AVOCADO MOTH (LEPIDOPTERA: STENOMIDAE) DAMAGE IN TWO AVOCADO CULTIVARS

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ABSTRACT

Avocado moth, *Stenoma catenifer* (Wals.), damages the avocado, *Persea americana* Mill. Two cultivars, Beatriz and Margarida, were assessed during the fruit development period. The progression of fruit damaged was different in the two cultivars. The incidence of *S. catenifer* fruit damage at the beginning of fruit development was higher in Beatriz (72.1%) than in Margarida (28.4%). However, the differences in damaged fruit decreased between cultivars over the season. The number of borer holes per fruit was also higher throughout the season in Beatriz than in Margarida, as indicated on the first (3.99 and 1.41, respectively, on day 8) and last (13.35 and 6.08, respectively, on day 133) observation date. Percent fallen fruits were initially the same (2.00 and 0.38%, respectively, on day 8), but significantly higher in Beatriz at the end of the season (97.19 and 81.60%, respectively, on day 133). Margarida was less damaged than Beatriz, as evidenced by percent damaged fruits, but mainly in the earlier assessments. The use of Beatriz as a trap plant in avocado orchards is discussed.

Key Words: Insecta, plant resistance, phenology, trap cropping

RESUMO

Avaliou-se os danos causados pela broca dos frutos *Stenoma catenifer* (Wals.) nos cultivares Beatriz e Margarida de abacate durante o período de desenvolvimento dos frutos. A progressão de frutos danificados foi diferente nos dois cultivares. No início da infestação, verificou-se que este percentual foi maior no cultivar Beatriz (72,1%) do que no Margarida (28,4%). Entretanto, a diferença de suscetibilidade entre os cultivares diminuiu gradativamente durante a safra. O número de orifícios por fruto foi maior durante a safra no cultivar Beatriz do que no Margarida, na primeira (3,99 e 1,41, respectivamente, no dia 8) e na última avaliação (13,35 e 6,08, respectivamente, no dia 133). A percentagem de frutos caídos foi inicialmente a mesma (2,00 e 0,38%, respectivamente, no dia 8), mas significativamente maior no Beatriz no final da safra (97,19 e 81,60%, respectivamente, no dia 133). O cultivar Margarida foi menos danificado do que o Beatriz, como evidenciou-se pelo percentual de frutos danificados, principalmente nas primeiras avaliações. Discute-se a utilização do Beatriz como planta armadilha nos pomares.

Several species of Lepidoptera are considered as pests of avocado, *Persea americana* Mill., fruit, including *Boarmia selenaria* Schiffermuller (Geometridae) (Wysoki & Jong 1989, Meisner et al. 1990) and *Cryptoblabes gnidiella* (Millière) (Pyralidae) (Wysoki & Jong 1989, Anshelevich et al. 1993) in Israel; *Sabulodes aegrotata* (Guenee) (Geometridae) (Bailey & Olsen 1990a, 1990b) and *Amorbia cuneana* (Walsingham)

(Tortricidae) (Bailey & Olsen 1990a) in California. In Latin America, the avocado moth, *Stenoma catenifer* (Walsingham) (Stenomidae), is the most serious pest of avocado and is widely distributed (Medina 1978, Gaillard 1987). Costa Lima (1945) first reported the avocado moth as a pest in Brazil, and since then it has been reported throughout Brazil (Medina 1978). The moth lays eggs on fruits. Larvae bore pulp and seeds and pupation occurs in the soil. Incubation, larval and pupal developmental time were reported as 16.0, 15.3 and 10.6 days, respectively, and mean number of eggs per female was 164 (26 ± 1°C; 60 ± 10% rh and 14 h L:10 h D photoperiod) in Margarida cultivar (Hohmann & Meneguim 1993).

The damage to avocado can cause total production loss (Hohmann & Meneguim 1993). Because there is concern about the introduction of this species into the United States (Wolfenbarger & Colburn 1979), fruit importation has been limited from countries where the pest occurs (Koller 1982).

Natural enemies could be a key management tactic used to control pest species in avocado orchards. Thus, the development and deployment of pest management tactics that do not destroy natural enemy populations are desirable (Bailey & Olsen 1990a). Pheromones (Bailey & Olsen 1990b, Anshelevich et al. 1993), biological control with egg parasitoids *Trichogramma* spp. (Wysoki & Jong 1989, Bailey & Olsen 1990b), *Trichogramma pretiosum* Riley and *T. annulata* de Santis (Hohmann & Meneguim 1993) and microbial control with *Bacillus thuringiensis* (Berl.) (Izhar et al. 1979, Meisner et al. 1990) are examples of non-aggressive control strategies that could be used to conserve natural enemy populations.

Although *T. pretiosum* Riley and *T. annulata* de Santis (Hohmann & Meneguim 1993) have been reported in avocado moth eggs, only chemical control of avocado moth in avocado orchards has been studied thus far (Santos et al., 1996, unpublished). Producers use chemical insecticides to control *S. catenifer* in avocado orchards (ca. 6 sprayings of organophosphates, carbamates, or pyrethroids) without knowledge of the susceptibility of different cultivars to this pest. The objective of this study was to compare avocado moth damage progression in two avocado cultivars during the season.

Material and Methods

The avocado cultivars, Margarida and Beatriz, were assessed for avocado moth damage in a five-year-old commercial orchard in Londrina (latitude 23°19'S, longitude 51°12'W), Paraná State, Southern Brazil, between February and June 1996. The orchard consisted of 90% Margarida and 10% Beatriz. The Margarida cultivar is produced in the fallow of other cultivars in orchards in the southern and southeastern regions of Brazil, and thus has a high commercial value. Producers interplant 10 to 20% Beatriz cv. plants in Margarida orchards as pollinizers. Avocado plants have protogyny (Fehr 1987) and cultivars are divided into two groups according differences in pollinization (Vithanage 1990). Margarida represents one group in which the pistil matures before the anther, with no synchronization in the maturity of the female and male reproductive organs. The pistil is viable in the afternoon while pollen of the same flower is viable in the morning of the following day. In a second group, which includes Beatriz, the pistil is viable in the morning and pollen of the same flower in the afternoon of the following day. Both cultivars are late. Crop management was the same in cvs.

Fruit development was observed at the onset of fruiting period. The experiment was initiated when the first symptoms of pest attack were detected and terminated at harvest. Twenty-six plant pairs of each cultivar were randomly selected. Each pair of plants was considered a block. Ten fruits from each plant were randomly marked and observed at 8, 17, 38, 57, 73, 94, 114 and 133 days after experiment beginning. A ran-

domized block design was used with two treatments and 26 blocks. The following characteristics were assessed: percent damaged fruits (fruit was considered damaged if it contained one or more holes caused by the borer); percent fallen fruit and number of holes per fruit.

The mean value of each time period represents the accumulated values of the previous period for the variables. Thus, the data from the last assessment date represents the total damage throughout the observation period.

Regression lines were compared for the progression of avocado moth damage in the two cultivars (Snedecor and Cochran 1967). This procedure was applied only to percent damaged fruit, as this was the only variable for which the homogeneity of residual variances requirement was fulfilled. Data from the first and last observation periods were used to compare damage between the cultivars for the percent fallen fruit (χ^2test) and number of holes per fruit (analysis of variance and Tukey's studentized range test) (SAS Institute 1989).

Results

Progression of percent damaged fruit was different between two cultivars, and is shown by a significant difference by comparing the slopes or regression coefficients; b_1 = 0.21 and b_2 = 0.44, for Beatriz and Margarida, respectively (Table 1 and Fig. 1). Beatriz had a higher avocado moth infection than Margarida. The initial incidence of attack cultivars was also evident different by comparing the elevation of regression lines; a_1 = 72.1 and a_2 = 28.4, for Beatriz and Margarida, respectively (Fig. 1). The regression equations for Beatriz (Y_1 = 72.1 + 0.21 X) and Margarida (Y_2 = 28.4 + 0.44 X) explain the time variation in damaged fruit (Fig. 1). This may be better appreciated by the values of determination for the coefficient values of the regression lines, which reached R^2 = 0.74 in Beatriz and R^2 = 0.92 in Margarida. Margarida was less damaged than Beatriz initially but the difference between cultivars decreased because pest populations increased in the orchard during the growing season, causing comparable damage in both.

The number of holes per fruit was variable in both cultivars and increased through time (Fig 2). The regression equation for each cultivar (Y_3 = 6.50 + 0.06 X and Y_4 = 1.70 + 0.04 X for Beatriz and Margarida, respectively) showed low slope values. However, the slopes differed significantly from zero (b_3 = 0.06* and b_4 = 0.04* for Beatriz and Margarida, respectively). Beatriz showed higher numbers of holes per fruit (Table 2).

No significant (χ^2 = 2.8) difference was found between cultivars initially at the first assessment. However, cumulative percent fallen fruit was significantly (χ^2 = 36.1**) greater in Beatriz than Margarida. The percent fallen fruit increased in both culti-

Table 1. Summary of the F test of slopes of the linear regression of cumulative percent damaged fruits caused by the avocado moth, Stenoma catenifer, in Beatriz and Margarida cv. Londrina, Pr, Brazil 1996.

Analysis of Variance	Degrees of freedom	Square sum	Mean square	F
Equality of slopes	1	373.37	373.37	9.07**
Residual error	12	494.08	41.17	

**Significant at 1% level of probability.

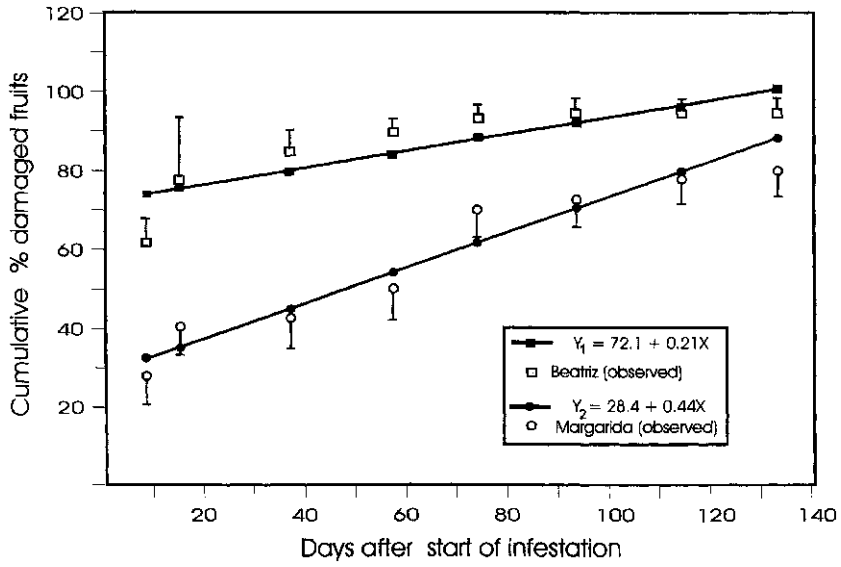

Fig. 1. Percent fruit damaged (mean S.E.) by *Stenoma catenifer* in Beatriz and Margarida avocado. Londrina, PR, Brazil, 1996.

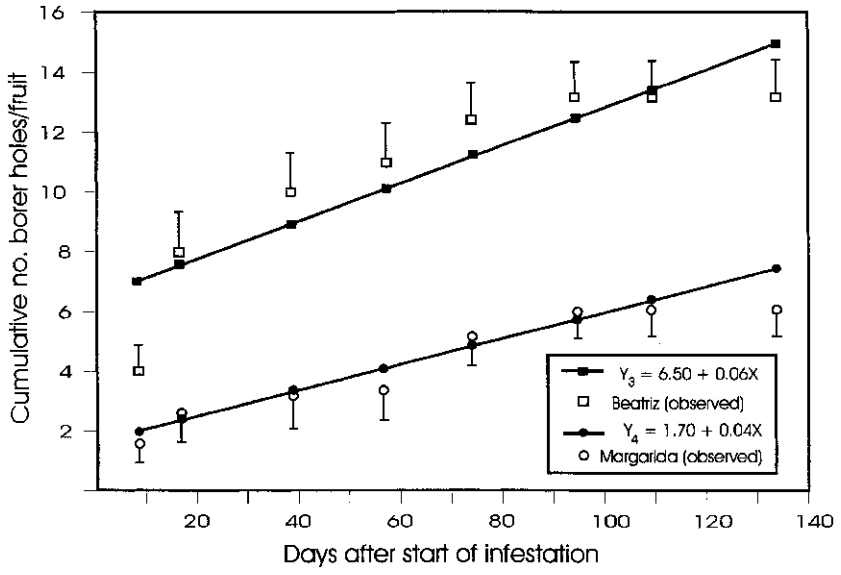

Fig. 2. *Stenoma catenifer* borer holes per fruit (mean S.E.) in Beatriz and Margarida avocado. Londrina, PR, Brazil, 1996.

TABLE 2. HOLES PER FRUIT (MEAN S.E.) IN THE AVOCADO CULTIVARS BEATRIZ AND MARGARIDA AT 8 AND 133 DAYS. LONDRINA, PR, BRAZIL, 1996.

	Holes per fruit[1]	
Cultivar	8 days	133 days
Beatriz	3.99 (0.63) a	13.35 (1.07) a
Margarida	1.41 (0.44) b	6.08 (0.83) b

[1]Means within the column followed by a different letter are significantly different ($P < 0.05$ Tukey's studentized range test).

vars, which is observed in the slope values ($Y_5 = 1.80 + 0.84$ X, Beatriz; and $Y_6 = 3.50 + 0.68$ X, Margarida) (Fig. 3). Accumulated moth damage to the fruit might influence the increase in fruit fall.

DISCUSSION

Gallo et al. (1988) proposed manual harvest and destruction of fallen fruit as a pest control strategy for the avocado moth. However, in the North of Paraná State, small farms predominate and they generally have small diversified orchards, including avocado, for their own consumption, with no pest and disease control. There is great genotypic diversity of avocado in these orchards, with plantings that flower at distinct times. Thus, there is an abundant food resource for the avocado moth all year.

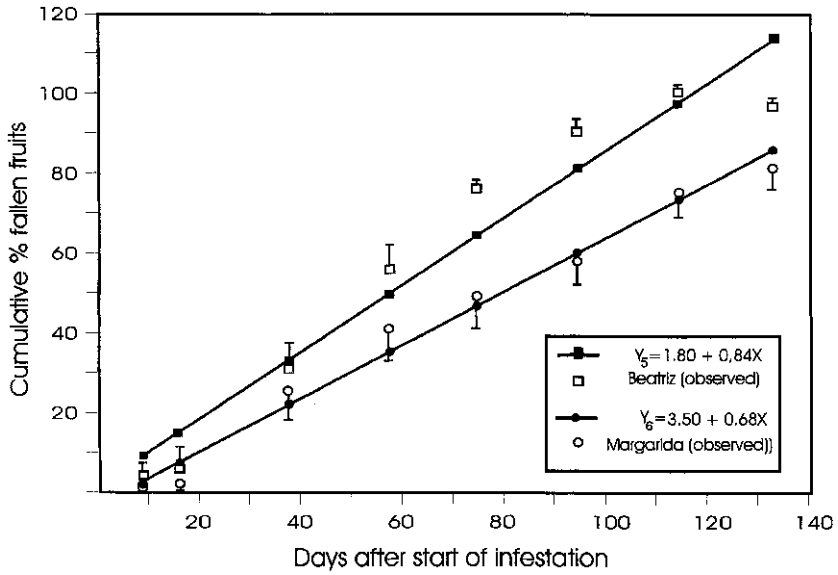

Fig. 3. Percent fallen fruit (mean S.E.) in Beatriz and Margarida avocado. Londrina, PR, Brazil, 1996.

Constant source of avocado moths originating in these small orchards makes manual harvesting ineffective in commercial orchards.

Margarida was less damaged by the avocado moth than Beatriz. Considering the progression of damage in the cultivars throughout the season, pest development in Beatriz contributed to the increased damage observed in Margarida at harvest. Pest control in a more susceptible trap crop (Beatriz) could potentially reduce final pest damage. Panda & Klush (1995) discussed the use of trap plants to manage pest populations in cropping systems, particularly in developing countries. Watson (1924) reported the use of *Crotalaria* spp. to attract green stink bugs, *Nezara viridula* (L.) in citrus orchards, while Nascimento et al. (1986) reported the use of *Cordia verbenacea* (Borraginaceae) to attract *Cratosomus* sp., also in citrus orchards. However, in practice, producers have not used these strategies because cultivation of plants with no economic value results in increased manual labor and management complexity, which makes adoption difficult. In the case of avocado, the plant used as a trap plant is already cultivated as a contrasting avocado pollinizer in orchards.

Spraying the most susceptible cultivar with more selective products could be elected instead of six insecticide applications area-wide, as proposed by Santos et al. (1996, unpublished). Hohmann & Meneguim (1993) reported up to 40% parasitism of avocado moth eggs by *T. pretiosum* and *T. annulata* in the North of Paraná. Parasitoids reared in the laboratory and released on the susceptible cultivars could be a suitable alternative to insecticide applications.

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