CONTROL OF DOCKS WITH HORMONE WEEDKILLERS

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DOCKS are notoriously bad weeds. Not only are they sometimes found growing thickly in annual crops of the farm and garden, but they are also frequently the principal weed invaders of pastures, especially dairy pastures. In these a heavy infestation will seriously reduce grazing capacity. It would be expected, therefore, that the use of a herbicide to prevent or reduce such a weed growth would be a strongly recommended feature of pasture management. But unfortunately docks, in contrast to many other weeds, have been found not to be very satisfactorily controlled by the hormone herbicides available at present.

Numerous experiments have been laid in many parts of the world over the past 8 years to investigate susceptibility of dock species to these hormones. The conclusion reached has been that they can be classed as only moderately susceptible except in the early stages of growth, when more successful eradication can be expected.

In common with much of the experimental work designed to determine the effectiveness of hormone herbicides on various weeds, that with docks, up to now, has also been mostly of an empirical nature. That is, the observations taken have provided results which are more qualitative in nature than quantitative. It must be remembered that although qualitative experiments in weed control are very valuable and necessary to give an indication of the success or otherwise of the various treatments, there is a limit to the amount of information they yield. For example, the percentage control achieved can only be very approximately estimated.

More accurate information of the degree of susceptibility of a species can be obtained from trials designed to yield quantitative data. As most of the preliminary work on the nature of the response of docks to the more commonly used hormone herbicides has been completed, a more accurate evaluation of the toxicity of these various substances would now seem warranted. Such a step would enable the better treatments to be more accurately identified. Also on such results recommendations can be more reliable and the use of relatively valueless materials avoided.

The study described in this paper has been an attempt at a quantitative evaluation. The specific object of the investigation was the assessment of the relative toxicity of 6 hormone herbicides of the phenoxyacetic acid group on the broad-leaved dock *Rumex obtusifolius* according to the stage of development of the plants and the rate of application of the herbicide sprays.

Experimental Procedure

The field chosen for the experiment was a heavily dock-infested pasture of the Massey Agricultural College dairy farm. It had been sown to Certified H1 and perennial ryegrass and red and white clover about 18 months previously. Utilisation had been by grazing only. At the time of spraying the sward was thick and tending toward rankness. Docks were to be found in every stage of development from seedlings to flowering and seeding.

Two adjacent blocks were laid across one end of the field. In each, plots 11yds. x 4yds. were marked out with at least 5yds. spacing between individual plots. Although only a small part of each of these plots was used for collection of data, the larger areas provided for a better distribution of the spray through the use of greater quantities. All treatments and a control were included once within each block, so that the whole experiment was in duplicate.

Down the centre of each plot a strip 1ft. wide was marked out. A close examination was then made of these strips to determine the number, the relative position, and the stage of development of all the broad-leaved dock plants growing in them. Recording the relative positions of the plants was facilitated by examining the centre strips progressively in 1ft. square sections and keeping a plan for each of these. Since the foliage of the dock plant grows almost directly above the root and without much lateral spreading, there was little difficulty in distinguishing individual plants. The number of plants in each square foot averaged about 4.

It was impossible to classify for stage of development with any high degree of accuracy, as no previous record had been made of the plants. Therefore 3 rather broad divisions were adopted, each being distinguished fairly easily from the appearance of the plant. These divisions were considered to be representative of 3 important stages in the growth cycle. They were designated "young," "mature," and "seed" and were typified respectively by small plants, large plants without any visible flowering stem, and plants in flower and seed.

Six proprietary hormone herbicides, all based on phenoxyacetic acid, were put under trial. They were:—

- (i) The ethyl ester of 2,4-D;
- (ii) the butoxyethanol ester of 2,4-D;
- (iii) the sodium salt of MCP;
- (iv) the butyl ester of 2,4,5-T;
- (v) an alkalolamine salt of 2,4-D; and
- (vi) the polyethyl glycol ester of 2,4-D.

Each material was applied at 2 rates: 1lb. of acid equivalent per acre at a dilution of 1 in 100 and 2lb. of acid equivalent per acre at a dilution of 1 in 50. By halving the dilution for the higher rate, the volume of spray put on each plot was kept the same.

Applications were made with a knapsack sprayer on 25 January 1952, which was a warm, mostly overcast day.

General observations on the immediate responses of the plants were made during the succeeding 2 or 3 weeks. The plots were examined in detail at 5, 10, and 30 weeks after spraying. Each plant which had been recorded on the plans was reidentified and a note made as to whether or not it retained any foliage, as there is a loss of all leaves with the more toxic materials. When 30 weeks had elapsed there was no doubt which plants had been killed, for in dead plants there was a general disintegration and rotting of the root tissues.

In all but a few of the recovered plants growth was active and in the small remainder recovery was indicated by buds which were developing from the underground stem.

Thus from the data collected at 30 weeks the percentage eradication given by the different spray treatments for each of the 3 stages of development of the plants was calculated.

Results: The immediate reaction given by the plants was fairly similar, irrespective of the treatment. Leaves curled due to curvature of the main rib and the petioles became very twisted. Newly grown stems bearing flower in bud curled quite markedly too, but in those plants which had reached a stage of late flowering or seed ripening there was no observable response.

Apart from the general absence of permanent damage to leaf tissue after application of the butyl ester of 2,4,5-T and the sodium salt of MCP, the other materials usually brought about a yellowing of the leaves followed eventually by their death.

The results collected from the observations at the 5th, 10th, and 30th weeks can be examined in 2 ways. First, the effectiveness of each treatment on dock will be dealt with.

In Table I is shown the percentage of plants killed within each of the 3 stages of development.

TABLE I.
The percentage of *Rumex obtusifolius* plants killed according to herbicide treatment and stage of development

Treatment	Rate of Application	Stage of Development		
		"Seed"	"Mature"	"Young"
2,4,5-T	1	0	3.5	11.3
2,4,5-T	2	1.1	1.6	5.4
2,4-D (amine)	1	0	10.2	26.1
2,4-D (amine)	2	2.9	55.8	51.3
2,4-D (ethyl)	1	1.9	16.9	24.6
2,4-D (ethyl)	2	0	41.3	46.1
2,4-D (butoxyethanol)	1	0	12.7	25.0
2,4-D (butoxyethanol)	2	0	14.3	27.3
2,4-D (PEG)	1	2.7	17.5	30.0
2,4-D (PEG)	2	0	20.0	26.1
MCP (sodium)	1	0	8.6	4.1
MCP (sodium)	2	0	8.6	16.7

The following are the more outstanding features brought out by these figures:

1. Plants which were in the stage of development between early flowering and seed ripening were almost invariably resistant. In 8 of the 12 treatments no mortality occurred at all and in the remaining 4 the numbers killed did not exceed 3 per cent. even in the best instance.

2. No material was really successful in reducing the dock population. Apart from the 2lb. applications of amine and the ethyl ester of 2,4-D, the control given was generally less than 30 per cent.

3. The amine salt of 2,4-D at 2lb. per acre gave the best result. It eradicated 55.8 per cent. and 51.3 per cent. of "mature" and "young" plants respectively. The ethyl ester of 2,4-D was definitely the next best treatment. Statistical significance tests supported these conclusions.

4. Both the butyl ester of 2,4,5-T and the sodium salt of MCP were almost valueless. Even in the most successful trial, that of 2lb. of the sodium salt of MCP on "young" plants, there was only a 16.7 per cent. eradication. Such a result was in keeping with the relatively mild responses shown by the foliage soon after spraying.

5. In nearly all the treatments there was a higher kill among the "young" plants than the "mature" plants. In fact the percentage eradication was about twice as great in the former category. The greater susceptibility of the "young" plants was not, of course, unexpected, as it has been commonly observed by other investigators that they are the more readily killed by hormone sprays. In one case, that of 2lb. per acre of amine salt, a lesser percentage of "young" plants were destroyed than of the "mature." This apparent difference in the action of amine from the other hormones was probably due, however, to some error in experimental technique, as the abnormal response occurred in only one of the amine plots.

6. Doubling the application rate of any material did not necessarily give a proportionate increase in the number of plants killed. For example, with both the polyethylene glycol ester of 2,4-D and the butoxy ethanol ester of 2,4-D the number of plants destroyed by the higher degree rate was virtually the same as that for the lower rate.

One exception of note was in the case of amine where the 2lb. per acre rate on "mature" plants gave a kill about 5 times greater than that obtained with the 1lb. rate. This was a statistically significant difference. In the case of the ethyl ester of 2,4-D the results were similar to those

given by the amine, but the extent of the difference between the 2 rates of application was less and only with the "mature" plants was it significant at the 5 per cent. level.

In consideration of any practical significance that these results might have, one important aspect must not be overlooked. It is the effect of a herbicide on the crop in which the weeds to be controlled are growing. The value of a herbicide does not reside entirely in its toxicity to the weeds, but also in its relative harmlessness to the crop plant. In these trials the ryegrass appeared to be completely unaffected by all the herbicides tested. The clover, particularly the white, was susceptible to many. Damage to foliage was very apparent in these plots where 1lb. or 2lb. per acre of the butyl ester of 2,4-T or 2lb. per acre of ethyl or butoxyethanol ester of 2,4-D or amine salt of 2,4-D at 2lb. per acre had been applied. Only the sodium salt of MCP was practically harmless. After about 5 weeks recovery was fairly complete except in those plots sprayed with 2lb. per acre of amine salt of 2,4-D or 2,4,5-T. In these there was a definite reduction in clover density.

The second aspect of the results to be considered is the time taken for recovery from defoliation by those plants not destroyed by the herbicides.

From the data collected at the 5th, 10th, and 30th weeks after spraying it was possible to get some idea of the importance of time in the recovery of dock from the effects of hormone herbicide sprayings. It is known, for example, that perennial plants respond more slowly than annual plants and hence the recovery time is greater. It is on this account that phytotoxic evaluations of materials on perennials can be reliable only if an adequate period intervenes between spraying and final collection of data. In Table II is shown the percentage of defoliated "young" and "mature" plants occurring with each treatment for the successive intervals after spraying.

TABLE II.
Percentages of "mature" and "young" plants killed or remaining defoliated at three intervals after spraying

Treatment	Rate of Application	Stage of Development	5 wks	10 wks	30 wks
2,4,5-T (butyl)	1	M	14	7	4
		Y	17	11	11
2,4,5-T	2	M	2	2	2
		Y	14	7	5
2,4-D (amine)	1	M	66	53	10
		Y	87	50	26
2,4-D (amine)	2	M	86	79	56
		Y	72	62	51
2,4-D (ethyl)	1	M	39	31	17
		Y	52	37	25
2,4-D (ethyl)	2	M	80	80	41
		Y	77	69	46
2,4-D (butoxyethanol) ..	1	M	57	44	13
		Y	56	50	25
2,4-D (butoxyethanol) ..	2	M	55	52	14
		Y	64	49	27
2,4-D (PEG)	1	M	43	40	18
		Y	60	46	30
2,4-D (PEG)	2	M	57	52	20
		Y	58	45	26
MCP (sodium)	1	M	12	10	9
		Y	11	6	4
MCP (sodium)	2	M	13	13	9
		Y	26	20	17

M equals mature. Y equals young.

It can be seen that the number at the 5th week did not prove to be in any way a reliable guide to the final mortality. Thus at this time more than 50 per cent. of the plants were defoliated in no less than 7 treatments on "young" plants and 6 on "mature." Figures ranged as high as 85 per cent. and 87 per cent. and several others exceeded 60 per cent. At 10 weeks there were still 5 and 4 treatments respectively in the same category.

By the 30th week, however, it was found that only in those plots sprayed with amine salt of 2,4-D at 2lb. per acre had a 50 per cent. control been achieved.

Since the winter months came between the 10th and 30th weeks, it is possible that the recovery time was rather longer than it would otherwise have been. But recovery is certainly not very rapid from the more toxic sprays. It is on this account that the identification of individual plants before and after treatment is desirable. Otherwise results are likely to be inaccurate due to the growth of new plants in the experimental area.

From the results presented in this paper it is clear that no solution to the problem of dock eradication has been found. None of the hormone substances tested was really effective. It has been shown, however, that for dock control there are quite large differences in the relative values of these hormones. Certain ones can be expected to give a better control than others. Thus especially the amine salt of 2,4-D, but also the ethyl ester of 2,4-D, should be regarded as 2 of the more effective materials of those available. The butoxyethanol ester of 2,4-D and the polyethylene glycol ester of 2,4-D were not particularly encouraging, and on the results could not be recommended. Results indicated that the use of the butyl ester of 2,4,5-T and the sodium salt of MCP should be avoided in any weed population in which docks are the most numerous component.

This work has been far from a complete study. It was undertaken in the field at one time of the year only and hence any differences in susceptibility due to season were overlooked.

Then no trials were laid down to study the effect of a second spray on plants regenerating after initial damage from herbicide. Maybe the percentage kill would in some cases be increased much nearer to complete control by such a second application.

To these problems answers and therefore further experiments are needed.

DISCUSSION

Q. What is the capacity of dock roots to regenerate after cutting and how long does dock seed remain viable?

A. (Yeates): Only the top 2in. of the root will regrow; the remainder of the root is not able to regenerate. American experiments have shown that seed is viable for 100 years, which indicates the possibility of bringing up seed by ploughing.

Comment: Department of Agriculture trials were a little more encouraging than those described in the paper. The PEG ester of 2,4-D and polypropylene glycol butyl ether ester of 2,4-D were promising; also amine salt of 2,4-D and the butyl ester of MCP, the latter having better selectivity in crops. *Rumex crispus* was the most susceptible species; *R. obtusifolius* was moderately susceptible and *R. pulcher* the most resistant. PEG ester of 2,4-D gave least clover damage. The diester was more damaging to clover.