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CROP PRODUCTION

Oviposition behavior and foliar consumption of *Chrysodeixis includens* (Lepidoptera: Noctuidae) in soybean genotypes

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ABSTRACT: The use of plant resistance acts by intervening in the herbivore-host relationship, through morphological, physical or chemical factors of the plant. This study evaluated the oviposition and foliar consumption of *Chrysodeixis includens* (Walker [1858]) in soybean genotypes, in free- and no-choice tests, correlating them with the factors, density and size of trichomes. The experiments were carried out in laboratory (25 ± 2 °C; RH= 70 ± 10%; photoperiod 14h) using five cultivars (BRS 391, BRS 6203 RR, BMX Valente RR, Tec Irga 6070 RR, BMX Icone Ipro) and two isolines (PELBR 10-6000 and PELBR 10-6049). The trichomes reported were filiform tectors and claviform multicellular glandular. The density of glandular trichomes, in stages V2 and V5, was higher on BRS 6203 RR and BRS 391, respectively. The higher density of glandular trichomes was observed in V5 and a higher density of tector trichomes in V2. The lowest densities and the smallest sizes of trichomes in V2 and V5 stages was observed on PELBR 10-6049. The size of tector trichomes and the number of eggs did not differ among the cultivars. Foliar consumption was lower for on BMX Icone Ipro and Tec Irga 6070 RR. Trichome density influences the consumption and oviposition behavior of *C. includens*.

Key words: *Glycine max*, Soybean Looper, free-choice, no-choice, antixenosis.

Comportamento de oviposição e consumo foliar de *Chrysodeixis includens* (Lepidoptera: Noctuidae) em genótipos de soja

RESUMO: O uso da resistência de plantas atua intervindo na relação herbívoro-hospedeiro, através de fatores morfológicos, físicos ou químicos da planta. O objetivo deste trabalho foi avaliar a oviposição e o consumo foliar de *Chrysodeixis includens* (Walker [1858]) em genótipos de soja, através de testes com e sem escolha, correlacionando-os com os fatores, densidade e tamanho de tricomas. Os experimentos foram realizados em laboratório (25 ± 2 °C; UR= 70 ± 10%; fotoperíodo 14h) utilizando cinco cultivares (BRS 391, BRS 6203 RR, BMX Valente RR, Tec Irga 6070 RR, BMX Icone Ipro) e duas linhagens (PELBR 10-6000 e PELBR 10-6049). Os tricomas encontrados foram tectores filiformes e glandulares multicelulares claviformes. A densidade de tricomas glandulares nos estágios V2 e V5, foi maior em BRS 6203 RR e BRS 391, respectivamente. A maior densidade de tricomas glandulares foi observada em V5 e a maior densidade de tricomas tectores em V2. As menores densidades e os menores tamanhos de tricomas nos estágios V2 e V5 foram observados em PELBR 10-6049. O tamanho de tricomas tectores e o número de ovos não diferiram entre as cultivares. O consumo foliar foi menor para BMX Icone Ipro e Tec Irga 6070 RR. A densidade de tricomas influência o comportamento de consumo e oviposição de *C. includens.*

Palavras-chave: *Glycine max,* lagarta-falsa-medideira, livre escolha, sem escolha, antixenose.

INTRODUCTION

Soybean, *Glycine max* (L.) is one of the most economically important crops worldwide which reflects in greater demand for cultivars aimed maximized productivity (ABDELGHANY et al., 2020). However, monoculture in large areas has driven the appearance of pests (MIR et al, 2022).

In Brazil, lepidopterans stand out for causing considerable damage, and the presence of the Soybean Looper, *Chrysodeixis includens* (Walker [1858]) (Lepidoptera: Noctuidae) gained prominence in several productive regions, due to aspects in the soybean cultivation and in the behavior of the insect (SILVA et al., 2020), requiring stricter management strategies, mainly for chemical control (PERINI et al., 2019). The synthetic insecticides and the Bt technology are still the most used forms to control the pest. However, the incorrect use of these strategies causes environmental damage and promotes the selection of insect resistance (BERNARDI et al., 2012; BUENO et al., 2012; PERINI et al., 2020a PERINI et al., 2020b; RODRIGUES, 2003).

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The susceptibility of *C. includens* to Bt cultive has not yet been affected, while different levels of resistance have been evidenced for the insecticides used in soybeans; although, control failures are not reported (BERNARDI et al., 2012; STACKE et al., 2019). This way, strategies to prevent or delay the evolution of resistance to Bt and insecticides are necessary to prevent the technologies from being lost (SILVA et al., 2020).

The varietal resistance is part of Integrated Pest Management (IPM) strategies which, in addition to reducing dependence on the use of chemical control, allows it to be used concomitantly with other control techniques (SMITH & CLEMENT, 2012). The plant resistant expresses its constitutive genes through morphological, physical and chemical characteristics resulting in lower susceptibility of plants to the pest (SMITH & CLEMENT, 2012).

The Antixenosis manifests itself through the inability of plants as a source of food or shelter for permanence and oviposition by the pest, forcing it to choose an alternative host (SMITH & CLEMENT, 2012). Important in these relationships, morphological factors such as trichomes, hairiness, density and tissue thickness they act in host selection and affect the colonization and/or feeding of insects (BUSOLI et al., 2015; LUCAS et al., 2000; SMITH, 2005).

The reports of the presence of antixenosis to *C. includens* in soybean genotypes caused by structural factors of the plant promoted the reduction in the number of eggs per plant and extended the oviposition time (BEACH; TODD, 1988; SCHLICK-SOUZA et al., 2018), In addition, genotypes with higher trichome densities had a negative effect on larvae (HULBURT et al., 2004) and reduced foliar consumption (ONGARATTO et al., 2021; SCHLICK-SOUZA et al., 2018; SMITH & GILMAN, 1981; WILLE et al., 2017).

In this context, the objective was to evaluate soybean genotypes regarding the manifestation of antixenosis to *C. includens* through the evaluation of oviposition behavior and foliar consumption, in free- and no-choice tests, correlating them with density and size of trichomes.

MATERIALS AND METHODS

We used five soybean cultivars (BRS 391, BRS 6203 RR, BMX Valente RR, Tec Irga 6070 RR, Bmx Icone Ipro) and two isolines (PELBR 10-6000 and PELBR 10-6049) from the Embrapa Clima Temperado Breeding Program.

C. includens Rearing and plant material

The initial population of *C. includens* was reared on artificial diet, adapted from GREENE et al. (1976) according to the method described by PARRA (2001) at the Bioefficiency Center in an acclimatized room at 25 ±1 ºC, 70 ±10% RH, photophase of 14 h. The genotypes were cultivated in 11 L pots containing commercial substrate (composition: pine bark, vermiculite, acidity corrector and macronutrients) and maintained in a greenhouse at Embrapa-ETB following the technical recommendations for soybean cultivation (MEETING, 2018).

Structural classification, density and size of trichomes

The design was completely randomized, containing 7 cultivars and 15 replications. Five plants were used, highlighting one leaf from each plant, in the phenological stages V2 and V5 (FEHR & CAVINESS, 1977). For the preparation of the slides, the central foliolus was used and the quantification of trichomes was performed on the leaf blade, on both sides (adaxial and abaxial), discarding the main vein and 5 mm² cross-sections were performed freehand using a stainless-steel blade.

For the clarification process, we used the methodology adapted from SHOBE & LERSTEN (1967). Leaf fragments were placed in 10% sodium hydroxide solution for 24 h, after, were immersed in distilled water for 30 min and then in 12% sodium hypochlorite solution for 30 min to disrupt the cell membrane, immersed again in distilled water (30 min) and dehydrated in an increasing ethanol series (30, 50, 70, 95%) for 10 min each and finally stained in 0.1% fuchsin for 5 s.

Semi-permanent slides were prepared from the fragments, using a 50% glycerin solution (PURVIS et al., 1964) as the mounting medium, covered with a cover slip and sealed with clear enamel. The structural classification, density (mm^2) and size of the trichomes (µm) were determined using a 10x stereoscopic microscope (Nikon eclipse E200) located at LabAcaro. For the evaluation of the size of trichomes, 15 tector and glandular trichomes were measured randomly for the different cultivar in the phenological stages V2 and V5 by the image capture program Bel View 7.1.

Oviposition behavior

The experiment was carried under controlled conditions (25 ±1 ºC, 70 ±10% RH, 14 h photophase). In free-choice and no-choice tests, soybean cultivars at the V5 phenological stage were used (FEHR & CAVINESS, 1977) due to the greater number of leaves for oviposition. Couples were formed with up to 48 h of age, pre-mated for five days (MORAES et al., 2020) and, released into the cages (30 cm in diameter x 110 cm in height) covered with a "voil" cloth, containing in its interior food for adults (10% honey solution), according to PARRA (2001).

In free-choice test, a pot containing the 7 cultivars randomly distributed and equidistant from a central point was used. The design was in randomized blocks using 7 genotypes and 5 blocks, totaling 7 couples per block. While, for the no-choice test, a genotype allocated in the center of the pot was used. The design was completely randomized, using 5 replications for each genotype.

The number of eggs, for both tests, were counted in all leaves two days after the release because the oviposition peak for the species is 7 days after the formation of couples.

Feeding behavior

The experiment was carried out at LabAcaro, in a Biochemical Oxygen Demand (BOD) under controlled conditions (25 ±1 ºC, 70 ±10% RH, photophase 14 h). The design was completely randomized, with 25 replications containing the 7 cultivars. Each repetition corresponded to a Petri dish, containing at the base moistened filter paper to maintain the turgidity of the foliar discs.

The leaves, in V2 and V5 stages, were collected and cut using a 2.5 cm diameter cylindrical punch. The foliar discs were measured before the release of the third-instar larvae and after 24 h using a leaf area meter (LI-COR model LI 3100C) to evaluate the leaf area consumed. In free-choice test, Petri dishes (150 x 15 mm) were used, which contained 7 leaf discs of each, arranged randomly and equidistant from a central point on the plate. At the central point, 7 third-instar larvae were released. While in no-choice test, Petri dishes (90 x 15 mm) were used containing a leaf disk, placed at the central point of the plate where a third-instar larvae was released.

Data analysis

The tests were evaluated through the multiple comparison of the averages of the cultivar, since there is no proven pattern of susceptibility or resistance for the evaluated cultivar.

The normality and homoscedasticity were analyzed by using the Shapiro-Wilk and Bartlett tests, respectively. The occurrence of interaction between stage and factors for trichome density (glandular: F= 82.4629, df = 6, P= 0; tector: F = 41.008, df = 6, P = 0) and size of trichomes (glandular: F= 3.60, df = 6, P= 0; tector: F = 2.38, df = 6, P = 0.03) were considered for further analysis. Since they did not meet the assumptions for normality and homoscedasticity, we chose to use the non-parametric Kruskal-Wallis test, followed by the test of multiple comparisons of means, Dunn's test ($P \leq 0.05$), and the Mann-Whitney test for pairwise comparison, whenever the ANOVA results were significant.

For the size of trichomes, for which the assumptions were met, an ANOVA was performed, followed by the multiple amplitude test, Tukey's test ($P \leq 0.05$), when the results were significant. The trichome density and trichome size were correlated with oviposition and foliar consumption using Spearman's correlation coefficient ($P \leq 0.05$).

RESULTS AND DISCUSSION

Structural classification, density and size of trichomes

Amphistomatic leaves, with stomata of the paracytic type, that is, two subsidiary cells (CS) with their major axes arranged parallel to the guard cells (CG) (Figure 1). The same was observed by LEAL-COSTA et al. (2008) for leaf anatomy of transgenic and conventional soybean plants. Regardless of the cultivar evaluated, all were amphistomatic with paracytic stomata, accompanied by one or more subsidiary cells, positioned parallel to the stomatal cleft (LOURENÇO et al., 2011).

Presence of filiform uniseriate tector trichomes (Figure 2a) with basal cell (CB), median cell (CM) and elongated apical cell (CA) (Figure 2b) and uniseriate glandular trichomes, multicellular claviform, which rise above the peduncle (Figure 2a) presenting basal cell (CB), peduncle (PE) and apical cell (CA) (Figure 2b) occurring on both sides of the leaf, mainly on the veins (NS) (Figure 2a). Both types of trichomes reported in *G. max* are common to Fabaceae and trichomes are appendages seen on both foliar faces (LEAL-COSTA et al., 2008; LOURENÇO et al., 2011).

Although, the present research did not find significant differences between density of tector and glandular trichomes on the adaxial and abaxial faces, in V2 stage (glandular: F = 1.4238, df = 6, P= 0.2030; tector: F = 0.3288, df = 6, P = 0.9219) and V5 (glandular: F = 0.7171, df = 6, P= 0.6359; tector: F = 0.7183, df = 6, P = 0.6349). LOURENÇO et al. (2011) observed a higher concentration of glandular trichomes on the abaxial surface, as well as YOSHIKAWA et al. (2013) and SCHLICK-SOUZA et al. (2018) for some cultivars, while, BREWER & SMITH (1994), have evidenced

Figure 1 - Paracytic-type stomata. Subsidiary cells (CS) parallel guard cells (CG). Exemplary: PELBR 10-6000.

a higher density of trichomes on the adaxial surface of soybean leaves.

As the leaf limb expands, the trichome density decreases (SILVA & MACHADO, 1999). CHIANG & NORIS (1983) reported that before the development of soybean leaves, the density of trichomes on the abaxial surface is very high, however, no significant difference were reported for the cultivars after the leaves were fully expanded. Furthermore, observed that the trichome density was greater in resistant cultivars when compared to susceptible cultivars.

The results for glandular trichome density showed significant differences for the genotypes in stages V2 ($\chi 2 = 75.42$, df = 6, $P \leq 0.05$) and V5 ($\chi 2 = 77.62$, df = 6, $P \leq 0.05$) (Table 1). The highest density in V2 stage was observed on BRS 6203 RR and V5 stage on BRS 391.

The lowest density of glandular trichomes in V2 stage was observed on PELBR 10-6049, which did not differ from BMX Icone Ipro and Tec Irga 6070 RR, respectively ($P \geq 0.05$), while in V5 stage, the lowest density of glandular trichomes occurred on BRS 6203 RR, which did not differ significantly from

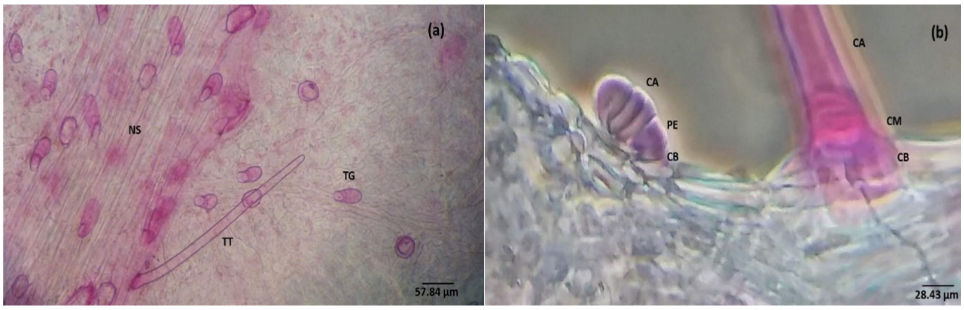

Figure 2 - a. Uniseriate tector trichomes (TT) and multicellular claviform glandular trichomes (TG), higher concentration of trichomes on the foliar vein. Exemplary: PELBR 10-6049; b. Tector trichome consisting of basal cell (CB), median cell (CM) and apical cell (CA) and glandular trichome consisting of basal cell (CB), Peduncle (PE) and apical cell (CA). Exemplary: BRS 6203 RR.

Table 1 - Mean density (mm^2) of tector and glandular trichomes (± standard error) of soybean cultivars at phenological stages V2 and V5.

Treatment	Phenological stages					
	V2			V5		
	Glandular trichomes					
BRS 6203 RR	50.64 ± 3.87	a	A	13.18 ± 1.76	d	B
BMX Valente RR	30.13 ± 2.92	b	^{ns}	32.18 ± 2.08	b	^{ns}
Tec Irga 6070 RR	29.05 ± 2.70	b	A	15.57 ± 2.09	cd	B
BRS 391	24.47 ± 2.31	b	B	48.25 ± 2.33	a	A
PELBR10-6000	13.01 ± 1.62	c	B	27.26 ± 1.78	bc	A
BMX Icone Ipro	12.96 ±2.05	c	B	21.63 ± 2.05	c	A
PELBR 10-6049	6.65 ± 0.97	c	B	15.97 ± 1.58	cd	A
	Tector trichomes					
BRS 6203 RR	30.41 ± 2.79	ab	A	14.76 ± 0.71	b	B
BMX Valente RR	39.71 ± 3.43	a	A	28.08 ± 1.57	a	B
Tec Irga 6070 RR	44.71 ± 5.60	a	A	14.59 ± 0.66	b	B
BRS 391	26.31 ± 2.01	b	^{ns}	23.94 ± 0.94	a	^{ns}
PELBR 10-6000	15.41 ± 1.60	cd	B	26.68 ± 1.05	a	A
BMX Icone Ipro	18.48 ± 0.93	c	B	25.75 ± 0.87	a	A
PELBR 10-6049	20.85 ± 1.61	bc	A	12.96 ± 0.69	b	B

PELBR 10-6049 and Tec Irga 6070 RR, respectively (P ≥ 0.05) (Table 1).

The density of tector trichomes showed significant differences in stages V2 (χ2 = 60.60, df = 6, P ≤ 0.05) and V5 (χ2 = 79.11, df = 6, P ≤ 0.05). In both stages, the BMX Valente RR showed the highest mean density of tector trichomes, but did not differ from Tec Irga 6070 RR and 6203 RR in stage V2 (P ≥ 0.05) and from PELBR 10-6000, BMX Icone Ipro and BRS 391 RR in stage V5 (Table 1).

The lowest density of tector trichomes in V2 stage occurred on PELBR 10-6000, however, it did not differ from BMX Icone Ipro and PELBR 10-6049 (P ≥ 0.05). In V5 stage, the lowest density of trichomes occurred on PELBR 106049, Tec Irga 6070 RR and BRS 6203 respectively (P ≥ 0.05) (Table 1).

Significant differences were also observed between the stages of crop development (Table 1). The highest mean density of glandular trichomes was observed in V5 stage, for most, except for BRS 6203 RR and Tec Irga 6070 RR and BMX Valente RR, which did not differ significantly (P ≥ 0.05). For the tector trichomes, a higher mean density was observed in V2 stage, except for PELBR 10-6000 and BMX Icone Ipro and for BRS 391, which did not differ significantly (P ≥ 0.05) (Table 1).

The density of leaf trichomes varies for the species, but variations may also occur in the same plant (SOUTHWOOD, 1986) and its distribution can occur uniformly on the surface, or more densely in certain points of the leaf (SOUTHWOOD, 1986; WERKER, 2000). BREWER & SMITH (1994) visualized that different leaves contained varying trichome densities. The present research noted this by verifying differences between leaves in V2 and V5 stages, as well as the highest concentration of glandular trichomes located on the veins (Figure 2a).

The genotypes showed significant differences for the size of glandular trichomes in V2 stage (F = 4.14, df = 6, P = 0.01) and in V5 stage (F = 2.50, df = 6, P= 0.03) (Figure 3). In V2 stage, the genotype BRS 6203 RR presented the largest size of trichomes, but they did not differ from BRS 391, PELBR 10-6000 and BMX Icone Ipro, respectively (P ≥ 0.05). While, the smallest size occurred for PELBR 10-6049, which did not differ from Tec Irga 6070 RR, BMX Valente RR, BMX Icone Ipro and PELBR 10-6000 (P ≥ 0.05) (Figure 3).

In stage V5, all genotypes exhibited similar trichome sizes (Figure 3). The genotypes, in V2 stage (F = 1.05, df = 6, P = 0.40) and in V5 stage (F = 2.02, df= 6, P = 0.07), did not present significant differences for the size of tector trichomes (Figure 3).

Differences in trichome size in 10 soybean isolines evidenced that the trichomes on the abaxial

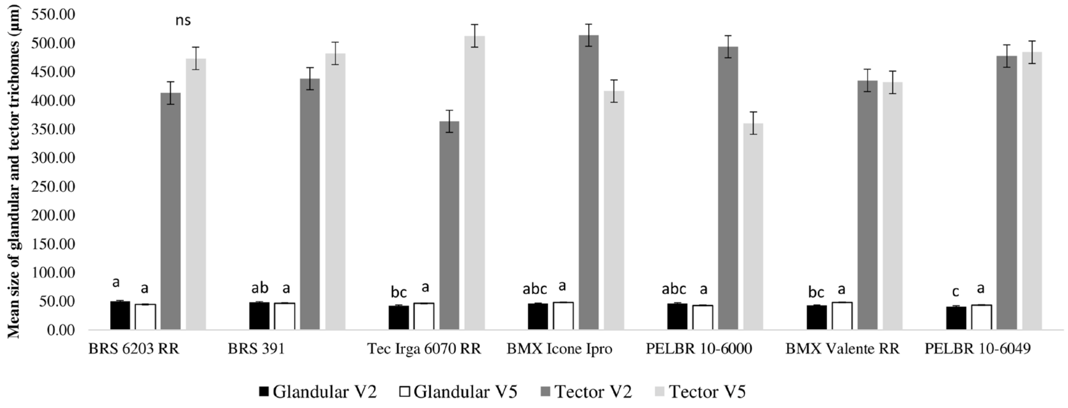

Figure 3 - Mean size of tector and glandular trichomes (µm) for the different soybean cultivars. Means followed by the same lowercase letter do not differ significantly by Tukey's test ($P \leq 0.05$). ns Not significant.

face were longer than those on the adaxial face, with sizes ranging from 866 to 955 µm on the adaxial face and from 879 to 1127 µm on the abaxial face (AMALIAH et al., 2019).

Leaf trichomes play an important role in determining soybean resistance to pests. In soybean plants, the density and size of trichomes become a barrier during colonization, chewing and oviposition of insects (COAPIO et al., 2018; KRISNAWATI et al., 2017; MORAES et al., 2020).

The size of trichomes in soybean cultivars made it difficult to movement, feeding and oviposition of phytophagous small (TURNIPSEED, 1977). KRISNAWATI et al. (2017) checked that in the soybean, trichomes density was more important in the antixenosis to *Spodoptera litura* (Fabricius, 1775) (Lepidoptera: Noctuidae) than trichome size.

Oviposition behavior

The lowest number of eggs occurred on PELBR 10-6049, while the larger number occurred on Tec Irga 6070 RR, however, the oviposition behavior did not present significant differences, in free-choice ($F = 1.7604$, df = 6, $P = 0.1502$) and in no-choice test ($F = 0.9577$, df = 6, $P = 0.4740$) (Table 2).

The number of laid eggs on a genotype is important for the initial assessment of an infestation. The lower preference of a genotype for the insect suggested the presence of chemical or morphological factors in the plant that inhibit host acceptance and consequent antixenosis for oviposition (SMITH, 2005; SMITH & CLEMENT, 2012). This fact, did not occur in the present study, being the genotypes were equally ovipositioned.

The oviposition behavior is mediated, in most cases, by chemical cues associated with the potential of the host, the latter, assessed through contact stimuli that affect oviposition preferences (RENWICK, 1989). The non-selection of one or more genotypes provides evidence that the evaluated genotypes are suitable for development, with no need, at principle, for a selective choice of hosts (PASTORIO, 2020).

Feeding behavior

Significant differences were found, in V2 stage in free-choice test ($\chi2 = 57.02$, df = 6, P= 0) and in no-choice ($\chi2 = 68.49$, df = 6, P= 0). Tec Irga 6070 RR, BRS 6203 RR and BMX Icone Ipro were the less consumed in V2 stage in a free-choice test, but they did not differ from BRS 391 and BMX Valente RR ($P \geq 0.05$) (Table 3). The BMX Icone Ipro and Tec Irga 6070 RR were also the less consumed in no-choice test ($P \leq 0.05$), the latter, did not differ from BRS 6203 RR and PELBR 10-6000 ($P \geq 0.05$) (Table 3).

In V5 stage, in free choice test ($\chi^2 = 50.9709$, df = 6, P = 0), the BMX Icone Ipro was the less consumed ($P \leq 0.05$), while the most consumed was BRS 6203 RR; however, it did not differ from PELBR 10-6000, PELBR 10-6049 and BRS 391 ($P \geq 0.05$) (Table 3). In no-choice test ($\chi2 = 90.24$, df = 6, P = 0), the BMX Icone Ipro and Tec Irga 6070 RR were less consumed, the latter, did not differ from PELBR 10-6000 and BRS 391, which were not differed from PELBR 10-6000, which in turn, did not differ from BMX Valente RR and BRS 6203 RR (Table 3).

Foliar consumption in free-choice and no-choice test showed that the BMX Icone Ipro

Table 2 - Mean number of eggs (± standard error) of *Chrysodeixis includens* (Walker, 1857) in different soybean in V5 phenological stage in free-choice and no-choice tests.

Treatment	---Phenological stages V5---	
	Free-choice ns	No-choice ns
BRS 6203 RR	23.60 ± 3.11	10.40 ± 0.40
Tec Irga 6070 RR	27.60 ± 9.15	22.80 ± 12.80
BMX Valente RR	26.80 ± 4.20	20.00 ± 2.68
PELBR 10-6000	22.40 ± 1.29	10.80 ± 0.49
BRS 391	17.00 ± 2.05	16.00 ± 5.50
BMX Icone Ipro	15.20 ± 1.96	13.20 ± 1.32
PELBR 10-6049	13.20 ± 1.16	10.00 ± 0.00

ns Not significant.

and Tec Irga 6070 RR were less consumed in both phenological stages (V2 and V5) (Table 3). The lower consumption of BMX Icone Ipro is attributed to the Intacta technology, which expresses the Cry1Ac protein (BEL et al., 2019). While, for the Tec Irga 6070 RR, there is no evidence from studies in the literature, and it should be investigated for the presence of other parameters involved in plant protection against herbivory.

Characteristics capable of affecting the insect-plant interaction, at the genotype level, are essential to promote pest suppression (PRINCE et al., 2011). Genotypes with high levels of antixenosis interfere with the initial food stimulus, inhibiting or hindering the consumption of the insects due to physical, morphological barriers or nutritional inadequacies of the host (PAINTER, 1951).

The resistance by antixenosis and antibiosis can overlap, being difficult to be interpreted in isolated assays (SMITH, 2005); therefore, it is important to evaluate other parameters to reject or confirm the additional presence of resistance by antibiose (ONGARATTO et al., 2021).

Morphological adaptations of plants, such as trichomes, can affect the insect behavior due to the release of substances that repel or hinder colonization, locomotion, oviposition and feeding (SMITH & CLEMENT, 2012). Genotypes can still have combinations of physical, chemical and morphological characteristics that can be positive or negative in the plant-insect interaction (QUEIROZ et al., 2020; SMITH, 2005).

The correlation between trichome size and foliar consumption, and trichome size and oviposition, in free-choice and no-choice test, for both phenological stages (V2 and V5), there were no significant differences for both glandular and tector trichomes (P ≥ 0.05) (Table 4), indicating that this morphological characteristic did not influence oviposition behavior and foliar consumption of *C. includens*.

Table 3 - Mean consumption (± standard error) of *Chrysodeixis includens* (Walker, 1857) in different soybean at phenological stages V2 and V5 in free- and no-choice test.

Treatment	---V2---		---V5---	
	Free-choice	No-choice	Free-choice	No-choice
PELBR 10-6000	1.06 ± 0.19 a	0.60 ± 0.11 ab	1.10 ± 0.19 ab	1.32 ± 0.19 ab
PELBR 10-6049	1.04 ± 0.19 a	0.78 ± 0.11 a	1.07 ± 0.21 ab	0.86 ± 0.15 bc
BRS 391	0.82 ± 0.17 ab	1.06 ± 0.22 a	0.95 ± 0.18 ab	0.66 ± 0.11 bc
BMX Valente RR	0.75 ± 0.17 ab	0.90 ± 0.16 a	0.60 ± 0.14 b	1.80 ± 0.15 a
Tec Irga 6070 RR	0.42 ± 0.15 bc	0.21 ± 0.09 bc	0.68 ± 0.19 b	0.01 ± 0.01 d
BRS 6203 RR	0.24 ± 0.11 c	0.63 ± 0.57 ab	1.46 ± 0.22 a	2.11 ± 0.14 a
BMX Icone Ipro	0.01 ± 0.00 c	0.03 ± 0.01 c	0.01 ± 0.01 c	0.51 ± 0.17 cd

Means followed by the same lowercase letter in the column do not differ significantly by Dunn's test (P ≥ 0.05).

Table 4 - Spearman correlation coefficient (rs) obtained between trichome density (DT) *vs* leaf consumption (CF), trichome size (TT) *vs* leaf consumption (CF), trichome density (DT) *vs* oviposition (OVI), and trichome size (TT) *vs* oviposition (OVI), in the soybean phenological stages V2 and V5, in free-choice (LE) and no-choice (SE) tests.

Variables	---------------Phenological stage V2---------------				------------------------Phenological stage V5-----------------------			
	--------Glandular trichomes--------							
	rs LE	P	rs SE	P	rs LE	P	rs SE	P
DT x CF	-0.25*	0.0099	-0.05	0.6181	0.05	0.6363	0.17	0.1176
TT x CF	0.05	0.6192	0.07	0.4894	-0.15	0.1349	-0.01	0.9614
DT x OVI	--	--	--	--	0.16	0.9287	0.36*	0.0339
TT x OVI	--	--	--	--	-0.20	0.2417	0.27	0.1220
Variables	--------Tector trichomes--------							
	rs LE	P	rs SE	p	rs LE	P	rs SE	P
DT x CF	-0.10	0.3075	0.03	0.7384	-0.22*	0.0236	0.14	0.1891
TT x CF	0.07	0.4558	0.10	0.3268	0.10	0.2960	-0.15	0.1484
DT x OVI	--	--	--	--	0.26	0.1316	0.46*	0.0056
TT x OVI	--	--	--	--	-0.23	0.1766	-0.30	0.0812

*Significant for Spearman correlation ($P \leq 0.05$).

The correlation between trichome density and foliar consumption showed a negative correlation, in free-choice test, for glandular trichomes, in V2 phenological stage ($rs = -0.25$, $P \leq 0.0099$) and for tector trichome in V5 phenological stage ($rs = -0.22$, $P \leq 0.0236$), indicating that this characteristic may be associated with non-preference for feeding to *C. includens* by genotypes with higher trichome density (Table 4).

Foliar consumption by *C. includens* significantly reduced when, presented sharp-trichomes tips in relation to blunt-trichomes tips (GARY et al., 1985). While, KHAN et al. (1986) observed that the trichomes of one soybean cultivar offered resistance to the larvae of another plusiinae, *Trichoplusia ni* (Lepidoptera: Noctuidae) (Hübner, 1803), but it became susceptible when the trichomes were scraped.

The correlation between density and oviposition was positive and significant, in no-choice test, for glandular trichomes ($rs = 0.36$, $P \leq 0.0339$) and tector trichomes ($rs = 0.26$, $P \leq 0.0056$), suggesting that this attribute may be related to the preference of *C. includens* to oviposit in soybean genotypes that have higher trichome density. Despite these correlations being significant, showed a weak relation intensity ($rs \leq 0.30$) (RUMSEY, 2016).

The oviposition of *C. includens* in soybean genotypes at three levels of pubescence, glabrous, normal and dense, presented greater oviposition in leaves with greater density of trichomes LAMBERT et al. (1992). The results of SCHLICK-SOUZA et al. (2018) showed antixenosis for oviposition; however, no correlations were found between trichome density and oviposition, for *C. includens* in soybean genotypes.

CONCLUSION

The soybean BRS 6203 RR, BRS 391, Tec Irga 6070 RR, BMX Icone Ipro, BMX Valente RR, PELBR 10-6000 and PELBR 10-6049 have amphistomatic leaves, with paracytic stomata and presence of uniseriate filiform trichomes and uniseriate glandular trichomes multicellular claviforms. Soybean genotypes with higher trichome densities are more preferred for oviposition, while for consumption genotypes with denser trichomes are less preferred.

The genotypes BMX Icone Ipro and Tec Irga 6070 RR were the least consumed in phenological stages V2 and V5, this last one, indicates antixenosis to feeding. The BRS 6203 RR and BRS 391 showed the highest densities of glandular trichomes.

The PELBR 10-6049 was found between the lowest densities and the smallest sizes of trichomes and between the most consumed in the phenological stages V2 and V5. There was no correlation between trichome size and oviposition behavior and between trichome size and foliar consumption.

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DECLARATION OF CONFLICT OF INTERESTS

The authors declare no conflict of interest. The foundation had no role in the study design; in the collection, analysis or interpretation of data; in the writing of the manuscript and in the decision to publish the results.

AUTHORS' CONTRIBUTIONS

All authors contributed equally to the design and writing of the manuscript. All authors critically reviewed the manuscript and approved the final version.

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