Herbicide Screening Trials on Vegetable Crops

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Received for publication January .6, 1967.

The past decade has witnessed tremendous achievements in weed research and ever since 1940, a great deal of information has accumulated on chemical weed control. The increase in the cost of labour and the intensive nature of the present day cultivation have necessitated the adoption of chemical weed control in vegetable and other crops as a routine operation, especially in countries like the U. S. A. New chemicals are being tested every year all the world over on different crops in the attempt of screening the best suited chemical for a particular crop. However, the varied climatic, environmental, soil and other factors coupled with the difference in the spectrum of weeds found have complicated the use of herbicides and have prevented the universal application of ' one type of herbicides for one type of vegetable'.

Vegetables are cultivated in Hawaii at elevations ranging from 20 feet to 4000 feet above sea level under a wide range of soil and climatic conditions. This fact has necessitated the conduct of extensive herbicide screening trials at representative regions in Hawaii. The results presented in this paper form a part of the Herbicidal Screening trials conducted at the Manoa Campus Experiment Station (low elevation, warmer region with an annual rainfall of about 60") at the University of Hawaii, Honolulu, U. S. A. The climatic conditions of Hawaii resemble those in the State of Kerala. The vegetation, the crops grown and the weeds found in these two states are, to a very great extent, similar. The results of the experiments conducted at Hawaii should, therefore, be of general interest to the tropical countries and of particular interest to Peninsular India.

Review of Literature

The literature on the chemical weed control on vegetable crops is so voluminous that an attempt is not made here to review all the work done in the past. Burgis (1962) found that when Dacthal was applied at 12 lb per acre it gave 30 per cent control of the weeds besides increasing the crop yield in cabbages. Excellent results were obtained with linuron in carrots. On the other hand, crop injury has also been reported with certain chemicals like Simazine and Solan (Boyce, 1963). Romanowski

The work was undertaken at the Department of Horticulture, University of Hawaii, U. S. A. during the year 1965-66 when the author was at the University on an East West Centre scholarship for post-doctoral programme.

et al (1963) conducted extensive trials with a number of chemicals in Hawaii on tomatoes grown under varying soil and climatic conditions and found that Vegadex, Tillam, Dacthal, Randox und Amiben to be effective in controlling the weeds under Hawaiian conditions. Their experiments also confirmed that one chemical that ranked first under a particular set of conditions reacted altogether differently under another set of conditions. Romanowski and Nakagawa (1965) listed a series of chemicals suited for different vegetable crops under Hawaiian conditions. Vegiben was found to be superior in certain parts of Hawaii, but the authors cautioned that it is of questionable value throughout the islands. They advocated its trial use by the farmers for transplanted pepper and tomatoes. Nakagawa and Romanowski (1964) recommended Vegidex for beans. green broccoli, cauliower, head cabbage, corn and cucumber for pre-emergence applications. Dacthal W-75 was found to be effective as pre-emergence spray for transplanted crops> pepper and tomatoes. For carrots and celery these workers recommended petroleum solvents.

Materials and Methods

Sixteen chemicals in all were tried in this experiment on 11 vegetable crops as detailed elsewhere. The new chemicals like Balan, Lorox, Treflan and Vegiban which have been registered for use on certain vegetable crops, but not formally recommended by the University, were included in the trial apart from the previously tested chemicals like Dacthal, Dymid, Eptam, Amiben, Randox, Sinox, Chloro-IPC, Tillam and Vegadex. Other chemicals which have been found to be promising from the past experiments and included jn this trial were Prefar, Tok E-25 and CP 31393 (Ramrod).

Details of the herbicide applied and crops tested

The details of the treatments, crops tested and the experimental design are given below.

Treatments (active ingredient/acre)

1 Prefar 6 lb. (preplant)
2 Tok E-25 6 lb
3 Tok E-25 6 lb (post emergence)
4 Dymid 6 lb
5 Dymid 6 lb (post emergence)
6 Eptam 6 lb (preplant)
7 Amiben 6 lb
8 Check
9 Dacthal 10.5 lb (post emergence)
10 Dacthal 10 5 lb
11 Lorox 2 lb
12 Tillam 6 lb (preplant)
13 Check cultivated
14 Randox 6 lb
15 Chloro-IPC 6 lb
16 Sinox PE 6 lb
17 Vegadex 4 lb and Sinox PE 3 lb
18 Treflan 2 lb (preplant)
19 Treflan 2 lb (post emergence)
20 CP 31393 6 lb
21 Balan 2 lb (preplant)
22 Balan 2 lb
23 Vegiban 4 lb granular (post emergence)
24 Vegadex 6 lb
25 Vegadex 6 lb granular

NOTE: — *All treatments were applied as pre-emergence unless otherwise staled*

Crops tested

1 Tomato- N-52
2 Head cabbage (Coppenhaegen Markel)
3 Chinese cabbage (Won Bok)
4 Paikon (Chinese Half Long)

5 Mustard spinach (Tendergreen)
6 Carrot (Red Cored Chantenay)
7 Onion (Granex)
8 Bush Bean (Bountiful)
9 Pea (Manoa Sugar)
10 Sweet corn (Hawaiian Sugar)
11 Radish (Early Scarlet Globe)

Experimental design

Split plot
Main plot size 5′ × 40′
Sub plot size 4′ x 10′
Replications 2

Method of application of the chemicals

The herbicides were applied as sprays unless otherwise stated. The required concentrations were made by dissolving the chemicals in water. Solutions were applied at the rate of 40 gallons per acre at 30 lb p. s. in all the plots where spray applications were made. Caution was taken to apply the chemical uniformly and at the rates indicated by adjusting the speed of the sprayer. The sprayer consisted of back mounted fibre glass tanks pressurised with Nitrogen gas.

Method of evaluating experimental results

The following weed control and crop tolerance ratings as adopted by Romanowski et al (1964) were used in this experiment.

Weed control ratings	*Crop tolerance ratings*
1 No control	1 No injury
2 Slight control	2 Slight injury
3 Fair control	3 Moderate injury
4 Good control	4 Severe injury
5 Complete control	5 Dead

The data on weed killing effects were collected when the crops were four weeks old in the case of pre-emergence application of weedicides. The ratings on the crop injury were made On two occasions, namely, immediately after the establishment of the crop and also when the crop was four weeks old. In the latter period the weeds in the check plots had grown to about 5 inches in height.

The data on the post emergence applications of weedicides were collected 20 days after the application.

During the course of the experiment (September to December) very heavy rainfall was recorded in the early period which necessitated a delayed post emergence application of the chemicals. Slight damage was also noticed on the crops after the rains.

Experimental results

The data presented in Table I show the crop tolerance to the chemicals applied as pre-emergence weedicides.

Of the chemicals tried, Lorox at 2 lb per acre caused severe injury to all the crops, except sweet corn. On the other hand, Prefar, Treflan, CP 31393, Balan 2≠, and Vegadex 6≠ were not toxic to any of the vegetables tested. Dacthal, although injurious on tomatoes, was safe on all other vegetables.

The general tolerance of the vegetables to the different chemicals applied may be summarised as follows:

Sweet corn, broad beans, peas and daikon showed the highest degree of tolerance to most of the chemicals. Head cabbage and Chinese cabbage also had moderate to high degree of tolerance. Mustard was badly affected by Amiben, Tillam, Sinox and to a moderate extent by Vegadex, while carrot was damaged by the application of Dymid, Eptam, Randox, Sinox and Vegadex. The chemicals that caused phytotoxic injury to radish were Dymid, Tillam, Chloro IPC,

TABLE I

Crop tolerance to different herbicides applied as pre-emergence sprays/granules (crop tolerance ratings)

Serial No	Name of Chemical	Tomato	Head cabbage	Chinese cabbage	Daikon	Mustard	Carrot	Okra	Radish	Peas	Corn	Chilli	Brinjal
1	Prefar	1.5	2.0	1.5	1.0	1.0	1.5	1.5	1.0	1.0	3.0	1.5	
2	Tok E—25	5.0	2.5	2.5	2.0	2.0	1.5	4.0	3.0	2.5	2.5	1.0	
3	Dymid 6≠	1.0	2.5	2.0	1.0	1.0	4.5	4.0	2.0	3.0	2.0	4.0	
4	Eptam 6≠	4.5	4.5	4.0	2.5	3.5	4.0	5.0	1.5	3.0	3.0	2.5	
5	Amiben 4≠	3.0	4.5	4.5	4.0	4.0	2.5	5.0	2.0	3.0	4.0	5.0	
6	Dacthal 10.5≠	4.5	1.0	2.0	1.0	1.0	1.5	3.0	1.0	1.5	1.0	2.0	
7	Lorox 2≠	5.0	5.0	5.0	5.0	5.0	4.0	5.0	4.0	4.0	2.0	4.0	
8	Tillam 6≠	3.0	5.0	4.5	2.0	4.0	3.5	4.0	1.0	1.5	1.5	3.5	
9	Randox ≠	2.0	2.5	3.0	1.5	3.0	4.5	2.5	1.5	2.0	1.5	1.5	
10	Chloro IPC 6 ≠	4.5	2.0	1.5	1.5	2.0	1.5	2.5	1.0	1.0	1.5	4.0	
11	Sinox PE 6≠	4.5	5.0	5.0	4.0	5.0	3.5	3.5	1.5	1.5	1.5	4.0	
12	Vegadex 4≠ +Sinox PE3≠	4.0	4.0	4.5	2.5	3.5	4.0	4.5	2,0	1.5	1.5	4,5	
13	Treflan 2≠ (Preplant)	4.5	3.0	3.5	2.0	2.5	2.0	4.0	2.5	4.0	4.5	2.0	
14	Treflan 2≠	2.5	1.5	2.0	1.0	1.0	1.5	2.0	1,0	1.5	2.5	2.0	
15	CP 31393 6≠	2.0	2.0	2.5	1.0	2.0	5.0	2.0	2.0	2.5	2.5	1.5	
16	Balan 2≠ (Preplant)	2.5	2.0	1.5	2.0	2.0	2.5	3.0	1.5	2.5	3.5	1.0	
17	Balan 2≠	1.0	1.5	2.0	1,5	1.0	1.0	2.0	1.5	2.0	2.5	1.5	
18	Vegadex 6≠	2.0	2.5	2.5	1.5	2.0	3,5	2.0	1.0	1.0	1.5	2.0	
19	Vegadex 6≠ (granular)	2.5	3.0	3.0	1.5	3.0	4.0	3.0	1.0	1.5	2.5	3.0	

≠ denotes lb. active ingredient per acre

Ratings: 1. No injury, 2 Slight, 3 Moderate, 4 Severe, 5 Dead

TABLE II

Weed control ratings of different chemicals

Sl. No. (1)	Name of the herbicide (2)	Weed control ratings (3)	Crop tolerance (4)	Weeds not controlled (5)
1	Prefar	2.0	excellent	nutgrass
2	Tok E-25	4.5	good	nutgrass
3	Dymid	4.5	good	nutgrass
4	Eptam	4.5	fair	nutgrass
5	Amiben	4.0	poor	nutgrass
6	Dacthal	4.0	good/excellent	nutgrass
7	Lorox	5.0	V. poor	all plants killed
8	Tillam	3.0	poor	pigweed, nutgrass
9	Randox	1.0	fair	nut grass
10	Chloro I P C	3.0	good	nutgrass, Amaranth
11	Sinox PE	1.0	fair/poor	ineffective to many weeds
12	Vegadex + Sinox PE	2,0	fair/poor	Amarnath, pigweed, nutgrass
13	Treflan (Preplant or (Post plant)	4.0	fair	nutgrass
14	CP 31393	3.5	good	Amarnath pigweed
15	Balan (Preplant or post plant)	3.5	excellent	nutgrass
16	Vegadex	1.5	good	nutgrass
17	Vegadex (granular)	2.0	excellent	nutgrass, Amaranth

Ratings:— 1 No control, 2. Slight control, 3. Fair control, 4. Good control 5 Complete control

TABLE III

Selected list of herbicides and vegetables against which they can be applied

Sl. No (1)	Name of the herbicide (2)	Vegetables on which it can be applied (3)
!	Tok E-25	Head cabbage, Chinese cabbage, Daikon, Carrot, Peas, Sweet corn, Radish
)	Dymid	All vegetables above and tomatoes (except carrots, onions and radish)
8	Eptam	Daikons, Broad beans, Radish
4	Amiben	Carrots, Broad beans
5	Dacthal	Head cabbage, Chinese Cabbage, Daikons, Mustard, Carrot, Onions, [Broad beans, Peas, S. corn, Radish
6	Chloro IPC	All vegetables listed under (1) except tomato and raddish
7	Treflan	Tomatoes and all the vegetables listed under (1) including Mustard and Onion
8	CP 31393	All the vegetables tested except carrot
9	Balan	All the vegetables tested

Note:— All the chemicals applied as pre-emergence

Sinox and Vegadex. In general, tomatoes and onions seem to be less tolerant to the weedicides tried.

Among the new herbicides tried, namely, Tok E-25, Treflan, Balan, and Lorox, the last one is highly phytotoxic. Tok E-25 caused damage only to tomatoes and onions.

The observations on the weed killing efficiency of the different chemicals are summarised in Table 2. As will be seen from the table Tok E-25, Dymid, Eptam, Amiben, Dacthal, Treflan, and Balan were efficient on most of the weeds. Coupled with crop tolerance these chemicals could be classed as efficient weedicides for the vegetable crops. Vegadex which proved to be successful in previous experiments was not effective in this trial. Among the new chemicals tested Treflan and Balan seem to be very promising and suited to

most of the vegetable crops. It will be seen from the Tables 1 and 2 that although certain chemicals were less toxic to the crops they were not efficient weed killers. Based on the crop tolerance and weed killing efficiency the herbicides suited to the different vegetables under Manoa conditions (low elevation, warmer regions) are listed in Table 3.

Post emergence application of the herbicides

The chemicals that were applied as post emergence sprays were Tok E-25 6 lb per acre, Dymid 6 lb per acre, Dacthal 10.5 lb per acre, Treflan 2 lb per acre and Vegiben 4 lb per acre. As post emergence weedicides none of these chemicals was toxic to the crops at the dosages applied. All these weedicides recorded good control of the weeds.

Discussion

The results presented in this paper show the suitability of certain chemicals as effective weedicides for vegetable crops under Manoa conditions. The trials were conducted at the Manoa Experiment Station, University of Hawaii, Honolulu, U. S. A. which represents low elevation area with warmer climatic conditions, As far as the applications of the results are concerned the conditions under which the trials were conducted have to be borne in mind. It seems reasonable to assume that the results will be applicable to the conditions that exist in the State of Kerala. The results of the experiment should invariably be of value in planning weedicide trials on vegetables in Kerala, where the climatic conditions approximate to that of Hawaii.

The various weedicide trials conducted in the past have emphasised the fact that the climatic, environmental and soil conditions influence the efficacy of the herbicides to a greater or lesser extent (Romanowski *et al*, 1963; Nakagawa and Romanowski, 1965). The influence of soil types and organic matter content of the soils on the efficiency of the weedicides also have been well established. Low organic matter in the soil usually results in crop injury even when the chemicals are applied at lower dosages. The soils of Hawaii vary much in their organic matter content and the conflicting results obtained with certain chemicals in the past could well be attributed to this factor. The necessity to take up trials in representative regions where there are wide variations in the factors mentioned cannot, therefore, be overemphasised.

Vegadex, Dacthal, Randox, Sinox PE, Dymid, and Chloro IPC are recommended for vegetables in Hawaii. The results reported in this paper are also in general agreement with those of previous trials. However, Vegadax as spray or granules was not an effective weed killer in this experiment. This may be either due to the lower dosage applied or due to the high organic matter content in the soil. The heavy rainfall that occurred subsequent to the application of the chemical might as well be responsible for the poor rating. If this is so, Vegadex seems to be of doubtful validity in areas with heavy rainfall. The other chemicals that were effective on a wider range were Eptam, Amiben, CP 31393, Balan, and Treflan. Chloro IPC does not seem to be very effective on the weeds. Romanowski and Nakagawa (1965) noted that Chloro IPC did not

prove well under warm areas due to the excessive volatilisation of this chemical. The moderate weed control noticed in this trial might quite probably be due to cloudy conditions that prevailed during early periods.

Of the four new weedicides tried, namely, Tok E—25, Treflan, Balan and Lorox, the last one was highly toxic to all the plants. The plots applied with Lorox was devoid of any plants and even towards the close of the experiments they remained barren. It seems, therefore, that apart from high phytotoxicity Lorox has long lasting residual effects too. Erickson (1964) found that toxicity of Monuron continued upto three years in certain kinds of soils. The other three chemicals seem to be promising. If these chemicals prove to be consistent in future trials, they may find a better application under tropical climatic conditions.

As post emergence weedicides Tok E-25 Dymid, Dacthal, Treflan and Vegiben were all effective. None of these chemicals was toxic on the vegetables at the dosages applied.

The phytotoxic injury to the crops subsequent to the application of the weedicides varied depending upon the type of vegetable and the chemical applied. Sweet corn was the most tolerant crop followed by broad beans and peas. Some of the chemicals, although not phytotoxic to the crop, were not effective on weeds. Balan and CP 31393 were the only chemicals that were not toxic to any of the vegetables, yet effective on weeds. Dacthal, although caused injury to tomatoes was safe on all the other crops. These chemicals may find a wider application for the simple reason that they can be put to use on a wide range of vegetable crops.

Summary and Conclusions

1. The trials reported in this paper were conducted at the Manoa Experiment Station, University of Hawaii, Honolulu, U. S. A. which represented a low elevation warmer area.

2. Sixteen weedicides were tried on 11 vegetable crops in this experiment.

3. Among the weedicides tried as pre-emergence sprays, Lorox 2 lb per acre caused severe injury on all the vegetables tested except sweet corn. The chemicals that were not toxic to any of the vegetables were Prefar, Treflan CP 31393, Balan and Vegadex. Dacthal, although injurious on tomatoes, was safe on all other vegetable crops.

4. The weedicides Tok E 25, Dymid, Eptam, Amiben, Dacthal, Treflan and Balan were effective on a wide spectrum of weeds. They were also non-toxic to most of the vegetables tested.

5. Sweet corn, broad beans, peas and daikon showed the highest degree of tolerance to the weedicides applied. On the other hand tomatoes and onions seemed to be less tolerant to the weedicides applied.

6. Based on the weed killing efficiency and crop tolerance the weedicides like Tok E-25, Dymid, Eptam, Amiben, Dacthal, Chloro IPC, Treflan, CP 31393 and Balan seem to be very effective under warmer conditions for a wide range of vegetable crops.

7. As post emergence weedicides Tok E-25, Dymid, Dacthal, Treflan and Vegiben were found to be efficient on most

weeds and can be safely applied on several vegetable crops.

Acknowledgements

Thanks are extended to Dr. Roman R. Romanowski Jr., Professor of Horticulture, Department of Horticulture, University of Hawaii for his keen interest and guidance in the conduct of the trials. Thanks are also due to the East West Center, Honolulu, Hawaii and the Federal Government of U. S. A. for the award of the scholarship to the author for his post-doctoral programme.

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