CLOVER TOLERANCE

By F. B. THOMPSON, Rukuhia Soil Research Station,
Hamilton

WHEN weedkillers are applied to weeds growing in association with plants of value it is desirable that the treatments should not only effectively control the weeds but also that they should not cause excessive damage to the associated crop or pasture. Most of the damage to pastures resulting from weed control measures is the suppression or killing of clovers caused by spraying with hormone weedkillers. It is, therefore, important to determine the tolerance of clovers to the various hormones available or likely to become available. During the last few years the Department of Agriculture has investigated in some detail the effects of various hormones on several species of clover at different stages of growth. A series of trials along these lines has been conducted at the Rukuhia Soil Research Station during the last 18 months and the results from these trials will be discussed in this paper.

EXPERIMENTAL

There were 12 well-replicated trials involving a total of 434 plots in which the clover plants were counted before and after the treatments. Altogether 20,000 plants were counted. In addition to determining the percentages of plants surviving the treatments the effects of the hormones were assessed by observing the degree of wilting, burning, and suppression of clover growth. In some trials the clover growth was determined by cutting and weighing.

Six of the trials were on seedling clovers (2 to 3 trifoliate leaves) sown broadcast in autumn 1955 and counts were made of the plants in portions of the plots. The number of clovers per unit area varied somewhat and in order to obtain more uniformity in the trials with clover sown the following spring the seeds were sown 2in. apart in rows. The plants were later thinned to 4in. or 6in. apart. The sowing of the clovers was greatly facilitated by an ingenious device designed and made by I. C. Sweetman, Rukuhia Soil Research Station, which picked up individual seeds by suction applied through revolving hypodermic needles and then dropped them down a chute. The device was attached to a seed sower mounted on a tractor and suction was obtained from the tractor manifold, or, in the case of the larger seeds, from a pump driven from the power take-off. In these trials half of the plants were treated in the seedling stage and the remainder when almost mature. Additional information was obtained from observations on clovers in pasture-spraying trials.

These trials were conducted on white clover (*Trifolium repens*), subterranean clover (*T. subterraneum*), and red clover (*T. pratense*).

The materials used were new formulations of derivatives of phenoxybutyric acid and phenoxypropionic acid which were compared with phenoxyacetic acid materials at present in common use for pasture spraying. All materials were applied at 1lb. acid equivalent per acre, except for some of the 2,4,5-T treatments which were at ½lb.

RESULTS

Salts of MCPB, MCP, and 2,4-D: In trials on clovers sown in spring in rows in which the sodium salt of MCPB, the potassium salt of MCP,

and the amine salt of 2,4-D were applied to both seedling and mature white and subterranean clovers there was practically no reduction in the numbers of clover plants. However, both the MCP and the 2,4-D salts caused withering after application and slight retardation of maturity, particularly on the white clover treated at the practically mature stage, whereas the sodium salt of MCPB had practically no effect.

The salts of MCPB and MCP only were applied to the red clover. Neither treatment caused any reduction in the numbers of plants. MCP caused more withering of the foliage of mature plants than did MCPB. When applied to seedling red clover MCP reduced the weight of the red clover at maturity by 20 per cent., whereas the sodium salt of MCPB caused no reduction in weight.

A recent field trial in which pasture containing mature red clover was sprayed showed that the sodium salt of MCPB, even at 2lb. acid equivalent per acre, retarded the clover growth less than did 1lb. of the potassium salt of MCP. However, even 1lb. of MCPB retarded clover growth relative to the untreated area.

Esters of MCPB, 2,4-DB, MCP, 2,4-D, and 2,4-DP: In this series, also on spring-sown clovers, the materials used were the butoxy ethanol ester of MCPB, the butoxy ethanol ester of 2,4-DB, the butyl ester of MCP, the butoxy ethanol ester of 2,4-D, and the mixed polypropylene glycol butyl ether esters of 2,4-DP. The 2,4-D and 2,4-DP were omitted in the red clover trials.

The mixed esters of 2,4-DP was the only treatment which caused any appreciable reduction in the numbers of clover plants. It considerably reduced the numbers of white clover and slightly reduced the subterranean clover when applied to the mature plants. The effect on the numbers of plants was very slight when the treatment was applied to the seedling clovers.

The relative effects of the treatments on the clover foliage judged by the degree of wilting and burning, about 3 weeks after spraying, are indicated in the following table:—

Treatment	Effect on clovers		
	Subterranean	White	Red
Butoxy ethanol 2,4-DB	Trace	Trace	Trace
Butoxy ethanol MCPB	Trace	Trace	Moderate
Butyl MCP	Trace	Very slight	Severe
Butoxy ethanol 2,4-D	Very slight	Very slight	No application
Mixed esters 2,4-DP..	Slight	Moderate	No application

The relative order of toxicity was the same for both the seedlings and the mature clovers.

Previous trials with phenoxyacetic acid compounds have shown that 2,4-D is more toxic to red clover than is MCP. The observed greater toxicity of MCPB than 2,4-DB is therefore interesting. The observation was confirmed by the following relative weights of red clover from cuts three months after the treatments were applied to seedling clovers:—

Treatment	Relative weight of red clover					
No treatment	..	..	..	..	..	100
Butoxy ethanol 2,4-DB ..	..	..	..	..	..	91
Butoxy ethanol MCPB ..	..	..	..	..	..	76
Butyl MCP	..	..	..	..	..	51

In the field trial on mature red clover in pasture previously mentioned the treatments also included the butyl esters of both MCPB and 2,4-DB each at 1lb. and 2lb. acid equivalent per acre. For the first few weeks after treatment the MCPB caused more withering and depression of growth than the 2,4-DB. After about 4 weeks the MCPB recovered somewhat, whereas the 2,4-DB treated clovers still showed considerable hormone damage and very little growth. In a trial in which the butyl esters were applied at post-emergence to peas the yield from the 2,4-DB plots was significantly less than that from MCPB.

MCP, 2,4-D, and 2,4-DP: Materials applied in this series were the potassium salt of MCP, the butyl ester of MCP, the ethyl ester of 2,4-D, the butoxy ethanol ester of 2,4-D, and the mixed polypropylene glycol butyl ether esters of 2,4-DP. Clovers were sown broadcast in autumn 1955 and were treated in the seedling stage only.

Four of the treatments were common to the trials on the clovers sown in spring 1955 in which there was practically no reduction in the numbers of clover plants. However, in the autumn trials all treatments except the potassium salt of MCP on subterranean clover killed a large proportion of the plants. The mixed esters of 2,4-DP were particularly toxic and on the most resistant species, subterranean clover, this mixture killed 84 per cent. of the plants relative to the control.

The other results followed the general pattern of the data presented at the Eighth Weed Conference (1), except that the potassium salt of MCP, the butyl ester of MCP, and the two esters of 2,4-D all reduced the numbers of white clover plants similarly.

The ethyl ester of 2,4-D was considerably more severe on subterranean clover than the butoxy ethanol ester. Both esters practically eliminated the red clover.

Esters of 2,4,5-T and 2,4,5-TP: Seedling clovers were treated in autumn 1955 with the butoxy ethanol ester of 2,4,5-T at $\frac{1}{2}$ lb. and 1lb. acid equivalent per acre and the mixed polypropylene glycol butyl ether esters of 2,4,5-TP at 1lb.

Practically all treatments significantly reduced the numbers of surviving clover plants and in many instances the reduction was more than 50 per cent. The 1lb. rate of 2,4,5-T was more toxic than $\frac{1}{2}$ lb., but the difference was not significant on the white clover.

The 2,4,5-TP was more severe than 2,4,5-T on white clover. The two materials were similar on subterranean clover. On red clover 2,4,5-T was the more toxic, but the reduction in clover numbers was so great with both formulations that the relative figures are of little importance.

In another treatment $\frac{1}{2}$ lb. per acre of ATA was added to the butoxy ethanol ester of 2,4,5-T at $\frac{1}{2}$ lb. acid equivalent. On the red and white clovers the mixture was little different from the 2,4,5-T alone, but on the subterranean clover the mixture was slightly less toxic.

COMPARISON OF RESULTS IN DIFFERENT SEASONS

Comparable figures from different trials may be obtained if the percentage of plants surviving a treatment is expressed as a percentage of the corresponding figure for the untreated control in that trial. Results obtained in different seasons may thus be compared by taking figures for a treatment common to all seasons. By including figures from trials in 1954, reported last year (1), results obtained from the potassium salt of MCP on seedling clovers in three consecutive seasons may be compared as shown in the table on the next page:—

RELATIVE PERCENTAGE OF SEEDLING CLOVERS
SURVIVING POTASSIUM MCP
(Control equals 100)

Clover	Sown November 1954	Sown April 1955	Sown October 1955
Subterranean	101	88	100
White	94	42	98
Red	90	63	100

In general the three clovers were sprayed at different times. The period between spraying the first and last trial in any season was 2 to 3 weeks. Therefore, weather conditions were not necessarily similar for the three clovers in the one season.

The results on the spring-sown clovers are very similar in spite of differences in experimental technique. In 1954 the clovers were sown broadcast, whereas in October 1955 they were drilled in rows with the single seed sower.

The effects of the treatments in autumn were much more severe than similar treatments applied in summer to clovers at the same stage of growth.

Similar differences between applications in autumn and spring 1955 were obtained with the butyl ester of MCP, the butoxy ethanol ester of 2,4-D, and the mixed esters of 2,4-DP.

SUMMARY AND CONCLUSIONS

From trials with derivatives of phenoxyacetic, phenoxybutyric, and phenoxypropionic acids applied at 1lb. acid equivalent per acre on subterranean, white, and red clover at both the seedling (2 to 3 trifoliate leaves) and practically mature stages of growth it is concluded that:—

1. The sodium salt of MCPB causes less damage to clovers than any of the other hormone materials used.
2. The butyl and butoxy ethanol esters of MCPB and 2,4-DB are less damaging than the salts or esters of MCP or 2,4-D but suppress clover growth slightly more than the sodium salt of MCPB.
3. The differences between butyric acid and the acetic acid derivatives were most noticeable with red clover and least noticeable with subterranean clover.
4. The mixed polypropylene glycol butyl ether esters of 2,4-DP were more toxic to subterranean and white clovers than were esters of MCP and 2,4-D.
5. The mixed esters of 2,4,5-TP were more severe than the butoxy ethanol ester of 2,4,5-T on seedling white clover. The materials were similar on subterranean clover. Both were very severe on red clover.
6. The addition of ½lb. per acre of ATA to ½lb. acid equivalent of 2,4,5-T had little effect on the toxicity of the 2,4,5-T to white and red clovers. The mixture was slightly less severe on subterranean clover than 2,4,5-T alone.
7. Treatments applied to seedling clovers in autumn were much more severe than similar treatments in summer on spring-sown clovers.

ACKNOWLEDGMENT

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REFERENCE

1. Maclean, Shona, 1955. Clover Tolerance. Proc. 8th N.Z. Weed Control Conf. 28-34.

DISCUSSION

Q.—Were the clover species in the trial grazed?

A.—No.

Q.—Has the polyethylene glycol ester of 2,4-D been tried on red and white clovers?

A.—Yes, the preparation is drastic on clovers.

Q.—What was the effect on any weeds that did appear in the clover trial?

A.—The trial was hand-weeded before treatment and was a clover tolerance trial only.

Comment: The degree of wetting influences clover damage. Low wetting in the above trials may have increased tolerance. The polyethylene glycol is itself a wetting agent and with increased cover being obtained greater damage would follow.

Q.—Has any work been done on clover tolerance when the species are growing in a young vigorous pasture?

A.—Yes. The relative story is the same as in the clover tolerance trials.