THE EFFECTS OF MCPB AND 2,4-DB ON SEEDLING AND ESTABLISHED CLOVERS

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Summary

1. The results are reported of two experiments in which MCPB and 2,4-DB were applied to seedling red and white clovers; and of seven experiments in which MCPB, 2,4-DB, MCPA and 2,4-D were applied to established white clover.

2. In one experiment MCPB and 2,4-DB at 2 and 4 lb/ac were applied to Cotswold B.R. Clover and to S.100 White Clover at four growth stages between emergence and second trifoliate leaf stage. On the white clover 2,4-DB was significantly less toxic than MCPB whereas on the red clover there was no significant difference between the two chemicals. The white clover became more resistant to both chemicals with increasing age, whereas the red clover was more resistant before the expansion of the first trifoliate leaf than immediately afterwards.

3. In the experiments on established white clover, applications of 2 and 4 lb/ac MCPA or 2,4-D usually produced significant reductions in the amount of clover leaf and in numbers of flowering heads. In contrast, similar applications of MCPB or 2,4-DB had no significant effect. The general conclusion from the experiments is that MCPA was most toxic to the clover; that 2,4-D was slightly less toxic than MCPA; and that MCPB and 2,4-DB were considerably less toxic than either of the 'acetics'.

Introduction

The experiments aimed at covering two of the more important aspects of weed control in clovers, namely the effects of MCPB and 2,4-DB on young seedling red and white clover, and on established white clover in association with companion grasses.

Nine experiments were laid down, consisting of two on seedling clovers, four on established leys, and three on indigenous clover in permanent pasture. Since the experiments are still in progress, the results that are reported deal only with the direct toxicity of the 'butyrics' to the clovers and the comparison with their 'acetic' equivalents. Such considerations as duration of toxic effect or speed of recovery are not included.

Details of experiments

The basic information concerning each experiment may be found in Table 2. Details of management were as follows:-

Wytham - The clover was drilled in alternate rows of red and white clover ten in. apart in spring 1956. The area was kept clean, where necessary, by hand weeding. The seedbed being dry, the area was irrigated to produce uniform germination; after emergence, rainfall was sufficient for growth. Plant counts were made after the first two applications. When appropriate the clovers were hand cut and weighed fresh. Plot size 2 yd x 1 yd.

H/35/55 Witney - After being direct sown in spring 1955, the area was lightly grazed and then rested until spraying in late June 1955. Thereafter the field was grazed off and on for the rest of the year. Plot size 12 yd x 2 yd.

H/12/56 Cote, H/27/56 Bletchingdon and H/25/56 Nuffield - These experiments were carried out on leys under various management. Cote had been grazed and was cut for hay after spraying; Bletchingdon was cut for silage and then was grazed at and after spraying, and Nuffield was being grazed off and on by dairy stock all summer. Plot sizes 6 yd x 4 yd.

H/13/56 Whitfield - White clover seed that had been harvested from permanent pastures on the same farm was cleaned and drilled with companion grasses in 1950 to form a new permanent pasture. During 1956 the field was grazed on and off by sheep and cattle. Plot size 6 yd x 4 yd.

H/36/55 Waddesden, H/15/56 Worminghall and H/14/56 Long Wittenham - Long established permanent pastures: the first two have been grazed each summer by beef cattle, and Wittenham was grazed on and off by dairy stock. Plot sizes 6 yd x 4 yd.

All the experiments, apart from Wytham, were of randomised block design and contained three replicates. In the Wytham experiment, one block was unrandomised. The spraying at Wytham was carried out with a small plot compressed air sprayer of special design; all the other experiments were sprayed by an 'Oxford Precision Sprayer' (1).

Chemicals

The sodium salts of MCPB and 2,4-DB were made from pure acid supplied by May and Baker Ltd. In the 1955 experiments the sodium salt of MCPA was used, and in 1956 the potassium salt was substituted. In both years the triethanolamine salt of 2,4-D was used. Owing to difficulty in keeping the chemicals in solution in the Oxford mains water, all 1955 spray solutions contained Versine sodium salt at 5 ml/l of spray solution. All 1956 spraying was carried out with distilled water.

Results

In order to differentiate between young and established clover, the experiments are reported in two sections. The first on young clovers includes the results of experiments at Wytham (H/11/56) and at Witney (H/35/55). The second section on established clover contains the results of the remaining experiments.

Young clovers

Information concerning Cotswold Broad Red and S.100 White clover in the young seedling stage is derived from the Wytham experiment (H/11/56); and further information on S.100 clover is obtained from the Witney experiment (H/35/55). Full details of treatments, etc. may be found in Tables 2, 3 and 4.

It must first be stated that counts made 3-4 weeks after spraying in the Wytham experiment on the plants that received the first and second applications, showed that MCPB and 2,4-DB at either dose had not produced significant mortality. It follows therefore that the effects of applying MCPB or 2,4-DB discussed hereafter result from checks to growth or vigour and not from plant mortality.

Differences in chemical toxicity

In the Wytham experiment the main post-spraying assessment revealed differences in chemical toxicity as measured by yield of top growth. As may be clearly seen in Figure 1 there were marked differences between the reactions of red and white clover. On white clover, 2,4-DB at each time of application resulted in a slightly greater yield of top growth than did similar applications of MCPB. On older white clover (4-6 trifoliate leaves) in the Witney experiment there were no significant differences between the effects of the two chemicals. On the red clover, MCPB and 2,4-DB did not produce significantly different yields of top growth at any time of application. With neither chemical did increasing the dose from 2 to 4 lb/ac produce any significant change in yield of red or white clover. Summing up the points that have been mentioned, only one difference between MCPB and 2,4-DB was revealed in the two experiments, and that was that MCPB was slightly more toxic than 2,4-DB to white clover when applied between emergence and the two trifoliate leaf stage.

MCPA and 2,4-D were included in the Witney experiment. They were both extremely toxic and at doses as low as 1 lb/ac produced significant reductions in clover presence. In contrast, MCPB and 2,4-DB at 4 lb/ac did not significantly reduce clover presence (see Table 4).

Time of application

One of the objects of the Wytham experiment was to compare applications of MCPB and 2,4-DB at different times in the growth of the clover seedlings. To make this comparison possible the chemicals were applied on four different occasions between emergence and the second trifoliate leaf stage. While the detailed results are shown in Table 3, the overall effects may be seen more easily in Figure 1.

On the white clover, early applications of MCPB and 2,4-DB in the cotyledon stage produced checks to the clover that resulted in lower yields of top growth than those from subsequent applications of the two chemicals. With increased age up to the second trifoliate leaf stage, the white clover became more resistant to both MCPB and 2,4-DB. Confirmation of this effect is available in the Witney experiment which was sprayed when the clover was even older (4-6 trifoliate leaf stage); applications of up to 4 lb/ac of MCPB or 2,4-DB did not significantly reduce clover presence.

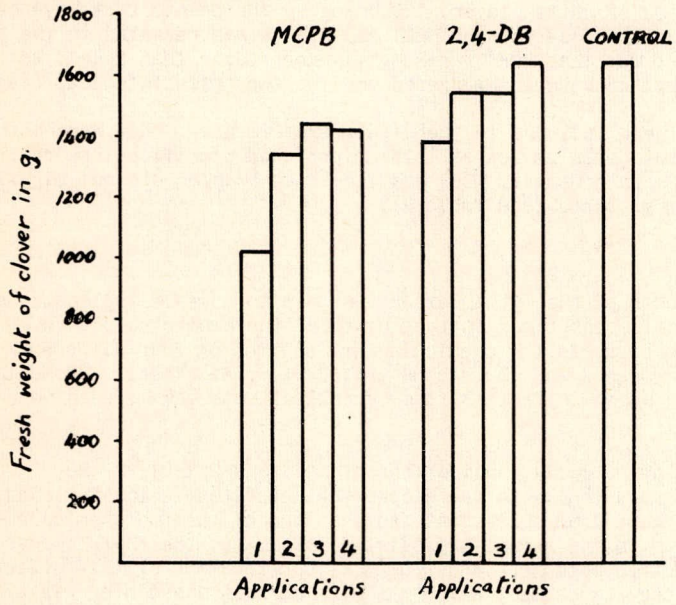
On the red clover, increased age at spraying did not bring increased resistance to MCPB and 2,4-DB: the fourth application resulted in significantly less top growth of clover than all but one of the earlier applications. Applications from emergence up to the expansion of the first trifoliate leaf were little different in effect and all resulted in slightly more top growth than the control plots. This quantitative difference in response must be considered with a qualitative difference that was observed. The earlier applications of both MCPB and 2,4-DB produced appreciable numbers of four, five and even six-leaf stems which being otherwise normal gave the plots a vigorous appearance. The plants that received the last application (1-2 trifoliate leaves) were visibly depressed: a reduction in leaf area was associated with a loss of bright green colour and a peculiar backwards and downwards bending of the leaf edges. The main conclusion as to red clover is that the plant's reaction is not straight-forward and that further experimental work is required.

Figure 1 Experiment No. H/11/56 WYTHAM

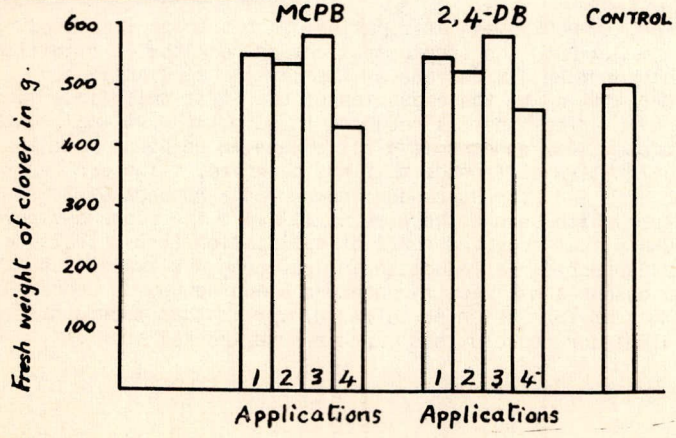
Histograms showing the weights of top growth cut after spraying.

Each histogram is a mean of the 2 and 4 lb/acre applications.

S.100 WHITE CLOVER



BROAD RED CLOVER



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Established white clover

Information concerning the effects of MCPB and 2,4-DB on established white clover was obtained in one experiment laid down in 1955 and six in 1956.

In the six experiments MCPB, 2,4-DB, MCPA and 2,4-D were compared at 1, 2 and 4 lb/ac low volume, and in the seventh (Waddesdon 1955) the 2,4-D treatments were omitted. The main post-spraying assessment was made by throwing 120 quadrats of an appropriate size on each plot, points being awarded for presence or absence of clover leaf. A secondary assessment was made of the numbers of white clover flowers in the central 2 yd x 6 yd of each plot in those experiments in which the number of flowers on the control plots indicated that such an assessment would be worthwhile. The detailed results for each experiment may be seen in Tables 4 and 5.

Differences between chemicals

The most outstanding difference in toxicity was between the 'butyrics' and the 'acetics'. Of the forty-two 'butyric' treatments in the seven experiments, only one was significantly lower than control. Of the thirty-nine 'acetic' treatments, twenty-seven caused significant reductions in the amount of clover present. At 2 lb/ac, none of the butyric treatments significantly reduced the presence of clover leaf, while ten out of thirteen 'acetic' treatments did so. Although MCPB and 2,4-DB had little effect on the presence of clover leaf in the sward, at 4 lb/ac they caused significant reduction in the number of flowers on several occasions (see Table 5). However, this reduction was small compared with the 60 and 70% depressions in flowering caused by 1 lb/ac of 2,4-D or MCPA: while the 2 and 4 lb/ac rates of 2,4-D and MCPA reduced flowering still more. From the results in Table 8 it is concluded that in these experiments MCPB was very slightly less toxic to the clover than was 2,4-DB. Both butyrics were considerably less toxic than 2,4-D, which in turn was slightly less toxic than MCPA.

The effect of varying dosage

Since the application of MCPB and 2,4-DB did not, apart from isolated occasions, produce significant effects on clover leaf or flower production, it is not possible to draw any general conclusions as to the effects of varying dosage. With MCPA and 2,4-D, increased dose usually significantly increased toxicity to the clover.

Table 1

Established white clover

Collected results showing means for each treatment for all experiments of similar design, at the first assessment after spraying.

Assessment	Chemical	Control	lb/ac 1	2	4	Mean	
Percentage clover presence in 120 quadrats per plot	MCPB	84	83	85	81	83)	six experiments
	2,4-DB		84	85	77	82)	
	MCPA		71	48	33	51)	
	2,4-D		73	56	37	55)	
Flowers on each plot as percentage of control	MCPB	100	117	110	86	104)	four experiments
	2,4-DB		104	98	90	97)	
	MCPA		30	11	3	15)	
	2,4-D		40	19	6	22)	

Clover reaction in different experiments

The performance of MCPB and 2,4-DB in the seven experiments was fairly consistent throughout, but the results in Table 4 show that in two experiments (Cote and Wittenham) the reaction of the clover to MCPA and 2,4-D differed markedly from the other five experiments. In these two experiments the clover suffered less from high applications of MCPA and 2,4-D than in the other five. A partial explanation of this effect at Cote may be that a substantial shower which fell four hours after spraying washed the chemical off the leaf. No similar explanation can be provided for the Long Wittenham experiment: the chemicals were applied under satisfactory conditions and no rain fell during the following twenty-four hours. It is interesting to note in this experiment that although the presence of clover leaf was only mildly reduced, flowering was considerably depressed and was much in line with the other experiments. The relative resistance to MCPA and 2,4-D of the clover at Wittenham as compared with susceptibility of that, for example, at Worminghall, suggest that amongst the indigenous white clover of England there may be strain differences. On the other hand the differences in presence of clover leaf after spraying might be a reflection of the competitive ability of the grasses that made up the rest of the sward.

Discussion

In planning this series of experiments, it was hoped to examine the reaction of clovers to MCPB and 2,4-DB in those situations in which the chemicals are most likely to be used, but it was appreciated that the experiments were insufficient in number and detail to give comprehensive information on unexpected clover reactions. In this category is the interesting difference between seedling red and white clovers in their response to applications of MCPB and 2,4-DB at various ages up to the second trifoliate leaf stage. It is evident that the reaction of red clover particularly is not fully known and that

further critical work is necessary. The results on established white clover are more straightforward: the comparative resistance to doses up to 4 lb/ac of MCPB and 2,4-DB is apparent in the assessments and should permit the safe commercial use of these chemicals on clovers in established swards not being grown for seed.

The methods used to assess the established clover experiments were the presence/absence method for clover leaf and measurements of flower suppression. While these two give a reasonable indication of performance after spraying, they do not cover every aspect of growth and development. Since the main object of the experiments was to compare MCPB and 2,4-DB with MCPA and 2,4-D whose effects are known, the two types of assessment were considered adequate.

Acknowledgements

The writer wishes to thank Miss O. M. Hill and Mr. M. E. Thornton, both of the Department of Agriculture Oxford University, for their work on the experiments that are reported.

References

(1) Fryer, J. D. and Elliott, J. G. (1955) Spraying equipment for the experimental application of herbicides. Proc. Brit. Weed Control Conf. 1954, 375-389.

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Table 2

Details of experiments 1955-6

Ex. No.	Location	Type of Field	Type of Clover	Time of Application	Chemicals	Gal/ac Vol. rate	Assess-ment
Seedling Clover							
H/11/56	Wytham, Berks.	Arable. Clay.	S.100 White. Cotswold Broad Red.	Cotyledon, 1st Spade, 1st & 2nd Trifoliate.	MCPB, 2,4-DB, at 2 & 4 lb/ac	100	1 & 2
H/35/55	Witney, Oxon.	Direct sown ley	S.100 White	4-6 trifoliate leaves	MCPB, 2,4-DB, MCPA, 2,4-D all at 1, 2, 4 lb/ac	12	4
Established Clover							
H/12/56	Cote, Oxon.	Third year ley	N.Z. Mother White English Wild White	13/6/56	" " "	12	3 & 4
H/27/56	Bletchingdon, Oxon.	Estab'd ley	N.Z. Mother White	11/7/56	" " "	12	3
H/25/56	Nuffield, Oxon.	Estab'd ley	S.100 White	25/6/56	" " "	12	3 & 4
H/13/56	Whitfield, Northants.	Reseeded in 1950	Local indigenous white	20/6/56	" " "	12	3 & 4
H/36/55	Waddesdon, Bucks.	Permanent pasture	White clover	24/5/55	MCPB, 2,4-DB, MCPA all at 1, 2, 4 lb/ac	12	3
H/15/56	Worminghall, Oxon.	Permanent pasture	White clover	21/6/56	MCPB, 2,4-DB, MCPA, 2,4-D all at 1, 2, 4 lb/ac	12	3 & 4
H/14/56	Long Wittenham, Berks.	Permanent pasture	White clover	15/6/56	" " "	12	3 & 4

Type of Assessment: 1. Plant counts; 2. Green weights; 3. Flowering head counts; 4. Presence/absence counts.

Table 3

Experiment No. H/11/56. Wytham. Seedling clovers. Weights in grammes

Means for each treatment of top growth cut by hand on each plot after spraying.

Clover Type	Growth Stage at spraying	Date of spraying	Control	lb/ac						
				MCPB			2,4-DB			
				2	4	Mean	2	4	Mean	
WHITE (cut on 20-28th August 1956)	Cotyledon.	11.6.56.	1634	1096	989	1042	1407	1345	1376	S.E. % of mean = 12.4%
	Cot. - 1st spade leaf.	18.6.56.		1308	1371	1339	1501	1583	1542	Significant differences:-
	1st spade leaf.	22.6.56.		1484	1411	1448	1463	1626	1545	1 513
	1-2 trifoliate leaves.	30.6.56.		1400	1454	1427	1614	1657	1636	2 362
	Mean			1322	1308	1314	1496	1553	1525	3 162
RED (cut on 26th July 1956)	90% cotyledon a few spades.	11.6.56.	489	535	566	551	602	492	547	S.E. % of mean = 10.1%
	1st spade leaf.	18.6.56.		540	546	543	527	523	525	Significant differences:-
	Spade - 1st trifoliate.	22.6.56.		588	574	581	624	560	592	1 150
	1-2 trifoliate leaves.	30.6.56.		439	429	434	420	461	440	2 106
	Mean			525	529	527	543	509	526	3 47

1 SD between the mean of any two treatments.
2 SD between the means of all treatments of one chemical at one spraying.
3 SD between the means of all applications of two chemicals.

Table 4

White clover

The main post spraying assessment in each experiment, shown first as mean percentage presence of clover leaf resulting from 120 throws of a quadrat per plot; the figures are then shown Arc Sin % transformed.

Ex. No.	Location	Control	MCPB lb/ac 1	MCPB lb/ac 2	MCPB lb/ac 4	2,4-DB lb/ac 1	2,4-DB lb/ac 2	2,4-DB lb/ac 4	MCPA lb/ac 1	MCPA lb/ac 2	MCPA lb/ac 4	2,4-D lb/ac 1	2,4-D lb/ac 2	2,4-D lb/ac 4	Quadrat size	P = 0.05 SD between: 2 Treatments	P = 0.05 SD between: Treatment and control
H/35/55	Witney	72	82	69	64	62	68	62	19	7	3	31	16	2	6in. square		
Sown Clover																	
H/12/56	Cote	76	67	80	78	78	68	75	78	67	74	72	72	75	1.25in. ring		
H/27/56	Bletchingdon	79	81	83	77	76	77	76	77	49	22	74	71	42	"		
H/25/56	Nuffield	84	88	84	77	82	80	77	62	43	15	78	48	24	"		
H/13/56	Whitfield	90	89	92	88	89	91	88	60	31	4	77	27	2	"		
Permanent Pasture																	
H/36/55	Waddesdon	82	85	85	87	84	91	83	61	37	19				3in. square		
H/15/56	Worminghall	88	85	84	79	88	88	69	62	32	13	53	37	17	2in. ring		
H/14/56	L. Wittenham	89	88	88	92	90	88	80	87	71	53	83	82	58	1.25in. ring		
	Transformed														S.E.% mean		
H/35/55	Witney	58.1	64.4	56.2	53.4	52.8	56.1	51.9	26.1	15.2	10.9	34.9	21.3	7.8	9.3	10.9	9.5
Sown Clover																	
H/12/56	Cote	59.8	55.5	63.8	62.8	62.4	56.0	60.1	62.4	54.9	60.1	58.7	58.8	60.1	4.3	7.4	6.0
H/27/56	Bletchingdon	62.7	66.5	66.1	61.8	60.7	61.9	60.6	61.9	44.6	28.1	59.5	57.5	40.1	4.8	7.9	6.4
H/25/56	Nuffield	67.3	70.3	67.6	61.1	64.8	63.7	61.8	54.1	41.0	22.4	62.5	43.8	29.9	5.1	8.3	6.8
H/13/56	Whitfield	71.8	70.6	73.8	69.9	71.4	72.3	69.8	51.9	33.5	11.1	61.7	30.8	6.8	4.5	7.5	6.1
Permanent Pasture																	
H/36/55	Waddesdon	65.3	67.4	64.9	68.4	66.8	72.5	65.7	51.5	37.2	25.9				6.0	10.5	9.1
H/15/56	Worminghall	70.9	67.2	66.8	63.0	71.1	70.3	56.8	57.2	34.2	21.4	47.0	36.4	23.3	7.7	12.2	10.0
H/14/56	L. Wittenham	71.3	70.4	70.7	73.7	71.6	70.1	63.6	69.4	57.6	47.1	66.9	62.4	49.7	3.5	6.6	5.4

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Table 5

White clover

Counts of total flowering heads in the central 12 sq. ft of each plot, one month after spraying.
Means for each treatment.

Experiment	Control	lb/ac												SE % mean	P = 0.05 SD between:	
		MCPB			2,4-DB			MCPA			2,4-D				Treatments	Treatment & control
		1	2	4	1	2	4	1	2	4	1	2	4			
Nuffield	240	289	322	239	273	182	201	68	26	8	160	55	13	14.7	72	59
Whitfield	186	178	192	130	134	130	177	28	8	1	42	4	0	17.0	52	42
Worminghall	296	257	177	129	261	249	209	10	1	0	5	5	0	31.1	131	107
Wittenham	496	470	425	376	413	434	326	199	73	22	200	111	44	17.6	155	127
Overall mean	254	298	279	218	265	248	228	76	27	7	101	48	14			
		Overall mean = 265			= 247			= 37			= 54					

THE EFFECTS OF MCPB AND 2,4-DB ON ESTABLISHED LEGUMES

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Summary

The results are reported of two experiments. In one MCPB and 2,4-DB were applied to established lucerne and weed grasses. In the other MCPB, 2,4-DB and 2,4-D were applied to established S_{100} white clover with companion grasses.

Established lucerne

1. When compared at 2 and 4lb/ac MCPB was more toxic to the lucerne than was 2,4-DB as measured by the proportion of lucerne to other species in green cuts, one, eleven and thirteen months after spraying.

2. One month after spraying 2lb/ac MCPB caused an approximate 53% reduction in weight of cut lucerne, while 2lb/ac 2,4-DB caused a 22% reduction. The equivalent figures thirteen months after spraying were:-

   2lb/ac MCPB - 19% reduction, 2lb/ac 2,4-DB - 5% increase.

Established white clover

1. In four different assessments in the ten months following spraying, the order of chemical toxicity to the clover was:- MCPA most toxic, followed by 2,4-D and then MCPB. 2,4-DB was the least toxic chemical.

2. Applications of 2lb/ac or above of MCPA or 2,4-D usually produced significant toxicity to the clover; similar applications of MCPB or 2,4-DB did not do so.

Introduction

In view of the important effect on weed control in grassland that would follow the successful development of the phenoxy-butyric acids (MCPB and 2,4-DB), it was agreed that the Grassland Research Institute and the A.R.C. Unit of Experimental Agronomy should in 1955 initiate a cooperative investigation of the effects of the compounds on leguminous crops.

Two experiments were planned: one on established lucerne and the other on established white clover, to investigate over a period of a year the direct effects on the crops of varying concentrations of MCPB and 2,4-DB when applied at about the normal time for perennial weed control (in the clover experiment MCPA and 2,4-D were included for comparison). Responsibility for the experiments was divided so that the Grassland Research Institute provided the sites, the A.R.C. Unit of Experimental Agronomy provided and applied the chemicals and

the work of assessment was shared. The work was carried out much as planned except that the long dry period in the spring of 1956 caused a reduction in the growth of white clover which prevented a detailed assessment twelve months after spraying.

Details of experiments

The Lucerne experiment

A healthy crop of du Puits lucerne sown in two foot rows in 1953 on a clay loam with flints at Hurley (Berks.). The most competitive weeds present were Agrostis gigantea and Poa trivialis.

MCPB (sodium) and 2,4-DB (sodium) at 1, 2 and 4lb/ac were applied in 12 gal/ac; versine sodium salt at 5ml/l of water was added to the spray solutions to prevent precipitation. The plot size was 28ft by 12ft. Each randomised block, of which there were three, contained three control plots.

February 1955. Scuffled between rows. No fertilizer dressing.

Late May 1955. The crop was cut for silage.

17th June 1955. The chemicals were applied when the crop was 12-14 in. high.

22nd July 1955. The crop was cut for silage and samples were taken from each plot.

September 1955. Grazed by sheep.

31st May 1956. The crop was cut for silage and samples were taken from each plot.

25th July 1956. The crop was cut for silage and samples were taken from each plot.

Assessments made on 28th June 1955, 22nd July 1955, 31st May 1956, and 25th July, 1956.

The white clover experiment

A mixture of S_{100} Clover, S_{37} Cocksfoot, S_{48} Timothy and S_{215} Meadow Fescue was sown in spring 1952 on a sandy clay loam. The clover was vigorous and free from broad-leaved weeds at the time of spraying.

MCPA (sodium)

MCPB (sodium), 2,4-DB (sodium)/and 2,4-D (amine) were all applied at 0.5, 1, 2 and 4lb/ac in 12 gal/ac. Versine sodium salt at 5ml/l of water was added to all spray solutions to prevent precipitation. The plot size was 36ft by 6ft. Each randomised block, of which there were three, contained three control plots.

16th April 1955. Fertiliser application 2 cwt/ac (12% N, 12% P_2O_5, 15% K_2O)

23rd May 1955. The area was mown for silage.

20th June 1955. The area was gang-mowed.

30th June 1955. The chemicals were applied.

27th July 1955. Each plot was cut with a motor scythe for estimates of clover contribution.

Sept/Oct. 1955. The area was hard grazed by cattle.
Spring, 1956. " " " " " " "

Quadrat assessments of the clover in the plots were made on 2nd and 24th November 1955, 28th March 1956 and 3rd May 1956.

Chemicals

The sodium salts of MCPB and 2,4-DB were made from pure acid supplied by May and Baker Ltd. The sodium salt of MCPA and the triethanolamine salt of 2,4-D were used. All the chemicals were applied as solutions in water by means of an 'Oxford Precision Sprayer'. (1)

Results

The lucerne experiment

The first effects of spraying could be seen after eleven days on 28th June 1955. To a degree varying with treatment, the lucerne had suffered reduction in leaf area and height, the latter due to curling of the stems; in addition the leaves had lost their bright green colour. Visual scores were made by two independent observers on these effects and the results may be seen in Table No. 1.

Table 1

Scores of appearance of lucerne by two observers on 28th June 1955. Means for each treatment. Full Vigour = 20. Death of top growth = 0.

Chemical	lb/ac		
	1	2	4
MCPB	15.8	13.5	11.2
2,4-DB	18.2	17.3	16.3

Control mean = 19.2

The figures show that all treatments had a visible effect that became more marked as the concentration of chemical increased. At equivalent concentrations, MCPB was more toxic than 2,4-DB.

The first detailed post-spraying assessment took place five weeks after spraying on 22nd July, 1955, when an area 28ft by 3ft on each plot was cut and weighed fresh. Sub-samples were taken for visual estimation of botanical composition. The results of this and two similar assessments carried out in 1956 are shown in Table 2.

Table 2

The lucerne experiment (sprayed 17th June, 1955)

Fresh weights and compositions of samples in 84 sq ft of each lucerne plot. Means for each treatment.

Treatment	Gross fresh weight lb	Composition - %			Calculated weight of lucerne lb
		Lucerne	Grass	Other spp.	
Cut on 22nd July 1955					
Control	20	73	18	9	14.4
1 lb/ac MCPB	17	76	20	3	12.6
2 " "	12	58	34	8	6.7
4 " "	10	57	38	5	5.7
1 " 2,4-DB	16	68	27	5	10.9
2 " "	16	71	22	8	11.4
4 " "	13	75	23	2	9.9
Cut on 31st May 1956					
Control	20	70	30	T	14.3
1 lb/ac MCPB	20	76	23	1	15.2
2 " "	18	66	34	T	11.9
4 " "	14	61	39	0	8.5
1 " 2,4-DB	19	66	34	T	12.3
2 " "	21	69	30	1	14.3
4 " "	19	68	31	1	12.7
Cut on 25th July 1956					
Control	20	85	14	1	16.7
1 lb/ac MCPB	19	83	17	T	15.8
2 " "	17	81	19	0	13.5
4 " "	14	76	24	T	10.4
1 " 2,4-DB	17	87	12	1	14.8
2 " "	21	84	16	T	17.6
4 " "	19	81	18	1	15.1

T = Trace.

MCPB at 2 and 4lb/ac was sufficiently toxic to the crop to cause a substantial reduction in the weight of lucerne harvested. This effect is visible in all three assessments, and although the cuts on 31st May and 25th July 1956 show that partial recovery had occurred; the weight of lucerne on these plots was still significantly (P = 0.05) below control thirteen months after spraying.

2,4-DB produced effects rather different to MCPB. All treatments of 2,4-DB caused a reduction in weight of lucerne that was substantial a month after spraying but small twelve and thirteen months after spraying. No clear cut effect of increased dose of 2,4-DB is visible in the results for percentage contribution of lucerne or weight of lucerne.

The conclusion from this experiment is that at 2 and 4lb/ac, MCPB was more toxic to the lucerne than was 2,4-DB.

The white clover experiment

During the ten months that followed the spraying of this experiment, assessments of the clover population were made on five occasions. In order that the results may be presented with clarity, they have been grouped under three headings, but a general impression of the initial effects on the clover may be gained from Figure 1.

Differences in chemical toxicity

One of the objects of the experiment was to bring out differences in chemical toxicity to the clover; for this reason the method of assessing the results was varied from time to time. The outcome of three different types of assessment may be seen in Table 4. The value for each chemical is a mean of twelve plots and, since the concentrations used were the same for all chemicals, they are directly comparable in each assessment. In all the assessments that were analysed, 2,4-DB was significantly ($P = 0.05$) less toxic to the clover than were 2,4-D and MCPA. In three of the four assessment (presence of clover on 2/11/55 and 3/5/56 and ground cover on 24/11/55) MCPA was significantly ($P = 0.05$) more toxic than the other three chemicals. The results of all the assessments lead to the conclusion that the order of chemical toxicity was:- MCPA most toxic, followed by 2,4-D, MCPB, and then 2,4-DB.

(4D11)

Figure 1

H.22.55. HURLEY. Established S.100 White Clover

Assessment on 2/11/55 - 4 months after spraying

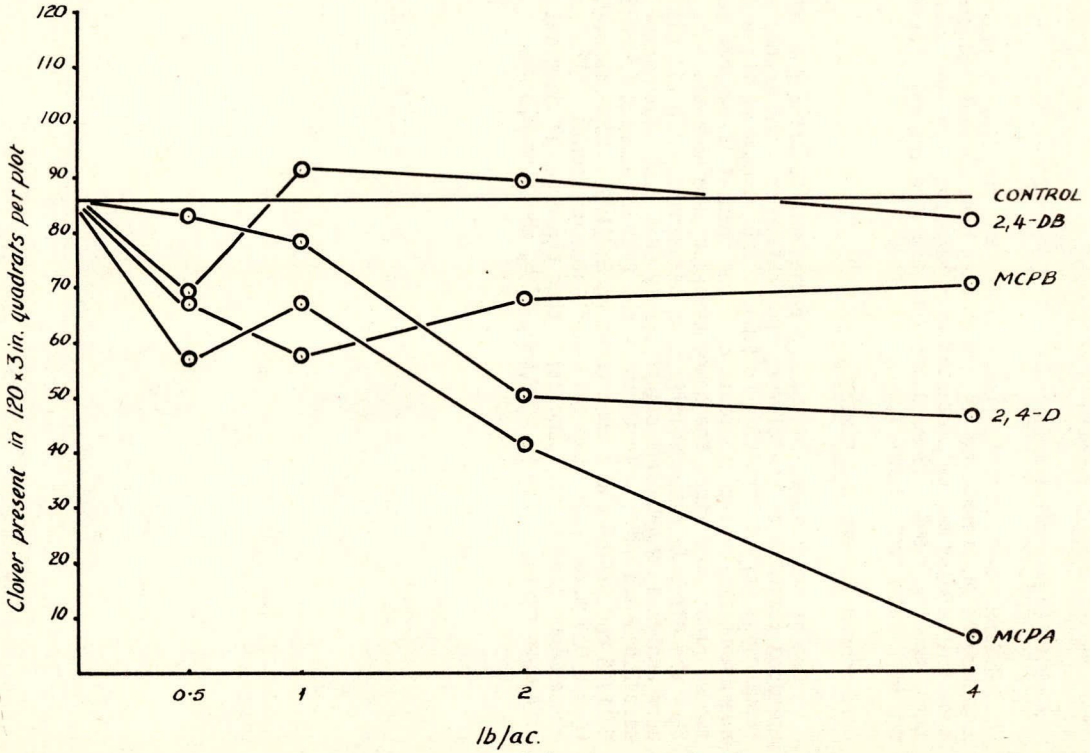

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Table 3 White Clover Experiment.

The table shows the results of four different assessments. In each assessment the single figure for each chemical is a mean of the four concentrations (0.5, 1, 2, 4lb/ac). The results are shown first as measured and then Arc Sin % transformed.

Type of Assessment	Control	2,4-DB	MCPB	2,4-D	MCPA	P = 0.05
% Clover contribution on 27/7/55.	19.5	16.5	11.5	10.5	9.0	
Transformed	25.7	23.3	19.7	18.7	17.0	SD between chemicals = 3.6
Presence of clover on 2/11/55	86.3	82.2	65.6	64.5	42.9	
Transformed	58.2	56.1	47.8	47.2	35.9	SD between chemicals = 5.6
% Ground cover of clover on 24/11/55	62.5	59.7	46.2	35.2	19.7	
Transformed	52.4	50.7	42.7	35.5	24.0	SD between chemicals = 5.9
Presence of clover on 3/5/56	83.5	77.7	63.7	61.5	49.2	
Transformed	59.3	52.3	48.1	45.8	39.3	SD between chemicals = 6.1

The effect of increased concentration

When a light dose of a growth regulator herbicide is mildly toxic to a plant population, an increased dose usually produces increased toxicity. In this experiment MCPA and 2,4-D followed the normal pattern and the raising of the chemical concentration from 1 to 4lb/ac significantly reduced the presence of clover on 2nd November 1955 and on 3rd May 1956.

In contrast, any response of the phenoxy-butyrics was too small to be measured in the assessments. In all the assessments that were carried out, increased dose from 0.5 to 4lb/ac of MCPB or 2,4-DB did not result in a significant increase in toxicity to the clover.

The persistence of chemical effect

Before considering the changes in clover population that occurred on the treated plots in the ten months following spraying, it is necessary to give some idea of the management and its effect on the control plots.

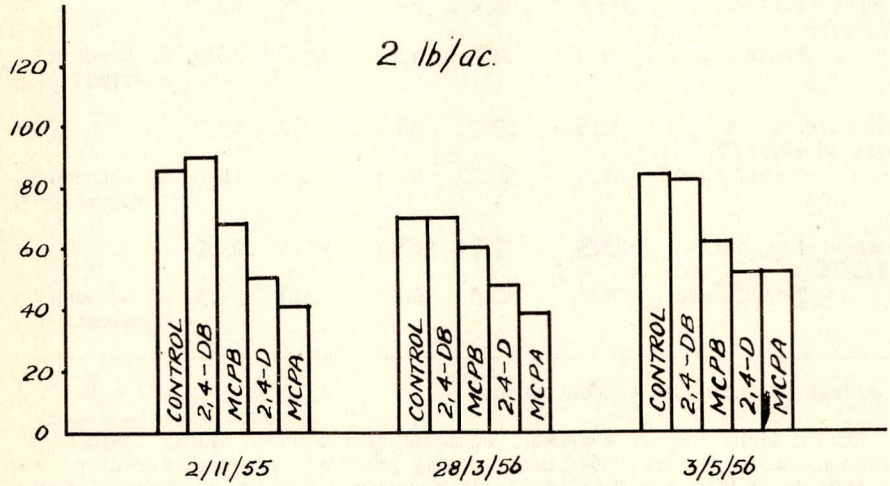
For three weeks after spraying the sward was allowed to grow before being mown, thereafter in the autumn the area was hard grazed by cattle. This management might be said to favour slightly the grasses rather than the clover. From November 1955 onwards, the management was designed to favour the clovers by fertiliser application and early grazing in the spring.

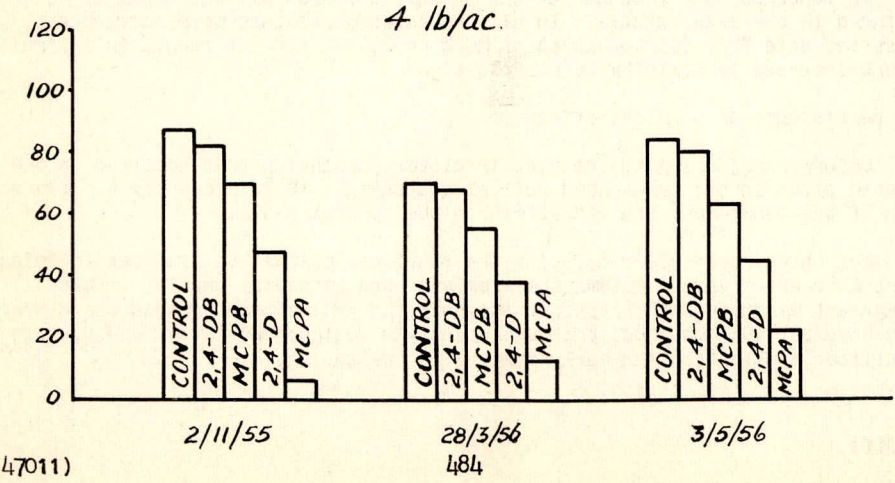
Figure 2

Histograms showing the presence of clover due to each treatment assessed on three different dates.

Means for each treatment of 120 three in. quadrats per plot scoring for presence or absence. Maximum 120.

The treatments were applied on 30th June 1955.





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The histograms in Figure 2 show the effects of the 2 and 4lb/ac rates of each chemical and the changes that took place in the period of six months over winter. Since the method of assessment was the same at each date, the histograms are directly comparable.

At both rates of application the clover presence on the 2,4-DB plots was very similar to that on the control plots and the question of persistence of effect does not therefore arise. MCPB and 2,4-D may be grouped together because, although at equivalent concentrations, 2,4-D was the more toxic, the clover sprayed with either chemical showed little change relative to the controls over the six months period from November 1955 to May 1956. The 2 and 4lb/ac applications of MCPA initially reduced clover presence more than did similar applications of the other chemicals; but thereafter the MCPA plots showed a slight recovery, which was however small compared with the initial depression.

Discussion

The investigation of the toxicity of a series of chemicals to a perennial crop is separated into two parts. Examination must first be made in terms of growth and yield of the immediate results of applying the chemical, and then an indication of the persistence of the chemical is provided by the recovery or otherwise of the crop in the period after the predicted disappearance of the chemical from the soil.

In considering this latter effect in the two experiments it is necessary to bear in mind that the areas were selected for comparative freedom from broad leaved weeds, because only on such sites could the direct effect of the chemical on the crop be examined. Both experiments contained grasses in sufficient quantity to be competitive with the legumes and any check in the growth of the legume due to spraying would permit an increase in grass growth which would in turn hinder the recovery of the legume. In the absence of broad leaved weeds the conditions were somewhat more severe than might be expected in normal farm weed control.

The initial toxicities of the different chemicals appear to be clear cut both on lucerne and white clover but the persistence of effect in the clover experiment is perhaps not so reliable. The control plots in summer, 1956 did not produce as vigorous a stand of clover as was present in 1955, and it was apparent that some factor possibly dry weather in summer 1955 and spring 1956 had reduced clover growth. Since the control plots were lacking in growth, one would not expect to detect differences in recovery.

Reference

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Spraying equipment for the experimental application of herbicides.
Proc. Brit. Weed Control Conf. 1954, 375-389.

INVESTIGATIONS ON THE EFFECT OF DIFFERENT RATES OF MCPB, 2,4-DB, MCPA AND 2,4-D ON RED AND WHITE CLOVERS FOR SEED

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Summary

1. The results are presented of three experiments on the effect of phenoxybutyric compounds on red and white clover seed crops compared with the standard herbicides MCPA and 2,4-D.

2. MCPB and 2,4-DB at 1, 2 and 4 lb/ac, MCPA at 0.5, 1 and 2 lb/ac and 2,4-D at 0.25, 0.5 and 1 lb/ac all affected the crop appreciably and reduced numbers and size and vigour of flowering heads, and also the yield in the only experiment for which yield data are available.

3. MCPB and 2,4-DB were considerably less damaging to the crop than MCPA and 2,4-D.

4. When sprayed about 2 weeks after the last cut before putting up for seed white clover was most affected and late flowering red clover least affected, with broad red clover intermediate.

5. Time of spraying in relation to flowering date is considered of great importance, and further experiments are planned to investigate this factor.

Introduction

During the course of our work on the certification of clover crops for seed, many farmers have raised the problem of controlling certain pernicious weeds in those crops by using the recently introduced phenoxybutyric compounds.

The rules (1) governing the conditions of certification on field inspection, state "In any crop the number of weed plants of each of the species named in the following list and likely to be seed bearing in the crop at time of harvest, shall not on the average exceed the number stated".

General list applicable to all crops

	Number of plants/sq. yd
Cirsium spp. (thistles)	2
Rumex spp. (docks and/or sorrels)	2
Special list	
(a) White clover crops	
Geranium pusillum and/or G. molle (cranesbills)	1
Matricaria inodora (mayweed)	1
Prunella vulgaris (self heal)	1
Sherardia arvensis (field madder)	1
Holcus lanatus (yorkshire fog)	1
Melandrium album (white campion)	2
(b) Red clover crops	
Plantago lanceolata (ribgrass)	½
Daucus carota (wild carrot)	½
Geranium dissectum (cut-leaved geranium)	1

These standards may appear to allow of a high tolerance of weeds in the crop for field certification. Nevertheless it has often been necessary to ask growers to take steps to reduce the number of weeds, particularly docks and thistles, by resorting to hand roguing or other methods of eradication in order to attain such standards.

New methods of seed cleaning have assisted in reducing impurities in the cleaned sample, but in a survey (2) carried out by the Official Seed Testing Station of the N.I.A.B. 1951 - 1952, weeds of the Rumex spp., for example occurred in 28% of the 4,990 samples tested of red clover, and in 38.2% of 1,284 samples of white clover.

Whilst work on the effect of these new herbicides on weeds is being done elsewhere, little is known of their effect on the clover plant and its ability to set seed. Consequently a series of trials was started in the East Midland Province in 1956 to study the effects on seed crops of different rates of application of MCPB, 2,4-DB, MCPA on red clovers; and of MCPB, 2,4-DB and 2,4-D on white clovers.

Experimental Method

MCPB and 2,4-DB, each at 3 rates, were compared on three crops of clover for seed using 2,4-D at three rates as a standard for white clover and MCPA for red clover. A randomised block design was used with eleven treatments (including two controls per block) replicated three times, making 33 plots in all. Plot size was 12 yd x 2 yd and spray applications were made with an Oxford Precision Sprayer, a hand sprayer designed for experimental use. In each case the field had been cut for hay or silage before putting up for seed, and the treatments were applied after the crop had been allowed to regrow for about 2 weeks.

Counts of flowering heads and scorings for head size and vigour of flowering were made by throwing 20 x 1 sq. ft random quadrats per plot and counting in each quadrat all heads which had flowered or had begun to flower. A score was awarded for each quadrat based on the size and vigour of the flowering heads. Yields were assessed by throwing 10 random quadrats 18 in. square per plot (giving a harvested area of 2.5 sq. yd per plot) and hand picking all ripe heads, which were oven dried and rubbed out by hand. The unripe heads in each quadrat were also recorded.

At the time of writing the experiments have not been concluded, as the two red clover trials are still to be harvested, nor has the available date been analysed statistically.

Results

White Clover (S.100)

The dates and stages of growth of clover at which the crop was sprayed and assessed are as follows:-

Date of spraying Stage of growth	30th June, 1956. Clover 6 in. high with 10% of heads in flower, flowers about half open.
Date of assessment for head counts etc. Date of harvest	17th August, 1956)) about 7 weeks after 20th August, 1956) spraying
Stage of growth	Most heads brown but about 10-15% still flowering or green.

The table overleaf summarises the data collected.

Table 1

Treatment	No. of Heads per sq. ft	Vigour as % of Control	Yield as % of Control	No. of Unripe Heads per sq. ft
MCPB 1 lb/ac	16	78	58	2.3
MCPB 2 lb/ac	15	72	55	3
MCPB 4 lb/ac	12	63	31	3
Mean of all rates of MCPB	14	71	48	2.8
2,4-DB 1 lb/ac	21	89	84	1.4
2,4-DB 2 lb/ac	18	76	69	1.5
2,4-DB 4 lb/ac	17	75	53	1.5
Mean of all rates of 2,4-DB	19	80	69	1.5
2,4-D 0.25 lb/ac	6	54	2.4	3
2,4-D 0.5 lb/ac	3	46	0.3	2.2
2,4-D 1 lb/ac	1	17	0.3	0.4
Mean of all rates of 2,4-D	3	39	1.0	1.9
Control (i) Unsprayed	23	100	99	1.5
Control (ii) Unsprayed	21	100	101	1.5
Mean of Controls	22	100	100	1.5

All treatments checked the clover and reduced yield to an appreciable extent. 2,4-D under the conditions of this experiment had a disastrous effect even at the lowest rate of 0.25 lb/ac, reducing the yield to almost nil. MCPB and 2,4-DB at 2 lb and 4 lb/ac reduced the number of flowering heads, the vigour and the yield markedly. Only the 1 lb rates were at all comparable with the controls, but even the best treatment, 1 lb 2,4-DB, reduced the vigour appreciably and the yield by 16%, though the number of flowering heads was not affected. There was a consistent difference in head counts, vigour and yield between the two butyric compounds in favour of 2,4-DB, which was also the only chemical which did not increase the number of unripe heads at harvest.

Broad Red Clover

The dates and stages of growth at which the crop was sprayed and assessed are as follows:

Date of spraying Stage of growth	23rd July, 1956 12 in. - 15 in. high, earliest plants in bud
Date of first assessment Stage of growth	17th August, 1956 (3.5 weeks after spraying) about two-thirds in flower
Date of second assessment Stage of growth	10th September, 1956 (7 weeks after spraying) Flowering completed, about one-third of heads brown

The available data is summarised below.

Table 2

Treatment	Number of heads per square foot		Number of heads as % of Control		Vigour as % of control		% of unripe heads
	3.5 weeks after spraying	7 weeks after spraying	3.5 weeks after spraying	7 weeks after spraying	3.5 weeks after spraying	7 weeks after spraying	7 weeks after spraying
MCPB 1 lb/ac	7	13	66	77	72	77	74
" 2 lb/ac	5	13	46	75	48	73	73
" 4 lb/ac	5	13	49	73	48	60	65
Mean of all rates of MCPB	5.7	13.0	54	75	56	70	71
2,4-DB 1 lb/ac	8	12	75	70	68	59	48
" 2 lb/ac	6	9	56	53	54	59	51
" 4 lb/ac	5	8	48	47	45	48	50
Mean of all rates of 2,4-DB	6.3	9.7	59	57	56	55	50
MCPA 0.5 lb/ac	1	10	8	58	18	75	95
" 1 lb/ac	0	6	1	37	3	62	95
" 2 lb/ac	0	4	0	24	0	52	99
Mean of all rates of MCPA	0.3	6.8	3	40	7	63	96
Control (i)	10	17					66
" (ii)	12	17.5					74
Mean of Controls	11	17.2	100	100	100	100	70

The figures for head counts and vigour are given for each of two dates after spraying. From the counts made 7 weeks after spraying it can be seen that all treatments appreciably reduced number of heads and their size and vigour. The best treatment, 1 lb MCPB reduced number and vigour of heads by 23% compared with controls. 2,4-DB was more severe than MCPB, the mean reduction for all rates being 43% as against 25% for MCPB, whilst the corresponding reduction for MCPA was no less than 60%.

The percentage of unripe heads in the counts made 7 weeks after spraying indicate that MCPA delayed flowering considerably, which is confirmed by the earlier counts quoted. MCPB had no effect on percentage of unripe heads but 2,4-DB appeared to have hastened maturity, the proportion of ripe heads at this date being consistently higher than the controls.

A comparison of head counts and scores for vigour made at the two dates shows that the MCPB and MCPA plots made considerable recovery in the interval relative to the controls while the 2,4-DB plots showed no change.

Late Flowering Red Clover

Date of spraying Stage of growth	26th June, 1956 6 in. - 10 in. high, no sign of flowering
Date of assessment Stage of growth	4th September, 1956 (10 weeks after spraying) Full flower, very few brown heads

Yield figures are not yet available but the following table summarises head counts and scores for head size and vigour.

Table 3

	No. of Heads per Sq. ft	Vigour as % of Control
MCPB 1 lb	38	101
" 2 lb	38	92
" 4 lb	38	93
Mean of all rates of MCPB	38	97
2,4-DB 1 lb	37	85
" 2 lb	35	73
" 4 lb	32	74
Mean of all rates of 2,4-DB	35	77
MCPA 0.5 lb	38	109
" 1 lb	36	97
" 2 lb	34	97
Mean of all rates of MCPA	36	101
Control (i)	34	100
Control (ii)	38	100
Mean of Controls	36	100

All rates of MCPB and MCPA have been without effect on numbers of flowering heads at this date, and they have had no appreciable effect on head size and vigour. 2,4-DB while not reducing head numbers, has markedly reduced their size and vigour and this may well lead to some reduction of yield. Observations made seven weeks after spraying showed much more severe effects from 2,4-DB, and some check from the other treatments, from which the clover has subsequently largely recovered.

Discussion

All treatments gave an appreciable check to the seed crop in two of the three experiments and either reduced the yield or showed every sign of doing so. Even the 1 lb rate of MCPB and 2,4-DB (about half the normal rate) affected the crops of White Clover and Broad Red Clover sufficiently under the conditions of the experiment to make one reluctant to recommend spraying at this rate and stage of growth except as an alternative to serious financial loss through, for example, certain failure of a crop to reach certification standards. In contrast to the numerous experiments where spraying of the butyric compounds has had no appreciable effect on vegetative growth of clover this is perhaps a little surprising. A check to the flowering process appears to be less easily overcome than a check to vegetative growth.

It should be noted that application rates of MCPA were only a half, and of 2,4-D were only a quarter, those of MCPB and 2,4-DB, so that a direct comparison is only possible with the 1 lb and 2 lb rates of MCPA and MCPB and the 1 lb rate of 2,4-D and 2,4-DB. The data for these rates show quite clearly that the butyric compounds were considerably less harmful to the clover than MCPA and 2,4-D in two of the three experiments (in the third there were no appreciable effects from any compound). This greater selectivity of MCPB and 2,4-DB is a strong argument for their use on clover seed crops by those farmers who now use MCPA or 2,4-D (as a few seed growers have done for some years), and encourages the hope that a safe technique can be worked out for their use on these crops.

Of the three types of clover used for these experiments the treatments have been most severe on White Clover and almost harmless on Late Flowering Red Clover with Broad Red Clover intermediate. This seems to us to be connected with the seasonal growth habit of the different clovers and particularly with the length of time between putting up for seed and maximum flowering. White Clover has the shortest period before flowering followed by Broad Red Clover with Late Flowering Red Clover appreciably the longest. All three clovers in our experiments were sprayed around two weeks after putting up for seed. During this time the White Clover had grown rapidly and was already partly flowering, the Broad Red Clover was just coming into bud while the Late Flowering Red Clover was making only vegetative growth. One would therefore expect the disturbance of the flowering process to be greatest with White Clover and least with Late Flowering Red Clover, and our results bear this out. We believe therefore that the most important aspect of the use of herbicides on clover seed crops is the question of time of application in relation to flowering. It may be that with Late Flowering Red Clover it will be possible to spray the seed crop itself while with White Clover spraying for weed control may need to be carried out before the last cutting or grazing. This obviously may affect the degree of weed control which can be achieved and entail further investigations on this point. We intend to do further work on spraying the three types of clover at different times in relation to period of flowering and hope that this may help towards the establishment of chemical weed control as standard practice with yet another crop.

References

(1) WELSH PLANT BREEDING STATION Seed Crop Certification Scheme Rules, Regulations and Conditions.

(2) BROAD, P. D. (1952) The occurrence of weed seeds in samples submitted for testing by the O.S.T.S. J. nat. Inst. agric. Bot., 6, 275-286.

DISCUSSION ON THE PREVIOUS FIVE PAPERS

H. P. Allen (Introduction to discussion)

This section of our afternoon session on the gamma phenoxybutyric compounds must surely be of the most vital interest becuase it is in grassland rich in clover that these compounds have been expected to play their major roles. It is now two years since this new group of herbicides was introduced through the Harrogate Conference by Professor Wain, and by Carpenter and Soundy - and to-day the field performance of these chemicals is being reviewed.

I should like to open discussion on this group of papers under five headings.

Effect on seedlings

First, the effects of MCPB and 2,4-DB on the various ley legumes in the seedling stage, i.e. 3-4 trifoliate leaves and younger.

White Clovers

I think the general verdict is that, compared with the acetic compounds, both MCPB and 2,4-DB may be considered extremely gentle. That is not to say that there is no toxicity established. Elliott states that 2,4-DB (all treatments considered) resulted in a significantly greater yield of top growth than MCPB when applied between emergence and the two-trifoliate leaf stage. He quotes yield differences in favour of 2,4-DB of over 35% by the cotyledon stage treatment, and of 14% even following spraying at the two-trifoliate leaf stage. The results of Le Brocq and Beech on seedling S.100 and wild white clovers show 2,4-DB as very slightly safer than MCPB in initial effect. These workers found, however, that both MCPB and 2,4-DB depressed seedling white clover (S.100 and wild white) to quite a marked degree, and that even 30 days after spraying there was approximately 25% reduction in general bulk and density of S.100 and over 30% depression in the case of wild white clover. I highlight this point because it is one on which the workers presenting these papers are not in full accord. Later assessments this summer by Le Brocq and Beech have indicated almost complete recovery of white clovers on the butyric plots, and I leave the details of this to Mr. Le Brocq.

Red Clovers

A most interesting point arising from Elliott's work is that whereas with white clover increased age brought increased resistance to MCPB and 2,4-DB, with red clover (Cotswold Broad Red) applications at cotyledon, first true leaf and first trifoliate leaf stage did not produce different results; in fact, all slightly increased top growth over control. Application at the two-trifoliate leaf stage, however, resulted in significantly less top growth of red clover than earlier applications. None of the other papers brings out this point, but we must bear in mind that only Elliott carried out trials specifically designed to test this feature.

I have heard of occasional practical instances of well established seedling red clover - in the 3-4 trifoliate leaf stage when sprayed - suffering depression as a result of MCPB application, and I feel that the response of red clovers to this chemical is summed-up very accurately and concisely by Elliott who says that "the reaction of broad red clover is not straightforward and further experimental work is required".

Lucerne

There is information from only two experiments on seedling lucerne, 6 leaf stage (Le Brocq and Beech). Briefly MCPA proved very toxic and MCPB caused considerable setback at all rates, i.e. 24, 30 and 36 oz a.e., but there was considerable recovery after ten weeks.

2,4-DB was safest of all chemicals tested, and after 30 days recovery from the very slight depression caused by 24 and 30 oz, was almost complete.

Effect on established plants

Most of the reported trials demonstrate that at the practical rate of 2 lb a.e./ac the phenoxybutyric compounds (MCPB and 2,4-DB) are relatively safe. In Elliott's experiment, even at 4 lb/ac though flowering was reduced by the butyrics this reduction was small compared with the 60-70% reduction in flowering caused by MCPA and 2,4-D. Ochiltree's 1955 results bear this out. Carpenter and Wilson calculated from their trials an MCPA : MCPB toxicity ratio of 8-10 : 1. The experiment carried out by Elliott, Green and Evans, however, showed 2,4-DB to be significantly less toxic to 3 year old S.100 white clover than MCPA and 2,4-D, and the figures in Table IV of that paper also show MCPB to be significantly more toxic than 2,4-DB on this clover - also over control!

Established Lucerne

The depressant effect of MCPB on lucerne in the Elliott, Green and Evans experiment was apparent right through to July 1956 - though by then there was evidence of some recovery. 2,4-DB treatment caused an initial depression, noticeable one month after treatment but very slight after 13 months.

Persistence of effect

Carpenter and Wilson, and Elliott, Green and Evans, have all directed their work to include a study of this most important aspect. Carpenter indicates that effects of MCPB and MCPA on seedling white clover may persist for up to 2 years after treatment, and suggests that this persistence is probably due to an upset of the grass/clover ratio in a young ley which can only very slowly be restored. Carpenter has not found the reduction in clover after two years significant and suggests that it is masked by general increase in growth on all plots over the two-year period. Carpenter makes the interesting statement that there is a constant relationship between MCPB effect and MCPA effect which persists from treatment throughout the two years, i.e. that the extent of the difference between the chemicals remained constant during the recovery period.

MCPA application above 1 lb/ac caused a severe reduction in growth rate of white clover during the season following spraying but in the second year the growth rate became normal (equal to control and MCPB treated plots) which leads Carpenter to suggest that the influence of these changes on eventual constitution of the sward needs much study.

The histograms in figure 2 of Elliott, Green and Evans' paper support the data in table IV and show that the considerable setback caused to S.100 white clover by MCPA was still evident in May 1956 - 12 months after application and, surprisingly enough, that MCPB at 2 lb/ac had caused a setback to the clover, which, like the MCPA effect, was still apparent after 12 months.

Effect of dosage rate

There is little to say on effects of dosage rates of MCPB and 2,4-DB on clover and lucerne in the experiments described in these papers. A fair generalisation would be that increased dosage has had relatively little influence on effect of MCPB and 2,4-DB on the legumes, either as seedlings or as established plants.

Effect on clover grown for seed

The only report to deal directly with this aspect is that of Deakins and Ormrod who conclude, in brief, that MCPB and 2,4-DB at 1, 2 and 4 lb/ac, MCPA at 0.5, 1 and 2 lb/ac and 2,4-D at 0.25, 0.5 and 1 lb/ac all affected red and white clover seedlings, appreciably reducing numbers, and size and vigour of flowering heads. MCPB and 2,4-DB were considerably less damaging than the acetics. White clover was most affected, broad red intermediate and late flowering red least affected. Time of spraying in relation to flowering date is considered very important.

In addition to the trials reported here, brief mention must be made of a report by S. A. Evans on the results of 14 N.A.A.S. trials with the gamma phenoxybutyrics which he describes as showing disappointing results, due partly to the variation in clover population within sites, and partly to the difficulty of carrying out adequate and representative assessments. The protective effect of a cover crop on undersown clovers is very well borne out in these experiments.

Summary

My summary must be short. In order to stimulate discussion I should like to emphasise the unexpected reactions of white clover and red clover to MCPB (and, to a lesser extent to 2,4-DB) namely the considerable setback caused by both chemicals to seedling S.100, wild white, Alsike, broad red and late flowering red in the Le Brocq - Beech experiments; the reduction in established white clover caused by MCPB in the trial by Elliott, Green and Evans; and thirdly the increase in susceptibility of Cotswold broad red clover when sprayed at the 2 trifoliate leaf stage - again in Elliott's experiment.

Do these results indicate isolated anomalies, or do they reflect field occurrences of an equally surprising nature? Naturally, the verdict on the phenoxybutyric compounds as weedkillers in leys and pastures must be made bearing in mind weedkilling capacity and safety to legumes but, to my mind, these "unexpected" results suggest the need for much careful investigation because they are points of the very greatest importance in determining the future of these chemicals in grassland.

Prof. R. L. Wain

The fact that MCPB can be decomposed in the soil to the acetic acid should be taken into account when trying to explain why variable results have been obtained. Firstly, if the spray has been applied in such a way that a lot of it goes on to the soil this might produce a detrimental effect on a crop, which one would not expect to arise to the same extent if very little of the compound had reached the soil. Again, spraying might be done very carefully but if it is followed soon afterwards by rain then the spray will get washed off on to the soil.

In the soil itself we have shown that breakdown of MCPB does occur, but it is not a simple β-oxidation process. It is well-known that if soil has been treated on some previous occasion with MCPA the bacterial population is better adapted to break down that material. In such a soil, the destruction of MCPB might well occur more quickly, thus allowing little MCPA to be produced by β-oxidation. Detrimental effects on crops would then be less.

Lastly, it is probable that temperature can influence the breakdown of the butyric to the acetic derivative.

All these factors then may help to explain differences which may be observed in the performance of these phenoxybutyric acids under different conditions.

Mr. R. Garrett Jones

May the effect of any susceptible weeds present be not simply to shield the clover but to contribute towards the breakdown from the butyric to the acetic derivative and thus to increase the effect on clover, either by direct contact above ground or by liberating the substance in the soil?

Mr. J. G. Elliott

There were no weeds in our experiments on established grass/clover mixtures and there would be little shielding effect. Similarly, there was very little bare ground. In the seedling clover there was much bare ground and much of the chemical must have gone into it, but in practice we must expect that this will happen.

Mr. P. F. Le Brocq

In our experiments much of the ground was covered with yellow charlock etc. very little of the chemical would have fallen on the ground. The majority would have fallen on the leaves and might have been translocated throughout the charlock to the soil as suggested.

Mr. K. Carpenter

It is very difficult to illustrate this point very accurately in the field. The difference between red and white clover was confirmed in pot experiments where much of the soil was exposed to the spray and gave exactly the same relative relationship between the two. Exactly the same results were obtained as with late season experiments; a lot of these experiments are normally done at the end of the season. A lasting check was observed and the stand was poor. In this case we observed that a check at spraying will last until the autumn. Experiments are followed through for two years. Considerable check (30% or more) has been noted from the first time of spraying up to the time of assessment. The effects of the higher rates persist to the following year and there is a much bigger check, with comparable rates of MCPA.