DEVELOPMENT OF TOMATO PINWORM (LEPADOPTERA: GELECHIIDAE) ON FOLIAGE OF SELECTED PLANT SPECIES

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The tomato pinworm, Keiferia lycopersicella (Wals.), is an important pest of tomatoes in the southern U.S., Mexico and Caribbean (Poe 1973). The host range of the pest has been studied by several authors and summarized by Batiste & Olson (1973). All favorable hosts are in the family Solanaceae and include the cultivated crops tomato, Lycopersicon esculentum L., eggplant, Solanum melongena L., and potato, S. tuberosum. L. esculentum var. cerasiforme (Dunal.) Alef. and at least 10 species of Solanum have also been noted as suitable hosts. Suitability has been determined largely on the basis of successful development of larvae to the pupal stage. In an unpublished laboratory study comparing tomato, potato and eggplant, the tomato pinworm completed development in less time and suffered the lowest mortality rate on tomato (Walz 1948). Batiste & Olson (1973) utilized ovipositional preference and adult emergence as criteria for suitability.

A laboratory culture of the tomato pinworm has been maintained on tomato at the Gulf Coast Research & Education Center since 1976 using the techniques of Schuster & Burton (1982). Insects from this colony have been utilized for both laboratory and field experiments. During experiments requiring paired, newly-emerged adults, females were often the first to begin emerging from newly collected pupae. Swank (1947) observed that the pupal stage of females was slightly less than one day shorter than that of males. No observations were made on the egg or larval stages. Walz (1948) observed that females completed development in less time than males and that the difference was most apparent in the pupal stage. Weinberg & Lange (1980) observed no differences in the developmental times of males and females. Knowledge of sexual differences in developmental rates is essential in understanding population dynamics and managing laboratory colonies for biological research.

The purpose of the present study was to compare selected plant species for suitability based upon larval survival and development and to compare developmental times of male and female tomato pinworms in the egg, larval and pupal stages on tomato.

Plant species selected for evaluation of host suitability included tomato cv. Walter, eggplant cv. Black Beauty, potato cv. Red Bliss, pepper (Capsicum annuum L.) cv.
Yolo Wonder and American black nightshade (S. americanum Mill.). Pepper was included as an unsuitable host plant (Swank 1937) and American black nightshade was included since it is the most common nightshade in peninsular Florida. This host was probably evaluated as S. nigrum L. by Swank (1937) and found unsuitable.

All plants were grown from seed, except potato which was propagated from tubers, and maintained in a greenhouse. Newly expanded leaflets were excised and individually placed on moistened filter paper in 160 ml plastic cups with tight-fitting lids. Two neonate larvae from the laboratory colony were placed on each of ten leaflets per plant species. The plastic cups were held in a room at ca. 27°C and a photoperiod of 14:10 (L:D). The insects were observed daily and survival, pupation and adult emergence were noted. Leaflets were replaced as needed. One-week-old larvae and pupae were weighed to the nearest 0.1 mg. The experiment was repeated three times and data were averaged for each replicate prior to analyses of variance. If significant F values were obtained (P = 0.05), differences among means were compared for significance (P = 0.05). Percentage data were transformed by using arcsine square root of %/100 prior to analyses but are presented in the original scale.

All larvae on pepper and nightshade foliage died within three days with little or no evidence of feeding (Table 1). Two larvae on nightshade foliage did feed; one formed the blotch mine that is characteristic of first instar pinworm larvae. Neither larva survived a week.

Approximately two-thirds and one-half of the insects developed to the pupal and adult stages, respectively, when larvae were fed foliage of potato, eggplant or tomato. Differences in larval or pupal mortality on these plants were not statistically significant. Larval development times and weights also did not vary among these host plants; however, there was a trend toward a shorter development time and a higher weight for larvae fed potato foliage compared to larvae fed either eggplant or tomato foliage. Weights of resultant pupae similarly were not affected by larval host plant. The larva-pupa development time for larvae confined on potato foliage was significantly shorter than that for larvae on tomato foliage.

Potato, eggplant and tomato were suitable hosts for tomato pinworm larvae while pepper and American black nightshade were not. Considering larva-pupa development, potato and eggplant foliage were at least as suitable as tomato foliage and potato may be more suitable. Previously, Walz (1948) observed shorter developmental times and lower mortality of larvae reared on tomato foliage than larvae reared on potato or eggplant foliage. Foliage of field-grown potato was found to be “strikingly” infested

### TABLE 1. Development of the Tomato Pinworm on Foliage of Solanaceous Plants

<table>
<thead>
<tr>
<th>Plant</th>
<th>% survival&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Development (days)</th>
<th>Larval&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Pupal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Larva had</td>
<td>Larva-pupa wt (mg)</td>
<td>Pupa</td>
</tr>
<tr>
<td>Potato</td>
<td>76.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>11.8NS</td>
<td>18.5a</td>
<td>3.0NS</td>
</tr>
<tr>
<td>Eggplant</td>
<td>73.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>13.6</td>
<td>19.2ab</td>
<td>1.8</td>
</tr>
<tr>
<td>Tomato</td>
<td>72.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>13.2</td>
<td>20.3b</td>
<td>1.4</td>
</tr>
<tr>
<td>Pepper</td>
<td>0.0b</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>American black nightshade</td>
<td>0.0b</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

<sup>a</sup>Survival data transformed / X + 0.5 prior to analysis. Means are presented in the original scale.

<sup>b</sup>One-week-old larvae.

<sup>c</sup>Means within columns followed by the same letter are not significantly different (P = 0.05; Duncan’s [1955] multiple range test). NS indicates differences among means are not significant.
with tomato pinworm larvae in California (Elmore & Howland 1943); however, tomato is most often mentioned as the most common host in the field. Since larvae are confined to the host plant on which eggs are deposited, ovipositional preferences of females can play a major role in “field suitability” and should be considered in evaluating overall host plant suitability.

The developmental time reported in this study on tomato was considerably shorter than the developmental time reported by Weinberg & Lange (1980). This may be because of the different host plants utilized in this study (L. esculentum (Mill.) and in the previous study (L. esculentum var. cerasiforme (Dunal.)). The larval-pupal time reported by Lin and Trumble (1985) on tomato at room temperature was similar (26°C, 20.4 days) to that presently reported (20.3 days).

A study of the development of males and females was conducted in a growth chamber at 26 to 27°C and 12:12 (L:D) photoperiod. Tomato leaflets containing eggs that were no more than 24 h old were obtained from 24- to 48-h-old pairs of tomato pinworms from the laboratory colony. Leaflet sections containing single eggs were cut and placed individually on moistened filter paper in 150 ml plastic cups with tight-fitting lids. After 72 h, an uninfested tomato leaflet cv. Hayslip was placed under each leaflet section. The cups were then inspected every 12 h until egg hatch and every 24 h thereafter. New leaflets were provided to each surviving larva about one wk after egg hatch. The numbers of days to egg hatch, pupation and adult emergence was recorded. The experiment was repeated two times with 26 individuals in the first replicate and 28 in the second. The data were combined over the replicates and comparisons of developmental times for males and females were made using t tests.

Of the 59 individuals that survived to adult emergence, 30 were males and 29 were females. Developmental times for males and females did not differ significantly in the egg (4.8 vs 4.9 days, respectively; t = 0.727; df = 57; P > 0.40) or larval stages (9.8 vs 10.0 days, respectively; t = 0.974; df = 57; P > 0.20); however, females completed pupal development in fewer days than males (6.0 vs 6.5, respectively; t = 3.074; df = 57; P < 0.005). Although females required fewer days than males to complete egg to adult development (26.9 vs 21.1, respectively), the difference was not significant (t = 0.338; df = 57; P > 0.50).

The data suggest that the difference between male and female adult emergence observed in the laboratory colony was due to the difference in the duration of the pupal stage. This supports the observations of Walz (1948) and Swank (1987) although the difference between developmental times in this study was not as great. Conversely, the data contradict the observation of Weinberg & Lange (1980) that there were no differences.

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REFERENCES CITED

LEMNAPHILA SCOTLANDAE (DIPTERA: EPHYDRIDAE) AND THREE OF ITS PARASITES DISCOVERED IN FLORIDA

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A small leaf-mining fly, Lemnaphila scotlandae Cresson, was discovered attacking a duckweed, Lemna valdiviana Phil., in water tanks at the Biological Control Laboratory in Gainesville in June 1986. States where this fly, perhaps the best known native fly that attacks aquatic plants, has been reported are Illinois, Michigan, New York and Ohio (Steinly et al. 1987). Merritt & Cummins (1978) reported it from the “East” (United States). Additional collections were made from March to October 1987 at 7 sites in north-central Florida: Alachua County—Calf Pond, Bivens Arm (Gainesville), Orange Lake; Hamilton County—6.4 km NW White Springs; Levy County—Manatee Springs State Park; Putnam County—Rodman Reservoir; and Sumter County—Lake Okahumpka. In November 1988 it was collected in southern Florida: Broward County—Pt. Lauderdale Research and Education Center. Additional host plants were L. gibba L. and L. minor L. Three hymenopterous parasites were also reared from puparia. They were Opius lemnaphila Muesebeck (Braconidae), Trichopria anqustipennis Muesebeck (Diapriidae), and T. pulchra Muesebeck. All were previously reported only from New York (Krombein et al. 1979). Attempts to obtain egg parasites were unsuccessful.

A brief description of the biology of L. scotlandae was published by Scotland (1939). White to yellowish eggs were laid singly on the edges of the upper surfaces of leaves. Larvae eclosed after two days and mined within the leaves for about ten days. Amber-colored puparia were formed within mined leaves, one per leaf. Sexual maturity was attained the day after emergence. Unlike most flies, adult L. scotlandae feed on their host plant. They have strong spines on the labella with which they scrape the leaf surface. Scotland (1940, illustrated the labella and the characteristic parallel feeding scars. These scars, which look like gouges that might be made by a miniature rake, are diagnostic for the presence of this fly. Transparent leaves are good indicators of a possible fly infestation but are not diagnostic because larvae of the weevil, Tanysphyrus lemnac Fab., cause similar damage. When fly puparia are present, they can be easily seen.