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DAILY ACTIVITY OF *SCYPHOPHORUS ACUPUNCTATUS* (COLEOPTERA: CURCULIONIDAE) MONITORED WITH PHEROMONE-BAITED TRAPS IN A FIELD OF MEXICAN TUBEROSE

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The agave weevil, *Scyphophorus acupunctatus* Gyllenhal, has a wide distribution in the world (Vaurie 1971; CABI/EPPO 2006). It is considered a specialist in its feeding habits, because it only attacks a few species within the families Agavaceae and Dracaenaceae. *Scyphophorus acupunctatus* is the most important insect pest of wild and cultivated agaves around the world. In Mexico, this weevil causes economic losses in tequila, mescal, henequen, and Mexican tuberose production (Camino et al. 2002; González et al. 2007; Aquino et al. 2007). The damage is caused mainly by larvae, which feed inside the heads of plants of *Agave* spp. and *Yucca* spp., and the bulbs of the Mexican tuberose, *Polianthes tuberosa* L. (Solís-Aguilar et al. 2001; Camino et al. 2002; Servín et al. 2006). Application of insecticides is the main suppression method available for *S. acupunctatus* (González et al. 2007).

Scyphophorus acupunctatus males produce a pheromone attractive to both sexes (Ruíz-Montiel et al. 2003). In laboratory experiments, Ruiz-Montiel et al. (2009) found that males released the pheromone during the photophase and scotophase with no peak in pheromone release. However, whether weevils respond to the pheromone during the whole d remains to be investigated. The daily periodicity in the responsiveness of a weevil species to its pheromone has been investigated in a few cases (Faustini et al. 1982; Walgenbach et al. 1983). A complete knowledge of the chemical ecology of the agave weevil would assist in the development of new strategies of control for this pest.

We investigated the daily activity of *S. acupuntactus* by monitoring with 2 different colored traps baited with pheromone. The experiment was conducted in a commercial field of Mexican tuberose located in Cuauchichinola (Llano el Guarín; 18 39'15"N, 99 23'01.52"W, 995 masl), Mazatepec, State of Morelos, Mexico. When the experiment began, plants were 1 mo old. The experiment was conducted during 5 d, during 22-26 Jul 2008.

The trap used in this experiment consisted of a rectangular 4-liter plastic container (25 cm high × 20 cm diam) (Alco Distribuidora, México) with frontal and posterior windows (15 × 12 cm) and two small lateral windows (5.5 × 12 cm), all perforations were situated 5.5 cm above of the container base. Pheromone lure was hung from a wire tied to two 0.5-cm holes at the center of the container lid. The pheromone lures were membrane release devices (FeroComps, Mexico City) that each released about 3 mg/d. The trap was buried about 5 cm into the soil and filled with soapy water (3%) for capturing weevils attracted to the lure. Two identical rows with 4 traps (2 green and 2 yellow) were placed in a straight line inside the field, the distance between traps was 30 m, and the first trap was located 100 m from the crop edge. The distance between rows of traps was 30 m. The position of the trap within the row was completely random.

Before each observational d, traps were rotated along the line to remove possible trap bias on weevils caught. The weevils captured were sexed according to Ramirez-Choza (1993). Traps were emptied each h, beginning at 08:00 h until 20:30 h. Previous observations had shown that no weevils were caught after 20:30 h. Sunrise and sunset were at approximately 07:30 and 19:30 h, respectively. Weevils recovered from the traps in each h were counted and placed in labeled containers with 70% alcohol.

We analyzed the data using a generalized linear model with a negative binomial error structure and logit link function to examine how time of the d, d, and the color of the trap affected the activity of *S. acupunctatus*. The negative binomial distribution is more robust for modeling zero-inflated and over-dispersed insect count data (Sileshi 2006). Results from the negative binomial generalized linear model were analyzed by using an analysis of deviance. The analyses were done using *R* statistical software.

A total of 3904 weevils, 3054 females and 850 males, were captured during the experiment. The activity of *S. acupuncatus* was affected by time of d and d (Table 1). The activity of *S. acupuncatus* was restricted to the photoperiod, and started be-

TABLE 1. NEGATIVE BINOMIAL GENERALIZED LINEAR MODEL ANALYSIS OF DEVIANCE OF THE EFFECTS OF TIME OF D, D, AND COLOR OF TRAP ON THE ACTIVITY OF *SCYPHOPHORUS ACUPUNCTATUS*.

Factor	Df	Deviance	*Pr* > χ
Time of d	2	1460.1	< 0.0001
D	1	141.3	< 0.0001
Color of trap	1	0.2	> 0.05

tween 09:00-11:00 h, progressively increased as the d progressed with a peak between 16:00-17:00 h (Fig. 1) and declined to cease completely about 1 h after sunset. Relatively few studies have investigated the daily periodicity of weevil responses to their aggregation pheromone. Faustini et al. (1982) found that time of d influences responsiveness of *Sitophilus granarius* (L.) with male response restricted to a 4-h interval centered toward early photophase (08:00-12:00 h). The fight response of *Ips duplicatus* (Sahlberg) to pheromone-baited traps occurred during the d with a broad peak around mid-to late afternoon (Chen et al. 2010). Although *S. acupunctatus* males and females only respond to the species' pheromone during the d, males release the pheromone throughout all 24 h of the d (Ruíz-Montiel et al. 2009); this suggests that pheromone release is not synchronized with flight activity. A similar situation has been reported for *Anthonomus grandis* L., where males emit pheromone throughout all 24 h of the d, but weevils are only active during the photophase (Gueldner & Wiygul 1978). It is possible that pheromone emission is not synchronized to the response of agave weevils because the primary function of the pheromone is not entirely related to the sexual behavior of *S. acupunctatus*.

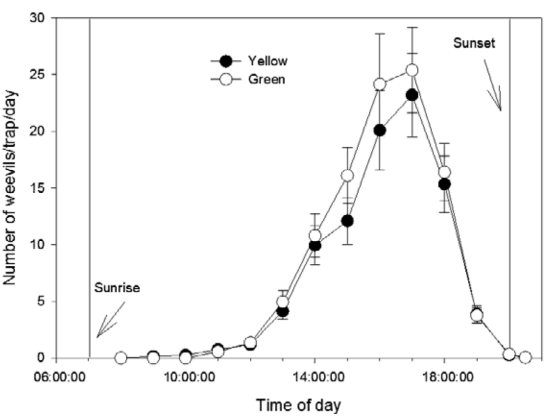

Fig. 1. Diurnal timing of capture of *Scyphophorus acupunctatus* in traps baited with pheromone during five successive d during 22-26 July, 2008. Values are mean ± standard error.

The trap color did not affect the catches of *S. acupuncatus* (Table 1). Similar results have been found for other weevils. For instance, there was no significant difference in catches of *Rhynchophorus palmarum* (L.) with respect to 8 distinct colors of bucket traps (Oehlschlager et al. 1993). A similar result was reported by Giblin-Davis et al. (1996) in *Metamasius hemipterus sericus* (Olivier). Future studies are needed to investigate the importance of visual cues for host plant location in *S. acupunctatus*.

From a practical point of view, the information obtained in this study may be useful for timing sprays of chemical or microbial insecticides. Generally, tuberose growers apply insecticides during the morning when the majority of weevils are not very active, thus inadvertently reducing the chance of insecticide exposure.

SUMMARY

The daily activity of *Scyphophorus acupunctatus* Gyllenhal (Coleoptera: Curculionidae) was studied using yellow and green traps baited with aggregation pheromone in a commercial field of Mexican tuberose, *Polianthes tuberosa* L. The experiment was conducted during 5 d during 22-26 Jul, 2008. A total of 3904 weevils, 3054 females and 850 males, was captured during the experiment. The activity of *S. acupunctatus* was affected by time of d and d, but not by the color of the trap. The diurnal activity of *S. acupunctatus* started between 09:00-11:00 h and peaked between 16:00-17:00 h. Weevils were not captured during the night. The capture of weevils was similar in the first 2 d of the experiment, and increased in subsequent d.

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