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RESPONSES OF RUMEX OBTUSIFOLIUS L.

TO SEVERAL

'HORMONE' HERBICIDES.

BY

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CHAPTER I

INTRODUCTION:

Weeds have been a problem to man ever since he began to till the soil. Their presence is a factor lowering yield and increasing the cost of production of almost every economic crop. Weed eradication and control measures therefore, are bound to loom large in the management of crops at various stages throughout their growing period.

Following upon such discoveries as those of Slade et al (1) and Mitchell and Hamner (2) that synthetic growth-regulating substances possessed properties capable of causing violent and often fatal disturbances to plant growth, new and effective methods of destroying undesirable species were developed. In fact, it can be said that the whole thought and practice of weed control was revolutionized by the promotion of certain practical aspects proceeding from the rapidly accumulating knowledge of plant-growth substances.

Research soon indicated, however, that weed control problems did not suddenly cease to exist, for many species were shown to possess a moderate to high degree of resistance to the 'hormone' materials. Among such species were included docks (*Rumex* spp.); perennials, characterized by a long tapering or

fanged storage root system, and a strong capacity to produce adventitious buds from the short portion of underground stem.

Preferring medium to heavy damp soil conditions, these weeds are serious invaders of pastures on rich dairying land while heavy infestations in annual crops can lead to greatly reduced yields. It was but a natural development therefore, that the possibility of control of these plants by the new 'hormone' herbicides was investigated in some of the initial experiments.

One of the earliest observations on the susceptibility of *Rumex* spp. to 2,4-dichlorophenoxyacetic acid (2,4-D) was made by Marth and Mitchell (3). The first large scale trials however, were made in South England, where, during the 1945-46 season, 177 acres of heavily dock-infested pasture and crop land were either dusted or sprayed with the sodium salt of 2-methyl-4-chlorophenoxyacetic acid (MCPA) at rates of 2 lb. acid equivalent (A.E.) per acre as a dust, or 1 lb. A.E. per acre as a spray (4). Moderate susceptibility was indicated, as was shown by the spectacular epinastic responses and frequent death of the leaves and petioles, as well as by the decreased infestation of the treated fields when examined some weeks later. The extent to which the roots had been killed, however, remained undecided. Templeman (5) reporting on MCPA applied at 8 lb. A.E. per acre

likewise was unable to reach a conclusion as to the extent of root kill, but Tincker (6) made a claim for a 50% eradication of Rumex crispus with 'Methoxone' - an MCPA dust preparation.

By using the sodium salt of 2,4-D as a powder dispensed in a dose of 5% in bentonite, Scarponi (7) claimed that it was possible to destroy Rumex crispus. No confirmation of this report has appeared but Pellegrini found that a formulation containing the sodium salt of 2,4-D in solution was an improvement (8). Gysel (9) and Wurgler (10) have reported varying successes with 2,4-D preparations similar to that of Pellegrini, sprayed on to individual plants. In a Western Australian experiment a 2,4-D compound at 4 lb. A.E. per acre reduced the prevalence of dock in a pasture from an 80% to a 50% infestation; the post-treatment analysis being made 6 months after spraying (11).

The results reported by Halliday and Templeman (12) and Holmes (13) for the sodium salts of MCPA and 2,4-D respectively, indicate that the differential responses shown by dock plants are not so much due to the kind of herbicide employed as to the stage of maturity at the time of treatment.

In the trials conducted by the New Zealand Department of Agriculture, several preparations, in addition to the materials already discussed, have been studied for their herbicidal effects on Rumex spp. (14,15). These include both oil-based, and the water soluble

polyethylene glycol-based esters of 2,4-D, the triethanolamine salt of 2,4-D and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) compounds. It was found that in addition to stage of development, variation in response could also be attributed to the herbicidal preparation used. Thus, the oil-based ethyl ester of 2,4-D was more effective than the sodium salt of either MCPA or 2,4-D. Also the results obtained with the polyethyleneglycol-based esters of 2,4-D were very promising.

It is seen from the above review of work done, that much information pertaining to the control of docks by 'hormone' substances has been collected, but the data has been principally of an observational or empirical nature rather than of a quantitative kind. The preliminary observational trials are now largely completed. For further progress in the development of effective treatment, it is now important that more accurate assessments of the toxicities of the various 'hormone' herbicides be undertaken from the point of view of the percentage mortalities achieved at varying dosage rates. That is, more accurate evaluations in terms of killing capacity of herbicides used at different concentrations under diverse environmental conditions are required.

By the use of techniques involving quantal responses, assessments of some herbicides on several weed species other than Rumex, have been made.

Willis (16), for example, compared the relative effectiveness of two 'hormone' herbicides as agents in buttercup control. He used the factors of plant numbers, flower-stalk numbers and weight of foliage per unit area, before and after treatment, as criteria for comparison. Plant numbers per unit area was the only factor used in a similar experiment reported by Woodford for dinitrobutylphenol preparations as toxic agents to Stellaria media in peas (17).

It is data of this kind that is urgently required for all weed species that are regularly the object of spraying programmes. Rumex species come within this category and one of the aims of the present study has been the assessment of the relative toxicity of several hormone herbicides on Rumex obtusifolius L. growing in a ryegrass-clover pasture. Stage of growth has been recognized as having an important influence on the efficacy of weed control treatments. In the present investigation therefore, stage of growth has been studied as a variable modifying the assessments.

Germinating seeds are readily damaged by contact with high concentrations of growth regulating substances (18,19,20). Mullison and Hummer (21) showed that exposure of seeds of many species to the vapours of several of these chemicals resulted in malformations of the seedlings and reduced germination percentages. But evidence for these 'hormone' materials causing damage to ripened seeds, attached to the parent plant

at the time of spraying, is meagre. Studies made by Marth et al (22) on the effect of 2,4-D acid on maturing grass and cereal seeds showed that neither the germination capacity of the sound seed nor the vigour of the seedlings was detrimentally affected. McIlrath et al (23) however, found that cotton seeds, present at the time of spraying with 2,4-D, were severely damaged, as evidenced by the reduced viability of the seeds and the reduced survival rate of the seedlings.

In an endeavour to add further information on this aspect of the action of growth-regulating substances, an examination was made during the present investigations of the abnormal effects produced by various 'hormone' herbicides on very immature and nearly ripened seeds present on Rumex obtusifolius plants at the time of spraying.

Measures which tend to exhaust the readily-available energy reserves of plants have long been known to weaken their ability to recover from damage and so the possibility of eradication is enhanced. Hence, in order to facilitate more effective control of many notorious weeds, changes in the levels of carbohydrate materials in root and other storage organs have been determined at various stages of development for several plants including Convolvulus arvensis (24, 25, 26), Agropyron repens (27) and Cirsium arvense (27,28).

From the work of several investigators, it became evident that the 'hormone' herbicides cause a loss in Dry Weight of plant parts (29,30). Experiments with Ipomoea lacunosa (29), Convolvulus arvensis (31), Taraxacum officinale (32) and Fagopyrum esculentum (33) have all indicated that this loss is due to a steady decline in the weight of starch and starch-like substances. Recent work by Rhodes (34) on the influence of an MCPA preparation on the metabolism of tomatoes, strongly suggests that the effectiveness of the toxic action resides in the capacity to deplete storage materials, especially in the roots.

Although death of a plant following 'hormone' treatment might not be the direct outcome of carbohydrate depletion, it seems logical to conclude that damage would be more severe at a time when energy reserves are at a low ebb. Work was undertaken therefore, to determine the level of readily-available carbohydrate reserves of dock roots at several stages of plant development.