CROP PROTECTION

Insecticide Resistance to Endosulfan, Monocrotophos and Metamidophos in the Neotropical Brown Stink Bug, *Euschistus heros* (F.)

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Resistência do Percevejo Marrom *Euschistus heros* (F.) aos Inseticidas Endosulfan, Monocrotofós e Metamidofós

RESUMO - As populações do percevejo marrom, *Euschistus heros* (F.), são normalmente controladas com inseticidas fosforados e ciclodienos (endossulfam). A ocorrência de casos de insucesso de *E. heros*, o percevejo mais comum nas regiões produtoras de soja do Paraná, São Paulo e da Região Central do Brasil, tem levado à investigação da resistência a esses inseticidas. Com essa finalidade foi avaliada a suscetibilidade de adultos provenientes de campos de soja, aos inseticidas endossulfam, monocrotofós e metamidofós. A população mais suscetível aos três inseticidas foi coletada em Londrina. A população mais resistente ao endossulfam (TR= 8,7) e ao metamidofós (TR= 2,7) foi proveniente de Pedrinhas Paulista (SP); para monocrotofós a população mais resistente foi coletada em Centenário do Sul (PR) (TR= 3,1). Percevejos *E. heros* provenientes de Toledo (PR) apresentaram níveis de suscetibilidade ao metamidofós comparáveis aos de Londrina (PR).

PALAVRAS-CHAVE: Insecta, inseticidas fosforados, ciclodienos, soja.

ABSTRACT - The Neotropical brown stink bug, *Euschistus heros* (F.), is usually controlled by organophosphate (OP) and cyclodiene (endosulfan) insecticides. Some unsuccessful control cases lead us to search for resistance to these insecticides in *E. heros*, the most common stink bug in the soybean growing regions of Paraná State, São Paulo State and Central Region of Brazil. Bioassays were performed with endosulfan, monocrotophos and metamidophos against adults. The most susceptible population was found in Londrina. Populations from Pedrinhas Paulista (SP) showed the highest resistance ratio (RR) to endosulfan (RR= 8.7) and metamidophos (RR=2.7); resistance to monocrotophos was detected on bugs from Centenário do Sul (PR) (RR= 3.1). Stink bugs collected from Toledo (PR), showed susceptibility to metamidophos comparable to those from Londrina.

KEY WORDS: Insecta, organophosphate, cyclodiene, soybean.

The velvetbean caterpillar (VBC), *Anticarsia gemmatalis* Hübner and the stink bug complex [*Euschistus heros* (F.), *Nezara viridula* (L.) and *Piezodorus guildinii* (Westwood) (Heteroptera: Pentatomidae)] are key pests of soybean in Brazil (Panizzi & Corrêa-Ferreira 1997). The VBC control is performed through applications of selective insecticides, such as insect growth regulators and microbial insecticides (nuclear polyhedrosis virus and *Bacillus thuringiensis*), and large spectrum insecticides (Moscardi & Sosa-Gómez 1993). Thus, several control alternatives exist to prevent the development of resistant populations of VBC. In contrast, stink bugs usually are controlled with non-selective insecticides, which belong to organophosphates group (OP), such as monocrotophos, metamidophos, chlorpyrifos, or cyclodiene group, such as endosulfan (Embrapa Soja 1999). Consequently, control strategies are based on spraying with a limited group of insecticides.

Use of these pesticides has led to control problems with stink bugs. Since the late 1990s soybean growers from Pedrinhas Paulista, Cândido Mota, SP, and Centenário do Sul, PR, claimed that insecticides did not provide efficient control of bugs. Although a biological control program using egg parasitoids is under development (Corrêa-Ferreira 1993, Moscardi *et al*. 1999), these agents are not available for extensive areas. Growers overuse the same type of insecticides year after year and development of resistant populations is likely to occur.

Insecticide resistance studies in soybean have been neglected. Therefore, a study was conducted to test different geographical populations of the neotropical brown stink bug (NBSB) to determine their susceptibility to the insecticides endosulfan, monocrotophos and metamidophos.

Material and Methods

Populations of the NBSB were obtained during February and March of 2000, from soybean fields at Cândido Mota, Pedrinhas Paulista (São Paulo State), Centenário do Sul, Londrina and Toledo (Paraná State) (Fig. 1). The number of collected insects were not enough to test all insecticides. The first three locations were selected due to grower´s claims that insecticides did not provide efficient control of bugs. Stink bugs were kept in rearing cages (50 x 50 x 50 cm) on soybean plants. One to two days after being collected, adults of stink bugs were submitted to the tests. Insecticides used in the bioassays were commercial formulations of monocrotophos (Nuvacron 400), metamidophos (Tamaron BR), and endosulfan (Thiodan CE). Bioassays were conducted with each geographical population, through tarsal contact of bugs with insecticide residues in a 500 ml sterilized glass bottles (8 x 14 cm, neck 5.5 cm). The bottles were filled with 500 ml insecticide suspensions (endosulfan: 280, 140, 70, 35, 17.5 and 8,75 mg a.i./L of water, monocrotophos: 320, 160, 80, 40, 20 and 10 mg a.i./L of water; metamidophos: 120, 60, 30, 15 and 7,5 mg a.i./L of water). After three minutes, the bottles were emptied and dried in a vacuum hood; the control group was treated with water. Groups of 10 to 15 adult NBSB were placed into each vial and exposed to the remaining

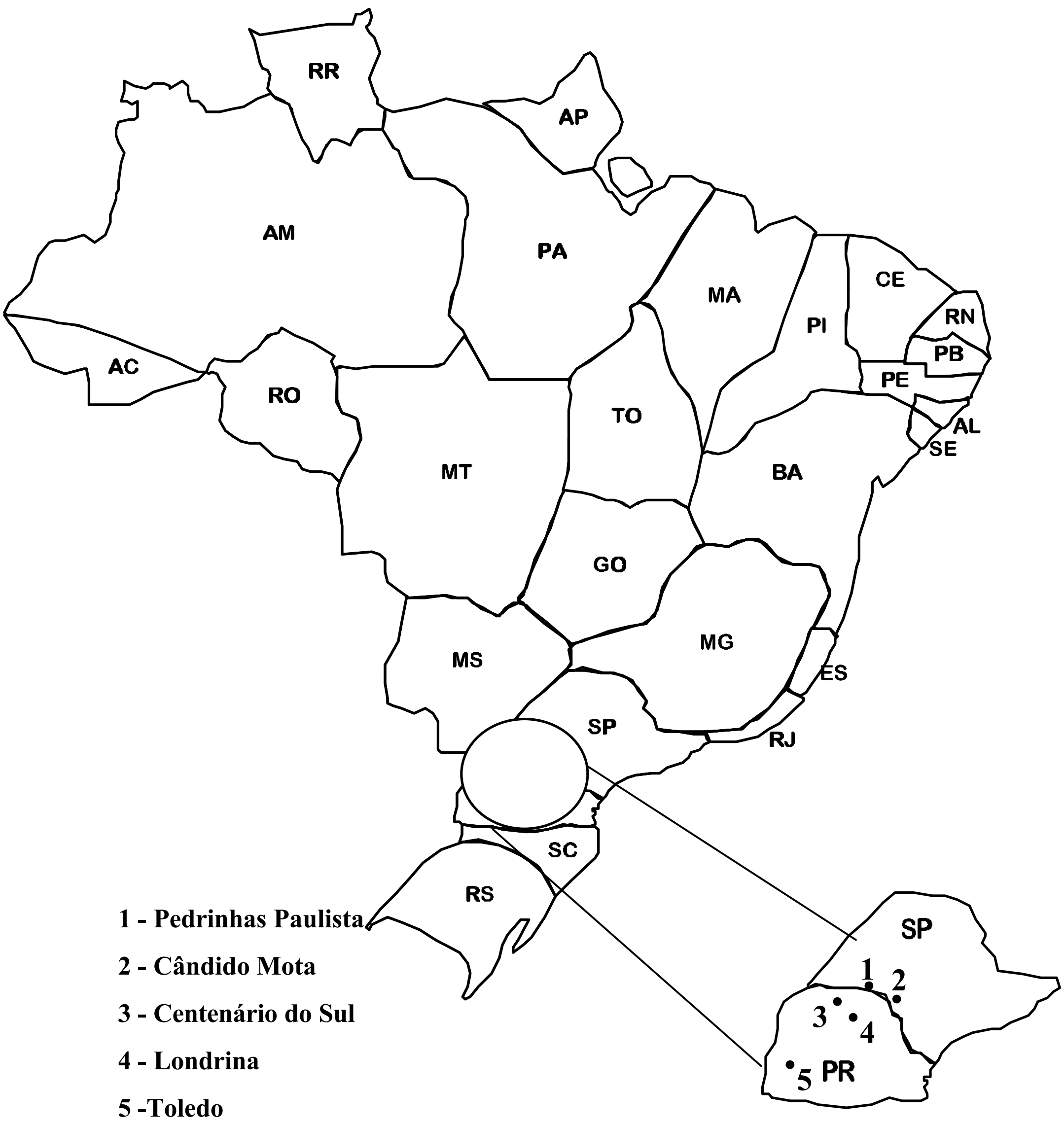

Fig. 1. South region of Brazil and distribution of the sampling points of *E. heros* populations.

residues of each insecticide concentration, in the presence of food (soybean seeds) and water imbibed cotton. Vials were kept at 25±1°C and photoperiod of 14:10 (L:D) h. Mortality was assessed after 48h. Each bioassay was replicated three times. The concentration-mortality regressions and associated parameters were estimated using a Probit analysis program (Microprobit 3.0, T.C. Sparks and A. Sparks, Lily Research Labs., Greenfield, IN), based on the method of Finney (1971). Differences among geographical populations were considered significant if 95% confidence limits of the LC_{50} values did not overlap.

Results and Discussion

The most susceptible population of *E. heros* to endosulfan, monocrotophos and metamidophos was observed from Londrina, PR (Table 1). This population possibly represents the normal response of NBSB to these insecticides and was referred as susceptible to calculate the resistance ratios (RR). To endosulfan the highest RR (8.7) was found in Pedrinhas Paulista population, followed by the Cândido Mota population (RR=3.3). The Cândido Mota and Pedrinhas Paulista populations showed low slope in the regression equation (0.905 and 0.990 respectively) suggesting heterogeneity (presence of susceptible and resistant genotypes) of response to endosulfan residues. The proportion of susceptible genotypes present in the resistant population also suggest that the resistance could be in early stage of development. In bioassays with endosulfan NBSB collected from Toledo also showed high mortality with the three highest concentrations, therefore it was not possible to obtain the regression line. With monocrotophos, the RRs were not as high as with endosulfan, however, the Centenário do Sul population was significantly different from the Londrina population showing a RR of 3.1. The results obtained from Cândido Mota populations assayed with monocrotophos did not follow the Probit model. Consequently the low RR (2.1) observed is not conclusive and, possibly this populations shows a intermediate level of resistance. Stink bugs from Centenário do Sul showed a higher heterogeneous response (b= 1.666) to monocrotophos than Cândido Mota and Londrina populations. This could mean that in Centenário do Sul some proportion of the population still remains susceptible to monocrotophos. The Centenário do Sul population was collected from a field that received two sprays of endosulfan for VBC control and two sprays of monocrotophos against stink bugs and the control was unsuccessful. Stink bugs collected from Toledo (PR), submitted to the bioassays and evaluated after 24h, showed susceptibility to monocrotophos (LC_{50}=21.5, $IC_{95\%}$= 11.8-

Table 1. Comparison of Probit associated parameters obtained after bioassays with *E. heros* geographical populations exposed to residues of insecticides. Evaluation after 48h, 26±1°C and 14:10 (L:D). 2000.

Population	n	LC_{50} (IC95%)	Slope ± SE	χ^2	RR
		Endosulfan			
Londrina, PR	135	8.74 (6.10 - 12.53)	4.254 ± 1.269	0.00 ns	1
Cândido Mota, SP	192	29.27 (1.25 – 138.84)	0.905 ± 0.424	1.392 ns	3.3
Pedrinhas Paulista, SP	270	76.45 (38.92 – 594.40)	0.990 ± 0.362	3.893 ns	8.7
		Monocrotophos			
Londrina, PR	222	5.37 (3.31 - 8.02)	2.552 ± 0.605	1.257 ns	1
Cândido Mota, SP	225	11.18 (8.22 - 15.09)	5.144 ± 1.296	5.584* (1)	2.1
Centenário do Sul, PR	130	16.63 (8.38 - 4690.28)	1.666 ± 0.780	0.326 ns	3.1
		Metamidophos			
Londrina, PR	221	8.83 (5.18 - 11.58)	4.155 ± 1.455	3.461*	1
Pedrinhas Paulista, SP	225	23.72 (19.58 - 28.48)	7.174 ± 1.648	1.648 ns	2.7

LC = Lethal Concentration of residues left by the insecticide suspension (mg a.i./l water).
df=3
RR= resistance ratio (field population LC_{50} divided by field Londrina population LC_{50})
(1)Values significantly heterogeneous P>0.05.

35.7, χ^2 = 1.66^{ns}; df=3) comparable to those from Londrina (PR) (LC_{50}=10.8; $IC_{95\%}$= 7.8-15.8; χ^2 = 0.94^{ns}, df=3). The NBSB from Londrina and Pedrinhas Paulista, when exposed to metamidophos residues, showed similar homogeneity in their response and the RR was not as high as with endosulfan. Although the bioassay with metamidophos and Londrina population showed a departure from the Probit model (significant χ^2), resistance to this insecticide may exist, since the NBSB from Pedrinhas Paulista were survival insects collected in areas with two applications against VBC and two against stink bugs.

In the soybean season, early applications of insecticides are directed against VBC, and unnecessary highly toxic pesticides are frequently used. This contributes to additional exposure of the first NBSB generations to these insecticides and influences the resistance evolution (Georghiou & Taylor 1986).

In view of the extension of the soybean crop area in Brazil the limited choices of recommended insecticides, and the fact that NBSB is a key pest (usually control is needed every year), a rational resistance management program should be adopted. Such program would prevent frequent problems in larger areas. Insecticides with the different modes of action, such as neonicotinoids and pyrethroids, may overcome problems of NBSB resistance to OP.

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