NO.49 THE INTERACTIONS OF CERTAIN HERBICIDES AND HERBICIDE MIXTURES ON PASPALUM DILATATUM (Poir)

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SUMMARY

There is an increasing demand for herbicidal combinations in total vegetation control and in the field of soil sterilization.

The selection of herbicide combinations must take into account their physiological compatabilities as expressed either by their possible synergism, antagonism, or simply additive or parallel effects.

This investigation is aimed to evaluate amitrol/sodium salt of 2,2-Dichloropropionic acid mixtures, and results indicate possible synergism in the species treated: Paspalum dilatatum (Poir).

1. INTRODUCTION:

In the field of total vegetation control, there is an increasing interest in the use of herbicide mixtures of two or more herbicides, either compounded in manufacture or applied as mixtures in the spray tank.

This approach to total vegetation control is now possible in view of the wide range of effective herbicides differing in their herbicidal properties. With a number of species, both annual and perennial, all at different stages of growth and development, living under varying conditions of soil type, moisture and light, the proper blending of herbicides with various methods of action constitutes a very important aspect of herbicide formulation.

The selection of such combinations cannot be made empirically on the known herbicide properties of absorption, translocation, or method of action of the constituent herbicides, since apart from the important problem of chemical compatability of such mixtures, work

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has clearly demonstrated the need for careful consideration of the physiological compatabilities of such selections.

On the basis of physiological interactions, combinations of herbicides may be classified in different categories, either additive, less than additive, (or antagonistic), or synergistic.

Amitrol has been widely suggested as a suitable additive to other herbicides primarily for its properties of ready absorption through foliage and roots, and its rapid translocation within the plant. The primary inclusion of amitrol in combination with the typical pre-emergence insoluble root-absorbing chemicals (Schieferstein and Loomis, 1956) was based mainly on its action in accelerating the removal of existing established species of deep rooted perennials to allow the proper action of the included pre-emergent chemical.

The inclusion of amitrol in mixtures to accelerate other foliage herbicides is being widely practised. Sheets and Leonard (1958) have reviewed the literature on amitrol combinations with herbicides on foliage applications particularly in regard to amitrol with sodium salt of 2,2-Dichloropropionic acid; 2,4-D; 2,4,5-T; 2,2,3-Trichlorpropionate (2,2,3-TPA). Gowing (1957) using probit analysis adopting 50% level of inhibition, found synergism between amitrol and sodium salt of 2,2-Dichloropropionic acid, antagonism between 2,4-D and sodium salt of 2,2-Dichloropropionic acid; and parallel effects between amitrol and 2,4-D.

In view of the variations in reaction with amitrol conbinations, and the importance of checking particular species, this paper reports investigations into the interactions of amitrol and dalapon on Paspalum dilatatum.

2. METHOD AND MATERIAL:

The experiments were conducted on a paspalum pasture renovated two years previously. At the time of spraying the paspalum had passed its flowering stage and a number of sub-dominant broadleaved species were growing in association.

Previous work (unpublished) had indicated that

for maximum kill of paspalum with sodium salt of 2,2-Dichloropropionic acid, or for maximum inhibition with amitrol, it was important to time spraying towards the end of the growing season, avoiding the active spring growth and mid-summer early flowering period. To test whether stage of growth rather than season influence was important, half of each plot concerned with this trial was mown.

Plot size was 1/200th acre with 2 ft. buffer strips, and 3 replications per treatment on a randomised design were used. All treatments were applied with fan nozzles at rate of 300 g.p.a.

Chemicals used for this trial were 50% w/w amitrol; 50% w/w amitrol plus 45% ammonium thiocyanate; 80% w/w sodium salt of 2,2-Dichloropropionic acid. The mixtures were prepared on the spot from the above. Subsequently this trial has been repeated using compounded mixtures appropriately manufactured. No additional wetting agent was used.

The selection of amitrol/sodium salt 2,2-Dichloropropionic acid mixture in the ratio of 1 : 3 was done empirically and other ratios are now under investigation on Paspalum dilatatum.

Similarly rates used were selected to investigate reported synergism on this species.

This report outlines results from the higher rates used in the trial, but the full trial includes similar comparison at half the rates indicated in Table 1.

Measurement of plant responses followed the scale adopted by U.S.D.A. viz .....

(a) Reaction - 0 ... no effect
10 ... complete top kill.

(b) % reduction in stand - result taken after regrowth (if any) and expressed as % of original stand.

(c) Herbicidal Index -(Final initial reaction x 10 + % reduction in stand) ÷ 2

Reaction was recorded visually and date for (b) by botanical analysis using line transect method across the plot.

Data was collected 2,4,8 weeks after the spraying date of 31.4.59., and then again on 1.10.59.

3. RESULTS:

The herbicidal responses of amitrol, sodium salt of 2,2-Dichloropropionic acid and interaction of amitrol + mixtures resulted in three characteristic responses:

(a) Variation in symptom response.

Amitrol plots followed a characteristic sequence of responses - at a time after spraying, depending on formulation; chlorosis occurred on initially sprayed growth in localised patches, but was completely systemic on new growth. On both classes of growth this was followed by a red pigmentation, finally resulting in tip necrosis. Tip necrosis progressed to leaf-injury until the eighth week, when maximum response was noted. In all cases, the amitrol formulation based on ammonium thiocyanate gave accelerated responses in time and intensity.

The phytotoxic pattern of the sodium salt of 2,2-Dichloropropionic acid on paspalum followed quite a distinct response. No apparent symptom occurred for 14 days when initially sprayed vegetation assumed a dull green colour, intensifying to a greyish green. This was followed by a general development of red pigmentation. This symptom held for some weeks, gradually followed by desiccation and death of the leaves.

In plots sprayed with the amitrol + sodium salt of 2,2-Dichloropropionic acid mixtures, responses both on initially sprayed growth and on new growth appeared to follow a compromise between the reactions of the constituent herbicides described above. In the first place the initial chlorosis was not as widely developed throughout, the plant red pigmentation was restricted to the tip of the leaves, and browning and desiccation of the leaves was more rapid and general on both initial growth and new growth.

This variation in the responses of paspalum to this combination of herbicides indicates interaction within the plant.

(b) Variation in speed of herbicidal action

There was wide variation in the speed of initial response and final herbicidal effect (Table 1)

As indicated, towards the end of four weeks the herbicide mixture had achieved considerable effect, with maximum effect at the end of the eighth week, while constituent herbicides, except amitrol and ammonium thiocyanate mixture, were considerably slower in action.

(c) Variation in growth response of sprayed plants of Paspalum dilatatum

Under the conditions of the experiment, variation was noted both in new growth immediately following spraying, and on regrowth following death of above-ground parts of the plant.

Both in mown and unmown strips, amitrol plots showed immediate stimulation of new growth after spraying, indicating some reaction on the basal buds of the stool. As indicated above, this growth was chlorotic on emergence and finally died. However, recovery from the crown was general in all amitrol plots (see % reduction in stand). This regrowth arose from basal buds generally situated in the centre of the crown.

Marked reduction in plant numbers occurred in the sodium salt of 2,2-Dichloropropionic acid plots, and recovery in October consisted of individual plants, rather than regrowth from each plant so characteristic of the amitrol plots. There was a marked reduction in new growth immediately following spraying. This observation was similarly noted in early summer treatments on this species, and in trials in progress on Guinea Grass (Panicum maximum Jacq.) at Ingham in North Queensland. The slow action of this herbicide and the maintenance of green leaves apparently ensures that the inherent

hormone system inducing dormancy of basal buds is not interfered with. In these cases of early treatment, inhibition was very noticeable, but mortality of individual plants very low.

The herbicidal activity of the combination in the experiment under review was in excess of the activity of either amitrol or the sodium salt of 2,2-Dichloropropionic acid alone. The mixture did not completely suppress new growth immediately after spraying, but death was fairly rapid. Final mortality figures as indicated by reduction in stand were consistently higher in all replications.

While this herbicidal mixture gave high mortality of paspalum stools in the late season spraying, the reaction of this mixture in early summer or pre-flowering treatment is of interest. In a trial (still in progress) spraying on 1st October, 1959 and 1st December, 1959, initial rapid response followed pattern already described. However, by February very active recovery, usually from one or two vestigial buds per stool occurred. These plants grew tall and flowered. This pattern was quite different from the effect of sodium salt of 2,2-Dichloropropionic acid where the slow growth and retention of green foliage during this period inhibited active recovery, so characteristic of the herbicidal mixture.

4. DISCUSSION:

The results indicate that physiological interactions between amitrol and sodium salt of 2,2-Dichloropropionic acid occur in Paspalum dilatatum and these reactions influence the herbicidal activity as expressed by symptoms, speed of action and growth responses.

The total responses, compared with the herbicidal activities of the constituent herbicides, suggest that the overall action is one of synergism, not a simple summation of the effects of the materials acting alone.

Investigations have been conducted separately on the constituent herbicides and this work may show some light on possible sites of action in the plant to account for the observed interactions.

Microscopic studies have established that one of the main effects of amitrol is to inhibit the formation of plastids (Rogers, 1957). How closely these symptoms are associated with the intrinsic action of amitrol is not known. It has been established that this chemical interferes with mitosis (Grigsby, 1954) that it affects tissue metabolism immediately after entry and causes an initial stimulation of respiration (Miller and Hall, 1957) and, perhaps the most important, that it has a specific effect on catalase in both plant and animals (Heim et al, 1955).

Studies with the sodium salt of 2,2-Dichloropropionic acid suggest that the main site is in the leaves (Ollson and Salisbury, 1957) and marked changes in chemical composition and metabolism are reported (Corns, 1956). Recent work (Hilton et al. 1959) indicates that this herbicide might be expected to act as an antimetabolite to the pantothenate synthesizing enzyme in grasses, acting by causing competitive action for the enzyme substrate.

In view of the extremely mobile nature of amitrol and sodium salt of 2,2-Dichloropropionic acid in plants and the selective nature of the latter, physiological studies of interaction are necessary. Similarly studies of reaction of this herbicide mixture and others on broad-leaved species, both annual and perennial, merit closer attention.

In the full evaluation of this particular interaction, it will be important to consider if some chemical compatibility or reaction is possible, due to the presence, however small, of the aminotriazole salt of 2,2-Dichloropropionic acid.

This trial and associated investigations raised basic problems in relation to the effective herbicidal action on tussocky perennial species. The influence of rapid defoliation of such species in the early season, in stimulating dormant basal buds indicates that such species may show pronounced apical dominance. This property is not so apparent in spraying of rhizomatous species (Pennisetum clandestinum Hochst. or Cynodon dactylon (L) Pers.) with amitrol/sodium salt of 2,2-Dichloropropionic acid mixtures.

5. REFERENCES:

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TABLE 1

REACTIONS OF PASPALUM DILATATUM TO HERBICIDES AND HERBICIDE MIXTURES

(SUMMARY OF 3 REPLICATIONS)

Chemical	Rate of Active/ acre	Date of spraying ... 21/1/59. Reaction: 0-10 Weeks from Spraying: 0	2	4	8	% Reduction of stand 1.10.59	Herbicidal Index
Amitrol 2,2-Dichloropropionic acid (sodium salt)	4 lbs) 12 lbs)	0	6	8½	9½	98	96.5
Amitrol	4 lbs	0	6	6½	4	40	40
2,2-Dichloropropionic acid (sodium salt)	12 lbs	0	3	5	6½	85	75
"	20 lbs	0	2	3	6	90	75
Amitrol	10 lbs	0	6	7	7	20	45
Amitrol plus ammonium thiocyanate	10 lbs	0	7	8½	9	30	60