ECOLOGIA, COMPORTAMENTO E BIONOMIA

Distribution of Eggs, Larvae and Adults of *Sternechus subsignatus* Boheman on Soybean Plants in No-Till System

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Distribuição de Ovos, Larvas e Adultos de *Sternechus subsignatus* Boheman em Plantas de Soja em Plantio Direto

RESUMO - Estudou-se a localização e a distribuição de ovos, larvas e adultos de *Sternechus subsignatus* Boheman (Coleoptera: Curculionidae) em plantas de soja [(*Glycine max* (L.) Merrill] e no solo, em diferentes horários do dia, em lavouras comerciais no sistema plantio direto, entre as safras agrícolas de 1990/91 a 1996/97, em Cruz Alta e Júlio de Castilhos (RS). Ovos e larvas foram encontrados na haste principal, nos ramos laterais e nos pecíolos, nas partes superior, mediana e inferior das plantas. Não se verificou movimento das larvas para as partes mais altas ou mais baixas das planta à medida que se desenvolveram. Ovos (90%) e a maioria das larvas (87%) foram encontrados na haste principal e na parte mediana das plantas (79% e 78%, respectivamente). Adultos foram encontrados no terço superior, médio e inferior das plantas e no solo, em todos os horários de coleta. Verificou-se movimentação dos adultos para as partes mais altas das plantas durante a noite, e para as partes mais baixas das plantas e para o solo, durante o dia. Esses resultados evidenciam que a maioria dos ovos e das larvas fica protegida no interior da haste principal e na parte mediana das plantas, sob a folhagem. Adultos, durante o dia, ficam escondidos nas partes mais baixas das plantas, entre as folhas e no solo.

PALAVRAS-CHAVE: Insecta, Curculionidae, ecologia, comportamento, sistema de cultivo.

ABSTRACT - Soybean [(*Glycine max* (L.) Merrill] commercial fields, maintained under a no-till system, were sampled during the crop seasons 1990/91 and 1996/97, in Cruz Alta and Júlio de Castilhos, Rio Grande do Sul State, to determine the distribution of eggs, larvae and adults of *Sternechus subsignatus* Boheman (Coleoptera : Curculionidae). Soybean plants and soil were examined at different time schedules. Eggs and larvae were recorded in main stems, lateral branches and leaf petioles, divided into the upper third, medium and lower third of soybean plants. Eggs (87%), and larvae (79%) were mainly observed in the main stem and in the medium plant sections (87% and 78%, respectively). Larval movement was not observed because larvae remained inside the galls, in

the same area where the eggs were laid. Adults were located in different places depending on the sampling time. At night, adults were observed to move to the upper third of the plant and, during the day, down to the lower third of the plant and to the soil. The insects are normally concealed during their pre- and post-embryonic stage throughout most of the day.

KEY WORDS: Insecta, Curculionidae, ecology, behavior, spatial distribution.

Beetles are an important group of insects associated with soybean [(*Glycine max* (L.) Merrill] in southern Brazil. *Sternechus subsignatus* Boheman (Coleoptera: Curculionidae) is the main representative, as it can cause damage during the early soybean vegetative stages. Some papers refer to sexual dimorphism and geographical distribution (Rosado Neto 1987), seasonal distribution (Hoffmann Campo *et al*. 1991), biology (Hoffmann-Campo *et al.* 1991, Lorini *et al.* 1997), infestation level and damage (Hoffmann-Campo *et al.* 1990), performance in different plant species (Hoffmann-Campo *et al.* 1996 a,b; Lorini *et al.* 1997; Silva 1997) and cultural control (crop rotation or trap crop) (Hoffmann-Campo *et al.* 1996 a,b; Silva 1996, 1997), planting date (Hoffmann-Campo *et al.* 1988; Lorini *et al.* 1997), soil tillage systems (Oliveira & Hoffmann-Campo 1996, Silva & Klein 1997) and chemical control (Lorini *et al.* 1997). Despite these studies, little is known about the localization of eggs and the distribution of larvae and adults on soybean plants.

This research was carried out to obtain information about the oviposition site of *S. subsignatus* eggs and larval localization in soybean plants, as well as the distribution of adults on various plant parts and in the soil at different time schedules.

Materials and Methods

Research on the distribution of *S. subsignatus* on soybean plants was carried out during the vegetative stage, when soybean plants were between 30 to 45 cm high, in commercial fields maintained under a no-till system, in Cruz Alta and Júlio de Castilhos, Rio Grande do Sul State.

Eggs and Larvae. Eggs (December 1992) and larvae (January 1993) were recorded in soybean plants, within the planting row, that had been divided into three sections (upper, medium and lower thirds), using a string. Main stems, lateral branches and petioles were also examined for egg and larval localization. Analysis of variance was performed, both for plant section and localization, in a complete randomized block design, with three replications (each replication was made for one plant). Data were transformed to $\sqrt{x} + 0.5$ for statistical analysis and the means compared by the Duncan test ($P \leq 0.05$).

Adults. Adults were sampled during the crop seasons 1990/91 and 1996/97, from December 1st to January 10th, for 24-hour periods (6 per season, totalling 36 replications), with a two-hour interval. Soybean plants from 1 m plant rows were divided into 3 sections, as described before, and sampled in order to determine on which plant parts the adults were located. Adults in the soil were also examined.

Analysis of variance was performed in a complete randomized block design, in subdivided plots, with 36 replications; treatments were represented by the 12 times collecting schedules and the sub-treatments were represented by the distribution of insects in the 3 plant sections (upper, medium and lower thirds) and soil. The data obtained were transformed to $\sqrt{x} + 0.5$ and the means compared by the Tukey test ($P \leq 0.05$), as this test is more suitable for comparing a large number of treat-

ments.

Results

Eggs and Larvae. The eggs were laid in orifices protected by epidermal tissue fibres (i.e., bark) cut by the female in a ring-shape, when preparing for egg laying, confirming Hoffmann-Campo *et al*. (1991). After hatching, the larvae bored into the stem at the oviposition site and remained there without moving. During the entire larval stage, eggs and larvae were recorded to be present in approximately equal quantity, in the same ecological niche. Most of the eggs (90%) and larvae (87%) were found in the main stems, but some were also recorded in lateral branches (9% and 12%, respectively) and only 1% of the eggs and larvae were located in soybean leaf petioles. Eggs (79%) and larvae (78%) were predominantly found in the medium third of the plant, whereas a reduced number of eggs and larvae were recorded in the upper and lower thirds of the plants (Table 1).

The main stems and the medium third of the soybean plants were significantly preferred for oviposition than the other plant sections. The number of eggs laid in the lateral branches was higher than in the petioles, while the number of recorded eggs found in the lower and upper thirds was statistically similar ($P<0.05$). A larger ($P<0.05$) and smaller number of larvae was recorded in the main stems and petioles, respectively. With respect to the medium thirds, the number of larvae was significantly higher in comparison to the other sections. The number of larvae recorded in the upper or lower thirds was not statistically different ($P<0.05$).

Adults. Analysis of variance indicated an interaction between sampling time and the incidence of *S. subsignatus* adults on soybean plant sections and in the soil (Table 2). Significant differences ($P<0.05$) were observed in the number of adults collected from the upper third of the plants and from the soil; no significant difference was detected regarding

Table 1. Distribution of *Sternechus subsignatus* eggs and larvae collected in the field, in Cruz Alta and Júlio de Castilhos, RS, from different structures and sections of the soybean plants.

	Number of Eggs[1]	Number of Larvae[1]
Plant Structures		
Main stems	1.50 ± 0.80 a	1.61 ± 0.85 a
Lateral branches	0.20 ± 0.45 b	0.22 ± 0.47 b
Petioles	0.02 ± 0.15 c	0.01 ± 0.12 c
CV (%)	22.1	21.7
Plant Section		
Upper third	0.14 ± 0.35 b	0.09 ± 0.29 b
Medium third	1.36 ± 0.66 a	1.46 ± 0.65 a
Lower third	0.23 ± 0.47 b	0.32 ± 0.57 b
CV (%)	22.8	22.7

[1]Means (± SD) followed by different letters differ significantly (Duncan $P \leq 0,05$).

the number of insects on the medium and lower thirds. A greater number of adults was found on the upper third, between 10 p.m and 4 a.m.. However, at 10 a.m., 12 p.m. and 2 p.m., the adults were consistently observed on the soil or in the residues of the previous crop. During the samplings at 6 a.m. and at 6 and 8 p.m., a greater number of adults was collected from the medium third of the plants. Some aspects of adult behavior were noted in all observations, such as, intense flight activity during the day and night, i.e., from 6 a.m. to 8 a.m. and from 6 p.m. to 8 p.m., respectively. Furthermore, feeding activity was detected during most of the observation period, except from 10 a.m. to 2 p.m.. Mating activities were more frequent at night, from 12 a.m. to 2 a.m.. Eggs were laid mainly from 4 a.m. to 6 a.m..

Table 2. Distribution (5m row) of *Sternechus subsignatus* adults recorded in twelve daytime schedules, in three soybean plant sections and in the soil, in Cruz Alta and Júlio de Castilhos, RS.

	Number of Adults[1]			
Daytime	Localization in plant and soil			
	Upper third	Medium third	Lower third	Soil
2 a.m.	33.0±19.24 a A	8.2±4.68 a B	0 a C	0 b C
4 a.m.	26.4±18.35 a A	6.4±4.41 a B	3.2±2.35 a C	0 b D
6 a.m.	3.7±2.52 ab C	18.6±11.90 a A	11.7±7.29 a B	0 b D
8 a.m.	17.3±11.91 ab A	9.8± 6.65 a B	2.7±1.81 a C	0 b D
10 a.m.	0 b B	0 a B	0 a B	25.0±17.31 a A
Noon	0 b B	0 a B	0 a B	24.8±18.92 a A
2 p.m.	0 b B	0 a B	0 a B	24.4±13.95 a A
4 p.m.	0 b C	23.7±16.91 a A	5.9±4.10 a B	0 b C
6 p.m.	6.0±4.40 ab B	20.3±13.48 a A	5.5±3.47 a B	0 b C
8 p.m.	13.4±9.65 ab A	13.0±10.21 a A	6.5±5.41 a B	0 b C
10 p.m.	25.6±16.99 a A	12.6± 8.39 a B	0 a C	0 b C
Midnight	34.2±21.00 a A	4.2± 2.67 a B	0 a C	0 b C
CV % Daytime	54.84	F = 10.21***		
CV % Localization	32.02	F = 429.05***		
Daytime x Localization		F = 231.53***		

[1]Means (± SD) followed by different letters, minuscule in the columns and capital in the lines, differ significantly (Tukey P≤0.05).
*** P<0.001

Discussion

Eggs and Larvae. Eggs and larvae were recorded in three different plant structures (main stems, lateral branches and leaf petioles) and in three sections of soybean plants (divided into upper, medium and lower thirds). It is possible that the preference of *S. subsignatus* females for utilizing the main stems and the medium and lower thirds of soybean plants, as a substrate for laying their eggs, may be a survival strategy as larvae develop more suc-

cessfully in those areas. The feeding larvae remain inside the girdled, ring-shaped area, prepared by the female for oviposition and, as they develop, penetrate into the medulla of the stems. This causes a localized swelling in the infested stem region, producing a gall, which is a structure formed by dried tissue (Hoffmann-Campo e*t al*. 1991).

Adults. In general, *S. subsignatus* adults were found on all plant parts as well as in the soil. However, at night, they moved to the upper third of the plants. During the day, they moved in the opposite direction, i.e, to the medium and lower thirds and to the soil. In the soil, they distributed themselves on or under the crop residue of the previous crop, or were sometimes found buried in the soil, as a consequence of their adverse reaction to sunlight (negative heliotropism). The behavior of the *S. subsignatus* adults of seeking shelter among the plant foliage or in the soil during the day, becoming more active at night when dehydration risks are diminished, confirms previous field observations where a greater incidence of the insect occurs in colder regions, mainly at night. According to Daly *et al.* (1978), insects that live and feed exposed in the plant foliage need to reduce drying risks through morphological, physiological or behavioral adaptations. *S. subsignatus* appears to use the latter adaptation to minimize the effects of harsh environmental conditions, such as, excessive heat. This is vital for survival as their natural black color with yellow stripes in the pronotum and elytra, does not reflect heat effectively.

Analysis of temperature and relative humidity data revealed a considerable variation throughout the day (average 32ºC and 47%). At night, however, temperatures and relative humidity were consistently lower and less variable (average 22°C and 77%). These environmental fluctuations may have influenced the distribution of adults on the soybean plants and in the soil. De Long (1932) refers to temperature, position of the sun, plant size and foliage density as important factors influencing insect populations. Thus, insect flight is an important protection mechanism allowing insects to move within a habitat (dispersion) and from one habitat to another (migration) looking for food sources, oviposition sites and shelter from adverse environmental conditions.

Behavioral characteristics could be the main reason why the control of *S. subsignatus* has been so difficult. Eggs and larvae are protected inside the plants, predominantly within the main stems. During the day, adults are hidden in the lower third of plants, among the foliage or in the soil and even in the residue of previous crops in no-till systems. This study shows a detailed analysis of the localization of *S. subsignatus* eggs, larvae and adults on soybean and provides evidence of variation according to the time of day/night and sampling schedule. This knowledge is a prerequisite in understanding the insects behavioral characteristics that allow them to escape and survive from insecticide applications. It also shows the necessity to evaluate nightly insecticide spraying systems, especially between 10 p.m. and 2 a.m., when the great majority of the adults are mating in the upper third of soybean plants and are, therefore, immobile.

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