PRELIMINARY STUDIES IN THE USE OF SYNTHETIC HORMONES AS WEED-KILLERS IN THE BOMBAY PROVINCE

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In recent years considerable interest has been aroused in a new weed-killing chemical and several articles have appeared in scientific as well as popular journals advocating the virtues of this chemical variously described as "2, 4-D" "M.C.P.A.", "D.C.P.", "Hormone", "Methoxone", etc. The earliest trials with these materials, which are of the nature of growth-regulating substances, as weed-killers were carried out in England and the United States. Such promising results were obtained that within three years of its introduction 2, 4-D and allied products have become the most widely used weed-killers in these countries. Harvey and Robbins (1947) and Kephart and Evans (1948) have published lists of weeds and crops susceptible or resistant to 2, 4-D in United States of America. Similar lists are also supplied by the manufacturing firms in other temperate countries. It has also been suggested by Van Overbeck (1947) that these chemicals would prove effective in controlling tropical weeds but no detailed lists of susceptible weeds in tropical countries are available.

These weedicides are now beginning to reach India and interested parties are anxious to know how far they will prove useful in controlling the weeds commonly found here. The Economic Botanist to Government, B. P., Poona, has been supplied with small quantities for experimental purposes by some firms interested in marketing these preparations in India, during the last two years. The purpose of this article is to summarize all the information that has been obtained during these preliminary trials.

Four different preparations were tried, *viz.*,

1. Methoxone or Agroxone containing 10% sodium-4-Chloro-2-Methyl-phenoxyacetate as the active principle, supplied by the Imperial Chemical Industries.

2. Fernoxone containing 80% of the sodium salt of 2, 4-Dichloro-phenoxyacetic acid also supplied by the Imperial Chemical Industries.

3. Weed-no-more containing 40% of the Butyl ester of 2, 4-dichlorophenoxyacetic acid supplied by Sherwin-Williams Co., Cleveland, U.S.A., through Thomas Cook & Son, Bombay.

4. Weedone containing 10% of an unstated compound of 2, 4-dichlorophenoxyacetic acid supplied by May & Baker, England.

These weed-killers differ entirely in their mode of action from all chemicals previously used as weedicides in that they are not poisonous or corrosive. They were first used in very low concentrations of 1 to 10 parts per million to stimulate the growth of plants. Higher concentration of 100 to 1,000 parts per million resulted in overstimulation and a short period of rapid abnormal growth followed later by death of certain plants. Different plants respond to the action of these chemicals in different ways. Some show a twisting and bending of the stems and leaves; others show a swelling of the tops of shoots or at the nodes, with cracks developing later; still others show only a drying of stems and leaves. All these responses have been observed in the preliminary trials herein reported (Fig. 1).

Different species of weeds as well as cultivated crops show wide differences in their response to the new herbicides. Some plants are killed by very small quantities; others do not show any signs of injury when much larger doses are used. This differential response of various plants to these chemicals places them in the class of selective weed-killers. All grasses and cereals like wheat, barley, rice, *sorghum* and maize are not affected in the least. Linseed, strawberries, tea and coffee plants are likewise resistant. These weedicides can, therefore, be used in the crops mentioned above for eradicating a number of weeds without fear of harming the crops. On the other hand, crops like cotton, tobacco, tomato, sweet-potato, brinjal, chillies and all legumes are extremely susceptible. Therefore, great care must be taken to see that sprays and dusts of these chemicals do not drift on to susceptible crops in fields nearby.

With this background, we may proceed to describe the results obtained in our preliminary trials with the preparations supplied by various firms. Of these, except Fernoxone which was in powder form, the rest were supplied in liquid form. They were applied in the form of a spray. The concentrations used were 0·05%, 0·1% and 0·2% of the active ingredients. If applied at the rate of 100 gallons per acre this amounted to the application of ½ lb., 1 lb., and 2 lbs. respectively of the active constituents.

As a result of these tests which have been carried out on both actively growing and mature herbaceous weeds of each of the species mentioned, it has been possible to classify the weeds into three classes, *viz.*,

1. Susceptible, *i.e.*, those which succumb to applications of ½ to 1 lb. per acre.

2. Intermediate, *i.e.*, those which require applications of at least 2 lbs. per acre for obtaining a kill.

3. Resistant, *i.e.*, those which show no signs of injury or recover in spite of injury even when treated at the rate of 2 lbs. per acre.

The accompanying tabular statement shows the degree of susceptibility of common weeds, their response and the end result of spraying with the new weed-killers. It must be emphasized that the classification is tentative and liable to change as more tests are conducted and more information becomes available. The response of plants is conditioned by several factors of which the stage of growth of the plant and the prevailing temperature are the most important. It must also be pointed out that we have noticed no particular differences in the effectiveness of the different preparations used. Therefore, when these products are offered for sale, it would be necessary to compare the prices on the basis of active constituents contained in each product before making a final choice.

There are two weeds in the above test, which are considered very serious pests in the Bombay Province, *viz.*, *Cyperus rotundus* (*lavala*) and *Striga* sp. It is, therefore, necessary to discuss the effect of 2, 4-D products on these weeds in greater detail.

Cyperus rotundus.—Though very closely related to plants belonging to the *Gramineæ* (which are resistant to these chemicals), *Cyperus rotundus* was badly injured by a 0·2% solution of these weedicides. The treated plants showed no response till the 6th day after treatment; thereafter, there occurred a sudden drying and drooping of the leaves which resulted in the death of the plants in 10-15 days (Figs. 2 & 3). Underground tubers from treated and killed plants when planted in pots and provided with favourable conditions for germination, failed to sprout, thereby proving that the chemical had been translocated downwards. Underground shoots at depths of six inches were also killed. A critical study on the control of this obnoxious weed is underway. The preliminary trials lead us to believe that the use of these new weedicides will afford an effective method of controlling *Cyperus rotundus*, in crops like wheat, *Sorghum* and in lawns.

Striga lutea and *S. densiflora*.—The weeds belong to the *Scrophulariaceæ* and are very common phanerogamic root-parasites on *Sorghum* in the Bombay Province. So far, clean cultivation and weeding the *Striga* plants before they flower is the remedy usually suggested. In our trials, both species of

Table showing the degree of susceptibility of common weeds, their response and the end result of spraying with the new weedicides

S. No.	Name of plant	Degree of susceptibility	Response	End result of spraying
1	*Acalypha indica* Linn	Susceptible	Bending and swelling of stems	Died in 16 days
2	*Ageratum conyzoides* Linn.	Intermediate	Bending of shoots and drying of leaves	Died in 20 days
3	*Alysicarpus rugosus* DC.	Resistant	Unaffected	..
4	*Amarantus spinosus* Linn.	Susceptible	Bending of stems and yellowing of leaves	Died in 18 days
5	*Argemone mexicana* Linn.	Susceptible	Bending and parching of leaves	Died in 12 days
6	*Bidens pilosa* Linn. ..	Susceptible	Bending and swelling of stems	Died in 16 days
7	*Boerhaavia diffusa* Linn.	Intermediate	Twisting of shoots & yellowing of leaves	Died in 20 days
8	*Cassia tora* Linn.	Resistant	Epinasty of shoots	Plants recovered
9	*Cæsulia axillaris* Roxb.	Susceptible	Bending and swelling of stems; yellowing of leaves	Died in 15 days
10	*Celosia argentea* Linn.	Susceptible	Swelling at nodes which burst later	Died in 16 days
11	*Commelina benghalensis* Linn.	Intermediate	Swelling at nodes and yellowing of leaves	Died in 20 days
12	*Cyperus rotundus* Linn.	Intermediate	Withering of foliage	Died in 15 days
13	*Corchorus trilocularis* Linn.	Susceptible	Bending and swelling of stems, drooping of leaves	Died in 18 days
14	*Datura fastuosa* Linn.	Susceptible	Drooping of leaves, bending and swelling of shoots	Died in 14 days
15	*Datura stramonium* Linn.	Susceptible	do	Died in 14 days
16	*Eclipta alba* Clke.	Susceptible	do	Died in 16 days
17	*Euphorbia geniculata* Ort.	Susceptible	Bending of shoots which crack later	Died in 18 days
18	*Euphorbia thymifolia* Linn.	Susceptible	Parching of leaves	Died in 12 days
19	*Euphorbia pilulifera* Linn.	Intermediate	Twisting of shoots and drooping of leaves	Died in 20 days
20	*Fimbristylis ferruginea* Vahl.	Resistant	Withering of above water foliage	Recovers
21	*Indigofera glandulosa* Willd.	Susceptible	Bending and swelling of tops; yellowing of leaves	Died in 18 days
22	*Ipomœa muricata* Jacq.	Susceptible	Chlorosis of leaves; withering of plant	Died in 12 days
23	*Ipomœa reniformis* Chois.	Resistant	Unaffected	..
24	*Lagasca mollis* Cav.	Susceptible	Swelling of shoot tips which rupture later	Died in 14 days
25	*Leucas aspera* Spr.	Susceptible	Epinasty and chlorosis of leaves	Died in 12 days
26	*Leucas stricta* Bth.	Susceptible	Curvatures of shoots and chlorosis of leaves	Died in 12 days
27	*Mirabilis jalapa* Linn.	Intermediate	Bending of shoots and drooping of leaves	Died in 20 days
28	*Mimosa pudica* Linn.	Resistant	Unaffected	..
29	*Nicandra physaloides* Gaert.	Susceptible	Bending of stem and drying of leaves	Died in 18 days
30	*Ocimum canum* Sims.	Susceptible	Drooping and drying of leaves	Died in 15 days
31	*Oldenlandia corymbosa* Linn.	Resistant	Unaffected	..
32	*Oxalis corniculata* Linn.	Resistant	Unaffected	..
33	*Phyllanthus urinaria* Linn.	Susceptible	Bending and swelling of stems	Died in 12 days
34	*Portulaca oleracea* Linn.	Susceptible	Yellowing and drying of shoots	Died in 18 days

TABLE—*Contd.*

S. No.	Name of plant	Degree of susceptibility	Response	End result of spraying
35	*Psoralea corylifolia* Linn.	Susceptible	Bending, swelling and cracking of shoots; chlorosis of leaves	Died in 18 days
36	*Sesuvium portulacastrum* Linn.	Intermediate	Bending and swelling of shoots	Died in 20 days
37	*Sonchus arvensis* Linn.	Susceptible	Twisting of shoots, chlorosis of leaves	Died in 15 days
38	*Sonchus oleraceous* Linn.	Susceptible	Bending and swelling of shoots; chlorosis of leaves	Died in 15 days
39	*Solanum nigrum* Linn.	Susceptible	Chlorosis of leaves and drying of shoots	Died in 15 days
40	*Striga densiflora* Bth.	Susceptible	Curvature of shoets and leaves which wither later	Died in 10 days
41	*Striga lutea* Lour.	Susceptible	do	Died in 10 days
42	*Tridax procumbens* Linn.	Susceptible	Epinasty, chlorosis and drying of leaves	Died in 15 days
43	*Xanthium strumarium* Linn.	Susceptible	Parching of leaves ond shoots	Died in 15 days

Striga have responded very quickly to the application of 0·1% of these weedicides. Twenty-four hours after treatment, the plants show distinct curvatures of shoots and shrivelling of leaves (Fig. 4). The plants were completely killed within a week of spraying while the host plant was unaffected. So destruction of these parasites after they appear above the surface of the soil could be speedily and efficiently accomplished by the use of these weedicides.

But these root-parasites complete nearly half of their life-history underground (*i.e.*, 4-6 weeks) during which time they are feeding on the roots of the host. By the time they appear above ground they have done a good deal of damage and even if they are removed, there may be others which continue to feed on the host. It was, therefore, considered worthwhile to study the effect of these herbicides on the parasites before they emerged above the surface of the soil. For this purpose, wet blotting papers with seeds of *Striga* strewn on them were inserted and kept close to the inner walls of glass jars, so that the *Striga* seeds were easily seen from the outside. The glass jars were filled with soil and seeds of a susceptible variety of *Sorghum* were sown in them. After about five weeks when the maximum number of haustorial connections had been formed by the *Striga* seedlings with the host, the soil surface in each glass jar was treated with a measured quantity of 0·1% of the weedicides. Detailed observations taken after treatment go to show, that the underground *Striga* seedlings present upto a depth of

six inches were killed in about six days time. From these trials it would, therefore, appear that these weedicides are capable of destroying not only the above ground parts of *Striga* plants but the underground seedlings as well. We are hopeful that these findings may point the way to controlling the depredations of *Striga* which may be both effective and within the means of the cultivator. *Striga* attack on *Sorghum* is a problem of longstanding importance in the Provinces of Bombay, Central Provinces and Madras and it is quite likely that the use of these weedicides may effectively solve this problem. The control of *Striga* by these means on a field scale is being studied in all the detail and seriousness the problem demands.

The above are two weed problems confronting the agriculturists in the Bombay Province. The new hormonal weedicides are likely to help considerably in tackling them. As regards how far the new products may be utilised in controlling the other weeds listed in the table, it is difficult to say. This would depend upon the intensity of the infestation and the cost of the new method of control as against the old one. Each problem deserves to be studied from all aspects. It is hoped that this preliminary report may result in a more extensive trial of synthetic hormones of controlling tropical weeds and furnish data which is sure to come in handy whenever or wherever any particular weed becomes a serious pest.

References

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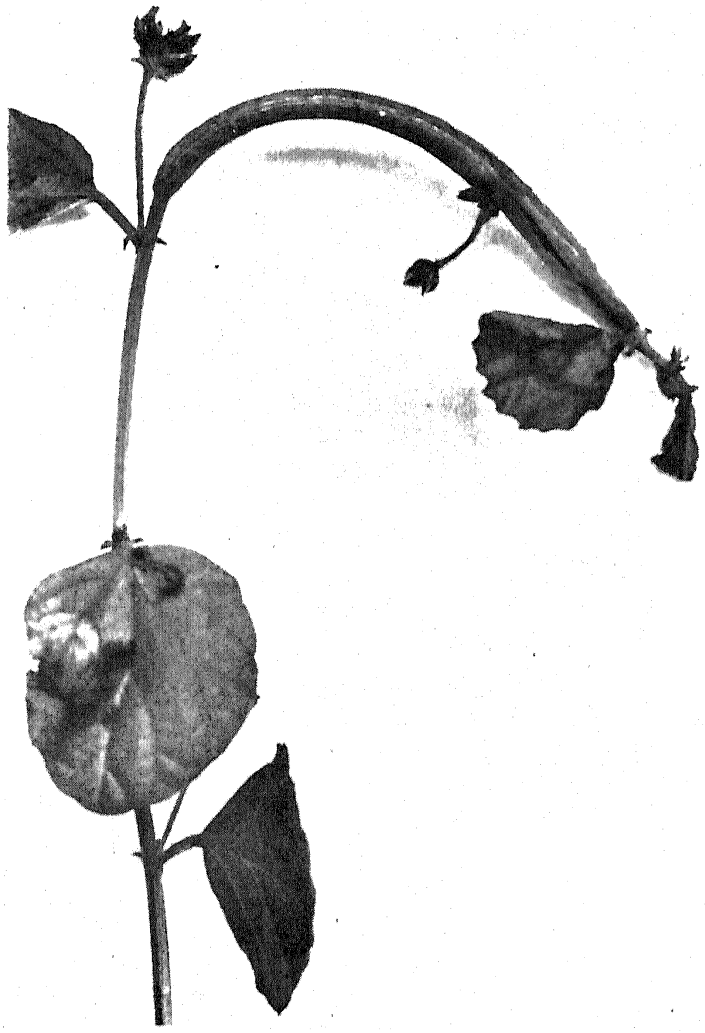

FIG. 1. *Psoralea corylifolia*, a dicot weed showing bending, swelling and cracking of the shoot as a result of spraying with 2, 4-D.

FIG. 2. *Cyperus rotundus* ('*Lavala*') plants before treatment.

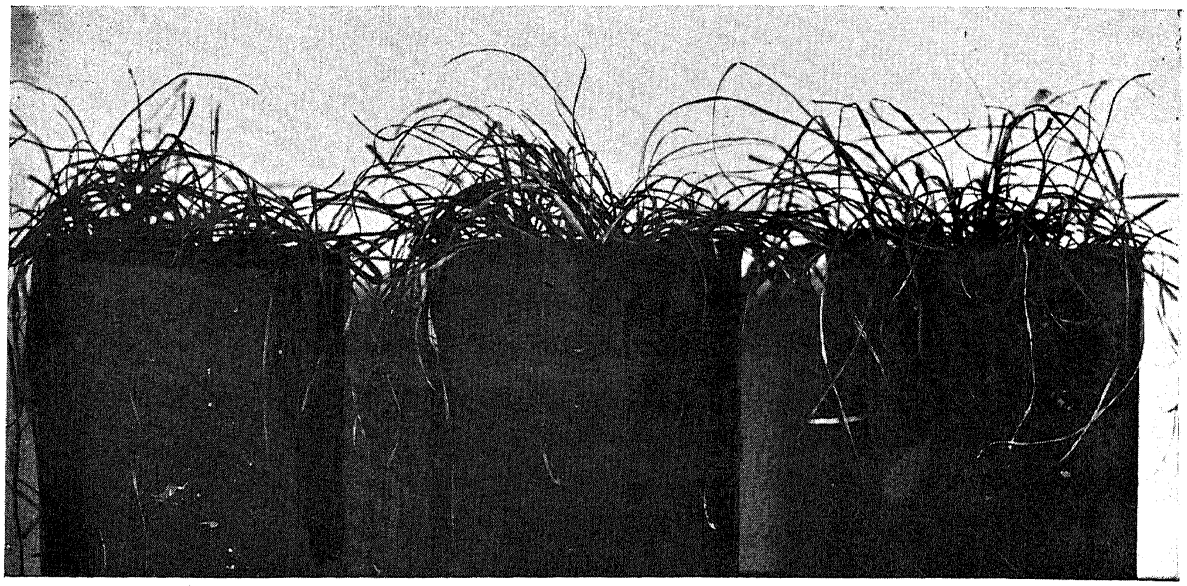

FIG. 3. The same set of plants as in Fig 2, 11 days after spraying with 0·2% Agroxone.

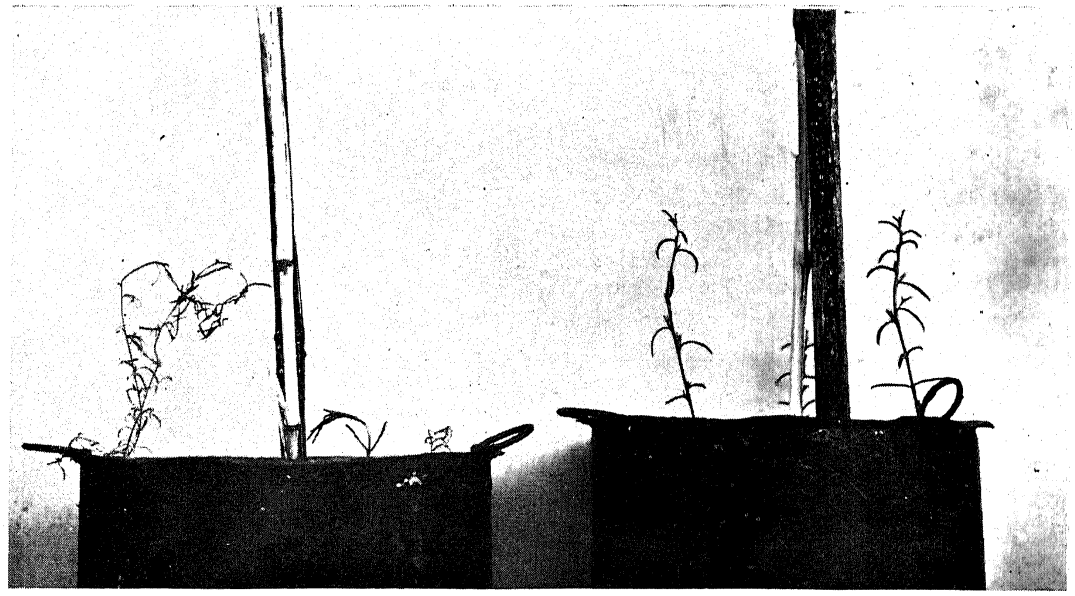

FIG. 4. On the left—*Striga* showing epinasty and shrivelling up of leaves, 24 hours after spraying with 0·1% Agroxone. Unsprayed plants on the right.