

DIFFERENTIAL TOLERANCE WITHIN CERTAIN CRUCIFEROUS CROPS TO VEGADEX, CIPC, DYMID AND TREFLAN*

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Abstract

The selectivity of Vegadex, CIPC, Dymid and Treflan was studied with six members of cruciferous crops, viz. head cabbage, cauliflower, chinese cabbage, leaf mustard, mustard cabbage and radish. In general, Vegadex and Treflan were found to be suitable herbicides while Dymid was very toxic to the crops studied. The selectivity was not due to a single factor but it was an interaction of morphological, physiological and genetical factors which made a particular crop tolerant or susceptible. It is assumed that genetical basis of selectivity is not of primary importance though it seems to affect secondarily. The differential selectivity of leaf mustard and mustard cabbage to CIPC and Vegadex is discussed on genetical basis.

Introduction

Literature is full of experiments conducted to evaluate suitable herbicides for cruciferous crops and of differential tolerance of these crops to the herbicides applied. The literature pertaining to the present study is reviewed briefly.

Vegadex or CDEC (2-chloroallyl diethyl dithiocarbamate) was found to give satisfactory weed control in cabbage and cauliflower when applied as pre-emergence at the rates of 3 to 6 pounds per acre (lb/A) (Hughes, 1960). In another trial, 2 to 4 lb/A showed selectivity in cabbage and radish beside other vegetables, but gave only fair weed control. When incorporated with the soil at the rate of 4 lb/A it gave 60 to 80 per cent weed control in siamese cabbage (Marcotte, 1961). It was recommended on sandy soil at the rate of 4 lb/A even on transplanted cabbage, pre-emergence to weeds (McCunnin, 1965). Dinkel (1962b) found 8 lb/A as the minimum rate which gave satisfactory results for 'Golden Acre' cabbage and 20 lb/A as the maximum rate which gave no crop injury. In another study 100 per cent weed control was observed when 4 lb CDEC was mixed with 5 lb Amiben but it damaged the cabbage severely (Dinkel, 1962a). The activity of CDEC was found to be influenced by a number of environmental factors, e.g. rainfall, humidity, temperature etc. (Taylorson, 1966).

Pre-emergence application of CIPC (Isopropyl-N-(3 Chlorophenyl) carbamate) or Chloroprotham on seeded cabbage has shown from slight to severe injury at the rates as low as 2 lb/A and some times even at 1 lb/A (Danielson, 1956 & 1957; Danielson & France, 1953; Palfrey, 1956). However, Miller (1960) got promising results for cabbage at the rate of 6 to 8 lb/A. It was reported to give poor weed control at the rate of 1/2 to 2 lb/A (Marcotte, 1961). Danielson (1957) reported that for CIPC, cauliflowers had about the same sensitivity as cabbages. Sasaki & Owada (1960) found radishes to be more tolerant than cabbage, chinese cabbage, chinese mustard and turnips. In another study they observed radishes to be less tolerant to autumn applications. Nylund *et al.* (1962) found it unsatisfactory for cabbage when applied as post-emergence to weeds. However, it gave an excellent weed control when mixed with 4 lb of Cycluron (Nylund *et al.*, 1963).

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Dymid or Diphenamide (N,N-dimethyl-2,2 diphenylacetamide) gave satisfactory weed control at the rate of 10 lb/A for cabbage and the rate upto 15 lb/A showed no injury (Dinkel, 1962 b). However, for 'Danish Ball Head' cabbage it did not give satisfactory results (Nylund *et al*, 1962). In another report it gave fair control at the rate of 8 lb/A (Nylund *et al*, 1963), while Dinkel (1962 a) found it to be unsatisfactory without injury to cabbage at 4 and 8 lb/A. Burgis (1962) observed that there was no significant difference in the total yield of cabbage and cauliflower when Dymid was used at the rate of 5 lb/A. It, however, gave 100 per cent control of all annual grasses and broad leaf weeds for 5 to 7 weeks but was ineffective against *Cyperus* sp. Ellis & Ilnicki (1963) found no significant higher yield at the rates of 4, 6 and 8 lb/A. Its application as post-transplanting of cabbage at the rate of 4 to 6 lb/A showed promise, with no visible crop injury; however, rain or irrigation within one day of application was essential (Wascom, 1965).

Treflan or Trifluralin (2,6 dinitro-N-di-n-propyl a,a,a, trifloro-p-toludine) gave good weed control when applied as pre-emergence at the rate of 4 lb/A, but reduced the number of mature plants of cabbage (Allott, 1964). Regan (1966) found that at the rates of 1/2, 1 and 2 lb/A it gave better broad leaf weed control than any other treatment used, when applied before transplanting cabbage. For cauliflower good broad leaf weed control was observed when incorporated in the soil before tansplanting. Some injury was produced at 2 lb/A rate, however, the rate of 1 lb/A was adequate to control the weeds. Dinkel (1962 b) found 4 lb/A as satisfactory control rate and 10 lb/A as maximum rate which gave no crop injury to cabbage. Nylund *et al* (1962) found it to be unsatisfactory for 'Danish Ball Head' cabbage, while Ellis & Ilnicki (1963) found that it injured cabbage and cauliflower, particularly when incorporated in the soil.

There are reports of other herbicides which showed promising results and selectivity for cruciferous crops (Hamaker, 1963; Orth, 1965).

The present study was conducted to find the genetic basis of differential tolerance within the members of cruciferous crops using above mentioned herbicides.

Materials and Methods

Four herbicides viz., Vegadex, CIPC, Dymid and Treflan were experimented on six crops viz., head cabbage (*Brassica oleracea* var. capitata cv. 'Copenhagen market', cauliflower (*B. oleracea* var. botrytis cv. 'Pua kea'), Chinese cabbage (*B. pekinensis* cv. 'Nagaoka early 60 days hybrid'), leaf mustard (*B. juncea* cv. 'kai choi'), mustard cabbage (*B. chinensis* cv. 'Pak choi') and radish (*Raphanus sativus* cv. 'Chinese half long'). The experiment was conducted in a completely randomized design with two replications. Two check plots were included in each replication. In one check plot no herbicide was applied, but weeding was performed by hand. This check was used to compare the crop injury. In the other check plot neither herbicide was applied nor weeding was performed by hand. This check was to compare the weed control. Individual plot size was 2.5' x 30.0'.

The description and the rates of the herbicides used are given in Table 1. The herbicides were diluted as to spray 80 gallons per acre of mixture and were sprayed with a hand sprayer, boom type 80.06 and at 25 pounds per square inch pressure. The field was irrigated by sprinklers as to provide two inches of water, immediately after sowing. Further irrigation was done whenever needed through sprinklers.

TABLE 1. Nature and the rate of herbicides used.

| Common name | Trade name | Chemical name | Form used | Active Ingredient |
|-------------|--------------|--|-----------|-------------------|
| *Vegadex | CDEC | 2-chloroallyldiethyl dithiocarbamate | Liquid | 4 lb/Gal 46.4% |
| *CIPC | Chlorpropham | Isopropyl-N-(3 chloro-phenyl) carbamate | Liquid | 4 lb/Gal 47.0% |
| *Dymid | Diphenamide | N, N-dimethyl-2,2 diphenyl acetamide | Powder | 80.0% |
| **Treflan | Trifluralin | 2,6 dinitro-N,N di-n-propyl a,a,a, trifloro-p-toludine | Liquid | 4 lb/Gal |

*Pre-emergence application @ 6 lb/A

**Incorporated @ 1 lb/A

Results and Discussion

The results of weed control and crop injury are summarized in Table 2 and Table 3 respectively. The data were recorded three and seven weeks after sowing. The mean figures of two replications, each consisting of two rows are given in these Tables.

All the herbicides used showed good weed control; however, CIPC did not control spiny amaranth, love grass and floras paintbrush. The control on wire grass and garden spurge was not satisfactory either. Dymid controlled all the herbs satisfactorily except apple of peru. Treflan and Vegadex had a good control on grasses and broad leaf weeds. Dymid was extremely toxic to all the crops studied. In general Vegadex and Treflan showed least injury to the crops. Thus it may be concluded that Dymid is not a suitable herbicide for cruciferous crops while Vegadex and Treflan may be recommended for such crops rather safely.

TABLE 2. Weed control on the rating scale: 1 = no control, 2 = slight, 3 = fair, 4 = good (commercially acceptable) and 5 = complete control.

| Weeds | Herbicides | | | |
|--|------------|------|-------|---------|
| | Vegadex | CIPC | Dymid | Treflan |
| <i>Eleusine indica</i> (wire grass) | 4.0 | 3.0 | 5.0 | 3.5 |
| <i>Eragrostis pectinacea</i> (love grass) | 5.0 | 2.0 | 4.5 | 4.0 |
| <i>Cyperus rotundus</i> (nut sedge) | 5.0 | 4.0 | 4.5 | 4.5 |
| <i>Amaranthus spinosus</i> (spiny amaranth) | 4.5 | 1.0 | 5.0 | 4.5 |
| <i>Nicandra physalodes</i> (apple of peru) | 5.0 | 5.0 | 1.0 | 4.5 |
| <i>Portulaca oleracea</i> (purslane) | 5.0 | 4.5 | 5.0 | 5.0 |
| <i>Emilia sonchifolia</i> (floras paintbrush) | 5.0 | 2.5 | 5.0 | 4.5 |
| <i>Euphorbia hirta</i> (garden spurge) | 5.0 | 3.5 | 5.0 | 4.5 |

TABLE 3. Crop injury on the rating scale: 1 = no injury, 2 = slight injury, 3 = moderate injury, 4 = severe injury and 5 = dead plants.

| Crops | Herbicides | | | | | | | |
|--------------------|------------|-----|------|-----|-------|-----|---------|-----|
| | Vegadex | | CIPC | | Dymid | | Treflan | |
| Weeks after sowing | 3 | 7 | 3 | 7 | 3 | 7 | 3 | 7 |
| Head cabbage | 1.5 | 2.0 | 4.2 | 4.0 | 4.7 | 5.0 | 1.0 | 1.0 |
| Chinese cabbage | 1.7 | 2.2 | 5.0 | 5.0 | 4.5 | 5.0 | 2.0 | 2.0 |
| Leaf mustard | 2.5 | 2.5 | 5.0 | 5.0 | 4.0 | 5.0 | 1.0 | 1.2 |
| Mustard cabbage | 1.0 | 1.0 | 2.5 | 4.0 | 4.0 | 5.0 | 1.7 | 1.5 |
| Radish | 1.0 | 1.5 | 4.0 | 4.2 | 4.0 | 4.5 | 2.0 | 2.0 |
| Cauliflower | 3.0 | 3.0 | 1.7 | 2.5 | 4.2 | 5.0 | 4.2 | 4.5 |

It is evident from the results that no single factor alone can explain the behaviour of the differential selectivity within these species. For example, CIPC was found to be the least toxic to cauliflower and most toxic to leaf mustard, while the effect of Treflan was almost reverse to this.

In general the effects of these two herbicides were quite opposite to each other in the other crops as well. It seems probable that the selectivity is caused by the interaction of morphological, physiological and genetical factors. Also, it became evident that the differential selectivity due to the genetic makeup of the plant is not of primary importance yet it seems to have secondary importance.

TABLE 4. Chromosome number and genome compliments of the crops.
(after Darlington and Wylie, 1955 and Yarnell, 1956)

| Crop | Haploid chromosome number | Genome compliment |
|-----------------|---------------------------|--|
| Head cabbage | 9 | AA BB CC D E F |
| Cauliflower | 9 | AA BB CC D E F |
| Mustard cabbage | 10 | A B C DD EE FFF |
| Leaf mustard | 18 | Aa Aa Ab Ba Ba Bb Ca Ca Cb Da Da Db Ea Eb Eb Fa Fb Fb |
| Chinese cabbage | 10 | A B C DD EE FFF |
| Radish | 9 | A BB C DD E FF |

Leaf mustard and mustard cabbage are morphologically quite similar to each other as both are leafy mustards. The absorption studies of CIPC by these two species revealed that both are quite similar in absorption pattern as well. In both the species CIPC remained mainly in the roots (Hirabayashi, 1964; Morikawa, 1964). In this particular case the selectivity can be explained on the basis of genetical factors. The haploid chromosome number of mustard cabbage (*Brassica chinensis*) is ten with the chromosomal formula ABCDDEEFF (Yarnell, 1956). On the other hand leaf mustard (*B. juncea*) has eighteen haploid chromosomes, with the chromosomal formula Aa Aa Ab Ba Ba Bb Ca Ca Cb Da Da Db Ea Ea Eb Eb Fa Fb Fb. Chromosome numbers and genome compliments of the crops used in the present study are given in Table 4. *B. juncea* is supposed to be evolved by amphidiploidy from *B. campestris* (n=10) and *B. nigra* (n=8) (Olsson, 1963). Furthermore, it has been reported that CIPC affects the chromosomes in a number of ways (Anonymous, 1959, 1966; Klingman, 1961). Thus, it seems probable that *B. juncea* is more susceptible than *B. chinensis* because of its complex chromosomal system. The differential response of these two species with Vegadex may be explained on the same basis as well. It is worth mentioning that though the chromosomal compliments of *B. chinensis* and *B. pekinensis* are quite similar to each other, yet the response was found to be quite different. This is not very surprising as two are morphologically different from each other.

On the basis of the results of this experiment it may be recommended that for further studies on genetic basis of differential tolerance, various varieties of a particular crop should be tried with a single herbicide or a group of similar herbicides, for example CIPC or Carbamates in general. Cruciferous crops are of particular importance for such studies because if genetics is found to play an important role it would be possible to study it in greater depth with these crops. This is because of the fact that inter-varietal, interspecific and intergeneric crosses are possible and have been made among cruciferous crops in the past.

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