PERFORMANCE OF NYMPHAL AND ADULT *Euschistus heros* (F.) ON MILKWEED AND ON SOYBEAN AND EFFECT OF FOOD SWITCH ON ADULT SURVIVORSHIP, REPRODUCTION AND WEIGHT GAIN

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ABSTRACT

Laboratory studies with nymphs and adults of the brown stink bug, *Euschistus heros* (F.), demonstrated differences in performance depending on their diet and on food-switch from nymph to adult. In general, *E. heros* had a better performance on milkweed, *Euphorbia heterophylla* L. compared to soybean, *Glycine max* (L.) Merrill. Total nymph mortality was smaller on milkweed (21.5%) than on soybean (28.6%). Nymphs completed their development faster (21.0 days) on milkweed than on soybean (23.5 days). Adult survivorship after 50 days was the same for bugs reared on milkweed or soybean (70%). However, for bugs reared on milkweed as adults (on soybean as nymphs) survivorship was 80%; for those reared on soybean as adults (on milkweed as nymphs) this value dropped to 55%. Number of egg masses and eggs/female was the same in all food combinations, but a greater percentage of females oviposited on milkweed (90%) than on soybean (50%). Food switch from nymph to adult increased % of females oviposition but decreased egg hatchability. Adult weight after 28 days was smaller for those fed exclusively on milkweed.

KEY WORDS: Insecta, Heteroptera, Pentatomidae, *Glycine max, Euphorbia heterophylla*, food-effect.

RESUMO

Desempenho de Ninfas e Adultos de *Euschistus heros* (F.) em Amendoim-Bravo e em Soja e Efeito da Troca de Alimento na Sobrevivência, Reprodução e Ganho de Peso de Adultos

Estudos em laboratório com ninfas e adultos do percevejo marrom, *Euschistus heros* (F.) demonstraram diferenças no desempenho dependendo da dieta e da troca de alimentação de ninfa para adulto. Em geral, o percevejo marrom teve um desempenho melhor no amendoim-bravo, *Euphorbia heterophylla* L. do que em soja, *Glycine max* (L.) Merrill. A mortalidade das ninfas foi menor em amendoim-bravo (21,5%) do que em soja (28,6%). As ninfas completaram o seu desenvolvimento mais rapidamente no amendoim-bravo (21,0 dias) do que

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em soja (23,5 dias). A sobrevivência dos adultos após 50 dias foi semelhante (70%) em ambos os alimentos. Entretanto, para os criados em amendoim-bravo na fase adulta (soja na fase ninfal) a sobrevivência foi de 80%; para os criados em soja na fase adulta (amendoim-bravo na fase ninfal) esse valor foi de 55%. O número de massas de ovos/fêmea foi semelhante em todas as combinações de alimento, mas uma percentagem maior de fêmeas ovipositou quando criadas em amendoim-bravo (90%) do que quando criadas em soja (50%). A troca de alimento da fase ninfal para a adulta aumentou a % de fêmeas que ovipositaram, mas diminuiu a eclosibilidade dos ovos. O peso dos adultos após 28 dias foi menor para aqueles alimentados exclusivamente em amendoim-bravo.

PALAVRAS-CHAVE: Insecta, Heteroptera, Pentatomidae, *Glycine max*, *Euphorbia heterophylla*, efeito do alimento.

INTRODUCTION

The brown stink bug, *Euschistus heros* (F.) is a major pest of soybean, *Glycine max* (L.) Merrill in South America, particularly in Brazil (Panizzi & Slansky 1985). Beyond soybean this insect is known to feed on several other plants in southern Brazil, including species of Leguminosae, Solanaceae, Brassicaceae, and Compositae (Link 1979, Corrêa-Ferreira & Panizzi 1982, Link & Grazia 1987).

In spite of being polyphagous, and therefore able to colonize alternate hosts during the mild winter of northern Paraná state, *E. heros* was recently found to overwinter underneath dead leaves in this area (Panizzi & Niva 1994). During summer, with the great number of weeds associated with the soybean crop, the brown stink bug apparently adapted to exploit some of these weeds as a nutritional resource. This was observed with such weeds as the milkweed, *Euphorbia heterophylla* L. (Euphorbiaceae) (Meneguim et al. 1989) and with the star bristle, *Acanthospermum hispidum* DC (Compositae), this last being already studied with regard to its role in the phenology of *E. heros* (Panizzi & Rossi 1991).

Because of the increasing incidence of the brown stink bug on the milkweed, in some areas where soybean is cultivated in northern Paraná state, we decided to select this weed and to investigate the effect of it on nymphal and adult performance of this insect. We also tested the effect of changing food from nymph to adult on adult survivorship, reproduction, and weight gain.

MATERIAL AND METHODS

A colony of the brown stink bug was established in the laboratory from adults field collected on soybean plants, using cages (50 x 50 x 80 cm) with potted soybean and milkweed plants, plus dried soybean and raw peanuts (*Arachis hypogea* L.) seeds. Soybean used was of the cv. 'Paraná'.

Nymphal Study. Egg masses obtained were collected on the day of oviposition, placed in plastic Petri dishes (9.0 x 1.5 cm), lined with moistened filter paper and taken to an environmental chamber at 25 ± 1°C, 60 ± 5% RH with a photoperiod of 14:10 (L:D). After reaching the second stadium, when feeding activity starts, nymphs were placed individually in Petri dishes and distributed at random in the chamber. Forty two nymphs (replicates) were

used for each food, i.e., immature fruits of milkweed and soybean. During March and April 1992 daily observations were made on nymphal molting and mortality, and foods were replaced every two days. Nymphal mortality (%) and developmental time (days) for each stadium and from the 2nd to the 5th stadia were calculated. Data were compared using t-test at P = 0.05.

Adult Study. During February to July 1992 further studies were carried out with adults. Nymphs obtained from additional egg masses were raised to adult in Petri dishes and fed immature fruits of milkweed or soybean. Upon reaching the adult stage single female-male pairs were placed in plastic rearing boxes (12.0 x 12.0 x 3.8 cm) with moistened filter paper and covered with a lid. Ten pairs were observed for each of the following treatments: MM = nymphs and adults fed on milkweed; SM = nymphs fed on soybean and adults fed on milkweed; SM = nymphs fed on milkweed and adults fed on soybean; and SS = nymphs and adults fed on soybean. The conditions of this study was similar to those in the nymph study. Daily records were made of oviposition, egg production and hatch. Adult survival up to 50 days, percent female ovipositing, fecundity (mean number of egg masses and eggs/female), and percentage egg hatch were calculated. Fresh body weight at emergence day and at day 28 of adult life were recorded, and % weight gain calculated. Data were analyzed with analysis of variance and Duncan's multiple range test at P = 0.05.

RESULTS AND DISCUSSION

Nymphal Performance. Results of this study indicated that nymph survivorship and developmental time was affected by the different foods. During the 2nd stadium nymph

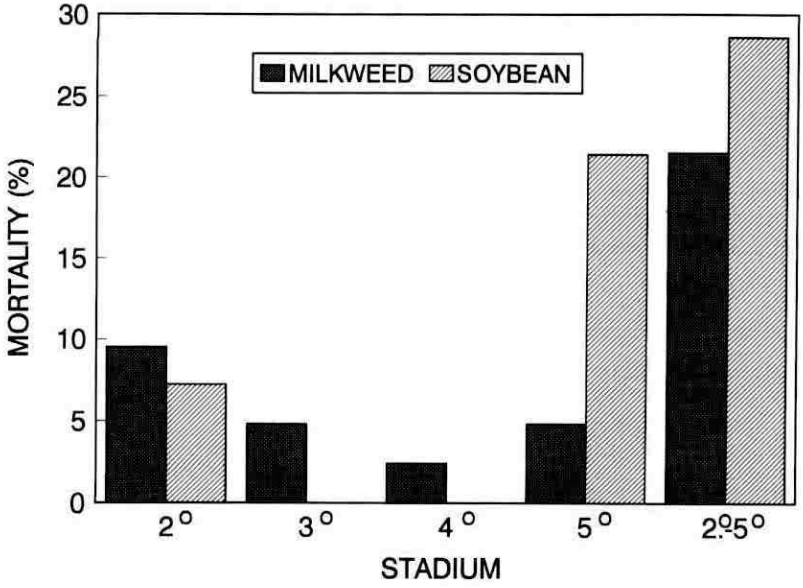

Figure 1. Nymph mortality (%) of *Euschistus heros* at each stadium and at stadia 2-5, feeding on immature fruits of milkweed or soybean.

mortality was slightly higher on milkweed (9.5%) than on soybean (7.2%) (Fig. 1); on the 3rd and 4th stadia no mortality was observed on soybean, but on milkweed 4.8 and 2.4% of the nymphs perished at the 3rd and 4th stadia, respectively. A great mortality (21.4%) was observed on soybean during the 5th stadia, while on milkweed only 4.8% of the nymphs died during this last stadium. Total mortality reached 21.5% on milkweed and 28,6 on soybean. These results can be partly explained because the fruits of milkweed have no pilosity, and, therefore, do not harm young nymphs. Hairy fruits, as soybean, are known to increase mortality of nymphs of pentatomids, such as *Thyanta accerra* McAtee (Jones 1979); the hairy indigo, *Indigofera hirsuta* L. fruits are known to cause greater mortality of nymphs of the neotropical *Piezodorus guildinii* (Westwood) compared to other species of indigo with glabrous fruits (Panizzi 1992). Also, the fruits of milkweed are exposed, and nymphs can freely access them; soybean seeds are protected with pod walls which in addition of carrying pilosity may be hard to penetrate mitigating the feeding ability of young nymphs. The effect of pod wall preventing nymphs of feeding was studied in the interaction of the milkweed bug, *Oncopeltus fasciatus* (Dallas) with *Asclepias syriaca* L., a milkweed of the family Asclepiadaceae (Ralph 1976).

The great mortality observed on soybean and not on milkweed during the 5th stadium may be attributed to several factors linked to chemical composition of the foods, with lack or unbalance of essential nutrients, presence of allelochemicals, and the physical barriers of the soybean pod preventing normal feeding activity. This stadium which precedes the final molt with more drastic change in the physiology and morphology may be more susceptible to death.

Nymph developmental time was significantly different at the 3rd and 5th stadia, being greater on soybean (Table 1). On the remaining stadia nymphs tended only to have a slower development on soybean. For total nymph duration (stadia 2 through 5) greater time was required on soybean (mean of female and male nymphs - 23.5 days) than on milkweed (mean of female and male nymphs - 21.0 days). No significant differences were observed between females and males. These results indicating faster development and greater survivorship of

Table 1. Mean developmental time (± SEM) of *Euschistus heros* feeding on immature fruits of milkweed or soybean (number of nymphs in parentheses).

Food	Stadium duration (days)[1]				Total developemntal time[1]	
	2nd	3rd	4th	5th	Female	Male
Milkweed	5.0 ± a	4.0 ± b	4.8 ± a	7.6 ± b	21.3 ± b	20.8 ± b
	0.4	0.1	0.1	0.2	0.3	0.4
(42)	(38)	(36)	(35)	(33)	(20)	(13)
Soybean	5.5 ± a	4.7 ± a	5.2 ± a	8.9 ± a	23.1 ± a	23.9 ± a
	0.2	0.2	0.2	0.2	0.6	0.3
(42)	(39)	(39)	(39)	(29)	(10)	(19)

[1] Means followed by the same letter in each column do not differ significantly using t-test (P = 0.05).

nymphs on milkweed suggest that this food is more suitable for nymphal development of *E. heros* than soybean. However, the fact that nymphs are much more abundant on soybean than in milkweed in the field, deserves further investigations. We suspect that at the field, not only nymphs but adults as well are not able to identify the milkweed *E. heterophylla* as a suitable food.

Adult Performance. Survivorship of adult *E. heros* was not greatly affected by the different food sources utilized, but the switch in food from nymph to adult (in the case of milkweed as nymphal food and soybean as adult food) did affect survivorship. After 50 days, 70 to 80% of the adults were alive in the MM, SS and SM treatments, while on the MS treatment adult survivorship dropped to 55%. Changing from milkweed as nymphal food to soybean as adult food seems to affect longevity while the reverse does not. Meneguim *et al.* (1989) did obtain greater survivorship of *E. heros* on milkweed than on soybean either immature pods or mature seeds.

Reproductive performance of *E. heros* considering number of egg masses or egg/female was similar among the different treatments (Table 2). There was a tendency only of greater deposition of egg masses and eggs when females were fed on soybean during both, nymphal

Table 2. Reproductive performance of female *Euschistus heros* feeding on immature fruits of milkweed or soybean (number of females in parentheses).

Food	Females ovipositing (%)	Number/female[1] (X±SEM)		Egg hatchability[2] (X ± SEM)(%)
		Egg masses	Eggs	
MM	90.0 (9)	6.8 ± 1.9 a (9)	61.7 ± 16.8 a (9)	94.4 ± 4.1 a (9)
MS	80.0 (8)	9.1 ± 2.4 a (8)	85.4 ± 26,2 a (8)	74.9 ± 10.9 ab (8)
SS	50.0 (5)	11.0 ± 2.2 a (5)	98.8 ± 27.1 a (5)	93.9 ± 2.0 a (5)
SM	70.0 (7)	8.0 ± 3.1 a (7)	69.3 ± 34.0 a (7)	45.9 ± 16.5 b (7)

[1] Means followed by the same letter in each column do not differ significantly using Duncan's multiple range test (P = 0.05).
[2] Data tranformed to aracsine$\sqrt{X/100}$ before analysis.
MM = nymphs and adults fed on milkweed; MS = nymphs fed on soybean and adults fed on milkweed; SS = nymphs and adults fed on soybean; and SM = nymphs fed on soybean and adults fed on milkweed.

and adult stage. However, less females oviposited when raised on this food (50%) than when raised exclusively on milkweed (90%). Food switch from nymph to adult increased % of females ovipositing in 20-30% compared to the worst treatment (SS). However, egg hatchability was affected by change in food, decreasing from ca. 94% at the MM and SS

Table 3. Fresh body weight (mg) of adult (females and males) *Euschistus heros* at emergence day (day 0) and at day 28 of adult life, feeding on immature fruits of milkweed or soybean (number of adults in parentheses) [in brackets % of weight gain].

Food	Mean (± SEM) body weight[1]	
	Day 0	Day 28
MM	57.8 ± 2.7 b (20)	76.3 ± 1.9 b (17) [32.0]
MS	66.6 ± 2.2 a (20)	84.8 ± 1.2 a (14) [27.3]
SS	67.8 ± 3.1 a (20)	92.2 ± 6.5 a (16) [37.9]
SM	62.8 ± 8.4 ab (20)	86.9 ± 7.0 a (16) [38.4]

[1] Means followed by the same letter in each column do not differ significantly using Duncan's multiple range test (P = 0.05).
MM = nymphs and adults fed on milkweed; MS = nymphs fed on soybean and adults fed on milkweed; SS = nymphs and adults fed on soybean; and SM = nymphs fed on soybean and adults fed on milkweed.

treatments to ca. 75% at the MS treatment to ca. 46% at the SM treatment (Table 2).

Adult body weight at emergence day was significantly greater at treatments SS, MS, and SM than for MM (Table 3). Twenty eight days later a similar situation was observed, with the bugs reared exclusively on milkweed presenting less weight; in spite of, having gained greater percentage weight (32.0%) than the MS treatment (27.3%) during this period. These results on weight gain suggest that despite the good performance of nymphs on milkweed, in terms of survivorship and developmental time, and of adults, in terms of reproductive performance, weight gain was not favored on this food. Therefore, switch in food from nymph to adult may mitigate the impact of a food in a particular event of an insect performance, such as weight gain; this change in food is an important component on the nutritional ecology of heteropterans, as previously pointed out by Panizzi & Slansky (1991).

In conclusion, these results demonstrate that the milkweed *E. heterophylla* is an adequate food to the brown stink bug *E. heros*. This weed is extremely abundant during summer occurring in low numbers during other seasons. We have found the brown stink bug associated with milkweed plants only when they occurred in between soybean plants during summer and in restricted areas. This occasional association at the field may be attributed to the inability of the insect to recognize the milkweed as a nutritional resource, since this association is a recent event in ecological time. Further investigations are needed to explain why this plant is so seldom explored by the insect even being a suitable food.

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