

Studies on Weed control by Herbicides: Observations on the phytocidal action of chemical herbicides on some weeds in Madras State

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Introduction : That growth-regulating substances have found wide use in the field of agriculture as weedkillers in recent years, revolutionising the method of eradication of weeds is too well known to need emphasis. Among the synthetic hormones, derivatives of phenoxyacetic acid such as 2, 4-D (2, 4-Dichloro-phenoxy acetic acid), MCPA (2-methyl 4-chloro phenoxyacetic acid) and 2,4,5-T (2,4,5-Trichloro phenoxy acetic acid) have proved to be the most effective. Commercial preparations of these are available in various forms such as acids, mineral salts, organic salts or amines and esters under different trade names. Against broad-leaved weeds 2, 4-D and MCPA are the most commonly used hormone weedicides. There is no great difference between these two chemicals in their biological activity. 2, 4, 5-T is also closely allied to 2, 4-D and has been found very effective in killing shrubby weeds and woody plants. It finds use also as an arboricide for killing trees and tree stumps.

Other chemicals that have gained ground as weedicides are PCP, (Pentachlorophenol), TCA, (Trichloroacetic acid), IPPC, (Isopropyl N-phenyl carbamate), DNOC, (Dinitro-Ortho Cresol), Ammonium sulphamate, NIX (Sodium isopropyl xanthate), Sulfosan (Ethyl xanthogen disulphide), MH (Maleic hydrazide) and many others. DNOC is only a contact herbicide and is not translocated in plants. Ammonium sulphamate is said to be translocated in certain perennial species, particularly shrubby ones, in addition to its having a contact action. IPPC is found to be a specific toxicant on certain grasses. It acts through the soil on plant roots and is ineffective as a foliage spray. It is said to be of much promise as a herbicide to control annual grasses in clover and alfalfa fields (Robbins *et al*, 1952). TCA and MH are specifically used to control certain perennial grasses. A few others like NIX, Sulfosan and Sodium 2, 4-Dichloro-phenoxy-ethyl-sulphate (Crag Herbicide I) are best used as pre-emergence herbicides.

The action of these chemicals, inclusive of the hormone type weedicides, on different weeds has been studied by various workers all over the world. Harvey and Robbins (1947) have published lists

of weeds susceptible or resistant to 2,4-D in the United States of America. Nickell (1953) has compiled in a tabular form, all the material published from 1947 to 1951 with the treatments to be given for the control of 454 weeds. Padwick (1948) was the first to study the responses of a few weeds to hormone weedkillers under Indian conditions. Thomas and Srinivasan (1949) studied the effect of MCPA on many weeds, which they classified as resistant or susceptible. Kumar and his associates (1949) described the responses of 43 species to 2,4-D and MCPA treatment. Venkatratnam (1950) discussing the scope for herbicides in South India mentioned the crop plants that are affected by these. Kumar and Solomon (1952) mentioned the weeds of Bombay State that are readily killed by 2,4-D treatment. Ramgopal (1955) has compiled a list of weeds commonly found in India, which can be controlled by chemical means. In Madras State, a number of chemical herbicides were tried on many roadside and wasteland weeds as well as a few important weeds of cultivated lands and the observations recorded on the effects of the weedicides are summarised in this paper with the belief that this will add to the information already available on the chemical control of weeds in India.

Herbicides used in the trials : The details of the different herbicides that were tried on the various weeds are as follows :

Name of the weedicide	Name of the chemical present	Cost of the weedicide	Cost of weedicide equivalent to a pound of acid
1. Sodium salt of 2, 4-D (BCPW)	Sodium salt of 2, 4-D	Rs. 9-4-0 per lb.	Rs. 9-4-0
2. 2, 4-D Weedkiller	Amine salt of 2, 4-D	Rs. 17-8-0 per Gal.	Rs. 6-0-0
3. Butyl Ester-40	Butyl ester of 2, 4-D	Rs. 17-0-0 per Gal.	Rs. 18-12-0
4. Ester-44 Weedkiller	Isopropyl ester of 2, 4-D	Rs. 18-6-0 per Gal.	Rs. 7-9-8
5. Agroxone-3	Sodium salt of M. C. P. A.	Rs. 32-0-0 per Gal.	Rs. 10-10-6
6. 2, 4, 5-T Ester-43	Isopropyl ester of 2, 4, 5-T	Rs. 53-15-0 per Gal.	Rs. 21-12-9
7. Brush Weedkiller No. 22	Mixture of esters of 2, 4-D & 2, 4, 5-T	Rs. 36-8-0 per Gal.	Rs. 12-4-9
8. Extar 'A'	Dinitro-ortho-cresol	Rs. 2-6-6 per lb.	..
9. Triherbide-NIX	Sodium isopropyl Xanthate	Rs. 3-2-0 per lb.	..
10. Sodium P.C.P.	Sodium pentachlorophenate	Rs. 2-0-5 per lb.	..
11. Sodium salt of TCA.	Sodium salt of trichloroacetic acid	Rs. 2-9-1 per lb.	Rs. 2-13-6
12. Maleic Hydrazide	Maleic hydrazide	Rs. 90-7-0 per lb.	..

The above chemicals at the dosage given, were applied on weeds at a spray volume of 100 gallons per acre, using Teepol as a wetting agent.

Effect of herbicides on few troublesome weeds: The results of the trials on eradication of some of the most troublesome weeds of cultivated lands, such as *Cynodon dactylon*, *Cyperus rotundus*, *Trianthema portulacastrum* and *Aristolochia bracteata* are briefly discussed in the following paragraphs.

Cynodon dactylon: TCA and PCP even at such high dosages as 10 and 20 pounds per acre did not prove to be useful because they had only a very temporary scorching effect and there was complete regeneration of the grass within two weeks. Extar 'A' at 8 lb in 100 gallons of water per acre was not at all effective. A spray of 2,4-D at 10 lb. and 20 lb. rate, mixed with 50 gallons of diesel oil per acre killed the aerial portions completely and prevented regrowth for a period of six to seven weeks. The isopropyl ester of 2,4-D at 2½ lb. along with 50 gallons of diesel oil per acre kept the field free of regrowths for about a month. A mixture of 2,4-D and MCPA in the form of their sodium salts at 5 and 10 lb. rates with five gallons of diesel oil per acre killed off the grass in about a fortnight under wetland conditions and regeneration was very sparse.

Cyperus rotundus: Treatments with Sodium pentachlorophenate, TCA and Extar 'A' were not effective beyond an initial scorching of aerial portions from which the plants recovered. All formulations of 2,4-D that were tried on this weed brought about a complete kill of the aerial portions within a week after application. A mixture of sodium salts of 2,4-D and MCPA at 5 lb. each per acre was very effective in killing this species and keeping the field free from regrowths for about three months under dryland conditions.

Trianthema portulacastrum: A dose of 4 lb. per acre of 2,4-D in the form of Sodium salt, or amine salt or ester and MCPA as Sodium salt was able to kill off this weed. The esters could effect the kill in seven days while other formulations required about 15 days. This weed was very easily killed in the seedling stage by herbicidal applications.

Aristolochia bracteata: A cent per cent kill was obtained when this species was sprayed with (1) Sodium salt of 2,4-D or MCPA at 5 lb. per acre (2) 2,4,5-T ester at one per cent concentration and (3) a combination of Sodium salts of 2,4-D and MCPA at 5 lb. each per acre. Under field conditions, regrowths from the underground parts were observed to some extent within a month of treatment, necessitating repeated spray applications. Soil applications

of TCA and IPC at 20 lb. per acre, after clipping off the aerial portions; did not have any inhibitory effect on the regeneration of the weed.

Effect of weedicides on different weeds

(Observations recorded)

Scientific Name of Weed	Chemical herbicides tried	Dose per acre in lb. (Acid equivalent) or % concentration	Effect
<i>Abutilon Indicum</i> (Malvaceae)	Sodium 2, 4-D	5 lb.	Completely killed in a week
<i>Acanthospermum hispidum</i> (Compositae)	Sodium M.C.P.A.	2 lb.	Killed within 20 days
	Amine 2, 4-D	2 lb.	Dried up in 7 days
	Extar 'A' (DNOC)	8 lb.	Dried up in 2 days
	Triherbide NIX	8 lb.	Dried up in 2 days
<i>Achyranthes aspera</i> (Amarantaceae)	Sodium 2, 4-D	5 lb.	Killed in a Week's time
<i>Aloe vera</i> (Liliaceae)	2, 4, 5-T Ester	5 lb.	Only a temporary scorching
<i>Alternanthera echinata</i> (Amarantaceae)	Sodium MCPA	2½ lb.	Effective kill in 20 days
<i>Amarantus viridis</i> (Amarantaceae)	2, 4-D Ester	5 lb.	Killed in 7 days
	Extar - A	8 lb.	Only a temporary scorching
<i>Ammania baccifera</i> (Lythraceae)	Sodium 2, 4-D	5 lb.	Complete kill in a week
<i>Argemone mexicana</i> (Papaveraceae)	Sodium 2, 4-D	5 lb.	Killed in a week to 15 days
<i>Aristolochia bracteata</i> (Aristolochiaceae)	Sodium 2, 4-D	5	Aerial portions completely dried up in 2 days
	Mixture of Na ₂ , 4-D & MCPA.	5	
<i>Asteracantha longifolia</i> (Acanthaceae)	Sodium 2, 4-D	5 lb.	Killed in a week to 15 days
<i>Azima tetraacantha</i> (Salvadoraceae)	Sodium 2, 4-D, 2-4-5 T ester	5 lb.	Scorching of foliage in 20 days
<i>Bidens pilosa</i> (Compositae)	Sodium 2, 4-D	5 lb.	Complete kill in 7 days
<i>Calotropis gigantea</i> (Asclepiadaceae)	Sodium MCPA	2 %	Dried up in a week
	Amine 2, 4-D	2 %	
<i>Blepharis molluginifolia</i> (Acanthaceae)	Triherbide NIX	8 lb.	Complete kill in 7 days
<i>Cardiospermum helicacabrum</i> (Sapindaceae)	Amine 2, 4-D	1%	Killed in 7 days
<i>Capparis zeylanica</i>			
<i>Capparis stylosa</i> (Capparidaceae)	2, 4, 5-T ester	5 lb.	Complete kill in 30 days
<i>Celosia polygonoides</i> (Amarantaceae)	Triherbide NIX	8 lb.	Complete kill in 7 days
<i>Centella asiatica</i> (Umbelliferae)	Amine 2, 4-D	1%	Complete kill in 7 days
<i>Commelina forskaloi</i> (Commelinaceae)	Extar 'A'	8 lb.	Only temporary scorching
<i>Corchorus trilocularis</i> (Tiliaceae)	Amine 2, 4-D	3 lb.	Epimasty and swelling of stem tips in 7 days

Scientific Name of Weed	Chemical herbicides tried	Dose per acre in lb. (Acid equivalent) or % concentration	Effect
<i>Cyanotis axillaris</i> (Commelinaceae)	Isopropyl ester of 2, 4-D & 2, 4, 5-T	2%	Killed in about 10 days
<i>Cytisus scoparius</i> (Leguminosae)	Brush killer	5 lb.	Effective kill secured in 80 days
<i>Datura fastuosa</i> (Solanaceae)	Sodium 2, 4-D	5 lb.	Killed in a week to 15 days
✓ <i>Digera arvensis</i> (Amarantaceae)	Sodium MCPA	2%	Dried up in 10 days
	Sodium 2, 4-D	2%	" " 15 days
	2, 4-D ester	2%	" " 6 days
✓ <i>Eupatorium glandulosum</i> (Compositae)	2, 4, 5-T ester	5 lb.	Not killed, resistant, Mortality very slow
	Brush killer	5 lb.	
<i>Euphorbia geniculata</i> (Euphorbiaceae)	Sodium 2, 4-D	5 lb.	Killed in a week
- <i>Flaveria australasica</i> (Compositae)	Sodium 2, 4-D Sodium MCPA	5%	Dried up in about 7 days
<i>Gynandropsis pentaphylla</i> (Capparidaceae)	Extar 'A'	8 lb.	Complete kill in 15 days
<i>Helichrysum bracteatum</i> (Compositae)	Brush killer	5 lb.	Effective kill in 80 days
<i>Ipomoea sepiaria</i> (Convolvulaceae)	Amine 2, 4-D	2%	Dried up in a week
<i>Justicia tranquebarensis</i> (Acanthaceae)	2, 4, 5-T ester	5 lb.	Only partial scorching
✓ <i>Lagasca mollis</i> (Compositae)	Amine 2, 4-D	1%	Killed in a fortnight
<i>Leucas urticaefolia</i> (Labiatae)	Triherbide NIX	8 lb.	Very good kill in seven days
- <i>Lippia nodiflora</i> (Verbenaceae)	Sodium MCPA Sodium 2, 4-D 2, 4-D ester	3 lb.	Killed in about two weeks
<i>Malvastrum coromandelianum</i> (Malvaceae)	Isopropyl ester 2, 4-D	10 lb.	Killed in about a month
<i>Millingtonia hortensis</i> (Shrubby growth from roots) (Bignoniaceae)	Butyl ester of 2, 4-D	10 lb.	Dried up in about a fortnight and no regrowths up to 8 months
<i>Mollugo cerviana</i> (Aizoaceae)	Isopropyl ester of 2, 4-D Extar 'A'	5 lb. 8 lb.	Completely killed in a week
<i>Morinda tinctoria</i> (Shrubby growths) (Rubiaceae)	Isopropyl ester of 2, 4-D	10 lb.	Fully dried up in 30 days
<i>Orthosiphon glabratus</i> (Labiatae)	Sodium 2, 4-D	5 lb.	Killed in a week
<i>Oxalis latifolia</i> (Geraniaceae)	Butyl ester of 2, 4-D Extar 'A'	5 lb. 8 lb.	Aerial parts killed in a week
✓ <i>Portulaca quadrifida</i> (Portulacaceae)	Amino 2, 4-D Extar 'A'	10 lb. 8 lb.	Killed within a week Dried up in 2 weeks
<i>Ruellia prostrata</i> (Acanthaceae)	Sodium 2, 4-D	5 lb.	Killed in a week to 15 days

Scientific Name of Weed	Chemical herbicides tried	Dose per acre in lb. (Acid equivalent) or % concentration	Effect
<i>Solanum elaeagnifolium</i> (Solanaceae)	Isopropyl ester of 2, 4-D	10 lb.	Dried up in 15 days but spraying is to be repeated after three months
<i>Sonchus oleraceus</i> (Compositae)	Sodium MCPA	2%	Dried in a week
<i>Spergula arvensis</i> (Caryophyllaceae)	Triherbide NIX } Extar 'A' }	8 lb.	Complete kill in a week
<i>Sphaeranthus indicus</i> (Compositae)	Sodium 2, 4-D	5 lb.	Killed in a week to 15 days
✓ <i>Stachytarpheta indica</i> (Verbenaceae)	Sodium MCPA	1%	Dried up in 10 days
✓ <i>Stemodia viscosa</i> (Scrophulariaceae)	Sodium 2, 4-D	5 lb.	Completely killed in 7 to 15 days
<i>Tragia cannabina</i> (Euphorbiaceae)	Sodium 2, 4-D	5 lb.	Satisfactory kill
<i>Trianthema decandra</i> (Aizoaceae)	Extar 'A'	8 lb.	Only temporary scorching
✓ <i>Trianthema portulacastrum</i> (Aizoaceae)	Sodium 2, 4-D Sodium MCPA Isopropyl ester of 2, 4-D	4 lb. } 4 lb. } 4 lb.	Killed in 15 days
✓ <i>Tribulus terrestris</i> (Zygophyllaceae)	Extar 'A'	8 lb.	Killed in 7 days Dried up within 15 days
<i>Wedelia calendulacea</i> (Compositae)	Sodium MCPA	1%	Dried up in a week to 10 days

Discussion: Of the various herbicides tried, 2,4-D and MCPA have been found to be very effective in killing many of the herbaceous broad-leaved weeds. Though a minimum dose of two pounds acid equivalent of the herbicide per acre is quite sufficient, a higher dose of 5 pounds also gives the same result but within a much shorter time. Thus with a lower dose of the chemical, the time taken to effect a complete kill is more. Further, the nature of the stems and leaves also decides the efficacy of the weedicides as well as the dosage required for a complete kill of the weed. To cite an example, *Portulaca oleracea*, a gardenland weed with fairly broad leaves and herbaceous stems could be killed by spraying 2,4-D at 2½ lb. per acre while for *Portulaca quadrifida*, a creeping herbaceous weed with small, thick and succulent leaves and thin stems, 5 to 10 lb. per acre were required to give the same result. The stage of growth of the weeds is also an important factor in the chemical method of weed control. In general, weeds in the seedling stage when they are vigorously growing, are the most susceptible to hormone weedicides. This is because of the fact that the spray can more easily penetrate the leaf surfaces of young plants than those of older plants.

Even among the various formulations of 2,4-D there are differences in phytocidal effect. The esters are the most effective as they are capable of quick penetration of the foliage while the amine salt and sodium salt are comparatively slow in their action. The sodium salt of 2,4-D and 2,4-D ester when sprayed on *Digera arvensis*, a very common Amarantaceous weed in the garden lands, at 2 percent concentration killed the weed in 12 days and 6 days respectively. It was also observed that *Trianthema portulacastrum* was killed in 15 days when sprayed with sodium 2,4-D at 4 lb. per acre while the isopropyl ester at the same dose took only 7 days to kill it. With pernicious perennial weeds with deep, creeping roots, rhizomes or stolons which serve as efficient organs of vegetative reproduction, complete eradication is a difficult problem. The more important weeds under this category, are *Cyperus rotundus*, *Cynodon dactylon* and *Aristolochia bracteata*. The various well-known mechanical methods of weed control are helpful only to some extent, at the same time being costly and laborious. Spraying of chemicals, especially of the hormone type, translocated herbicides, is of much promise in this regard. Although the aerial parts of these weeds can be readily destroyed by weedicide sprays, the underground parts are not effectively and completely killed. Until and unless all the vestiges of the underground system are killed, complete freedom from the menace of these weeds cannot be achieved. Further, the nature and extent of the underground parts of such weeds vary with different species and decide to a large extent, the degree of control by chemical herbicides. In the case of *Cyperus rotundus*, the first rhizome is easily killed and the viability of the second rhizomes is affected slightly by herbicidal sprays of 2,4-D while those in the deeper layers of the soil are least affected and they give rise to fresh growths after some time. Puttarudriah (1956) experimenting with a few herbicides on this weed, reports that there is relief only for about four months in the plots sprayed with Kathon M-7 (Amine 2,4-D). Phenoxylyene (Sodium MCPA) and Hedonal (sodium salt of 2,4-D) in order of their merit. This is almost in conformity with the finding at Coimbatore that spraying of a mixture of sodium salts of 2,4-D and MCPA at 5 lb. each per acre was helpful in keeping the field free from regrowth for a period of three months. Similarly with *Cynodon dactylon* and *Aristolochia bracteata*, only temporary relief could be achieved with herbicidal sprays and repeated sprayings were found necessary. Thus it appears, that it will be desirable to have a combination of cultural and herbicidal methods of control for these weeds. By suitable tillage operations we can aim at the destruction of the

underground parts that are left undamaged by herbicidal applications and in the course of one or two seasons, the weed population can be very much reduced.

Summary: Over a dozen chemical herbicides were tried on a total of 53 weeds and few important weeds of cultivated lands in and round about Coimbatore and the observations recorded are briefly summarised.

Many of the common dicotyledonous weeds of wastelands could be easily killed by a single spraying of 2, 4-D or MCPA at 2 to 5 lb. per acre while 2, 4, 5-T and Brush killer were found to be very effective against shrubby weeds such as *Capparis zeylanica*, *Azima tetracantha*, *Morinda tinctoria* and *Millingtonia hortensis* (root suckers) at the rate of 5 to 10 lb. per acre.

In the case of perennial weeds like *Cyperus*, *Cynodon* etc., repeated spray applications were necessary.

The efficacy of the weedicides is determined by the nature of the formulation, the concentration of the spray, the growth stage of the weeds and their morphological features and the weather conditions.

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