POPULATION DYNAMIC OF *Euschistus heros* (FABRICIUS, 1794) (HETEROPTERA: PENTATOMIDAE) IN SOYBEAN CROP

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ABSTRACT: Soybean *Euschistus heros* stink bug stands out as one of the main crop pests. In this context, it is essential to carry out samplings to verify population density, as it helps making control decisions. The objective of the present work was to evaluate the population dynamics of *Euschistus heros* in soybean crop. The experiment was carried out at the Experimental Farm of `Faculdade Quirinópolis` (FAQUI), municipality of Quirinópolis-GO. The experiment was installed in a total area of 3,000 m², subdivided into 30 plots of 100 m² (10 m x 10 m), each sub-area was considered a sample unit, where the *E. heros* bug was weekly assessed. The soybean cultivar used was the early-cycle Bonus IPRO 8579, with row spacing of 0.5 m and 9 plants per meter. Samples were collected using the beat cloth technique. In each sample unit (100 m^2 of area), five sampling points / cloth beat were examined. Evaluations were carried out from V4 (third fully developed trifoliate leaf), until R7 (beginning of maturation). The population fluctuation study was carried out with the average number of *E. heros* nymphs and adults. Figures were elaborated to demonstrate the population fluctuation between the average. *E. heros* infestation data and the phenological stage of the crop, and the influence of meteorological factors was analyzed through multiple regression analysis using the AgroEstat software. According to results obtained, meteorological factors did not influence population density. Infestation with nymphs <0.5 cm started in phenological stage R4, with population peak reached at R6 at 99 DAE. Regarding nymphs> 0.5 cm and bedbugs larger than 0.5 cm, similar behavior was observed. In this context, infestation begins at 64 DAE in R4, with population growth until the beginning of maturation in R7. With regard to adults, the population peak occurred at 106 DAE, in phenological stage R7. According to results obtained, higher *E. heros* population densities were found in phenological stage R6 and R7 of the soybean crop.

KEYWORDS: *Glycine max* (L.). Brown stink bug. Population density. Phenological stage. Meteorological factors.

DINÂMICA POPULACIONAL DE *Euschistus heros* (FABRICIUS, 1794) (HETEROPTERA: PENTATOMIDAE) NA CULTURA DA SOJA

RESUMO: O percevejo-marrom-da-soja, *Euschistus heros,* destaca-se como uma das principais pragas da cultura da soja. Neste contexto, é fundamental realizar amostragens para verificar a densidade populacional da espécie, pois tal procedimento, auxilia na tomada de decisão de controle. O objetivo do presente trabalho foi avaliar a dinâmica populacional de *Euschistus heros* na cultura soja. O experimento foi realizado na Fazenda Experimental da Faculdade Quirinópolis (FAQUI), no município de Quirinópolis-GO, sendo instalado em uma área total de 3.000 m², subdivididas em 30 parcelas de 100 m² (10 m x 10 m), cada subárea foi considerada uma unidade amostral, onde foram realizadas as avaliações semanais do percevejo *E. heros*. A cultivar de soja utilizada foi a Bônus IPRO 8579 de ciclo precoce, com espaçamento entre linhas de 0,5 m e 9 plantas por metro. As amostragens foram realizadas pelo método do pano de batida. Em cada unidade amostral (100 m^2 de área), foram examinados cinco pontos amostrais/batidas de pano. As avaliações foram realizadas de V4 (terceira folha trifoliolada completamente desenvolvida), até R7 (início da maturação). O estudo da flutuação populacional foi obtido com o número médio de ninfas e adultos de *E. heros.* Foram elaboradas figuras para demonstrar a flutuação populacional entre os dados médios de infestação de *E. heros* e o estádio fenológico da cultura, sendo que a influência dos fatores meteorológicos foi analisada por meio da análise de regressão múltipla através do software AgroEstat. De acordo com os resultados obtidos, os fatores meteorológicos não influenciaram na densidade populacional. A infestação de ninfas < 0,5 cm iniciou-se no estádio fenológico R4, com pico populacional atingido em R6 aos 99 DAE. Em relação as ninfas > 0,5 cm e percevejos > 0,5 cm, observou-se um comportamento semelhante, neste contexto, a infestação inicia-se aos 64 DAE em R4, com crescimento populacional até o início da maturação em R7. O pico populacional de adultos ocorreu aos 106 DAE, no estádio fenológico R7. De acordo com os resultados obtidos, verificou-se maior densidade populacional de *E. heros* no estádio fenológico R6 e R7 da cultura da soja.

PALAVRAS CHAVE: *Glycine max* (L.). Percevejo-marrom-da-soja. Densidade populacional. Estádio fenológico. Fatores meteorológicos.

INTRODUCTION

Soybean is frequently attacked by phytophagous stink bugs, and in this context, the species *Euschistus heros* (Fabricius, 1794) (Heteroptera: Pentatomidae), is considered a key soybean pest, mainly in regions of Brazil with higher temperatures (Godoy et al. al., 2010).

According to Bueno et al. (2015), bedbugs can cause drop in productivity, reduction in grain quality or inject toxins causing plant deformations. Therefore, it is essential to monitor the crop, and the application of insecticides should consider control levels and greater preservation of natural enemies, since the balance between pest insects and beneficial insects leads to increases in soybean productivity.

The population density of this pentatomid is influenced by several factors, therefore, meteorological factors biologically influence pest insects, which can change their spatial distribution and severity of crop attacks (Guini et al., 2007).

In this context, the relationship between temperature and insects is very important, as it can influence development, survival and reproduction. In practical terms, it can also change the population dynamics of pests, as well as their ability to cause damage to host plants (Panizzi; Silva, 2009).

The ideal temperature for the development of *E. heros* varies between 26°C and 28°C, with temperatures below 14°C and above 30°C being unfavorable. Thus, according to the aforementioned information, the migration of insects to regions with higher temperatures is justified (Chevarria, 2011).

According to Castex et al. (2018), relative air humidity and rainfall can have significant influences on insect population density, as higher egg mortality is observed in dry periods.

The control of *E. heros* is basically carried out with insecticides, however, this pest has shown resistance to some chemicals, which makes its management difficult and increases production costs (Sosa-Gómez et al., 2009).

According to Vivas-Carmona (2017), one of the techniques most used in crops to control insect infestations is the integrated pest management (IPM), which uses several control techniques, among which chemical and biological, which seek to avoid economic damage. Therefore, in order to determine the control level, correct insect sampling is necessary.

The study of the population dynamics and behavior of bedbugs enables understanding, throughout the crop development, in which phenological stages greater population densities of these pentatomids occur, which helps making control decisions and allows adequate management regarding the characteristics of each region (Souza et al., 2020).

The present study aimed to evaluate the population dynamic of *Euschistus heros* in soybean crop.

MATERIAL AND METHODS

The experiment was carried out at the Experimental Farm of the \`Faculdade Quirinópolis\` (FAQUI), in the 2019/2020 harvest, municipality of Quirinópolis-GO, at the following coordinates 18.480153 S and 50.497732 W, with altitude of 541 m a.s.l.

The soil in the area is classified as dystrophic Red Latosol, according to the Brazilian Soil Classification System (Santos et al., 2018). The climate has two well-defined seasons and significant annual humidity, temperature and precipitation variations, being classified as hot and humid Aw type, with summer rains (October to March) and dry winter (June to September), according to the Koppen climate typology (Ayoade, 1996).

Based on data from the National Water Agency (ANA) rainfall stations, regional rainfall varies on average from 1,500 mm to 1,700 mm, with temperature variations from 10°C to 35°C (Borges; Castro, 2010).

Soybean sowing was carried out on November 17, 2019 with the early-cycle Bonus 8579 RSF IPRO cultivar, with row spacing of 0.5 m and 9 plants per meter. For weed management, herbicides (Glyphosate 810 g a.i.ha^{-1} + Chlorimuron-ethyl 3.75 g a.i.ha^{-1}) associated with fungicide (Picoxystrobin 60 g a.i.ha^{-1} + Cyproconazole 24 g a.i.ha^{-1} + adjuvant 0.1% v/v) were used for the preventive management of foliar diseases, with bar spray and spray volume of 200 L ha^{-1} at 36 DAE (V11). No insecticide sprays were carried out during the experiment to avoid any interference in results.

The experiment was installed in a total area of 3,000 m², subdivided into 30 plots of 100 m² (10 m x 10 m), each sub-area was considered a sampling unit, where weekly evaluations of the *E. heros* bug were carried out.

Soybean crop samplings were performed using the beat cloth technique (Boyer; Dumas, 1963), in which plants were shaken on cloth measuring one meter in length by 1.50 in width until insects were dislodged and recorded. In each sampling unit (100 m² of area) five sampling points/cloth beat were examined.

It is noteworthy that the period used for data analysis were from 22 to 113 days after emergence (DAE), which corresponded to the vegetative (V4) and early maturation (R7) stages, according to the scale proposed by Fehr and Caviness (1977).

The population fluctuation study was carried out with the average number of nymphs smaller than 0.5 cm, nymphs larger than 0.5 cm, adults and bedbugs larger than 0.5 cm per cloth beat, weekly recorded. This last category was used due to the control decision making being based on when more adult bedbugs larger than 0.5 cm were found in samplings (Bueno et al., 2012).

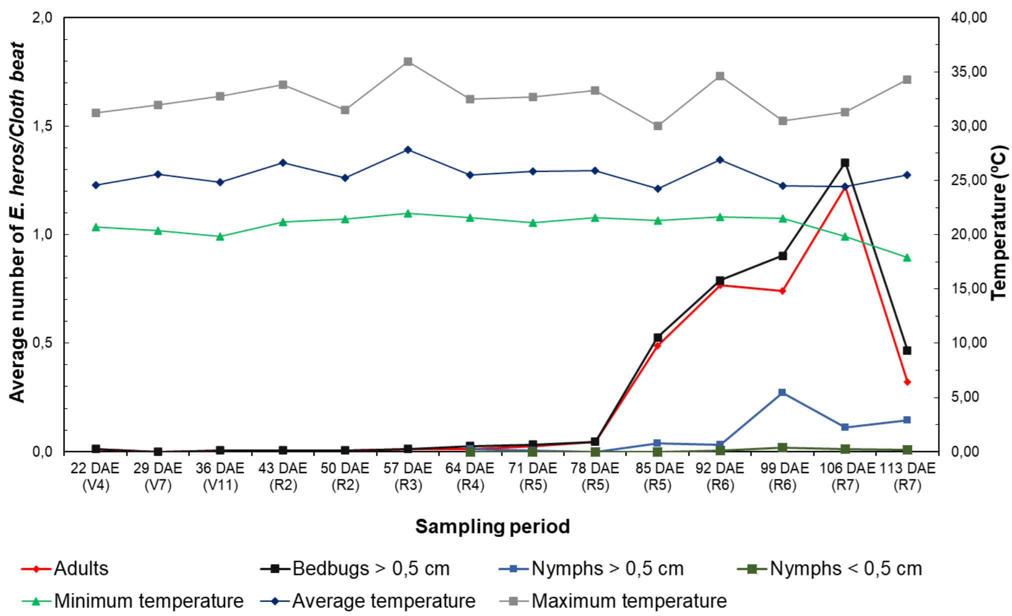
Figures were elaborated to demonstrate population fluctuation and the influence of meteorological factors was verified through multiple regression analysis performed using the AgroEstat software (Barbosa; Maldonado Junior, 2015).

The meteorological factors considered were: maximum, minimum and average temperatures (°C), rainfall (mm) and relative humidity (%), provided by the `Usina Boa Vista` Agroclimatology Station. For temperature, the weekly average was used, and in this context, for rainfall, the sum recorded in the week prior to the sampling date was considered.

RESULTS AND DISCUSSION

According to results obtained, adults started infesting the area in phenological stage V4 (third trifoliate leaf), and the presence of nymphs was only observed in R4 (completely developed pod) (Figure 1).

Figure 1. Average number of *E. heros* adults, bedbugs > 0.5 cm, nymphs > 0.5 cm and nymphs < 0.5 cm per cloth beat and relationship with temperatures (ºC).



It was observed that the infestation of nymphs < 0.5 cm started from R4 phenological stage, with maximum population peak reached in the full or complete grain phase, in the R6 phenological stage at 99 DAE (Figure 1).

According to Panizzi and Silva (2009), in annual crops, hemipterans need to infest the fields quickly, as soon as seeds begin to develop, as this is an ephemeral nutritional source.

In nymphs > 0.5 cm, the first peak is observed at 64 DAE in R4, then there was a decline until 92 DAE, however, at 99 DAE in R6, the second population peak is observed (Figure 1), later, a gradual decrease in population density is observed until 113 DAE in R7 (beginning of maturation).

Regarding the influence of meteorological factors on population density, it was observed that the occurrence of *E. heros* nymphs < 0.5 cm, nymphs > 0.5 cm, bedbugs > 0.5 cm and adults did not change with the variation of maximum, average, minimum temperatures, rainfall and air humidity (Figures 1, 2 and 3).

Figure 2. Mean number of *E. heros* adults, bedbugs > 0.5 cm, nymphs > 0.5 cm and nymphs < 0.5 cm per cloth beat and relationship with rainfall (mm).

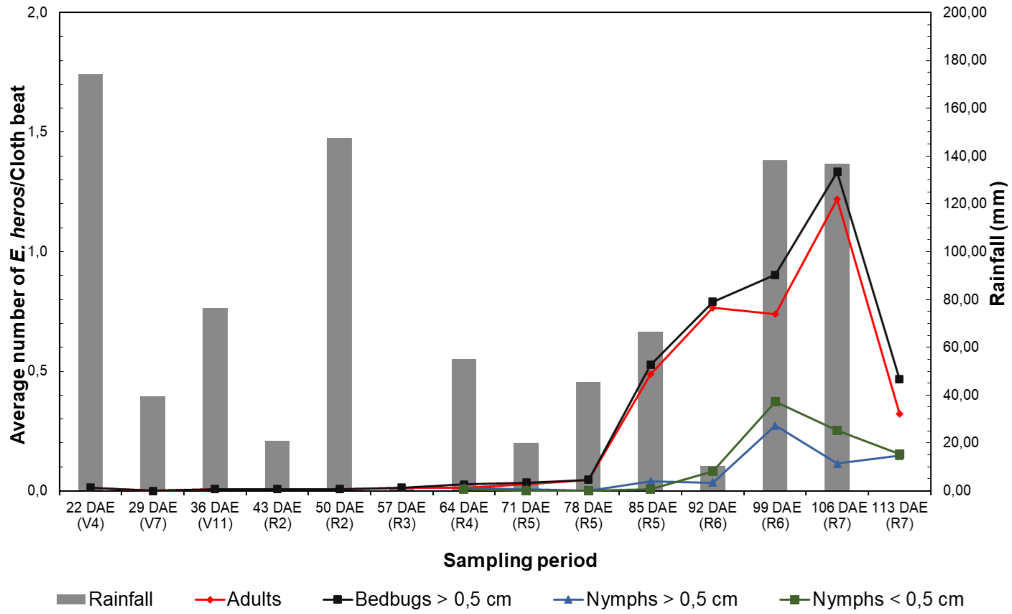
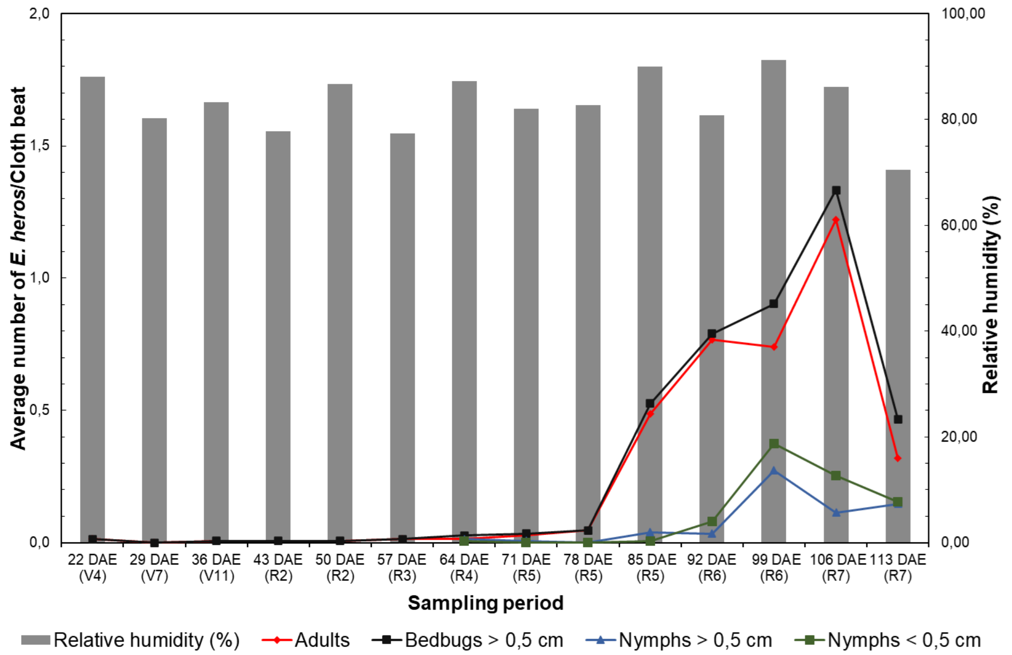


Figure 3. Average number of *E. heros* adults, bedbugs > 0.5 cm, nymphs > 0.5 cm and nymphs < 0.5 cm per cloth beat and relationship with humidity (%).



According to results, there was no correlation between environmental factors and abundance of *E. heros*, that is, meteorological factors did not influence population density, since P values were not significant (Table 1).

Table 1. Multiple regression analysis for *Euschistus heros* nymphs < 0.5 cm, nymphs > 0.5 cm, adults and bedbugs > 0.5 cm and meteorological factors. Quirinópolis - GO, Brazil.

Stage	Variable	Estimates of coefficients	R^2 Model	F model	P
Nymphs < 0.5 cm	Intercept	-2.5896	0.2303	0.4800 NS	0.5834
	Max. temperature	-0.026	–	0.0841	0.7731
	Min. temperature	-0.1573	–	0.7569	0.4092
	Average temperature	0.1648	–	0.3844	0.5529
	Rainfall	0.0006	–	0.0025	0.9581
	Humidity	0.0309	–	0.6084	0.4604
Nymphs > 0.5 cm	Intercept	-0.1473	0.1833	0.3600 NS	0.9644
	Max. temperature	-0.0085	–	0.0196	0.8956
	Min. temperature	-0.0549	–	0.1849	0.678
	Average temperature	0.032	–	0.0289	0.8685
	Rainfall	-0.0009	–	0.0121	0.9138
	Humidity	0.0096	–	0.1156	0.7403
Adults	Intercept	-16.6642	0.2786	0.6200 NS	0.2894
	Max. temperature	-0.1252	–	0.1849	0.6772
	Min. temperature	-0.7903	–	1.8225	0.2141
	Average temperature	0.8831	–	1.0404	0.3358
	Rainfall	-0.0024	–	0.3969	0.5436
	Humidity	0.1816	–	1.9881	0.1975
Bedbugs > 0.5 cm	Intercept	-16.6784	0.2779	0.6200 NS	0.3366
	Max. temperature	-0.131	–	0.1681	0.6947
	Min. temperature	-0.8455	–	1.69	0.2299
	Average temperature	0.9115	–	0.9025	0.3692
	Rainfall	-0.0025	–	0.36	0.5642
	Humidity	0.1897	–	1.7424	0.2229

NS not significant at 5% probability; R2= determination coefficient.

For category nymphs < 0.5 cm, nymphs > 0.5 cm, adults and bedbugs > 0.5 cm, it was observed that considering all meteorological factors (maximum, average, minimum temperatures, rainfall and air humidity), they explain only 23.03%, 18.33%, 27.86% and 27.79%, respectively, of the population density variation (Table 1).

The population density of adults reached peak at 106 DAE, in phenological stage R7 (beginning of maturation) (Figure 1), the increase in population density at this stage of development is due to the food preference for grains (Roggia, 2009).

The onset of infestations of bedbugs > 0.5 cm was observed at 64 DAE in R4, with increase in population density until the beginning of maturation (R7), reaching maximum population peak at 106 DAE (Figure 1). The monitoring of *E. heros* must be constant, so that the control is carried out when the population density of bedbugs > 0.5 cm reaches the control level, reducing the damage caused by the pentatomid in the soybean crop and the cost with the use of insecticides (Souza et al., 2020).

In this context, the reduction in the number of pesticide applications is essential to minimize the development of *E. heros* resistance, since the number of molecules available on the market with different modes of action is restricted, being the only case of resistance to insecticides in soybean crop detected in Brazil (Sosa-Gómez; Silva, 2010).

According to Panizzi and Silva (2009), abiotic factors such as temperature increase influence the behavior of sucking insects, and in this context, there is decrease in oviposition and food intake, therefore, increase in temperature influences the number of nymphs.

The maximum temperature ranged from 30.1ºC to 35.9ºC (Figure 1), being unfavorable to the development of this pentatomid, which hypothesis is reported by Cividanes and Parra (1994) in a study carried out on thermal and biological requirements of *E. heros* at different temperatures, and these authors showed greater egg viability at 26ºC with gradual decrease in oviposition from females reared at other temperatures (20, 22, 28 and 30ºC).

According to Souza et al. (2020), temperature was the variable that most influenced the population density of the soybean *E. heros* stink bug.

The results of the present study corroborate those obtained by Souza et al. (2020), in which *E. heros* prefers to feed on plants in the grain filling period (R5 and R6), occurring at higher population levels when compared to plants in full flowering (R2), until the beginning of pod formation (R3) (Figure 1).

Pentatomid species *E. heros* and *Dichelops melacanthus* are the most frequent and most important species for the soybean-corn system (Bueno et al., 2015), as they attack the soybean crop and later migrate to corn, attacking seedlings, causing economic losses.

The soybean-corn succession system is widely used in Brazil, which benefits the development of some pest insects such as soybean *E. heros* stink bug, which is widely distributed in successive soybean-corn crops, as no-tillage provides shelter through straw and crop succession provides food (Smaniotto; Panizzi, 2015).

Thus, *E. heros* nymphs smaller and larger than 0.5 cm showed population peak in R6, and the highest *E. heros* adult population densities were observed in R7, when meteorological factors did not influence the *E. heros* population density.

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