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Impact of cover crops and rainfall distribution on *Scaptocoris castanea* (Hemiptera: Cydnidae)

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Abstract – The objective of this work was to evaluate the population dynamics of the burrower bug (*Scaptocoris castanea*) in an area with cotton (*Gossypium hirsutum*) cultivated after cover crops. The insects were counted in soil samples collected at 0–40 cm depth. Insect incidence was documented in 18 cover crops, alone or intercropped, in each plant stage. Rainfall distribution was compared with fluctuations in the burrower bug population. *Crotalaria* species have a suppressive effect on the insect population, whereas some grass species favor its increase. Rainfall distribution directly influences the insect population.

Index terms: burrower bug, cotton, no-tillage system, pest management, soil pest.

Impacto de plantas de cobertura e da distribuição de chuvas sobre *Scaptocoris castanea* (Hemiptera: Cydnidae)

Resumo – O objetivo deste trabalho foi avaliar a dinâmica populacional do percevejo-castanho (*Scaptocoris castanea*) em área com algodão (*Gossypium hirsutum*) cultivado após plantas de cobertura. Os insetos foram contados em amostras de solo coletadas a 0–40 cm de profundidade. A incidência de insetos foi documentada em 18 espécies de cobertura, isoladas ou consorciadas, em cada estágio da planta. A distribuição das chuvas foi comparada com a flutuação populacional do inseto. Espécies de crotalária apresentam efeito supressivo sobre a população do percevejo-castanho, enquanto algumas espécies de gramíneas favorecem o seu aumento. A distribuição das chuvas influencia diretamente a população de insetos.

Termos para indexação: percevejo-castanho, algodão, sistema plantio direto, manejo de pragas, praga de solo.

In tropical conditions, the no-tillage system technology is very promising for soil conservation (Agegnehu & Amede, 2017; Xiong et al., 2018). One of the main requirements to ensure the efficiency of this system is an adequate soil coverage by straw-forming species (Ramos et al., 2018; Gómez-Muñoz et al., 2021). Cover plants should produce a high amount of biomass, which should persist on soil surface to protect it physically during periods of water excess or scarcity (Ferreira et al., 2018; Rigon et al., 2020). Moreover, when included in the no-tillage system, cover plants allow the maintenance of nutrients in the rhizosphere of plants under crop rotation (Ferreira et al., 2022), such as that of cotton (*Gossypium hirsutum* L.)/soybean (*Glycine max* L.)/corn (*Zea mays* L.).

In the case of cotton crops, which, in Brazil, can remain for more than 200 days in the field, the straw from previous crops protects soil surface from weathering (Ferreira & Lamas, 2010; Khan et al., 2021). Despite the known benefits promoted by cover plants, the straw formed in the no-tillage system may affect positively or negatively soil insects, whose development and behavior can also be influenced by rainfall distribution.

Among the soil insect pests that compromise cotton yield, the burrower bug [*Scaptocoris castanea* (Perty, 1830) (Hemiptera: Cydnidae)] stands out. Outbreaks of this underground insect are common in areas cultivated with cotton, soybean, rice (*Oryza sativa* L.), and corn (*Zea mays* L.), as well as in forage grasses in the Brazilian Cerrado biome (Nardi et al., 2007; Forero et al., 2019; Souza et al., 2019; Cossolin et al., 2020).

The burrower bug has sucking mouthparts with salivary glands used to rupture the cell wall of the host plants, whose roots they feed on, significantly delaying the development or even causing the death of these plants (Cossolin et al., 2019). Therefore, this polyphagous pest can use cover plants as a food substrate and as a site to maintain its populations in the cultivated area (Adetunji et al., 2020). Still regarding its behavior, the bug burrows deeper into the soil in search for moisture during the dry season and returns to the surface at the beginning of the rainy season (Oliveira & Malaguido, 2004; Souza et al., 2019).

The objective of this work was to evaluate the population dynamics of the burrower bug in an area with cotton cultivated after cover crops.

The experiment was set up in an area infested by the burrower bug population in the municipality of Santa Helena de Goiás, in the state of Goiás, Brazil (17°49’23’’S, 50º35’18’’W, at 575 m of altitude), during the 2014/2015 crop season.

The used cover crops were sown after the soybean crop, in 10×10 m plots, and the cotton plants were grown as the subsequent summer crop.

The experimental design was a randomized complete block with 18 treatments and 4 replicates. The treatments consisted of cotton cultivation after the following cover crops, alone or intercropped: *Crotalaria juncea* L., *Crotalaria ochroleuca* G.Don, *Crotalaria spectabilis* Roth, *Urochloa ruziziensis* (R.Germ. & C.M.Evrard) Morrone & Zuloaga, corn, millet (*Pennisetum glaucum* R.Br.), pigeon pea [*Cajanus cajan* (L.) Millsp.], sesame (*Sesamum indicum* L.), sorghum [*Sorghum bicolor* (L.) Moench], sunflower (*Helianthus annuus* L.), and fallow – with a predominance of *Chamaesyce hirta* (L.) Millsp., *Digitaria horizontalis* Willd., *Alternanthera tenella* Moq., *Centratherum punctatum* Cass., and *Eleusine indica* (L.) Gaertn.

Herbicide glyphosate (1.08 kg a.i. per hectare) was applied to the cover crops 45 days before cotton sowing to desiccate the plants and form the straw. The cotton plants were then sown in the field, spaced at 0.76 m between rows, with nine plants per meter. Soil fertility correction was based on the soil analysis.

The effect of the cover plants-cotton succession on the burrower bug population was evaluated from cotton sowing until 120 days after plant emergence (DAE) by counting live insects in 0.07 m^3 soil samples collected at the 0–20 and 20–40 cm depths, extrapolated into number of insects per cubic meter to determine insect infestation level. The number of plants per plot (stand), the height of plants at 120 DAE, the number of bolls per plant, the percentage of fiber, and yield were recorded to evaluate the effect of insect incidence on the development of cotton plants. To detect adult flight dispersion, cages were placed at 1.8×1×1.8 m in the field, with one cage per plot. During the experimental period, rainfall records obtained from a nearby meteorological station were compared with fluctuations in the insect population. The results were subjected to the analysis of variance, and means were compared by the Scott-Knott test, at 5% probability.

The number of nymphs and adults of burrower bugs presented a dependent relationship with the cover crops (Figure 1). *Urochloa ruziziensis*, sorghum, and millet favored the population of nymphs. These three types of grass species also showed a greater number of nymphs than the other cover crops. Furthermore, *U. ruziziensis* had the greatest number of adults and of nymphs + adults, confirming that bug populations remain on this forage grass until the cotton crop is planted in the area.

The cover crop species, alone or intercropped, that were not favorable to the insect populations were: *Crotalaria* spp., sunflower, corn, pigeon pea, and sesame, as well as some spontaneous species that grew during fallow, i.e., *C. hirta*, *D. horizontalis*, *A. tenella*, *C. punctatum*, and *E. indica* (Table 1).

Although, when isolated, *U. ruziziensis* favored the incidence of burrower bugs, when intercropped with *Crotalaria* spp. and sesame, it showed a low incidence of insects, indicating that intercropping with antagonistic species may be useful to control this soil pest. However, the antagonism between intercropped plants can also null their effects on the insect, as found for millet, sorghum, and associations of *U. ruziziensis* with sorghum, pigeon pea, and sunflower, which showed intermediate infestations. There was a tendency for leguminous plants to suppress the burrower bug population and for grasses to maintain it. In addition, fallow influenced the low incidence of burrower bugs on the cotton crop.

The presence of the studied soil pest did not compromise the population density of cotton plants, but affected their vegetative development (measured by plant height) depending on the predecessor cover crop (Table 1). When planted after sesame, pigeon pea, corn, sunflower, *C. juncea*, *C. spectabilis*, *C. ochroleuca*, fallow, and *U. ruziziensis* + *C. ochroleuca*, cotton plants showed higher heights. The height of all of these grass species was compromised by the presence of the soil pest; the exception was corn, which presented a high height.

The number of bolls per plant and the percentage of fiber were not affected by the treatments (Table 1), showing that these attributes were not impacted by the bug population. Cotton yield, subjected to other biotic and abiotic factors, also did not differ statistically between treatments.

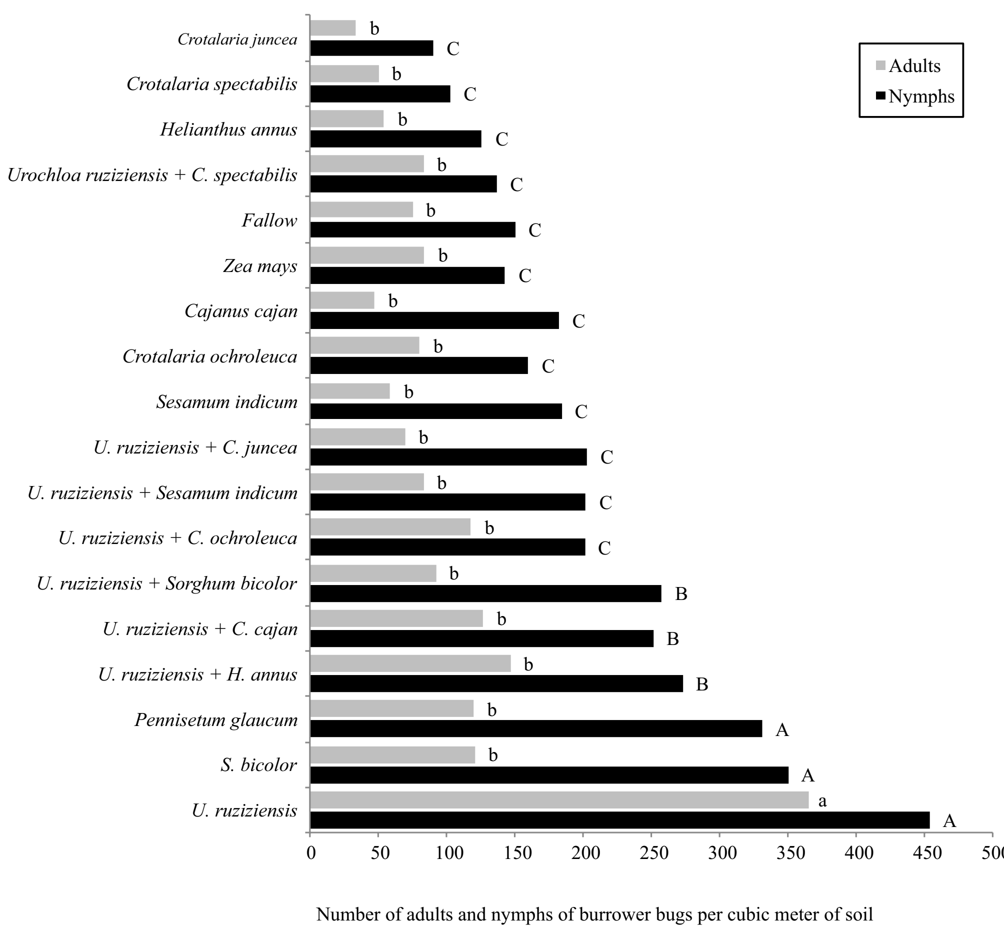

Figure 1. Effect of the cover plant-cotton (*Gossypium hirsutum*) succession on the infestation of burrower bugs (*Scaptocoris castanea*). Equal lowercase letters do not differ for the number of adults, and equal uppercase letters do not differ for the number of nymphs by the Scott-Knott test, at 5% probability.

The distinct responses in the burrower bug populations due to the cover plant species may be related to the coevolutionary biochemical run resulting from the insect-plant interaction. Pest species in coevolution develop biochemical processes that allow them to overcome plant defense and suppression mechanisms (Birnbaum & Abbot, 2018). Wenke et al. (2010) added that plants may attract insects and nematodes by releasing volatile compounds – such as alcohols, esters, and aldehydes – through their roots or repel them by producing hydrocarbons.

A positive influence of the rainy season, an abiotic factor, was verified on the abundance of the insect populations. Periods of high rainfall availability invariably coincide with a high population density of the pest (Figure 2). In contrast, a reduction in rainfall and a consequent reduction in soil moisture contribute to a decrease in the burrower bug population. A direct relationship was observed between rainfall records and the fluctuation of the insect population in the cotton crop, with curves resulting from the same behavior over time at the beginning of the rainy season.

Influenced by humidity, insect population density oscillated over time. The sampled population was reduced at the end of the rainy season (Figure 2). As this period approaches, the population of burrower bugs move to deeper layers of the soil or migrate to other areas by flight dispersion (Oliveira & Malaguido, 2004; Souza et al., 2019). In the present study, it was presumed that the individuals moved, since few bugs were found dead among those collected and none were found inside the cages allocated in the field, confirming the geotropic movement of the insects in the direction of deeper layers in search for greater soil moisture.

Based on the obtained data, the first decline in the pest population occurred at 21 to 28 DAE, when there was a reduction in rainfall volume, followed by a new population peak between 35 and 56 DAE, when rainfall increased again. However, the burrower bug population did not respond to the third peak of rainfall distribution between 91 and 105 DAE, as there was a reduction in the number of individuals collected. The insects stopped being detected at 119 DAE in the beginning of April (Figure 2), the same period reported by Pereira et al. (2012) in a crop-livestock integration system in Brazil.

For the three identified rainfall peaks, two synchronous peaks of the insect population were

Table 1. Average number of burrower bugs (*Scaptocoris castanea*) per cubic meter of soil and its effect on the agronomic parameters of cotton (*Gossypium hirsutum*) cultivated after cover crops[(1)].

Cover crop	Number of insects	Plant stand (m^{-2})	Height (cm)	NB[(2)] (n)	Fiber (%)	Yield[(3)] (kg ha^{-1})
Cajanus cajan	229.7c	10.3a	132.9a	15.7a	43.6a	3,996a
Crotalaria juncea	240.4c	9.0a	143.5a	16.1a	42.6a	4,389a
Crotalaria ochroleuca	124.3c	9.7a	138.9a	17.6a	43.4a	4,203a
Crotalaria spectabilis	152.9c	9.9a	145.1a	17.5a	42.9a	4,249a
Fallow	225.3c	9.9a	139.2a	15.8a	42.9a	4,301a
Helianthus annus	180.5c	9.6a	140.9a	16.9a	43.4a	4,229a
Pennisetum glaucum	451.4b	10.1a	126.1b	15.2a	44.1a	3,941a
Sesamum indicum	243.1c	11.1a	136.9a	14.9a	43.6a	4,132a
Sorghum bicolor	471.1b	9.7a	120.6b	14.2a	43.9a	3,723a
Urochloa ruziziensis	819.6a	9.7a	111.1b	13.4a	45.2a	3,773a
U. ruziziensis + *C. cajan*	378.0b	9.8a	128.3b	16.0a	43.0a	4,102a
U. ruziziensis + *C. juncea*	272.6c	9.6a	123.5b	16.9a	45.5a	4,070a
U. ruziziensis + *C. ochroleuca*	319.1b	9.8a	133.8a	17.1a	43.5a	4,090a
U. ruziziensis + *C. spectabilis*	219.8c	10.0a	126.9b	14.2a	43.8a	4,050a
U. ruziziensis + *H. annus*	419.2b	11.2a	124.4b	17.1a	43.2a	4,017a
U. ruziziensis + *S. bicolor*	349.5b	9.6a	123.9b	14.4a	44.4a	3,956a
U. ruziziensis + *S. indicum*	283.3c	9.6a	128.5b	16.2a	43.4a	3,938a
Zea mays	227.0c	9.5a	131.7a	14.1a	43.3a	4,060a
Coefficient of variation (%)	18.34	11.70	6.61	17.52	2.82	8.91

[(1)]Means followed by equal letters, in the columns, do not differ from each other by the Scott-Knott test, at 5% probability. [(2)]Number of bolls per plant. [(3)]Yield in kilogram of cotton seed per hectare.

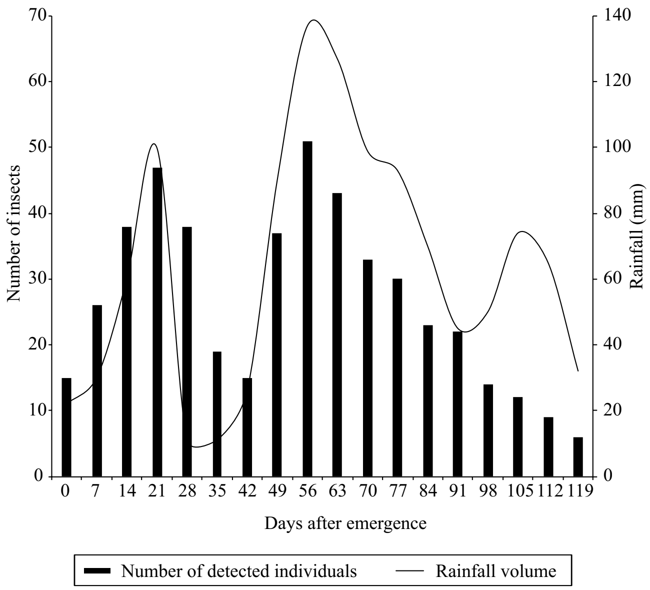

Figure 2. Relationship between the burrower bug (*Scaptocoris castanea*) population in the cotton (*Gossypium hirsutum*) crop and days of rainfall after plant emergence.

observed, showing a positive correlation between these variables (Figure 2). With the gradual increase or decrease in the rainwater volume accumulated in the soil, there was a concomitant response of the burrower bug population from the beginning of cotton germination until approximately 91 DAE. After this, the new peak in rainfall did not affect the insect population, which, apparently, was no longer stimulated by hydric availability, possibly starting overwinter diapause in deeper soil layers.

The obtained results are indicative that certain cover crops, especially *Crotalaria* spp., pigeon pea, sesame, and sunflower, are disadvantageous for burrower bug populations, differently from *U. ruziziensis* that allowed the maintenance of the soil pest in the cultivated area. Furthermore, the fluctuation of the burrower bug population is directly affected by rainfall availability.

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