POPULATION DENSITY AND MATING FREQUENCY OF *PLODIA INTERPUNCTELLA* IN THE PRESENCE OF SYNTHETIC PHEROMONE

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Permeation of the environment of an insect with synthetic pheromones can reduce the effectiveness of the mating communication mediated by a natural sex pheromone[1,2,3] and can ultimately lead to reduced crop damage[4].

(Z,E)-9,12-tetradecadian-1-ol (ZETA) is produced by female Indian meal moths, *Plodia interpunctella* (Hubner), and serves to sexually excite and attract males[5,6]. Females release ZETA and perhaps other materials that may affect the pheromone responses of males[7].

We here report data which show that synthetic ZETA will reduce mating frequency of the Indian meal moth. The effectiveness of the ZETA treatment was largely dependent on the population density of the insect.

METHODS AND MATERIALS: The relationship between population density and mating frequency in the presence of several constant pheromone concentrations was determined in a 2.8 X 2.3 X 3.1-m high room and in four 0.6 X 0.6 X 0.6-m aluminum boxes constructed with 1 acrylic plastic side. From 1 to 33 pairs of insects were released nightly into the boxes, and from 3 to 100 pairs were released into the room. Virgin male insects were released 1 hr before the 10-hr scotophase, and females were released 20 min later. Insects were collected 22-23 hr after release, and females were dissected for spermatophores and scored as mated or not mated. Control data were taken prior and subsequent to each series of tests in the room and concurrently with experimental tests in boxes.

Dosages for the experimental treatments were regulated by evaporating ZETA containing an antioxidant from containers with appropriate surface areas. Specific methods are reported elsewhere[8].

Additional information was obtained by observing the behavior of male, female, and paired insects in the presence and absence of ZETA at different population densities. Most observations were made during the last 1 hr of the photophase and the 1st hr of the scotophase. In addition, the spontaneous activities of insects were monitored over 72-hr periods in the absence of any known variables except photoperiodic changes. The spontaneous activity was scored automatically according to CO_2 production[9].

RESULTS: Decreasing the population densities markedly decreased

the frequency of mating in the presence of ZETA in the environment (Fig. 1). In the absence of ZETA treatments, 72% of the control insects mated.

In the absence of ZETA, males newly exposed to calling females exhibited a consistent sequence of behavior, here separated into orientation and copulation behavior. In the orientation sequences, males became active, vibrated their wings, and moved about until the calling females were located. The males' location of calling females where moderate air velocities occurred appeared strongly facilitated by an anemotaxis that graded into a simple chemokinesis where no air movement occurred. Copulation behavior began when a male contacted a female from the rear with his antenna and legs. He then moved anterior to the female, inserted his head and forelegs under the head of the female, cast the tip of his abdomen over the female so it was in firm contact with her genitalia, and then rotated to a copulation position posterior to and facing away from the female. Females were not passive but moved in coordination with the males during copulation behavior and sometimes approached males to make the initial contact. It was recently reported that males produce a pheromone that stimulates the female during the copulation behavior[10].

Males habituated to ZETA did not demonstrate the orientation responses described upon introduction of calling females. The presence of ZETA apparently eliminated the sex pheromone communication over distances greater than 1-2 cm. In contrast, the copulation behavior apparently was not affected by synthetic ZETA once females were actually contacted by males.

Males, whether habituated to ZETA or not, occasionally fly or run. This activity, most prevalent during the scotophase, occurred for about 2 hr/day. When such active males physically contacted calling females, copulation often occurred.

DISCUSSION AND CONCLUSION: Synthetic ZETA reduced the efficiency of sexual communication of Indian meal moths. Over a range of population densities of 0.1 to 17 pairs/m^2 of wall area, pheromone-mediated communication was efficient enough in the absence of synthetic ZETA to assure a uniformly high (60%+/night) frequency of mating. The presence of synthetic ZETA impaired this sexual communication to the point at which population density became a limiting factor (Fig. 1).

The evolutionary development of a strong distance communication mechanism by an insect species allows a more dispersed distribution than would otherwise be possible. If insects were, on the average, too widely spaced for efficient mating communication to occur the replacement of each generation would not be assured. Further, if the insects' ability to communicate over distances were artificially impaired, higher average population densities would be needed to assure a high frequency of mating.

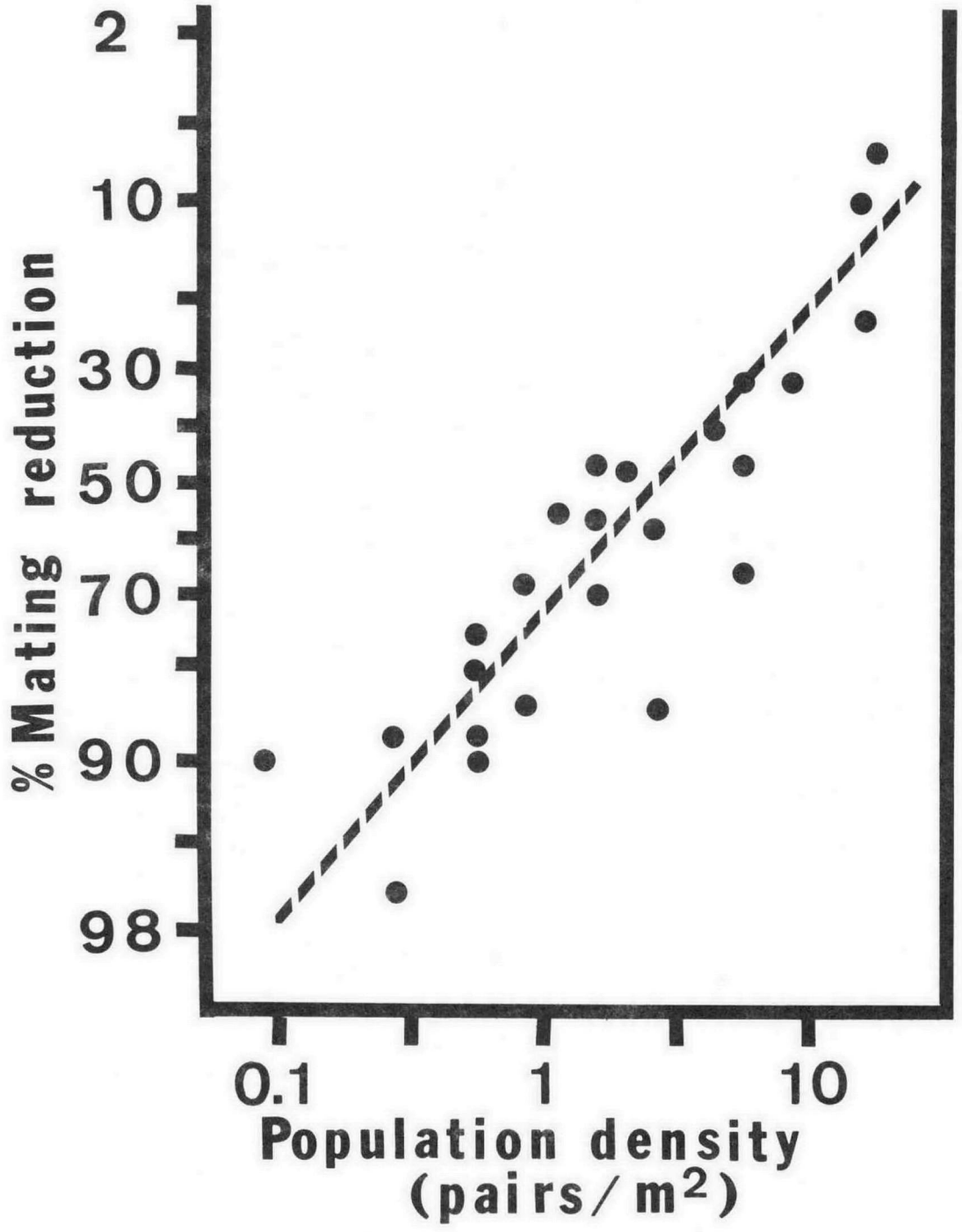

FIGURE 1. Reduction of mating relative to controls among *Plodia interpunctella* at indicated population densities in the presence of (Z,E)-9,12-tetradecadien-1-ol acetate (pheromone). Dosages of pheromone released/night per m^3 of volume into 0.2 m^3 enclosed environments were between 5×10^{-2} mg and 2×10^{-1} mg. Each point represents the average of 5 replications.

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