Feeding preference of *Spodoptera frugiperda* on different sorghum genotypes

Preferência alimentar de **Spodoptera frugiperda** em diferentes genótipos de sorgo

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ABSTRACT: The resistance of plants to pests is a feature of great importance for agriculture, as it reduces costs with insecticides and promotes increased yield resulting in higher profits. This work aimed to evaluate the feeding preference of the *Spodoptera frugiperda* caterpillar by different sorghum genotypes. The experiment was carried out at the Entomology Laboratory of Universidade Estadual de Mato Grosso do Sul, at University Unit of Cassilândia, from March to June 2016. The experimental design was completely randomized with ten replicates. The treatments were composed by seven sorghum genotypes: Agromen 50A40, Agromen 50A50, DOW 1G100, DOW 1G220, DOW 1G233, XB 6022 and LG 6310. Evaluations were performed with 1st instar caterpillars. The number of caterpillars that settled in the genotypes at 5, 10, 15, 20, 25, 30, 60 minutes and 24 hours after the infestation was recorded. The feeding preference index and the fresh leaf mass consumed were estimated. The Agromen 50A40 genotype showed lower attractiveness rating for the *S. frugiperda* among all evaluated sorghum genotypes.

KEYWORDS: *Sorghum bicolor*; antixenosis; non-preference; armyworm.

RESUMO: A resistência das plantas às pragas é uma característica de grande importância para a agricultura, pois reduz os custos com inseticidas e promove o aumento da produtividade, resultando em maiores lucros. Este trabalho foi desenvolvido com o objetivo de avaliar a preferência alimentar da lagarta *Spodoptera frugiperda* por diferentes genótipos de sorgo. O experimento foi conduzido no Laboratório de Entomologia da Universidade Estadual de Mato Grosso do Sul, na Unidade Universitária de Cassilândia, no período de março a junho de 2016. O delineamento experimental foi inteiramente ao acaso, com 10 repetições. Os tratamentos foram compostos por sete genótipos de sorgo: Agromen 50A40, Agromen 50A50, DOW 1G100, DOW 1G220, DOW 1G233, XB 6022 e LG 6310. As avaliações foram realizadas com lagartas de 1º instar. Anotou-se o número de lagartas que se estabeleceram nos genótipos aos 5, 10, 15, 20, 25, 30, 60 minutos e 24 horas após a infestação. Foi estimado o índice de preferência e a massa fresca de folha consumida. O genótipo Agromen 50A40 apresentou menor atratividade para a *S. frugiperda* dentre todos os genótipos de sorgo avaliados.

PALAVRAS-CHAVE: *Sorghum bicolor*; antixenose; não-preferência; lagarta-do-cartucho.

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INTRODUCTION

Sorghum (*Sorghum bicolor*) is a species that presents high adaptability to different environments and has physiological characteristics that allow it to tolerate and develop satisfactorily in water deficient conditions when compared to other crops. Because of that, the crop has potential to be cultivated in the second crop in the Brazilian ecoregion called Cerrado (ALMEIDA FILHO et al., 2010). Currently, in Brazil, approximately 622 thousand hectares of sorghum are cultivated, with mean grain yield estimated at 2,667 kg ha^{-1} (CONAB, 2017).

Even with these characteristics, some relevant factors have caused significant damage to their production, as pests (ELLIOT et al., 2014). The fall armyworm, of the genus *Spodoptera* is one of the pests that cause significant damage, it is widely distributed in the world, causing significant damage, and among the 30 species described, half are pests of sorghum and several crops of economic importance. Among them, the *Spodoptera frugiperda* (Smith) stands out for feeding on over 80 species of plants including cotton, corn, and soybean (POGUE, 2002).

According to BARROS et al. (2010), the *S. frugiperda* feed on the leaves initially, consequently starting to consume grains in the initial stage of grain filling in certain cultures. Among the factors related to the control of this insect-plague, to reduce the damage caused in crops, several insecticides are used. By misusing these chemicals, the imbalance in the environment is becoming increasingly common and resulting in higher production costs (ANDRADE et al., 2016).

Several methods have been used to control the armyworm, and the diversification of sorghum genetic material has been of great importance in controlling the pest, and the plant resistance may be the most viable (CRUZ et al., 1998). Genetic improvement of sorghum, aiming at resistance to meet future grain and forage demand, can be an effective component of the integrated pest management program (ARUNA et al., 2015).

Considering the importance of controlling this pest, the objective of this work was to evaluate the feeding preference of the *Spodoptera frugiperda* on different sorghum genotypes.

MATERIAL AND METHODS

Location

The experiment was carried out at the Entomology Laboratory of Universidade Estadual de Mato Grosso do Sul (UEMS), at University Unit of Cassilândia, from March to June 2016. The *Spodoptera frugiperda* caterpillars were obtained from the National Research Center of Maize and Sorghum (CNPMS – EMBRAPA), located in Sete Lagoas (MG).

Source of *Spodoptera frugiperda*

The *S. frugiperda* caterpillars were stored in the laboratory with artificial diet (KASTEN JUNIOR et al., 1978). The breeding and reproduction methodology proposed by PARRA (1986) was used. The conditions of breeding and reproduction were: temperature of $27 \pm 1°C$, relative humidity of $70 \pm 10\%$ and a photoperiod of 14 hours.

Plant preparation

Seven sorghum genotypes were used: Agromen 50A40, Agromen 50A50, DOW 1G100, DOW 1G220, DOW 1G233, XB 6022 and LG 6310. Sorghum genotypes were sown in pots with the volume of 5.0 dm^{-3} filled with soil collected in the 0 to 20 cm depth layer. The soil used is classified as Entisol (95 g kg^{-1} of clay, 50 g kg^{-1} of silt and 855 g kg^{-1} of sand).

Before to the implementation of the experiment, soil samples from the $0 - 20$ cm depth layer were collected and sent to the Soil Fertility Laboratory of the Faculty of Engineering, Faculdade de Engenharia de Ilha Solteira (FEIS / UNESP), to perform the characterization of the soil chemical properties. The results of the soil chemical analysis are presented pH in CaCl2: 5,4; M.O.: 14,0 g dm^{-3}; P (resina): 2,0 mg dm^{-3}; K (Melich-I): 1,11 cmolc dm^{-3}; Ca (KCl): 10,0 cmolc dm^{-3}; Mg (KCl): 7,0; H + Al: 22,0 cmolc dm^{-3}; Al: 0,14 cmolc dm^{-3}; SB: 46,0%; S-SO4: 2,0 mg dm^{-3}; B: 0,08 mg dm^{-3}; Cu: 0,60 mg dm^{-3}; Fe: 8,00 mg dm^{-3}; Mn: 5,70 mg dm^{-3} and Zn: 0.30 mg dm^{-3}.

The pots were irrigated so that the soil reached the field capacity. After that, ten seeds per pot were sown. The sowing depth was 3.0 cm. Five days after emergence (DAE) a thinning was performed leaving only one plant per pot.

At 15 DAE 150 mg dm^{-3} of nitrogen (urea) were applied, 300 mg dm^{-3} of phosphorus (single superphosphate) and 150 mg dm^{-3} of potassium (potassium chloride). Before to application, the sources were diluted in water and then applied. For irrigation,a daily application of 180 mL of water per pot was standardized.

Evaluations

The evaluations were carried out with 1st instar caterpillars *of S. frugiperda*. The design was entirely randomized with ten replicates. Each arena (repeat) was formed by a 15 cm diameter Petri dish with damp filter paper placed on the bottom of the plate. The leaves of each sorghum genotype were collected at the pre-flowering stage.

The leaves were washed and dried with paper towel. Leaf rectangles of 3.0×3.0 cm (9.0 cm²) were then cut longitudinally and parallel with the central vein. The rectangles were arranged circularly in the arenas and fixed with pins. At the center of the plate, 140 newly hatched caterpillars of *S. frugiperda* were released, and the arena was then sealed with the lid of the petri dish. The number of *S. frugiperda* caterpillars

was recorded at 5, 10, 15, 20, 25, 30 and 60 minutes after infestation. It was also noted the number of caterpillars that settled in each treatment after 24 hours of infestation.

The preference index for newly hatched caterpillars of *S. frugiperda* was estimated, considering as a 100% index the genotype in which the largest number of *S. frugiperda* caterpillars was found 24 hours after infestation. The initial (before releasing) and final (24 hours after infestation) masses were obtained with an analytical balance. From the initial and final masses, it was possible to estimate the fresh mass consumed by the *S. frugiperda* of each genotype.

Statistical analysis

The obtained data were transformed into $(x + 0,5)^{1/2}$ and then submitted to analysis of variance, and F test tested the significance of the mean squares obtained in the analysis of variance at the 5% probability level. The averages for genotypes were grouped by the clustering test proposed by SCOTT; KNOTT (1974) at the 5% probability level. The attractivity data were submitted to polynomial regression analysis as a function of time. The Student's t test was applied to evaluate the significance level of the regression coefficients.

RESULTS AND DISCUSSION

The highest percentage of fresh mass consumed by *S. frugiperda* was observed in genotypes XB 6022, DOW 1G100 and DOW 1G220, with consumption of 19.59, 19.20 and 16.15% of leaf sections, respectively. These results are showing feeding preference of the *S. frugiperda* for these sorghum genotypes. The genotype Agromen 50A40 presented the lowest percentage of

fresh mass consumed (7.58%), thus revealing the preference of the *S. frugiperda* for the other genotypes studied, to detriment of this one (Table 1).

The feeding preference and leaf consumption by *S. frugiperda* may be related to the plant, the insect, and the environmental factors. These are ways of manifesting resistance, according to BUENO et al. (2006), who also reports that these genetic traits of the cultivar differ in resistance and are less likely to be related to the target pest and may also be related to age and part of the plant and the physiological stage. According to SMITH (2005), a plant ceases to serve as a host for the insect when there is no the insect-plant interaction, demonstrating the potential of this pest to choose another plant as the host, thus characterizing the antixenosis.

The *S. frugiperda* occurs more frequently in maize, which is more susceptible when compared to sorghum (CORTEZ, 1997) due to the insect's difficulty in feeding of sorghum. When the *S. frugiperda* feed, its maxillary palms and labratory gustatory receptors transmit information to the nervous system, which perceive the presence of chemical, physiological and / or morphological changes in the plant and transmit commands to the central nervous system of the insect, causing it to choose other plants to feed on (SMITH, 2005).

The number of *S. frugiperda* caterpillars attracted by the Agromen 50A40 and XB 6022 genotypes about the time after infestation presented a linear behavior (Fig. 1), while for other genotypes the number of *S. frugiperda* caterpillars did not change as the time progressed (Table 2).

The number of *S. frugiperda* caterpillars in the leaf sections in the Agromen 50A40 genotype showed a linear behavior, with a decrease in the number of caterpillars (Fig. 1A). These results indicate the non-preference of the *S. frugiperda* for this sorghum genotype. For genotype XB 6022, there was a linear increase in the number of *S. frugiperda* caterpillars in

Table 1. Initial fresh mass, final fresh mass and fresh mass consumed from leaf sections of sorghum genotypes offered to *Spodoptera frugiperda* caterpillars for 24 hours. Cassilândia, Mato Grosso do Sul, 2016.

Genotypes	Initial fresh mass	Final fresh mass	Fresh mass consumed	
	--------------------------- g ---------------------------			%
Agromen 50A40	147.4	135.8	11.6 b	7.58 c
LG 6310	138.2	123.1	15.1 b	10.68 b
DOW 1G233	171.2	149.4	21.8 a	13.52 b
DOW 1G100	181.6	145.7	35.9 a	19.20 a
XB 6022	151.8	122.2	29.6 a	19.59 a
DOW 1G220	168.5	142.5	26.1 a	16.15 a
Agromen 50A50	160.1	141.6	18.4 b	12.27 b
Mean	159.8	137.2	22.7	14.14
F test	2.19^{ns}	1.14^{ns}	6.41*	5.31*
CV (%)	10.00	11.25	26.73	24.95

Means followed by the same letter in the columns belong to the same group by the SCOTT; KNOTT (1974) cluster test, at 5% probability; ^{ns}not significant by the F test; *significant at 1% by the F test; CV: coefficient of variation.

the leaf sections (Fig. 1B), indicating the *S. frugiperda* feeding preference for this genotype.
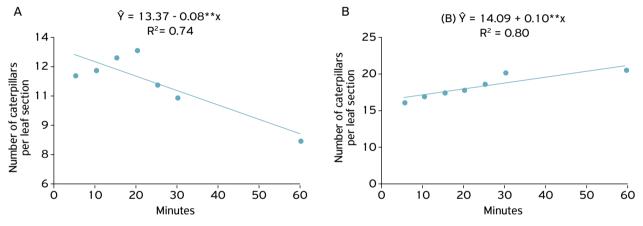
There was a reduction in the number of *S. frugiperda* caterpillars attracted by the Agromen 50A40 genotype when comparing the 5th minute with the 60th minute after infestation. The inverse occurs for genotype XB 6022. These results are a partial indication of the susceptible and resistant genotypes.

The different taste receptors of the insect can detect quantitative and qualitative variations on the chemical composition of the tested plant tissues, which depends on the different types of phytochemicals present in the plant, which have the effect of repelling the insect (SMITH, 2005).

There was no difference between sorghum genotypes regarding the number of caterpillars attracted in the first 25 minutes after infestation (Table 3). BOREGAS et al. (2013) found that in this stage of larval development of the insect there may occur interference in the adaptation and development of

the insect in the host, that is, the caterpillars tend not to feed in the first minutes until finding a suitable host, and for this reason they migrate from one plant to another.

At 30 minutes, the genotypes Agromen 50A40, Agromen 50A50 and LG 6310, presented a smaller number of *S. frugiperda* caterpillars compared to the others. At 60 minutes, genotypes DOW 1G100 and XB 6022 presented the highest number of *S. frugiperda* caterpillars compared to the other genotypes. After 24 hours of infestation, the genotypes XB 6022, DOW 1G100, DOW 1G220 and DOW 1G233 presented a higher number of *S. frugiperda* caterpillars, indicating a higher feeding preference of *S. frugiperda* for these sorghum genotypes. The Agromen 50A40 genotype showed lower feeding preference for *S. frugiperda* after 60 minutes compared to the other genotypes.

The migration of *S. frugiperda* caterpillars from one genotype to another can be due to the stiffness of the leaves'

A — $\hat{Y} = 13.37 - 0.08^{**}x$, $R^2 = 0.74$

B — (B) $\hat{Y} = 14.09 + 0.10^{**}x$, $R^2 = 0.80$

**Significant at 1% by the Student's t test.
Figure 1. Relationship between time after infestation and number of *Spodoptera frugiperda* caterpillars attracted by sorghum genotypes Agromen 50A40 (A) and XB 6022 (B). Cassilândia, Mato Grosso do Sul, 2016.

Table 2. Relationship between time after infestation and number of *Spodoptera frugiperda* caterpillars attracted by different sorghum genotypes. Cassilândia, Mato Grosso do Sul, 2016.

Time (Minutes)	Agromen 50A40	LG 6310	DOW 1G233	DOW 1G100	XB 6022	DOW 1G220	Agromen 50A50
	----------------- Number of *S. frugiperda* per leaf sections -----------------						
5	11.9	13.9	13.0	17.1	13.9	13.7	14.5
10	12.2	14.5	15.0	16.7	14.8	15.8	15.6
15	12.9	13.1	16.6	15.7	15.4	16.4	14.5
20	13.3	13.2	16.8	18.1	15.9	15.8	14.4
25	11.4	13.4	15.0	17.6	16.9	16.3	13.1
30	10.7	14.1	16.7	19.7	18.9	15.4	13.0
60	8.4	13.7	17.0	20.6	19.2	14.4	14.0
F test	2.58*	0.08ns	0.43ns	0.46ns	3.04*	0.56ns	0.41ns
Regression	L**	ns	ns	ns	L**	ns	ns
CV (%)	14,23	16,49	21,17	21,61	11,63	13,70	14,62

ns not significant by the F test; *significant at 5% by the F test; **significant linear equation at 1% by the Student's t test; CV: coefficient of variation.
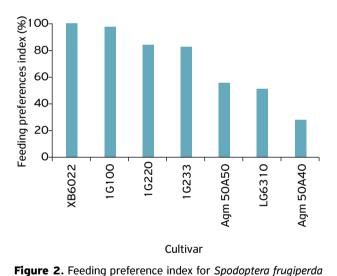
Table 3. Number of *Spodoptera frugiperda* caterpillars attracted by different genotypes of sorghum at different periods after infestation. Cassilândia, Mato Grosso do Sul, 2016

Genotypes	Time							24 hours
	Minutes							
	5	10	15	20	25	30	60	
Agromen 50A40	11.9	12.2	12.9	13.3	11.4	10.7 b	8.4 c	5.9 c
LG 6310	13.9	14.5	13.1	13.2	13.4	14.1 b	13.7 b	10.7 b
DOW 1G233	13.0	15.0	16.6	16.8	15.0	16.7 a	17.0 b	17.2 a
DOW 1G100	17.1	16.7	15.7	18.1	17.6	19.7 a	20.6 a	20.6 a
XB 6022	13.9	14.8	15.4	15.9	16.9	18.9 a	19.2 a	21.0 a
DOW 1G220	13.7	15.8	16.4	15.8	16.3	15.4 a	14.4 b	17.4 a
Agromen 50A50	14.5	15.6	14.5	14.4	13.1	13.0 b	14.0 b	11.6 b
F test	1.00^{ns}	0.64^{ns}	0.81^{ns}	0.98^{ns}	1.66^{ns}	3.53^{*}	7.83^{*}	17.71^{*}
CV (%)	17.27	17.66	16.26	16.36	17.65	16.71	15.58	15.77

Means followed by the same letter in the columns belong to the same group by the SCOTT; KNOTT (1974) cluster test, at 5% probability; ^{ns}not significant by the F test; *significant at 1% by the F test; CV: coefficient of variation.

epidermis, which increases with larger amounts of silica present in each plant, acting as a mechanical barrier, making it difficult to the *S. frugiperda* to feed (DJAMIN; PATHAR, 1967; CARBONARI; MARTINS, 1998).

With the feeding preference index, it is possible to verify that the *S. frugiperda* has a higher feeding preference for the genotypes XB6022 and 1G100, and less preference for the Agromen 50A40 genotype (Fig. 2). The lower feed preference of *S. frugiperda* for the genotype Agromen 50A40 can be attributed to the large amount of fiber present in the leaves (BOREGAS et al., 2013).

Figure 2. Feeding preference index for *Spodoptera frugiperda* caterpillars (1st instar) on sorghum genotypes after 24 hours. Cassilândia, Mato Grosso do Sul, 2016.

CONCLUSION

Among all sorghum genotypes evaluated, the Agromen 50A40 genotype showed less attractiveness by the *Spodoptera frugiperda*.

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