TRUE BUGS (HEMIPTERA: HETEROPTERA) ASSOCIATED WITH SOYBEAN (*GLYCINE MAX* (L.) MERR.) IN SOUTHERN CONE

César A. Stella*, José L. Pall* and Jaime Bernardos**

* Facultad de Ciencias Exactas y Naturales, Universidad Nacional de La Pampa, Av. Uruguay nº 151, L6300CLB, Santa Rosa, La Pampa, ARGENTINA. E-mails: cesarstella7@gmail.com; pall.joseluis@gmail.com
** INTA. Instituto Nacional de Tecnología Agropecuaria (INTA) Anguíl, La Pampa, ARGENTINA. Email: bernardos.jaime@inta.gob.ar

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ABSTRACT: The area selected for growing soybean (*Glycine max* (L.) Merr.) in Argentina, has increased in the last few years; reaching 28.6 millions hectars throughout the country, out which, 500.000 belong to La Pampa province. Usually, arthropods inhabit soybean crops during entire crop cycle. These small organisms manifest a high sensitivity to environment variations. These features are considered to be indicators of habitat heterogeneity, ecosystem diversity and the state of stress environment. The survey of phytophagus insects is not only necessary from an agricultural point of view but also from an environmental perspective. This data, allows the researcher to measure the level of Environmental stress, which contributes to the acknowledgement of an important and diverse segment of the local and regional biota. This paper was carried out in a farm planted with soybeans near "Intendente Alvear", La Pampa, Argentina. The sample method consisted of a combination of two collections methods, i.e, "pitfall" and "light trap" in three phenological stages of crops sampled (R3, R6 y R8). On the whole; a total of 3.289 Heteroptera were captured distributed as follows: 9 families, 18 genus and 20 species. The data provided in this work can be considered in Integrated Management.

KEY WORDS: Argentina, arthropods, pitfall, light trap, integrated management

Soybean (*Glycine max* (L.) Merr.), comprises one of the most important crop plants in the world, accounting for 48% of the world market for oil crops, and is also one of the most significant sources of protein for human consumption and fodder (Zhang et al., 2004; Melgar et al., 2011). By 2015, the harvest and ending stocks of soybeans in the world will be estimated at around 317 million tons, out of which 57 million tons are Argentinians, which makes it the third largest producer behind the US and Brazil (USDA, 2015). Over recent years in our country, the area selected for thick sown crop covered about 28.6 million hectars where 69% was destined for soybeans, that is to say, approximately 20 million hectars, out of which 521,000 belong to the province of La Pampa (SIIA, 2015).

The soybeans crop in the province has remarkably increased in the last thirty years, these conditions need to be analysed, because they portray the dominance of a species on geographical scale determines the exclusion of others, resulting in species richness and evenness decrease both locally and regionally (Hooper et al., 2005; Hillebrand et al., 2008; Estrada, 2008; Aizen et al., 2009). It can be considered that the loss of agricultural diversity is an indicator of environmental deterioration, where not only the diversity of crops but also the diversity of species and ecological processes associated with heterogeneous landscapes are adversely affected (Altieri, 1999).

Despite agricultural modernization processes, ecological principles are entirely left aside, as a consequence modern agro-ecosystems become unstable.

Producing imbalances which manifest as follows: recurrent outbreaks of pests and diseases in numerous crops and salinization and soil erosion, water pollution and other environmental problems (Estrada, 2008). The apparition and subsequent expansion of soybean in the Pampas region modified the traditional alternation of agricultural cycles and livestock; therefore, it was replaced by a permanent agriculturization, developing a tendency to monoproduction generated by the high relative profitability soybean in contrast with other possible productions (Reboratti, 2010). At the same time, the loss of plant diversity reduces food sources and shelter for phytophagous organisms and their natural enemies, generating higher damages in the crops by insect pests (Rosenstein et al., 2007). Herbivores considered plague exhibit greater colonization, higher reproduction, longer residence in the crop, less disruption in finding crop and lower mortality due to natural enemies (Estrada, 2008).

Soybean, a single crop, has natural enemies, among them: arthropods; which are the most diverse group of animals in the world, occupying all ecosystems, representing all lifestyles and all trophic roles (Marrero et al., 2008); These organisms manifest the following features: small size, diversity and high sensitivity to changes in the environment. As a consequence, these traits are considered good indicators of habitat heterogeneity, biodiversity and ecosystem stress state of the environment (Weaver, 1995). In the description of 1.7 million organisms, nearly a million species belong to insects, out of which 90% is in only five orders (Cassis et al., 2006).

Hemiptera constitute the fifth order of insects in many species, after Coleoptera, Diptera, Hymenoptera and Lepidoptera (Panizzi, 1998; Cassis et al., 2006). According to Henry (2009), the suborder Heteroptera comprises more than 45,000 species, which exhibit different eating habits (e.g., predators, herbivores and blood-sucking). They include insects of various sizes from millimeters to centimeters, aquatic habit, semi-aquatic and terrestrial (Henry, 2009).

The capture of phytophagous insects, in particular, contribute to the acknowledgement of an important and diverse segment of the local and regional biota (Campos et al., 2009), where some families are used as bio-indicators, by knowing the status of their populations, an investigator can determine the "health" of the environment where these populations develop. (Di Giulio et al., 2001).

Amongst the insect pests of soybean, the phytophagous bugs deserve thorough analysis, because their low levels of abundance can cause significant economic damage (Trumper & Edelstein, 2006), The process of estimating the population density of an insect considered plague is a key concept to compare economic thresholds, and determine on whether or not to make a management intervention pest populations step. True bugs are generally chosen for study because they are considered as an indicator of the diversity of insect group, the richness of insect fauna is strongly connected with the total diversity of said group (Di Giulio et al., 2001). The assembly damaging soybean cultivation bedbugs is mainly composed of the pentatomid *Nezara viridula* (Linnaeus), *Piezodorus guildinii* (Westwood), *Edessa meditabunda* (Fabricius) and *Dichelops furcatus* (Fabricius) (Massoni & Frana, 2006; Stadler et al., 2006; Gamundi & Sosa, 2007; Luna & Iannone, 2013); which become an important segment the pests that attack soybeans that feed primarily pods causing a direct and irreversible damage to the developing seeds (Gamundi & Sosa, 2007; Depieri & Panizzi, 2011).

The impact on changes in the landscape and agronomic practices on biodiversity require a study of the Heteroptera community in the northeast of La

Pampa (Reboratti, 2010; Mesquita & Alves, 2013). Then, the present work intends to depict: on the one hand, the richness ,abundance, and the identification of the main Heteroptera phytophagous and predators present in the phenological stages of soybean (R3, R6 and R8); and on the other hand, to compare the effectiveness of the sweep-net and pitfall used to catch bugs. The results provide new contributions for systematic group and constitute a contribution to Integrated Management.

MATERIALS AND METHODS

Study area

This work was developed in the Pampeana phytogeographical region (Cabrera, 1994), where Molisolls soils prevail; with an annual rainfall regime 850mm (Casagrande et al., 2006).In this area, samplings were carried out in a lot of soybeans in a farm located five kilometers away from the town of "Intendente Alvear" (35°16'S 63°36'W) (Fig. 1). The lot comprised 42has, which were firstly planted in a conventional manner with soybean group four inoculated with Nitrap; and lately, treated with glyphosate, in the postemergent stage of the soybean.

Activity Field

Three samplings were conducted of true bugs (M1: 26-01-2013; M2: 16-03-2013; M3: 10-04-2013) in three different phenological stages of soybean, R3-R6-R8 (Fher et al., 1971) respectively, with two capture methods: pitfall traps and sweep-net. Data collection for five transects were projected on separate batch cultivation 200 m from each other (Fig. 2), in which the trapping methods were applied. Pitfall traps consisted of a plastic glass of 1000cc and mouth diameter 10.8cm, which were placed 1/3 of solution (water, salt and detergent), where six traps were located by transect, three in the outer edge of the crop and three inside of the lot, and were left there for a period of seven days. Sweep-network consisted of a wooden stick 55cm long and a loop of wire with a diameter of 34 cm, to which was attached a durable fabric cone-shaped on each transect six points were taken over which was applied the pitfall coinciding with the network at each point was sampled on both sides of the transect covering a total of 20m (Fig. 3). The material was collected in bags of polyurethane which contained 70% alcohol, then were transferred and deposited in plastic containers 250cc with 75% alcohol, with their respective labels.

Lab Activity

The task was developed in the Department of Natural Sciences, Universidad Nacional de La Pampa. A file comprising the data for the presence/absence of true bugs collected by trap/transect/sampling. The identification of Heteroptera was performed using dichotomous keys, scientific papers, and comparison with material from Museo de Ciencias Naturales de La Plata (MLP), Argentina, and Museo Argentino de Ciencias Naturales (MACN), Buenos Aires, Argentina. Regarding, Miridae family its identification was carried out by the specialist Diego Carpintero.

The specific bugs were photographed using a Kodak Easy Share (12 megapixels) and a binocular microscope Wild M-Stereomicroscope 72. The material studied is deposited in the Museo de Historia Natural de la Pampa and Museo de Ciencias Naturales de La Plata (MLP).

Analysis of data

The Heteroptera were recorded in spreadsheets, separated into families, genera and species using a database of digitized photos of distinctive features among them, generated with the TAXIS ver.3.5 Meyke (1999, 2004) program, along with the use of keys to differentiate families; (Rengifo-Correa & Gonzalez, 2011; González Reyes et al., unpublished results.); then specific levels with keys and bibliographical material were identified.

Species accumulation curves based on individuals for all sampling program using the EstimateS 7.0 (Colwell, 2004) were generated to ensure that any response is not detected product sampling biases (Krebs, 1989). The Berguer-Parker index carried out in order to assess the relative abundance (Magurran, 1988). The similarity between samples was evaluated, taking into account the composition of bugs through a Kruskal Wallis (Kruskal & Wallis, 1952). In addition, Jaccard Index (Magurran, 1988) was calculated.

RESULTS

A total of 3,289 samples were obtained, distributed in 9 families, 18 genera and 20 species collected in three corresponding to the phenological stages (R3, R6 and R8) of soybean (Table I) (Figs. 4-23).

An increase in the abundance of Heteroptera was observed, as crop maturity progressed (Fig. 24), it rose by 59.53% if we compare the 113 (3.43%) specimens captured in the first sample with 2,071 (62.96%) for the third sampling, while richness increased in three species. Berguer-Parker index indicated a relative abundance of 81%, represented by the species *Piezodorus guildinii*.

The analysis of Kruskal Wallis (non-parametric method), showed a $p = 0.42$ and H (Chi 2) = 1.70, evidencing the similarity between species composition among the three samples.

A curve species accumulation was done, leading to the conclusion that for the last sampling performed, the effort was good, this is expressed in the curve (M3), which is close to an asymptote (Fig. 25).

The effectiveness of trapping methods was compared, considering the abundance of bugs, regarding the number of individuals captured, the sweep-net overruled the pitfall trap (Fig. 24).

Taking into account the periphery and center of the lot, it is observed in the periphery the amount of bugs was higher than in the center (Fig. 24), by Jaccard index, 60% similarity between the two was obtained; evaluating each method, the sweep-net earned more individuals in periphery in the last two samples, while the pitfall trap did not show an important difference in the abundance of bedbugs throughout the study.

It was observed a gradual increase in the dominant phytophagous species the crop *Piezodorus guildinii* and predator with more presence *Atrachelus cinereus cinereus* (Fabricius); although this research did not aim at performing predator/prey comparisons, the significant increase in both species could be related, because the amount of nymphs of P. *guildinii* found, and the amount of predators Atrachelus *cinereus cinereus* were both present and in large numbers.

CONCLUSIONS

On the whole the, Heteroptera composition was changed throughout the different phenological stages of the crop; as crop maturity advanced, a relationship between the phenological stages of soybean and existing Heteroptera families was drawn, due to variation in the availability and quality of food provided by the crop. Heteroptera as many in the stadium R8 was obtained.

It is convenient to use the sweep-net because it allowed collecting more individuals than the pitfall trap. A significant difference between those caught in the periphery in contrast with those caught the center was obtained; however the number of species remained constant. *Piezodorus guildinii* was the predominant species in culture with 81% relative abundance.

While this study was not considered evaluate predator / prey interactions, it would be interesting in the future to verify whether there is a relationship of this kind between *Atrachelus cinereus cinereus* and *Piezodorus guildinii.* This study sets the basis for future taxonomic, ecological, biological and conservational research on Heteroptera in La Pampa. This work provides concise information on the species present in the soybean crop.

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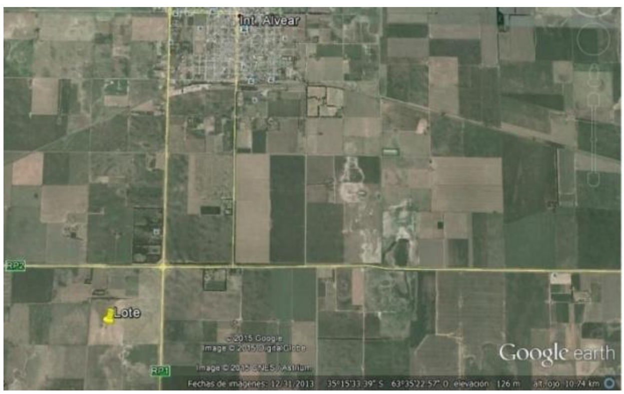


Figure 1. Satellite Location Lot soy, 2013, La Pampa, Argentina.

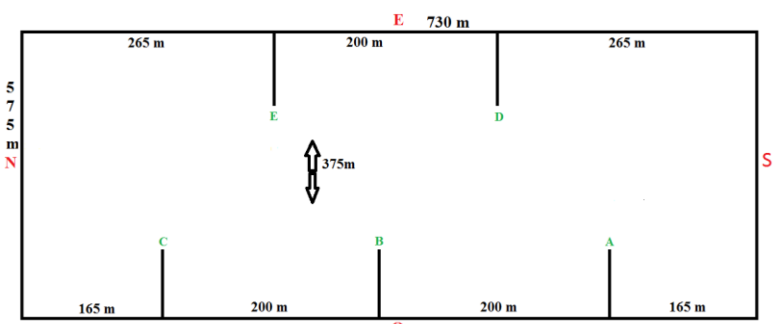


Figure 2. Size of plot and transect made, 2013, La Pampa, Argentina.

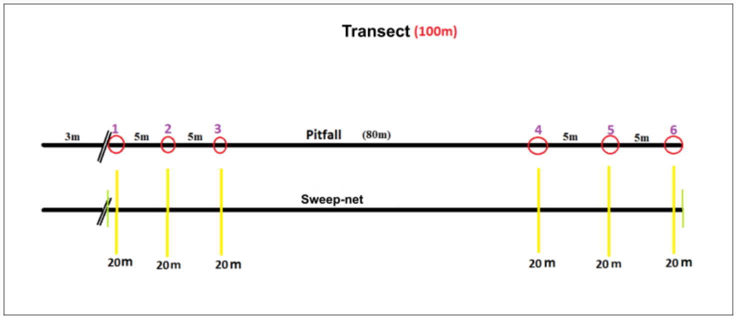
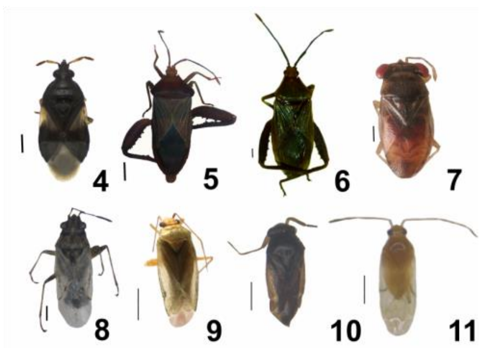
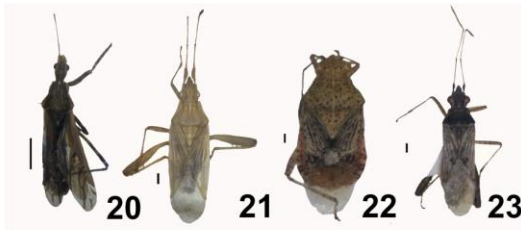


Figure 3. Location of methods, sweep-net and pitfall network, used on transects, 2013, La Pampa, Argentina.



Figures 4-11. 4 Fam. Anthocoridae: *Orius tristicolor*; 5-6 Fam. Coreidae: 5 *Athaumastus haematicus*, 6 *Athaumastus subcarinatus*; 7 Fam. Geocoridae: *Geocoris callosulus*; 8 Fam. Lygaeidae: *Nysius simulans;* 9-11 Fam. Miridae: 9 *Melanotrichus flavosparsus,* 10 *Spanagonicus argentinus,* 11 *Taylorilygus apicalis*. Scale 1mm.

Figures 12-19. 12-13 Fam. Miridae: 12 *Chileria pamparum*, 13 *Orthotylus flavosparsus*; 14-15 Fam. Nabidae: 14 *Nabis argentinus*, 15 *Nabis capsiformis*; 16-19 Fam. Pentatomidae: 16 *Nezara viridula*, 17 *Dichelops furcatus*, 18 *Piezodorus guildinii*, 19 *Edessa meditabunda*. Scale 1mm.



Figures 20-23. 20 Fam. Reduviidae: *Atrachelus cinereus cinereus*; 21-23 Fam. Rhopalidae: 21 *Harmostes procerus*, 22 *Niesthrea* pictipes, 23 *Xenogenus pituratum*. Scale 1mm.

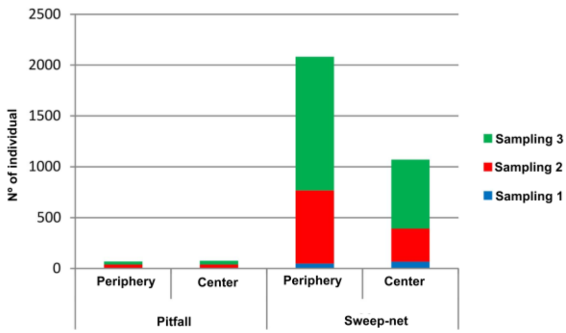


Figure 24. Comparison of both methods capture center and periphery of the soybean crop, given the abundance, 2013, La Pampa, Argentina.

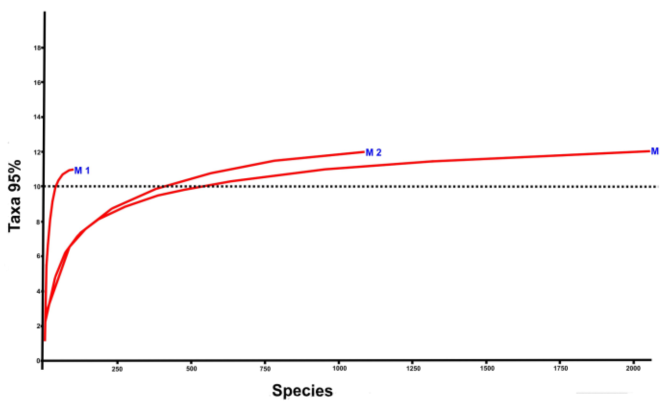


Figure 25. Curve species accumulation by individuals of each sampling in 2013, La Pampa, Argentina.

Table I. Heteroptera present in soybean, 2013, La Pampa, Argentina.

Family	Genus	Species	26/01/2013 M1	16/03/2013 M2	10/04/2013 M3	Eating habits
Pentatomidae	*Dichelops*	*furcatus* (Fabricius) (Fig. 17)	X	X	X	Phytophagous
	Nezara	*viridula* (Linnaeus) (Fig. 16)		X	X	Phytophagous
	Piezodorus	*guildinii* (Westwood) (Fig. 18)	X	X	X	Phytophagous
	Edessa	*meditabunda* (Fabricius) (Fig. 19)		X	X	Phytophagous
Coreidae	*Athaumastus*	*subcarinatus* (Stål) (Fig. 6)			X	Phytophagous
	Athaumastus	*haematicus* (Stål) (Fig. 5)		X	X	Phytophagous
Reduviidae	*Atrachelus*	*cinereus cinereus* (F.) (Fig. 20)	X	X	X	Predator
Nabidae	*Nabis*	*capsiformis* (Germar) (Fig. 15)	X	X	X	Predator
	Nabis	*argentinus* (Meyer-Dür) (Fig. 14)	X	X	X	Predator
Geocoridae	*Geocoris*	*callosulus* (Berg) (Fig. 7)	X	X	X	Predator
Rhopalidae	*Harmostes*	*procerus* (Berg) (Fig. 21)	X			Phytophagous
	Niesthrea	*pictipes* (Stål) (Fig. 22)			X	Phytophagous
	Xenogenus	*picturatum* (Berg) (Fig. 23)	X	X		Phytophagous
Lygaeidae	*Nysius*	*simulans* (Stål) (Fig. 8)	X	X	X	Phytophagous
Anthocoridae	*Orius*	*tristicolor* (White) (Fig. 4)	X			Predator
Miridae	*Melanotrichus*	*flavosparsus* (Sahlberg) (Fig. 9)			X	Phytophagous
	Spanagonicus	*argentinus* (Berg) (Fig. 10)	X			Phytophagous
	Taylorilygus	*apicalis* (Fieber) (Fig. 11)		X	X	Phytophagous
	Chileria	*pamparum* (Berg) (Fig. 12)	X			Phytophagous
	Orthotylus	*flavosparsus* (Sahlberg) (Fig. 13)			X	Phytophagous
TOTAL		20	12	12	15	