Cytological Effects of Pesticides

XVII. Effect of the insecticide dichlorvos on root-mitosis of *Vicia faba*¹

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The insecticide 0,0-dimethyl-0-(2,2-dichlorovinyl) phosphate (I) has many common names of them: chlorvinphos, dichlorvos, DDVP, Vinylophos, Vapona and Vaponite may be mentioned.

Dichlorvos was found to be effective against peach leaf-curl aphid (Verma and Bhalla 1976) and cotton leaf-roller which attack, *Gossypium hirsutum* cotton (Sidhu and Dhawan 1979).

DDVP is volatile (145 mg/m³ at 20°C) and is slowly released as a vapor from wax resin stands or other suitable materials. It is chiefly in this form that DDVP is used for domestic extermination of insects (Hollaender 1976).

DDVP induced sister-chromatid exchanges and chromosomal aberrations in cultured chinese hamster cells (Tezuka *et al.* 1980). Concerning the cytogenetic effect of dichlorvos on plants, chromosome aberrations have been recorded in root-tips of onion (Sax and Sax 1968) and barley (Bhan and Kaul 1975) after treatment of the seeds with DDVP.

In the present investigation the effect of pure dichlorvos on root-mitosis of *Vicia faba* has been studied.

Materials and methods

Seeds of *Vicia faba* (var. Giza 2) and pure dichlorvos² were used in the present study. The insecticide was dissolved in distilled water, the used concentrations were: 32, 63, 125 and 250 ppm.

Seeds were sterilized, soaked for 24 hours in tape water, then germinated in rolls of filter paper placed in containers with tap water at the bottom. Treatments of the lateral roots (about 2 cm in length) with the experimental agent were conducted for 4 hours. Germination

of the seeds and treatments of the lateral roots were carried out at 20°C. Dichlorvos is hydrolyzed to 50% at 20°C in 61.5 days Schrader (1963) so, the

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² Standard sample delivered from EPA, North Carolina.

used solution was freshly prepared. Roots were fixed in acetic-alcohol (1:3) and stained after the Feulgen technique.

Three replicates were performed for each treatment and the control. Each replicate consisted of 3 seedlings. A single root was examined from each seedling (i.e., 9 roots from 9 seedlings). Chromosome disturbances were scored in the pro-, meta- and ana-telophase stages.

Results and discussion

The used concentrations of dichlorvos caused decrease in the mitotic index of *Vicia faba* root-meristems; such decrease was found to be statistically non-significant (Table 1). Dichlorvos (Nuvan) has been reported to reduce the mitotic index in *Hordeum vulgare* (Bhan and Kaul 1975).

Table 1. Mitotic index after treatment of *Vicia faba* roots with different concentrations of dichlorvos solution

Concentration	No. of counted cells	No. of mitoses	Mitotic index*
			mean $\pm$ S.E.
Control	10269	863	83.96 $\pm$ 4.99
250 ppm	10181	701	68.77 $\pm$ 4.88
125 ppm	10214	726	71.49 $\pm$ 7.97
63 ppm	9952	709	71.23 $\pm$ 0.77

* Number of mitoses/1000 cells, mean of three replicates.

Table 2. Percentage of abnormal mitoses and abnormal cells in the different mitotic stages after treatment of *Vicia faba* roots with different concentrations of dichlorvos solution

Conc.	% of abn. dividing cells	% of abn. prophase cells	% of abn. metaphase cells	% of abn. ana-telophase cells	% of abn. interphase cells
	mean $\pm$ S.E.	mean $\pm$ S.E.	mean $\pm$ S.E.	mean $\pm$ S.E.	mean $\pm$ S.E.
Control	1.84 $\pm$ 0.72	1.93 $\pm$ 0.75	4.55 $\pm$ 2.63	0.88 $\pm$ 0.88	0.02 $\pm$ 0.02
250 ppm	15.36 $\pm$ 2.17**	2.21 $\pm$ 0.58	39.67 $\pm$ 5.10**	27.39 $\pm$ 7.18*	0.16 $\pm$ 0.03*
125 ppm	12.83 $\pm$ 2.70*	4.76 $\pm$ 2.19	29.85 $\pm$ 5.41*	14.13 $\pm$ 1.70**	0.20 $\pm$ 0.03*
63 ppm	5.51 $\pm$ 1.01	2.13 $\pm$ 0.56	16.37 $\pm$ 4.46	7.25 $\pm$ 2.37	0.15 $\pm$ 0.06

* Significant at 0.05 level (t-test).

** Significant at 0.01 level (t-test).

Dichlorvos treatments induced cells with chromosome abnormalities which increased in number as the concentration of the insecticide increased (Table 2). The percentage of abnormal mitoses induced by the concentrations 125 and 250 ppm of the insecticide was statistically significant. Both concentrations of the toxicant induced also a statistically significant percentage of abnormal interphase cells (Table 2).

Disturbed meta- and anaphases (Fig. 1), where the chromosomes spread ir-

regularly over the cell, comprised 91% and 84% of the abnormal mitoses after treatment with 250 and 125 ppm of dichlorvos respectively. Pro-metaphases, where the chromosomes retained their arrangement as in the prophase stage (Fig. 2), were also observed in some cells and classified under disturbed type. Treatments with the different concentrations of dichlorvos induced chromosome stickiness and anaphase-bridges (Fig. 3). Micro-, binucleated (Fig. 4) interphase cells as well as interphase cells with deformed nuclei were observed after treatment with the different concentrations of the insecticide. The above mentioned types of abnormalities were observed in the mitosis of *Vicia faba* after treatments with other

Figs. 1-4. 1, disturbed metaphase. 2, prophase-metaphase. 3, anaphase-bridges. 4, binucleated interphase cell. After treatment of *Vicia faba* roots with 250 ppm (1, 3) and 125 ppm (2, 4) aqueous dichlorvos solution.

organophosphorous insecticides e.g. Leptophos, Dursban and Methamidophos (Amer and Farah 1979, 1983, 1984). It has been mentioned that, the aberrations induced by DDVP in barley were exclusively of the breakage type which included chromatid and isolocus breaks, free fragments and extreme fragmentation (Bhan and Kaul 1975). In the present study, chromosome fragmentation was observed in few cells after treatment with 63 and 32 ppm of dichlorvos but extreme fragmentation was not observed. The divergence between the results of the experiments on DDVP might be due to the different sensitivities of the test systems.

Comparing the effect of dichlorvos with that of the insecticide dipterex "trichlorphon" on root mitosis of *Vicia faba* (Amer and Ali 1984), it was found that, a much lower concentration of dichlorvos induced a higher percentage of cells with chromosome abnormalities. However, the mitotic inhibition, induced after root-treatment with trichlorfon (Amer and Ali 1984) may be attributed to the used high concentration of the insecticide (0.5%), since 0.1% aqueous solution of formulated dipterex with 50% active ingredient (Hussein 1961) and 0.1% aqueous pure dipterex solution (Amer 1966) did not affect mitosis. More over, it has been found that dichlorvos effects on embryonic shoots of barley were more pronounced than those of trichlorfon often equalling or surpassing those of ethylmethanesulfonate (EMS) (Panda and Sharma 1980).

Summary

The effect of the pure insecticide dichlorvos has been studied on root-mitosis of *Vicia faba* plant (var. Giza 2). The roots were treated with 250, 125, 63 and 32 ppm of the insecticide for four hours.

Dichlorvos treatments induced cells with chromosome abnormalities, which increased in number as the concentration of the insecticide increased. Disturbed meta- and anaphases where the chromosomes spread irregularly over the cell comprised the main type of the observed abnormalities. Stickiness of the chromosomes anaphase-bridges, micro- and binucleated interphase cells were also observed.

The effects of the insecticides dichlorvos and trichlorfon on root-mitosis of *Vicia faba* are discussed.

References

- Amer, S. M. 1966. Comparative study of phytotoxicity and cytological effects of dipterex and its o-methyl ether. *Naturwiss.* (11): 278.
- and Ali, E. M. 1983. Cytological effects of pesticidex XIV. Effect of the insecticide dipterex "trichlorphon" on *Vicia faba* plant. *Cytologia* 48: 761-770.
- and Farah, O. R. 1979. Cytological effects of pesticides IX. Effects of the phosphonothiate insecticide Leptophos on *Vicia faba*. *Cytologia* 44: 907-913.
- and — 1983. Cytological effects of pesticides XII. Effects of the phosphorothioate insecticide "Dursban" on the mitosis of *Vicia faba*. *Cytologia* 48: 27-33.
- and — 1985. Cytological effects of pesticides XV. Effects of the insecticide Methamidophos on root-mitosis of *Vicia faba*. *Cytologia* 50: 521-526.
- Bhan, A. K. and Kaul, B. L. 1975. Cytogenetic activity of dichlorvos in barley. *Indian. J. Exp. Biol.* 13: 403-405.
- Hussein, M. G. 1961. The effect of certain insecticides on cytology of *Vicia faba* and *Gossypium*. Ph. D. Thesis, Cairo University.
- Hollaender, A. 1976. Chemical Mutagens, Principles and Methods for their Detection. Vol. 4. Plenum Press. New York and London. p. 275.
- Panda, B. B. and Sharma, C. B. S. R. 1980. Cytogenetic hazards from agricultural chemicals 3. Monitoring the cytogenetic activity of trichlorfon and dichlorvos in *Hordeum vulgare* *Mutation Research* 78: 341-345.
- Sax, K. and Sax, H. J. 1968. Possible mutagenic hazards of some food additives, beverages and insecticides. *Japan. J. Genetics* 43 (2): 89-94.
- Schrader, G. 1963. Die Entwicklung neuer insektizider Phosphorsäure-Ester. Verlag Chemie

- G M B H, Weinheim/Berg Str. p. 43.
- Sidhu, A. S. and Dhawan, A. K. 1979. Incidence of cotton leaf-roller *syleptaderogata* on different varieties of cotton and its chemical control. *Entomoan* **4** (1): 45-50.
- Tezuka, H., Ando, N., Suzuki, R., Terahata, M., Moriya, M. and Shirasu, Y. 1980. Sister- chromatid exchanges and chromosomal aberrations in cultured chinese hamster cells treated with pesticides positive in microbial reversion assays. *Mutation Research* **78**: 177-191.
- Verma, K. L. and Bhalla, O. P. 1976. Control of peach leaf-curl aphid *branchy caudus-helichrysi anuraphis* with particular reference to evaluation of pre bloom and post bloom applications with different aphicides. *Indian J. Entomol.* **38** (2): 118-120.
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