WEEDKILLERS IN HORTICULTURE

By - Mr. G.A. Helson, Research Superintendent
of the Horticultural Division.

* * *

Weedkillers may be classified as falling into one or other of two groups - (1) Non-hormone type; (2) Hormone type. Those belonging to the former type are used fairly extensively in commercial horticulture in New Zealand, while those belonging to the second group are not used to any great extent yet because in nearly all the crops grown in commercial horticulture are very susceptible to injury or because growers fear that injury to crops may follow their use.

(1) NON-HORMONE TYPE:

(i) Sulphuric acid is used extensively for the weeding of onion crops.

(ii) Power kerosene is used for the weeding of carrot and parsnip crops, applied when the plants are in the four-leaf stage. If used later, tainting is likely to result, and each drum of kerosene must be tested before use because of the variation in phytotoxic effect - one of the chief drawbacks in the use of power kerosene.

(iii) Peas are weeded by the use of sodium dinitro-ortho-cresylate, a coal tar product marketed in New Zealand under the trade name of Sinox and in Australia under the trade name of Dinoc. Onions and leeks have also been treated with this material.

(iv) The chlorate and arsenite of sodium have been used as weedkillers in lawns and bowling greens, but these have largely been superseded by the use of hormone weedkillers. Arsenic pentoxide has also been used extensively on lawns for the control of Onchunga weeds etc.

(2) HORMONE TYPE:

Within the last twenty years great developments in weed control, however, have taken place since the independent discovery in England and America of the lethal effect of growth-stimulating substances (particularly phenoxyacetic acid derivatives) applied in comparatively high concentration (1,2,4,6, and 8). These substances are generally effective on dicotyledonous plants but not on monocotyledonous plants. Templeman and Sexton (10) discovered that arylcarbamic esters have the reverse effect, i.e. will kill monocotyledonous but not dicotyledonous plants.

The two substances which have been most widely used in practice as selective weedkillers are 2,4-dichloro-phenoxyacetic acid (2,4-D), in America, and 2-methyl-4-chloro-phenoxy-acetic acid (Methoxone), in England.

The new weedkillers may be applied as salves, aerosols, dusts and sprays. Aerosols have been little used although Hamner and Tukey (2) report this method to be very effective. Marth (5) reports that dust application of 2,4-D is less effective than spray applications.

Penetration may take place through the roots or the cuticles of stems and leaves, through the testa of seeds, or through exposed surfaces on stems or roots. Generally plants are more susceptible to phenoxyacetic acid derivatives at higher temperatures when there is active growth and maximum downward translocation of carbohydrates. These conditions can best be satisfied by spraying just before the plants are in full leaf, when growth is still active and the leaves are vigorously producing carbohydrates. This applies particularly to perennials which have reserve stores of carbohydrates in underground organs; annuals or seedlings have no such reserve, consequently seedlings in general are readily affected by hormones.

Both phenoxyacetic acid derivatives and carbamates are generally

specific in their action and affect susceptible plants when applied in minute doses. It is amazing how bindweed (*Convolvulus arvensis*), fairly resistant to sodium chlorate or arsenic pentoxide applied at 50 pounds per acre, crumple up on being sprayed with 2,4-D applied at the rate of one half pound per acre.

Little is known of the mechanism of action of carbamates and phenoxy-acetic derivatives. The former affect cell division. The response of plants to hormone-like substances varies - plants may become epinastic, their tissues proliferate and split; or parts may become chlorotic, wither and die. Tukey et al. (11) report that in bindweed sprayed by 2,4-D pollen grains were disorganised, flowers arrested in development, chlorophyll formation was checked and cell division was activated in the large vascular bundles of the leaves. The majority of the cells in the leaves were plasmolysed; cell division was greatly increased in all cambial zones and phloem regions of the stem and rhizome. Swanson (9) concluded that meristematic tissues and those capable of reverting to meristematic conditions are most readily affected by 2,4-D. The characteristic effects of hormones are distorted growth, production of galls or roots on stems and depletion of carbohydrate reserves, and greatly increased rates of respiration. These aspects are frequently followed by death of the cells.

Weedkillers of the hormone type are non-poisonous, non-corrosive, and can be used successfully for high volume or low volume application.

In the soil hormones are apparently oxidised and disappear after periods varying from about 30 to 90 days, depending upon the amount applied, and the temperatures. Up to the present, there is nothing to suggest that hormones will accumulate in the soil until they reach the toxic proportions. Temporary soil sterilisation may, however, result from heavy applications to the soil. While cereals and grasses are usually not affected within a few weeks after treatment, beans, peas, lettuces, tomatoes, cabbage, broccolli, sugarbeet, lucerne and many other crops are extremely sensitive to small quantities of hormone-like weedkillers and crop failures may occur in these circumstances.

Hormones are not poisonous to man or animals, even if taken in fairly large doses, and there is no danger in using them on pastures or in other areas where stock have access. When application is made to pastures, however, great care should be exercised to prevent spray drifting on to other susceptible crops. When poisonous plants are being sprayed, stock, nevertheless, should be excluded from the area, as there is considerable danger of such plants being made palatable by the application of hormone weedkillers (3).

Water-soluble types are, on the whole, less effective against perennials than the oil-soluble esters, but they are very effective against a wide range of annuals and their selective action is more marked.

THE INDISCRIMINATE USE OF HORMONE WEEDKILLERS: The effect of hormone-type weedkillers on susceptible plants makes their use dangerous to some plants, and during the past year the Horticulture Division of the Department of Agriculture has received many reports of damage to horticultural crops from various parts of New Zealand. Plants affected by direct application of spray, by spray drift or from vapours arising from recently treated areas - over distances as far as half a mile - and by the use of spraying equipment previously used for the application of hormone-type weedkillers, include grapes, tomatoes, kumeras, pear, lemon, fig, pumpkin, barberry, flowers and shrubs. Grapes and tomatoes, both outdoor and under glass, are particularly susceptible. Thus only with the greatest care should weedkillers be used anywhere near flowers, shrubs, vegetables and other valuable plants. Applications should be made only on a very calm day to prevent drift, and valuable plants should be protected. The use of newly-developed, non-volatile, hormone-type weedkillers will do much to prevent damage to such crops. Slight injury to plants is first detected, in most instances, in the leaves of the plant, but this may not appear until one or two weeks after application. Severe injury is usually apparent in a few days. Sprayers or other equipment used for the application of hormone weedkiller must be thoroughly cleansed. The only really safe method is to have separate spraying equipment used only for the application of the weedkillers.

Orchard (7) lists the plants susceptible to hormone weedkillers. With few exceptions, these include most of the plants of importance in horticulture.

REFERENCES:

- (1) Hamner, C.L., and Tukey H.B. 1944 Science 100: 154-155.
- (2) Hamner, C.L., and Tukey H.B. 1944 Bot. Gaz. 106: 232-245.
- (3) Helson, G.A.H. 1950 N.Z. Journal Agric. 81(4): 328.
- (4) Marth, P.C., and Mitchell, J.W. 1944 Bot. Gaz. 106:224-232.
- (5) Marth, P.C., and Mitchell, J.W. 1945 Bot. Gaz. 107: 129-136.
- (6) Mitchell, J.W. and Hamner, C.L. 1943 - 44, Bot. Gaz. 105: 477-483.
- (7) Orchard, H.E. 1950 Jour. Agric. Dept. Sth. Australia, 63(6): 252.
- (8) Slade, R.E., Templeman, W.G., and Sexton, W.A. 1945 Nature 155: 497-498.
- (9) Swanson, C.P. 1946 Bot. Gaz. 107: 522-531.
- (10) Templeman, W.G., and Sexton, W.A. 1945 Nature 156: 630-631.
- (11) Tukey, H.B. et al., 1945 Bot. Gaz. 107: 62-73.

QUESTIONS AND DISCUSSION

MR. MADDEN: Barberry is still a menace in some of the inland parts of Tarinaki. Could hormones be used to kill it altogether?

Have the oil companies standardised kerosene for the spraying of carrots?

MR. HELSON: I am not sure that barberry could be affected enough for the hormones to be used as a complete control. The barberry I saw was in a hedge and had been contacted by drifting weedkiller. There was extreme distortion of the plant, a flattening of the stems, and all the new leaves were unrecognisable as barberry. However, from what I saw there would not be sufficient to say you could control barberry.

I understand the oil companies have done a great deal to standardise kerosene, but I think advice is still given that with each batch you get you should run a trial before you put it out.

DR. YEATES: In December of one year I emptied a spray pump with which I had been using 2,4-D on to a barberry hedge which had convolvulus in it. It killed the convolvulus, but the barberry was apparently unaffected. I have applied 2,4,5-T mixture to an isolated barberry, and it is apparently dead.

MR. BARKER: How dangerous would MCPA and 2,4-D be when used on pea crops?

MR. JOHNSON (Christchurch): Garden peas will apparently tolerate 3/8 lb of acid equivalent MCPA, but that was on a very small trial.

MR. MITCHELL: If there is any damage from the use of hormone weed-killers to stock, trout streams, etc., contractors leave themselves very liable for substantial claims.

MR. HELSON: As far as I know the hormones are not toxic to fishes or aquatic life, but I have seen no mention of research on the subject.

MR. MITCHELL: D.D.T. is effective as far as fish are concerned.

MR. HELSON: As far as is known hormone weed-killers are not toxic to birds and warm-blooded animals.

MR. GUNDESON: Extensive trials were conducted in the United States on 2,4-D and its effect on aquatic life. We were advised that there was no question of any danger.

MR. ROBINSON: I know of a case where there is a garden pond containing golden carp and cockabullies the children have put in. The owner used water from the pond to mix with hormone killers and the spray went back into the pond, but there was no effect whatever on the fish.

MR. BLACK: Have you any information about the use of activated charcoal to

protect susceptible plants growing close to weeds?

MR. HELSON: I have heard of the use of activated charcoal, but know of no work with it in New Zealand.

MR. SKINNER (Otago): We have used activated charcoal, and found it highly effective as a protection. I have used it on one or two garden plots damaged through contact with 2,4-D, and in all cases the plants have shown recovery. They survive after being treated fairly soon after contamination.

* * *
*