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RESISTANCE OF BT TRANSGENIC MAIZE TO LESSER CORNSTALK BORER (LEPIDOPTERA: PYRALIDAE)

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The lesser cornstalk borer, *Elasmopalpus lignosellus* (Zeller) (Lepidoptera: Pyralidae), maize causes the symptom known as "dead heart" to maize. The objective of this research was to evaluate if Bt maize would protect seedlings against lesser cornstalk borer damage and whether different temperatures affect the insect-plant interaction.

Two experiments were conducted. Seeds from Pioneer Bt maize hybrids P33G27, P34R07, P34G82, P33A14, and P34D34, expressing the toxin Cry1A(b) were obtained from the market. Seeds from the hybrids Mycogen (experimental) and Garst 8539 expressing, respectively, the toxin Cry1F and Cry9C as well as the control Garst 8539 (non-Bt) were obtained from the seed producers. Lesser cornstalk borer for artificial infestation were obtained from a colony maintained by USDA-ARS-CPMRU, in Tifton, GA.

The first experiment included 7 maize hybrids tested at two plant growth stages (3 and 4 leaf) at a constant temperature of 27 ± 0.7°C and photophase of 14 h light: 10 h darkness. The experimental unit was 9 seedlings infested with 2 second/third instars per plant and replicated 3 times. One week after infestation, the experiment was evaluated by weighing and counting the number of surviving larvae and the number of undamaged plants. A damage score (0-no damage, 10-dead plant) was used.

There was a significant difference between the Bt and the non-Bt hybrids regarding the damage score and the number of dead plants (Table 1). However, there was no significant difference among the Bt hybrids regarding those variables. The degree of plant damage and number of dead plants/plot were highly correlated (r = 0.998). Fewer numbers of lesser cornstalk borer larvae survived on Bt than non-Bt maize. In addition, larvae surviving on Bt maize weighed less than those surviving on non-Bt maize (Table 1). There was a high correlation (r = 0.991) between the number and weight of surviving larvae. A significant reduction on the number of survivors, caused by Bt toxin, was reported to lesser cornstalk borer on transgenic sugarcane (Fitch et al. 1996).

TABLE 1. MEAN ± STANDARD ERROR OF THE DAMAGE SCORE AND SEEDLING MORTALITY CAUSED BY LESSER CORNSTALK BORER, NUMBER OF LARVAE AND LARVAL WEIGHT OF SURVIVING WORMS INFESTING BT AND NON BT MAIZE HYBRIDS AT 27°C AND 14 H LIGHT:10 H DARK PHOTOPHASE.

			Larval	
Maize hybrid (Bt toxin)	Plant damage score[1]	Number of dead plants[1]	Number of survivors	Weight (mg)
P34R07 (Cry1Ab)	0.9 ± 0.1 a	0.0 ± 0.0 a	1.7 ± 1.6	4.0 ± 2.1
P33G27 (Cry1Ab)	0.6 ± 0.2 a	0.3 ± 0.2 a	2.8 ± 2.3	3.9 ± 3.2
P34G82 (Cry1Ab)	0.7 ± 0.2 a	0.0 ± 0.0 a	1.9 ± 0.7	1.4 ± 0.8
P33A14 (Cry1Ab)	0.6 ± 0.1 a	0.0 ± 0.0 a	3.3 ± 2.0	2.8 ± 1.2
P34D34 (Cry1Ab)	0.9 ± 0.1 a	0.0 ± 0.0 a	2.4 ± 1.4	3.3 ± 0.8
G8539 (Cry9C)	0.7 ± 0.2 a	0.0 ± 0.0 a	5.1 ± 2.7	6.1 ± 1.7
G8539 (Non-Bt)	9.4 ± 0.3 b	8.5 ± 0.2 b	1.7 ± 2.7	24.0 ± 5.5
F	481.79	576.40	—	—
Coef. of variation	18.62%	8,47%	—	—

[1]Data transformed to square root of (× + 0.5) for statistical analysis. In each column, means followed by the same letter are not significantly different by Duncan Multiple Range Test (P ≤ 0.05).

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TABLE 2. MEAN ± STANDARD ERROR NUMBER OF DEAD PLANTS[1] OF BT AND NON BT MAIZE HYBRIDS UNDER DIFFERENT TEMPERATURES AND ARTIFICIAL INFESTATION BY LCSB IN A GROWTH CHAMBERS WITH PHOTOPHASE OF 14 H.

	Temperature			
Maize hybrid	20°C	24°C	28°C	32°C
Mycogen Exp.(Cry1F)	0.3 ± 0.6 a	0.0 ± 0.0 a	0.3 ± 0.6 a	0.3 ± 0.6 a
P33G27 (Cry1Ab)	0.0 ± 0.0 a	0.0 ± 0.0 a	0.3 ± 0.6 a	0.0 ± 0.6 a
Garst 8539 (Cry9C)	0.3 ± 0.6 a	0.7 ± 0.6 a	0.0 ± 0.6 a	0.0 ± 0.0 a
Garst 8539 (Non-Bt)	2.0 ± 1.0 b	4.7 ± 0.6 b	5.0 ± 0.6 b	5.0 ± 0.0 b

[1]Data transformed to square root of (× + 0.5) for statistical analysis. F= 128.14 and Coefficient of variation: 17.81%. In each column, means followed by the same letter are not significantly different by Duncan Multiple Range Test (P ≤ 0.05).

The second experiment evaluated the temperature effect on Bt maize-lesser cornstalk borer interaction. Plants were maintained in growth chambers regulated at constant temperatures (20°C, 24°C, 28°C, or 32°C during the day and 20°C during the night). The experimental unit included 5 seedlings from the Bt maize hybrids Mycogen experimental (Cry1F), Pioneer P33G27 (Cry1Ab), and Garst 8539 (Cry9C), and non-Bt Garst 8539 and was replicated 3 times. The infestation method used was the same as the previous experiment and the evaluation was based on the number of dead plants.

The results showed a significant difference between transgenic and non-transgenic maize regarding the number of dead plants (Table 2). However, there was a significant interaction between temperature and genotype for this variable. The temperature affected the plant development and the amount of lesser cornstalk borer damage, being significantly lower on controls at 20°C compared with other temperatures (Table 2). Conversely, there was no significant difference among the Bt maize hybrids expressing the Cry1F, Cry1Ab or Cry9C toxin regarding temperature. Therefore, Bt transgenic maize expressing all evaluated toxins can be considered an effective approach to manage lesser cornstalk borer damage. While some larvae survived on the Bt transgenic maize, they were smaller and weighed less than the ones on the non-Bt maize and, at all temperatures tested, did not cause significant damage on Bt maize seedlings.

Bt plants have been used to control many pests, including lesser cornstalk borer. Fitch et al. (1996) found 80-100% mortality of lesser cornstalk borer on transgenic sugarcane. Singsit et al. (1997) reported various levels of Bt transgenic peanut resistance to lesser cornstalk borer, ranging from complete mortality to a 66% reduction in larval weight. Bt maize controlled fall armyworm, *Spodoptera frugiperda* (Smith) (Lepidoptera: Noctuidae), southwestern corn borer, *Diatraea grandiosella* (Dyar) (Lepidoptera: Pyralidae), corn earworm and *Helicoverpa zea* (Boddie) (Lepidoptera: Noctuidae) (Lynch et al. 1999, Williams et al. 1998).

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SUMMARY

To determine if Bt maize seedlings are protected against lesser cornstalk borer damage, Bt hybrids at the 3 and 4 leaf stages were tested under temperatures between 20-32°C and artificial infestation. A high level of resistance was reported in all Bt maize as expressed by larval survival, larval weight, damage score, and number of surviving plants. All Bt maize protected plants against lesser cornstalk borer damage. Also, the resistance present in the Bt maize was not affected by daytime temperature.

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