Insect Toxicological Studies of Maleic Hydrazide Translocated in the Potato Plant

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Doubts about long-range biological effects due to the use of agricultural chemicals in the production and storage of foodstuffs remains a cause for great concern. Attempts have been made through legislation to regulate the amount of individual pesticides in our food. However, very little is known about extra-toxic effects of sub-lethal intake of mixtures of pesticides or about the form and significance of the chemicals as consumed by animals (e.g. as plant metabolites). The question of specific modifications to the original chemical by different plants and specific suscepti-

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bilities of different animals makes the problem even more complex. Such a situation appears to have arisen in the case of maleic hydrazide (MH), 1,2-dihydro-3,6-pyridazinedione, which is used in agriculture as a plant growth regulator.

While it has been found that MH *per se* is relatively non-toxic to rats and mice (1), Fischnich *et al.* (2) reported a significant reduction in the fertility of rats fed with potato tubers from plants sprayed with MH before harvest compared with rats fed a diet with tubers treated with MH during storage. Furthermore, Robinson (3) found a large reduction in the fecundity of pea aphids reared on broad beans grown in soil treated with MH compared with those reared on plants freshly dipped or sprayed with MH. Yule *et al.* (4), using sexual insects (*Musca domestica* L. and *Drosophila melanogaster* Meig.), tested the hypothesis that plant metabolites resulting from treatment with MH could interfere with animal reproduction and found no effects with above-tolerance doses of MH translocated in beans. These authors also confirmed Robinson's findings with MH and pea aphids (3), but favoured the proposal of an indirect

nutritional effect through the treated plant as made by van Emden (5).

The present work using insects and potatoes was designed to test if the positive toxicological results with rats and potatoes (2) might be due to plant-specific metabolites of MH.

Experimental

Potato plants (Solanum tuberosum L., cv. Kennebec) were sprayed 5 weeks before harvest with an aqueous solution of MH-30 containing 0.75% a.i. (cf. reference 2). Fresh potatoes were taken from cold storage during the following winter as required to prepare fresh batches of Drosophila rearing medium. Fresh, boiled or freeze-dried tubers were substituted for the whole dry weight of corn meal in a standard diet (6). Ten female and 10 male 1-day-old flies were transferred from a breeding stock of D. melanogaster into a 12-ounce glass jar containing approximately 100 g. of media, and reared and counted as described previously (4).

Three replicated treatments were included in three experimental series: standard medium containing 50 g. fresh, boiled potatoes per 100 g. medium (CP);

CP with 1 to 4 ml. of an aqueous solution of 0.25% W/V pure MH freshly added, giving a concentration in the medium of 25-100 ppm MH (CP + MH); standard medium with MH-treated potatoes added (MHP). From chemical analysis (7), the average MH content of fresh tubers was found to be 57.6 ppm MH, the MH content was not reduced on boiling, and the wet medium contained approximately 30 ppm MH. In one series of experiments 10 g. freeze-dried potatoes were added per 100 g. wet medium giving an MH content of approximately 25 ppm.

Results

In three series of experiments each comprising 3 inbred generations of flies per medium type, no significant reduction in fecundity was found comparing a range of doses of freshly-added MH and potato-translocated MH (Table 1). The sole exception to this was in series A(P), which was the first experiment conducted and whose large variability may reflect inexperience which subsequently decreased with practice. The addition of MH in either form may have slightly affected fly fecundity compared with CP, as 4/9 of the experiments showed a significant difference between CP and one of the other pairs of treatments. However, no significant difference between any pair of treatments

TABLE 1

Total Numbers of Adults Produced from 10 ♀ Breeding in Different Larval Media

	Genera-tion	Number of progeny CP	CP + MH*	MHP	No. of reps.	MH added* (mg.)
	P	870[a,b]	898[b]	475[a,b]	5	3.5
A	F_1	917[b]	601[b]	816	5	10.0
	F_2	486	525	373	2	3.5
	P	674[b]	824	897[b]	5	10.0
B	F_1	610[b]	686	958[b]	3	3.5
	F_2	643	674	576	3	2.5
	P	1054[a]	954	982[a]	3	2.5
C	F_1	822	739	833	3	2.5
	F_2	735	766	788	3	2.5

Treatments: CP — untreated potatoes; CP + MH — untreated potatoes + pure MH/100 g.*; MHP — Potatoes field-treated with MH

Series: A and B — fresh, boiled potatoes; C — freeze-dried potatoes

[a] F test, variance ratio significant at P = 0.05

[b] t test, difference of means significant at P = 0.05

was found in the most likely tests (F_2).

Discussion

Drosophila bred well in the potato-agar medium, development time was normal and moulds presented no

difficulty.

Our conclusion from insect tests is that translocated MH in bean plants (4) and in potato tubers has no deleterious effects on animal reproduction. The question of a specific susceptibility of rats towards translocated MH remains to be resolved.

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