Cytological Effects of Pesticides

XII. Effects of the phosphorothioate insecticide dursban on the mitosis of *Vicia faba*

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The insecticide 0, 0-diethyl 0-(3, 5, 6-trichloro-2-pyridyl) phosphorothioate "dursban or chlorpyrifos" is widely used in plant protection. It is used for the control of the spiny boll worm (*Earias insulana*) in fields of okra (*Hibiscus esculentus*) in Cyprus (Melifronides *et al.* 1978); for the control of rhodesgrass scale in sunturf bermudagrass in U. S. A. (Murdoch and Mitchell 1976). In Egypt "dursban" is used for controlling cotton pests e. g. *Earias insulana* and *Pectinophora gossypiella*. It is also used to control *Gryllotalpa gryllotalpa* and *Agrotis ypsilon* in fields of potato and strawberry (Program of pest control, U, A, R, 1972/73, 1976/77). Dursban was also promising when applied as seed treatments to control the adult slender seed corn beetle (*Clivina impressifrons*) (Sechriest *et al.* 1971).

Dursban is very slowly leached from and decomposed in the soil (Smith 1966). About 20% of the insecticide was detected in the soil 3 months after its application (Townsend and Specht 1975). A study of its cytological effects is, therefore, highly indicated. In the present study, the effects of "dursban" on root-mitosis of *Vicia faba* have been studied.

Materials and methods

Compare part VI of this series (Amer and Farah 1974). Seeds of *Vicia faba* (v. Giza 2) and the pure insecticide 0, 0-diethyl 0-(3, 5, 6-trichloro-2 pyridyl) phosphorothioate (dursban) were used in the present study. The used concentrations were: saturated, 0.5, 0.25, and 0.125 of the saturated solution. Three replicates were performed for each treatment. The effect of "dursban" has been studied on root-mitosis after both seed soak and root-treatments.

Results and discussion

Seed-soak and root-treatments with different "dursban" concentrations induced a significant percentage of abnormal mitoses; the percentage of which increased as the concentration of the experimental agent increased. However, the roots recovered 24 hours after replacement in water (Table 1).

The different treatments with "dursban" did not effect the mitotic index (Table 1).

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Table 1. Mitotic index, number and percentage of abnormal: mitoses and interphase cells in *Vicia faba* roots as affected by seed-soak-and root- treatments with "dursban" solutions

Treatment	Mitoses			Interphase cells			MI $\pm$ S.E.
	No.	No. abn.	% abn. $\pm$ S.E.	No.	No. abn.	% abn.	
I. Seed-soak-treatment for 24 hrs.							
with: 1, sat. soln.	1274	123	9.79* $\pm$ 1.46	9092	36	0.40	122.68 $\pm$ 9.09
2, 0.5 sat. soln.	1569	93	5.94* $\pm$ 0.35	9362	81	0.83	143.44 $\pm$ 21.20
3, 0.25 sat. soln.	1562	78	5.02* $\pm$ 0.61	9198	140	1.51	145.15 $\pm$ 3.47
4, 0.125 sat. soln.	1611	30	1.83 $\pm$ 0.29	9168	47	0.51	149.28 $\pm$ 6.48
Control	1446	13	0.92 $\pm$ 0.09	9122	24	0.26	136.50 $\pm$ 13.23
II. Root-treatment for 4 hrs.							
with: 1, sat. soln.	823	129	16.34* $\pm$ 2.44	9599	404	4.21	78.45 $\pm$ 14.53
2, 0.5 sat. soln.	856	144	17.04* $\pm$ 0.64	9669	422	4.35	80.29 $\pm$ 17.26
3, 0.25 sat. soln.	852	98	11.68* $\pm$ 1.57	9424	256	2.71	82.78 $\pm$ 4.81
4, 0.125 sat. soln.	851	35	4.27 $\pm$ 1.12	9357	200	2.13	83.18 $\pm$ 4.47
Control	794	11	1.32 $\pm$ 0.42	9826	146	1.53	76.08 $\pm$ 15.09
III. Root-treatment for 4 hrs.							
and recovery for 24 hrs.	1009	16	1.62 $\pm$ 0.16	9180	79	0.86	98.76 $\pm$ 9.30
Control	1032	10	0.93 $\pm$ 0.33	9195	135	1.46	100.77 $\pm$ 6.15

* Significant to control at 0.01 level of probability (t-test).

"Dursban" differs in this respect than other organophosphorous insecticides such as "Rogor" (Amer and Farah 1974), and "Leptophos" (Amer and Farah 1979).

Table 2 represents the effect of "dursban" on the mitotic stages. A low percentage of prophases with micronuclei was observed (Table 2 and Fig. 1). Micronuclei were also observed in the other mitotic stages after seed-soak-and root-treat-

Figs. 1-8. 1-4: Micronuclei in the different mitotic stages. 1, prophase. 2, metaphase each with a micronucleus. 3, anaphase with lagging chromosomes and a micronucleus. 4, two interphase cells each with a micronucleus, after root-treatment for 4 hours with: Saturated (1, 4), 0.125 sat. (2), and 0.25 sat. "dursban" solution (3). 5, disturbed metaphase. 6, anaphase with bridge and two lagging chromosomes. 7, anaphase with two lagging chromosomes. 8, telophase with two lagging chromosomes and a micronucleus, after root-treatment for 4 hours with: 0.5 saturated (5), 0.25 sat. (6, 8), and sat. "dursban" solution (7).

Table 3. Percentage of the different types of abnormalities occurring in the abnormal mitoses of *Vicia faba* roots, after seed-soak, and root-treatments with "dursban" solutions

Treatment	Mitoses		Percentage of the different types of abnormalities relative to the number of abnormal mitoses				
	No.	No. abn.	% Dist.	% Lag.	% Frag.	% Brid.	% Micro n.
I. Seed-soak-treatment for 24 hrs							
with: 1, sat. soln.	1274	123	63.41	21.95	10.57	1.63	2.44
2, 0.5 sat. soln.	1569	93	34.41	47.31	15.05	3.23	2.15
3, 0.25 sat. soln.	1562	78	44.87	34.62	17.95	5.13	—
4, 0.125 sat. soln.	1611	30	23.33	50.00	20.00	10.00	—
II. Root-treatment for 4hrs.							
with: 1, sat. soln.	823	129	62.02	21.71	7.75	2.33	6.98
2, 0.5 sat. soln.	856	144	65.28	16.67	4.86	4.17	10.42
3, 0.25 sat. soln.	852	98	61.22	23.47	8.16	2.04	10.20
4, 0.125 sat. soln.	851	35	42.86	37.14	5.71	2.86	11.43
III. Root-treatment for 4 hrs. and recovery for 24 hrs.							
	1009	16	50.00	18.75	6.25	6.25	18.75

ments with "dursban". The latter treatment, however, induced a higher percentage of micronuclei (Table 3 and Figs. 1-4 and 8). Dursban resembles γ -irradiation in this respect which also caused the induction of micronuclei in the different mitotic stages (Compare Amer and Mikhael 1972). Interphase cells with micronuclei were also observed in the mitosis of *Vicia faba* as a result of treatment with other chemicals, e. g., pentachlorophenol (Amer and Ali 1969); amitrole (Mohandas and Grant 1972); isopropyl-N-phenyl carbamate, IPC and "Duphar" (Amer and Farah 1974), and Leptophos (Amer and Farah 1979). In this connection, Sparrow and Singleton (1953) mentioned that micronuclei are a fair index of fragment production. Dursban produced micronuclei also in polychromatic erythrocytes in mouse bone marrow after both i. p. injection and administration in diet daily (Amer *et al.* 1980).

As is evident from Tables 1 and 2 the percentage of abnormal interphase cells is much lower than that of abnormal mitoses and abnormal ana-telophases. This may be an indication that, most of the abnormal metaphases continued their mitotic cycle till the ana-telophase stage whereas they either recovered or did not further continue their mitotic cycle.

Disturbed meta- and anaphases, where the chromosomes spread irregularly over the cell comprised the most dominant type of the observed anomalies (Fig. 5 and Table 3). Its percentage decreased by dilution of the experimental agent (Table 3). Such type of abnormalities may be due to the disturbance of the spindle apparatus.

Treatments with "dursban" induced a considerable percentage of lagging chromosomes (Figs. 3, 6-8) and chromosome fragmentation (Table 3) which may induce micronuclei.

Summary

The effects of the phosphorothioate insecticide "dursban" have been studied on root-mitosis of *Vicia faba*. Two types of treatments were carried out using different concentrations of the insecticide: Seed-soak-treatment for 24 hours, and root-treatment for 4 hours. Both treatments induced a significant percentage of abnormal mitoses, the percentage of which increased as the concentration of the experimental agent increased. The different treatments with dursban did not effect the mitotic index. Disturbed meta- and anaphases where the chromosomes spread irregularly over the cell dominated. Lagging chromosomes and chromosome fragmentation were also observed. Micronuclei were observed in the different mitotic stages.

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