Binary Floral Lure Attractive to Velvetbean Caterpillar Adults (Lepidoptera: Noctuidae)

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ABSTRACT

Evaluation of combinations of flower odor compounds in northern Florida revealed that linalool was synergistic in attractiveness with phenylacetaldehyde (PAA) to the migratory moth velvetbean caterpillar (Anticarsia gemmatalis Hübner). This noctuid was the most common species collected from traps with a binary lure composed of PAA and linalool, with over 900 males and females collected in Sep 2005 and almost 13,000 collected in a 4-week period in Aug and Sep 2006. Different lid openings of the vials containing the chemical blend in an attempt to vary the release rate of the binary lure did not affect the number of velvetbean caterpillar moths captured. Traps baited with the binary lure and placed in May, Jun and early Jul of 2005 and 2009 failed to capture adults demonstrating the absence of adult moths early in the season. Management application of floral attractants in an attract-and-kill strategy is discussed.

Key Words: floral lure, attractant, trapping, moths, Anticarsia gemmatalis

RESUMEN

Una evaluación de las combinaciones de olores de compuestos florales en el norte de Florida revelo que linalol era sinergista con el fenilaldehído (PAA) en la atracción a la polilla migratoria gusano del frijol (Anticarsia gemmatalis Hübner). Este noctuido fue la especie más común en trampas colectadas con cebos del compuesto binario PAA y el linalol, con más de 900 machos y hembras colectados en septiembre de 2005 y casi 13,000 recogidos en un periodo de 4 semanas en agosto y septiembre de 2006. Con el fin de variar la velocidad de liberación del atractivo binario se usaron tapas de diferente abertura las cuales no afectaron el número de adultos del gusano del frijol capturados. Trampas cebadas con un señuelo binario colocadas en mayo, junio, y principios de julio del 2005 y 2009 no capturaron adultos demostrando la ausencia de polillas adultas a principios de la temporada. Se discute el manejo para la aplicación de atrayentes florales en una estrategia para atraer-y matar.

Translation provided by the authors.
Glycine max (L.) Merrill, peanut Arachis hypogaea L., alfalfa Medicago sativa L., cowpeas Vigna unguiculata (L.) Walpers, and velvetbean Mucuna pruriens (L.) DC were in the southeastern U.S. (Buschman et al. 1977; Herzog & Todd 1980; Buschman et al. 1981; Slansky 1989). It apparently overwinters in central and southern Florida and southern Texas where it feeds on wild legumes such as clovers Melilotus spp. and Trifolium spp., medics Medicago spp., kudzu Pueraria lobata (Willd.) Ohwi, and vetches Vicia spp. (Watson 1916; Buschman et al. 1981; Slansky 1989). Mating behavior studies (Johnson et al. 1981) led to the identification of the sex pheromone (Heath et al. 1983) and to the design of trapping systems (McLaughlin & Heath 1989; Mitchell & Heath 1986). However, the pheromone components are costly to synthesize and are not commercially available.

Meagher & Landolt (2008) found large numbers of velvetbean caterpillar moths in traps baited with a 2-component blend of PAA and linalool. Two experiments following this research were designed to test whether both floral volatiles (PAA and linalool) were needed for attraction and if capture number was influenced by the release rates of the chemicals.

**Materials and Methods**

Standard Universal Moth Traps, “Unitraps” (Great Lakes IPM, Vestaburg, MI, USA) were used to capture moths that were attracted to chemical compounds. These traps were constructed of a white bucket, a yellow cone on top of the bucket, and a dark green cover above the cone. Chemicals were added to cotton balls in the bottom of the trap. Both chemicals tested were dispensed from a separate vial. Phenylacetaldehyde (W287407) and linalool (W263508, racemic mixture) were purchased from Aldrich Chemical Co. (Milwaukee, WI, USA). A gravimetric method was used to estimate the loss of PAA and linalool from vials with lid opening diameters of 1.0, 1.6, 3.2, 6.4, and 12 mm that were placed outdoors and indoors. For both chemicals, four 8-mL vials were loaded with 5 mL chemical and placed in traps on 2 Jul 2009 in Gainesville, FL. The vials were reweighed weekly until 30 Jul. Because of high humidity outdoors, the vials were brought inside and placed in a laboratory fume hood and weighed periodically until 5 Nov 2009. Vial weight change over time was analyzed with regression analysis (PROC REG, SAS 9.2, SAS Institute 2008) and slopes were compared by Student’s t test statistic (Wuensch 2007).
RESULTS

Early Season Samples

Traps baited with the binary lure of PAA + linalool and placed in Williston from 6 May to 2 Jun 2005 and from 28 May to 18 Aug 2009 captured several species of moths but not velvetbean caterpillar adults. Peanuts were planted in Williston by the time of sampling, but there was no evidence of larval infestation by velvetbean caterpillar.

Importance of Blend Components

This experiment tested whether both compounds, PAA and linalool, were needed to attract moths. During a 17-d-period, a total of 934 male and female velvetbean caterpillar adults were collected in the Unitraps baited with floral lures. Captures varied between sampling dates but were generally highest in traps with the binary lure and lowest in traps with linalool (Fig. 1a). The binary lure of PAA + linalool attracted 81% of all captured velvetbean caterpillar moths, whereas the low captures by the single lures of PAA or linalool were not statistically different from captures by the unbaited traps ($F = 13.4; df = 3, 12; P = 0.0004$) (Fig. 1b). Although several other pest moth species were collected in high numbers in traps baited with PAA and PAA + linalool, very few moth of any species were collected in traps baited with linalool singly (data not shown).

Testing of Different Release Rates

This experiment tested the attraction of moths to traps releasing different amounts of the binary lure compounds. Release rates were adjusted by changing the size of the opening in the lid of the vials containing the chemicals. Large numbers of velvetbean caterpillar moths (12,924) were collected in traps during the 4-week test (Fig. 2a). Average total captures varied between 1470 moths on 18 Sep in the 6.4 mm treatment to 2 moths on 25 Aug in the 12 mm treatment. Across all dates there was a non-significant trend for an inverse relationship between lid opening and moths captured as fewer moths were found in traps with the higher release rates ($F = 0.62; df = 4, 16; P = 0.6556$) (Fig. 2b).

An additional experiment attempted to estimate the release rates of each chemical from vials with different lid openings by measuring the weight loss of vials over time under outdoor and indoor conditions. Lid openings affected the release of the chemicals as shown by different regression slopes (mg change in weight per day) among the openings. For the outdoor experiment, vials containing PAA gained weight with the 1.0, 1.6 and 3.2 mm openings, but lost weight with the 12 mm openings (weight loss = 4.1 mg per day) (Fig. 3a). Vials containing linalool all gained weight except for the 12 mm opening (weight loss = 1.34 mg per day) (Fig. 3b). For both chemicals, slopes among openings were significantly different ($P < 0.05$) except for the 1.0 mm versus 1.6 mm comparisons ($P > 0.05$). Weight loss rates of vials placed in a dry environment inside the laboratory hood were higher, although PAA vials with 1.0 mm and 1.6 mm openings, and linalool vials with all openings except 12 mm, still gained weight (Fig. 4). Weight loss of vials with PAA increased from 0.2 to 1.4 to 4.9 mg per day for openings of 3.2, 6.4 and 12 mm, respectively. Vials with linalool had a loss of 5.3 mg per day when the opening was 12 mm. Loss rates among openings for both chemicals were significantly different ($P < 0.05$) except for the 1.0 mm versus 1.6 mm comparisons ($P > 0.05$).

Fig. 1. Mean (±) SE numbers of velvetbean caterpillar moths captured in Universal moth traps ($n = 5$ per date per treatment) baited with phenylacetaldehyde (PAA) and linalool (LIN) dispensed from polypropylene vials, 2005, Williston, FL, USA. A. Captures over time. B. Summarized and compared per treatment. Bars followed by the same letter are not significantly different ($P > 0.05$, Contrasts, PROC Mixed).
Sex Ratio

The sex ratio of captured velvetbean caterpillar moths in traps baited with PAA and PAA + linalool was male-biased. In 2005, over 5 times as many male velvetbean caterpillar moths were captured as female moths (sex ratio for PAA, 5.818, $\chi^2 = 74.9, P < 0.0001$; PAA + linalool, 5.333, $\chi^2 = 355.8, P < 0.0001$). In the 2006 release rate experiment, male moths were again more commonly collected than female moths. However, as the release rate increased the sex ratio decreased (lid opening 1.0 mm, 4.688, $\chi^2 = 1272.1, P < 0.0001$; 1.6 mm, 4.507, $\chi^2 = 1101.1, P < 0.0001$; 3.2 mm, 4.427, $\chi^2 = 1060.2, P < 0.0001$; 6.4 mm, 3.982, $\chi^2 = 906.8, P < 0.0001$; 12 mm, 3.205, $\chi^2 = 547.9, P < 0.0001$; correlation coefficient = 0.997).

DISCUSSION

This study follows up on research completed with several lure combinations in Florida (Meagher & Landolt 2008). In that study velvetbean caterpillar moths and other moth species such as C. includens, Argyrogramma verrucu (F.), Mocis disseverans (Walker), M. latipes (Guenée), Diaphania hyalinata (L.), Heliothis virescens (F.), and Spodoptera eridania (Stoll) all were captured in higher numbers in PAA + linalool-baited traps than in unbaited traps. Our experiments following that research showed the synergistic effect of the addition of linalool to PAA-baited traps because velvetbean caterpillar moths were captured in higher numbers in PAA + linalool-baited traps than in unbaited traps. Our experiments following that research showed the synergistic effect of the addition of linalool to PAA-baited traps because velvetbean caterpillar moths were captured in higher numbers in PAA + linalool-baited traps than in unbaited traps.
Because the peanut fields were being managed commercially, it was initially surprising that large numbers of velvetbean caterpillar moths were captured starting in Aug. However, it was soon discovered that large areas of hairy indigo \((\text{Indigofera hirsuta L.})\) bordered the fields and were heavily infested by velvetbean caterpillars. This exotic plant is known to be a good host and in Brazil velvetbean caterpillar can maintain populations on it for most of the year (Panizzi et al. 2004).

 velvtebean caterpillar moths were captured in traps suggest the possibility of using these attractants in an attract-and-kill strategy to manage moth populations (Landolt et al. 1991). Previous research showed the utility of the attract-and-kill strategy when alfalfa looper \((\text{Autographa californica (Speyer)})\) populations were controlled and oviposition on host plants was reduced in a screenhouse with pesticide-coated stations baited with a floral odor-based lure (Camelo et al. 2007). The PAA + linalool lures were attractive to both male and female moths, although there was a strong male bias of velvetbean caterpillar captured in traps. The sex ratio decreased with increasing release rates of the blend, but traps still contained high numbers of male moths relative to female moths. The success of the attract-and-kill strategy will depend on several other factors, such as the age of the population responding to the lures and the percentage of the actual population trapped. However, results shown in this study provide an incentive to future attractants research.

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