RESPONSE OF *TRICHOGRAMMA PRETIOSUM* FEMALES TO VOLATILE SYNOMONES FROM TOMATO PLANTS[1,2]

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ABSTRACT

Volatile synomones in tomato plants stimulate search behavior in *Trichogramma pretiosum* Riley, resulting in increased rates of parasitization in both the laboratory and field. In a Y-tube olfactometer, female *T. pretiosum* are attracted by volatiles from tomato.

Key Words: Host-habitat location, parasitism, semiochemical, behavior, *Heliothis*, parasitoid.

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INTRODUCTION

Altieri et al. (1981) reported that parasitization by *Trichogramma* spp. was significantly higher in weedy soybeans or in soybeans interplanted with corn than in weed-free soybean monocultures. They also demonstrated that water extracts of *Amaranthus* sp. and corn increased parasitization by *Trichogramma* spp. in a variety of crops. Nordlund et al. (1984) demonstrated that parasitization by *Trichogramma* spp. was higher on tomato than on adjacent corn or beans. In addition, contact with synomones[6] in a hexane extract of tomato leaves increased rates of parasitization of corn earworm [*Heliothis zea* (Boddie)] (CEW) eggs by *Trichogramma pretiosum* Riley in both the laboratory and field (Nordlund et al. 1985). Relatively little study, however, has been directed toward the elucidation of the involvement of host-plant produced synomones in the host-habitat location behavior of parasitoids, despite the recognized importance of this step in the host selection process (Price et al. 1980; Vinson 1981).

Tomato plants produce many volatile chemicals. Andersson et al. (1980) identified 12 volatiles and reported that the chemical characteristics of commercial tomato cultivars are very homogeneous. Volatile synomones, which can be detected at a distance, should be of more value in host-habitat location than those that are effective on contact alone. The experiments described here were conducted to determine if *T. pretiosum* females respond to volatile synomones from tomato plants.

[1] Hymenoptera: Trichogrammatidae

[2] Mention of a commercial or proprietary product does not constitute an endorsement by the USDA.

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[6] A substance, produced or acquired by an organism, which, when it contact an individual or another species in the natural context, evokes in the receiver a behavioral or physiological reaction adaptively favorable to both emitter and receiver (Nordlund and Lewis 1976).

METHODS AND MATERIALS

The *T. pretiosum* used in these experiments originated from corn grown in Hermosilla, Mexico. The parasitoids were reared in the laboratory by the procedures of Lewis and Redlinger (1969) in CEW eggs at ca. 26°C and 70% R.H., and were used on the day of emergence.

Corn earworm eggs were obtained from laboratory cultures, washed with sodium hypochlorite as described by Burton (1969), irradiated with ca. 22 KRAD (60 Co source) when 8 - 36 hr old, and stored in a freezer at < -10°C.

Fresh tomato leaves ("Better Boy" or "Floridade") were masticated in a blender with redistilled hexane. The homogenate was then dried with sodium sulfate, filtered through a coarse fritted buchner funnel, and vacuum distilled to a concentration of 1 mg/μl.

The jar olfactomer used consisted of 16 wide-mouth gallon (3.8 l) jars, each set up as shown in Figure 1, and connected to a single flowmeter through a series of Y-connectors and equal lengths of Tygon® tubing. The CEW eggs were applied to a 7.6×17.8 cm piece of paper (20/paper) that was then placed in the jar on 5 glass support rods. A glass insert (ca. 2.5 cm long, 2.9 mm ID) was at the front of each jar (Fig. 1). "Better Boy" extract (20μl was applied to the inside surface of the insert at the front of each treated jar and the hexane was allowed to dissipate before the experiment was initiated. Air was passed through an activated charcoal filter and flowmeter to the jars at a rate of ca. 0.7 l/min per jar. Ten female parasitoids were introduced through the insect introduction port (Fig. 1) in a 2-dram shell vial and allowed to function for ca. 30 min. The CEW eggs were then collected and dissected as described by Lewis and Redlinger (1969) to determine parasitization. The experiment was replicated 8 times for each test and each test was conducted 4 times.

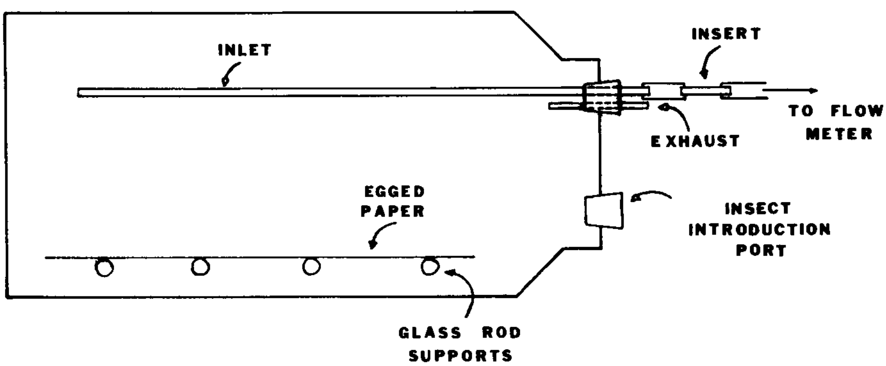

Fig. 1. A schematic representation of the jar setup used in the jar olfactometer.

A Y-tube olfactometer described by Nordlund et al. (1983) was used to determine if parasitoids were attracted to the tomato volatiles. It was made of 2 cm I.D. glass tubing with each arm 20 cm long and a leg 33 cm long. Air passed through an activated charcoal filter was introduced at ca. 20 ml/min through each arm, with the flow rate controlled by separate flow meters. The experiments were conducted at room temperature in a laboratory illuminated with fluorescent lights and with an incandescent bulb (150 W) positioned ca. 50 cm directly over the Y-tube. Between replications, the treated side of the olfactometer was alternated so that effects of irregularities in the Y-tube itself or room lighting would be eliminated. "Better Boy" extract (20μl) was applied to Whatman No. 1 filter paper (ca. 6 cm^2). A piece of untreated filter paper was placed in the control arm of the olfactometer. Ten female parasitoids were released from a 2-dram shell vial into the end of the leg of the olfactometer. After 10 min, the number of parasitoids in each arm of the Y-tube was recorded. After each replication, the olfactometer was thoroughly washed with soap and water, rinsed with acetone, and dried in an oven. This experiment was replicated 24 times.

A field experiment was conducted in "Silver Queen" corn (1 - 2 m height), to determine if the volatile materials in tomato stimulated parasitization in the field. Plots of 1 row $\times$ 3.0 m were set up with ca. 3.0 m between plots. Simulated oviposition sites (Nordlund et al. 1981) were established at ca. 0.3-m intervals by placing 1 CEW egg on a leaf that had been lightly sprayed with a 1 μg/l solution of moth scale extract (Lewis et al., 1972), using the method of Nordlund et al. (1974), except that a 4.0% solution of UCAR 154 (Union Carbide Corp., 12840 South Crawford Ave., Alsip, IL 60658) was used in place of Plantgard®. In the treated plots, cotton rolls (No. 2 medium, Uni-Disco, Inc., P. O. Box 4450, Detroit, MI 48228), treated with 0.1 ml of "Floridade" tomato extract were suspended at mid plant height by a thread, ca. 1 m from each end of the plot. In control plots, 2 cotton rolls, treated with 0.1 ml of hexane were hung in a similar manner. The *T. pretiosum* were released (ca. 50 unsexed adults/cup) from two, 1 oz. (28.6 ml) plastic cups that were placed on the ground ca. 1 m from each end of the plot. The CEW eggs were allowed to remain on the plants for ca. 4 hr after which they were collected (Reading 1) and dissected to determine parasitization. The CEW eggs were applied again to the simulated oviposition sites and were allowed to remain on the plant for ca. 18 hr (overnight) after which they were collected (Reading 2). CEW eggs were applied again and allowed to remain for ca. 4 hr. This experiment was replicated 10 times on each of 3 dates.

Data were analyzed by analysis of variance with arcsin transformations conducted on percentages before analysis (Steel and Torrie 1960). Means given in the text are followed by the standard error in parenthesis.

RESULTS AND DISCUSSION

In the jar olfactometer, the mean percentage of parasitization in treated jars [20.5 ($\pm$ 3.5)%] was significantly higher ($P < 0.05$) than in control jars [9.2 ($\pm$ 2.5)%]. The mean number of parasitoids found in the treated arm of the Y-tube olfactometer [5 ($\pm$ 0.3)] was significantly greater ($P < 0.05$) than the mean number found in the control arm [2 ($\pm$ 0.2)]. The presence of tomato extract also resulted in significantly higher rates of parasitization in the extract treated plots of the field experiment (Table 1). There was no significant interaction between treatment and date in any of these experiments.

These data demonstrate that volatile synomones in tomato leaves stimulate behavior that results in increased rates of parasitization by *T. pretiosum* in both the laboratory and field. The data also demonstrate that these synomones attract, at least to some extent, *T. pretiosum* females. Thus, it may be possible to use

Table 1. Parasitization of *Heliothis zea* eggs by *Trichogramma pretiosum* in plots of "Silver Queen" corn in which cotton rolls, treated with a hexane extract of "Floridade" tomato leaves, or hexane were suspended.*

Reading	Exposure (hr)	N	$\overline{X}$ ($\pm$ SE)% of parasitization in Extract plots	Hexane plots
1	4	30	49.5 ($\pm$ 4.3)a	28.8 ($\pm$ 4.1)b
2	18	28†	44.7 ($\pm$ 4.8)a	19.7 ($\pm$ 3.3)b
3	4	20‡	30.3 ($\pm$ 3.0)a	16.4 ($\pm$ 3.0)b

* Means for each reading followed by different letters are significantly ($<$ 0.05) different as determined by analysis of variance.

† In 2 treated plots no eggs were recovered so these replications were eliminated from the analysis.

‡ The 3rd reading of one test was destroyed by rain.

these materials to stimulate increased rates of parasitization, particularly in less preferred habitats such as fields of some varieties of corn (Nordlund et al. 1984, 1985), by application of a slow release formulation. These data also point out, again, the important influence of plants on the activities and performance of beneficial insects. These findings could be significant to plant breeders as they attempt to produce crop varieties that are less subject to damage from herbivorous insects.

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