

THE EFFECT OF FOUR SELECTED PESTICIDES ON THE BEHAVIOUR
OF CATERPILLARS IN SCOTIA SEGETUM DEN. ET SCHIFF.

Ludovít Weismann, Lýdia Švataráková, Zbyšek Šustek*
*Institute of Experimental Biology and Ecology, Slov. Acad. Sci., CBES,
814 34, Bratislava, Czechoslovakia*

Weismann, L., Švataráková, L., Šustek, Z., The effect of four selected pesticides on the behaviour of caterpillars in *Scotia segetum* Den. et Schiff. *Biológia* (Bratislava) 39, 129—135, 1984.

The caterpillars in *S. segetum* were reared from 2nd instar with semisynthetic diet intoxicated with different doses of four pesticides, viz. Temic G 10, VÚAgT 282, Dyfonate 10 G and Furadan G 10. In all cases, the caterpillars manifested symptoms of intoxication like a inhibition of growth, a decrease in pupae weights, an increase in the number of defect individuals and an increase of unemerged pupae. The final effect of the intoxication is retarded frequently into the later development stages. All effects of the intoxications are closely correlated in the caterpillars studied. The most effective pesticides appear to be Furadan and Dyfonate in higher doses.

The use of pesticides represents one of the negative factors which can affect the development of living non-pest organisms, the continuity of trophical chains in ecosystems and their stability with all possible fatal consequences in the economy and in the health of human population. The knowledge of reactions of non-pest organisms on the newly developed or introduced pesticides represents an important precondition of a prevention against their possible negative consequences. The aim of the present paper is to demonstrate the reactions of caterpillars of *Scotia segetum* Den. et Schiff. on four selected pesticides, viz. Temic G 10 (10 % albicarb, a product of Union Carbide Europe SA), VÚAgT 282 (5 % chlorigophos, a product of Research Inst. of Agricultural Technology), Dyfonate 10 G (10 % phonophos, a product of Stauffer Chemical SA, Genève) and Furadan G 10 (10 % carbofuran, a product of FMC Chemical SA). The reasons for the choice of these pesticides were: the actual extensive application of Furadan, Dyfonate and of Temic in agriculture and the prevention of unadvisable effects of newly developed pesticide VÚAgT 282.

Material and methods

All caterpillars used in the experiment were reared from the 2nd instar to the pupae or to adults respectively. The methods of rearing and of preparing the semi-synthetic food substrate were described in details by Weismann and Švatará-

* Corresponding author.

ková [1973]. The water solution of the tested pesticides was added into the semi-synthetic diet in such quanta to each 250 g of the diet to it contain the following doses, viz. 0.01 % Temic G 10, 0.1 % Temic G 10, 0.01 % VÚAgT 282, 0.01 % Dyfonate 10 G, 0.05 % Dyfonate 10 G, 0.01 % Furadam G 10, 0.05 % Furadan G 10. All caterpillars of each variant were weighted together in 2 days intervals. In each variant, 30 caterpillar were initially.

The speed of growth of the caterpillars is characterized by the logistic formula:

$$M_t = \frac{\bar{M}}{1 + e^{a - rt}}$$

where M_t is the weight of a caterpillar in the day t , \bar{M} is the average weight of a mature caterpillar, e is basis of natural logarithms, a is the parameter characterising the exponential phasis of the growth, r is the parameter characterizing all factors inhibiting the growth, t is the time (in days) from the start of the experiment. The parameter a was estimated by the formula:

$$a = \ln \frac{\bar{M} - M_i}{M_0}$$

where M_0 represents the average weight of a caterpillar at the start of the experiment, M_i represents the average weight on the day i ($i = 1, 2, \dots, t$). The value of i was approximated by the iteration. The parameter r was estimated by the formula:

$$r = \frac{\ln \bar{M} - \ln M_0}{t}$$

For the evaluation of other data the linear regression was used.

Results

The growth curves (fig. 1—2) show that all doses of all pesticides tested caused a considerable decrease in average weight of the caterpillars and that

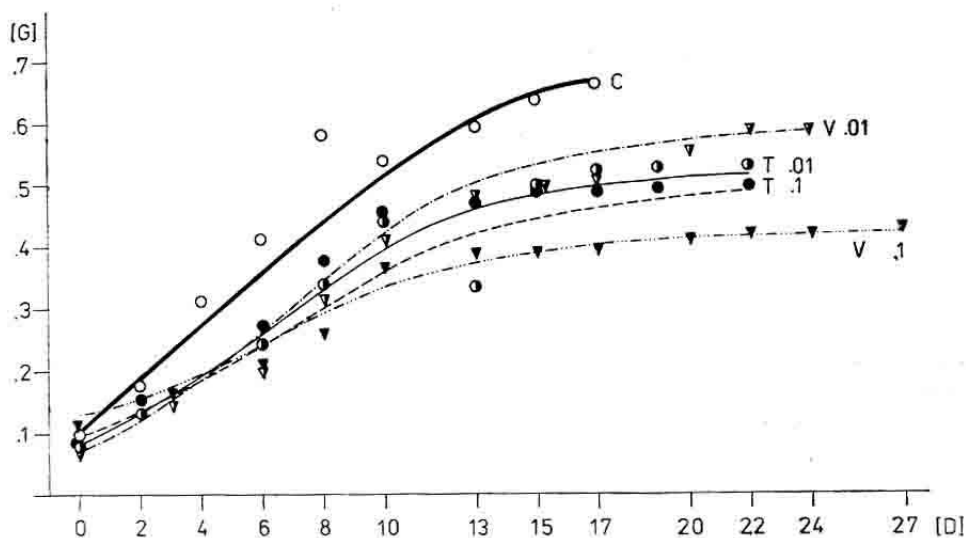


Fig. 1. The growth curves of the intoxicated caterpillars in *S. segetum* and of the caterpillars in the controle. (C = controle, T .01 = Temic G 10 0.1 %, T .1 = Temic G 10 0.1 %; V .1 = VÚAgT 282 0.01 %; V .1 = VÚAgT 282 0.1 %, ordinate = average weight of caterpillars in grams, abscisa = time in days.)

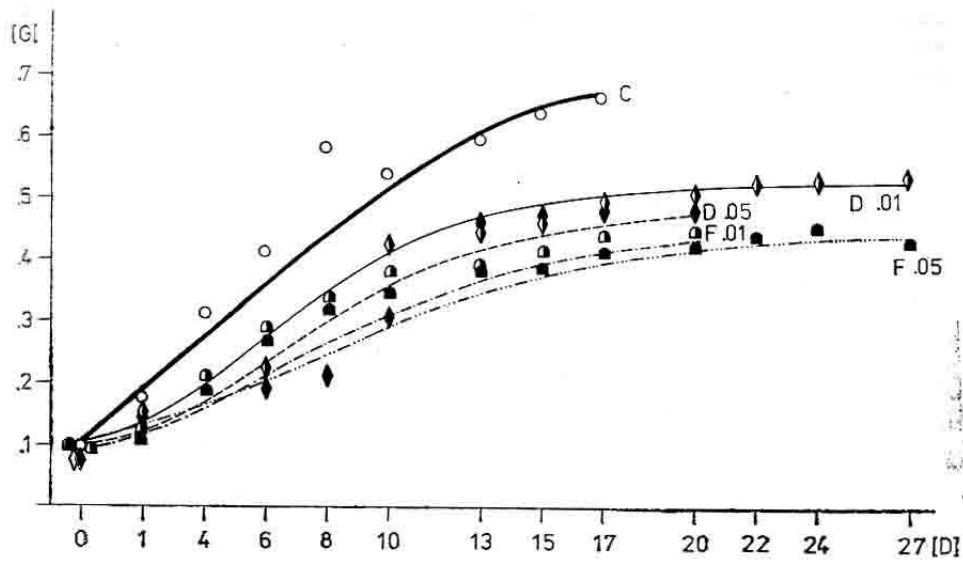


Fig. 2. The growth curves of the intoxicated caterpillars in *S. segetum* and of the caterpillars in the controle. D. 01 = Dyfonate G 10 0.01 %; D. 05 = Dyfonate G 10, 0.05 %; F. 01 = Furan G 10 0.01 %; F. 05 — Furan G 10 0.05 %; other symbols as in fig. 1.)

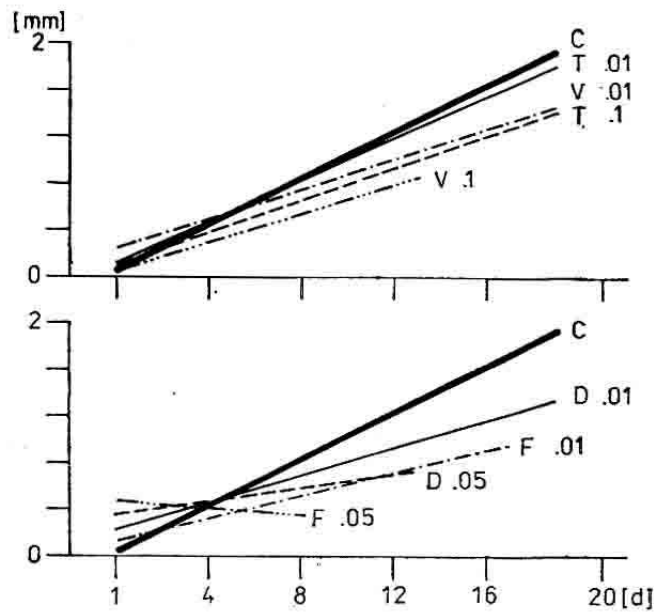


Fig. 3—4. Influence of four pesticides tested on the head capusula with width of the caterpillars in *Scotia segetum* (ordinate — head capusula with, other symbol as in fig. 1).

they prolonged the length of development for 3–6 days. The mutual differences in the influence of individual doses on the weight seem to be insignificant with the exception of VúAgt 282 in 0 in 0.01 % and 0.1 % solution (fig. 1). However, they are significant when comparing the development length (fig. 1–2) and the head width (fig. 3–4) in all cases. Consequently the increasing doses caused also a considerable decrease in the average pupal weights (fig. 5). However, the large standard deviations of the pupal weights indicate a great individual variability in the reactions of caterpillars on intoxication and rather different degree of resistance to the toxins in individual caterpillars.

The decrease in the pupal weights is closely correlated with the increase in number of the defective individuals (both pupae and adults as well) and with the increase of number of unemerged pupae (fig. 5). A deep influence of the intoxication is indirectly demonstrated also by the delay of the pupation and by the length of the pupal stage (fig. 6). The close relation was observed also between the decrease of pupae weight and the number of healthy adults. Ac-

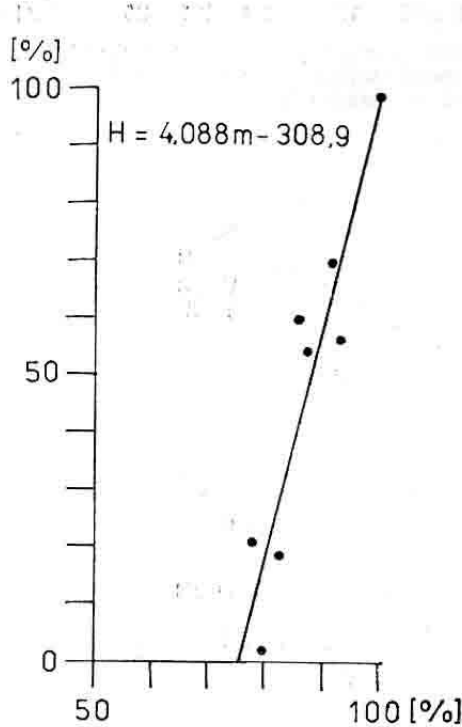


Fig. 5. Relation of the percentage of the healthy adults of *S. segetum* and of relative decrease in pupal weight. [ordinate = percentage of healthy adults (H), abscisa = relative decrease in pupal weight in %].

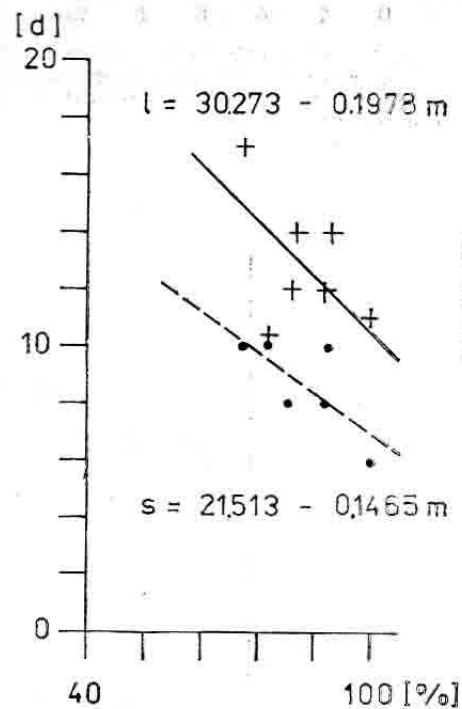


Fig. 6. Relations of the delay of the start of pupation in *S. segetum* and of its length with the relative decrease pupal weight [ordinate = time in days, abscisa = relative decrease of pupal weight in %, s = start of the pupation, l = length of pupal stage].

Accordingly, the decrease of pupal weights under 76 % of normal weight appears to be lethal.

Basing on the above facts, the tested pesticides and their doses may be arranged successively according to the degree of their effect on the development in the following way: Temic G 10—0.01 %, Temic G 10—0.1 %, VÚAgT 282—0.01 %, Dyfonate 10 G—0.01 %, Furadan G 10—0.01 %, Furadan —0.05 %, Dyfonate 10 G—0.05 % and VÚAgT 282—0.1 %.

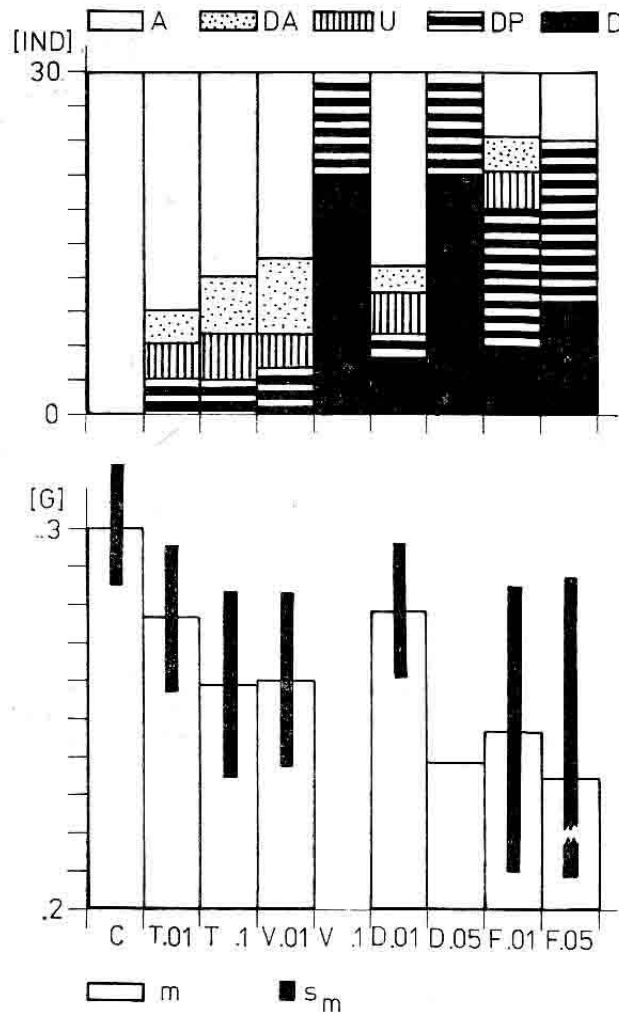


Fig. 7. Relation of numbers of healthy and defective individuals in *Scolia segetum* and of the decrease in average pupal weight [IND = number of individuals, m = average pupal weight in grams, A = healthy adults, DA = defective adults, U = unemerged pupae, DP = defective pupae, D = dead larvae, s_m = standard deviation of pupal weight, other symbols as in fig. 1].

Table 1
Regression of the biomass growth and head capsula growth in intoxicated larvae
in *Scotia segetum*

Praeparate	Conc. %	Average biomass of the larvae g	Average width of the head capsula mm
Controle	—	$m = \frac{0.6740}{1 + \exp. [1.7526 - 0.2953 t]}$	$l = 0.95561 + 0.05269 t$
Temic	0.01	$m = \frac{0.5220}{1 + \exp. [1.6844 - 0.2767 t]}$	$l = 1.00454 + 0.04979 t$
Temic	0.1	$m = \frac{0.4950}{1 + \exp. [1.3913 - 0.2307 t]}$	$l = 1.02201 + 0.03623 t$
VŮAgt 282	0.01	$m = \frac{0.5898}{1 + \exp. [1.9309 - 0.2846 t]}$	$l = 1.12807 + 0.03153 t$
VŮAgt 282	0.1	$m = \frac{0.4300}{1 + \exp. [1.0315 - 0.2228 t]}$	$l = 1.01113 + 0.03182 t$
Dyfonat	0.01	$m = \frac{0.5295}{1 + \exp. [1.6779 - 0.29108 t]}$	$l = 1.12217 + 0.02902 t$
Dyfonat	0.05	$m = \frac{0.4871}{1 + \exp. [1.6133 - 0.2603 t]}$	$l = 1.18143 + 0.02257 t$
Furadan	0.01	$m = \frac{0.4410}{1 + \exp. [1.5526 - 0.2420 t]}$	$l = 1.06663 + 0.02379 t$
Furadan	0.05	$m = \frac{0.4405}{1 + \exp. [1.3494 - 0.1910 t]}$	$l = 1.23871 - 0.01011 t$

t = time in days, l = head capsula width, m = biomass.

Discussion

Irrespective the relatively low toxicity of the 0.01 % and 0.1 % doses of Temic G 10 and of the 0.01 % doses of VŮAgT 282 as indicated by the low mortality of the caterpillars in *S. segetum*, the main effect of all insecticides tested appears to be retarded to pupal or to imaginal stages. So, even introducing rather small quantum of these substances into ecosystems seems to be capable of calling forth serious changes in the development of living organisms. As indicated by the large number of unemerged pupae and of defective adults, these changes might occur in nature fully unpredictably with the delay due to a high degree of dilution of pesticides.

From the practical point of view the use of Furadan G 10 and Dyfonate 10 G is to be treated as rather noxious. This is in the case of Furadan G 10 due to its high toxicity, in the case of Dyfonate 10 G due to high toxicity of its higher doses, and due to a possible hyperdosage in practice.

From another point of view, the large scale of variability of the pupal weights in intoxicated caterpillars indicates a high degree of resistance in a part of the caterpillars and consequently the possibility of a selection of resistant populations of *Scotia segetum* during a space of time.

Translated by authors.

References

WEISMANN, L., ŠVATARÁKOVÁ L., 1973: Influence of sodium fluoride on behaviour of caterpillars in *Scotia segetum* Den. et Schiff. *Biológia* (Bratislava), 28, p. 105—109.

VPLYV ŠTYROCH VYBRANÝCH PESTICÍDOV NA VÝVOJ HÚSENÍC SCOTIA SEGETUM DEN. ET SCHIFF.

Ludovít Weismann, Lýdia Švataráková,
Zbyšek Šustek

Húsenice *Scotia segetum* sa chovali od II. instaru na polosyntetickej potrave intoxikovanej rôznymi dávkami štyroch pesticídov, Temicu G 10, VÚAgT 282, Dyfonátu 10 G a Furadanu G 10. Vo všetkých prípadoch húsenice vykazovali príznaky intoxikácie, ako spomalenie rastu, pokles váhy kukiel a vzrast výskytu defektných jedincov a nevyliabnutých kukiel. Konečný vplyv intoxikácie bol často posunutý do neskorších vývojových štádií. Všetky prejavy intoxikácie boli v úzkom vzťahu. Ako najtoxickéjšie sa ukázali Furadan G 10 a vyššie dávky Dyfonátu 10 G.

Došlo 15. 6. 1983

ВЛИЯНИЕ ЧЕТЫРЕХ ИЗБРАННЫХ ПЕСТИЦИДОВ НА РАЗВИТИЕ ГУСЕНИЦ SCOTIA SEGETUM DEN. ET SCHIFF.

Людовит Вайсманн, Лыдия Шватаракова, Збышек Шустек

Гусеницы *Scotia segetum* питались с второй возрастной стадии на полусинтетической пище интоксигированной разными дозами четырех пестицидов, Temic G 10, VÚAgT 282, Dyfonat 10 G и Furadan G 10. Во всех случаях гусеницы обнаруживали признаки интоксикации как замедление роста, снижение массы куколок и повышение встречаемости дефектных индивидуумов и невылупленных куколок. Окончательное влияние интоксикации было часто передвинуто в более поздние стадии развития. Все проявления интоксикации были в тесном отношении. Самыми токсическими показались Furadan G 10 и высшие дозы Dyfonat 10 G.