Research Report No. B.5.

A NEW METHOD OF SELECTIVE WEED CONTROL FOR RELATED PLANTS, IN PARTICULAR BROAD LEAF WEEDS IN BEET

W. E. Ripper

Fisons Pest Control Limited, Cambridge

Several speakers yesterday referred to the problem of developing herbicidal effects with selectivity between closely related plants of which one is a crop plant and the other a weed. The question was raised whether the biochemist can be fairly requested to uncover mechanisms which can be exploited in this way, because herbicides have hitherto been given selective action either by making use of physiological differences between the crop plant to be left unaffected and the uneconomic plant to be destroyed or by exploiting physical differences in the cuticle of the plant which cause the weed to retain and absorb more of the weedkiller than the economic plant. The two methods of differential action have enabled us to develop many valuable weedkillers; but so far it has not been possible to formulate a herbicidal compound which can distinguish between plants of closely related genera, of which one is a weed and the other a crop.

The development of a method of control of broadleaved weeds in beet was faced with just this problem in respect of Chenopodium album; a similar difficulty is posed by charlock in rape, by black grass and other annual grasses in cereals, by wild oats in barley etc. . . As the conventional methods of to-day do not provide a sufficient margin of selectivity, experiments were made using adsorbents to give the crop plant additional protection whilst using conventional pre-emergence weedkillers.

Hartley (1) has described the use of charcoal mixed with the seed of a crop followed by an application of pre-emergence weedkiller, but this arrangement also protected the weed seed which germinated in the band of charcoal and so did not effect any weed control in the actual row of the crop. Coating the seeds with charcoal (2 and 3) was tested by Linser (4), on seeds of cereals, maize, peas and clover. When we tried this technique with beet it led in our experiments to a delay in the germination and sometimes to inadequate protection as the radicle very soon penetrates into contaminated soil. Any delay in the emergence of the beet is considered undesirable.

To achieve the two objectives of killing the weeds in the beet row and of protecting the beet seedlings sufficiently to make up for the not quite adequate selectivity of herbicides, the beet seed had to be given enough time to germinate and to grow in soil uncontaminated by the pre-emergence weedkiller until the germinating weeds above the adsorbent sandwich had been killed, and the weedkiller had been attenuated by evaporation, decomposition or otherwise to a concentration which could not damage the young beet plant when it broke through the adsorbent layer.

The method consists of 5 steps; A. a seed furrow is opened and a seed is placed therein; B. the seed furrow is partly filled in and if necessary consolidated; C. a narrow band of adsorbent is sprayed or placed in the partly filled in furrow; D. the furrow is completely filled in and consolidated; E. a 6-12 in. band of pre-emergence weedkiller is sprayed on the top of the soil (see Fig. 1).

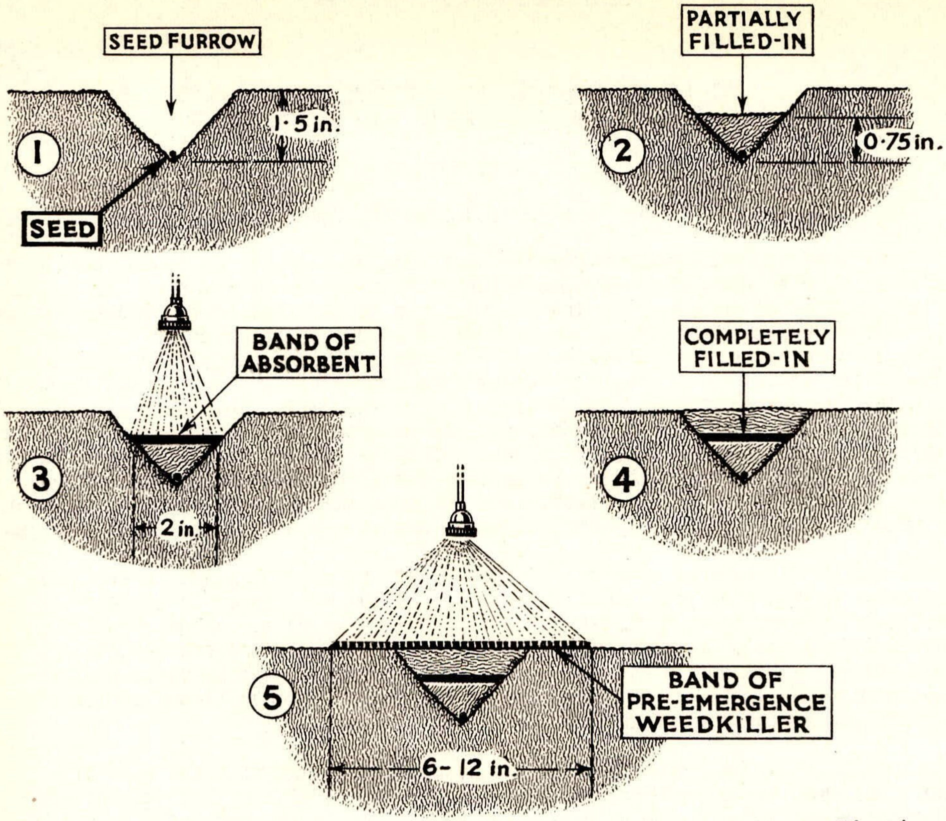
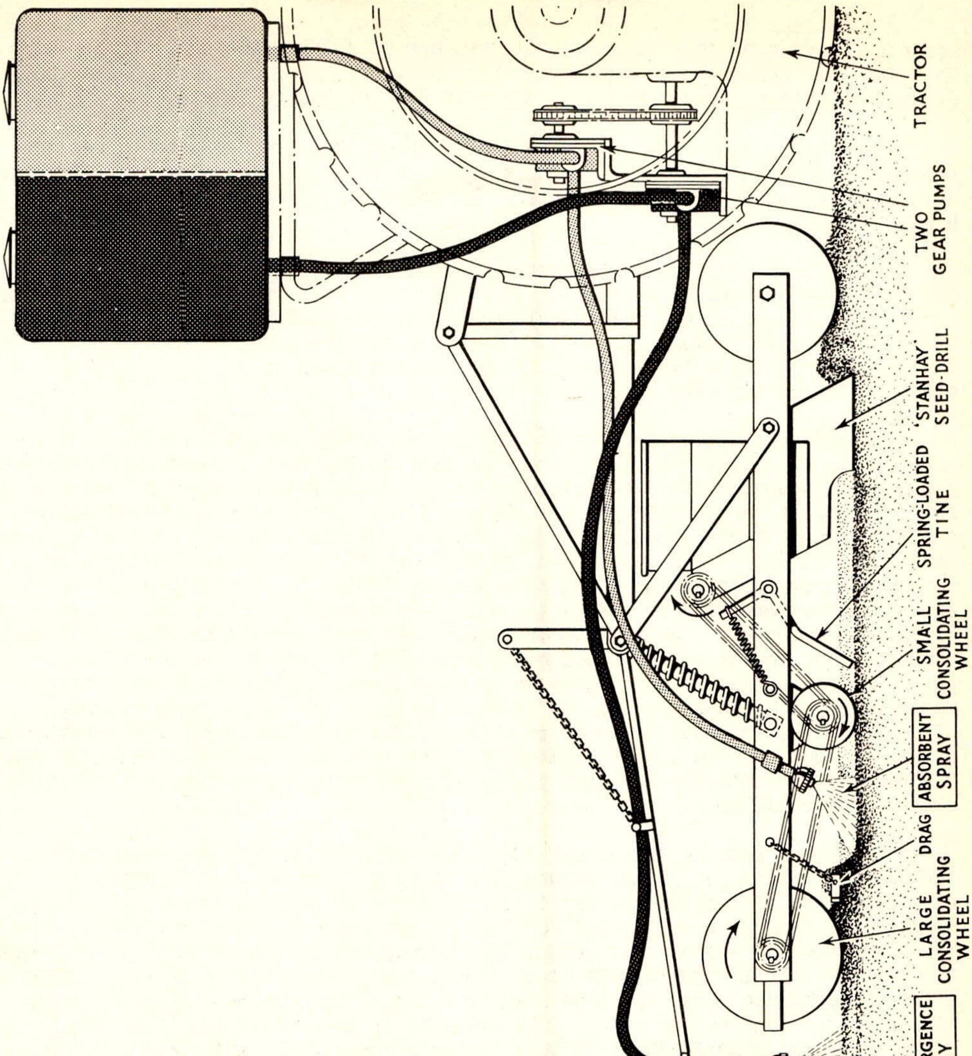


Fig. 1

After we satisfied ourselves in field experiments that the above mentioned steps when carried out manually and sprayed by the Oxford Precision Sprayer, performed in the desired manner, a suitable implement was designed, constructed and field tested which performs operations A to E in sequence and in one agricultural operation. For this purpose a band sprayer as made by Fisons Pest Control Limited (model "Beetmaster) was fitted to a modified Stanhay spacing drill, and a second spraying system for the adsorbent introduced. This consisted of a tank, filter pump, controls, pipes and hoselines and nozzles spraying immediately behind the partial filling-in tine and before the consolidating wheel (see Fig. 2). After some development work this implement was made to work well and was used to study the utility of this method of selective weed control in field experiments.

The sandwich of adsorbent remained visible for the rest of the year on cutting a profile of the soil, but the protective effect was lost when the beet plant penetrated the adsorbent. 2,3,6-Trichlorobenzoic acid was found useful to demonstrate this phenomenon because of its dramatic effect on beet when the beet plant penetrated the adsorbent sandwich.

Fig. 2


TRACTOR
TWO GEAR PUMPS
'STANHAY' SEED-DRILL
SPRING-LOADED TINE
SMALL CONSOLIDATING WHEEL
ABSORBENT SPRAY
DRAG
LARGE CONSOLIDATING WHEEL
PRE-EMERGENCE SPRAY

A considerable number of herbicides were tested, including propham, MCPA, monuron and diuron, in a series of experiments on sandy light soil at Docking, Norfolk. As adsorbents, various types of activated charcoal were used alone or diluted with inert or adsorbent carriers at various dosage levels.

Parker (5), Nelson (6) and others have shown that propham often gives good control of wild oats and grasses in beet and at the same time controls Polygonum aviculare and other broad leaved weeds but occasionally causes damage to the beet.

With a view to obtaining adequate control of Polygonum aviculare, Chenopodium album and Convolvulus arvensis in beet with propham emulsions and to produce a reliable method which would not cause damage to the beet, adsorbent bands of 2 in. width were placed 0.75 in. over each beet row which was sown 18 in. apart and some 1.5 in. deep. Band applications of 35, 70 and 100 lb/ac of activated carbon were compared.

The method of investigating the protective effect of the adsorbent was to arrange on one tool frame four Stanhay seeding units, two of which were standard and two had been modified for adsorbent placement. This arrangement was used to drill 2 rows of beet at a depth of 1.25 and 1.5 in. with adsorbent application and two further beet rows without the adsorbent at the same depth and to repeat this three times. This gave a plot wide enough for one spraying width with a variable dosage sprayer according to Pfeiffer, Brunskill and Hartley (7) which was used immediately after sowing to apply decreasing quantities of the weed-killer to be tested. When beets and weeds were well established the beets were counted using the standard method of beet population counts, generally used prior to mechanical thinning; the weeds were counted in one foot quadrats and categorised as killed, stunted and normal plants. The counts were repeated after six weeks in order to discover which of the affected plants had recovered. It was obvious even to superficial observation that the adsorbent protected rows reached further into the area sprayed by the higher concentrations of the pre-emergence weedkiller.

Histograms showing the dosage ranges which produced complete eradication, permanent stunting, or normal growth of crop plants and weeds illustrate the utility of the effect and the additional selectivity achieved (see Fig. 3, also Table 1). Similar results were obtained in numerous repetitions of these field experiments which showed that weedkillers with marginal selectivity, if they are transient within the definition given above, are sufficiently adsorbed in the adsorbent sandwich above the crop seed to protect the crop even when the weed-killer is carried down by rain. The evidence to date indicates that this method overcomes the failures through the occasional toxic effect of propham on beets.

Field experiments with the same technique for the control of broadleaved weeds in Brassica crops with MCPA and propham, and of black grass in wheat and barley have shown that rape sown at a depth of 1.5 in. with an adsorbent sand-wich at 0.75 in. above the seed was sufficiently protected against MCPA, while the weeds susceptible to MCPA were controlled. In a similar way weeds susceptible to propham were killed with this pre-emergence weedkiller without affecting the rape. (see Fig. 4 and Table 2).

EXPONENTALLY DECREASING DOSAGES of PROPHAM on SUGAR BEET, BROAD-LEAVED WEEDS & GRASSES

ERADICATION ······
IRRECOVERABLY STUNTED
STUNTED, BUT RECOVERED ···
NORMAL ···········

YARDS	lb/ac/ PROPHAM	SUGAR BEET in./100 in./ ROW 1 WITH ABSORBENT	ROW 2 WITH ABSORBENT	ROW 3 WITHOUT ABSORBENT	ROW 4 WITHOUT ABSORBENT	KNOTGRASS		FAT HEN		CHICKWEED		SPEEDWELL		BINDWEED		FUMITORY		ANNUAL MEADOW GRASS	
7	8·9	8	8	9	9														
8	7·7	16	13	9	7														
9	6·85	10	8	7	13														
10	6·05	13	9	11	7														
11	5·3	12	11	13	9														
12	4·6	9	11	10	6	0	0			0	0								
13	4·2	15	8	13	13	0	0							0	0				
14	3·65	16	8	11	12	0	0												
15	3·3	13	14	5	14	2						0	0						
16	2·75	15	12	9	8	1		2		0	0			1	0				
17	2·42	13	8	8	8	3		0											
18	2·12	9	12	9	14	1		0										0	0
19	1·88	7	11	12	11	1		0		0	1	2	0					0	0
20	1·66	6	9	7	10			0										2	0
21	1·42	13	11	9	13			0						0	0	0	1		
22	1·26	14	12	9	6			1				0	0						
23	1·1	15	10	8	8											1	0	0	0
24	0·98	12	9	11	8													0	0
25	0·86	18	7	12	7	1		0		7		1				5	0	1	
26	0·75	15	11	10	10									4					
27	0·67	17	7	7	7														
28	0·6	1	13	14	8														
29	0·51	10	10	10	12			2											
30	0·46	13	9	13	16			1		3		2		1					

Fig. 3

Black grass in cereals was controlled in the same way without affecting the wheat, which was sown 2 in. deep; in similar experiments with wild oats using propham, wild oat seeds germinating under the adsorbent band or very deep in the soil were not controlled by the pre-emergence weedkiller, while the others were killed with higher dosages of propham.

Further field experiments under different climatic conditions are in progress and the factors involved are being analysed in growth chambers using various types of soil. While a great deal of work has still to be done before recommendations for practical use can be made, the results so far obtained show that the placement of an adsorbent layer in the soil above the seed increased the selectivity of pre-emergence treatments with herbicides so that a control of weeds related to the crop plant was possible; in particular many broadleaved weeds in beet and several grass weeds in cereal crops were controlled in an economic way, which proved practical under field conditions.

The author is indebted to Dr. N. H. Pizer of the National Agricultural Advisory Service for advice on soil chemistry, to Mr. O. Rose of the British Sugar Corporation for advice on sugar beet problems, to Dr. D. H. Sharp of Fisons Pest Control Limited for the supply of absorbents and advice on their performance, also to Mr. C. W. Thaxton for assistance with field work.

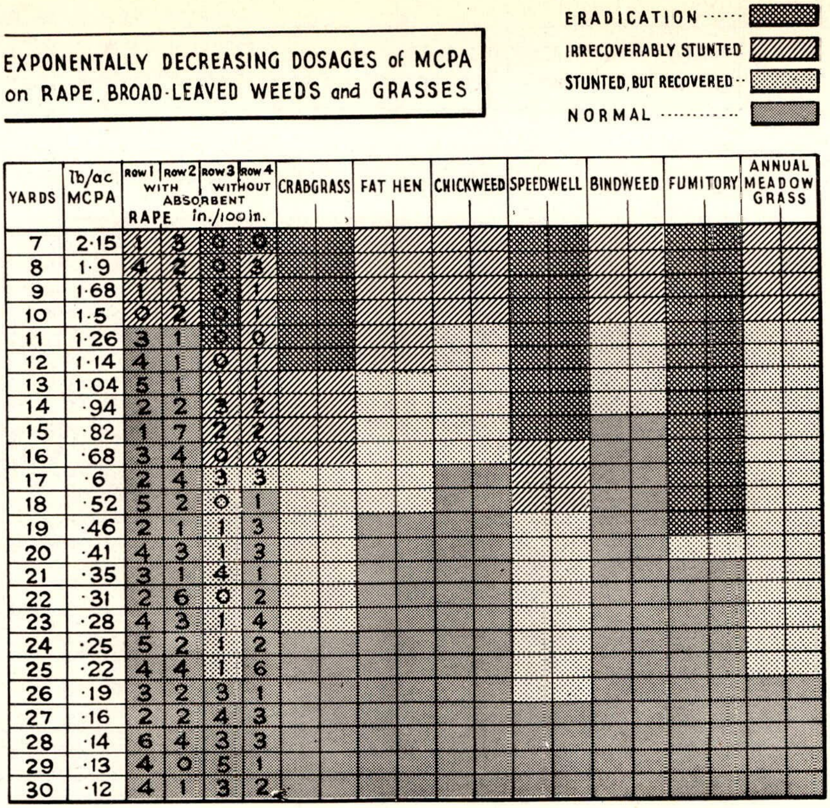


Fig. 4

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Table 1

	Highest concentration of propham in lb/ac at which the crops grow normally	
Crop	Without adsorbent	With 35 lb/ac adsorbent
Beet	2.75	5.3
Rape	2.75	5.3

	Lowest concentration of propham/ac at which weeds are	
Weeds	Eradicated	Permanently stunted
Chenopodium album	4.63	4.2
Polygonum aviculare	4.63	2.42
Galium aparine	5.3	1.5
Convolvulus arvensis	4.2	3.3
Veronica chamaedrys	3.3	2.4
Fumaria officinalis	1.88	1.2
Poa pratensis	2.42	1.88

Table 2

	Highest concentration of MCPA in lb/ac at which the crops grow normally		
Crop	Without adsorbent	With adsorbent/ac	
		35 lb	70 lb
Rape	0.22	0.6	1.5

	Lowest concentration of MCPA/ac at which weeds are	
Weeds	Eradicated	Permanently stunted
Chenopodium album	>2.15	1.14
Polygonum aviculare	1.14	0.68
Galium aparine	>2.15	1.5
Convolvulus arvensis	>2.15	1.5
Veronica chamaedrys	0.82	0.52
Fumaria officinalis	0.52	0.46
Poa pratensis	>2.15	1.5

DISCUSSION ON THE PREVIOUS PAPER

Dr. K. Holly

I have one question on this most original technique. Everything would seem to depend upon the efficiency of the adsorption. Could Dr. Ripper tell us whether he found much difference between the adsorbents diluted with different carriers and also whether particle size of the adsorbent is of great importance.

Dr. W. E. Ripper

Dr. Holly is perfectly right. Everything depends on the adsorbent and there are many different grades on the market. We have currently, together with Dr. Scott, carried out studies in the laboratory to find out which adsorbents are required for the various pre-emergence weedkillers, dealing with physical characteristics of the adsorbent. We have had much help in this work by my colleague Dr. Sharp who is a specialist on adsorbents. It is rather an involved problem and would appear that we were very fortunate in our original selection of adsorbents for use with propham. There is no doubt that a great deal of work remains to be done.

THE EFFECTS OF SOME NEWER HERBICIDES ON ANNUAL GRASS WEEDS

K. Holly

Agricultural Research Council
Unit of Experimental Agronomy, Oxford

Summary

The response of Avena fatua and Alopecurus myosuroides to pre- and post-emergence applications of 33 potential herbicides was investigated in pot experiments. A number of chemicals were found to be sufficiently toxic to warrant detailed investigation of their selectivity in crops in which these weeds are a problem.

Introduction

There are only a very small number of annual grass species which are of consequence as weeds in Britain but three of these are of major importance in agriculture. These are wild oats (Avena fatua and Avena ludoviciana), which can be troublesome in most arable crops but particularly so in cereals, and blackgrass (Alopecurus myosuroides) which is primarily a weed of autumn-sown cereals and of herbage seed crops. Present methods of control are almost wholely cultural and only partially effective. An efficient chemical method of selective control of any of these weeds in the crops in which they are important would be of immense value. Accordingly, such potential new herbicides as have been made available to us have been tested on a pot scale for their toxicity to these two annual grasses both as pre-emergence and foliage applications and the results are presented in this report.

Methods

Cultural conditions varied somewhat between experiments and relevant points are given in the presentation of results. All spraying was done with special laboratory apparatus embodying a fan nozzle, through which the spray liquid was pushed by compressed air at 30 p.s.i. This nozzle was moved mechanically over the pots at a constant speed. The dose levels of each compound were selected on the basis of existing knowledge so as to be within the range at which many plants were affected but not so high as to be above the range in which any selectivity is likely to occur. Spray solutions or suspensions made up in water for post-emergence application always contained a surface-active agent [Teepol] to ensure thorough wetting of the foliage. Compounds insoluble in water and which would not give satisfactory suspensions were dissolved in acetone, which is non-toxic at the amounts used. Pre-emergence treatments were always applied on the day after sowing. No system of mechanical incorporation of the herbicide into the soil was used.

Watering after treatment was by a combination of even overhead watering in measured amounts and sub-surface irrigation. Treatment effects were assessed by recording the number and fresh weight of the above-ground parts of plants that survived for 3-6 weeks after treatment. Counts of plant emergence were also made after pre-emergence treatment.

Results

The main experiment was conducted on plants grown in a 2:1 soil-sand mixture in 8 in. diameter pots, and involved pre-emergence applications to A. fatua, sown approximately 0.8 cm deep on the preceding day, and post-emergence applications to A. fatua seedlings at the 2-leaf stage and A. myosuroides seedlings at the 3-leaf stage when commencing to tiller. A.ludoviciana was not included as an earlier experiment had shown that it did not differ appreciably from A. fatua in its response to foliage applications of amino triazole, various substituted ureas, and dalapon (full chemical names together with the contractions used are given in Figure 1).

The spray was applied at a volume rate of 22 gal/ac. The weekly totals of natural rainfall plus overhead watering during the month immediately following spraying were 0.08, 0.68, 0.69 and 1.12 in. successively.

The results of this experiment are presented in Figure 1, supplemented in a few instances with comparable data from other experiments. Similar chemicals are grouped together for convenience of discussion. The list is headed by TCA which has already found practical use for the selective control of annual grasses, including A. fatua in some situations. This chemical acts primarily as the result of root uptake and in consequence is more effective as a pre-emergence treatment. The results obtained on A. fatua at 2 lb/ac are typical of the effects obtained with TCA at low doses. Many of the plants emerged and remained alive but failed to make any growth. As a post-emergence treatment it was quite effective at the higher dose, particularly on A. myosuroides, but was much less toxic than the related dalapon which is readily absorbed by the foliage. The effect of the latter compound on A. fatua has already been studied in some detail (1). Dalapon was particularly effective on seedlings of A. myosuroides at the low dose of 1.5 lb/ac and was also of the same order of effectiveness as TCA as a pre-emergence treatment on A. fatua. Trichloropropionic acid was as effective as dalapon as a pre-emergence treatment on A. fatua but was markedly inferior as a post-emergence treatment on both species.

Another group of compounds chemically related to TCA, including trichloroacetanilide, trichloroacet-chloroanilide, trichloroacet-toluidide and trichloroacetylurea, all had only a small effect as post-emergence sprays but resembled TCA in having a considerable effect when applied pre-emergence to A. fatua. Only the last-named compound approached TCA in effectiveness as a pre-emergence weedkiller, but all these compounds may have some advantage over TCA in being relatively water insoluble and thus resistant to leaching. The selectivity of these compounds as pre-emergence sprays was investigated in two separate experiments on a wide range of species grown in soil in 'flats'. Although many dicotyledonous plants were much more resistant to them than were any of the grasses, no indication was obtained that they possessed a selectivity markedly greater than that of TCA. Dichloral urea is another compound taken up only through the roots and reputed to have some selectivity as a killer of grasses when used as a pre-emergence spray. This was verified in a separate experiment on a wide range of species grown in soil in 'flats'. Results from this experiment are given in Figure 1 and show that although A. myosuroides was susceptible, A. fatua was very much more resistant.

The substituted ureas fenuron and monuron, and to a lesser extent the even less water soluble diuron, were highly effective as pre-emergence treatments on A. fatua at low doses. A later experiment, also in a soil-sand mixture in pots, and including a wider range of doses, again indicated a considerable susceptibility to this type of compound, with monuron somewhat superior in effect to fenuron and diuron. These compounds also had a very considerable effect on A. fatua when applied post-emergence, even though it is generally accepted that they are taken into the plant primarily through the roots. The data presented in Figure 1 indicate fenuron and monuron to be superior to diuron when applied to seedlings. Further data on the effect of these three compounds on A. fatua seedlings at stages of growth from 2 leaves to 4 leaves is available from three other experiments. In all instances the plants were grown in a soil-sand mixture in pots and had an appreciable amount of overhead watering or rain after treatment. The results verified the inferiority of diuron but the relative effectiveness of fenuron and monuron was variable. Control of A. myosuroides seedlings was very nearly complete with all three compounds, the apparent inferiority of diuron at the lower dose being due to the near-normal growth of a single survivor.

Neburon was not available at the time of the main experiment but was subsequently compared with diuron in a pre-emergence application to plants sown in soil in 'flats'. At equivalent doses on A. fatua it was markedly inferior to diuron, which gave results comparable to those obtained in the main experiment. It had more effect on A. myosuroides but was again inferior to diuron. Chloro-ethylamino-triazine at only half the dose was slightly more effective than neburon on both species in the same experiment, but was more outstanding for its marked toxicity as a post-emergence spray to seedlings of both species in another experiment on plants grown in a soil-peat mixture.

Amino triazole is in a class by itself and is noteworthy as being readily absorbed and translocated by foliage. The effect of this compound as a pre-emergence soil treatment was relatively slight on both species but 2.5 lb/ac gave complete control as a foliage spray on seedlings of both plants. This effect was verified on A. fatua seedlings in two further experiments, though in one instance the plants were not completely killed but they suffered a virtual cessation of growth.

It has already been established that CIPC is a useful pre-emergence herbicide for the control of A. fatua and A. myosuroides. The results of the present experiment verified this, though indicating that survivors of the former species make considerable growth. Seven other substituted carbamates were tested but all except isopropyl methylphenyl carbamate were markedly inferior to CIPC on both species.

CDEC, CDEA and CDAA were all relatively ineffective except in so far as the first mentioned gave good pre-emergence control of A. myosuroides in a separate experiment in soil in 'flats'.

Some chemicals of the synthetic growth regulator type were tested. 3,4-DA had been reported from Canada to have some effect on A. fatua (4) but in this instance it caused only a partial reduction in growth. 2,3,6-TBA had little killing effect but caused a very marked reduction in growth of A. fatua when applied at 2.5 lb/ac pre-emergence. Similarly, NPA had little killing effect but caused a very severe reduction in growth of A. myosuroides when applied pre-emergence to plants sown in soil.

Maleic hydrazide was very toxic as a post-emergence spray to seedlings of both species and to a rather lesser degree as a pre-emergence application to A. fatua. In Canada the application of this compound at 0.5-1.0 lb/ac to A. fatua at the post-flowering 'milk stage' has been found to almost completely prevent the formation of viable seed (3). In an attempt to verify this a pot experiment was conducted jointly with Miss Thurston of Rothamsted (5) on

A. fatua and A. ludoviciana, in which 1 lb/ac of MH was applied at three different stages of growth, at and after flowering. Such treatment caused some reduction in seed number and weight of both species and at the most susceptible stage of growth reduced total viable seeds produced by approximately two-thirds and the number of viable but dormant seeds by over three-quarters. However, nothing short of complete prevention of viable seed production would appear to be of practical value in view of other difficulties in the application of the technique.

Of the remaining compounds, endothal had a considerable effect as a post-emergence spray on both species, but much less when applied pre-emergence to A. fatua. With hexachloroacetone the reverse was true and a relatively high dose seemed necessary. Dinoseb has been reported to be an effective pre-emergence herbicide in some circumstances but in this experiment was without effect on A. fatua; as a post-emergence application it caused considerable reduction in growth but no appreciable kill of A. myosuroides.

Discussion

The object of the present study was to determine whether there were any compounds among the newer herbicides worthy of more detailed study as possible selective weedkillers, for the control of annual grasses.

The main difficulty with wild oat is that selective control of an annual grass in other annual grass crops is required. Among the chemicals found to be effective as post-emergence sprays, dalapon, amino triazole, maleic hydrazide, endothal and the substituted ureas are already known to be highly toxic to grass and other crops in which wild oats are a problem and it is difficult to see how they can be utilised. The manufacturers of amino triazole have indicated that cultivated oats possess some resistance to this chemical but a detailed experiment showed that they were as susceptible as wild oats. The only other highly effective compound was chloro-ethylamino-triazine whose selectivity certainly warrants careful investigation.

Blackgrass seedlings were controlled by the same compounds that killed wild oats. In addition CIPC was quite effective. The latter has some selectivity in grass seed crops (2) and some of the other compounds may warrant investigation in this connection.

For the selective control of wild oats there appears to be more promise amongst chemicals which might be used for pre-planting and pre-emergence treatments. TCA has already found practical application in this way in sugar beet, and the related dalapon, trichloropropionic acid and trichloroacetylurea require further investigation of their selectivity. Although the substituted ureas are highly toxic to wild oat their liability to cause crop damage makes them too unreliable and dangerous to use. Of the carbamates the selectivity of isopropyl methylphenyl carbamate requires investigation in comparison with CIPC. Only a few compounds were tested pre-emergence on blackgrass but of these chloro-ethylamino-triazine, NPA and CDEC warrant further consideration.

Pot experiments of the type described in this report indicate chemicals that are worthy of further study. Much experimental work remains to be done before it can be determined whether any such chemicals can form the basis of a successful practical technique for the selective chemical control of these weeds.

Acknowledgements

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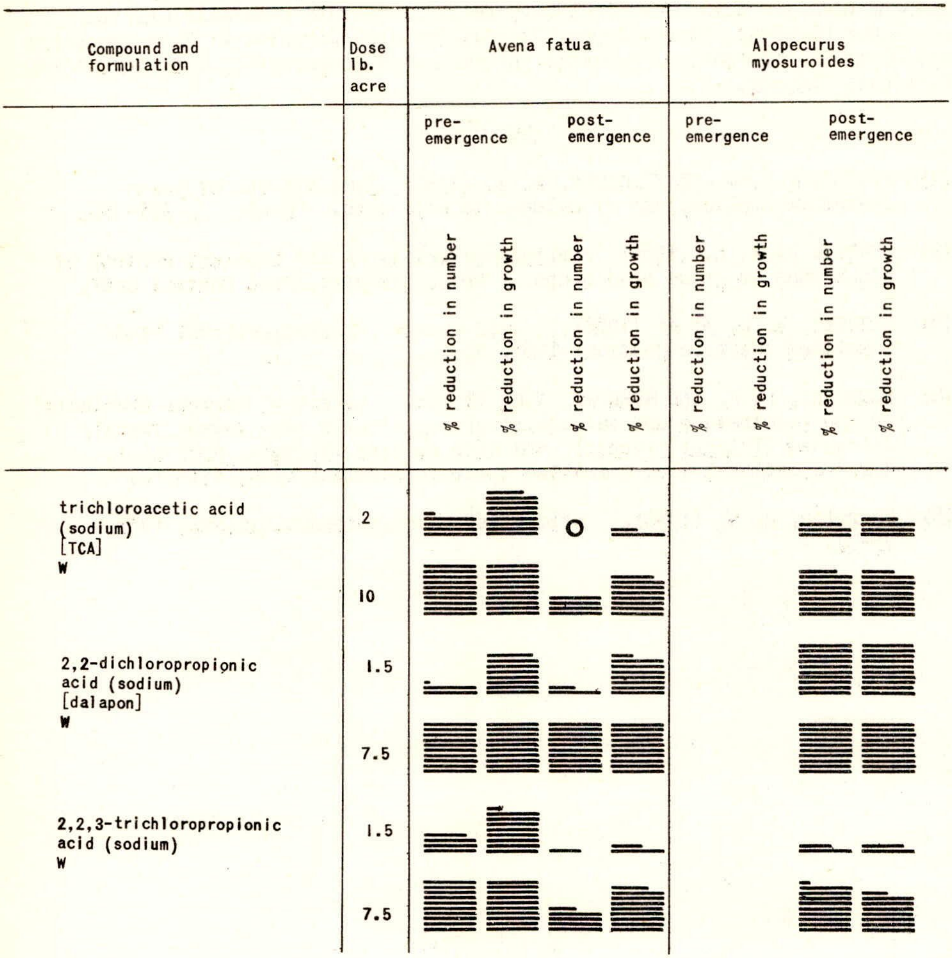
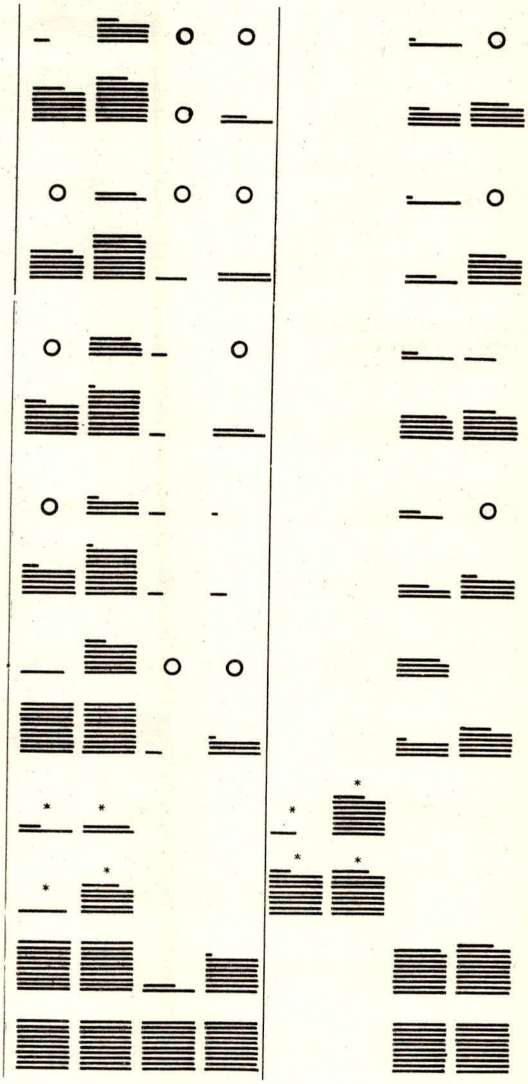
Figure I

The percentage reduction in number and in the fresh weight of survivors of two annual grasses when treated pre- and post-emergence with a variety of compounds.

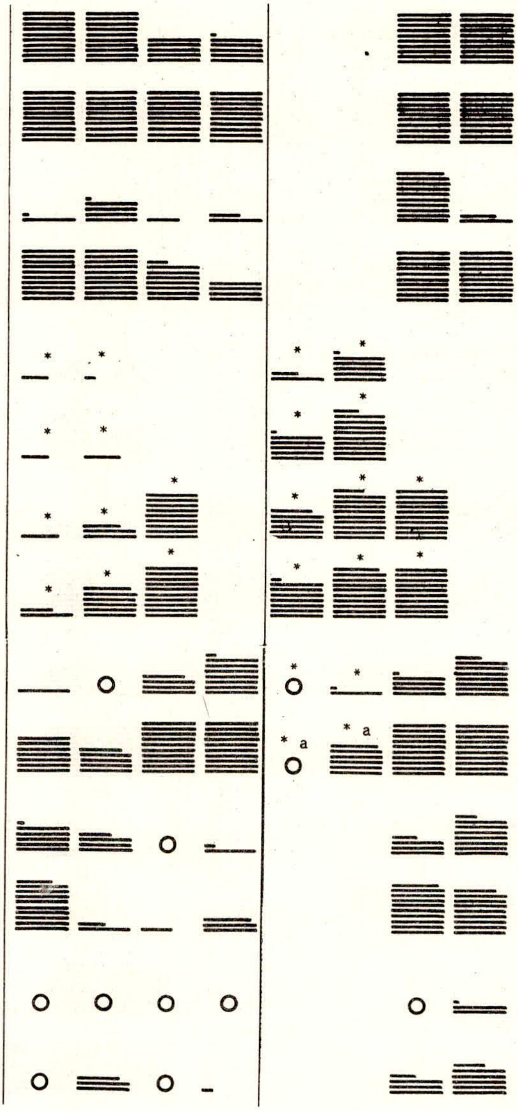
Each completed horizontal line within a column represents 10 per cent and the length of uncompleted lines is in proportion thereto.



trichloroacetanilide A	2
	10
trichloroacet-3- chloroanilide A	2
	10
trichloroacet-3- toluidide A	2
	10
trichloroacet-4- toluidide A	2
	10
trichloroacetylurea A	2
	10
dichloral urea [DCU] P	2
	8
3-phenyl-1,1- dimethylurea [fenuron] P	0.4
	2



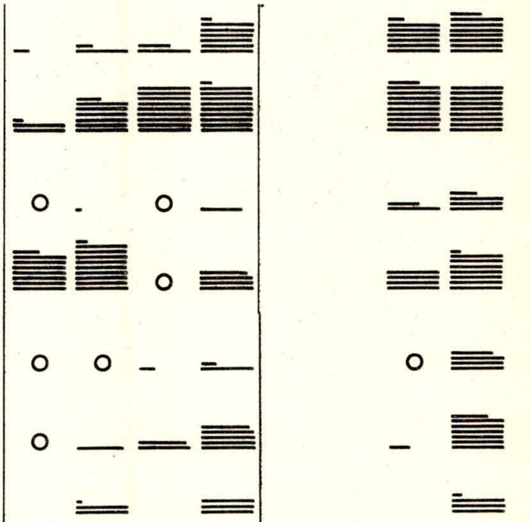
3-(p-chlorophenyl)-1,1-dimethylurea [monuron] P	0.4
	2
3-(3,4-dichlorophenyl)-1,1-dimethylurea [diuron] P	0.4
	2
3-(3,4-dichlorophenyl)-1-methyl-1-n-butylurea [neburon] P	0.5
	2
2-chloro-4,6-bis-(ethylamino)-s-triazine P	0.25
	1.0
3-amino-1,2,4-triazole W	0.5
	2.5
isopropyl N-(3-chlorophenyl) carbamate [CIPC] A	1
	5
sec-butyl N-(3-chlorophenyl) carbamate A	1
	5



2-chloroethyl N-(3-chlorophenyl) carbamate A	1	O	—	O	O	—	≡
	5	≡	≡	—	O	≡	—
2-(1-chloropropyl) N-(3-chlorophenyl) carbamate A	1	O	=	O	O	=	=
	5	—	≡	O	=	≡	≡
isopropyl N-(2-methoxy-5-chlorophenyl) carbamate E	1	O	—	O	O	—	O
	5	O	O	O	O	=	O
isopropyl N-(3-methylphenyl) carbamate A	1	≡	≡	O	O	=	≡
	5	≡	≡	—	—	≡	≡
2-chloroethyl N-(3-methylphenyl) carbamate A		O	—	—	O	O	O
	5	≡	≡	—	=	≡	≡
2-(1-chloropropyl) N-(3-methylphenyl) carbamate A	1	O	—	O	O	=	O
	5	≡	=	—	—	≡	≡

2-chloroallyl diethyldithiocarbamate [CDEC] E	1.5	O	O	O	O	* b ▬	* b ▬	▬	▬
	7.5	▬	▬	O	O	* b ▬	* b ▬	▬	▬
2-chloro-N,N-diethylacetamide [CDEA] E	1.5	O	O	O	O			▬	▬
	7.5	▬	▬	O	▬			▬	▬
2-chloro-N,N-diallylacetamide [CDAA]	1.5	O	▬	O	O			O	▬
	7.5	▬	▬	O	▬			▬	▬
3,4-dichlorophenoxyacetic acid (triethanolamine) [3,4-DA] W	0.5	O	▬	▬	O				
	2.5	O	▬	O	▬				
2,3,6-trichlorobenzoic acid (sodium) [2,3,6-TBA] W	0.5	▬	▬	O	O			▬	▬
	2.5	▬	▬	▬	▬			▬	▬
N-1-naphthyl phthalamic acid [NPA] P	1	O	▬	O	O	* O	* ▬		
	5	▬	▬	O	O	* c ▬	* c ▬		
maleic hydrazide [MH] W	1.5	▬	▬	▬	▬			▬	▬
	7.5	▬	▬	▬	▬			▬	▬

3,6-endoxohexahydrophthalic acid (sodium) [endothal] W	1.5
	7.5
hexachloroacetone B	2
	10
4,6-dinitro o-sec-butylphenol (triethanolamine) [dinoseb] W	0.5
	2.5
S.D. [P=0.05]	



Formulations: W = water solution
A = acetone solution
B = alcohol solution
E = emulsion in water
P = wettable powder in water

Footnotes: * = data are from subsidiary experiment
a = dose was 2 lb/ac in this instance
b = doses were 3 and 6 lb/ac respectively
c = dose was 4 lb/ac in this instance

PRELIMINARY TRIALS ON THE CHEMICAL CONTROL OF BLACKGRASS IN GRASS SEED CROPS

R. S. L. Jeater

National Institute of Agricultural Botany, Cambridge*

Summary

Trials were conducted to determine a method for the chemical control of blackgrass (Alopecurus myosuroides) in crops of perennial grasses for seed in their second harvest year.

In crops sown in drills satisfactory control was obtained by applying CIPC and propham at 2 and 4 lb/ac in October. CIPC at rates as low as 1.5 lb/ac applied in November 1954 was also successful. Except for CIPC at 4 lb/ac application in September did not give an adequate control.

Timothy, meadow fescue and cocksfoot sown in drills were not harmed by either CIPC or propham at rates up to 4 lb/ac applied in September and October. The application of CIPC at 3 lb/ac in November damaged timothy in 1955. There was no visible effect on broadcast crops of perennial ryegrass by the September application of these chemicals but later treatments resulted in crop damage.

Blackgrass was absent from broadcast crops of perennial ryegrass coming up for the second harvest year. The crop in this case may have suppressed germination and growth of this weedy annual grass.

Introduction

Annual grasses are a major weed problem in crops of perennial grasses grown for seed. They not only compete with the crop in the field but also lower the quality of the harvested seed. In some seed growing areas one of the most troublesome of these annual grasses is blackgrass. This is often associated with the heavier types of soil where control by cultivation is not always possible. A chemical method for the selective control of this weed grass would therefore be of great importance.

Freed (1) reported from Oregon that the application of 4 lb/of either propham or CIPC in October to well-established seed crops of alta fescue and creeping red fescue gave a satisfactory control of annual weed grasses without damaging the crop. In 1954 preliminary trials were started from the National Institute of Agricultural Botany to determine if a similar technique could be used for the control of blackgrass in grass seed crops in this country.

Experimental data 1954-55

Grass seed crops are normally sown in the spring and the first harvest is obtained in the following year and harvests may subsequently be taken for one or more years. To enable the chemicals to be applied in the autumn on well

* Present address: Plant Protection Ltd., Fernhurst Research Station, Nr. Haslemere, Surrey.

established seed stands the trials were laid out on crops in their second harvest year. They had therefore been down over 18 months at the time of spraying and also were known to have had a heavy infestation of blackgrass.

Two trials were carried out, the first on a crop of S48 timothy sown in 18 in. drills and the second on a broadcast crop of S23 perennial ryegrass. The following chemical treatments were used:

(1) CIPC at 1.5, 3 and 6 lb/ac active material
(2) TCA at 2.5, 5 and 10 lb/ac " "
(3) monuron at 0.5, 0.75 and 1.5 lb/ac active material

Application was made with a knapsack sprayer at 100 gal/ac. The randomised plots were 12 yd x 2 yd with a 1 yard path between them with 4 controls and were unreplicated.

There were two times of application:

S48 timothy	(1) 12th October 1954	(2) 15th November 1954
S23 perennial ryegrass	(1) 13th October 1954	(2) 16th November 1954

Results 1954-55

(1) S48 Timothy

Prior to harvest a count was made of the number of blackgrass plants in each plot (Table 1)

Table 1

S48 Timothy

Number of flowering blackgrass plants in each plot prior to harvest 1955

Chemical	Date of spraying	
	12.10.54	15.11.54
CIPC 1.5 lb/ac	37	5*
" 3 lb/ac	9*	8*
" 6 lb/ac	2*	0*
TCA 2.5 lb/ac	19*	44
" 5 lb/ac	30	12*
" 10 lb/ac	9*	25
Monuron 0.5 lb/ac	38	29
" 0.75 lb/ac	27	24
" 1.5 lb/ac	33	21*
Controls	87 119	129 123

* Plots in which the number of plants had been reduced to below the certification standard (2) of 1 plant/sq.yd, applicable to crops of perennial ryegrass, cocksfoot and meadow fescue.

Severe crop damage was noted in those plots treated with CIPC an 3 and 6 lb/ac in November while slight damage was caused by both applications of monuron at 1.5 lb/ac.

(2) S23 Perennial ryegrass

The most striking result from this trial was the complete absence of blackgrass from all plots including the controls. Crop damage was more extensive than in the timothy trial (Table 2).

Table 2

S23 Perennial ryegrass: plots showing crop damage

Extent of damage	Date of Spraying	
	13.10.54	16.11.54
Severe	CIPC 6 lb/ac	CIPC 3 & 6 lb/ac
Slight	CIPC 3 lb/ac TCA 5 & 10 lb/ac	CIPC 1.5 lb/ac TCA 10 lb/ac

In the case of severe damage the crops were either killed or did not produce any inflorescences, while with slight damage the inflorescences were small and late in emerging.

The results from these two preliminary trials suggested that in some cases at least these chemicals might be of use for the control of blackgrass in grass seed crops. Therefore in 1955 further trials were laid down using the phenyl carbamates (propham and CIPC).

Experimental data 1955-56

The work on timothy and perennial ryegrass was continued, one trial being laid out on each of these crops using the following chemicals:

(1) CIPC at 2 & 4 lb/ac applied as a spray.
(2) Propham at 2 & 4 lb/ac applied as a spray.
(3) Propham at 2 & 4 lb/ac applied as pellets.

The trials were laid out as randomised blocks replicated 3 times with 1 control in each block. The plots were 12 yd x 2 yd with a 1 yard path between plots.

There were two times of application as follows:

S48 timothy	(1) 29th September 1955	(2) 25th October 1955
S23 perennial ryegrass	(1) 26th September 1955	(2) 27th October 1955

Small trials using CIPC at 4 lb/ac applied on 29th September 1955 and 25th October 1955 were laid down on a crop of S143 cocksfoot and on one of S53 meadow fescue. These were designed primarily to determine the susceptibility of these grasses to the chemical. The trials were laid out as a Latin square with 3 replicates. All trials were sprayed at 20 gal/ac with an Oxford Precision Sprayer.

The perennial ryegrass crop was broadcast and the others were sown in 18 in. drills. All crops were in their second harvest year. Fixed quadrat assessments of the percentage ground cover of blackgrass seedlings were made in the winter and early spring on those crops grown in 18 in. drills.

Results 1955-56

(1) S48 Timothy

As in the previous year a count was made of the number of blackgrass plants in each plot prior to harvest (Table 3).

Table 3

S48 Timothy

Number of flowering blackgrass plants in each plot prior to harvest 1956 (Average of 3 replicates)

Chemical	Date of Spraying	
	21.9.55	25.10.55
CIPC 2 lb/ac	65	7.3*
" 4 lb/ac	18.3*	14.6*
Propham 2 lb/ac	72	21.6*
" 4 lb/ac	86.6	9.6*
Propham (pellets) 2 lb/ac	113	75.3
" " 4 lb/ac	52	43
Control	69	101

* Treatments in which the number of plants had been reduced below the certification standard (2) of 1 plant/sq.yd.

There was no sign of any crop damage in any of these plots.

(2) S143 Cocksfoot and S53 meadow fescue

No crop damage was visible on either of these crops as a result of the spraying. Unfortunately both crops including the trial areas were row-cropped in the spring of 1956 and therefore counts of the number of blackgrass plants present were not obtained.

(3) S23 Perennial ryegrass

As in the previous year the most outstanding point from this trial was the absence of blackgrass from all the plots including the controls. There was no damage to the crop as a result of the chemical treatments in September but CIPC at 4 lb/ac caused severe damage and CIPC at 2 lb/ac and propham at 2 and 4 lb/ac caused slight damage when applied in October as a spray.

Discussion

The preliminary trial on timothy in 1954-55 indicated that a control of blackgrass in a well established crop was possible from an autumn application of some chemicals. Further work with the phenyl carbamates in 1955-56 confirmed these results. Both CIPC and propham when applied at 2 and 4 lb/ac in October gave a satisfactory control. Earlier application in September was unsatisfactory except for CIPC at 4 lb/ac. Crop damage did not result from these early applications to timothy, cocksfoot and meadow fescue but application in November did cause crop damage to timothy in 1954-55. This late application has not been tested on cocksfoot and meadow fescue.

The most satisfactory method of applying these chemicals is as a spray. Pelleted forms of propham tested in 1955-56 did not give an adequate control and were difficult to apply evenly.

With perennial ryegrass sown broadcast the results were not so encouraging as considerable crop damage was caused. This agrees with Freed's observations in Oregon (1) where he recommended 3 - 4 lb CIPC and propham for alta fescue but only tentatively suggested 2.5 - 3 lb of propham for perennial ryegrass.

The complete absence of blackgrass from the trial area in both years suggests that the grass is unable to germinate and compete with a broadcast stand of perennial ryegrass in the second harvest year.

The trials indicate that CIPC or propham applied in October at 3 - 4 lb/ac does hold out hope for the control of blackgrass in crops of timothy, meadow fescue and cocksfoot in their second harvest year. More work is necessary both on this aspect and on the possibility of using the chemicals prior to the first harvest year.

Acknowledgements

It is a pleasure to acknowledge the help given by Mr. G. W. G. Briggs of the National Institute of Agricultural Botany who suggested these trials and also by Plant Protection Ltd. who allowed the author to collect the results in 1956.

References

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DISCUSSION ON THE PREVIOUS TWO PAPERS

Mr. H. A. Roberts

While it is true, as Dr. Holly stated, that there are only 3 annual grasses which are of great importance to agriculture, in horticulture, particularly vegetable crops, Poa annua is one of the most important weeds in this country. I hope when people are testing herbicides they will not forget Poa annua.

Dr. K. Warington

Mr. Jeater's paper mentioned the complete absence of blackgrass in the trial area in the second year, which suggests that the grass is unable to germinate and compete with ryegrass. I think this is quite easily explained, as blackgrass has a very short dormancy and in the second year few viable seeds would be left.

Mr. H. A. Roberts

I should like to ask Dr. Warington whether she can confirm that blackgrass does have a very short dormancy period in the field. I know that in the original work by Dr. Brenchley and Dr. Warington with soil samples in a greenhouse this was strikingly shown, but I wonder whether the behaviour is quite as definite, and therefore of such practical importance, under field conditions.

Dr. Warington

Yes, I think that is perfectly true. In soil samples we found a tremendous reduction in blackgrass germination, the first year after fallow - reductions down to 19% in one year compared with the previous year under crop. I think that proves that the dormancy is very short. Though these figures relate to germinations from soil kept in a greenhouse, reduction in the weed was equally evident to the eye in the field in the year following fallow.

Dr. W. E. Ripper

May I support Mr. Roberts for more work on Poa annua. It is over-running light lands in cereal and pea crops as soon as Polygonum aviculare is controlled.

Dr. R. D. Blackett

Would Dr. Holly expand on his work on tests particularly with reference to CDAA and CDEC against Avena fatua. In my greenhouse evaluation of this compound I found a complete cessation of growth of Avena fatua from seeds and germinated seedlings right up to the production of the first leaf. This seems to disagree with your findings.

Dr. K. Holly

We found in our pot experiments that both CDAA and CDEC were without effect on Avena fatua after emergence. We could in fact get quite appreciable effect pre-emergence with CDEC. With all pre-emergence compounds it is most important to determine their actual selectivity - whether they do in fact possess any selectivity or whether in the results of some pot experiments one is getting apparent selectivity through soil factors and the like. We have tried to check up on this in view of Dr. Blackett's results, with particular reference to any selectivity between wild oat and the cereals with these compounds. Therefore we have grown them all in sand culture where the compounds are freely available to the roots of all the species and there we have found virtually no evidence of any selectivity between wild oat and the cereals.