Technical Papers

Use of 2,4-Dichlorophenoxyacetic Acid as a Selective Herbicide in the Tropics

J. VAN OVERBEEK and ISMAEL VÉLEZ

Institute of Tropical Agriculture, Mayagüez, Puerto Rico

During the past year extensive trials were conducted on the use of 2,4-dichlorophenoxyacetic acid[1] as a selective herbicide for tropical crops in Puerto Rico. Its most beneficial use is in the sugar-cane culture, but in coffee plantations also it promises to be of considerable importance. While many of the major weeds associated with these crops are highly susceptible to 2,4-D, neither sugar cane nor the coffee plant have shown any adverse effects of sprays up to 0.3 per cent concentration.

It was found that weeds could be divided into four classes in regard to their sensitivity[2] to 2,4-D:

Class I consists of a group of highly sensitive plants, represented by Curve I of Fig. 1. *Commelina,* one of the most serious sugar-cane weeds in moist lands, is the main representative of this group. A single treatment with 0.05 per cent of 2,4-D at a cost which is often as low as 50 cents per acre[3] gave sufficient control. Several species of *Ipomea,* and *Stizolobium pruritum* (Wight) Piper (the *pica pica* feared by sugar cane workers on account of its stinging hairs), fall in the same sensitivity class, as does *Urera baccifera* (L.) Gaud., the giant nettle, which is a major pest in coffee plantations. Other weeds belonging to this class are: *Bidens cynapiifolia,* H. B. K., *Cissus sicyoides* L., *Cleome gynandra* L., *Clerodendrum fragans* Vent., *Momordica charantia* L.

Class II is a group of weeds characterized by Curve II and represented by several species of *Amaranthus* (pigweed). To this group also belong: *Achyranthes sessilis* (L.) Steud., *Kallstroemia caribaea* Rydgerg., *Poinsettia heterophylla* (L.) Kl. Garcke., *Ricinus communis* L., *Solanum torvum* L., *Synedrella nodiflora* (L.) Gaertn., *Teramnus uncinatus* (L.) Sw., and *Wedelia trilobata* (L.) Hitch.

Class III is a group of weeds characterized by Curve III, the major representative being *Cyperus rotundus* L. (nutgrass). Sufficient control was usually obtained with 0.15 per cent sprays. Other plants belonging to the same group are: *Chamaescyce* spp., *Crotolaria retusa* L., *Malachra capitata* L., *Portulaca oleracea* L., *Sida* spp., *Trianthema portulacastrum* L., and *Vernonia cinerea* (L.) Less.

Class IV comprises a group of plants which are relatively insensitive to 2,4-D sprays. Grasses are the most typical representatives of this group. However, the following nongramineous plants were also found to be resistant: *Aeschynomene* spp., *Aloe vulgaris* L., *Bradburya pubescens* (Benth) Kunth., *Bryophyllum pinnatum* (Lam.) Kurtz., *Chamaecrista* spp., *Dieffenbachia seguine* (Jacq.) Schott., *Emelista tora* (L.) Britton and Rose, *Indigofera suffructicosa* Mill., *Jussiaea angustifolia* Lam., *Meibomia supina* (Sw.) Britton, *Mimosa pudica* L., *Opuntia dillenii* (Kerr-Gawl) Haw., *Persicaria punctata* (Ell) Small, *Petiveria alliacea* L., *Urena lobata* L., *Xanthoxalis corniculata* (L.) Small.

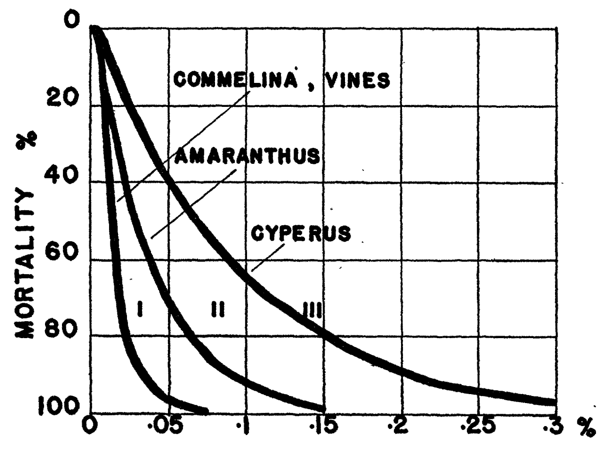

FIG. 1

The action of 2,4-D differs considerably from that of weed killers of the conventional type. The latter act rapidly, have a burning action on the foliage, but often do not damage the growing point sufficiently to prevent regeneration. On the other hand, 2,4-D penetrates inside the plant and without the typical leaf-burning destroys the growing regions in the course of a few weeks. In *Commelina* the growing point and the intercalary growth regions are destroyed. In *Cyperus* the well-protected growth region, located within the base of the leaf sheaths and 5 cm. or more below the surface of the soil, is decayed, while at the same time the leaves show no more serious outward sign of damage than yellowing.

[1] Converted into the more water-soluble ammonium salt by the addition of NH_4OH on an equimolecular basis.

[2] Applications were made to young weed plants, since it was found that mature plants are generally relatively insensitive.

[3] Cost of chemical only, applied at a rate of 50 gallons per acre. Depending upon the type of weed infestations, applications varied between 50 and 250 gallons per acre.

This preferential action on the growing region suggests that 2,4-D owes its effectiveness to competitive action with the plant's native growth-regulating substances. The fact that 2,4-D itself has definite growth-regulating properties (*1*) further strengthens this assumption.

Although in practice 2,4-D is sprayed on the surface of weeds rather than on the soil, some of it is bound to come in contact with the soil. In order to determine spray residues in soils, a test was devised which was based upon the high sensitivity of radish seedlings to 2,4-D. When radish seed was germinated on cotton soaked in 2,4-D solutions, it was found that concentrations as low as 0.1 ppm cause a striking reduction in root and hypocotyl growth in comparison to seeds germinating in water. A similar effect was found in radish seedlings germinating in soils which had been sprayed with 2,4-D. Under the conditions of our experiments 2,4-D was detectable in soils up to three weeks after 0.15 per cent solutions were sprayed directly on the soil at a rate of 300 gallons per acre, and up to five weeks when 0.3 per cent solutions were applied.

Reference

1. ZIMMERMAN, P. W. *Cold Spr. Harb. Sympos.*, 1942, **10**, 152–157; ZIMMERMAN, P. W., and HITCHCOCK, A. E. *Proc. Soc. hort. Sci.*, 1944, **45**, 353–361; VAN OVERBEEK, J. *Science*, 1945, **102**, 621.

Control of Ragweed Pollen Production With 2,4-Dichlorophenoxyacetic Acid[1]

FREDERICK G. SMITH, CHARLES L. HAMNER, and ROBERT F. CARLSON

New York State Agricultural Experiment Station
Cornell University, Geneva, New York

In surveying the selective herbicidal action of 2,4-dichlorophenoxyacetic acid, Hamner and Tukey (*2*) found that ragweed was among the more sensitive of the common weeds. Since ragweed is probably the most important cause of pollen allergy, its control is of great importance both as an economic and a public health measure. It was desirable, therefore, to investigate further the application of 2,4-D to ragweed control and to point out the practical possibilities.

In many urban areas in the East and Middle West before the war considerable effort and expense was put into campaigns to eradicate ragweed by cutting or treatment with various herbicides. The success of this means of controlling allergy due to ragweed pollen, and public interest in it, could undoubtedly be greatly increased by the availability of a cheaper, more effective method. Grigsby (*1*) has recently reported the use of several of the newer herbicidal compounds in ragweed control and has suggested that 2,4-D may be more effective. The essential requirement of any method, as Grigsby points out, is to prevent the formation or shed of pollen; but it is also desirable (1) to cause as little damage to other vegetation as possible, (2) to leave no residue toxic to animals, and (3) to require the minimum in cost of materials, time, and equipment.

[1] Journal Paper No. 646 of the New York State Agricultural Experiment Station, Cornell University, 20 September 1945.

RESULTS

Beginning on 26 July, plots 5 yards square were treated at weekly intervals in three locations where both eastern species of ragweed, *Ambrosia artemisiifolia* L. and *A. trifida* L., were growing abundantly among other common weeds. The treatments were made by water sprays of 1,000 ppm of 2,4-D containing 0.5 per cent Carbowax 1,500, as described by Mitchell and Hamner (*4*), and were applied with a 5-gallon knapsack sprayer at the rate of about 100 to 200 gallons per acre. Notes on the stage of flower development at the time of treatment and frequent observations of the effects were made to determine the latest safe time for treatment to prevent pollen formation or shed.

At the time of the first series of treatments the majority of plants had racemes varying from a few millimeters to 20–30 mm. in length. Within 24 hours these plants showed pronounced epinasty and twisting of pedicels, leaves, and stem tips. By the fourth day the twisting was more severe, growing points were enlarged, longer racemes were pendant, and a few lower leaves were chlorotic. By the fourteenth day none of the involucres had opened, and no further development of the flowers had taken place. Many plants showed extensive swelling and splitting of stem tips and the death of lower leaves. By the twenty-eighth day (23 August) the tops of about half of the smaller plants were dead, and larger plants showed typical red and yellow fall colors and were dying back from the tips. Controls at this time had developed normally and were shedding pollen.

At the time of treating the second series of plots (2 August) some of the racemes were fully developed and involucres were starting to open. Symptoms developed similar to the first treatment, and by the twenty-first day (24 August) some plants were dead, and there was no sign of pollen shed. Most of the involucres had not opened, and in those which had, the pollen sacs were dead.

At the time of the third series (10 August) most of the involucres were open, and some of the pollen sacs were mature. Eighteen days later (28 August) the younger racemes and tips of the older ones were dead, and no pollen had been shed, but at the base of the