

CHEMICAL WEED KILLERS*

THEIR POSSIBLE USE IN NATAL CANE FIELDS

By A. McMARTIN.

The use of chemicals for the destruction of weeds has been the subject of experiment in many countries for years, and in some has passed from the experimental stage into field practice.

Herbicides used in the past have included sprays of solutions of sodium arsenite, sodium chlorate and other materials toxic to plant life, and various types of oil sprays. These act as contact sprays; but in addition some, for example the arsenite and chlorate herbicides have soil sterilizing properties.

Selective Herbicides ; Hormones.

Of recent years interest has been intensified in chemical weed-killers by the discovery of the herbicidal properties of substances which naturally occur in plants in very low concentrations and which regulate various processes connected with growth. Although these substances have been known for a long time, it has only recently been discovered that if they are applied to plants at certain concentrations (higher than the natural one) they cause an upset of the physiological processes; starch formation is stopped and food reserves in the plant are used up; growth is arrested; the leaves may curl up, the stems twist and the plant eventually dies. Further, it was noticed that these phenomena only occurred to a marked extent on broad-leaved plants—members of the grass family (with few exceptions) were unaffected, or affected only to a small extent at the concentrations used on the former class of weeds. These weed-killers are thus selective, and can be used for killing susceptible broad-leaved weeds growing in a crop belonging to the grass family—pastures, cereals, and sugarcane.

They can be made synthetically, and at present two have been mainly used, viz., 2.4.D, an abbreviation for 2.4.-Dichlorophenoxyacetic acid, and methoxone, an abbreviation for sodium 4-chloro-2-methyl phenoxyacetate.

These herbicides may be used either as a dry dust or as a spray; the latter is much more effectual.

Conditions Required for Good Results.

All weeds are not equally affected, some being easily killed, while others are resistant; moreover, their susceptibility depends upon their stage of development and the weather conditions at the time of application.

Most of the susceptible weeds are easily killed in the young seedling stage, (when the fourth or fifth

leaf is showing), or when active growth is proceeding, for example, after rains.

Mortality also is quicker at higher temperatures; 2.4.D in particular is not so effectual at low temperatures, nor should it be applied in rainy weather; methoxone, however, has been found satisfactory at low temperatures, and when heavy rain has fallen after application.

Some perennials are more easily killed at or near the flowering stage, e.g. bindweed.

Generally, weeds are more susceptible under good growing conditions, and less susceptible in hot dry conditions.

Different Formulations of Herbicides.

Methoxone is obtainable as a dry powder at different concentrations for dust applications, or as a liquid for diluting to the spraying concentration. It is sold under the trade name "Agroxone."

2.4.D is prepared in different ways for use; there are four principal formulations, viz.—

1. 2.4.D as free acid, or crude 2.4.D. This is insoluble in water, and only slightly soluble in oil, hence cannot be used as a spray, but is suitable for dusting.
2. Sodium and ammonium salts of 2.4.D. These are soluble in a large volume of water, and can therefore be used for dilute sprays, applying large quantities of liquid per acre (20 to 100 gallons per acre).
3. Amines of 2.4.D. These are concentrated liquids, completely soluble in water, and are more effectual than the sodium and ammonium salts, and are the most selective forms. They may be used as dilute sprays or as concentrated sprays using a smaller volume per acre (2 to 10 gallons of liquid).
4. Esters of 2.4.D. These are soluble in oil, and are used as an emulsion or oil concentrate. They are somewhat volatile, and may damage susceptible plants in the vicinity of their use. Their greatest advantage appears to be on woody plants. They are expensive and should be treated with caution.

Amount to use.

The amount of hormone herbicide to use depends upon the susceptibility of the weed, and the conditions under which it is applied, but it should always be borne in mind that, whatever form is used,

the important matter is the quantity per acre of the active ingredient—as methoxone or 2.4.D—and not the actual concentrations used.

Easily-killed weeds are destroyed by 1 lb. per acre of the active principle used in a liquid form; if used as a dry dust 2 lbs. should be used, and all calculations should be made using these doses as a basis—thus concentrated sprays and dilute sprays should give the same amount per acre, by using low-gallonage and high-gallonage methods of application. For example, spraying 2.4.D at 100 gallons per acre requires a 0.1 per cent. solution (1 lb. of 2.4.D in 1,000 parts of water, or 100 gallons), whereas using 10 gallons per acre requires a 1 per cent. solution (1 in 100 parts of water, or 10 gallons).

The first experiments carried out here were with dusts only, it being then considered that large-scale applications of sprays using perhaps 100 gallons per acre would limit their use on a large scale. Since the introduction of concentrated sprays, however, in conjunction with field atomiser spraying outfits which use little liquid per acre—say 5 to 10 gallons—the position has been altered, and sprays are now favoured. Applied in liquid form, hormone sprays are considered twice as effectual as the dusts. Indications also are that the most effectual form of 2.4.D is the amine formulation.

In purchasing the proprietary brands of these weed-killers, it should be ascertained whether the active ingredient is methoxone or 2.4.D, and in which form the latter exists. This information is usually supplied on the container, as well as instructions for dilution.

As stated before, whatever dilution is used, the amount per acre should supply 1 lb. (or nearly so) of actual 2.4.D or methoxone. This quantity should be increased according to the type of weed, severity of weed infestation and type of crop.

The amount of spray to use—low-gallonage or high-gallonage—must be decided by conditions. It is generally recommended that for lawns, or roadsides or other situations where damage to nearby susceptible plants might be caused and the drifting of spray must be minimised, a low concentration applied as a coarse spray, using a larger volume, should be used.

For large-scale applications, however, the low-gallonage spray using a concentrated solution is usually recommended. This eliminates the carrying of large quantities of water, and large-scale spraying outfits are being placed on the market which it is claimed use as little as 5 gallons of liquid per acre. For this type of spray the amine formulation of 2.4.D appears very suitable.

Susceptibility of Weeds.

The following shows the relative susceptibility of various weeds which have been present in trials at the Experiment Station.

1. Very susceptible; easily killed by the basic dose (1 lb. active ingredient per acre, in liquid form):—

Wandering Sailor, *Comelina nudiflora*, killed by $\frac{1}{2}$ lb. per acre. This is a troublesome, creeping weed (often erroneously known to planters as Pigweed), difficult to eradicate by cultivation, but very easily destroyed by these hormone herbicides.

Dandelion, *Taraxacum officinale*.
Thorny pigweed, *Amaranthus spinosus*.
Chickweed, *Stellaria media*.
St. Paul's herb, *Siegesbeckia orientalis*.
Horseweed, *Erigeron canadensis*.

2. Susceptible; affected by the basic dose, but some may recover; requires double strength to obtain good mortality.

Goatweed, *Ageratum conyzoides*.
Blackjack, *Bidens pilosa*.
Devil's thorn, *Emex australis*.
Prostrate spurge, *Euphorbia inaequilatera*.
Wild hibiscus, *Hibiscus trionum*.
Mexican clover, *Richardsonia pilosa*.
Black nightshade, *Solanum nigrum*.

3. Slightly susceptible; a few killed, others retarded in growth, and many recover, after using double strength; may require second application.

Acalypha eckloni.
Bachelor's button, *Gomphrena globosa*.
Melothria maderaspatana.

4. Perennials requiring repeated applications:—

Nut grass, Water grass, *Cyperus esculentus* and *C. rotundus*. The leaves are killed by four times the basic dose (i.e. 4 lbs. per acre) but regrowth occurs from the underground tubers, and second and third applications have been found necessary; even then the weed is not completely killed out.

5. Resistant, at least to all but high doses:—

Ambrosia artemisiaefolia.
Euphorbia hirta and *E. hypericifolia*.
Pennywort, *Hydrocotyle asiatica*.
Grasses (*Eleusine indica* became yellow after 0.2 per cent. 2.4.D).

It should be realised that the above observations are derived from only a few trials, and that different results might be obtained under other conditions; thus many weeds not classed above as very susceptible have been found to be so in other areas.

Effect on Sugarcane.

In none of our trials has cane been affected, even in high doses.

Ultimate Effect of the Use of Selective Weed-killers.

Where the weed problem is one of mainly susceptible weeds in a crop resistant to the action of these weed-killers, their use is being found invaluable and economic.

The problem is different, however, where the weeds in a crop are a mixture of susceptible and non-susceptible types; among the latter, grass weeds are the greatest problem, as when they occur in any quantity they take possession of the treated area after the susceptible types have been killed out, and in our experiments at the Experiment Station where a mixed weed population was present for a start, the ultimate effect was to change this mixed population into a stand of resistant grass weeds, which then have to be destroyed by other means. If, of course, the cane has reached the stage of closing in further weed destruction might not be required.

Owing to their possible ultimate effect on the weed problem, then, the large-scale use of selective weed-killers must at present be regarded with caution. For application on particular areas—"spot application"—however, where patches of weeds occur which are difficult to eradicate mechanically but are susceptible to these chemicals, they will serve a useful purpose, and in fields where the numbers of resistant types are small, and could be dealt with by other means after the susceptible types have been killed out.

A development which promises to alter the position, however, is the use of a mixed spray, in which the selective weed-killer is diluted with a general contact spray of the oil type. Such mixtures, however, will require to be used with care to avoid damage to the crop, but experiments will shortly be undertaken here with the use of such mixtures.

Cost.

Selective weed-killers based on 2,4-D at present appear to range from about 8s. to 12s. per pound of that ingredient; methoxone is more expensive.

Method of Application.

Dusts may be applied by hand or by dusting machine. Sprays may be applied by a knapsack sprayer for small areas or "spot" application; but for larger areas spray booms are being introduced which can be mounted on a tractor.

Acknowledgments.

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killers, and to Miss H. L. M. Forbes of the Botanical Station, Durban, for assistance in identifying many of our local weeds.

Summary.

Weeds vary in their susceptibility to the selective hormone herbicides, and experience must be gained under local conditions to ascertain their effectiveness, taking into account the growth conditions, stage of development of the weed and amount of weed-killer used.

Sprays are more effectual than dusts.

The amount of active ingredient per acre is the important factor, not the actual concentration, and quantities used should be based on 1 lb. per acre of that ingredient in liquid form for the easily-killed weeds.

The presence of resistant weeds, especially grasses, introduces a factor into the problem which requires careful consideration, if our weed population is not to be eventually converted into one of pure stands of weeds which will not be eradicated by these weed-killers.

The use of selective weed-killers mixed with contact sprays might be the solution to this problem.

Experiment Station,
South African Sugar Association,
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Dr. McMARTIN explained, before reading the paper, that it was written primarily to answer questions put to the Experiment Station, chiefly by people who had read the manufacturers' advertisements on chemical weed-killers.

The PRESIDENT said that chemical weed-killers might be a big labour-saving device on the farm. Information desired about them was the scientific observation as carried out by Dr. McMartin and his staff, and not that obtained from the manufacturers. He felt that although much useful information had already been gleaned, a proper survey of the weed population of the cane fields was most necessary.

Dr. BATES stated that it would be remembered that the original development of these substances was during the war, when it was thought possible to use them against the enemy's food crops. This proved too difficult, however, and information about them was then released for civil use.

In Rhodesia these selective weed-killers had been tried, and there, too, it was preferred to examine new products very carefully.

A rather important point was that these weed-killers had a nasty habit of remaining in some portion of spraying machines, perhaps being absorbed by

leather or rubber parts. When the machine was used with other sprays one sometimes got most unlooked-for results. That was brought forcibly to notice in the case of tobacco, which had exhibited symptoms similar to disease.

The possibility of these hormones having an effect on soil had also to be fully explored, and it was as well that people should know there were dangers in their use. They had enormous practical possibilities, but required to be used with caution under practical advice.

Dr. DODDS asked if it was possible to introduce any substance such as a nitro group into the molecule which would make the weed-killer effective against the grass-like weeds.

Dr. McMARTIN replied that there were grass-killing hormones and that he had tried them on "water-grass," although this was not a true grass.

Dr. DODDS said that it appeared that the cost of eradicating weeds by means of these chemicals would be from eight to fourteen shillings an acre, and he enquired if Mr. Fielding could give an approximate figure of the cost of removing weeds by manual labour.

Mr. FIELDING replied that he could not state a figure for manual labour; but with the Ferguson machinery, he thought the cost would be in the neighbourhood of twenty-five shillings for fifteen acres with one scarifying.

Dr. McMARTIN, in reply to a question by Mr. Lewis, stated that these weed-killers could be used by mixing them with the soil; and, in reply to Mr. Duchenne, said that he had tried sodium chlorate weed-killers with very indifferent and erratic results.