

FURTHER DEVELOPMENTS IN CHEMICAL WEED-KILLERS

By A. McMARTIN.

In a paper given last year (McMartin³), the possible use of chemicals to control weeds in canefields was discussed, with particular reference to the hormone types of weed-killers, and the opinion was expressed that, while there would be many instances in which these materials would be of benefit, there would be many situations in which their use would be restricted owing to the presence of large numbers of weeds not affected by them—in particular members of the grass family.

Similar situations have been experienced elsewhere, and have led to the examination of other chemicals for their toxicity to grasses, with the hope of developing a weed-killer which would have a much wider application than the hormones in areas where the weed flora consisted of a mixture of types resistant and susceptible to these hormones.

In Puerto Rico the problem has been investigated by Crafts and Emanuelli^{1,2} who have advocated the control of grasses by means of a fortified-oil spray, to which 2.4.D. may be added to eradicate weeds not affected by the oil. Various formulations of oil sprays have been given by these authors, and recent experimental work undertaken at Mount Edgecombe has mainly been towards the formulation of similar types of sprays with material which is available locally, and the testing of these on our canefield weeds.

The basis of these sprays was the fact that unrefined diesel oil was toxic towards certain plants, but that, as such oil became more and more refined, so its toxicity decreased, and the further discovery that the toxic properties could be attributed to the aromatic substances which are removed in the refining. Diesel oil, therefore, with its aromatic content increased by the addition of these aromatic substances, forms the basis of one type of spray; but its toxicity is still greatly increased by the addition of sulphur, pentachlorophenol or dinitrophenols. The material used in our trials here has been pentachlorophenol, and the oils have consisted of diesel oil alone, diesel oil-aromatic oil mixtures, diesel oil-paraffin mixtures, and aromatic oil alone. Some mixtures were for use undiluted, while others were used diluted by emulsifying with water; in these latter cases the addition of a stabiliser or wetter, or both, to the emulsion becomes necessary.

Our trials so far have not demonstrated conclusively that the use of aromatic oil alone as the solvent for the pentachlorophenol is better than a diesel oil-aromatic oil mixture, but results appear better for the first few days after the spray has been

applied to the weeds, indicating a quicker mortality, if not eventually a larger one. What has been demonstrated forcibly, however, is the necessity of the pentachlorophenol in an oil spray when used dilute as an emulsion, weeds sprayed with such an emulsion without this substance being apparently quite unaffected.

Based on our first trials with these oil sprays, when the use of an aromatic oil alone appear to give quicker results, the following mixture, formulated by Crafts, has been mainly used for further trials and demonstrations:—

4 galls.	...	...	...	oil of high aromatic content
2 lbs....	...	...	...	pentachlorophenol
2 lbs....	...	...	...	wetting agent (such as Stanvac wetter)

(Other stabilising and wetting materials are Teepoll and hexylene glycol, used at $\frac{1}{2}$ per cent. and 5 per cent. respectively.)

These are mixed and the pentachlorophenol dissolved by applying slight heat. This is then made into an emulsion with 96 gallons of water (a little water should be added to the oil first and emulsified, then the remainder of the water added). This emulsion is used at the rate of 100 gallons per acre, for average conditions, but this may require to be increased or decreased depending upon the nature of the weed cover, the age of the weeds, and other factors. If a hormone such as 2.4.D. is also being used, it can be dissolved in the water which is added to the oil, if the sodium salt is used; but if the amine or ester formulation of 2.4.D. is used it may be added to the oil first. In our experiments all three forms have been used at the rate to supply the equivalents of 1 lb. or 2 lbs. 2.4.D. per acre.

The complete weed-spray as used in our trials, therefore, consists of the fortified oil emulsion plus one form of 2.4.D., and it soon became apparent that the mixture of the two types was greatly superior to the use of either alone in a field of mixed weeds, particularly where grasses and nutgrass occur.

Some species which are tolerant towards the oil spray, e.g., wandering sailor (or pigweed), are killed by the 2.4.D., while species resistant to the latter are affected by the oil spray. Nutgrass, which required 4 lbs. of 2.4.D. alone per acre to destroy the tops, is susceptible to 1 lb. of 2.4.D. in the oil mixture, and most grasses appear to be severely affected.

Sugarcane itself, of course, while unaffected by 2.4.D., is affected by the oil spray; but, if spraying is done when the cane is high enough to have trash

forming on the lower joints, the most damage that has so far been noticed under normal spraying conditions in the field has been the production of a few burned spots on some leaves, which are barely obvious. Some stools of cane which as an experiment were thoroughly sprayed were at first completely burned, but the growing points were not damaged and after a few weeks they were completely green again.

Small field trials carried out recently in canefields where the cane has been over two feet high, and where a mixture of blackjacks, ageratum, pigweed, amaranthus, nutgrass, grasses, and many other common weeds have occurred, have indicated that a clean weeding can be done, with practically no damage to the cane, with the oil emulsion used at 100 gallons per acre, plus 1 lb. of 2.4.D.

There yet remain to be discovered, however, the best manner in which these chemical weed-sprays can be employed and the most economical manner of their utilisation; and field techniques would require to be varied according to the weed problem presented to the grower. For example, many broad-leaved weeds are susceptible to a hormone spray alone—pigweed is extremely susceptible and can be eradicated with $\frac{1}{2}$ lb. of 2.4.D. per acre—and hence many fields where the weeds are mainly hormone-susceptible could possibly be profitably sprayed with that type of weed-killer alone for a first spray, to be followed up later by a spray of the oil emulsion type, with perhaps a hormone added, which may only require to be used in spots where the weeds are left. As more than one spraying would usually require to be done in any case in a field, it would in such cases be cheaper to use the combined spray only after the weed population had been reduced by the hormone spray—i.e., using the former as a “touch-up” spray.

On the other hand there are situations where an oil spray could perhaps be used without dilution, e.g., in clearing tramlines, ditches, etc., where the weed population often consists mainly of the grass family. So far we have considered only the possibility of these chemical weed-sprays as controls for growing weeds.

A very important aspect of chemical weed control, however, is that which owes its existence to the fact that so many weeds are more susceptible in their earliest stages of germination than at a later date. Many members of the grass family, for example, which are tolerant to the hormone sprays when well established, are affected if some of that material is in the soil in which the seed germinates, and the susceptible broad-leaved weeds cannot produce seedlings from seed in such soil, or young seedlings are produced and quickly die off. The phenomenon has led to the technique known as the pre-emergent spray.

The Pre-emergent Spray.

This promises to be the most important development in the use of chemical weed-killing, and can be used where the crop is one tolerant to the weed-killer used. It consists simply of treating this field after the crop has been planted, but before the weeds have appeared, and it has the effect of permitting germination to occur under conditions of a considerably reduced weed growth. Thus, spraying with 2.4.D. has been found elsewhere to keep germinating fields free from weeds for periods up to eight weeks, without materially affecting the germination of the cane.

Pre-emergent trials carried out here have shown that almost complete freedom from certain weeds has been obtained by spraying the bare ground, and once again the superiority of the mixed oil emulsion-hormone spray over the hormone spray alone has been demonstrated.

The most difficult weed to control appears to be nutgrass, but the numbers which do appear above ground can be considerably reduced by means of a pre-emergent spray; while pigweed, blackjack, ageratum and others can be reduced to negligible proportions. The number of grasses which appear above ground are markedly reduced, and many that do appear are unhealthy.

Pot tests carried out here have failed to show any effect on cane germination of spraying the combined spray on the soil at the rate of 100 gallons per acre.

The possibilities of a technique such as this are considered very promising and field trials along these lines are now being carried out.

Spraying Technique.

The type of sprayer used at present is the knapsack type, delivering a spray under pressure by means of a pump in the sprayer. With the type of nozzle at present in use, i.e., that supplied with the sprayer, only spraying rates using large amounts of spray per acre—100 gallons—have been possible; it is possible, however, to obtain nozzles which give a finely atomized spray and use low amounts of liquid per acre—down to 10 gallons, or less. This saves considerably on the amount of water to be carted, and as far as the hormone spray is concerned the important matter is the amount applied per acre, i.e., 1 lb. or 2 lbs; whether in 10 gallons or 100 gallons is immaterial. The effect of low gallonage concentrated oil emulsion spraying has not yet been tried.

The possibility of pre-emergent spraying of course opens the road to large-scale mechanised power-spraying, and several machines are being placed on the market which are either drawn by, or mounted on, a tractor for this particular purpose, capable of spraying up to 30 feet of ground and using about 10 gallons of liquid per acre.

A complete weed-spraying programme would thus consist of pre-emergent spraying, mechanised where possible, to be followed as required at later dates with spray gangs operating in the cane rows with portable sprays.

Cost of Weed Spraying.

At present it would be premature to give anything but an approximation of the cost of the materials required for weed-spraying.

The hormone 2.4.D. can be purchased for about 8/- per pound from several manufacturing firms; the prices for the fortified oils appear to depend upon several factors, but one interested company has suggested that at present the cost would be just over £1 per acre, so that the combined spray using 1 lb. of 2.4.D. per acre should at present not cost more than £1 10s. 0d. per acre, using 4 gallons per acre of the oil. There is thus at the outset this initial cost of material which is not involved in mechanical or hand-labour methods of weeding, and of course there is a capital outlay on spraying equipment.

On the other hand, spraying methods promise to be quick and require less labour than other methods; and in times of labour shortage they might with advantage be used either when available labour cannot cope with the weed growth, or to reduce the number of labour units used in weeding to release them for other jobs.

It is not intended to present a picture of our weed problem completely solved by means of chemical weed-sprays, but it is felt that the results now obtained are sufficiently promising to draw attention to their possibilities and to recommend to growers that where possible they try this method for themselves.

It is with this object that this paper has been written; as several trials are still under observation it has not been possible to write up fully an account of the results.

Thanks are due for supplies of the materials used in making the sprays to Messrs. Shell Chemical Co., Messrs. Standard Oil Co., and Messrs. Cooper and Nephews; and the writer wishes to acknowledge the work done by Mr. N. C. King of the Experiment Station in carrying out the experimental work on this subject.

REFERENCES.

¹ Crafts, A. S., and Emanuelli, A. (1948): Weed Control in Sugarcane. *La Revista Azucarera*, 31.

² Crafts, A. S., and Emanuelli, A. (1948): Combination of 2.4.D. with Fortified Oil-Emulsion Contact Herbicides. *Bot. Gaz.* 110, 148.

³ McMartin, A. (1949): Chemical Weed-killers--Their Possible Use in Natal Canefields. *Proc. S.A. Sugar Tech. Assoc.*, 23, 89.

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The PRESIDENT said that chemical weed-killers were becoming increasingly important. Some indication of what might develop was given a few years ago, when the principle of hormone control of weeds was first suggested, although the cost was then prohibitive and the substances known could control only certain types of weeds. We were now, however, in sight of an important economic method for the control of all weeds in cane fields. There were experiments on view in this matter at the Experiment Station.

He enquired if the word "aromatic" had been used by the author in its chemical sense referring to substances such as benzene.

Dr. McMARTIN replied that the word "aromatic" was used in its chemical sense.

Mr. BECHARD endorsed the President's view of the importance of the subject, stating that with the present shortage of labour, weeding was the biggest problem of the grower. It was illuminating to see what could be done by spraying, and he was particularly interested in the pre-emergent spray. It had occurred to him that the best time to tackle weeds was just prior to ploughing. However, weeds of the type of "water grass" are somewhat fostered by ploughing, and he enquired if that type of weed and also the "wild gooseberry" could be controlled by the pre-emergent spray. He also wished to know what quantity of spray would be required in a heavy growth of weeds. The control of weeds in the line, in particular, was a very big problem.

Dr. McMARTIN replied that in the case of "water grass" he thought that the better technique might be to plough it in and then spray. He had found that with this method a considerably smaller amount germinated. As far as the wild gooseberry was concerned, results had not been quite conclusive with 2.4.D, although the weeds were considerably reduced.

Opinions differed as to whether it was advisable to spray the rows of cane themselves, or in between the lines where machines could be used for weeding. If one wished to economise it might be better to spray in the lines only, although he considered the best method would be to use a pre-emergent spray followed by spraying in the rows.

The quantities of spray indicated in the paper were calculated on the area of ground covered, but when there was a very dense, rank growth of weeds, more would be required. This could be balanced, however, by using less where the weeds were young and succulent.

Dr. BATES asked how long the pre-emergent spray remained effective.

Dr. McMARTIN said that he had no data about the particular spray mixture he now used, but with 2.4.D

as used in Hawaii and Louisiana it was said to keep the field clean for eight weeks. He did not know how often it would be necessary to spray again after that time had elapsed.

Mr. DU TOIT stated that he had seen a reference to the sucrose yield from cane in Cuba being increased by the use of 2.4.D. It had been found that when cane had been sprayed with hormones some ten days before cutting, the sucrose content had been increased by between 1.8 and 2 per cent. on cane. Experiments along such lines here would be useful. Hormones, after all, were growth regulators.

The PRESIDENT pointed out that the original application of hormones was made with a view to stimulating normal growth, and their effect in producing other and excessive stimulation was a secondary development.

Dr. McMARTIN said that in field trials there appeared to be a certain amount of stimulation of growth in some weeds that were left. When "water

grass" was sprayed, the few plants which came up afterwards were of a darker green colour.

Dr. BATES drew attention to the difficulty of ridding spraying equipment of these hormone chemicals. There was a certain amount of danger in using spray apparatus for other purposes, after use with these substances.

Dr. McMARTIN agreed with this view and stated that plants often shewed peculiar symptoms, but in cane they would be safer than in general use, or for market gardens.

He had experienced difficulty in obtaining a small sample of the ester form of 2.4.D. The suppliers were exercising some caution before putting this form on the market, because of its volatility. One could visualise that if spraying was done with this form in the vegetable garden, and the vegetables died; chemical weed-killers generally would be given a bad reputation.