WEEDS IN POTATOES

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Summary

The problem of controlling weeds in potatoes is considered in relation to the emergence of annual weeds and to crop tolerance to the main triazine and urea derived herbicides. Two trials carried out on a silt loam soil at Levin in 1966 are described. In the first, the fresh emergence of weeds from seedbeds prepared during the months of September, October and November was recorded and trends in the density and distribution of species over the season were observed. During the three-month period full emergence occurred within three to four weeks of seedbed preparation.

Five chemicals were compared in the second experiment in applications made just before crop emergence and during the period of weed emergence. In the circumstances of the trial, no damage symptoms were observed during crop development but one treatment significantly reduced tuber yield.

INTRODUCTION

THE ADVENT of successful methods of chemical weed control in potatoes has provided a stimulus for the current interest in the effects of soil cultivation on the growing crop. Cultivation after planting, which has largely been accepted as a part of routine husbandry, is a corollary of mechanical weeding but only occasionally has it been clearly shown to be beneficial to the crop in itself. Under adverse weather conditions, for instance on wet and heavy soils, there may be value in cultivating a tilth after planting the crop, or the erosion of the soil cover may necessitate ridging operations to prevent tuber greening.

The weight of evidence is against post planting cultivation; soil moisture loss, root pruning, clod formation, haulm damage, spread of disease, increased frost susceptibility and inefficient plant spacing have all been attributed to cultivation practices. The possible advantages of replacing mechanical with chemical methods of weed control have been demonstrated in previous work (Cox and Elliott, 1965) and a comprehensive review of published work on the place of herbicides in the potato crop has been made by Stephens (1965). The present position in New Zealand has been summarized by Matthews (1966).

There is now a range of herbicides which, under suitable conditions, can give effective control of annual weeds and with their use soil cultivation may be reduced, or eliminated altogether, after the seedbed has been prepared and planted. In this paper the pattern of annual weed emergence which occurred after seedbed soil disturbance during spring and early summer at the Horticultural Research Centre, Levin, is described and local work on the tolerance of the potato variety Ilam Hardy to a range of chemicals with both soil and foliar action is reported. The results are related to previous work carried out in the United Kingdom and to the further development of chemical weed control methods.

ANNUAL WEED EMERGENCE

One of the major factors involved in bringing about the germination of most species in arable land is soil disturbance, and the work of Chancellor (1964) suggests that the significance or not of particular species as arable weeds may be determined largely by their germination response to cultivation and it can be expected that, during the normal sowing season, the act of preparing a seedbed will stimulate germination of the important species. The prevailing soil type and climate will affect the rate of emergence and density of the resulting population, but the pattern will normally be of numbers increasing to a peak during the weeks following seedbed preparation. This is illustrated by the following experiment which was carried out in 1966 on the Levin silt loam soil.

EXPERIMENT NO. Y377: THE EFFECT OF SEEDBED PREPARATION DURING THE MONTHS OF SEPTEMBER, OCTOBER AND NOVEMBER ON THE RATE AND DENSITY OF EMERGENCE OF ANNUAL WEEDS

The trial was laid out in small plots each 6 ft × 3 ft with four replicates on a winter ploughed site. Provision was made for twelve dates of seedbed preparation as detailed in Table 1 and at weekly intervals a fresh plot was rotary cultivated and raked to simulate normal practice on a larger scale. Before disturbing the soil, weeds already present were counted and removed and the fresh emergence then recorded at four weekly intervals. Observations were made beyond this period but further emergence was negligible on any treatment. The assessment area was contained in an 18 in. square fixed quadrat in each plot.

TABLE 1: EXPERIMENT NO. Y377—DETAILS OF TREATMENTS

<i>Number</i>	<i>Date of Seedbed Preparation</i>
1	September 8
2	15
3	22
4	29
5	October 5
6	14
7	21
8	27
9	November 4
10	10
11	18
12	25

Records of rainfall and soil temperature are given in Table 2. September Treatments 1, 2 and 4 were carried out under moist soil conditions, and heavy rain during the period September 16 to 22 resulted in a very wet seedbed on Treatment 3. During October, little rain fell (Treatments 5 to 8) and in November (Treatments 9 to 12) alternate periods of wet and dry weather occurred. Over the three months, soil temperatures rose steadily.

The pattern of weed emergence during the twelve-week period covered by the treatments is shown in Fig. 1. Early in the season after disturbing the seedbed, the greatest number of weeds appeared (Treatments 1 and

2). Treatment 3 gave a low count and the numbers rose on Treatments 4, 5 and 6 and then tended to fall off on the remaining plots as the season progressed.

From mid-September onwards, weeds began to appear on the ploughed land before treatment. The numbers did not seem to vary much with time (an average of 360 per sq. yd. was recorded on Treatments 3 to 12 inclusive) and these were killed when the seedbeds were made as they would be in normal practice.

Of the four main species occurring, *Polygonum persicaria* was the main constituent over the whole period of the experiment. *Coronopus didymus*

Fig. 1: Weed emergence from seedbeds prepared during September, October and November, 1966. Assessed 1, 2, 3 and 4 weeks after seedbed preparation.

TABLE 2: RECORD OF RAINFALL AND SOIL TEMPERATURE
AT 4 in. DEPTH

Period	Prior to Treatment No.	Total Rainfall (in.)	Average Soil Temp. (°F)
Sep. 2-8	1	0.56	44.6
9-15	2	0.97	45.7
16-22	3	1.94	50.9
23-29	4	0.98	50.5
Sep. 30-Oct. 5	5	0.19	50.5
Oct. 6-14	6	0.56	52.5
15-21	7	0.50	53.1
22-27	8	0.20	54.7
Oct. 28-Nov. 4	9	0.48	56.7
Nov. 5-10	10	1.80	57.7
11-18	11	0.19	58.1
19-25	12	2.31	55.6
Nov. 26-Dec. 3	—	0.01	59.2

germinated largely during the first five weeks of treatment and *Solanum nigrum* became of increasing importance during the second half of the experiment. *Chenopodium album* occurred fairly consistently throughout. These trends are shown in Table 3. Weed studies in potato seedbeds in the United Kingdom where climatic conditions generally give a shorter growing season and allow less flexibility in time of planting than is possible in New Zealand, have been carried out and some of the work has already been reported (Elliott and Cox, 1964). The period of weed emergence varies in duration according to site and season and seems to range from as little as three to as much as five or six weeks after seedbed preparation. Over the period of the experiment described

TABLE 3: PERCENTAGES OF CONSTITUENT SPECIES IN TOTAL
WEED POPULATION, 4 WEEKS AFTER SEEDBED PREPARATION

	Treatment No.											
	1	2	3	4	5	6	7	8	9	10	11	12
Date of seed- bed prepara- tion	Sep. 8	Sep. 15	Sep. 22	Sep. 29	Oct. 5	Oct. 14	Oct. 21	Oct. 27	Nov. 4	Nov. 10	Nov. 18	Nov. 25
<i>Polygonum</i> <i>persicaria</i>	48	60	67	65	47	75	66	71	79	82	63	70
<i>Chenopodium</i> <i>album</i>	5	14	14	8	7	11	21	7	3	7	18	11
<i>Coronopus</i> <i>didymus</i>	45	24	4	20	43	2	2	1	—	—	3	—
<i>Solanum</i> <i>nigrum</i>	2	2	13	5	3	12	10	21	17	11	12	16
Unidentified	—	—	2	2	—	—	1	—	1	—	4	3
Total	% 100	100	100	100	100	100	100	100	100	100	100	100
	No. 976	1,017	314	633	629	613	438	527	272	238	220	210

here, the indication was that emergence was substantially complete between three and four weeks after seedbed preparation. An indication of the indirect effect of the weather pattern on weed density was given by the low weed counts recorded during the very wet period in the early season and also towards the end of the experiment as drier conditions prevailed.

THE CHOICE OF CHEMICALS

The herbicide types which can be considered are conveniently grouped according to the way they act on the plant. The most important recent developments have occurred in a range of materials which are active through the soil and are taken up by the roots of plants. These are mainly triazine and urea derivatives and, in particular, those which also exhibit foliar activity have given good weed control with reasonable crop safety. Purely soil acting chemicals with a sufficiently long residual life, such as simazine or diuron, have given unreliable results in potatoes as the moist soil conditions needed for their activity against weeds also incur a greater risk of toxicity.

Several foliar applied materials, particularly paraquat and diquat, can give excellent control of emerged weeds but the potato has not shown satisfactory tolerance to any of these to allow applications after crop emergence to be recommended.

Neither has the potato shown a high degree of inherent tolerance to any of the combined soil and foliar acting materials, but the "depth protection" received by the root system normally makes possible techniques which safeguard the plant sufficiently from contact with the chemical. There are current recommendations for such materials as prometryne and linuron applied to the soil surface after planting and before shoot emergence and under conditions of adequate, but not excessive, rainfall and on a range of medium soils good results can be expected. Instances of crop damage have been reported, however, and in order to gain information on potato tolerance to a range of chemicals in this group on the Levin silt loam soil the following experiment was carried out.

EXPERIMENT NO. Y387: THE TOLERANCE OF POTATOES TO SEVERAL SUBSTITUTED UREA AND TRIAZINE HERBICIDES

Chitted tubers of the variety Ilam Hardy were planted by machine in two-row plots, spaced at 16 in. in the row and 30 in. between rows. The treated plots were 30 ft in length, reduced to 27 ft for harvest and single guard rows were planted between plots. The trial was laid out in a randomized block design of four replicates and was planted on September 26 after normal seedbed preparation and fertilizer application

TABLE 4: EXPERIMENT NO. Y387: DETAILS OF TREATMENTS

<i>Chemical</i>	<i>Doses (lb)</i>
Linuron	1, 2
Monolinuron	1, 2
Metobromuron	1, 2
Prometryne	1, 2
Ametryne	1, 2
Controls	

had been carried out. Routine fungicide applications for blight control were made necessary during the season and the plots were harvested using an elevator digger on January 24. Treatments, which are detailed in Table 4, were applied on October 13 when plants were beginning to emerge, using a tricycle plot sprayer delivering a spray volume of 30 gal/acre (all rates are given in lb a.i. per acre).

The optimum spraying time, intended to be just prior to the first appearance of potato shoots, had been delayed by unsuitable weather conditions and, in order to avoid direct contact with the foliage, visible potato shoots were covered with small pots during spraying. The confusing effect of weed competition was avoided by keeping the whole trial weed-free throughout its life. At the same time as the treatments were applied, controls plots received ½ lb/acre of paraquat/diquat mixture to remove emerged weeds (mainly *Polygonum persicaria*). Any weeds appearing thereafter were removed either by hand with minimum soil disturbance or with paraquat/diquat applied at very low pressure between the rows with the aid of an experimental hand-pushed weeder incorporating a "Vibrajet".

An assessment carried out on November 2 when the plant foliage was approximately 9 in. in diameter showed a very uniform crop with no apparent treatment differences and no visible signs of herbicide damage. The yields obtained are shown in Table 5.

TABLE 5: EXPERIMENT NO. Y387—TOTAL TUBER YIELDS

<i>Treatment (lb)</i>	<i>Yield (tons/acre)</i>
Linuron 1	17.6bcAB
Linuron 2	20.0abA
Monolinuron 1	19.4abA
Monolinuron 2	15.9cB**
Metobromuron 1	18.5abA
Metobromuron 2	19.3abA
Prometryne 1	19.2abA
Prometryne 2	18.8abA
Ametryne 1	19.2abA
Ametryne 2	19.1abA
Control mean	19.1
CV	6.5%

**Differs from control mean at 1% level of significance.

Only one treatment, monolinuron at 2 lb, significantly reduced yields below the mean control level of 19.1 tons/acre. Grading of the produce was carried out according to tuber size and no further treatment differences were detected.

CONCLUSIONS

Previous experience with these combined soil and foliar acting chemicals has shown that, although the group as a whole offers the best possibility

*Trade mark of Plant Protection Ltd., Fernhurst, Haslemere, Surrey, England.

of general purpose weed control at the present time, usually with advantages over alternative cultivation practices, the crop safety margin is not great and depends on application rate, soil type, rainfall and other factors. A dose of 1 lb may not give sufficient residual action and at 2 lb yields may be reduced as has happened with one of the materials included in the experiment above. The combination of circumstances leading to crop damage can be complex and small yield depressions are not easily detected or, indeed, may still be considered an acceptable improvement on previous methods. Annual weeds are most easily controlled if encouraged to germinate early in the life of the crop and here a purely foliar acting chemical has an important role. But even if no cultivation is carried out after seedbed preparation it is unlikely that full weed emergence will always occur before the potato shoots begin to appear. It is also unusual for a single chemical to have the optimum balance of soil and foliar activity and the dose required for control of emerged weeds is unlikely to match that which can give best residual action with crop safety. On technical grounds, it is suggested that the ideal future treatment for weed control in potatoes will consist of either a single application of a mixture of a purely foliar acting chemical with a soil acting residual material having a high degree of crop safety, applied before crop emergence, or of a foliar acting spray before crop emergence followed by one of a material which is selective post-emergence in potatoes. From the viewpoints of cost and disturbance of the developing crop, the first alternative seems the more desirable.

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