THE EFFECT OF GROWTH REGULATOR WEEDKILLERS ON CLOVER

REPORT ON 1954 EXPERIMENTS

W. OCHILTREE, (Plant Protection Ltd.)

Summary

(1) Broad and late flowering red clovers are much more susceptible to damage at all stages of growth from the application of 2,4-D derivatives than from the MCPA derivatives tested at equivalent rates of application.

(2) Seedling white clovers are more susceptible to MCPA derivatives than to 2,4-D derivatives but the difference in effect is less marked than in (1).

(3) Once white clovers are established, particularly in their second and third year of growth, there appears to be little difference in effect between the derivatives tested at equivalent rates of application.

Introduction

Mr. E. B. Scragg (North of Scotland College of Agriculture), Mr. K. Holly (A.R.C. Unit of Experimental Agronomy, Oxford) and the writer each presented a paper dealing with this problem at the 1953 Weed Control Conference at Margate. Results of these three papers were in broad agreement with each other.

Work at Fernhurst during 1954 has been to repeat last year's work on spraying clover in established leys and gain more information on the effect of growth regulator weedkillers applied to various species of seedling clover.

Details of Experiments carried out during 1954

Twelve areas were sown for small plot trials, with Alsike, New Zealand mother white clover, wild white clover, S100 white clover, broad and late flowering red clover. Each of the six clovers was sown alone and in a ley mixture. The area sown to a particular clover variety (or grass clover mixture) was divided into two parts - A and B. All parts A were used for seedling stage applications whereas applications to parts B were delayed until the clovers were established. Application of chemicals to all areas was at the rate of 100 gallons of water per acre but wild white and broad red clover were treated also at 10 gallons total spray per acre. The layout followed the random block pattern with three replicates of each treatment and a plot size of six square yards.

Eight large scale trials were laid down, in which chemicals were applied by a Land Rover mounted sprayer. Four were on clover grass mixtures undersown in spring cereals and four on established leys.

In all trials treatments were as follows:

Treatment

1	MCPA potassium salt	applied	at	12 oz.	active	acid	equivalent	per	acre
2	" "	"	"	"	24 oz.	"	"	"	"	"
3	2,4-D di-ethanolamine	"	"	12 oz.	"	"	"	"	"
4	" "	"	"	24 oz.	"	"	"	"	"
5	MCPA normal butyl ester	"	"	12 oz.	"	"	"	"	"
6	" " "	"	"	24 oz.	"	"	"	"	"

Treatment

7	2,4-D normal butyl ester applied at 12 oz. active acid equivalent per acre	
8	" " " " " " 24 oz. " " " "	
9	Control (untreated)	

Note

Henceforth in this report:

MCPA potassium salt will be referred to as MCPA (potassium)
2,4-D di-ethanolamine will be referred to as 2,4-D (amine)
MCPA normal butyl ester will be referred to as MCPA (butyl)
2,4-D normal butyl ester will be referred to as 2,4-D (butyl)

The quantity of chemical applied is referred to in terms of oz. of active acid equivalent per acre.

Presentation of results

Results are expressed only in histogram form. (Fig.1-8) These show the percentage area covered by clover (stand) resulting from the various treatments.

Space being limited only the results of the small plot trials (Experiment 1) are given in detail. References are made in the text to the results of the large-scale trials.

Factors affecting results

Conditions this season were not ideal for the growth of seedling clover due to late germination, strong grass growth and other factors. This may have influenced the results of the ley mixture trials.

Results

Comparative effect of MCPA and 2,4-D derivatives on various species of clover as seedlings and established plants

Broad red and late flowering red clover seedlings

The following is in descending order of toxicity:-
2,4-D (butyl), 2,4-D (amine), MCPA (butyl) and MCPA (potassium).

2,4-D (butyl) and (amine) at 24 oz. seriously depressed these clovers. There was some recovery from 12 oz. of the 2,4-D derivatives, particularly 2,4-D (amine).

Recovery of these two clovers after application of the MCPA derivatives at both rates was rapid. This was very striking in the case of MCPA (potassium) where damage following treatment was light and recovery exceptionally rapid, particularly when used at 12 oz. The reader's attention is drawn to histograms Q, R and S (broad red clover) and G and H (late flowering red clover) which illustrate the above points.

In one of the large scale trials where broad red clover had been undersown and conditions of growth were favourable there was a good stand of clover some 2 - 3 months after treatment with MCPA (potassium) at both rates, MCPA (butyl) at both rates and 2,4-D (amine) at the lower rate. The higher rate of 2,4-D (amine) and both rates of 2,4-D (butyl) seriously depressed the crop. In another trial where conditions of growth were unfavourable only the clover treated with MCPA (potassium) at 12 oz. recovered without injury.

This shows that although the comparative effect of 2,4-D and MCPA derivatives on seedling red clovers may remain the same from trial to trial, the margin of safety in using any particular chemical varies according to growing conditions. To illustrate this point, compare histograms G with those of H (late flowering red clover) and Q and R with those of S (broad red clover). These show depression was greater and recovery less rapid when clovers were competing with grasses in ley mixtures than when they were sown alone.

Established broad and late flowering red clover

The comparison between MCPA and 2,4-D derivatives as applied to established red clover is similar to that found for seedling plants. Reference to histograms T (broad red clover) and I (late flowering red clover) shows this.

White clover seedlings

Of the white clovers, Alsike appeared to be extremely susceptible to hormone sprays, S100 and wild white clover rather susceptible, and New Zealand mother white clover somewhat more resistant.

Recourse to the figures will indicate that at 24 oz. the 2,4-D derivatives are less damaging than the MCPA derivatives but at the 12 oz. rate of application differences between derivatives are not so marked.

MCPA (butyl) at 24 oz. appears to have seriously depressed all clovers tested.

An interesting point is that, whereas Alsike and New Zealand mother white clover appear to be more susceptible to 2,4-D (butyl) than 2,4-D (amine), the reverse is the case for S100 and wild white clover.

Established white clover

Though differences do exist in the results of the small plot trials between the effect of 2,4-D and MCPA derivatives on these clovers they are not so noticeable as with the seedling white clovers.

The results of the large scale trials on S100 in second and third year harvest leys both in 1953 and 1954 suggest that there are no major differences between the effect of MCPA (potassium), MCPA (butyl), 2,4-D (amine) and 2,4-D (butyl) at equivalent rates of application and that, although initial depression is severe, given conditions of good fertility and after management, the clovers recovered completely within eight weeks.

The interval between application and assessment was only four weeks with established clover in Experiment I, therefore, further assessments must be undertaken before a reliable picture is formed.

Effect of volume of spray on degree of depression

In broad red clover seedlings low volume application was more damaging than high volume, while in last year's experiments on dense stands of established red clover the reverse was the case.

In seedling clovers low volume spraying gives a virtually complete cover at high concentration. In a dense crop, on the other hand, high volume will give better penetration and therefore greater cover. It is presumed that this is the reason for the difference.

DISCUSSIONS AND CONCLUSIONS

It appears that it would be reasonably safe to spray red clover at any stage of growth with MCPA (potassium) at 12 oz. Under ideal conditions it may even be possible to apply a higher rate of this chemical.

Only the 12 oz. rate of any chemical could be considered and that only under ideal conditions when spraying seedling white clover.

The results of work in comparing varying volumes of application in relation to damage are not sufficient to make a definite statement on the subject. They do, however, indicate that a volume of 10 gallons per acre appears to be more damaging than a volume of 100 gallons per acre on seedling clovers and that this aspect deserves further investigation.

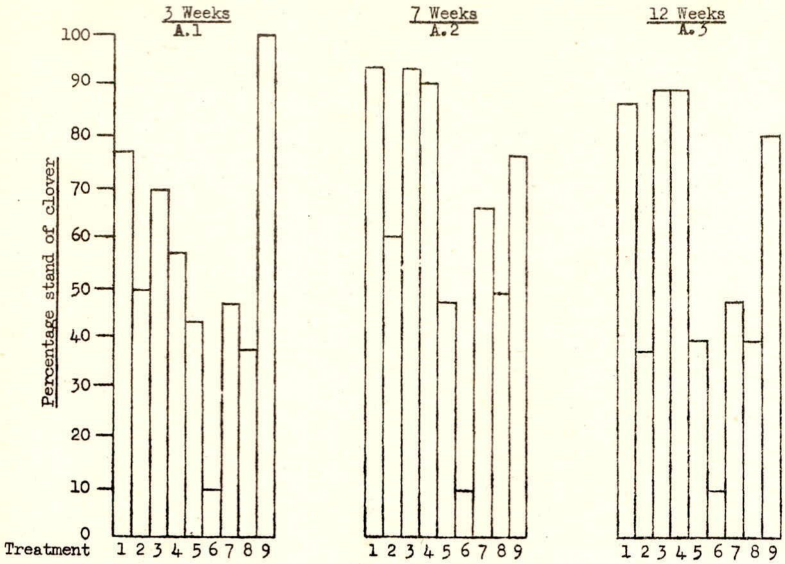
Other factors such as density of weed, competition between grasses and clovers, fertility and after-management do appear to play a major part in this problem.

Results from these experiments do not justify any general recommendation for the spraying of seedling white clovers.

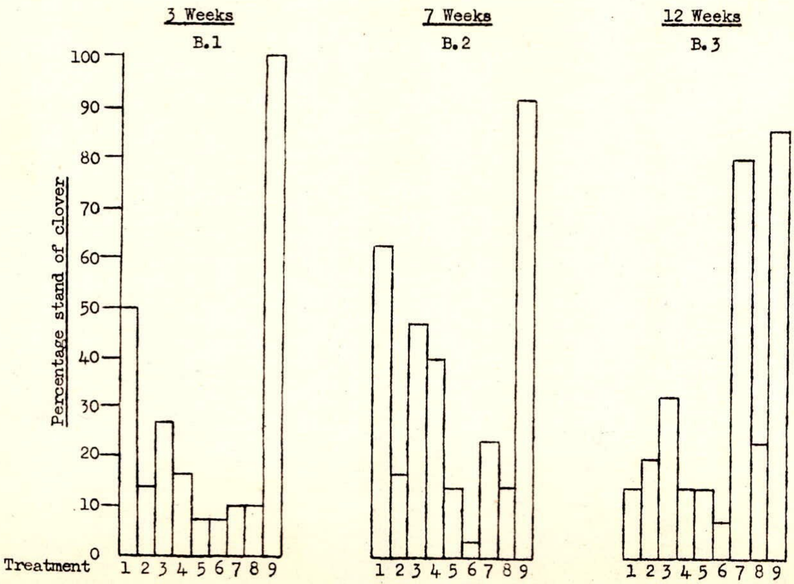
ALSIKE CLOVER

1st Spray 14th June, as seedlings

Pure Stand



In Ley

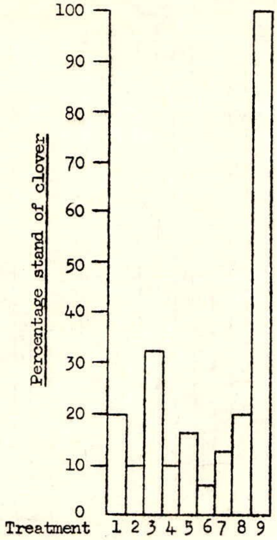


Alsike (Cont) 2nd Spray 5th August, as an established crop

Pure Stand

4 Weeks

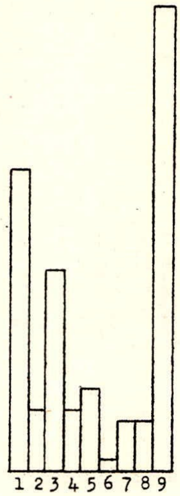
C.1



In Ley

4 Weeks

C.2



KEY TO TREATMENTS

For use when referring to histograms

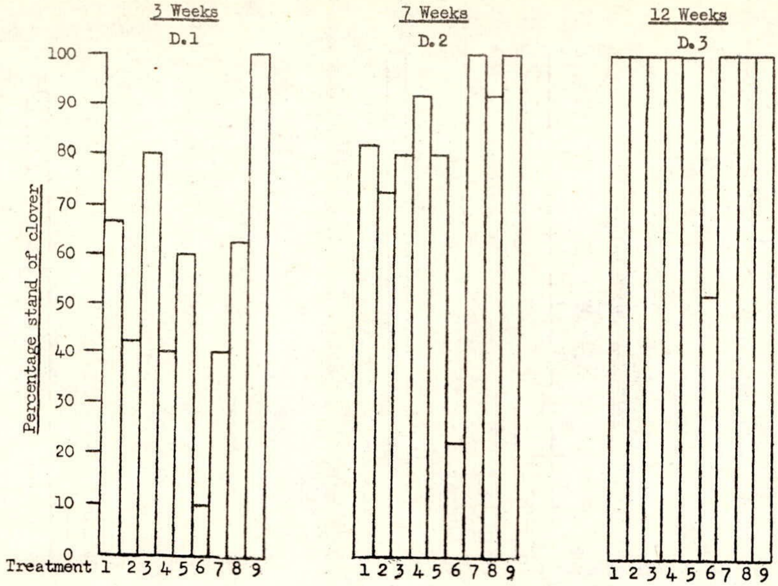
Treatment Number:			
1.	MCPA (potassium)	12 oz.	a.a.e./acre
2.	" "	24 oz.	" "
3.	2,4-D (amine)	12 oz.	" "
4.	" "	24 oz.	" "
5.	MCPA (butyl)	12 oz.	" "
6.	" "	24 oz.	" "
7.	2,4,-D (butyl)	12 oz.	" "
8.	" "	24 oz.	" "
9.	Control.		

Note: Number of weeks shown above each histogram refers to the time which has elapsed since spraying.

NEW ZEALAND MOTHER WHITE

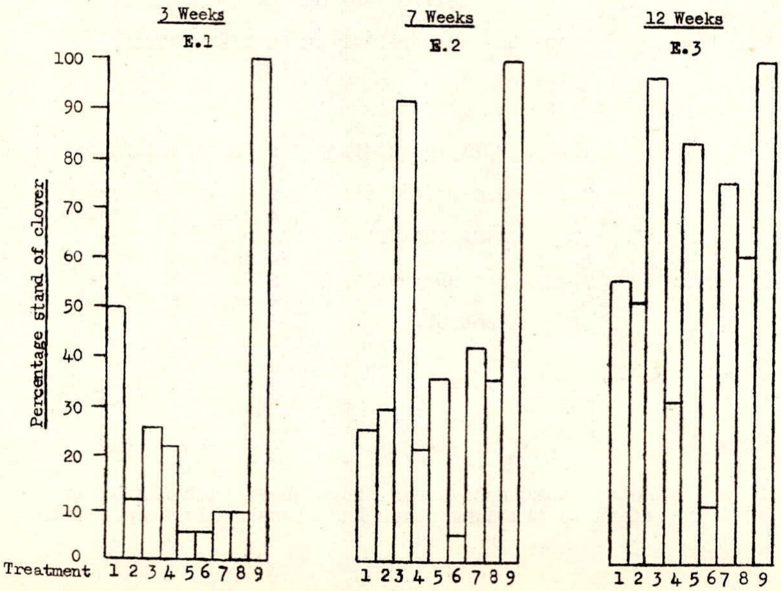
1st Spray as seedlings, 14th June.

Pure Stand



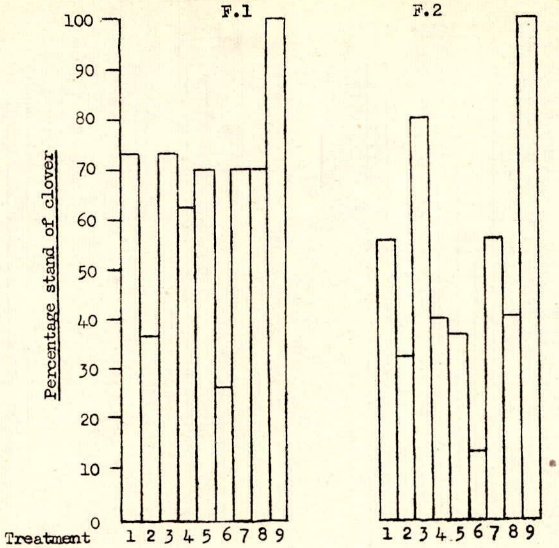
New Zealand Mother White (Continued)

In Ley



2nd Spray as an established crop, 5th August

Pure Stand	**In Ley**
4 Weeks	**4 Weeks**
F.1	F.2



KEY TO TREATMENTS

For use when referring to histograms

Treatment Number:			
1.	MCPA (potassium)	12 oz.	a.a.e./acre
2.	" "	24 oz.	" "
3.	2,4-D (amine)	12 oz.	" "
4.	" "	24 oz.	" "
5.	MCPA (butyl)	12 oz.	" "
6.	" "	24 oz.	" "
7.	2,4,-D (butyl)	12 oz.	" "
8.	" "	24 oz.	" "
9.	Control.		

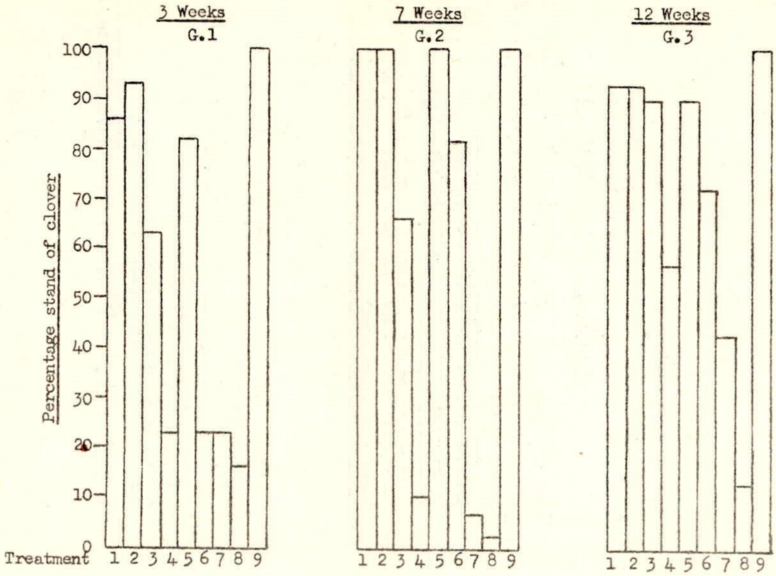
Note: Number of weeks shown above each histogram refers to the time which has elapsed since spraying.

EXPERIMENT I (CONT)

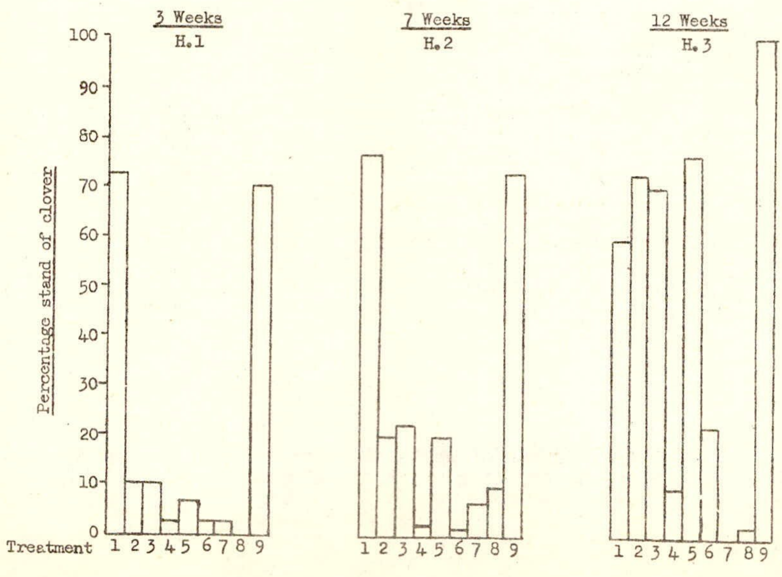
LATE FLOWERING RED CLOVER

1st Spray as seedlings, 14th June

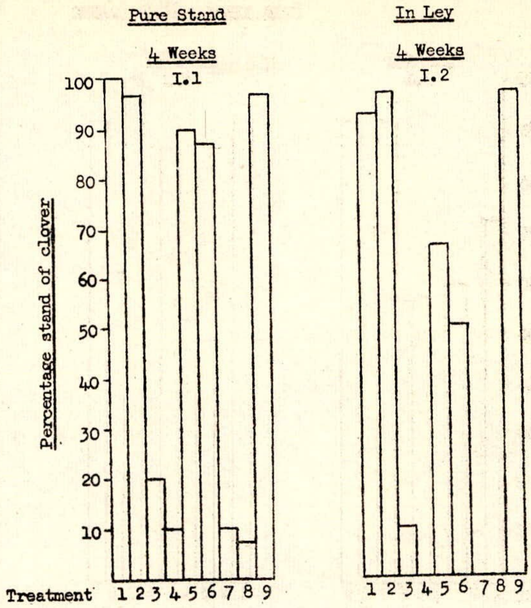
Pure Stand



In Ley



2nd Spray as an established crop, 5th August



KEY TO TREATMENTS

For use when referring to histograms

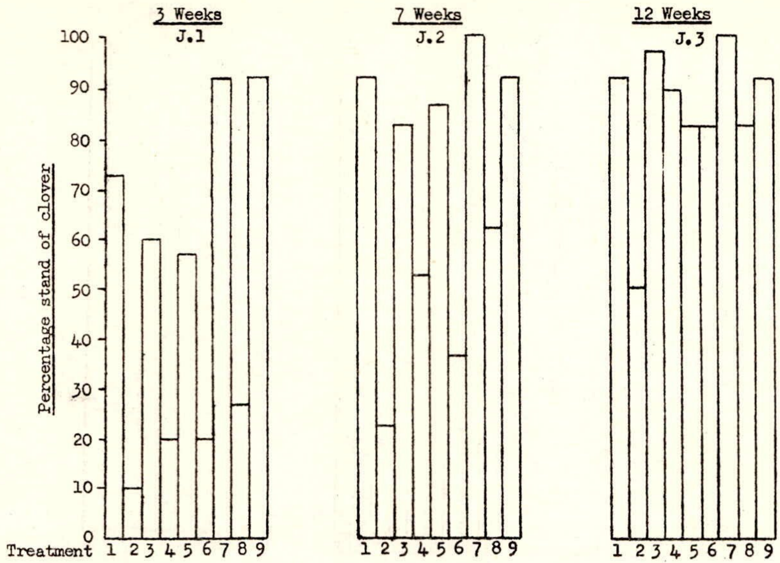
Treatment Number:			
1.	MCPA (potassium)	12 oz.	a.a.e./acre
2.	" "	24 oz.	" "
3.	2,4-D (amine)	12 oz.	" "
4.	" "	24 oz.	" "
5.	MCPA (butyl)	12 oz.	" "
6.	" "	24 oz.	" "
7.	2,4,-D (butyl)	12 oz.	" "
8.	" "	24 oz.	" "
9.	Control.		

Note: Number of weeks shown above each histogram refers to the time which has elapsed since spraying.

EXPERIMENT I (CONT) WILD WHITE CLOVER

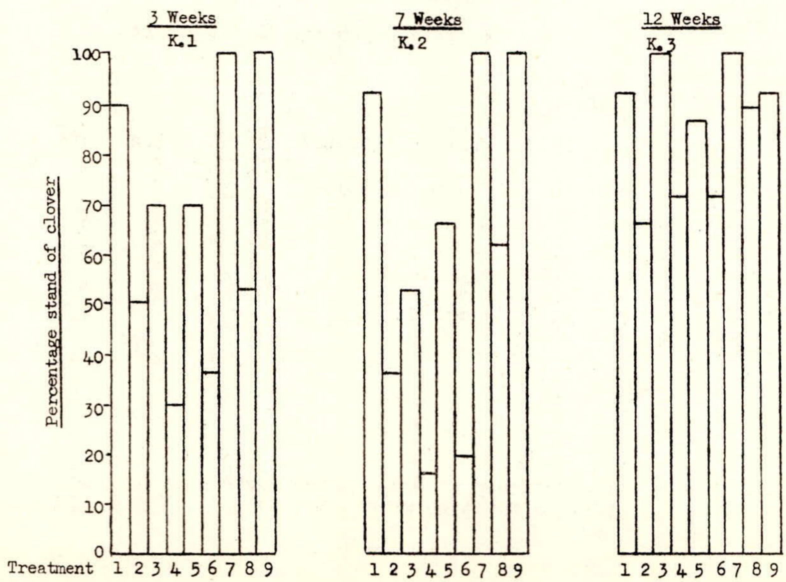
1st Spray as seedlings, 14th June

Pure stand - High Volume



Wild White Clover (Continued)

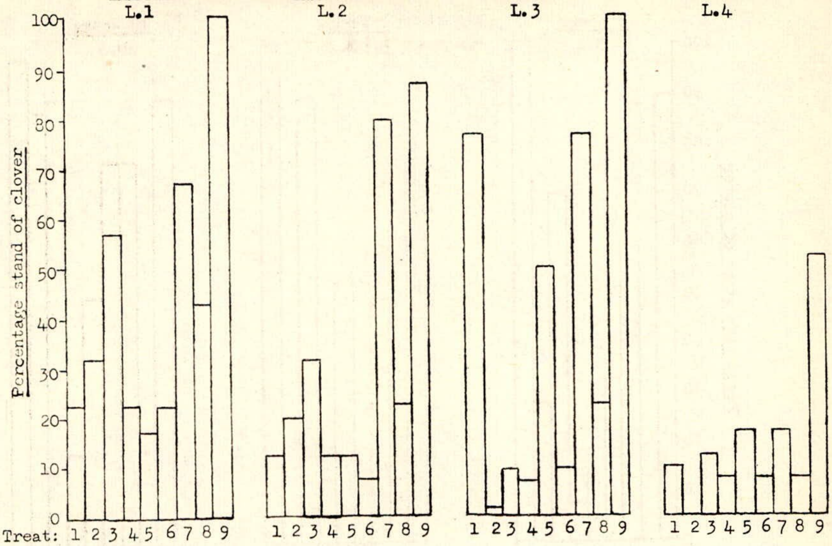
Pure stand - low volume



In Ley

High Volume | Low Volume

7 Weeks L.1 | 12 Weeks L.2 | 7 Weeks L.3 | 12 Weeks L.4

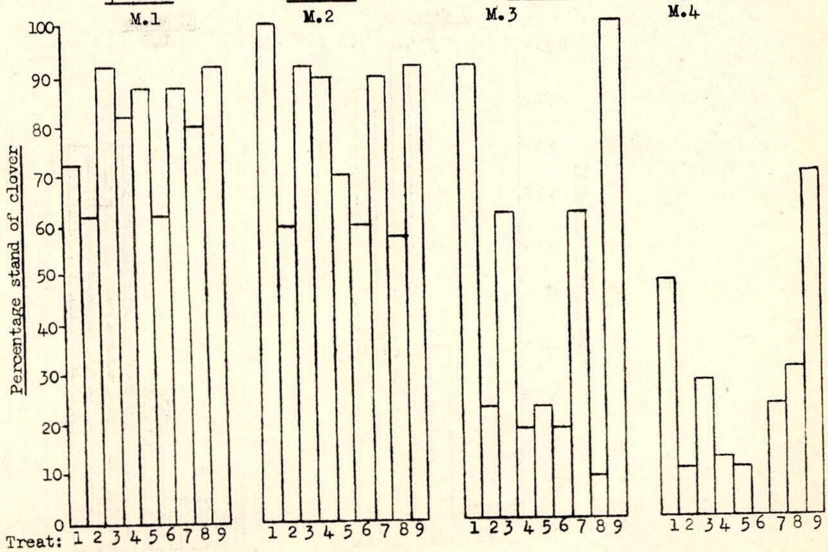


Wild White Clover (Continued)

2nd Spray as an established crop, 5th August

Pure stand | In Ley

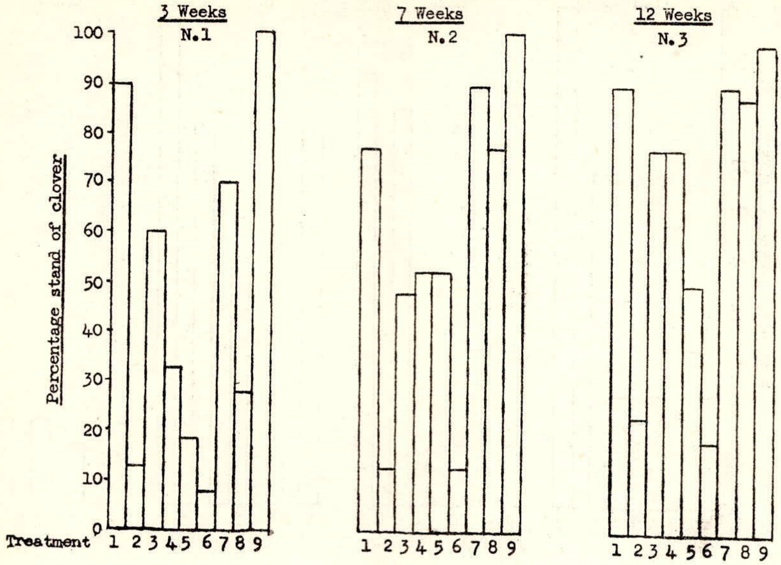
High Volume 4 Weeks M.1 | Low Volume 4 Weeks M.2 | High Volume 4 Weeks M.3 | Low Volume 4 Weeks M.4



EXPERIMENT I (CONT) S100 CLOVER

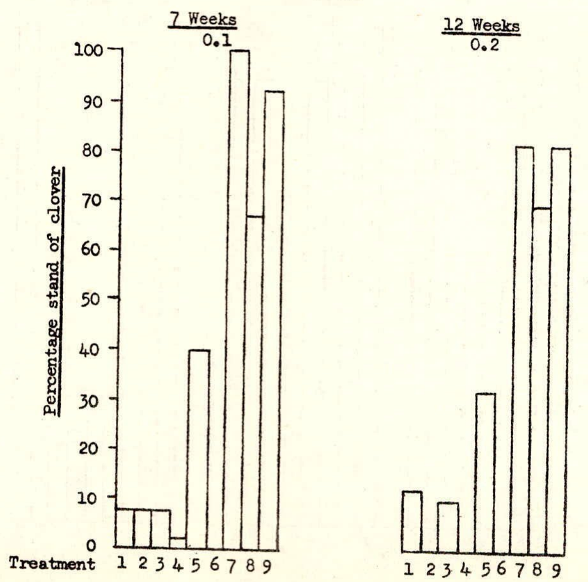
1st Spray as seedlings, 14th June

Pure Stand

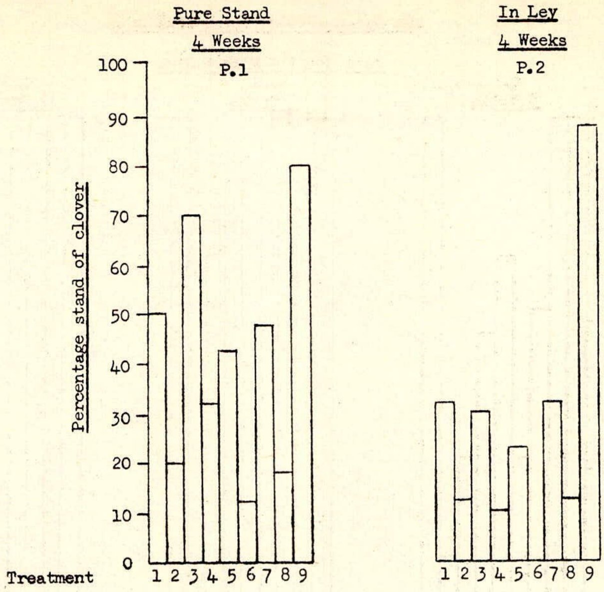


S100 (Continued)

In Ley



2nd Spray as an established crop, 5th August



KEY TO TREATMENTS

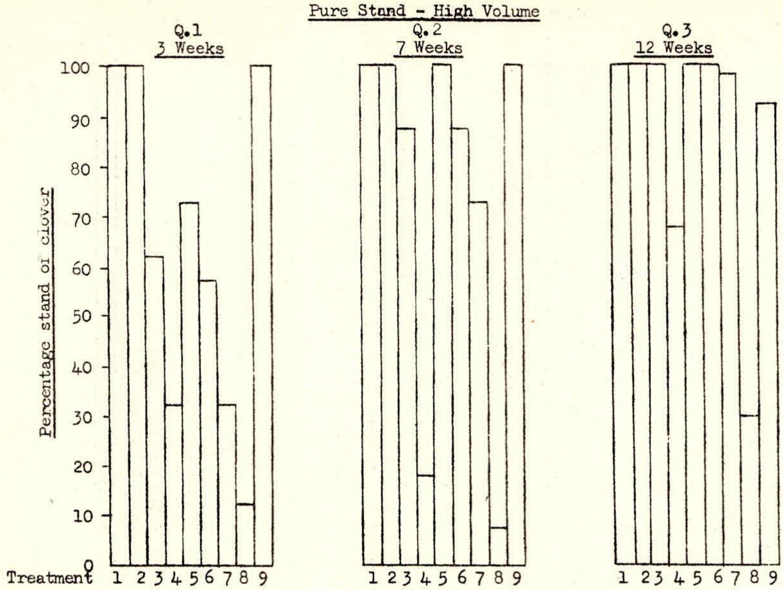
For use when referring to histograms

Treatment Number:			
1.	MCPA (potassium)	12 oz.	a.a.e./acre
2.	" "	24 oz.	" "
3.	2,4-D (amine)	12 oz.	" "
4.	" "	24 oz.	" "
5.	MCPA (butyl)	12 oz.	" "
6.	" "	24 oz.	" "
7.	2,4,-D (butyl)	12 oz.	" "
8.	" "	24 oz.	" "
9.	Control.		

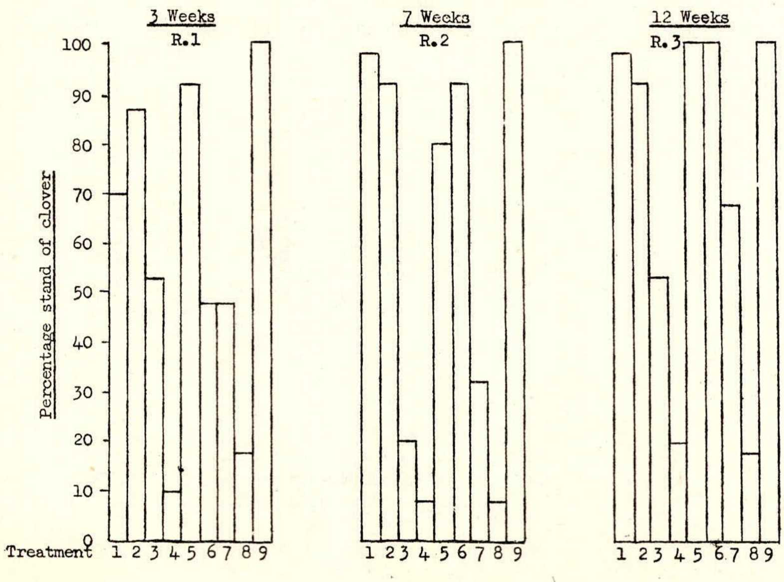
Note: Number of weeks shown above each histogram refers to the time which has elapsed since spraying.

1st Spray as seedlings, 14th June

Pure Stand - High Volume



Pure Stand - Low Volume

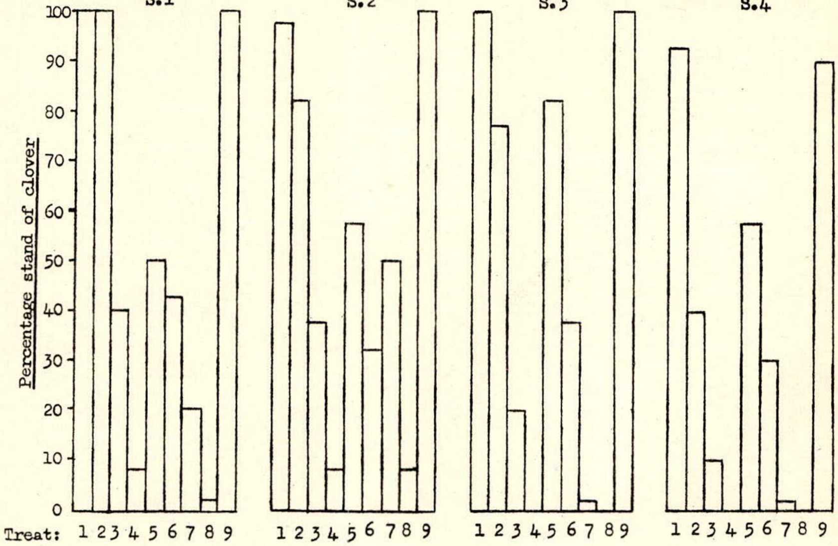


Broad Red Clover (Continued)

In Ley

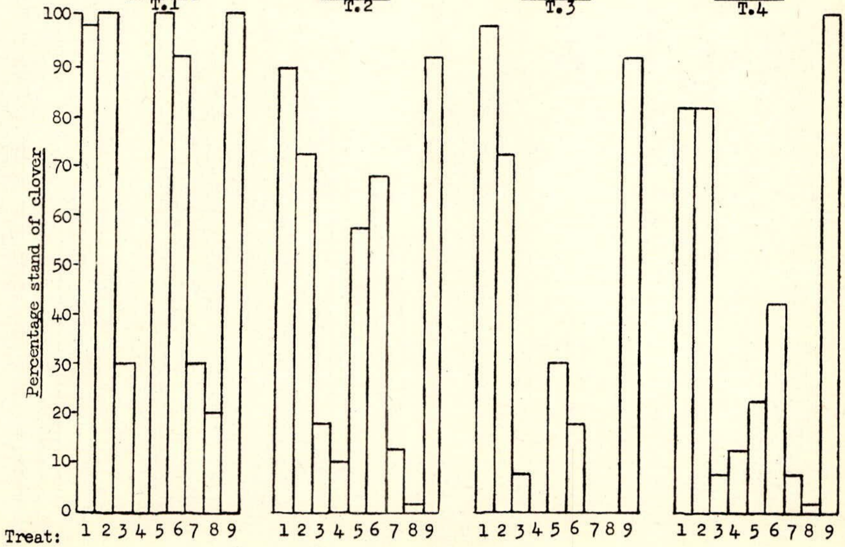
High Volume | Low Volume

7 Weeks S.1 | 12 Weeks S.2 | 7 Weeks S.3 | 12 Weeks S.4



2nd Spray as an established crop, 5th August

High Volume 4 Weeks T.1 | Low Volume 4 Weeks T.2 | High Volume 4 Weeks T.3 | Low Volume 4 Weeks T.4



B.A.C.A/N.A.A.S/A.R.C. JOINT TRIALS ON UNDERSOWN CLOVER

A Progress Report

S. A. EVANS, (Ministry of Agriculture, N.A.A.S.)

Summary

Trials on the spraying of undersown clover with growth-regulator herbicides, carried out jointly by members of the British Agricultural Contractors Association, the National Agricultural Advisory Service and the Agricultural Research Council Unit of Experimental Agronomy, are briefly reported, but no conclusions are drawn as insufficient data is yet available. The value of the trials is criticised.

Introduction

It is known that clover seedlings may be killed when directly sprayed with growth regulating weedkillers used at doses normally applied to kill weeds, but cereals undersown with clover have been sprayed with these materials where weeds have been a nuisance and the clovers have often appeared to be unharmed and the final establishment of clover completely satisfactory. The growing practice of spraying undersown crops is obviously accompanied by a definite risk of damage to the clovers and several instances of severe damage have been reported.

Pot and greenhouse experiments (where clover, unprotected by crop or weeds, has been sprayed with varying amounts of growth - regulator herbicides) have been carried out by Holly (1), Ochiltree (2) and Scragg (3) and it appears that different varieties of clover show varying susceptibility to the different growth regulating weedkillers, and that both red and white clover may suffer appreciable mortality from applications of weedkiller at rates normally used for killing weeds. As a result of field experiments, however, Scragg concludes that, for the climatic conditions prevailing in the N.E. of Scotland, it is possible to spray undersown cereal crops without reducing clover establishment below that necessary for good grass in the following season but he recommends that not more than 1 lb. acid equivalent per acre of MCPA (sodium) or ½ lb. acid equivalent per acre MCPA (amine) should be used. (In Canada (4) the recommendations are even more cautious - not more than ½ lb. MCPA (sodium) or ¼ lb. 2,4-D (amine) per acre are recommended, and it is advised that spraying should not be carried out until the weeds or cereals protect the legume, and that only low pressures (35-50 lb./sq. in.) should be used.)

In the discussion following the research reports in the section on 'Undersown Cereals' at the 1953 British Weed Control Conference at Margate (p.141 of the Proceedings) it is interesting to note that opinions differed on the effects of the shelter afforded by the crop and weeds to the undersown clover on the mortality of the clover: opinion also differed on the importance of the regeneration of clover from late germinating seeds in producing a satisfactory 'take' of clover following spraying.

The lack of knowledge regarding the factors that contribute towards safe spraying does not allow any definite recommendations to be made, apart from advocating that undersown crops should not be sprayed unless sufficiently weedy to justify the possibility of damage.

The need for a co-ordinated programme of experimental work on the spraying of undersown crops was stressed at a meeting between the Ministry of Agriculture and Fisheries, the A.R.C. Unit of Experimental Agronomy, the

Association of British Insecticide Manufacturers, and the British Agricultural Contractors Association on 5th November, 1952 (the same meeting in fact which led eventually to the organisation of the British Weed Control Conferences).

In 1953 a programme was started following offers of co-operation from the N.A.A.S. Crop Husbandry Officers Conference and from members of the British Agricultural Contractors Association. The B.A.C.A. members agreed to carry out the spraying and the N.A.A.S. officers to do the recording. The A.R.C. Unit of Experimental Agronomy provided field books and guidance in laying down the trials and helped with the co-ordination of the programme. The object was to obtain information of a practical nature on the factors that contribute towards the safe spraying of undersown crops in the hope that at a later date it would be possible to issue firm recommendations to farmers and spraying contractors. With the results to hand of only 10 trials carried out in 1953/4 no conclusions can yet be reached and this report is necessarily a progress report.

Trial Work

The trials were planned to be carried out on spring wheat, barley or oats undersown with grasses and clover, the clover being preferably of only one type to ease assessment. Where two types of clover were present distinction between the two were to be made in the assessments. Crops were to be sufficiently weedy and the weeds susceptible enough to MCPA and 2,4-D to justify commercial spraying.

Two basic treatments were to be included in each trial:-

(i) MCPA sodium salt at 1½ lbs. acid equivalent per acre in 6-10 gallons water per acre. This was the standard treatment to allow comparison between centres.

(ii) The product, at a rate per acre, volume rate and pressure, which the co-operating contractor considered the most efficient for use on the undersown crop. If this coincided with (i) then it was suggested that 2,4-D should be used at a rate the contractor thought suitable.

If the two basic treatments were adopted the minimum size of each trial would be 9 plots (two treatments and one control per block replicated three times). In addition, however, any other treatment could be included which the N.A.A.S. Officer or the contractor wished to try; the maximum number of treatments in one trial in 1953/54 was in fact 4. The plots were to be the width of the spray-boom used and not less than twenty yards in length.

Assessment of each trial, carried out by the N.A.A.S. Officer, assisted in some cases by the contractor, involved (i) the recording of the stage of growth and approximate density of the undersown clover and grasses and of the weeds in each plot at the time of spraying, (ii) the effect after 2-3 weeks of the spray on the clover, weeds and crop, (iii) assessment of clover establishment (a) in the autumn after harvest by means of counts of clover within twenty 1 ft. quadrats per plot; and (b) again in the following spring by assessment of 'percentage ground cover' of the clover in twenty 1 ft. quadrats per plot.

Table 1 gives brief details of each trial laid down in the spring of 1953.

Notes on the effects of the treatments to the clover.

In the trials where clover establishment was reduced by the spray treatments there was, with one exception, no apparent difference within each trial between the effects of the different sprays - all treatments had similar effects. A slight difference in susceptibility between red and white clover was noted in two trials.

Notes on the individual trials are given below.

Trial 1. Neither treatment affected establishment but 2,4-D was noted as scorching the clover leaves.

Trial 2. No treatment affected establishment as assessed by quadrat counts but the vigour of the clover as observed after harvest was reduced on the treated plots. Red clover and white clover were each assessed separately.

Trial 3. Clovers suffered up to 20% mortality (autumn assessment) from spraying and it was observed that S.100 seemed to be slightly more affected by both treatments than red clover, although separate counts were not made of the two species. By the following spring, however, assessment showed no difference in clover establishment or in apparent vigour between any treated plots and the control plots.

Trial 4. Establishment of white clover was unaffected by either treatment, but red clover, as assessed after harvest, showed slight suppression by both treatments. By July 1954 assessment showed no differences in the clover between any treated plot and the controls.

Trial 5. Establishment of red clover was good, but of white clover rather poor; but neither was apparently affected by spray treatments. Assessment was rather confused by lodging of the barley which affected the 'take' of clover.

Trial 6. No differences in establishment due to sprays, as such, were discernible; but the recorder stated that the clover in the control plots appeared to be checked by the severity of the charlock infestation.

Trial 7. Separate assessments of red clover and Alsike were not made. Autumn assessment showed the clover to be reduced in all treated plots and this suppression persisted into the following spring, when all treated plots had a reduction in clover of about 50% below the control plots.

Trial 8. The clover was damaged by all treatments, the population being reduced by a half to two-thirds, and the vigour also being reduced. The differences between the treated plots and the control plots were still apparent in spring 1954.

Trial 9. The Clover was suppressed by both treatments but rather more with the higher rate of application than with the lower; this suppression persisted into the following spring.

Trial 10. A possible slight suppression resulted from both treatments as assessed in the autumn after spraying, but by the following spring no differences were apparent.

The time between sowing the clover and spraying varied between seven and ten weeks, and in each case the clover was at least approaching the 3-leaf stage at the time of spraying. Recording of the stage of growth of cereals

Site	District Officer	Contractor	Crop	Clover (rates/ acre) ≠	Date of sowing of clover	Date of spraying
Cornwall (1)	B.K. Kilburn	W.S. Sturtridge Esq.	Dredge Corn	1 lb. S100 1 lb. New Zeal (Cert)	21/4	8/6
Cornwall (2)	E.H. Coak	Farm Utilities Ltd.	Dredge Corn	Broad and late flowering Red, S100 & Wild White	7/4	9/6
Cornwall (3)	G.R. Loveless	F. Davey & Sons Ltd.	Barley	Late flowering Red, S100 & Wild White	29/3	27/5
Devon (4)	A.J. Brown	H. Lee Esq.	Oats	4lbs. S123 2lbs. S100	23/3	28/5
Dorset (5)	D.W. Watkins	Wessex Land Services	Barley	2¾lb. Broad red 1½lb. Wild White	23/3	20/5
Hants (6)	R.S. Boyer	Southern Agricultural Services Ltd.	Barley	10lb. Broad Red	7/3	20/5
Leicester (7)	J. Hodgson	ARC Unit of Expt. Agron.	Oats	6lb. Broad Red 3lb. Alsike	17/3	20/5
Lincs. (8)	A.R. Staniforth	Pest Control Ltd.	Barley	12lb. Broad Red	end April	4/6
Notts. (9)	R.J. Fox	C.J. Hempsall & Sons (Contractors) Ltd.	Barley	14lb. Broad Red	16/4	8/6
Salop (10)	M.J. Bourne	Pest Control Ltd.	Barley	2½lb. S100 White	27/4	9/6

≠ S100 and New Zealand (Cert) are strains of white clover (Trifolium repens) S123 is a strain of late flowering red clover (Trifolium pratense) Alsike (Trifolium hybridum)

* Black bindweed - Polygonum convolvulus
Charlock - Sinapis arvensis
Chickweed - Stellaria media
Dock - Rumex sp.
Fat hen - Chenopodium album
Plantain - Plantago sp.
Poppy - Papaver rhoeas
Redshank - Polygonum persicaria
Runch - Raphanus raphanistrum
Shepherds Purse - Capsella bursa-pastoris
Speedwell - Veronica sp.
Spurrey - Spergula arvensis.

Stage of growth of clover *	Cover offered by crop and weeds	Treatments (rates per acre)	Volume rate (gals./acre)	Pressure used in Sprayer (lbs/sq. in.)	Main weeds *	Control of weeds
4-5 leaves 1-3in. high	Slight, even	1½ lb. MCPA ¼lb. 24D ester	-	15	Shepherds, Purse, Chickweed, Speedwell, Spurrey, Charlock	Partial with both treatments
2-3 leaves 2½ in. high	Good, even	1½lbs. MCPA ½lb. MCPA 1½ lb.24D amine	6	50	Charlock, Chickweed	Satisfactory with all treatments
2-3 leaves 2in. high	Good, even	1½lb. MCPA ⅓lb. 24D amine	7	15	Fat Hen Chickweed Plantain	Partial with both treatments
3 leaves ½-1 in. high	Moderate, even	½lb. MCPA ½lb. 24D ester	75 75	60 30	Charlock Dock	Good with MCPA, poorer with 2,4-D Charlock advanced at time of spraying
3 leaves 1½in. high	Good, even	¾lb. MCPA 1½lb. MCPA 2¼lb. MCPA	10	50	Charlock Redshank Fat Hen	Good with higher rates, moderate with low rate of application
2-3 leaves 2-2½in. high	Dense, even	1½lb. MCPA ½lb. MCPA	16	-	Charlock	Satisfactory with higher rate of application
3 leaves ½-1½ in. high	Fairly dense, even	1½lb. MCPA " " 1 lb. 24D amine " "	80 7.2 80 7.2	80 30 80 30	Chickweed, Black Bindweed, Redshank	Satisfactory with all treatments
2-4 leaves 1-2in. high	Slight, even	1½lb. MCPA 1 lb. 24D amine ⅜ lb. 24D ester	8	30	Fat Hen	Reasonable with all treatments
2-3 leaves 3 in. High	Slight, even	1½lb. MCPA 0.94lb. MCPA	10	-	Fat Hen	Good with both treatments
1-4 leaves 1½ in. high	Slight, even	1½lb. MCPA ¾lb. 24D (sodium)	6	40	Poppy Runch	Good control of poppy with both treatments, Runch controlled by MCPA, but not quite as well with 2,4-D.

* It is not made clear in all field books whether "true" leaves or "trifoliate" leaves have been counted: so far as is known the figures given here refer to "true" leaves

is not complete but in the trials where barley was the cover crop, the barley was, with one exception, on average 14-16 in. high and well tillered at the time of spraying. The crops of oats and dredge corn were on average about 12 in. high and mostly well tillered. Although the weed type and density differed in each trial the main weeds at least were beyond the young seedling stage when sprayed.

Discussion

From Table 1 and the notes on the establishment of clover at each trial it is obvious that no conclusions can be drawn. However, certain comparisons are interesting, e.g. trials 8, 9 and 10 were each recorded as having a rather slight cover of both crop and weeds over the clover and the clover at each was recorded as being damaged. Against this, however, trials 3 and 7 were recorded as having a greater cover, but here again clover was damaged, and trial 1 with 'slight cover' showed no clover suppression, although here the clover was recorded as being more advanced at the time of spraying than in any other trial. Another interesting point is that in trials 7, 8 and 9 the suppression of the clover persisted into the spring following the year of treatment; whereas in trials 3 and 10, clover damage was recorded in the autumn, but by the spring, assessment showed no difference in the 'take' of clover. Such comparisons as these from fully recorded trials may help to elucidate the problem of spraying undersown cereals when a greater volume of data is available.

Criticism of the trials

There are two approaches to elucidating the many factors involved in the safe spraying of undersown cereals. One is the fundamental approach, spraying clovers under controlled conditions in the greenhouse; the other is the practical approach using field experiments. Unfortunately, the lack of research workers limits the amount of work that can be done in either field and progress towards the solution of the problem is bound to be slow. The programme described is an attempt to obtain information quickly by a compromise of what is essentially a field survey, based on carefully sprayed plots and standardised observations. Because of the lack of uniformity and the great variability that may occur between the trials and the simplicity of assessment, the programme depends, if it is to result in any definite conclusions, upon a large number of trials being completed. The fact that in the present programme only ten trials were put down in 1953 was disappointing and a glance at Table 1 shows how difficult it is, with so few trials, to obtain any useful indications as to what factors are of importance in the spraying of undersown clover.

It is understandable that many contemplated trials may never be concluded. The pressure of work on a contractor may prevent a trial from being sprayed; or the inexperience in trial work with herbicides of the persons concerned may lead to a trial being unsuitably laid down; or, again, the intrusion of factors which affect the establishment of the clover more than the spray (e.g. a 'lodged' cereal crop) may lead to the abandonment of the trial.

Even where trials are completed, however, results may be not all that could be desired. Recording may be incomplete for several reasons - it is possible, for example, that instruments may not be available for taking necessary records (e.g. thermometer); or the N.A.A.S. officer in charge of the trial, because of his other commitments, may not be able to visit the trial often enough to ensure adequate recording. Perhaps most serious of all is the difficulty of setting standards for assessment, so as to ensure adequate records being made which can be compared with records from other trials. As an example in these trials, assessment of 'cover afforded to the clover by the cereal and weeds' was made by eye only and recorded in the words of the observer - obviously not a method that is going to allow easy comparison between the trials, for what is 'good' cover to one observer may be 'fairly good' or 'dense' or 'heavy' to other observers - this is obviously a difficulty not only of standards but of language as well.

Experience with these and other trials has shown that it is essential that instructions for the methods of laying down the trials and for making assessments should be set out clearly and unambiguously in the 'field book' issued to each person in charge of a trial. The observations and assessments required must be asked for in simple and precise terms: each fact that requires recording must have a specific place allotted to it in the record book. (Not only does this make it easier for the recorder but also for the person who has to collate the results of all the trials). Composite questions may not be answered satisfactorily: for example, a question asking for 'the type of weeds present, their average height and number of leaves' may be only half answered, the height being recorded and not the number of leaves, or vice versa. For further example, in the present series of trials it is not made clear in all field books whether the number of leaves on the seedling clovers at the time of spraying refers to 'true' leaves or 'trifoliate' leaves.

Such difficulties as these are inherent in the programme of joint trials; but there is the other side of the picture. Considerable data can be made available without a big demand being made on the time of any one person involved in a trial; the conditions under which the trials are put down will be wide and varied, and are likely to cover all the factors that may be important in determining the safety of spraying undersown clover; and the results in fact relate directly to practical field conditions as met with by the farmers and contractor.

There is an absence of adequate information from research stations on the use of herbicides on undersown clover, but the co-operation of the B.A.C.A., the N.A.A.S. and the A.R.C. Unit of Experimental Agronomy in laying down these trials means that some data are becoming available on this important subject. The continuance of the trials is therefore very desirable. The B.A.C.A. and other contractors, the N.A.A.S. and the A.R.C. did in fact agree to a further series of trials in 1954/5 and 11 trials were put down in the spring of this year (1954); and it is hoped that a further series of trials will be laid down in the spring of 1955.

References

1. HOLLY, K. 1953.
"The Effect of Growth Regulator Herbicides on Seedling Clovers and Grasses."
Proc. Brit. Weed Control Conf. 1953. 116-124.

2. OCHILTREE, W. 1953.
"The Effect of Growth Regulator Weedkillers on Clovers - Progress Report on Some Preliminary Experiments."
Proc. Brit. Weed Control Conf. 1953. 124-140.

3. SCRAGG, E. B. 1953.
"The Phytocidal Effects of Hormone Type Herbicides on Clover Species and Strains, with Reference to the Spraying of Undersown Crops and Directly Reseeded Grassland."
Proc. Brit. Weed Control Conf. 1953. 107-116.

4. Sect. A., Rep. Herbicide and Weed Class. Committee 1954.
Department of Agriculture, Ottawa.

WEED CONTROL IN PEAS AND LUCERNE WITH IPC & CIPC

L. G. SPENCER,
Imperial Chemical Industries Limited,
Jealott's Hill Research Station,
Bracknell, Berks.

Summary

Peas are used in East Anglia to facilitate cleaning land infested with wild oat (*Avena fatua*). The dormancy of the seed combined with the number often encountered make eradication difficult. The two trials described were undertaken to see if a chemical approach might assist cultural methods since peas are fairly tolerant of IPC and CIPC. Applications of 4, 8 and 12 lb/acre of both compounds as liquid sprays in 40 and 100 gals water/acre were made. In one series of treatments the chemicals were incorporated by rotary cultivation into the top 3½" of soil immediately prior to drilling peas; in the other the chemicals were applied to the surface only, immediately after drilling.

On a Fenland soil, good control of wild oats and no damage to peas resulted from all application rates of both carbamates mixed in the soil. On a Norfolk clay with a low organic matter content, incorporation in the soil produced good control of the weed but the crop tolerated 4 lb/acre of IPC only. Surface applications were useless.

As a result of the variability in weed control and occasional crop damage produced when up to 5 lb/acre of IPC were applied at sowing to lucerne, the problem of grassy weeds was tackled by the application of the phenyl carbamate when the crop was established but dormant. In six trials IPC was applied at 5, 10 and 20 lb/acre. In three of the trials CIPC was applied at 5, 10 and 20 lb/acre and in the other three at 2½, 5 and 10 lb/acre, all as dusts in 2 cwts China clay/acre. The results were variable but in general 20 lb/acre IPC and 5 lb/acre CIPC gave the best results without harming the lucerne.

Introduction

Wild oats (*Avena fatua*) are a serious problem in certain parts of this country, despite the substitution of cleaning crops for cereals for a number of years. The problem is even more serious in the cereal belts of Canada and the U.S. and the advent of IPC and CIPC as herbicides stimulated work there with chemicals on the wild oats (1, 2). Work in the Pacific North West where the carbamates were incorporated in the soil prior to the sowing of crops showed great promise. Surface applications of the carbamates at economic rates produced very variable results both there and in two trials carried out at Jealott's Hill in 1951. The degree of tolerance of crops varied and we found that peas tolerated up to 10 lb/acre of IPC applied at sowing. Peas are one of the common cleaning crops for wild oats in East Anglia and so the carbamates were tested when (a) applied to the surface of the soil immediately after sowing and (b) incorporated into the soil immediately prior to sowing.

Two of the factors which discourage some farmers from growing lucerne are (i) the difficulty of getting the crop through its seedling stage in the face of weed competition despite numerous pre-sowing cultivations and (ii) the invasion of the established crop by grass weeds, particularly during the dormant winter period. These weeds often reduce the value of and shorten the life of the crop. In the case of (i), work carried out by Jealott's Hill in 1950 using IPC applied as a dust at 5 lb/acre when the crop was sown gave variable weed control and in one trial there was damage to the lucerne. So in later trials applications of IPC and CIPC at higher rates during the dormant period (i.e. either in late autumn or early spring) were tested.

Experimental Results

Wild oats in peas

Two trials were carried out in fields known by the farmers to be heavily infested. The first was at Spalding, Lincs where the field was ploughed to a depth of 1 ft. as part of the farmers' technique of dealing with wild oats. It was a typical Fen soil with a very high organic matter content. The second was at Stalham, Norfolk where the field was ploughed at normal depth. It was a very "stiff" clay with a low organic matter content.

Treatments

(1) IPC (isopropyl-N-phenyl carbamate) water dispersible liquid (10% A.P.) 4, 8 and 12 lb in 100 gals water/acre.

(2) CIPC (m-chloro isopropyl-N-phenyl carbamate) water dispersible liquid (4 lb A.P. per gal) 4, 8 and 12 lb in 50 gals water/acre.

Types of application

(A) Surface application (post-sowing)

The seed bed was rotary-hoed to a depth of 3½ ins in both directions and the peas drilled and harrowed. Immediately afterwards the chemicals were sprayed on the soil surface.

(b) Incorporation in the soil (pre-sowing)

The chemicals were sprayed on the partially prepared seed bed and then worked in by rotary hoe in both directions to a depth of 3½ in. The peas were then drilled in the normal manner.

In both trials, when stirring the soil with the rotary hoe, large numbers of germinating oats which had not emerged through the soil surface were destroyed. This did not prevent an excellent strike subsequently. The following tables show the results:-

Table I

Spalding, Lincs (Fen soil)

Application lb/acre	IPC		CIPC	
	Wild Oats	Peas	Wild Oats	Peas
0 (A) To soil	35.4	23.3	35.4	23.3
4 surface	23.5	22.9	40.7	21.1
8 after	28.8	22.6	19.4	23.8
12 sowing	28.8	21.4	26.9	21.6
0 (B) Worked	49.2	23.7	49.2	23.7
4 into seed-	10.8	21.8	7.6	21.1
8 bed prior	7.0	22.1	4.9	22.8
12 to sowing	5.3	23.4	1.7	27.1

Application date: 15th April, 1954
Weeds and peas counted: 18th May, 1954
Pea variety "Shasta".
Wild oats = plants/sq.ft.
Peas = plants per yard row.

Table II

Stalham, Norfolk. (Heavy "stiff" clay soil)

Application lb/acre	IPC		CIPC	
	Wild Oats	Peas	Wild Oats	Peas
0 (A) To soil	5.0	29.75	5.0	29.75
4 surface	2.9	33.8	2.5	23.5
8 after	2.1	34.5	2.1	14.0
12 sowing	1.5	25.0	2.3	9.0
0 (B) Worked	5.25	47.0	5.25	47.0
4 into seed-	1.05	40.5	0.75	18.0
8 bed prior	0.9	23.0	0.7	5.0
12 to sowing	0.4	15.8	0.1	10.8

Application dates: 24th and 25th March 1954.
Weeds and peas counted: 18th May, 1954
Pea variety "Harrison's Glory"
Wild oats = plants per sq.ft.
Peas = plants per yard

Grass weeds in dormant lucerne

The following treatments were applied when all lucerne "tops" were dead (except in the spring 1952 trial, when some young shoots were present).

IPC at 5, 10 and 20 lb/acre in all trials (1-6) CIPC at 5, 10 and 20 lb/acre in trials 1-3 CIPC at 2½, 5 and 10 lb/acre in trials 4-6	Applied as dusts in 2 cwts China clay/acre

All lucerne had been sown for at least two years. Table III lists the trials, soil types and percentage of grasses killed by treatment. Table IV summarises the effect of the carbamates on the crop itself. The information in both tables is purely visual and the observations were made just prior to the first cut of the season in every case.

Discussion and Conclusions

Wild oats in peas

It is evident from Tables I and II that applications of the carbamates to the soil surface did not give adequate wild oat control. In contrast when mixed intimately with the soil, good control was obtained by 8 and 12 lb/acre of CIPC and 12 lb/acre of IPC at both centres.

The peas in the Fenland soil sustained no damage, but in Norfolk only 4 lb/acre of IPC permitted a satisfactory crop of peas. The amount of chemical damage combined with rabbit and pigeon attacks prompted the farmer to "summer fallow" this latter trial. The consequent wild oat "strike" on the areas where the chemicals were stirred in was much smaller than on other plots. The results of the first germination next spring will be obviously of great interest.

Grass weeds in dormant lucerne

The variability of the results in six trials leaves the value of the technique very much open to question. Black grass (*Alopecurus agrestis* L) was not killed completely by even 20 lb/acre of CIPC in one trial. With CIPC damage, in varying degrees, occurred to the crop. IPC was generally safe up to 20 lb/acre. However this seems a very uneconomic rate of application.

Both in peas and lucerne there was confirmation of the American view that CIPC is more phytotoxic than IPC.

References

(1) Leggett, H. W. The chemical control of wild oats (*Avena fatua*). Proc. Ninth Annual N.C. Weed Control Conf. p.23-25.

(2) Helgeson, E. A. Control methods followed in the U.S. Proc. Ninth Annual N.C. Weed Control Conf. p.25-26.

(3) Wiese, A. F. & Dunnham, R. S. Fall applications of IPC and CIPC for killing wild oats (*Avena fatua*) prior to sowing oats. Agron. J. 1954, 46 (8), p.358-360.

TABLE III

The Effect of the Chemicals on the Lucerne

Treatment	Spring Application	Autumn Application				
	(1) Blewbury (Berks) CHALK	(2) Blewbury (Berks) CHALK	(3) Finchampstead (Berks) MEDIUM HEAVY	(4) Everleigh (Wilts) CHALK	(5) Wargrave (Berks) GRAVEL - SILT	(6) Shiplake (Oxon) MEDIUM HEAVY OVER GRAVEL
	Var: "Du Puit"	Var: "Du Puit"	Var: Not known	Var: "Flamande"	Var: "Du Puit"	Var: "Grimm"
5 lb IPC	As control	As control	As control	As control	As control	As control
10 lb "	Probably superior to control	Probably superior to control	Superior to control	As control	As control	As control
20 lb "	Slight damage	Superior to control	Superior to control	As control	Slight depression	As control
5 lb CIPC	Slight damage	As control	Superior to control	As control	Slight depression	As control
10 lb "	Some depression in growth	Some depression in growth	Very slight damage	As control	Slight kill Marked depression	Slight depression
20 lb "	Some depression in growth	Some depression in growth	Some depression in growth	Slight damage	Moderate kill Marked depression	Slight kill Marked depression

(22394/18)6

TABLE IV

% Grass Kill

Treatment	Spring Application	Autumn Application				
	(1) Blewbury (Berks) CHALK 1952	(2) Blewbury (Berks) CHALK 1952	(3) Finchampstead (Berks) MEDIUM HEAVY 1952	(4) Everleigh (Wilts) CHALK 1953	(5) Wargrave (Berks) GRAVEL-SILT 1953	(6) Shiplake (Oxon) MEDIUM HEAVY OVER GRAVEL 1953
CONTROL	Moderate infestation of meadow grasses (chiefly Poa pratensis.) Some barren brome* (Bromus sterilis). Little cocksfoot* (Dactylis glomerata). Little couch (Agropyron repens)*	Slight infestation of meadow grasses (chiefly P. pratensis). Little couch. Little cocksfoot*	Heavy infestation of meadow grasses (chiefly P. pratensis. Perennial ryegrass* (Lolium perenne), bent* (Agrostis spp.). Little cocksfoot*	Slight infestation of meadow grasses (chiefly P. pratensis). Black grass* (Alopecurus agrostis)	Meadow grasses (chiefly P. pratensis). Little annual meadow grass (Poa annua) No influence on the crop	Meadow grasses (Chiefly P. pratensis). Little annual meadow grass. No influence on the crop
IPC 5 lb	60%	30%	30%	40% Poa No kill Black G.	30-40%	15-20%
" 10 lb	75%	60%	65%	80% Poa No kill Black G.	80-90%	60%
" 20 lb	90%	70-80%	90%	100% Poa 70% Black G.	100%	90%
CIPC 5 lb	70%	40-50%	80%	2½ lb: 10-20% Poa No kill Black G.	2½ lb: 70-80%	2½ lb: Slight kill
" 10 lb	90%	60%	90%	5 lb: 60% Poa Slight kill Black G.	5 lb: 100%	5 lb: 75% kill
" 20 lb	95%	70%	100%	10 lb: 100% Poa 50-60% Black grass	10 lb: 100%	10 lb: 95%-100%

* Indicates grass species competing with the crop.