Note

ECLOSION TIME AND LARVAL BEHAVIOR OF THE TOMATO FRUIT BORER, *Neoleucinodes elegantalis* (Guenée) (Lepidoptera: Crambidae)

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ABSTRACT: In several regions of Brazil, *Neoleucinodes elegantalis* (Guenée) is one of the most serious tomato pests. The moth lays eggs on the calyx or developing fruit, and shortly after eclosion larvae penetrate into the fruit, where they remain until pupation. Once larvae have entered the fruits, insecticides and biological control agents are relatively ineffective. Because *N. elegantalis* is most susceptible to conventional treatments when the larvae are outside the host tissues (or fruit), it would be advantageous to know the time required for egg development and the length of time that the larvae spend on the surface of the fruit. To answer these questions detailed behavioral studies were untaken. Eggs were collected from the field and maintained in an environmental chamber at 20°C, 75 ± 5% R.H., and a 12L:12D photoperiod. The time of egg eclosion was recorded with a video camera, whereas larval behavior and time required to enter the fruit were determined by direct observations. The majority of eggs (93%) hatched within the first two hours after the beginning of photophase. Larvae spent 51.1 ± 31.1 (mean ± SEM) min on the surface of the fruits. Once a suitable site was identified, larvae required an additional 23.8 ± 19.4 min to completely enter the fruit. Eighty-six percent of the larvae were successful in penetrating the fruit. Of the larvae that bored into the fruit, 42% selected the upper portion, 18% selected the middle portion, and 40% selected the lower portion.
Key words: Insecta, tomato, tomato fruit borer, larval behavior

TEMPO DE ECLOSÃO E COMPORTAMENTO DE LARVAS DA BROCA-PEQUENA-DO-TOMATEIRO, *Neoleucinodes elegantalis* (Guenée) (Lepidoptera: Crambidae)

RESUMO: *Neoleucinodes elegantalis* (Guenée) é uma das pragas mais sérias do tomate em várias regiões do Brasil. A fêmea deposita seus ovos no cálice ou nos frutos em desenvolvimento, e logo após a eclosão a larva penetra no fruto, onde permanece até a pupação. Depois que a larva entra no fruto, inseticidas e agentes de controle biológico são relativamente ineficazes. Como *N. elegantalis* é mais suscetível a métodos de controle quando a larva encontra-se no exterior do hospedeiro, seria vantajoso conhecer o período de tempo necessário para o desenvolvimento dos ovos e quanto tempo a larva passa na superfície do fruto. Para responder estas questões, detalhados estudos comportamentais foram conduzidos. Ovos foram coletados no campo e mantidos em câmara ambiental a 20°C, 75 ± 5% U.R., e fotoperíodo de 12L:12E. O horário de eclosão foi registrado com uma câmera de vídeo, enquanto que o comportamento da larva e o tempo requerido para que ela penetre no fruto foram determinados com observações visuais. A maioria dos ovos (93%) eclodiu dentro das primeiras duas horas da fotofase. Larvas passaram 51,1 ± 31,1 (média ± erro padrão) min na superfície do fruto. Uma vez que sítios adequados eram identificados, as larvas necessitaram de 23,8 ± 19,4 min adicionais para entrar completamente nos frutos. Oitenta e seis por cento das larvas penetram com sucesso no fruto. Destas, 42% selecionaram a porção superior, 18% selecionaram a porção média, e 40% selecionaram a porção inferior do fruto.
Palavras-chave: Insecta, tomate, broca-pequena-do-tomate, comportamento de larva

INTRODUCTION

The tomato fruit borer, *Neoleucinodes elegantalis* (Guenée) (Lepidoptera: Crambidae), is a serious tomato pest in Brazil, Venezuela and Colombia. Adults emerge from the pupal stage within 1 to 7 h after the beginning of scotophase, mate within 48 to 72 h of eclosion (Eiras, 2000), and shortly thereafter begin depositing eggs. The female moth lays up to 160 eggs (Marcano, 1991) usually in batches of 2-3 eggs on fruits that are 1-3 cm in diameter (Toledo, 1948, Salinas et al., 1993; Blackmer et al., 2001). The majority of eggs are laid either directly on the fruit or on the underside of the calyx (Blackmer et al., 2001). When moth densities are high, tomato fruits

may receive multiple oviposition bouts. The eggs hatch in 5-7 days at 20 - 25 °C (Marcano, 1992), and the emerging larvae enter the fruit shortly thereafter where they feed and remain until pupation. Under moderate to severe infestations, up to 14 larvae/fruit have been reported (Toledo, 1948, Muñoz et al., 1991), but it takes only one larva to make the fruit unmarketable. Despite current control strategies, which include 2-3 weekly insecticide applications, and cultural practices such as the destruction of infested fruits or wild solanaceous hosts (Gallo et al., 1988), the reduction in the number of infested fruits has been less than satisfactory (Maranhão et al., 1996). Because the larvae spend a limited amount of time on the surface of the fruit, pesticides and biological control agents are mostly ineffective.

The purpose of this work was to determine the interval of time from egg maturity to hatch, and to document larval behavior prior to fruit penetration. This information will be useful to growers, since the chemical control will be more efficient if application is made before the neonate larvae penetrate the fruit.

MATERIAL AND METHODS

Time and duration of eclosion

N. elegantalis eggs were collected from tomato fields (*Lycopersicon esculentum* L. cv. 'Santa Clara') located near São José de Ubá, RJ, Brazil. They were carefully removed from the plants and placed in Petri dishes containing moistened filter paper. In the laboratory, eggs were maintained in an environmental chamber (Electrolab 102FC) at 20°C, 75 ± 5 % R.H., and a 12L:12D photoperiod. At 5 d of age (or when the head capsule could be seen through the chorion), eggs were placed under a Panasonic TV camera (PV-54) that was connected to a Magnavox TV monitor (33MS405T), and a JVC videocassette recorder (HR-J600U). Initiation and duration of eclosion were recorded over a 4-d period for a total of 100 *N. elegantalis* eggs. Environmental parameters in the observation arena matched ambient conditions for a 12L:12D photoperiod with lights on at 6:00 am.

Larval behavior before penetrating the fruit

Greenhouse-grown tomato plants (cv. 'Santa Clara') were used to examine larval behavior. Only plants that had fruits 1-3 cm in diameter were used for these studies. Individual neonate larvae were placed near the calyx of tomato fruits with a camel hair brush. Larvae were placed near the calyx of the tomato fruit, since most eggs are laid in this region under field conditions (Blackmer et al., 2001). In total, 50 larvae were observed and the following variables were recorded: direction of movement, time spent on the surface of the fruit, head-wagging behavior, time necessary for head to enter the fruit, time necessary for larva to completely enter the fruit, and point of entry on the fruit. These observations were conducted at 22 ± 2°C, 65 ± 5% R.H., from 7:00-10:00 am.

RESULTS AND DISCUSSION

Seventy-five percent of the *N. elegantalis* eggs collected from the field hatched within 24 h after the larval head capsule first became visible through the chorion. Ninety-three percent of the eggs hatched within the first two hours following photophase initiation, and no eggs hatched after the 5th hour of photophase. The time required to exit the egg averaged 3.89 ± 0.28 min.

Larvae that were placed on the fruit spent a considerable time wandering across the surface before they entered the tomato. Larvae spent 51.1 ± 31.0 min (range 7-123 min) on the surface of the fruit before selecting an entry site. Once a larva began burrowing, it took an additional 23.8 ± 19.5 min to enter the fruit. The total mean time to enter the fruit was 74.4 ± 35.7 min (range 21-202 min). Most larvae (86%) entered the fruit, and their entrance holes were located under the calyx (32%), on the upper surface of the fruit (10%), middle surface (18%) or lower surface (40%). Approximately 42% (N=21) of the larvae remained near the top of the tomato and most of these larvae crawled under the calyx (76%). Fifty-eight percent (N=29) of the larvae crawled downward on the fruit. Of these individuals, 31% (N=9) settled at the middle, and 69% (N=20) settled at the bottom of the fruit.

Sixty-two percent (N=31) of the visible larvae, which were not hidden beneath the calyx, engaged in head-wagging behavior just before entering the fruit. Head-wagging behavior was characterized by lateral movements of the head at approximately 60° angles to the body, which lasted for a few minutes. Only 18% of the larvae entered the fruit without first engaging in head-wagging behavior. Ninety-four percent (N=47) of the larvae attempted to enter the fruit and 86% of these (N=43) were successful. Because the fruit surface is covered with short, 4-lobed glandular trichomes, head-wagging behavior may be associated with contact chemoreception or may help the larvae remove trichomes before entering the fruit. Further observations should be carried out to elucidate the role of the head-wagging behavior.

These studies are the first to provide information on the time of eclosion and time required for *N. elegantilis* larvae to penetrate tomato fruits. This information can be used to determine the best time to apply pesticides. Egg hatch occurs shortly after the beginning of the photoperiod, which in the field will be sunrise. The majority of larvae penetrated the fruit within 1-2 h. Pesticide applications in the tomato-growing regions of Rio de Janeiro State are generally made much later in the day (personal observations). A simple change in the timing of pesticide applications, coinciding with larval activity, might substantially enhance insecticide efficacy. Furthermore, if pesticides were applied until runoff occurred or if pesticides were mixed with a wetting agent, coverage to the base of the fruit would be improved, resulting in a higher likelihood of control.

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