POPULATION DYNAMICS OF *ENCARSIA PORTERI* (HYMENOPTERA: APHELINIDAE), EGG PARASITOID OF SOYBEAN PESTS (LEPIDOPTERA: NOCTUIDAE) IN NORTHERN ARGENTINA

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ABSTRACT: Soybean, *Glycine max* (L.) Merrill (Fabaceae), is an strategic crop in Argentina. The phytophagous insects affect its productivity, and Lepidoptera Noctuidae larvae are very important pests of the crop. In Northern Argentina, the species are *Anticarsia gemmatalis* (Hübner) (Erebidae: Eulepidotinae), *Rachiplusia nu* (Guenée) and *Chrysodeixis includens* Walker (Noctuidae: Plusiinae). Egg parasitoids are relevant antagonist of soybean Lepidoptera pests, and *Encarsia porteri* (Mercet) (Aphelinidae), is widely used in biological control in many parts of the world. The aim of this contribution is to characterize the population dynamics of *E. porteri* attacking lepidopterous pests in northern Argentina, and to gain a better understanding of the effectiveness of this native egg parasitoid in regulating their populations. Samples were taken weekly from a commercial soybean crop in both agricultural seasons, 600 leaflets were reviewed at each sampling date; Pest eggs were identified and isolated until the parasitoids emerged. There has been a significant difference between the two monitored seasons: *E. porteri* parasitoidism was low in the 2006 season, while in 2007 it was considerably higher. It is important to emphasize that for an adequate control of the pests it is necessary to know the action of its natural enemies.

KEY WORDS: *Glycine max,* defoliating species, incidence, control, natural enemies

Soybean, *Glyicine max* (L.) Merrill (Fabaceae) is an important crop in subtropical regions of Argentina and is under the attack of several insect pests (Aragón & Flores, 2006). The most harmful species for crops are phytophagous; amongst which the lepidoptera noctuidae stands out (Nasca & Lázaro, 1993). Its larvae behave as defoliators, affecting the photosynthetic performance and thus productivity of the crop.

Anticarsia gemmatalis (Hübner) (Erebidae: Eulepidotinae), *Rachiplusia nu* (Guenée) and *Chrysodeixis includens* Walker (Noctuidae: Plusiinae), were mentioned as important soybean pests in Northwest Argentina; in addition, other species could be sporadically present, such as *Spodoptera frugiperda* (J. E. Smith), *S. eridania* (Stoll), *S. cosmiodes* (Walker) (Noctuinae: Prodeniini), *Helicoverpa gelotopoeon* (Dyar), *H. zea* (Boddie) (Heliothinae), *H. armígera* (Hübner), *Agrotis ipsilon* (Guenée) (Noctuinae: Noctuini) and *Mocis latipes* (Guenée) (Erebidae: Erebinae) (Lázaro et al., 1990; Valverde et al., 2008c; Casmuz et al., 2010; Barrionuevo et al., 2012; Murúa et al., 2014).

Previous research determined that these pests have an important complex of natural enemies in Northern Argentina, among which the parasitoids stand out, and mainly wasps (Hymenoptera) (Berta et al., 2009); but the highest incidence were produced by egg parasitoids*: Trichogramma pretiosum Riley*, *T. bruni Nagaraja* (Trichogrammatidae), *Telenomus cyamophylax Polaszek* (Platygastridae) and *Encarsia porteri* (Mercet) (Aphelinidae) (Ovruski & Frías, 1995; Valverde, 2003, 2005; Valverde & Virla 2007; Valverde et al., 2008a,b).

Encarsia porteri is a heterotrophic parasitoid (males develop in Lepidoptera eggs and females in Hemiptera eggs) widely used in biological pests control (Flanders, 1936a,b). In South America, it is distributed throughout Peru, Brazil, Chile and Argentina (De Santis, 1979; Polaszek et al., 1992, 1995; Cave, 1995; Bernal Vega & Basedow, 2000; Olivera et al., 2003). In Argentina, it was cited for Chaco, Santiago del Estero, Tucumán, Buenos Aires and Mendoza provinces (Ovruski & Frías, 1995; Viscarret et al., 2000).

E. porteri has several hosts: *Aleurothrixus aepim* (Goeldi), *A. porteri* Quaintance & Baker, *A. floccosus* Maskell, *Aleurothrixus graneli*, *Bemisia tabaci* (Gennadius), *Aleurocanthus sp.* and *Trialeurodes vaporariorum* (Westwood) (Aleyrodidae), and *Colias vauthieri* Guérin-Meneville (Pieridae), *Gnorismoschema operculella* (Zeller), *Phthorimaea operculella, Sitotroga cerealella* (Gelechiidae), *Rachiplusia nu* Guenée, *Chrysodeixis includens* (Walker) *Helicoverpa zea* (Boodie), *Helicoverpa gelotopoeon, Anticarsia gemmatalis* (Hűbner) and *Copitarsia turbata* (Herrich & Schaffer) (Cuculliinae). *Agrotis subterránea, Alabama argillacea, Mamestra brassicae* (Noctuoidae)*, Anagasta kuehniella, Diatraea saccharalis, Ephestia kuehniella, Galleria mellonella* (Pyralidae), *Cydia pomonella, Cydia pomonella, Eucosma aporema* (Tortricidae), *Plutella maculipennis, P. xylostella* (Yponomeutidae) (Lepidoptera) (Noyes, 2016).

In Brazil, the *E. porteri* was found attacking the *B. tabaci* (Oliveira et al., 2003). In Chile, it was found affecting the whiteflies *T. vapororiorum*, *Aleurothrixus floccosus,* and *Crocidosema* (*Epinotia*) *aporema* (Walsingham), *Proeulia auraria* (Clarke) (Lepidoptera: Tortricidae), *Phthorimaeae operculella* (Zeller), *Rachiplusia nu*, and *Tuta absoluta* (Meyrick) (Paz, 2012). In Peru, it was cited affecting populations of *Bemisia tuberculata* Bondar (Andrade Filho et al., 2012). In Argentina, *E. porteri* was obtained from *Anticarsia gemmatalis* and *C. includens* eggs (Ovruski & Frías, 1995) inhabiting soybean crops; Viscarret et al. (2000) mentioned *E. porteri* parasitoidizing *B. tabaci* group on cotton (*Gossypium hirsutum*) and soybean crops, in Santiago del Estero and Tucumán respectively; and attacking *T. vaporariorum* on sage (*Salvia splendens*) in Buenos Aires province. In addition, Holgado & Mácola (1998) obtained it from *Siphoninus. phillyreae* (Haliday) (Hemipteran: Aleyrodidae) in Mendoza province.

The literature reveals that there are information on hosts and host plants, but there is a lack of knowledge on some biological aspects of the parasitoid like population dymanics and incidence on pests in which develop. Therefore, the aim of this research was to characterize the population dynamics of *E. porteri* attacking *Anticarsia gemmatalis, Rachiplusia nu* and *Chrysodeixis includens* in northern Argentina in Tucumán, and to gain a better understanding of the effectiveness of this egg parasitoid in regulating populations of these pests. Future control strategies may include augmentation of natural enemies or the importation of additional egg parasitoids; therefore, base-line data also are needed to determine the impact of such future programs.

MATERIALS AND METHODS

Samples were taken during two crop seasons (2006, 2007) in a commercial soybean plot in fields of the Instituto de Investigación Animal del Chaco Semiárido (IIACS INTA Leales) (Leales Department, Tucumán, Argentina: 27º11'34.85 S - 65º13'31.96 O, 327 m.asl). The area of study is located in the agrological "depressed lowplains region" (Zuccardi & Fadda, 1985). The variety of soybean sown was A-8000 RG (MD VIII). Crop management has been done following the conventional practices, sowing in late December and harvesting in May in both seasons. Seed were treated with "Imidacloprid", and then two pyrethroid insecticides were sprayed for controlling larvae (cypermethrin, 25%, 75cc per hectare), on January 6th and February 1st during the first season; and on January 17th and February 12th during the second one.

Sampling

Samples were taken from the vegetative (V_1) to the reproductive (R_8) stages (see Fehr et al., 1971, for phenological descriptions), taken a rising variable number of leaflets, xx in V_1 , XX in V_2 stage and xx in V_3 stages, and from V_4 a total of 600 per date of sample, taking into account leaves availability and crop phenology. Sampling was done weekly in a 2 hectares plot, randomly choosing 20 sites; on each location a group of ten plants was taken, from which leaflets were extracted. 97200 leaflets were checked throughout both crop seasons, 16 sampling dates in the first and 18 in the last.

Identification

In the laboratory, leaflets were examined under a stereoscopic microscope (20x), and those containing eggs lepidoptera eggs were isolated with the portion of leaflet to which they were attached. These were placed in gelatin plastic capsules (2 x 0.5 cm), kept under laboratory conditions (24ºC, 75-85 % RH and natural photoperiod) until the emergence of Lepidoptera larva or parasitoids.

After the emergence, egg chorion was rinsed with lactophenol and, using entomological needles, cleaned in order to be observed under stereoscopic microscope. The identification of the eggs at species level was made considering the structure and design of chorion micropile following the keys of Weigert & Angulo (1977), Gregory & Barfield (1989), Angulo & Olivares (1991), and Angulo et al. (2006).

Data Analysis

All eggs parasitoidized by oophagous species and the number of eggs affected by *E. porteri* were analyzed through a Generalized Linear Model (GLM) with a Poisson error structure linked to the function of the logarithm (α= 0,05). For each model, crop season was included as a fixed factor; the total number of eggs per season was included as a covariate, while dates were included as a shift variable. The inclusion of a shift variable allows to treat data as rates (i.e. number of parasitoidized eggs per sampling date) instead of absolute numbers (i.e. counting) (Heck et al., 2012). In this case, shift is the variable used to show the number of sampling in a Poisson regression (Heck et al., 2012). The standard errors of estimated and statistical parameters were calculated considering over dispersion. For statistical analysis, IBM SPSS Statistics for Windows, Version 22.0 was used.

RESULTS AND DISCUSSION

In 2006 crop season, 618 Noctuidae eggs were collected and 818 in 2008, with an increment of 24.4%.

During the study, there were collected eggs of the following species: *A. gemmatalis Mocis latipes* (Guenée) *R. nu*, C. includens, *Spodoptera eridania* (Stoll), *Spodoptera cosmiodes* (Walker), *Peridroma saucia* (Hübner), *Agrotis* sp. and *Feltia* sp. However, the three species more abundant and frequents were

Anticarsia gemmatalis, Chrysodeixis includens and *Rachiplusia nu* (53, 15 and 13% *C.* respectively).

Fluctuation of host eggs and *E. porter*

The total number of Lepidoptera eggs was different in both crop seasons. However, the statistical analyses do not show significant differences in the registered values.

In 2006 crop season, it was detected the highest number of eggs in the first phase of the vegetative stage, an abrupt fall in the middle of it, and another peak at the final of the vegetative development and at the beginning of the flowering stage, decreasing gradually during crop senescence (Fig. 1).

In the 2007, there was a lower number of eggs at the beginning of the crop development, and the number of eggs had a significant increase since the last vegetative stages, reaching maximum values from the end of the vegetative stage to the beginning of the flowering period. Regarding the number of eggs parasitoidized by *E. porteri*, it was higher than in the previous season, the highest values were observed coinciding with the occurrence of a noticeable peak of eggs (Fig. 1).

Parasitoidism Levels

In 2006 season, parasitoidism by *E. porteri* was minimum, with a mean of 0,38% of attack (range 0 – 0,91%).

In the 2007, the number of eggs parasitoidized by *E. porteri*, it was higher than in the previous season, mean 9,77% (range: 0 - 9,77%). The highest values were observed coinciding with the occurrence of a noticeable peak of eggs.

The higher parasitoidism by *E. porteri* was recorded for 2007 crop season. It was statistically proved by a GLM analysis with Poisson error structure (X^2 wald = 37,954, P≤ 0,005). Concerning population fluctuation of *E. porteri* throughout crop development, there were not found antecedents that allow to compare the results obtained in the research. The difference in the levels of parasitoidism registered in both seasons is not surprising, given that it is known that one of the fundamental properties of population dynamics is that number or density of individuals increases when the conditions are favorable (Van Driesche, 1996). This population rise could have its origin due to an increase in reproduction or survival of parasitoids descendants, induced by an increment of hosts availability. Specifically, in the case of *E. porteri,* its population dynamics is surely conditioned by the simultaneous presence of both classes of hosts, because of its heterotrophic condition. In Argentina*, Bemisia tabaci* Genn and *Trialeurodes vaporarorium* (Westw.) have been cited affecting soybean crop (Viscarret et al., 2000; Gonsebatt et al., 2006).

Despite a slight difference in the levels of attack by *E. porteri* against *A. gemmatalis* eggs, the statistical analysis demonstrated that the egg parasitoid did not show hosts preference (Fig. 2).

CONCLUSION

The levels of attack by this species of egg parasitoid are low. *E. porteri* seems to show denso-dependent strategy, but limited by the availability of the two host taxa (Lepidoptera and Hemiptera).

The highest *E. porteri* parasitoidism level during 2007 crop season was coincident with a noticeable peak of lepidoteran eggs in the period.

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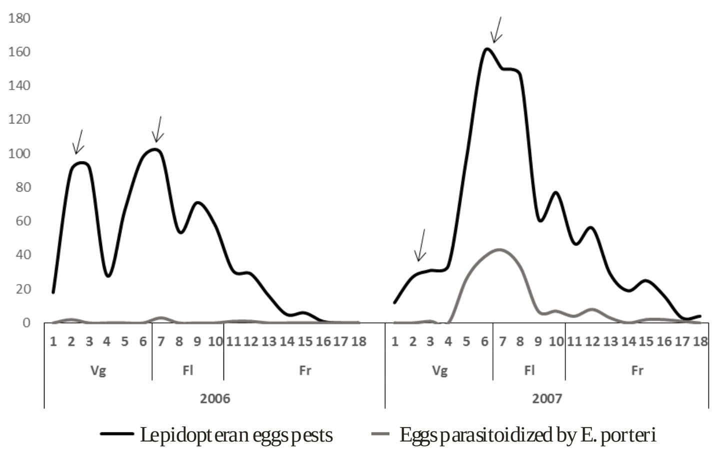

Figure 1. Number of eggs of Lepidoptera pest in soybean and eggs parasitoidized by *E. poteri,* throughout the phenological development in two crop seasons in Leales (Tucumán). (Vg: Vegetative stage, Fl: Flowering; Fr: Fructification). The arrows indicate insecticides application.

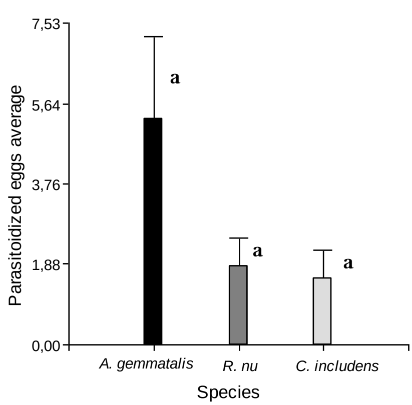

Figure 2. *E. porteri* parasitoidism levels together with the main pests species of soybean.