ESTIMATE BIODIVERSITY ARANEIDS (ARTHROPODA: QUELICERIFORMES) AND FORMICIDAE (INSECTA: HYMENOPTERA) IN CULTURES OF SOYBEAN AND PEANUTS FROM A SITE OF THE ECOREGION PAMPEANA

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ABSTRACT: The arthropods are a dominant group due to his morphologic characteristics. La Pampa not only possesses a scanty knowledge of the arthropodological fauna, but also presents an expansion of the agricultural area on the natural ecosystems. As controllers of these plagues, we find the spiders and the ant. The aim of this work is to evaluate the biodiversity of spiders (araneids) and the ants (formicids), in two crops peanut and soybean located in Maisonave, North-East of La Pampa, (64º S and 35º O). Samples were carried about all over a hectare of surface from December, 2008 to March, 2009. In every plot three transects were settled separated one another by 25 meters. In each transect each pitfall was placed to a distance of 25 meters. The obtained material was preserved in alcohol to 80% and settled in the subject Biology of the Invertebrate II, Faculty of Exact and Natural Sciences, of the U.N.L.Pam. The analyses were performed with Estimates. The obtained results show a dominance of the species *Solenopsis saevissima* in the ants (formicids); while in the spiders (araneids) the families Lycosidae and Thomisidae are the ones which present major abundance.

KEY WORDS: Biodiversity, soy bean, peanut, crop, Araneidae, Formicidae, Argentina.

Knowledge of biodiversity is a global challenge, due to the environmental impact of human activities on natural systems (Lagos, 2004), with the protection of biodiversity in a relevant global conservation.

In Argentina there is a simplification of the landscape for expansion and intensification of agriculture, causing a rapid fragmentation of the landscape (Zaccagnini et al., 2008) resulting in biodiversity losses.

There is concern about the possible decline of biodiversity and hence the sustainability of the current production system (Houston, 1994). In agricultural systems, biodiversity provides ecosystem services such as nutrient recycling, control of the local microclimate, regulation of local hydrological processes, the abundance of undesirable organisms and detoxification of harmful chemical residues (Altieri & Letorneau, 1982; Andow, 1991).

Conserving biodiversity is important to the proper functioning of the agro ecosystem (Zaccagnini & Calamari, 2001). Arthropods make up a high percentage of this diversity. Greater heterogeneity in culture stablish more diverse and / or abundant arthropods than in a monoculture. In the latter, removal of plant diversity reduces food sources and shelter for phytophagous organisms and their natural enemies causing increased damage from insect pests (Weaver, 1995). It is at this point that becomes important the need to know the crop arthropods for a possible IPM.

Furthermore, studies have shown that margins adjacent to agricultural areas also support arthropod populations by providing alternative sources of food, protection from pesticides and shelters during the cold season (Weyland & Zaccagnini, 2008).

The cultures began to increase, producing a fragmentation, leaving few remaining natural areas, thereby impairing diversity.

In recent years, in our province, there was a marked increase in crops such as soybeans and peanuts: in the north dominates the peanut crop, while in the central area soybean predominates.

Peanuts (*Arachis hypogaea* L.) is an annual legume 50 cm tall, presenting branched stem with oval leaves (Gispert, 1984), and has a taproot (Gillier & Wild, 1970). Argentina is concentrated mainly in the production and marketing of peanuts and edible fruit confectionery type, which are mainly exported to the European Union (Boito et al., 2006), although it is worth noting its importance as oilseed.

The soybean *Glycine max* (L.) Merrill, has a taproot, pubescent pods containing seeds rounded (EEA INTA Marcos Juárez, 2007). It is remarkable for its high protein content and nutritional quality. It occupies an intermediate position between legumes and oilseeds (Kantolic et al., 2006). The soybean and its derivatives (pellets, oil, etc.) are the main export of Argentina, one of the leading producing countries worldwide. This increase in the area planted with soybeans gave agricultural frontier expansion, due to a rapid clearing system and the replacement of natural or for crops, which means a direct loss of native biodiversity (Donald, 2004; Grau et al., 2005).

In most of them, particularly in soybean and peanut, general insecticides are applied to achieve high productivity. This results in the disappearance of natural enemies (biological control) on harmful species, which is one of the pillars of integrated pest management (IPM). Spiders and ants are important predators of other arthropods and often spatially and temporally share the same habitat.

In the last decade there has been an increasing interest in generalist predators, especially spiders (Rinaldi, 1998; Avalos et al., 2005), which are numerically important and are a diverse and successful group in all ecosystems because of its ease to disperse and colonize new habitats (Halaj et al., 1998). Their abundance and diversity in general, are positively correlated with environmental diversity at different spatial scales (Samu & Lovei, 1995), which is reflected in the variety of behaviors that they own and the habitats they occupy, and also the potential to capture a larger number of prey (Nyffeler et al., 1987, 1992; Provencher & Riechert, 1994; Riechert & Lawrence, 1997; Riechert & Maupin, 1998; Riechert 1999). The diet of spiders can be restricted when a prey type is offered in high densities, as often happens with certain pests in monoculture (Cheli, 2004). Among the arthropods, arachnids stabilizers act as agents of insect populations (Pérez-de la Cruz & de la Cruz-Perez, 2005). The study of spider predation on arthropods associated with crops, is important because of the wide diversity of insects in the agroecosystem, which include phytophagous species, predators, parasitoids, pollinators and medically important hematophagous, among others (Entwistle, 1972, 1982), involving the spiders as organisms that prey mainly insects and are part of the natural enemy complex of the same in almost all terrestrial ecosystems (Turnbull, 1973; Foelix, 1996).

Another important predator group is the ant crops. For its high diversity and biomass develop significant roles in various ecosystems (Corrêa et al., 2006; Tizón et al., 2009; Quirán & Pilati, 1997), an activity that is associated with social behaviors that develop as division of labor within the colony and cooperative work (Schultz, 2000; Wilson & Hölldobler, 2005) held in their nests, those favoring an acceleration of nutrient cycling caused by the addition of organic matter (Farji

Brener, 1992; Quirán & Casadío, 1994). They operate on several trophic levels as diverse invertebrate predation, removal and seed consumption (Hölldobler & Wilson, 1990; Pilati et al., 1997; García & Quirán, 2002), highlighting the importance here of granivorous ants (Rios Casanova et al., 2004; Pilati & Quirán, 1996; Claver, 2000). However, the importance of ants belonging to other associations as mycophagous food, fodder and generalist predator has not yet been determined, although they are also diverse and abundant in these agricultural areas (Mac Kay, 1991; Rojas & Fragoso, 2000; Casadío & Quirán, 1990).

It is necessary to know the regional biodiversity of arthropods for good practice for the protection and conservation, based on local wealth of an area at a given time, allowing estimates to larger spatial and temporal scales. Estimation of arthropods is difficult, being a hyper diverse group and most successful evolving on earth. Its anatomical and physiological characteristics have allowed them to occupy a variety of niches and micro habitats (Lagos, 2004).

In some cases they act as pollinators and dispersal of seeds in reducing plant fragments and nutrient cycling (Lagos, 2004). This study is conducted to determine the biodiversity and araneids and formicids taxocenosis of each of the cultures to determine the diversity of arthropods according to the physiognomy (structure and architecture) of the plants and of the functional groups along the phenology. It is hoped that the diversity of arthropods and functional groups vary along crop phenology, which in turn is influenced by the structure and architecture of the plant and that the abundance and richness of arthropods decrease in the centre of the cultivation.

MATERIALS AND METHODS

Study area:

The study was realized in two plots of peanuts and soy, in Maisonave (35º 2' S and 62º W), Department of Realicó (La Pampa, Argentina), (146 m asl), which are located biogeographically in the Province of Espinal, the Dominio chaqueño (Cabrera 1994) and geographically in the center-north of the province La Pampa, limiting to the north with Cordoba. This area which presents climatic differences, was subdivided in three agroecological subzones: Subzone II A (plain of hills and ridges); Subzone II B (plain with central stone) and Subzone II C (plain of the plateaus with stone) (Lorda et al., 2008).

Subarea II B comprises a small strip east Rancul Department, eastern half Department Conhelo and the Departments of Realicó, Trenel and Capital, with a total area of 1,043,741 ha.

The rainfall is about 670 mm per year, with an important month and annual variation. The climate is template with average temperature in winter of 7.7 °C and in summer of 22.8 ºC, the soils are sandy, with presence of clays in the lower areas (Cano et al., 1980). The 180 km of orientation N-S of this Subzone determine climatic differences. This situation determines a displacement in the sowing date of the summer crops between 10-15 days.

The limitations are: little effective depth, excessive natural drainage, seasonal drought and potential wind erosion in view of improper practices of soil management.

Production systems are adapted to the climate conditions and the variability in the depth of the stone, which may emerge in certain areas, or be found between 60 and 120 cm. deep. The most fertile soils are in a fringe that extends from the Provincial Route No. 2 to the north in the Department Realicó and from 40 to 50 km with direction E-W, taking as axis the National Route N° 35. They make it possible the excellent development of the forage crops and thick harvesting as sunflower or soybean, that in this area yields reach over 1800 kg/ha and 2,000 kg/ha, respectively.

Experimental Design:

The study was conducted in two plots, one for each crop, one of soy and another of peanut, using pitfall traps ("pit-fall"). Sampling was carried out from December 2008 to March 2009, once a month, covering great part of the crop phenological cycle.

The two crops cover a total area of 200 hectares. In both of them, two plots were randomly selected of one hectare each.

The field with peanut is limited by different crops, while that of soya is also surrounded by small patches of natural vegetation. In each plot three transects were drawn, each one_separated by 25 meters from the other, in which pitfall traps were placed at a distance of 25 meters from each other, resulting 5 traps per transect, and 15 traps per plot. The traps consisted in plastic containers of 1 litre of capacity and a diameter of approximately 15 cm. heaping up two thirds of its capacity with a mixture of water, sodium chloride and detergent and were allowed to operate for five days. The samples were transported to the laboratory for cleaning and fixing with 80% alcohol. After the labeling for each sample was performed the material was identified with a binocular loupe of 72 X. The taxonomic identification was performed in araneids to family level using keys (Benamú, 2007) and to the formicidae to species level (Bolton, 2007). The specimens were deposited in the chair of Invertebrate Biology II, Faculty of Natural Sciences, UNLPam. For data analysis, software PAST ver. 1.94b (2009) and StimateS 8.0 (Colwell, 2006) were used.

Curves of rarefaction were obtained. They allow comparisons of numbers of species between communities when the sample size is not equal. These software calculate the expected number of species in each sample.

The curves of Rarefaction were obtained by samples.

Rates of dominance, Simpson index and Pielou Equity (Magurran, 2004) were achieved.

RESULTS

6.854 arthropods were collected, of which 4.874 belonged to peanuts crop and 1.980 individuals of the soy. The Formicidae collected were 3.386, corresponding to 16 species. The araneids addep up 288 copies, distributed in 16 families. It can be seen that the species *Solenopsis saevissima* was dominant in the crop peanuts, and presented a greater abundance in the center of the study plot, compared with the edge (Fig.1).

In soybeans, *Pheidole bergi* was the dominant species, being more abundant in the center of the plot (Fig. 2).

As for araneids, there was a greater abundance of the families: Lycosidae, Dysderidae, and Thomisidae. In soybeans, the family Lycosidae appears mostly in the edge (Fig. 3). In peanuts, the family more abundant is Dysderidae on the edge, while the family Lycosidae is more abundant in the center (Fig. 4).

The structure of the plants of peanut and soybean change throughout their phenology. In turn, each plant is different with respect to height and diameter. The plant of peanut increases more in diameter but less in height, compared with soy, which is the other way round (Figs. 5 and 6).

Comparing both crops, a significant difference is shown (P = 0.01628). Evenness, abundance and diversity increase in soybean (Fig. 7).

According to rarefaction curves for peanuts, it is observed that the greatest diversities occur in January and March, falling in February and reaching minimum values in December (Fig. 8), with a similar behavior in soybean (Fig. 9).

The estimator Mao Tau, tends to asymptote for both peanut (Fig. 10) as for soybean (Fig. 11), demonstrating that the sample was adequate, and giving a 92% of the species sampled in peanuts, and 88% for soybeans.

In the peanut crop it is observed that predators begin to increase in December and continue like this as the culture progresses into January, where they make the peak, then decline sharply and begins a recovery for the month of March. For herbivores and others sampling is started with few individuals in December, but increase in January and February, to decrease when reaching March (Fig. 12).

In soybean, there was a greater richness of predators in December, begins in January to decrease and continues, reaching a steep slope in February and starts recovery in March. The richness of herbivores is high in December and January; decreases in February and is recovered in March (Fig. 13).

The evenness, diversity and abundance in the soybean, have a significant difference in all the phenological cycle in Table 1 (Fig. 14).

The evenness, diversity and abundance in the peanut crop, show a significant difference in the months of February and March in Table 2 (Fig. 15).

In peanuts, a greater abundance of araneids were seen on the edge, unlike the Formicidae that were more abundant in the center. (Figs. 1 and 2).

Soy showed a greater abundance of Formicidae such as araneids of the edge (Figs. 1 and 2).

DISCUSSION

The families of Araneids best represented were Lycosidae and Thomisidae, both in peanut and soybean. These results are consistent with the data of Liljesthröm et al., 2002 and Rubio et al., 2004 for a soybean crop in the provinces of Buenos Aires and Corrientes, respectively.

The lowest values registered in the graphic of rarefaction of peanut are explained in December, because of/by the beginning of the phenological crop cycle, and in February, because of/by fumigation that are very frequent in January end and February principle. In the case of soybeans, the curves of accumulation show no marked differences, probably due to less frequent fumigation.

There were differences in the abundance and richness of species in both crops, which can be explained in part by the structure of the plant. The soybean develops one high plant, which occupies a large area and, consequently, can accommodate large numbers of arthropods.

The results obtained with StimateS show that the sampling effort was correct. For the case studied, MMMeans was the best estimator because it was closer to the stability.

For analysis of functional groups, we observed that in both crops, there is a greater richness of species of predators, with respect to the presence of phytophagous. This could be understood as a result of the fumigation that are very frequent in those times of the crops, and recoveries observed in these populations, could be explained because predators usually take refuge in the surrounding natural small patches and recolonize quickly after an application. This situation does not match Andow (1991) and Tonhasca (1993), who argue that "herbivorous insects achieve higher levels of abundance and natural enemies lower abundance in simple farming systems than in diverse ones" and the results obtained in the Chaco ecoregion-Espinal, where the percentage is 65% herbivores and the predators is 23% (Weyland & Zaccagnini, 2008).

In the phenological crop cycle, of evenness remains constant, showing slight variations increase as growth progresses. Comparing the results of the edge and center of peanut, it can be seen that at the beginning of the development of the crop, the abundance is higher at the edge, but as it grows, it increases in the center, and decreases because of the fumigation. In soybean, with more separate applications over time, the center and edge difference is not so noticeable, the edge being higher in most sampling months. To this must be added the presence of small patches of natural contributors settlers, coinciding with Coombes & Sotherton (1986), Dennis et al. (2000) and Weyland et al. (2008), who argues that "empirical studies have shown that arthropod populations sustain margins by offering alternative sources of food, protection from pesticides and over-wintering shelters", this author also affirms the possibility of greater species richness found in margins with respect to crops by greater plant diversity on the site.

The species richness of formicids found is high for the study area, including in the ecoregion, which is similar to those found in other agroecosystems (Perez-de la Cruz et al., 2007; Pardave et al., 2008).

CONCLUSIONS

The araneids were dominated by the Thomisidae, Lycosidae and Dysderidae families.

The families of Araneids underrepresented were Oxyopidae, Philodromidae, Zodariidae.

The formicids presented as dominant species *Solenopsis saevissima* in peanuts and *Pheidole bergi* in soy.

The functional group of predators presents more abundance and richness for both crops, in peanuts and in soy as compared with other herbivores.

The soybeans showed more abundance and diversity, that the peanuts in relation to its structure, as it is of greater height, and can thus be shelter of more arthropods.

The differences in the results observed in the accumulation curves species of peanut and soy are due to the different frequencies of fumigation.

With regard to the comparison of the edge and center of the soybean, the abundance was greater at the edge, because the site of study is being surrounded by natural patches. Unlike peanut that suffered variations in the edge and in the center, because of insecticide applications.

The sampling effort was adequate, and demonstrated a wide diversity of arthropods in both crops.

It is necessary to further deepen such studies to apply a suitable control method.

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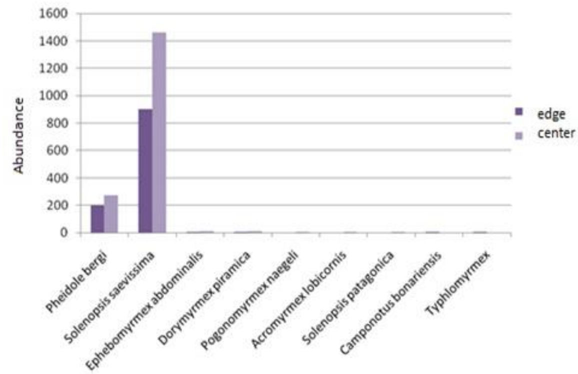

Figure 1. Abundance of ants per species collected in peanut Maisonave, La Pampa (Argentina) during 2008-9.

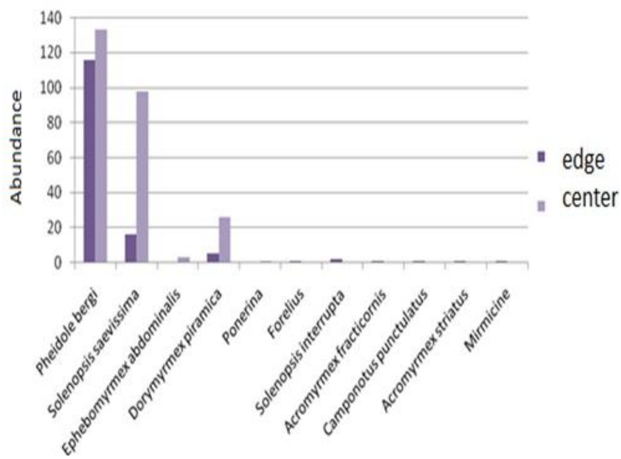

Figure 2. Abundance of ants per species collected in soybean (Maisonave, La Pampa, Argentina) during 2008-9.

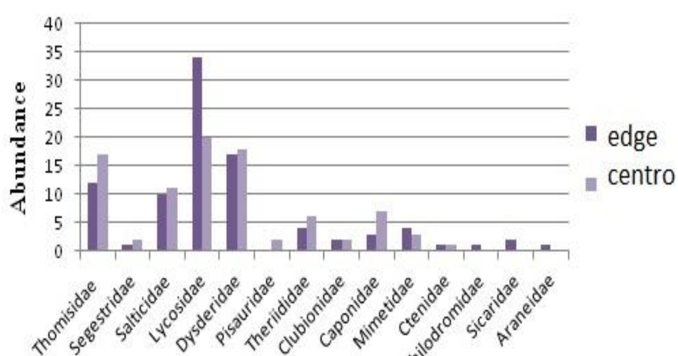

Figure 3. Abundance of araneidos per family in soybean (Maisonave, La Pampa, Argentina, 2008-9), at the edge and center of the plot.

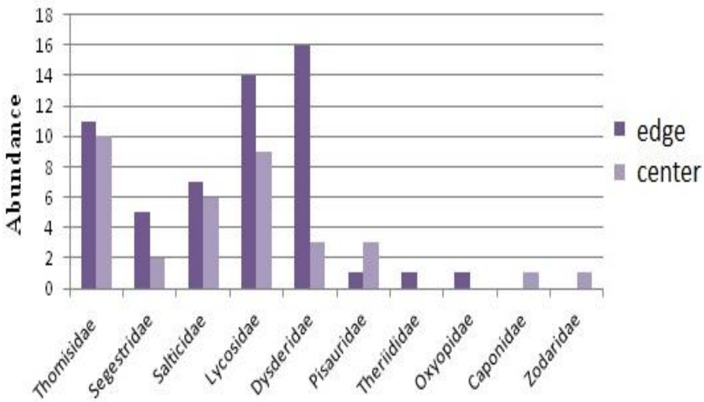

Figure 4. Abundance of family araneidos per peanut (Maisonave, La Pampa, Argentina, 2008-9) in edge and center of the plot.

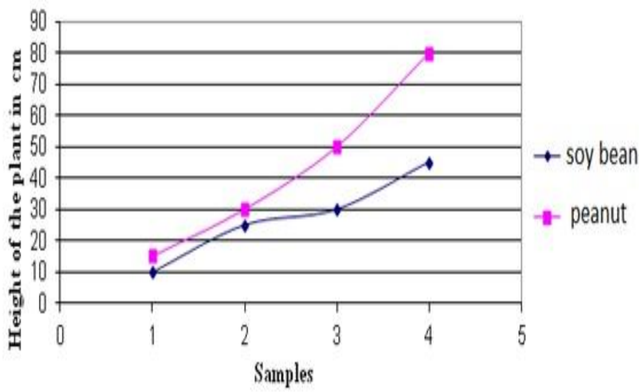

Figure 5. Comparative curves of height growth of peanut and soybean (Maisonave, La Pampa).

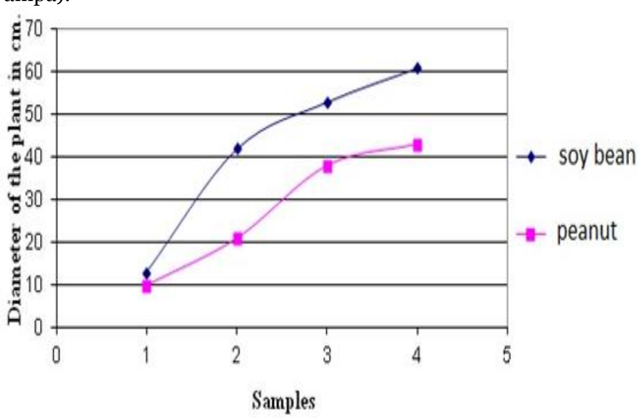

Figure 6. Diameter curves compare peanuts and soy (Maisonave, La Pampa).

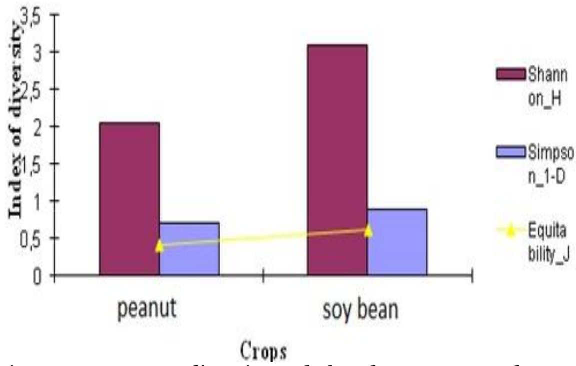

Figure 7. Evenness, diversity and abundance compared to peanut and soybean (Maisonave, La Pampa, Argentina, 2008-9).

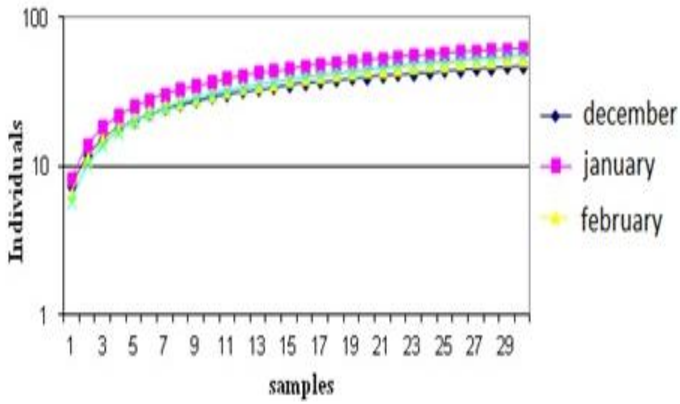

Figure 8. Arthropod rarefaction curves for mani (Maisonave, La Pampa, Argentina, 2008-9).

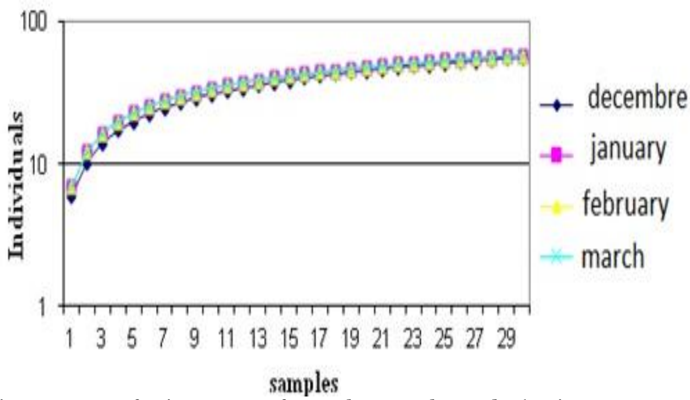

Figure 9. Rarefaction curves for soybean arthropods (Maisonave, La Pampa, Argentina 2008-9).

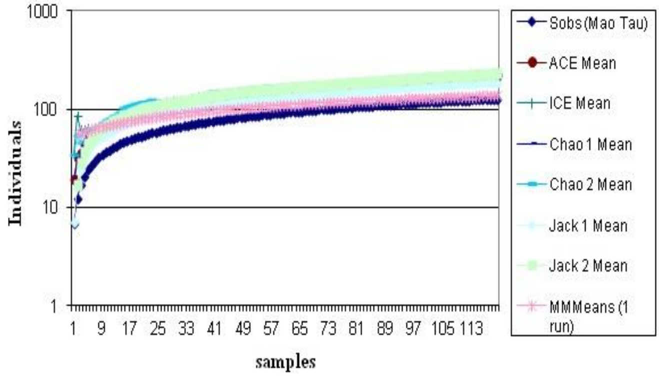

Figure 10. Estimates of arthropod richness and cumulative curves for peanuts (Maisonave, La Pampa, Argentina, 2008-9).

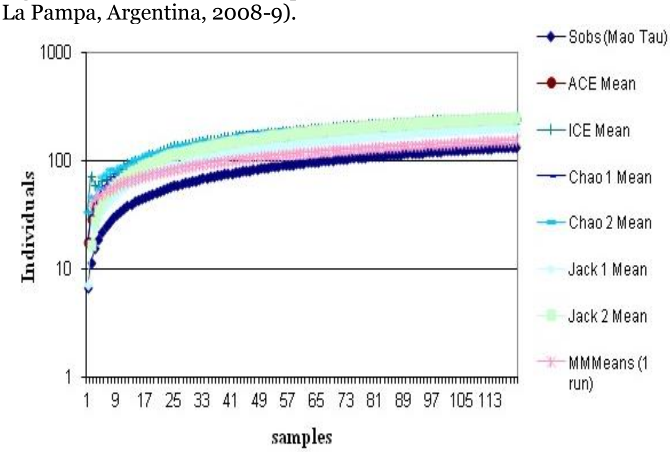

Figure 11. Estimates of arthropod richness and cumulative curves for soybean (Maisonave, La Pampa, Argentina, 2008-9).

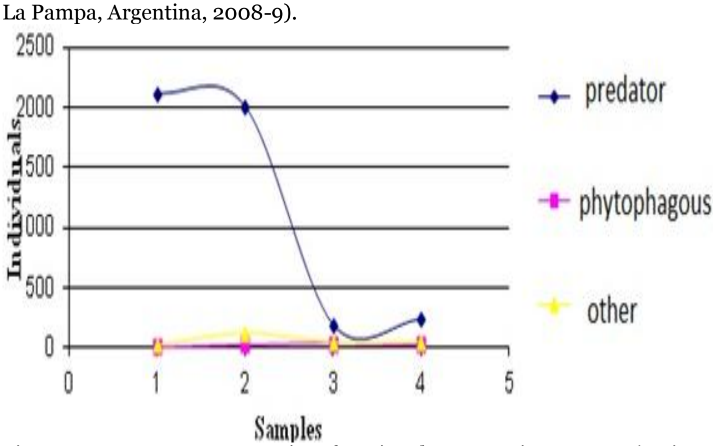

Figure 12. Curves comparative functional groups in peanut (Maisonave, La Pampa, Argentina, 2008-9).

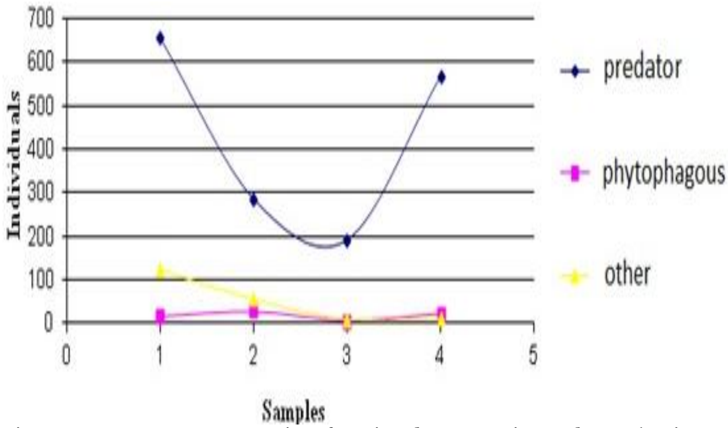

Figure 13. Curves comparative functional groups in soybean (Maisonave, La Pampa, Argentina, 2008-9).

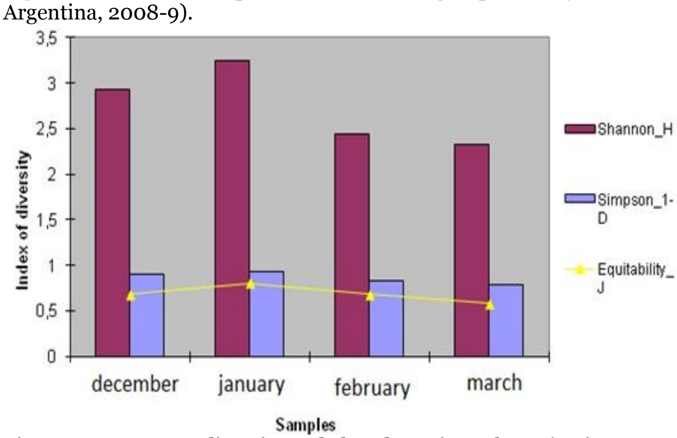

Figure 14. Evenness, diversity and abundance in soybean (Maisonave, La Pampa, Argentina, 2008-9).

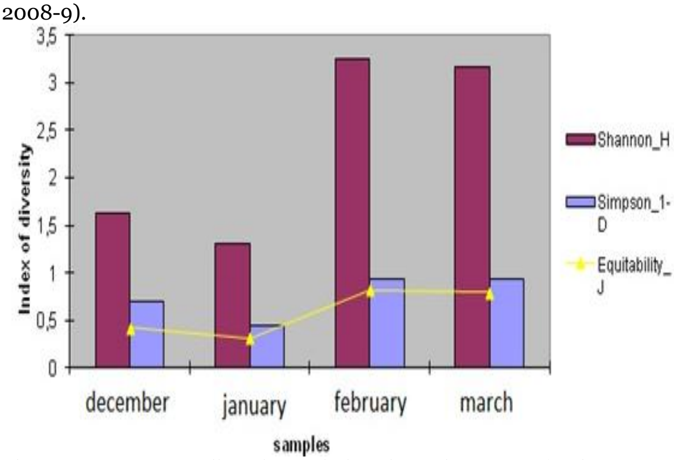

Figure 15. Evenness, diversity and abundance in peanut (Maisonave, La Pampa, Argentina, 2008-9).