 m spaced 1.5 m apart in a line in the centre of each main plot. Sub-treatments were:

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a. no subsequent weed control
b. weeds controlled by hoeing
c. weeds controlled by directed paraquat spray

Sub-treatments were applied about 6 weeks after the crops were planted and randomised within each main plot. The same sub-treatments were applied to the same sub-plot each season and were repeated as necessary through the life of the crop. The areas surrounding each sub-plot were kept weed free.

Each season a crop was grown in three 1 m rows 500 mm apart on the centre of each plot. Broccoli (*Brassica oleracea* var *italica*) was grown each winter and peppers (*Capsicum annuum*) (1989-90) or beans (*Phaseolus vulgaris*) each summer. Broccoli and peppers were transplanted, nine plants per plot, and beans were sown, 16 seeds per row. Crops were irrigated as necessary.

All plants were harvested from each plot. Broccoli heads were cut as they reached market maturity and weighed fresh (yields were not recorded first season). Peppers were harvested (green) each week as fruit reached market size, counted and weighed fresh. Beans were harvested in a single harvest when seeds in average pods reached 12 mm in length. Plants were cut and stripped of all marketable pods which were weighed fresh.

Weeds were counted, by species, in six quadrats (250 x 150 mm) per plot each autumn and spring 6-8 weeks after main treatment application and before the first sub-treatment application. When harvested, all weeds on each plot were cut near ground level and weighed fresh. They were not seperated into species.

RESULTS

Weed emergence

The trends in emergence numbers of the major weeds are shown in Table 1. Black nightshade emerged in large numbers in response to deep spring cultivation and initially to shallow cultivation but numbers in this treatment declined in the second and third spring. There was little emergence in the absence of spring cultivation even on plots cultivated in the autumn. Autumn emergence was negligible. Redroot showed a similar pattern but numbers did not differ significantly between deep and shallow spring and autumn cultivation until the third spring. Fathen numbers were relatively low but there was a trend towards highest emergence following deep spring cultivation in the absence of autumn cultivation.

In spring 1989 scrambling speedwell emerged in greatest numbers on plots not cultivated that spring. The following autumn, emergence was greatest where plots were cultivated in the autumn. The second spring most seedlings emerged following autumn cultivation regardless of depth. Spring 1991 saw a massive emergence of scrambling speedwell which was significantly depressed by deep spring cultivation. Summer grass emerged in greatest numbers following deep spring cultivation.

Sub-treatment weed control has had no significant effect, so far, on emergence numbers of black nightshade, redroot or summer grass. Fathen numbers had increased slightly in the absence of weed control by spring 1991. Scrambling speedwell numbers were significantly higher without weed control from spring 1989 (Table 1). There were no significant interactions between main and sub-treatment in weed emergence numbers.

Crop production and weed growth

The winter broccoli crops were not affected by main cultivation treatments but they were depressed in the sub-treatments without weed control (Table 2). Peppers (summer 1989-90) likewise were unaffected by main treatments but were so depressed in the sub-treatments without weed control that the crop was abandoned.

TABLE 1: Observed weed numbers/m^2 under five cultivation treatments

Cultivation treatment	Autumn 1989	Spring 1989	Autumn 1990	Spring 1990	Autumn* 1991	Spring 1991
Black nightshade						
None	80	40 b	1	3 b	0	9 b
Deep: spring & autumn	96	538 a	1	176 a	0	305 a
Deep: spring only	42	553 a	0	228 a	0	427 a
Deep: autumn only	35	19 b	2	8 b	0	13 b
Shallow: spring & autumn	62	336 a	2	21 b	0	33 b
Redroot						
None	47	40 bc	0	7 b	0	35 c
Deep: spring & autumn	57	85 a	0	64 a	0	405 a
Deep: spring only	33	82 ab	0	37 ab	0	204 ab
Deep: autumn only	61	32 c	0	5 b	tr	50 c
Shallow: spring & autumn	35	56 ab	0	43 ab	0	113 bc
Fathen						
None	106	7 bc	0	1 b	0	1
Deep: spring & autumn	56	32 a	3	5 ab	tr	12 a
Deep: spring only	49	40 a	1	9 a	0	21 a
Deep: autumn only	54	6 c	4	1 b	tr	1 b
Shallow: spring & autumn	61	23 ab	3	1 b	0	1 b
Scrambling speedwell						
None	476	85 a	45 bc	8 ab	4 ed	1030 a
Deep: spring & autumn	539	17 b	199 a	5 ab	53 ab	298 b
Deep: spring only	474	11 b	19 c	1 b	1 d	234 b
Deep: autumn only	457	62 a	118 ab	72 a	22 bc	870 a
Shallow: spring & autumn	507	11 b	205 a	14 ab	44 a	795 a
Sub-treatment						
None	463	80 a	204 a	55 a	50 a	1424 a
Hoed	477	25 b	74 b	2 b	4	335 b
Paraquat	532	7 c	74 b	3 b	8 b	162
Summer grass						
None	0	20 a	0 2	b 0		
Deep: spring & autumn	0	11 a	0	11 b	0	22 ab
Deep: spring only	0	23 a	0	34 a	0	51 a
Deep: autumn only	0	31 a	0	5 b	0	17 ab
Shallow: spring & autumn	0	24 a	0	3 b	0	10 ab

* % cover on visual estimate; tr=trace.
Numbers in each column by species with no letter in common are significantly different ($P<0.05$) on ANOVA analysis of square root transformed data. No letter indicates no significant difference.There were no significant interactions.

In 1990-91 beans yielded significantly better following shallow cultivation than on any other treatment (Table 3). Weeds were more vigorous following deep cultivation. In 1991-92 beans produced most following shallow cultivation and least on the autumn cultivated plots in the absence of a spring cultivation. Weed production was considerably higher in 1991-92 than the previous year, with biomass production after deep spring and autumn cultivation significantly greater than that after shallow cultivation. In both years bean yield was increased by sub-treatment weed control. Bean yield without sub-treatment weed control differed considerably between years and was inversely related to weed production.

TABLE 2: Pepper and broccoli yield in response to cultivation treatments (kg/ m^2)

Main cultivation treatment	Peppers 1989-90	Broccoli 1990	Broccoli 1991
None	3.2	1.0	0.77
Deep: spring and autumn	3.8	1.2	0.96
Deep: spring only	3.2	1.3	0.79
Deep: autumn only	3.2	1.1	0.80
Shallow: spring & autumn	3.5	1.0	0.80
Sub-treatments			
None	–	0.95 b	0.68 b
Hoed	3.3	1.20 a	0.88 a
Paraquat	3.5	1.20 a	0.91 a

Numbers in each column with no letter in common are significantly different (P<0.05). No letter indicates no significant difference.

TABLE 3: Bean pod yield and weed yield in response to cultivation treatments (kg/m^2)

Main cultivation treatment	Beans 1990-91	Weeds 1990-91	Beans 1991-92	Weeds 1991-92
None	1.94 b	0.47 b	1.48 ab	3.33* ab
Deep: spring & autumn	1.86 b	1.35 ab	1.61 ab	4.56 a
Deep: spring only	1.84 b	2.19 a	1.59 ab	3.45 ab
Deep: autumn only	1.91 b	1.00 b	1.19 b	3.36* ab
Shallow: spring & autumn	2.31 a	0.785 b	1.79 a	2.23* b
Sub-treatments				
None	1.71 b	1.15	0.72 b	3.38
Hoed	2.09 a		1.84 a	
Paraquat	2.12 a		2.04 a	

* Dominant weed scrambling speedwell
Numbers in each column with no letter in common are significantly different (P<0.05)

DISCUSSION

Three years after the commencement of the 1983 trial (Hartley 1990) there was significantly less emergence of some weed species, mainly black nightshade and redroot, on uncultivated than on cultivated land. In subsequent years weed numbers declined rapidly in the absence of further cultivation. In the current trial numbers of the major weed species showed an immediate response to cessation of cultivation. However, after 3 years weed numbers were still not low enough to avoid the need for additional weed control. Black nightshade and fathen declined rapidly in the absence of cultivation. Redroot, though stimulated by cultivation, was still emerging in significant numbers without cultivation. Germination of scrambling speedwell, which is primarily an autumn germinating weed, was stimulated by autumn cultivation. However, it continued to germinate strongly in the spring, without further cultivation, and became the major component of the weed biomass harvested in 1991-92 on plots not cultivated in the spring. It increased significantly in the absence of weed control within the crops whereas the other weeds did not, even though some of these weeds would have seeded before completion of crop harvest. This suggests that a substantial proportion of these weeds were coming from the weed seed bank already present in the soil.

The different cultivation treatments had little effect on crop production except for beans which yielded better after shallow cultivation than after deep cultivation. Sub-treatment weed control made a significant difference to crop yield but the technique used for weed control did not matter.

The correlation between weed biomass and bean pod yield found in the single weed species competition trials (Hartley 1992) was not seen in this experiment. This could be due to the mixed weed population in this trial. A substantial proportion of the weed biomass may have been contributed by weed species of low competition potential with no allelopathic effects. For instance the scrambling speedwell was low growing and would not have competed with the beans for light.

CONCLUSION

Most weeds were stimulated to germinate by cultivation and omitting cultivation reduced weed emergence significantly. However, it may take several years of a non-cultivation cycle to reduce weed levels sufficiently to avoid crop loss if no other weed control measures were applied. Scrambling speedwell appears to profit from non-cultivation and if this, or a similar weed, is present non-cultivation may lose its advantage as a weed management technique.

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