http://dx.doi.org/10.18512/1980-6477/rbms.v15n3p386-397

POTENTIAL RISK OF LOSSES IN MAIZE CAUSED BY *Dichelops melacanthus* (DALLAS) (HEMIPTERA: PENTATOMIDAE) IN BRAZIL

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Revista Brasileira de Milho e Sorgo, v.15, n.3, p. 386-397, 2016

ABSTRACT: The incidence of the green belly stink bug, *Dichelops melacanthus* (Dallas) (Heteroptera: Pentatomidae), on maize crop in Brazil has increased with time, especially due to the continuous availability of food throughout the year. This insect causes injury to seedlings, killing them shortly after their emergence from the soil. If the plant survives, it is possible to see areas with necrotic lesion that increase in a transverse pattern on the sheet, with perforations on the leaves or tillers (side shoots). This pest is currently one of the most important to maize, in conventional and *Bt* hybrids. The research compared the behavior of theses cultivars infested by the green belly stink bug, *D. melacanthus*. *Bt* and conventional maize cultivars were evaluated in a protected environment (greenhouse) and only *Bt* maize was evaluated at field. Evaluations based on plant development and insect injury occurred after seven days of the infestation period. The results indicated variability among cultivars related to insect infestation, measured by a visual scale for damage determination and plant development. Grain yield obtained from infested plots was 6352.2 kg ha^{-1} whereas in the non-infested plots was 8048.05 kg ha^{-1}, equivalent to an average reduction of 21.07%.
Keywords: Plant damage, grain losses, green belly stink bug

RISCO POTENCIAL DE PERDAS CAUSADAS POR *Dichelops melacanthus* (DALLAS) (HEMIPTERA: PENTATOMIDAE) EM MILHO NO BRASIL

RESUMO - A incidência do percevejo barriga verde *Dichelops melacanthus* (Dallas) (Heteroptera: Pentatomidae) em milho no Brasil tem aumentado nos últimos anos, especialmente devido à disponibilidade de alimento o ano todo. A injuria provocada pelo inseto pode causar a morte da plântula reduzindo o número ideal de plantas na colheita. Se a planta sobrevive, é possível visualizar áreas necrosadas ou perfilhamento. A praga é atualmente uma das mais importantes do milho, tanto em cultivares convencionais como em cultivares *Bt*. A presente pesquisa comparou o comportamento destas cultivares em ambiente protegido (casa de vegetação) e no campo, avaliando a injuria provocada pela praga, o desenvolvimento da planta e a produtividade de grãos (campo). Os resultados indicaram variabilidade entre cultivares em relação à injuria e ao desenvolvimento da planta. O rendimento de grãos nas parcelas infestadas foi 6352,2 $kgha^{-1}$ enquanto que nas parcelas sem infestação a produtividade foi 8048,05 $kgha^{-1}$, o equivalente a uma redução média de 21,07%.
Palavras-chave: Danos, perdas em rendimento de grãos, percevejo barriga-verde

With the release and commercial use of genetically modified maize in Brazil (*Bt* maize) there was a significant reduction in the incidence of the main pest, the fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae). In addition to the direct effect of *Bt* maize on the pest leading to its death, the innovative technology brought another great benefit to agribusiness, which was the reduction for chemical placed in the environment, used almost entirely for fall armyworm control. Unfortunately, the current cultivars of *Bt* maize are not efficient for other insect species, so-called "non-target". These species reached sufficient population density to cause economic damage to conventional maize only under special circumstances, especially in areas where the main pest was not present, or when it was present with low populations, not requiring control measures. With the reduction of chemicals use on *Bt* maize against the fall armyworm, new species are occupying the niche left by *S. frugiperda*, especially the sucking insects, including the green belly stink bug, *Dichelops melacanthus,* causing direct damage to freshly emerged maize.

Reduction of the use of agrochemicals and cultivation in a second crop season (Panizzi, 1997) are the main reasons for increasing the incidence of *D. melacanthus* in the initial stage of development of maize and wheat crops.

D. melacanthus damaging in maize seedlings was initially reported in the state of Mato Grosso do Sul; since then, its attack has increased year by year throughout the State. Nowadays, the geographical distribution of the insect also encompasses several other Brazilian States, including Parana, Santa Catarina, Rio Grande do Sul, Mato Grosso and southeast region of the State of São Paulo (Ávila & Panizzi, 1995).

Bioecology, damage and control methods were reported by Ávila and Panizzi (1995), Martins and Weber (1998); Gomez (1998), Chocorosqui (2001), Chocorosqui and Panizzi, (2004), Ceccon et al. (2004), Albuquerque et al. (2006), Martins et al. (2006, 2009), Carvalho (2007), Roza-Gomes et al. (2011). During feeding, *D. melacanthus* places in a longitudinal position of the maize plant, with the head facing the base of the plant, injecting saliva to facilitate the stylet penetration; the damaged leaves have holes with yellow halo and arranged in rows; when the plant does not die, the first leaves that emerge have streaks and transverse streaks. Plants with severe attack present dwarfism and some development of unproductive tillers (Cruz & Bianco, 2001; Bianco, 1997, 2005).

The wide use of crop rotation in no-tillage systems favors the supply of food sources and survival conditions to the insect during adverse periods of the year (winter or dry season) under crop residues (Chocorosqui & Panizzi, 2004; Carvalho, 2007). Especially in Brazil, another favorable factor which favors increases in the insect population is the cultivation of host plants in sequential crop, such as soybean, maize and wheat. According to Chocorosqui and Panizzi (2003), *D. melacanthus* bread on soybean but it is not an important pest of this crop; on the other hand, it does not colonize maize plants, despite adult insect causing severe damage to seedlings of this crop.

Dichelops furcatus, a key pest of soybean, bears much resemblance to the *D. melacanthus* species (Grazia, 1978; Panizzi et al., 2007) which is the most important pest for both maize and wheat (Chocorosqui & Panizzi 2004; Manfredi-Coimbra et al., 2005).

The objective of this work was to evaluate the susceptibility of different maize cultivars (*Bt* and conventional) regarding the presence of the

green belly stink bug, *Dichelops melacanthus*, in a protected environment (greenhouse), assessing the symptoms of damage and the plant development at the early stage growth, and to evaluate the effect of the insect on grain yield in the field. Although maize hybrids were evaluated carrying different *Bt*s events, it was considered that this characteristic is specific for chewers of the order Lepidoptera thus not influencing the results against *D. melacanthus*, a non-target sucking insect of *Bt* maize.

Material and Methods

Experiments were conducted in area of Embrapa Maize and Sorghum Research Center (19º27'14"S / 44º09'25"W, 730 m above sea level) in Sete Lagoas, Minas Gerais State, Brazil. The seeds of each evaluated genotype were obtained from the holding companies without treatment with systemic insecticides that could interfere in the results.

The susceptibility of different maize cultivars (*Bt* and conventional) was evaluated under greenhouse and at field (only *Bt* maize), comparing plots with and without the presence of *D. melacanthus*, measuring the resulting damage by using a visual scale of injury, the development of the plant (height and weight of plant canopy) and grain yield. The adult stink bugs used in the experiments were from the colony kept in the laboratory. The relative growth of each cultivar was also evaluated by comparing the height or weight of the infested plant divided by the equivalent value of the non-infested plant multiplied by 100.

Greenhouse test

Experiments were carried out under greenhouse, in a completely randomized design with 10 replications, each one represented by one plant, evaluating 15 different hybrids including *Bt* and conventional maize. Plastic pots with 4.5 kg of soil fertilized with 6g of NPK 4-14-8 formulation immediately incorporated into the soil received the seeds of each cultivar. Infestation on ten plants of each genotype was accomplished one week after the emergence (V1 growth stage), placing one adult per plant. The insects stayed on plants for eight days. For comparison, identical number of plants without infestation was used. Screen-coated wire cage covered all plants during infestation period. Daily inspection indicated replacement of any dead insects inside the pots.

At the end of the infestation period, each plant was evaluated for its development and damage caused by the pest using a visual scale, assigning zero to the absence of visible injury, one to mild injury, two to medium injury and three to severe injury (Bianco, 2005). A second evaluation was performed one week after the first, assigning the same scale of damage. Additionally, after the second evaluation we take the fresh weight from eight plants newly removed from the soil.

Field test

Only *Bt* maize cultivars were evaluated at field condition in a savanna area, using a randomized complete block design with split plots. Each plot with *Bt* cultivars was five-meter-long rows, spaced 0.70m. As fertilizer, 400 kg ha^{-1} of the commercial formula 8-28-16 + Zn was used. Three field experiments were carried out, with planting dates on February 21, 2014, January 9 and 28, 2015. Additional irrigation was used when necessary. The subplots comprised plants without infestation and plants infested by

one *D. melacanthus* per plant (one week after the emergence - V1 growth stage). The plots without and with the insects were covered by iron cages and fine screens throughout the period of infestation (two cages/subplot). Such cover remained on the plants for a period of seven days, after which the plants were visually evaluated for insect damage, using the same scale mentioned in the greenhouse experiment.

Statistical analysis

For both greenhouse and field experiments the statistical analyzes (Analysis of Variance and mean separation) were performed with the free software SISVAR (Ferreira, 2014).

Results

Greenhouse test

The cultivars AG 8088 and P 30F35 YH showed the lowest values in the visual damage scale (average of 0.8). On the opposite side, the highest damage score was attributed to two *Bt* cultivars (AG 8088 YG and AG 8088 PRO 2) and to a conventional cultivar (P 30F35), with an average of 2.47. Relatively high average damage (1.7) was attributed to cultivars DKB 390 YG, P 3646 H, 2B707 Hx, DKB 330 YG and DOW 2B587, the latter, a conventional cultivar. Finally, cultivars DOW 30A16 Hx, DOW 2B587 Hx, AG 8088 PRO, DOW 30A16 and P 30F53 scored a mean damage of 1.46. The results indicate variability among maize cultivars concerning insect injury (Table1), regardless the cultivar type.

Infested plants showed an average height of 41.43 cm, a value significantly lower than that presented by non-infested cultivars (51.74 cm), corresponding to 20% height reduction when under insect feeding. There was interaction between cultivar and infestation. The two cultivars (AG 8088 and P 30F35 YH) that presented the lowest damage scale values under infestation did not present reduced development compared to no-infested plants (Table 1). The same situation occurred with the cultivar AG 8088 PRO; no significant reduction in development was observed during the feeding period by the insect compared to the development of plants without infestation. All other cultivars showed significantly reduction of plant development when infested by *D. melacanthus*.

Table 1 shows the relative height of the plants, as the measurement from the base of the plant to the apex of the longest leaf. The mean height of the infested plant in relation to the height of the non-infested plant ranged from 51.24 to 98.54%. Infested plants of cultivars AG 8088 and P 30F35 YH showed the lowest scores of injuries (0.80), with 95.5% of the average height of the plants without infestation. In other words, in these two cultivars the average reduction in plant height was 4.5%. For the group of cultivars with average visual damage of 1.46 (DOW 30A16 Hx, DOW 2B587 Hx, AG 8088 PRO, DOW 30A16 and P 30F53), the relative height of the infested plants ranged from 68.09 to 91.22% of the value presented by the non-infested plants, suggesting differentiated reaction of the cultivars. The average size of the cultivar DOW 2B587 Hx with a damage score of 1.40 was only 68.09% of that presented by the same cultivar without infestation, therefore a reduction of 42%. This value was significantly different from the value of the other cultivars in the group, whose reduction in plant size was 10.72%.

With the increase in the level of injury caused by the pest, as occurred in the cultivars with an average visual damage of 2.06, the relative height

of the infested plant ranged from 71.08 to 87.93% of the height of the non-infested plants. In this group, despite the similar damage, the relative height of the plant varied with the cultivar, being significantly similar for cultivars DKB 390 YG and DOW 2B587, with an average plant height reduction of 14.47%. For cultivars P 3446 H, 2B707 Hx and DKB 330 YG, with similar relative plant growth, the average reduction was 26.54% compared to the average plant height without infestation. The cultivars AG 8088 PRO 2 and AG 8088 YG were also included in this latter group, with a mean damage score of 2.5, but with an average reduction in plant growth of 25.1%. A reduction of 48.76% in the development of the plant was observed in the cultivar P 30F35 whose visual damage score was also one of the largest (2.60), indicating its susceptibility to injury caused by the green belly stink bug (Table 1).

Table 2 shows the height of the plant seven days after the interruption of the feeding period by the insect. Probably there was no enough time for plant recovery due to the short period between absence of feeding and the second evaluation. There was no significant difference in plant development, except for two cultivars. The height of the cultivar P 30F35 Hx decreased 7.46% and 55.15 % in the first and second evaluation periods, respectively. On the other hand, cultivar P 30F35 presented a reduction of 48.76% of plant development in the first evaluation which was partially recovered during the subsequent period of seven days without the presence of the insect with a reduction in the development of 21.39 %. Considering only the cultivars with average visual damage equal to or greater than 1.9, the average reduction in plant development was 30.2%.

Although unlikely to be evaluated in the field once it is a destructive method, Table 2 also shows the relative weight of the plant canopy, that is, the percentage ratio between the weight of the infested plant and the equivalent weight of the non-infested one. Plants under attack of the green belly stink bug weighted from 40.91 to 83.13% of the green mass produced by plants without infestation.

Statistically, two groups of cultivars were differentiated in the evaluation of the fresh mass of plant canopy (Table 2). In the first group, the cultivars AG 8088 (C), DOW 30A16 Hx, P 30F53 (C), AG 8088 PRO, DOW 30A16 (C), P 3646 H, DOW 2B587 (C), DKB390 YG and P 30F35 Hx were the cultivars with the lowest reduction in mass, that is, with the green mass closer to the verified for the same cultivar in the absence of infestation. Four of the five conventional cultivars (C) evaluated are included in this group. On average, the green mass of this first group of cultivars was 73.9% of the values obtained for the cultivars without infestation. In other words, an average decrease of 26.13%.

The second group of cultivars, which showed higher fresh green mass reduction after being injured by the pest, included P 30F35 (C), DOW 2B587 Hx, DOW 2B707 Hx, AG 8088 PRO 2, DKB330 YG and AG 8088 YG), with an average of 49.90% in the production of green mass when plants were under attack by *D. melacanthus*.

Experiments carried out in a greenhouse are important to indicate the behavior of the pest related to different host plants in a relatively short time period. In this first experiment, the importance of the insect for maize was clear regardless the cultivar, conventional or *Bt*-expressing. For a continuous period of seven days with the insect feeding on plant, a reduction in the development was observed, measured by the size and weight of the crop canopy. In general, all evaluated cultivars showed to be a food source for the

Table 1. Response of *Bt* and conventional (C) maize hybrids to the injury of *Dichelops melacanthus* in greenhouse test: damage and plant height[1].

Cultivars	Damage on infested plots	Plant height (cm), seven days after infestation[1]		Relative Plant Height (RPH)[2]
		Infestation		
		Non-infested	Infested	
AG 8088 (C)	0.70D	50.80a	50.00a	98.54A
P 30F35 YH	0.90D	56.60a	52.40a	92.46A
DOW 30A16 Hx	1.30C	73.20a	64.80b	89.01A
DOW 2B587 Hx	1.40C	58.20a	39.50b	68.09B
Ag 8088 PRO	1.50C	38.50a	34.96a	91.22A
DOW 30A16 (C)	1.50C	62.70a	55.95b	89.49A
P 30F53 (C)	1.60C	39.79a	34.57b	87.40A
DKB 390 YG	1.90B	40.77a	35.74b	87.93A
P 3646 H	1.90B	53.50a	37.15b	71.08B
2B707 Hx	2.10B	59.40a	42.45b	71.51B
DKB 330 YG	2.14B	37.24a	28.30b	77.79B
DOW 2B587 (C)	2.25B	63.50a	52.63b	83.13A
AG 8088 PRO 2	2.43A	58.73a	43.63b	74.22B
AG 8088 YG	2.56A	33.03a	23.74b	75.58B
P 30F35 (C)	2.60A	50.15a	25.60b	51.24C
Average		51.74a	41.43b	

[1] Means followed by the same capital letter in the column and lowercase in the row do not differ significantly from each other by the Scott-Knott test (5%).

[2] RPH = height of the infested plant divided by the equivalent value of the non-infested plant multiplied by 100.

pest. Especially for *Bt* maize cultivars, whose main target in Brazil is the fall armyworm, *Spodoptera frugiperda*, the susceptibility of the plant to the green belly stink bug can undoubtedly raise the cost of crop production when demanding control measures.

Field experiment 1

In the first field experiment, the plant heights were on average 16.68 cm on the same day of infestation, with no significant difference between plots to be infested and those that would be.

Evaluating of the reaction of the plant to the injury caused by insect feeding, an uniformity among cultivars was observed in the scale of zero (without visible damage) to three (severe damage), with no significant difference between treatments and a mean damage score of 1.73. This evaluation was performed after a period of seven days of feeding (Table 3). Similarly, no significant difference in plant size reduction was detected, with an average of 11.27%. There was no cultivar x infestation interaction, but a significant difference between infested and non-infested plants was observed for all cultivars.

The average grain yield of the non-infested cultivars was 7512.15 kg ha^{-1}, significantly higher than the average of 6052.34 kg ha^{-1} observed for the

Table 2. Effect of *Dichelops melacanthus* feeding on plant height and weight of *Bt* or conventional (C) maize cultivars in greenhouse test[1].

Cultivars	Plant height (cm) seven days after the interruption of the feeding period[1]		Relative Plant Height (RPH)[2]	Relative Plant Weight (RPW)[2]
	Infestation			
	Non-infested	Infested		
AG 8088 (C)	62.00a	62.30a	101.03A	78.86A
DOW 30A16 Hx	91.40a	85.30a	93.59A	76.84A
P 30F53 (C)	53.60a	47.50a	89.14A	75.97A
AG 8088 PRO	53.60a	54.50a	103.43A	71.20A
DOW 30A16 (C)	83.10a	72.30b	87.16A	72.36A
P 3646 H	63.30a	41.20b	65.57B	67.51A
P 30F35 (C)	77.00a	60.50b	78.61B	40.91B
DOW 2B587 (C)	86.43a	57.71b	67.10B	83.13A
DKB390 YG	61.40a	45.50b	73.95B	72.50A
DOW 2B587 Hx	72.00a	46.00b	64.28B	58.59B
DOW 2B707 Hx	75.10a	50.60b	66.92B	63.06B
AG 8088 PRO 2	78.17a	58.33b	74.47B	52.49B
P 30F35 Hx	59.90a	26.60b	44.45C	66.42A
DKB330 YG	53.70a	34.60b	64.76B	49.95B
AG 8088 YG	51.40a	32.40b	67.42B	48.57B
Average	68.14a	51.69b		

[1] Means followed by the same capital letter in the column and lowercase in the row do not differ significantly from each other by the Scott-Knott test (5%).

[2] RPH or RPW: height or weight of the infested plant divided by the equivalent value of the non-infested plant multiplied by 100.

infested cultivars. There was no interaction between cultivar and infestation. Comparatively, there was no significant difference in grain yield reduction between cultivars, with an average of 19.65%

Field experiment 2

In the second field experiment, the plants showed on average 9.8 cm at the time of infestation and no significant difference between plots to be infested or not infested by the insect, similarly to the first experiment. The injury caused by the insect to plants represented mean damage scores ranging from 0.78 to 2.67 (Table 4). The lowest mean, attributed to cultivar P2830H, was significantly different from the others. On the opposite side, the cultivars P3646YH C2, P3862 YH and P3844H presented greater injuries, averaging 2.28.

Estimated grain yield of the cultivars was similar in the absence of the insect, with an average of 8126.57 kg ha^{-1}. In the presence of the pest, the grain yield was only 5677.86 kg $ha^{-1.}$ The grain yield of all cultivar under infestation was significantly lower than the yield of non-infested cultivars (Table 4), and the yield reduction did not vary among the cultivars, with a mean of 33.34%, showing the importance of the pest in the crop system of *Bt* maize.

Table 3. Effect of *Dichelops melacanthus* feeding on plant height, plant weight and grain yield of *Bt* maize cultivars at field. Experiment 1.

Cultivar	Damage on infested plots[2]	Reduction in plant height (%)	Grain yield (kg ha^{-1})[1] Infestation		Reduction in grain yield (%)[1]
			Non-infested	Infested	
P 30R50H	1.65A	12.95A	8874.47a	6310.94a	27.00A
DKB390 PRO 2 RR	1.85A	7.34A	7518.75a	6743.75a	14.75A
P 30F35 HR	1.70A	12.18A	6925.00a	5400.00a	21.33A
DOW 30A16 HX	1.67A	14.46A	7460.94a	6293.75a	13.16A
AG 8088 PRO 2 RR	1.78A	9.77A	7268.75a	5703.12a	24.98A
AG 8088 VT PRO	1.75A	10.94A	7025.00a	5862.50a	16.64A
Average	1.73	11.27	7512.15a	6052.34b	19.65

[1]Means followed by the same capital letter in the column and lowercase in the row do not differ significantly from one another by the Scott-Knott test (5%).

[2] Seven days after infestation.

Table 4. Plant damage, grain yield and yield reduction caused by *Dichelops melacanthus* in different cultivars of *Bt* maize. Field experiment 2.

Cultivar	Average damage score on infested plots	Grain yield (kg ha^{-1})[1] Infestation		Reduction in grain yield (%)[1]
		Non-infested	Infested	
P 2830H	0.78C	7882.14a	5907.14b	23.92A
P 3646YH C2	2.67A	8528.57a	4382.14b	46.26A
P 3862 YH	2.18A	7471.43a	5953.57b	29.89A
P 3844H	1.99A	8496.43a	6046.43b	32.73A
30F53Y HR	1.48B	8254.29a	6100.00b	33.91A
Average		8126.57a	5677.86b	

[1]Means followed by the same capital letter in the column and lowercase in the row do not differ significantly from one another by the Scott-Knott test (5%).

Field experiment 3

In the experiment 3 (Table 5), plant height was evaluated seven days after infestation. There was no interaction between cultivar and infestation. Furthermore, there was no significant difference between means of heights from non-infested or infested plants. The climatic conditions favored a faster development of the plants. There was no significant difference between the infested cultivars concerning the visual damage, with a mean of 1.4. Despite the relatively lower damage than that observed in the previous experiment, infested plants also showed significantly lower yield of grains than plants without infestation. There was no interaction between infestation and cultivars and the grain yield of the infested plants (7326.43 kg ha^{-1}) was significantly lower than the grain yield from non-

Table 5. Plant damage, plant height, grain yield and yield reduction caused by *Dichelops melacanthus* in different cultivars of *Bt* maize. Field experiment 3.

Cultivar	Average damage score on infested plots	Plant height seven days after infestation (cm)[1]		Grain yield (kg ha^{-1})[1]		Reduction in grain yield (%)[1]
		Infestation		Infestation		
		Non-infested	Infested	Non-infested	Infested	
P2830H	1.36A	41.57a	42.14a	7703.57a	6903.57b	20.63A
P3646YH C2	1.38A	34.55a	32.50a	8864.29a	6821.43b	22.51A
P3862 YH	1.48A	35.32a	36.77a	9821.43a	8585.71b	15.44A
P3844H	1.30A	47.74a	46.93a	7945.00a	8160.71b	16.29A
30F53Y HR	1.46A	35.70a	35.36a	8192.86a	6160.71b	26.45A
Average	1.40	38.98a	38.74a	8505.43a	7326.43b	

[1]Means followed by the same capital letter in the column and lowercase in the row do not differ significantly from one another by the Scott-Knott test (5%).

infested plants. The reduction in grain yield of infested plots compared to non-infested plots was not significantly different among cultivars, with an overall mean was 20.26%.

Discussion

The losses caused by *D. melacanthus* are related to the stage of development of the maize plant, which can be verified by a visual scale of damage (Brustolin et al., 2011), dry weight of the plant canopy or grain yield evaluations. The insect normally attacks on seedling stage between one and five leaves (Duarte et al., 2015). According to these authors, plants infested at the growth stages V4 and V5 did not show reduction in grain yield compared to plants without infestation. According to Slansky and Panizzi (1987) and Hori (2000), the highest susceptibility of maize seedlings to the injury of *D. melacanthus* is due to the inoculation in the plant of indole-3-acetic acid, a very toxic compound at the beginning of plant development. Albuquerque et al. (2006) suggested that the use of curative measures for pest control eight days after emergence of the plants is too late to avoid economic damages caused by the insects. Netto et al. (2015) also demonstrated the importance of the insect, emphasizing the reduction in plant height and grain yield of *Bt* and conventional maize plants under infestation with one adult insect per plant for a feeding period of 15 days, beginning three days after the plant emergence. Netto et al. (2015) use the same insect density of the present study, but the plants remained under the action of the pest for a much longer period and earlier. Although there are reports of the possibility of death of the seedling attacked by the insect (Ávila & Panizzi, 1995; Viana et al., 2001) in the present work no death was verified; possibly this fact can be explained by the high genetic quality of the current maize hybrids available in the Brazilian market.

Considering all cultivars evaluated in the field (Tables 3-5), without the presence of the insect the yield was 8048.43 kg ha^{-1}; whereas, in the presence of the insect grain yield was 6352.21 kg ha^{-1}, a difference

of 21.07% or 1696,22 kg ha^{-1}. According to the results of Duarte et al. (2015), the relationship between grain yield and pest density follows inversely the first-degree equation; the estimated yield was 2409.65 kg ha^{-1} for the density of one green belly stink bug per plant and 2785 kg ha^{-1} in the absence of the insect. In other words, a loss of 375.35 kg ha^{-1}, or equivalent to a reduction of 13.48% in grain yield, which represents values significantly lower than the obtained in the present work. Maize plants damaged by the insect presented reduced development and became less competitive for water and nutrients uptake.

Conclusions

Variability occurs between maize cultivars as response to the injury caused by the insect, evaluated by a visual scale, and can be used for a rapid selection of cultivars in protected environment as a greenhouse.

Cultivars of maize and insect infestation can interact with development of the plant (plant height and weight of the canopy). However, no interaction was observed with grain yield.

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