2,3,6-TBA, SOME USES AND SUGGESTED APPLICATIONS

By D. C. ISAACS, J. H. Barbour and Son Ltd.

SUMMARY

THE mode of action of 2,3,6-TBA is described. It has given good control of sweet briar (*Rosa eglanteria*) and promising results on inkweed (*Phytolacca octandra*), Watsonia, alligator weed (*Telanthera philoxeroides*), and Californian thistle (*Cirsium arvense*). Further work with blackberry (*Rubus* spp.) is warranted. Application, time of spraying, and persistence in plant and soil are discussed.

The physiological activity of certain benzoic acid derivatives was reported in 1942 (1), but it was not until 1950 that it was shown that 2,3,6-TBA exhibited high physiological activity in the *Avena coleoptile* straight growth test (2). Further investigations showed that 2,3,6-TBA produced leaf modifications and knob-like swellings on the stems of some plants (3), and it was soon suggested that because of its high phytotoxicity, this material might be suitable as a herbicide.

A commercial grade of trichlorobenzoic acids was released for field evaluation in 1954. Wide-scale trials followed and in 1958, 2,3,6-TBA, formulated as a liquid containing the diethylamine salt, became available as a herbicide. A formulation based on mixed polychlorobenzoic acids was released at the same time. More recently a granular formulation has been produced for evaluation.

PROPERTIES

Two important characteristics of 2,3,6-TBA are its persistence in the plant and its resistance to breakdown in the soil.

Whereas 2,4-D persists only long enough in bean plants to cause extreme distortion to three or four leaves, the substituted benzoic acids persist long enough to distort up to 11 leaves (4).

As 2,3,6-TBA is slightly soluble in water, it is leached under high rainfall conditions. At low rates in the soil there is evidence of some microbiological breakdown, but at higher rates this breakdown is slower, due probably to the toxicity of the chemical to the organisms responsible for the breakdown (5). Thus there is no excessive build-up of the breakdown organisms as is the case with 2,4-D.

MOBILITY

2,3,6-TBA moves readily in plants both from leaf and root. It even goes further than this as was demonstrated by the transference of the material from one plant to another via the soil (6). Applied to the leaf or stem of a bean, 2,3,6-TBA produced leaf modifications, travelled down to the roots, passed into the soil, and was taken up by another bean plant on which malformed leaves appeared.

VOLATILITY

2,3,6-TBA seems to be fairly safe to use in the field (7), but it is recommended that care be taken to prevent drift on to susceptible crops during application.

TOXICITY

The material is non-toxic, but may cause irritation to skin and eyes.

MODE OF ACTION AND SELECTIVITY

2,3,6-TBA is readily absorbed by leaves and roots of most plants. In susceptible plants the chemical is rapidly translocated and accumulated in meristematic tissues.

Mason (8) has studied the absorption and translocation of 2,3,6-TBA

in a susceptible species, bean, and in a resistant species, corn. He found that both species absorbed similar amounts of the chemical from leaf application. In the bean more than 50 per cent of the material absorbed was rapidly translocated to the apical bud where growth repression and distortion of emerging leaves occurred. With corn, translocation was slower and most of the transported material accumulated in mature leaves. This lack of translocation to actively growing tissues as well as an inherent resistance to the action of 2,3,6-TBA would account for the tolerance of corn to the chemical. The root uptake of 2,3,6-TBA by corn was slow and translocation limited in comparison with bean. There was evidence that 2,3,6-TBA did not act by antagonising naturally occurring growth regulators, nor did corn have a greater ability than bean to degrade the chemical. It would appear that the phytotoxic action of 2,3,6-TBA involves disturbance of normal biosynthesis.

APPLICATION

2,3,6-TBA can be applied to foliage or soil or to both. There is a suggestion that soil applications are more reliable than foliage sprays, though this may apply only in the case where dry conditions would reduce leaf absorption. On mature perennial plants early spring application prior to maximum leaf development gives most efficient control (9). The partially developed foliage allows some spray to reach the soil, the high proportion of meristematic tissue renders the plant particularly susceptible, and soil moisture conditions are optimum for root absorption. With annuals and seedling perennials, application should be made when the plants are young and growing vigorously.

In areas where the winter is fairly dry an autumn application would be satisfactory, but where rainfall is heavy during the winter, too much of the chemical is likely to leach past the root zone (10).

USES

In North America one spraying with 15 to 20 lb a.i. per acre of 2,3,6-TBA is giving control of convolvulus (*Convolvulus arvensis*), Californian thistle (*Cirsium arvense*), and woody vines such as honeysuckle (*Lonicera* spp.). Promising results have been reported on a variety of woody plants, including conifers (7). No firm recommendations are yet being made for weed control in crops.

2,3,6-TBA produces a highly specific effect on a number of weeds resistant to MCPA and 2,4-D such as cleavers (*Galium aparine*), chickweed (*Stellaria media*), and mayweeds (*Matricaria* and *Anthemis* spp.) (11). In Britain a mixture of 2,3,6-TBA and MCPA is used on cereal crops whose weed population includes these species. (The amount of 2,3,6-TBA applied is as low as 4 oz a.i. per acre. In some cases a synergistic action between 2,3,6-TBA and MCPA has been demonstrated (11).

TRIALS IN NEW ZEALAND

2,3,6-TBA is very expensive—about £3 per lb—so it is unlikely that it will displace conventional weedkillers on the more susceptible weeds. However, there are numerous weeds in this country that are not killed by a single application of 2,4-D or 2,4,5-T, and it is to these that most trial work has been confined.

Unless otherwise stated, trials were of a preliminary nature and in most cases were not replicated.

Inkweed (*Phytolacca octandra*) at Wanganui: 20 lb a.i. per acre of 2,3,6-TBA applied in April gave complete kill of mature bushes, though it was five months before the treatment could be called successful. Within a few weeks of treatment the edges of the leaves turned down and all the foliage changed to a reddish-brown. This condition persisted right through winter and it was not until spring that the leaf and stem tissues collapsed and the plants died. There were no differences between applications to

foliage only, foliage and soil, soil only, or to the soil round the stumps of plants that had been cut down.

Foliage application of 7½ and 15 lb a.i. per acre of 2,3,6-TBA in December produced the typical leaf rolling and colour change, but seven months after treatment the plants, though very unthrifty, were still alive. Some new distorted foliage was produced and part of this has died. Treatments at the same rates of soil round stumps of plants that had been cut were successful. Some distorted regrowth appeared on the stumps but this, except in one case, subsequently died.

Blackberry (*Rubus* sp.) at Auckland: 10 lb a.i. per acre of 2,3,6-TBA in September gave a good top kill, but distorted regrowth appeared in April. At **Palmerston North:** 10 and 20 lb a.i. per acre were applied in December. The action was slow, but the stems gradually died back from the tips. The 20 lb a.i. per acre rate gave a complete kill of top growth, but in June some of the roots were still alive. The lower rate caused the stems to die back to 1 to 2 ft from the ground only.

Watsonia (*W. bulbifera*) at Auckland: 10 lb a.i. per acre of 2,3,6-TBA applied in November gave a complete kill. No live bulbs could be found in May.

Alligator Weed (*Telanthera phloxeroides*) at Helensville: 10 lb a.i. per acre of 2,3,6-TBA in November gave a good top kill, but recovery was complete six months later. A replicated trial conducted by the Department of Agriculture at Dargaville showed that at least 20 lb a.i. per acre is required for good control.

Sweet Briar (*Rosa eglanteria*) at Wanganui: Autumn application of 20 lb a.i. per acre of 2,3,6-TBA on regrowths 18 in. high gave complete control. Department of Agriculture trials in the South Island have shown that 8 lb a.i. per acre containing 300 to 400 bushes gives good control.

Drain Weeds at Palmerston North: A mixture of 10 lb a.i. per acre of 2,3,6-TBA and 11 lb a.i. per acre of dalapon applied in autumn gave good control of a mixed population of grasses and broad-leaved weeds, but showed no better residual effect than ½ lb a.i. per acre amine salt of 2,4-D and 11 lb a.i. per acre of dalapon.

Californian Thistle (*Cirsium arvense*): In the Department of Agriculture trials at Rukuhia 15 lb a.i. per acre of 2,3,6-TBA applied in November gave promising control. A few new shoots, slightly distorted, appeared six months after application and some live roots were unearthed.

OTHER POSSIBLE USES

In general, it would be worth while to try 2,3,6-TBA on any weed resistant to the common hormone weedkillers. Scrub weeds and vines seem the most likely field. However, promising results have been noted on such widely differing species as bamboo (*Arundinaria macrospermum* and *Hydrocotyle* spp.), so there seems to be little restriction on the range of weeds that could be covered.

Weed control in crops with 2,3,6-TBA has been widely investigated overseas, but no firm recommendations have been made. Crops, such as onions, rice, sorghum (12), mangolds (13), turnips, asparagus, and lucerne (14) have been reported tolerant to low rates of the chemical.

DISCUSSION

2,3,6-TBA has several characteristics that are ideal in herbicides. Its mobility and persistence in the plant are outstanding, but the high rates required for mature perennials are likely to restrict its use. The movement from one plant to another through the soil may improve and prolong the effect of a foliage application, the exudate from the roots of treated plants being available to control plants protected from the spray or seedlings which germinate after application.

Time of application may be critical for efficient action, especially on

perennial plants in high rainfall areas. A high proportion of meristematic tissue in the plant renders it more susceptible or perhaps more **immediately** susceptible, because the chemical may be able to persist in the plant until a high proportion of actively dividing tissue is present. This appeared to be the case with the autumn treatment of inkweed, when the foliage only was sprayed, and the plants were checked but did not die until five months later, in the spring. It is regrettable that more trials could not have been laid down in the early spring to demonstrate this point. With soil application, if too long a period elapses before optimum conditions occur in the plant, the soil reserve of the chemical may be exhausted by leaching.

The persistence in the soil when higher rates are applied under drier conditions means that the plant is subject to prolonged treatment. This could be the principal factor in the success against weeds with extensive root systems and underground storage organs. The plant may overcome the effects of the initial spray, but when it produces new leaves it also absorbs 2,3,6-TBA from the reservoir in the soil and this new growth dies. This sequence could be repeated several times before the plant finally succumbs.

It may be possible to establish crops or pasture on treated areas where the chemical has leached out of the top layers of soil but remains in sufficient quantity lower down to prevent regrowth of weeds such as Californian thistle.

The success of the soil treatments indicates that a granular formulation may be very useful, especially for scrub weeds on hill country.

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