PHENYLACETALDEHYDE ENHANCES UPWIND FLIGHT OF MALE FALL ARMYWORM (LEPIDOPTERA: NOCTUIDAE) TO ITS SEX PHEROMONE

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The fall armyworm, *Spodoptera frugiperda* (J. E. Smith), is a migratory polyphagous pest that attacks several important crops (Luginbill 1928). Currently, adult male populations are monitored using a synthetic blend of sex pheromone components as a lure (Tumlinson et al. 1986, Mitchell et al. 1989). Chemicals other than sex pheromones have been assayed as moth attractants. For instance, floral compounds that attract noctuid moths have been isolated and identified. Baits of phenylacetaldehyde,

first isolated from a flower (*Araujia sericofera* Brothero) (Asclepiadaceae), captured hundreds of noctuid moths in field traps, including *S. frugiperda* (Cantelo & Jacobson 1979). Phenylacetaldehyde, benzaldehyde, 2-phenylethanol, and benzyl alcohol were identified from flowers of the shrub *Abelia grandiflora* (André) (Caprifoliaceae) (Haynes et al. 1991), a plant that elicits flight responses from cabbage looper, *Trichoplusia ni* (Hübner) (Grant 1971). Benzaldehyde, benzyl acetate, and phenylacetaldehyde were collected from night-blooming jessamine *Cestrum nocturnum* (L.) (Solanaceae), a plant known to attract looper moths (Noctuidae: Plusiinae) (Heath et al. 1992).

Phenylacetaldehyde in combination with sex pheromones or blacklights increased moth trap capture (Smith et al. 1943, Creighton et al. 1973, Cantelo & Jacobson 1979). Both male and female *T. ni* were attracted to phenylacetaldehyde in flight tunnel, greenhouse, and screen cage bioassays (Haynes et al. 1991, Landolt et al. 1991, Heath et al. 1992). Our objective was to determine if phenylacetaldehyde enhances the attractiveness of sex pheromones to fall armyworm in a flight tunnel bioassay.

Fall armyworms used in the bioassays were reared in the laboratory on a pinto bean-based artificial diet according to the procedures of Guy et al. (1985). Pupae were sexed and placed in 163 ml (5.5 oz.) paper cups (Sweetheart, Chicago, IL) that were placed in 24 × 24 cm screen cages for eclosion. Pupae were maintained under reversed photoperiod (14: 10, light:dark) in an environmental chamber held at 26°C and 70% RH. Adults had access to cotton balls saturated with distilled water and a honey-sugar solution. Pupae were transferred daily so that cages contained adult males of a known age.

The tunnel used was a Plexiglas rectangular box (2.0 by 0.6 by 0.6 m). The floor had alternating black and white panels (ea. panel 10 cm long). Air was pulled past an activated charcoal filter and through the tunnel at the rate of 0.22 m/sec by a blower motor. A cylindrical moth release cage (9 cm by 5.1 cm diameter) and a two-compartment source cage (6 cm long by 2 cm diameter), both made from metal screen, were hung in the middle at the downwind and upwind portions of the tunnel, respectively. Distance between the cages was 1.4 m. Room conditions during testing were ≈ 26°C and 65–80% RH, and observations were aided by overhead red lights.

Adults were placed in the tunnel room at least one hour before testing and tests were conducted 1-4 h post-scotophase. The commercial pheromone lures used were purchased from Scentry® (Ecogen, Inc., Langhorne, PA) and from Trécé® (Trécé, Inc., Salinas, CA). A standard lure containing 2 mg of the pheromone blend (*Z*)-9-tetradecen-1-ol acetate (*Z*9-14: AC) (80.3%), (*Z*)-11-hexadecen-1-ol acetate (*Z*11-16: AC) (19.2%), and (*Z*)-7-dodecen-1-ol acetate (*Z*7-12: AC) (0.5%), loaded in a solvent refined rubber septum, was prepared by J. H. Tumlinson (USDA-ARS CMAVE). A hexane solution of 10 mg/ml of phenylacetaldehyde (Aldrich Chemical Co., Milwaukee, WI) was prepared, and 100 μl of this solution was pipetted onto filter paper. The bioassay protocol was to place an individual moth in the release cage, hold it in the plume for 10 seconds, and then release it down the tunnel. Each moth was observed for 2 min and upwind flight and contact with the source screen cage was scored. Each replicate contained between 5 and 20 moths, with totals of from 70–150 moths tested per treatment. The experiment was designed as a randomized complete block, and percentage responses were transformed into arcsine-square roots before analysis of variance (PROC GLM, SAS Institute 1995). Comparisons between each pheromone lure and lure plus phenylacetaldehyde combination were tested using the contrast statement in PROC GLM.

The addition of phenylacetaldehyde in the source cage increased upwind flight and contact with the lure in all combinations tested. Phenylacetaldehyde in combination

with the standard lure increased upwind flight from 68.6% ± 5.6 (SE) to 87.4% ± 7.3 (df = 1, 28; F = 12.5; P = 0.0014), and increased contact with the source cage from 51.9% ± 7.6 to 76.6% ± 6.1 (df = 1, 28; F = 8.0; P = 0.0085). The combination of phenylacetaldehyde with a Scentry lure increased upwind flight from 61.1% ± 6.3 to 80.0% ± 9.1 (df = 1, 28; F = 4.3; P = 0.0468, and increased contact from 30.8% ± 6.3 to 56.3% ± 9.0 (df = 1, 28; F = 3.9; P = 0.0584). Similar results were obtained with a Trécé lure, upwind flight increased from 66.5% ± 6.8 to 88.3% ± 3.3 (df = 1, 28; F = 9.8; P = 0.0041) and contact increased from 48.7% ± 8.0 to 75.0% ± 8.7 (df = 1, 28; F = 10.9; P = 0.0026) when phenylacetaldehyde was added. No differences were found in upwind flight or contact among lures lacking phenylacetaldehyde ($P > 0.05$), and fall armyworm males did not respond to phenylacetaldehyde alone (n = 50).

Phenylacetaldehyde generally has enhanced trap catch of moths in pheromone traps or with blacklights (Creighton et al 1973, Cantelo & Jacobson 1979). Our study is the first to show that a floral compound such as phenylacetaldehyde can increase attraction of *S. frugiperda* males to a pheromone source. Pheromone-baited traps for *S. frugiperda* have been used to detect seasonal population trends (Tingle & Mitchell 1977, Waddill et al. 1982), document migration patterns over large areas (Mitchell et al. 1991), and predict larval populations and plant infestation (Silvain & Ti-A-Hing 1985, Silvain 1986, Linduska & Harrison 1986). Phenylacetaldehyde as an enhancement may increase trap capture in the field, thereby improving current uses of pheromones and potentially creating new lure and toxicant systems for management of this pest (Landolt et al. 1991).

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Summary

More male fall armyworms, *Spodoptera frugiperda* (J. E. Smith), flew upwind to combinations of pheromone-treated septa and phenylacetaldehyde than to pheromone-treated septa alone in flight tunnel bioassays. No moths flew upwind to phenylacetaldehyde alone at the dose tested. This compound may increase pheromone-baited trap captures in the field, thereby improving current uses of pheromones and potentially creating new lure and toxicant systems for management of this pest.

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