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THE RELATIVE TOXICITY OF MCPA, MCPB, 2,4-D AND 2,4-DB to WEEDS

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Summary

This report describes a programme of some sixty field experiments comparing the relative toxicity of MCPA, MCPB, 2,4-D and 2,4-DB to annual and perennial weeds and discusses some of the factors that may influence the interpretation of the results. The overall results are summarised in Fig. 1 showing the toxicity of MCPB, 2,4-DB and 2,4-D relative to that of MCPA = 1. More detailed results are presented in the appendix tables.

Introduction

It is a remarkable fact that although MCPA and 2,4-D have been used commercially in Great Britain for ten years no extensive and critical assessment has been made of their relative toxicity to weeds. Apart from reports on a number of isolated experiments, only one paper in the proceedings of the first two B.W.C.C. Conferences is devoted to this subject (2), and from the literature generally it appears that few critical studies of comparative toxicity to annual weeds have been made in other countries. This can probably be explained by the remarkable speed at which these two herbicides were developed commercially, allowing reasonably accurate field recommendations to be made from a great fund of practical experience. Even so, those responsible for making the recommendations must often have felt the need for the more precise guidance that can only be obtained as a result of detailed experimental work.

In 1954, the discovery by Wain (3) of the phenoxybutyric compounds made it a matter of urgency that the toxicity of these promising new herbicides to weeds should be compared with that of MCPA and 2,4-D so that an assessment of their efficiency as weedkillers could be made, and preliminary recommendations issued. There had, in fact, developed an opportunity and a need for the results of field investigations to lead the practical usage of these new herbicides by the farmer. It was decided that the Unit of Experimental Agronomy should carry out a programme of field experiments, which had as its main object a comparison of the toxicity of MCPA, MCPB, 2,4-D and 2,4-DB to common annual and perennial weeds. This paper discusses the method used and summarises the principle results from work during 1955-56.

Formulations used in the experiments

The herbicides were all prepared from technically pure acids, the following derivatives being used: MCPA (sodium), MCPA (n-butyl ester), MCPB (sodium), MCPB (butoxyethanol ester), 2,4-D (triethanolamine) and 2,4-DB (sodium). Stock solutions of 10% w/v a.e. were made up in distilled water. In 1955 distilled water was generally used for further dilution of the phenoxybutyric salts because of the tendency of the calcium and magnesium salts to precipitate in hard water, but on occasions, the sequestering agent ethylene diamine tetra acetic acid as sodium salt (EDTA) was added and hard water used successfully. In 1956 EDTA was present in all 10% stocks at a concentration of 0.225% and hard

water was used for further dilution. Wetting agents were not used. All spray solutions were made up in bottles in the laboratory prior to use in the field.

Procedure

(a) Annual Weeds

The sprayed plot was standardised at one yard square and the assessed area at 2 x 2 ft. With plots of this size it is possible to continue to make accurate observations and counts throughout the growing period of the crop. Weed densities from 30-700 seedlings or more per 4 square ft were accepted early in the programme but later the range was restricted to 50-150 on the grounds of quicker and more accurate counting and lower natural mortality. In practice, the area selected for an experiment was marked out as a grid of plots and the number of plants counted in each. Plots with densities falling outside the accepted limits were then discarded. If a marked trend of density was present from one side of the area to another, the replicates of grouped plots were arranged so that as far as possible all treatments of a replicate were situated on plots of approximately similar density. If the distribution of density over the experimental area appeared to be random and very variable, the plots were grouped into high, medium and low density plots, where there were three replicates, or into high and low density plots, where there were two and the treatments of a replicate randomised within a group. In this case, plots of a replicate were not necessarily together in a compact block. This departure from the normal randomised plot layout was considered justified, since the effect of weed density on the results of the treatments was likely to be much greater than the effect of changes in soil fertility or topography.

Spraying was carried out within a hessian windshield by means of a specially designed hand-sprayer operated by compressed air. The volume rate was standardised at 100 gal/ac and the pressure at 30 p.s.i. The jet used was a size 00 ceramic fan jet, the small throughput of which allowed a reasonable time for a uniform distribution of the spray. The use of this small jet resulted in a smaller droplet size than is typical of commercial high volume applications, a factor that has to be borne in mind when interpreting the results. It is emphasised that the object of the experiments was to study relative rather than absolute toxicity.

The lower limits of the dosage range chosen for each species was determined by the known minimum effect given by MCPA under average conditions; this dose was then used as the starting point on which to build a logarithmic series of doses. The upper limit of the series for MCPA was a dose considered likely to give 100% kill of the species under investigation; the dose-range for MCPB and 2,4-DB was extended until two or three times the maximum dose of MCPA was reached. In general, about seven doses of MCPA and about ten of each of MCPB and 2,4-DB were used in each experiment.

With practice, it was found possible for two men to spray at the rate of 100 plots per hour and in any one day a team of two could, under favourable conditions make up the spray solutions, travel 20 miles to a site, mark out, count and spray an experiment of 120 plots.

Assessments were made at regular intervals after spraying, generally a score for deformity followed by mortality counts, measurements of height and flowering suppression and estimates of vigour. The degree of each response obtained at a given dose was plotted for each compound and relative toxicity values obtained at selected levels of response.

(b) Perennial Weeds

The experiments on perennial weeds were also planned with a view to obtaining data from which to construct dose-response curves for the herbicides under test, but their scope was more limited because of the restricted number of useful plots available at the various sites. Plot size varied from 16-48 square yards and was determined by shoot or plant density and practical considerations inseparable from experiments in grassland. Spraying was carried out using an 'Oxford Precision Sprayer' at 10-30 gal/ac.

In addition to the main programme of the A.R.C. Unit, some experiments on annual weeds were carried out by N.A.A.S. officers. These followed a similar pattern to the Unit's experiments but the plot size was generally 2 x 1 yards and spraying was carried out with an 'Oxford Precision Sprayer' at a volume rate of about 25 gal/ac. The results of ten N.A.A.S. experiments are included in this report.

Discussion of the Results

In a report of this type, a detailed discussion or presentation of the individual results of some sixty experiments cannot be attempted. It is hoped that sufficient detail has been given in the main summary table, (this was available on request from the Conference Office), to allow other investigators to compare the general results with their own, but of necessity much has been omitted. For some species, e.g. Sinapis arvensis data from a considerable number of accurate experiments allows confidence to be placed in the figures obtained, while for other species, e.g. Polygonum convolvulus the results of only a single experiment are available and these must be treated with reserve.

From the table, it can be seen that the results of several experiments on one species show considerable variation. Weed stands are not only variable in stage of growth but their vigour and survival are determined by such factors as soil fertility and type, weather conditions, plant density, insect attack and crop competition. These factors may all influence the relative toxicity of herbicides, particularly those of the growth-regulator type. Experience has shown also that in a single experiment the dose-response relationship may vary according to the response assessed (e.g. mortality, vigour, height) and the interval between spraying and assessment. It is clear, therefore, that a very large programme of experiments carried out over a period of several years, would be required before a really reliable estimate could be made of the precise range of differences in toxicity that exist between comparable phenoxyacetic and phenoxybutyric compounds. Major differences in toxicity are, however, readily discernible.

Another difficulty in arriving at a precise value for relative toxicity is that in many instances the dose-response curves or probit lines for the different compounds are not parallel, even when the longest feasible time has elapsed between spraying and assessment. In these cases, a single relative toxicity value has little significance except when a degree of response can be selected as being of particular interest; two or three values at different response levels are, therefore, presented in the table.

A summary of the overall results for the individual weed species is given pictorially in Figure 1, which is based not on the means of all assessments carried out but on the results that are considered most reliable and of the greatest practical significance. For instance, where reliable mortality curves have been obtained, greater weight has been given to the relative toxicity readings from these than from curves derived from deformity scores or height measurements. Similarly, where response curves or probit lines are not

parallel, preference has been given to comparison at a high level of response, e.g. 80% mortality, than to lower levels of less practical interest.

A statistical treatment of the results has not yet been attempted. Conversion of many percentage kill figures to probit values (1) have been made and the values plotted against log dose, but the resulting probit lines for each herbicide have so often been far from parallel that this procedure has been discontinued for the present. Another difficulty in the interpretation of results is the natural change of plant density in the control plots during the intervals between spraying and the various assessments. With the growth-regulator herbicides, the period between spraying and final mortality is often many weeks and large changes in weed density may take place without herbicide treatment. Since the effects of the herbicides, and the natural changes in population can seldom be considered to be independent of one another, Abbotts' formula often cannot be used legitimately(1).

Because relative toxicity can be affected by many factors in the field no definite conclusions should be drawn from the results of a single experiment but there seems little reason to doubt the results of several experiments on one species, provided that they are in reasonably close agreement.

Conclusions

It is concluded from these experiments that to many weeds MCPB and 2,4-DB are considerably less toxic than MCPA, but to a few species their toxicity approaches that of MCPA.

MCPB (sodium) was less than half as toxic as MCPA (sodium) to 14 of the 24 species tested, but was nearly as toxic to the following: Cirsium arvense, Equisetum palustre, Fumaria officinalis, Polygonum aviculare, P. convolvulus, P. persicaria, Ranunculus repens, Rumex crispus, and Sonchus asper. 2,4-DB was often of similar toxicity to MCPB but was more than twice as toxic to: Papaver rhoeas, Polygonum aviculare, P. convolvulus, P. lapathifolium, P. persicaria, Ranunculus arvensis, Rumex obtusifolius and Scandix pecten-veneris. 2,4-D (triethenolamine) was more toxic than MCPA (sodium) to several species including Polygonum spp. and Sinapis arvensis.

In a small number of experiments, the toxicity of MCPB (butoxy ethanol) was only markedly greater than that of MCPB (sodium) when rain fell soon after spraying.

Acknowledgements

Many of the sites were located by N.A.A.S. officers in the neighbourhood of Oxford and the Unit is greatly indebted to them and to the farmers who allowed their fields to be used for the experiments. The N.A.A.S. experiments, the results of which are included in the report were carried out by the following: Mr. P. Jamieson (Yorks and Lancs), Mr. A. L. Boyd (Eastern), Mr. G. A. Toulson (Wales) and Mr. D. W. Watkins (South-west). The authors wish to acknowledge the invaluable assistance given by Dr. E. K. Woodford in the planning of the programme and in the interpretation of results, and to Mr. S. A. Evans, N.A.A.S. Liaison Officer to the Unit, who was responsible for the selection of sites.

References

(1) FINNEY, D. J. (1947). Probit Analysis. Cambridge University Press.

(2) KASASIAN, L. (1954). A comparison of the effects of MCPA and 2,4-D on annual weeds. Proc.Brit.Weed Control Conf. 1953, 74-80.

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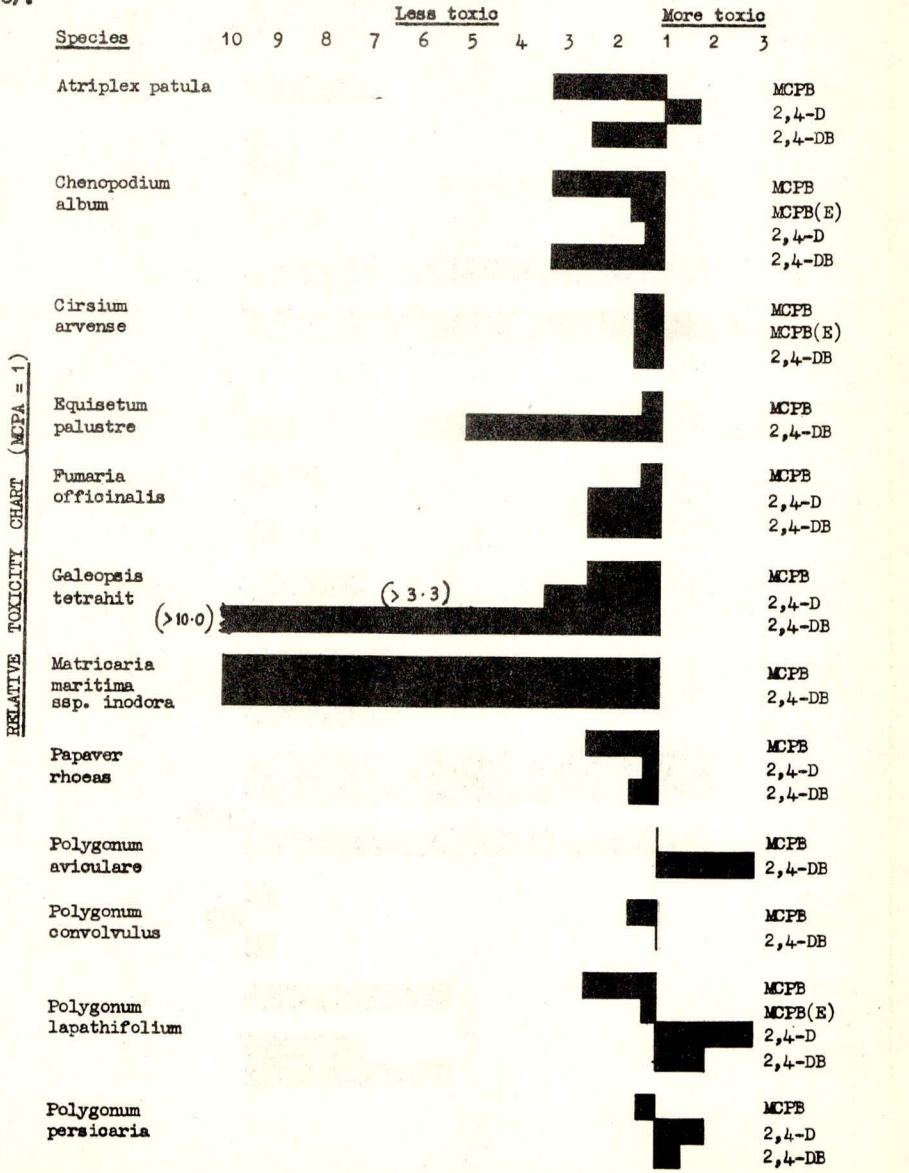
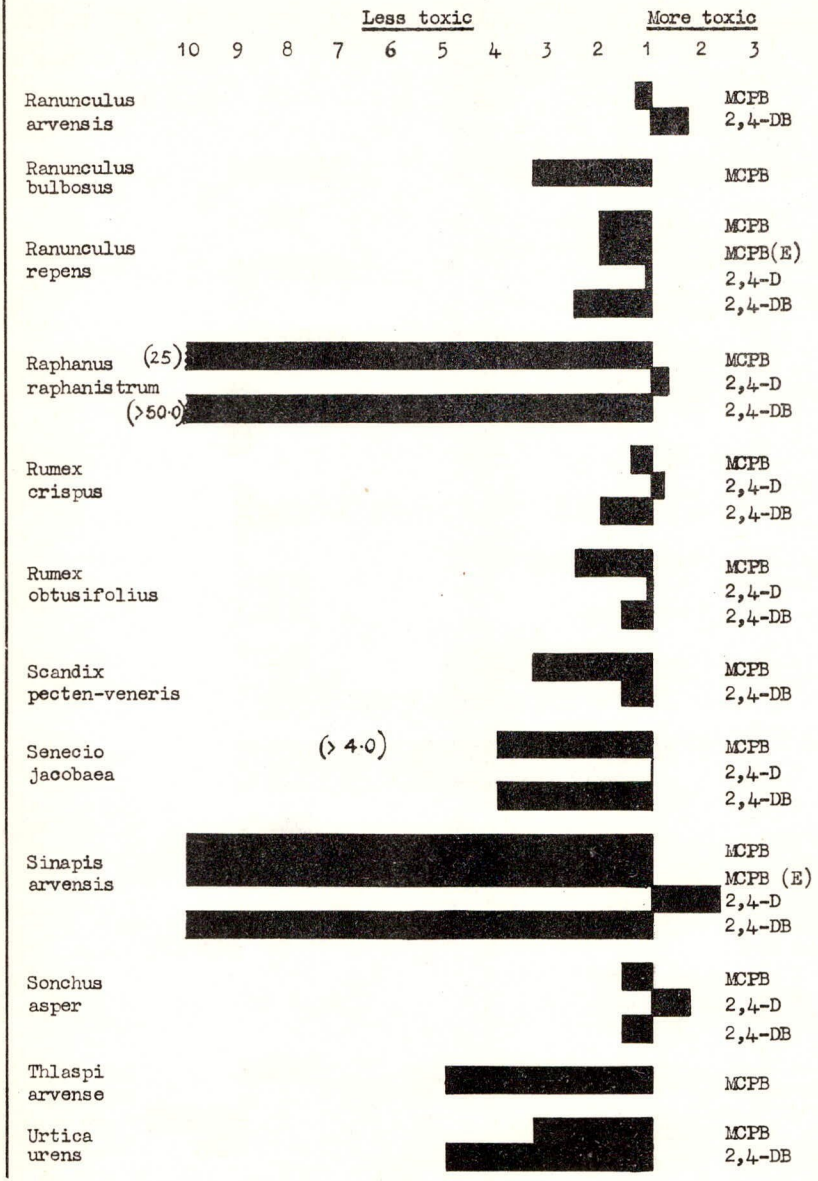
TABLE I

The toxicity of MCPB, 2,4-D and 2,4-DB to 17 annual and 7 perennial weeds as compared with the toxicity of MCPA which has been taken as 1

Hatched areas to the left of 1 indicate the extent to which the compound is less toxic than MCPA (5 = 1/5 as toxic). Hatched areas to the right of 1 indicate the extent to which the compound is more toxic than MCPA (2 = twice as toxic).




Less toxic
More toxic
10 9 8 7 6 5 4 3 2 1 2 3
Ranunculus arvensis
MCPB
2,4-DB
Ranunculus bulbosus
MCPB
Ranunculus repens
MCPB
MCPB(E)
2,4-D
2,4-DB
Raphanus raphanistrum
(25)
(>50·0)
MCPB
2,4-D
2,4-DB
Rumex crispus
MCPB
2,4-D
2,4-DB
Rumex obtusifolius
MCPB
2,4-D
2,4-DB
Scandix pecten-veneris
MCPB
2,4-DB
Senecio jacobaea
(> 4·0)
MCPB
2,4-D
2,4-DB
Sinapis arvensis
MCPB
MCPB (E)
2,4-D
2,4-DB
Sonchus asper
MCPB
2,4-D
2,4-DB
Thlaspi arvense
MCPB
Urtica urens
MCPB
2,4-DB

Notes

1) This chart is based on results obtained with the following derivatives: MCPA (sodium), MCPB (sodium) 2,4-DB (sodium), MCPB (phenoxy butyric ester (E)) and 2,4-D (triethanolamine).

2) The number of experiments on which the relative toxicity value is based is indicated for each species and compound. Values based on a single experiment should be regarded as indicative only.

Exp. No.	Stage of Growth when sprayed No. true leaves	Height in.	Apprcx. No. plants/sq.yd.	Crop	Volume Rate	Replicates	Days between spraying and assessment	Type of response and degree
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Atriplex patula								
W/29/55	2-4	2	400	Spring barley	100	2	5 58	Deformity score 50% Mortality score 50%
W/7/56	cot.-1 pr.	0.5-3	200	Spring oats	100	3	22 64 74	Deformity score 50% % reduction in height 60% % kill 50% 90%
Chenopodium album								
W/2/55(N)	cot.-2	1	360	-	25	3	50	Number score 50%
W/11/55	cot.-2	1	1600	Spring wheat	100	2	31	Vigour score 50%
W/30/55	8-13	2-6	100	Direct sown ley	100	2	19 35	% kill 50% % kill 50%
W/23/56	8-9	4-6	120	Linseed	100	3	50 50 50	% kill 50% % kill 70% % kill 90%
Cirsium arvense								
W/26/56	4-16 in., only the most advanced with first buds visible. Many shoots 1 in. high, 2-4 leaves		12	Old pasture	30	3	19	Deformity score 50%

TABLE

Dosage lb/ac					Relative Toxicity (MCPA = 1.0)				Remarks
MCPA	MCPB	MCPB (ester)	2,4-D	2,4-DB	MCPB	MCPB (ester)	2,4-D	2,4-DB	
(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
0.20	1.6	-	-	2.5	0.12	-	-	0.08	
0.46	1.5	-	-	1.1	0.30	-	-	0.42	100% kill by 4.0 lb MCPA
0.31	3.8	-	0.31	3.8	0.08	-	1.0	0.08	
0.32	2.0	-	0.15	1.2	0.16	-	2.0	0.27	
0.30	1.4	-	0.15	0.80	0.21	-	2.0	0.37	100% kill by 3.5 lb 2,4-D
2.5	7.7	-	1.5	5.7	0.32	-	1.7	0.43	
0.06	0.30	-	0.13	0.15	0.20	-	0.45	0.40	100% kill by 0.7 lb MCPA
0.25	0.90	-	-	0.80	0.28	-	-	0.31	100% kill by 1.1 lb MCPA (High natural mortality)
1.0	3.4	-	-	5.4	0.29	-	-	0.19	
0.09	0.38	-	-	0.38	0.24	-	-	0.24	100% kill by 0.8 lb MCPA, 3.0 lb MCPB and 2,4-DB
0.15	0.55	0.26	0.20	0.55	0.27	0.59	0.77	0.27	100% kill by 1.5 lb MCPA
0.30	0.90	0.51	0.37	0.90	0.33	0.59	0.83	0.33	& 2,4-D, 3 lb MCPB ester.
0.77	2.0	1.2	0.90	2.0	0.38	0.67	0.91	0.38	Max. kill by MCPB & 2,4-DB = 93% at 4 lb/acre
0.52	1.7	0.70	-	-	0.30	0.77	-	-	Sprayed 15/6/56 over-grazed and trampled area

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Cirsium arvense (Contd.)								
W/27/56	75% well developed shoots with 1-7 flower buds & 12-24in. high. 20% rosettes with 3-4 leaves 1-2in. high. Remainder intermediate.		15	Old pasture	30	4	25 77	Shoot mortality score 30% % kill 90%
W/38/55	4in.-4ft 6 in. well developed buds on older shoots.		12	Old pasture	11	3	48 48 weeks 62 weeks	Deformity score 50% % kill 30% % kill 67%
W/33/55	Large shoots 24-30in. with well developed buds. Small shoots 6-24in., no buds.		40	Ley sown spring 1955	50	3	57 46 weeks	Deformity score 50% % kill 80%
W/24/56	16-18in., majority in very early bud stage. Shoots still emerging.		30	Old pasture	30	4	21 107 107	Deformity score 50% % kill 50% % kill 80%
Equisetum palustre								
W/35/55	Vegetative shoots 4-18in. high.		60	Permanent grassland	100	3	20	% kill of shoots Probit 6.0
Fumaria officinalis								
W/7/55(N)	90% flowering 8in.		Dense	Spring barley	25	3	24	Vigour score 50%
W/11/56	cot.-4	2-3	80	Spring barley	100	3	19 43 43	Deformity score 50% Vigour score 50% % kill 50%
Galeopsis tetrahit								
W/23/55	1-3 pairs	0.5-4	350	Spring oats	100	2	29	Deformity score 50%

(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
0.80	1.9	1.9	-	-	0.42	0.42	-	-	Sprayed 6/7/56
0.50	1.1	0.50	-	-	0.43	1.0	-	-	
0.45	0.8	-	-	-	0.55	-	-	-	Sprayed 15/7/55. Increase in control plots = 35%. Max. kill 83% by 4.5 lb MCPB.
1.2	0.98	-	-	-	1.2	-	-	-	
2.2	2.0	-	-	-	0.73	-	-	-	
0.45	0.87	-	-	1.1	0.53	-	-	0.42	Sprayed 29/6/55. Soft thistle growth. Max. kill: 99% by 8.0 lb MCPB and 2,4-DB. 24% increase on controls.
1.4	1.7	-	-	1.7	0.83	-	-	0.83	
0.49	1.5	-	-	-	0.30	-	-	-	Sprayed 12/6/56 Max. kill 85% with 4.0 lb MCPB
0.90	2.0	-	-	-	0.45	-	-	-	
1.7	3.8	-	-	-	0.45	-	-	-	
0.25	0.38	-	-	1.5	0.66	-	-	0.17	
1.0	1.7	-	-	-	0.59	-	-	-	100% kill not achieved by 3.4 lb MCPA or MCPB (c.75%)
1.5	1.5	-	3.1	3.1	1.0	-	0.48	0.48	98% kill by 4 lb MCPA and MCPB
0.8	1.3	-	3.9	3.9	0.62	-	0.20	0.20	
1.3	1.3	-	3.0	>4.3	1.0	-	0.43	<0.30	
0.80	1.8	-	>2.3	>5.7	0.43	-	<0.34	<0.14	MCPA gave less than 50% kill with 3.8 lb/ac. No rain.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	
Matricaria maritima ssp. inodora									
W/25/55	1 pair	0.5	700	Spring barley	100	2	27	% kill	50%
Papaver rhoeas									
W/14/55	Cot.-6	0.5-2	400	Spring wheat	100	2	32	% kill	50%
N.A.A.S. Wimborne	Seedling - 15	-	90	Spring oats	10	3	47	% kill	50%
W/15/56	3-12	0.5-4	250	Spring oats	100	3	47	% kill "	50% 70% 90%
Polygonum aviculare									
W/6/55	Cot.-1.5	1	500	Spring wheat	100	2	24 47	Deformity score % reduction in height	50% 50%
W/3/55(N)	4	-	-	Spring oats	25	3	19 19	Vigour score % reduction in height	50% 50%
Polygonum convolvulus									
W/7/55	Cot.-1	0-1	700	Spring wheat	100	2	37	% kill	
N.A.A.S. Trawscoed	5	5	20	Spring oats	18	3	24	% kill	50%
Ranunculus repens									
W/3/56	Rosettes 4-5	-	-	Old pasture	10	3	43	% reduction of ground cover	50%
W/16/56	Rosettes 4-5	-	150	Old pasture	20	3	16	Deformity score	50%
W/17/56	Rosettes 4-6 Beginning to run	-	300	Old pasture	20	3	16	Deformity score	70%
W/18/56	Rosettes 2-8	-	100	Old pasture	20	3	22	Deformity score	50%

(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
0.84	6.4	-	-	6.4	0.13	-	-	0.13	>80% kill by 2.0 lb MCPA. Probit lines parallel.
0.70	2.1	-	-	1.0	0.33	-	-	0.71	>90% kill by 2.0 lb MCPA, 6.4 lb MCPB & 2.2 lb 2,4-DB. Probit lines parallel.
0.56	0.84	-	-	-	0.67	-	-	-	82% kill by 2.5 lb MCPA. Probit lines parallel.
0.26	0.90	-	0.26	0.62	0.29	-	1.0	0.42	100% kill by 2.3 lb MCPA, 8.5 lb MCPB, 2.3 lb 2,4-D and 4.5 lb 2,4-DB.
0.49	1.5	-	0.49	1.0	0.32	-	1.0	0.50	
0.84	2.9	-	0.84	1.7	0.29	-	1.0	0.50	
1.6	1.4	-	-	0.68	1.1	-	-	2.5	50% kill by 4.3 lb MCPA.
1.1	0.84	-	-	0.38	1.2	-	-	3.3	
0.95	1.2	-	-	-	0.77	-	-	-	100% kill not achieved by 3.7 lb MCPA.
1.0	1.5	-	-	-	0.67	-	-	-	
-	-	-	-	-	0.82	-	-	0.98	High natural mortality.
0.84	1.7	-	-	-	0.49	-	-	-	80% kill by 2.0 lb MCPA
0.60	0.80	-	0.42	1.0	0.77	-	1.4	0.59	Sprayed 18/4/56
0.50	0.80	-	0.50	0.80	0.62	-	1.0	0.62	Sprayed 14/5/56
0.85	2.1	1.7	0.37*	-	0.40	0.50	2.3*	-	Sprayed 14/5/56 * = MCPA (ester)
0.27	0.50	-	0.40	1.7	0.55	-	0.67	0.16	Sprayed 15/5/56

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ranunculus repens (Contd.)								
W/19/56	Rosettes 3-6 Early flowering stage. Beginning to run.	-	-	Flood meadow	20	3	15	Deformity score 50%
Raphanus raphanistrum								
W/21/55(i)	4.5-6.5	3	30	Spring wheat	100	2	16	% kill 50%
W/21/55(ii)	4.5-6.5	3	30	Spring wheat	100	2	16	% kill 50%
W/23/55	4-6	-	20	Spring oats	100	2	29	% kill 50%
W/21/56	4-6 Flower buds	3-6	60	Spring oats	100	3	14 32 32	Deformity score 50% Deformity score 50% % kill 70% 90%
Rumex crispus								
W/19/55	All stages from shoots with 3 leaves to plants with many shoots of 6 or more leaves		30	Winter wheat	67	2	34	% reduction of flowering shoots. Probit 6.0 Probit 7.0
Rumex obtusifolius								
W/25/56	Small plants 3 leaves 2in. high to near flowering plants 8in.		-	Ley sown in 1955	30	4	7 34	Deformity score 50% % kill of shoots 20%
Scandix pecten-veneris								
W/24/55	3	3	80	Spring wheat	100	2	40	% reduction in height 50%
Senecio jacobaea								
W/29/56	Young to mature bud stage and rosettes and seedlings.		c.2			3	16 79 79	Deformity score % kill non-flowering plants 90% % kill flowering shoots

(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
0.48	1.3	-	0.71	2.3	0.37	-	0.67	0.21	Sprayed 17/5/56
0.22	>3.8	-	-	-	<0.058	-	-	-	less than 50% kill by 3.8 lb MCPB
1.2	-	-	-	-	-	-	-	-	less than 20% kill by 3.8 lb MCPB
0.61	-	-	0.43	-	-	-	1.4	-	less than 50% kill by 3.8 lb MCPB or 2,4-DB.
0.50	10.0	2.8	0.5	>16.0	0.05	0.18	1.0	<0.03	
0.35	4.4	2.3	0.25	12.0	0.07	0.15	1.4	0.03	
0.32	7.8	5.4	0.25	18.0	0.04	0.06	1.2	0.02	100% kill by 4.0 lb MCPA and 2,4-D
0.95	>16.0	16.0	0.75	>16.0	0.06	<0.06	1.2	<0.06	
0.70	0.90	-	0.60	1.2	0.78	-	1.2	0.58	Probits not parallel.
1.6	2.6	-	1.3	3.1	0.61	-	1.2	0.52	
1.3	4.0	-	1.3	1.9	0.32	-	1.0	0.67	Heavy rain immediately after end of spraying. Order of spraying: MCPA, MCPB, 2,4-D, 2,4-DB.
1.1	2.2	-	1.5	2.1	0.50	-	0.7	0.53	
0.60	2.2	-	-	1.1	0.27	-	-	0.56	50% kill by 3.2 lb MCPA
-	-	-	-	-	-	-	-	-	All three graphs give similar picture but as only 2 points per chemical difficult to get comparative readings.
1.6	6.0	-	<1.6	>6.0	0.27	-	>1.0	<0.27	
		-	Similar	-		-	Similar	-	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Sinapis alba								
W/28/56	Mature bud stage	14	Drilled in rows	-	81	1	18	Height profile 40in. level
Sinapis arvensis								
W/5/55(N)	5	2.5	180	Spring oats	25	3	14	Vigour score 50%
W/6/55(N)	2-3	1.5	100	Spring oats	25	3	44	Number score 50%
W/15/55	4-6 Variable	-	200	Spring barley	100	2	39 24	% kill. Probit 7.0 % Flower suppression 80%
W/17/55	5 Flower bud stage	2-5	100	Spring barley	100	2	25	% reduction in height 50%
W/28/55	3	3.5	60	Spring barley	100	2	18 18	Vigour score 50% % reduction in height 50%
W/31/55	Advanced bud stage	2-10	40	Spring barley	100	2	24	% kill 50%
W/12/56	Cot.-2	0-1	200	Spring barley	100	3	35	% kill 90%
	3-4.5	1.5-4					23	% kill 90%
	"	"					36	% kill 90%
	5-6 Flower bud	2-10					46	% reduction in height 90%
							46	% kill 90%
W/5/56	3-4	1-1.5	150	Spring wheat	100	3	31	Vigour score 100%
							41	% kill 90%
							41	% kill 100%
	3.5-7	1-5					30	% kill 90%
							30	% kill 100%
	7 early flowering	3-20					26	Vigour score 50%
							51	% reduction in height 70%
							51	% reduction of control 50%

(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
0.14	2.9	-	-	-	0.048	-	-	-	Starting point too low at 0.05% MCPA MCPB 0.5% (Logarithmic sprayer).
-	-	-	0.11	0.94	-	-	1.0	0.12	
0.11	2.8	-	-	-	0.041	-	-	-	
0.10	1.0	-	-	2.2	0.10	-	-	0.04	100% kill by 0.7 lb MCPA, 1.9 lb MCPB and by 3.0 lb 2,4-DB. Probit lines not parallel.
0.07	0.28	-	-	0.40	0.25	-	-	0.17	
0.30	2.4	-	-	3.2	0.12	-	-	0.09	
0.05	0.38	-	-	0.40	0.13	-	-	0.12	90% kill with 0.25 lb MCPA
0.05	0.65	-	-	0.85	0.08	-	-	0.06	
0.10	1.5	-	-	-	0.07	-	-	-	100% kill by 0.5 lb MCPA 92% kill with 7.7 lb MCPB
0.03	0.54	-	-	-	0.06	-	-	-	100% kill by 0.1 lb MCPA and 1.5 lb MCPB
0.15	3.0	-	-	-	0.05	-	-	-	
0.03	0.48	-	-	-	0.07	-	-	-	100% kill by 0.2 lb MCPA and 2.1 lb MCPB
0.10	1.7	-	-	-	0.06	-	-	-	
0.11	1.1	-	-	-	0.10	-	-	-	100% kill by 0.35 lb MCPA & 3.5 lb MCPB
0.18	4.5	-	-	-	0.04	-	-	-	
0.05	0.38	-	-	-	0.14	-	-	-	
0.18	0.24	-	-	-	0.14	-	-	-	
0.08	1.3	-	-	-	0.06	-	-	-	
0.34	>8.5	-	-	-	< 0.05	-	-	-	
0.26	3.8	-	-	-	0.07	-	-	-	
0.15	4.0	-	-	-	0.04	-	-	-	
0.13	1.0	-	-	-	0.13	-	-	-	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	
Polygonum lapathifolium									
W/22/56	3-4	2-4	-	Spring barley	100	3	26 56	Deformity score % kill	50% 50% 90%
Polygonum persicaria									
W/8/55(N)	Cot.-4	-	1800	Spring oats	25	3	23	Vigour score	50%
W/9/56	1-3	0.5-1	250	Spring oats	100	3	36	% kill	50% 85%
W/4/55(N)	Cot.-1	-	250	Spring oats	25	3	27	% kill	50%
N.A.A.S. Trawscoed	5-6	-	250	Spring oats	20	3	24	% kill	50%
N.A.A.S. Bedford	2-4	1.5	700	Spring oats	94	2	41	Vigour score	50%
Ranunculus arvensis									
W/3/55	3-4	3	80	Winter wheat	100	3	40	% kill	50%
Ranunculus bulbosus									
W/14/56	Rosettes 5-7 Seedlings 4	-	30	New ley	20	3	13 29	Deformity score Deformity score	50% 20% 50% 20%
Sinapis arvensis									
W/13/56	Cot.-2	0-1	400	Spring barley	100	3	30	Vigour score % kill	90% 90%
W/8/56	3.5-4.5	1.5	100	Spring wheat	100	3	31 58 58	% kill % kill % kill % kill % kill Score for damage	60% 80% 90% 80% 90% 50%
Sonchus asper									
W/27/55	3-7	1-14	80	Spring oats	100	2	30	Vigour score	50%

(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
4.4	11.8	5.0	1.3	3.5	0.37	0.91	3.4	1.3	Shower 30 minutes after spraying. 100% kill by 5.0 lb 2,4-D and 10.0 lb MCPA and MCPB ester.
3.6	8.0	4.8	1.1	1.4	0.45	0.77	3.3	2.6	
7.8	>11.8	10.0	3.0	4.3	<0.60	0.77	2.6	1.8	
-	-	-	1.3	1.1	-	-	1.0	1.2	100% kill not achieved with 3.0 lb 2,4-D or 2,4-DB.
1.6	2.3	-	1.3	1.8	0.71	-	1.2	0.91	100% kill only by 5.0 lb 2,4-D.
4.9	>5.9	-	4.3	5.3	<0.83	-	1.1	0.91	
0.7	1.0	-	-	-	0.71	-	-	-	Max. kill 75% by 1.5 lb MCPA, 2.5 lb MCPB.
3.0	5.0	-	-	-	0.59	-	-	-	Max. kill = 50% (Probit lines parallel)
0.9	1.7	-	0.2	0.4	0.58	-	4.5	2.5	85% kill by 3.4 lb 2,4-D and 7.7 lb 2,4-DB
0.15	0.20	-	-	0.09	0.77	-	-	1.7	100% kill by 0.5 lb 2,4-DB
>1.7	>0.33	0.50	-	0.50*	-	1.0	-	1.0*	Heavy rain 2 hours after spraying. Sprayed 9/5/56.
0.70	1.7	<0.25	-	<0.25*	0.24	-	-	-	
>1.7	>3.3	0.80	-	0.50*	-	0.62	-	1.0*	
1.1	2.8	<0.25	-	0.25*	0.40	-	-	-	* = MCPA (ester)
0.13	2.0	1.3	0.05	0.71	0.06	0.10	2.6	0.18	
0.06	0.84	1.0	<0.03	0.35	0.07	0.06>	1.9	0.18	
0.038	0.24	-	-	-	0.16	-	-	-	
0.06	0.84	-	-	-	0.07	-	-	-	
0.10	2.1	-	-	-	0.05	-	-	-	
<0.026	0.14	-	-	-	<0.18	-	-	-	100% kill by 0.09 lb MCPA and 1.24 lb MCPB
<0.026	0.21	-	-	-	<0.12	-	-	-	
0.05	0.49	-	-	-	0.10	-	-	-	
1.5	2.5	-	0.94	2.5	0.59	-	1.7	0.59	70% kill by 3.8 lb 2,4-D.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Spergula arvensis								
W/26/55	1-3 branches	1-3	100	Spring barley	100	2	34	No measurable effect
Thlaspi arvense								
W/4/55	Cot.-1	0-1	150	Spring oats	100	3	25	% kill. Probit 5.0 Probit 6.0
Urtica urens								
W/10/55	Cot.-1 pr.	0-1	2500	Spring wheat	100	2	31	% kill 50%

All chemical names, unless otherwise stated, refer to aqueous solutions of the sodium salt of the chemical excepting 2,4-D which was the triethanolamine.

(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
from maximum doses: MCPA 1.7,					2,4-D 3.8,		2,4-DB 5.8,		MCPB 5.8 lb.
0.15	0.37	-	-	-	0.4	-	-	-	Probit lines not parallel.
0.38	2.6	-	-	-	0.15	-	-	-	97% kill by 1.1 lb MCPA
0.45	1.3	-	-	2.0	0.34	-	-	0.23	100% kill by 2.8 lb. MCPA

THE CONTROL OF JUNCUS EFFUSUS USING THE BUTYRIC HOMOLOGUES OF MCPA AND 2,4-D

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Summary

1. A trial is reported in which the butyric homologues of MCPA and 2,4-D were tested to determine their effect on Juncus effusus in a reseeded upland pasture.

2. MCPA and 2,4-D proved superior to the butyric forms in the control of rush, but 2,4-DB showed considerable promise.

3. MCPB and 2,4-DB had no adverse effect on the clover content of the pasture.

Introduction

In some upland areas of the West Midlands the problem of rush invasion on reseeded land is extremely important. More often the benefits of improvement following reseeding are wiped out by the rapid invasion of rush, particularly J. effusus. Sufficient work has already been undertaken which shows that the use of MCPA or 2,4-D combined with cutting of the J. effusus is an effective means of control. Unfortunately the use of either of these herbicides does often result in a kill of white clover from the pasture, and where rush is indigenous white clover is difficult to maintain. The introduction of the butyric homologues has raised the question of possible control without detriment to the clover content of the pasture.

Site Details

The field chosen for this trial had been reseeded in June, 1954 to a perennial ryegrass, (Lolium perenne), timothy (Phleum pratense), white clover (Trifolium repens) mixture. The field was not drained and tended to be water-logged in parts during the winter months. Prior to reseeding J. effusus was present in profusion, and following reseeding regrowth occurred partly from buried seed and partly from unkilled clumps.

The rainfall of the area averaged 40 in. and the field was at an elevation of 1000 ft above sea level. Prior to reseeding 4 tons of ground limestone and 10 cwt basic slag (15% P_2O_5) per acre had been applied. Since reseeding the field was grazed with sheep and cattle, and the area under trial was always open to grazing.

Experimental Results

Layout - Five treatments (including control) replicated three times in randomised blocks.

Plot size - 12 yd. x 2 yd. (1/200 acre)

Treatments

1. 2 lb MCPA (sodium) per acre
2. 2 lb 2,4-D (amine) per acre
3. 2 lb MCPB (sodium) per acre
4. 2 lb 2,4-DB (sodium) per acre

The spray materials were applied at 30 gallons per acre, using an Oxford Precision Sprayer on the 4th July, 1955. The weather was dry and warm during spraying, and continued to be so for the following ten days. A month following spraying the plot areas were mown over and the rushes removed.

Assessments

The proportion of ground occupied by J. effusus within an 18 in. quadrat was estimated using the 0 - 10 scale; these estimates were made before spraying and in the following spring.

Estimations of White Clover (T. repens) present were made using a 6 in. quadrat, marks being given on a 0 - 10 basis for ground covered. Readings were taken before spraying, in the authumn,and in the spring.

RESULTS

TABLE I
Percentage cover of Juncus effusus

TREATMENT	4th July, 1955		11th May, 1956	
	Actual Ground Cover %	Ground Cover (C = 100)	Actual Ground cover %	Ground Cover (C = 100)
MCPA	56.8	97.4	0.4	0.6
2,4-DA	55.3	94.8	0.2	0.3
MCPB	55.2	94.7	12.3	21.1
2,4-DB	57.1	97.9	2.8	4.8
CONTROL	58.3	100.0	52.3	89.7

Significant difference at 5%: 5.7

TABLE II
Percentage Cover of White Clover (T. repens)

TREATMENT	Actual Ground Cover % (4th July)	Cover as % of that at time of spraying			Difference		
		4th July 1955 (1)	19th Nov. 1955 (2)	11th May 1956 (3)	(1)-(2)	(1)-(3)	(2)-(3)
MCPA	10.0	100	60	28	-40 *	-72 **	-32 *
2,4-DA	8.7	100	42	15	-58 **	-85 **	-27 **
MCPB	13.0	100	131	153	+31 *	+53 **	+21 NS
2,4-DB	12.8	100	147	143	+47 **	+43 **	-4 NS
CONTROL	16.8	100	95	103	-5 NS	+3 NS	+8 NS

* Significant at P = 0.05
** Significant at P = 0.01

Discussion

This trial confirmed results obtained elsewhere namely that 2,4-D and MCPA at 32 oz per acre can give an effective control of Juncus effusus.

MCPB at the same rate of application is less effective, although the actual rush kill was substantial giving approximately 70% reduction of rush ground cover. The amount of rush remaining would be sufficient to present a problem at a later date and the treatment could not be considered as being satisfactory.

2,4-DB showed considerable promise, and although it did not quite measure up to MCPA or 2,4-D, the degree of control was adequate, especially when the effect on the white clover of the pasture is taken into consideration.

The use of both MCPA and 2,4-D gave a drastic reduction in the amount of white clover present, and the vigour of the sward suffered. This was obvious from the counts taken in November, 1955 and more so from the May, 1956 counts. It would appear that a proportion of the clover present in November was so weakened by spraying that it was unable to live through the winter.

Neither MCPB nor 2,4-DB caused any reduction in the white clover content or suppressed the vigour of the sward. In fact, following the removal of the rushes these areas were better grazed and this indirectly resulted in a better cover of white clover. This was reflected in the counts made in November and May.

Conclusions

2,4-DB has shown considerable promise as a herbicide for the control of J. effusus on reseeded land, leaving the white clover present unharmed. MCPB at the rate used does not seem to give a satisfactory control.