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OVIPOSITIONAL PREFERENCE, HOST RANGE AND LIFE HISTORY OF EGGPLANT FRUIT AND SHOOT BORER, *Leucinodes orbonalis* Guenee (LEPIDOPTERA: PYRALIDAE)[1]

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ABSTRACT

The ovipositional preference of eggplant fruit and shoot borer (EFSB), *Leucinodes orbonalis* Guenee, was determined for seven crops, namely: eggplant (*Solanum melongena*), white potato (*Solanum tuberosum*), sweet potato (*Ipomoea batatas*), tomato (*Lycopersicon esculentum*), okra (*Abelmoschus esculentus*), pole sitao (*Vigna sinensis*) and black nightshade (*Solanum nigrum*). The number of eggs laid was determined three days after EFSB moth infestation of the test plants at vegetative and early fruiting stages. The location of the eggs deposited on the plant parts was also noted.

Given a free-choice the EFSB preferred to oviposit on eggplant only. The eggs were mostly found on the lower leaf surface of topmost open and middle leaves although few were also deposited on the upper leaf surface and petiole.

The comparative life histories of the EFSB on the crops were determined by continuously rearing neonates on each crop until death. The EFSB was able to successfully complete its life cycle on eggplant, black nightshade and white potato. On tomato and pole sitao, larval development was completed but the pupae were abnormal while EFSB larvae were able to survive only for two days and 12 hours on sweet potato and okra, respectively. There was no significant difference in longevity of the adult moths reared on eggplant and black nightshade, but significantly longer than that on white potato. The weights of the sixth instar larvae continuously reared on the three crops did not differ significantly, although those on eggplant had the highest and those on white potato had the lowest average weight. The 6th instar larvae on tomato were slightly heavier than those on pole sitao. There was an observed difference in pigmentation of larval body. The larvae

reared on tomato and pole sitao were darker than those reared on eggplant, black nightshade and white potato.

The black nightshade could serve as alternate host for rearing the EFSB in the laboratory when eggplant is unavailable.

Key words : ovipositional preference, life history, eggplant fruit and shoot borer, *Leucinodes orbonalis*, eggplant pest.

INTRODUCTION

Eggplant (*Solanum melongena*) is considered one of the most important vegetables in the Philippines in terms of volume of production (about 179,000 tons per year valued at almost P2 billion) and hectarage (estimated at 20,000 hectares). It is popular among consumers as a common part of their meal because of its relatively low price and ease of preparation compared to other vegetables. It is a rich source of calcium, mineral and fiber, and studies have shown that it also possesses high antioxidant property.

The crop is attacked by a complex of pest species with eggplant fruit and shoot borer (EFSB), *Leucinodes orbonalis* Guenee, as the most serious. The EFSB was observed attacking almost all parts (leaves, midribs, flowers, fruits and shoots) resulting in the general weakening of the plant. The larva leaves the leaf as it dries up or decays and bores into the petiole, shoot or fruit (Fig. 1a &b).

Many studies have been undertaken to understand the biology and habits of EFSB and the possible control strategies to be employed. Eggplant is planted after rice or corn in Central Luzon, rotated with other vegetables such as okra, tomato, sweet pepper, or intercropped with fruit trees like citrus as practised by farmers in Batangas. Given the long cropping season of eggplant ranging from 3 to 7 months, this would imply continuous presence or overlapping generations of EFSB in the field. Although EFSB is generally considered monophagous, it is imperative to determine other possible alternate hosts and compare its biology on such host plants.

This study aimed to: (a) determine the host range of *L. orbonalis* and (b) compare the biology and ovipositional preference for selected potential alternate hosts.

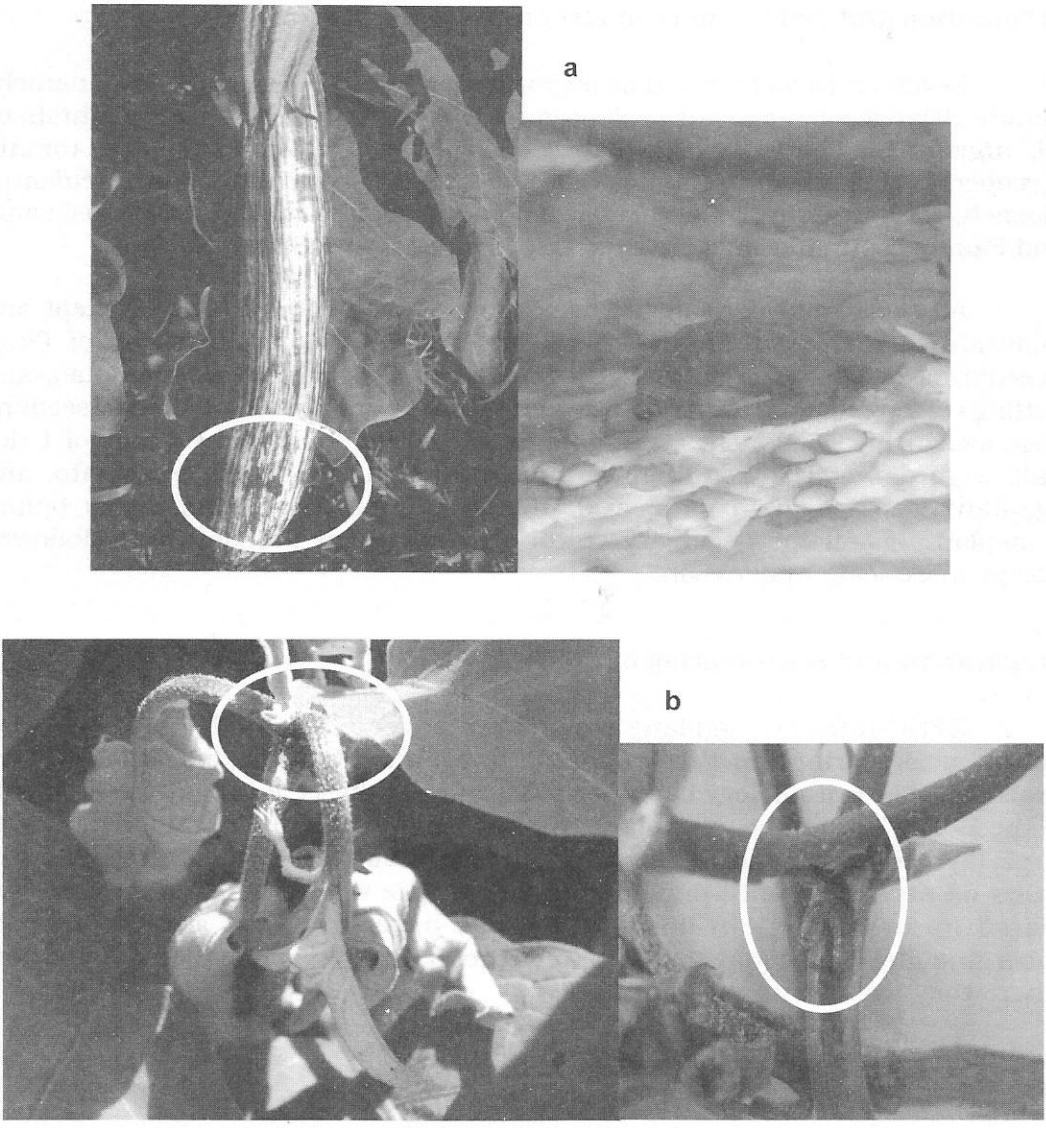


Figure 1. **(a)** Entry hole of eggplant shoot and fruit borer (EFSB) larva on the fruit marked by excreta (left); larva feeding inside the fruit (right) and **(b)** wilted shoot of eggplant with EFSB boring in the stem (left) and the larva recovered from wilted shoot (right).

MATERIALS AND METHODS

Preparation and maintenance of test crops

Seven crops were tested as ovipositional and food hosts of EFSB, namely: Family Solanaceae: eggplant (*Solanum melongena* Linneaus), black nightshade (*S. nigrum* Linneaus), white potato (*S. tuberosum* Linneaus) and tomato (*Lycopersicon esculentum* Mill.); Family Malvaceae: okra (*Abelmoschus esculentus* Moench,); Family Convolvulaceae: sweet potato [(*Ipomoea batatas* (Linneaus) Lam.] and Family Leguminosae: pole sitao [*Vigna sinensis* (L.) Savi].

All the plants used in the ovipositional preference study were kept and maintained in the greenhouse of Entomology Laboratory, Institute of Plant Breeding, College of Agriculture, UP Los Baños. Seeds of okra, pole sitao, and cuttings of sweet potato and tubers of white potato were directly planted in seedling bags measuring 9 x 9 inches containing sterilized soil mixture at a ratio of 1 rice hull: 2 garden soil: 1 hog manure, by weight. Black nightshade, tomato, and eggplant were sown in pots, and then hardened in seedling trays before transplanting. All the necessary cultural management practices were followed except insecticide application.

Preparation and mass rearing of EFSB

EFSB-infested eggplant fruits were collected from the field in Brgy. Santisimo Rosario, San Pablo, Laguna and brought to the Institute of Plant Breeding (IPB) Entomology Laboratory. These were dissected to gather the larvae of the EFSB. The larvae were placed on fresh eggplant fruit contained in plastic cups layered with sand at the bottom. The larvae were transferred to fresh fruits as necessary until pupal stage. The pupae were carefully collected and placed in an acrylic pan lined with tissue paper until the adults emerged. Emerging moths of equal sex ratio were then placed in ovipositional chambers where they mated and produced eggs.

Determination of the ovipositional preference of EFSB for selected crops

Five plants per crop were randomly placed equidistantly inside a nylon net cage. In each net cage, newly emerged adult moths (1 male and 1 female moths/ plant/ crop = 35pairs/cage) were released at the center of the cage and maintained for 4 days to allow mating and egg laying on the plants selected. On the 5th day, the moths were removed to prevent further egg deposition. The plants were examined to record the number of eggs laid per plant, and the plant parts where laid. There were three cages prepared, each serving as a replicate and arranged following the Completely Randomized Design.

Comparison of the life histories of *L. orbonalis* on the selected crops

Based on results of field surveys (ABSPII 2006) and published reports (Hutsons 1931, Maureal et al 1982, Navasero 1983, Alam 2003), black nightshade (*S. nigrum*), white potato (*S. tuberosum*), sweet potato (*I. batatas*), okra (*A. esculentus*), pole sitao (*V. sinensis*), and tomato (*L. esculentum*) were chosen as test crops for food and ovipositional hosts of EFSB.

In a no-choice test, all the test crops were evaluated as alternate food for the EFSB larvae by placing fruits of eggplant, tomato, and okra; tubers of white potato and sweet potato; pods of pole sitao; berries of black nightshade separately in plastic containers with individual larvae.

Each plastic cup was lined with moistened tissue paper and provided with a plant part (leaf, fruit, tuber, or pod). One neonate (newly-hatched first instar larva) was transferred to each plastic cup. Observations were taken daily on the development and duration of each stage, moth emergence and longevity. The weight (mg) of the sixth instar larva recovered from each crop was also taken. Paired adult moths were placed in ovipositional chambers with the host crop they were reared on to record the number of eggs laid per female. The percentage of eggs that hatched was computed.

Location and date of the study

This research was conducted in the Entomology Laboratory of the Institute of Plant Breeding-Crop Science Cluster, College of Agriculture, University of the Philippines Los Baños from December 2005 to May 2006.

RESULTS AND DISCUSSION

Ovipositional preference of *L. orbonalis* for the crops offered under caged conditions

Given a free-choice, the female *L. orbonalis* preferred to deposit its eggs only on eggplant. No eggs were found deposited on black nightshade, white potato, sweet potato, okra, pole sitao or tomato. On eggplant, the eggs were laid on the topmost and middle leaves, majority of which were found on the lower leaf surface. This conforms to the findings of Sandoval (2006) that female moths preferred to oviposit on topmost leaves of eggplant. Aside from the upper and lower leaf surfaces, eggs were also seen on the petiole. The results suggest that when eggplant and the other crops are present together in the field, the EFSB moths will lay eggs only on eggplant.

Suitability of the test crops as host for EFSB larvae

Plant parts fed on by EFSB larva. During preliminary trial, when EFSB were fed with either leaves or shoots of the test crops at any one time, no EFSB developed except on eggplant whose shoots were fed upon by the insect. When other parts were used, the EFSB larvae fed on fruits of the black nightshade and tomato, tuber of sweet potato and white potato, and pod of pole sitao and okra.

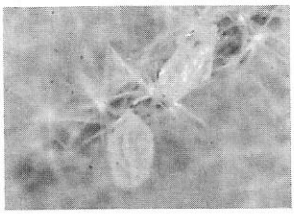
Comparative life histories of *L. orbonalis* on the selected test crops. Table 1 presents the comparative life histories of *L. orbonalis* reared on eggplant, black nightshade, white potato, sweet potato, okra, pole sitao and tomato. EFSB undergoes a complete metamorphosis with the following stages: egg, larva, pupa and adult (Figure 2). Aside from eggplant, EFSB successfully completed its development from egg to adult on black nightshade and from larva to adult on white potato. The EFSB larvae fed on the berry fruit of the black nightshade and tuber of white potato.

Egg. The eggs of *L. orbonalis* are white to dirty white, turning orange when about to hatch. Few hours before hatching a visible black spot would be seen. The eggs of EFSB reared on eggplant hatched in 3 to 4 days with a mean of 3.25 days while those reared on black nightshade which laid their eggs on the underside of the leaflets, hatched in 4 days. The EFSB eggs are usually laid singly or in cluster of 2-4.

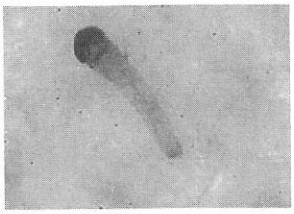
Larva. There are six larval instars observed and in congruence with the reports of Saxena (1970), Lall and Ahmed (1965), Allam et al. (1982) and Navasero and Calilung (1990). In contrast, Atwal (1976) reported four to five larval stages. The order of suitability of the test crops as larval food for the EFSB is as follows: eggplant = black nightshade = white potato = tomato > pole sitao. The durations of the larval periods were not significantly different among individuals reared on the test crops although it was shortest on eggplant and longest on pole sitao. Both okra and sweet potato cannot be considered as suitable food hosts. There were no significant differences in the weights (mg) of the pre-pupae or sixth instar larvae reared on eggplant, black nightshade and white potato. On the other hand, the abnormal larvae reared on tomato and pole sitao weighed less. The weights of the sixth instar larvae can be ranked as follows: eggplant > black nightshade > white potato > tomato > pole sitao. Larvae reared on tomato and pole sitao had darker body pigmentation compared to those reared on eggplant. Those reared continuously on eggplant, black nightshade and white potato were comparable in color, unlike their pupal cases.

Table 1. Comparative life histories of eggplant fruit and shoot borer (EFSB), *Leucinodes orbonalis*, reared continuously on each crop plant. IPB Entomology Laboratory, April-May, 2006. [a]

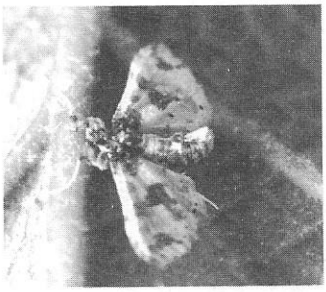
DEVELOPMENTAL STAGES / BIOLOGICAL PARAMETERS	DURATION (DAYS) OF THE DEVELOPMENT OF EFSB REARED ON DIFFERENT CROPS													
	Eggplant		Black nightshade		White Potato		Pole Sitao		Tomato		Sweet Potato		Okra	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Egg	3-4	3.25	4	4.00										
Larva														
1st instar	2-3	2.03b	2-3	2.68a	2-3	2.40ab	2-4	2.50ab	2-4	2.56ab	2	2.00b		
2nd instar	1-2	1.73c	2-3	2.39ab	2	2.15bc	2-4	2.83a	2-4	2.44ab				
3rd instar	1-3	1.80b	1-2	1.82b	2	2.26ab	2-3	2.33ab	2-4	2.60a	all samples did not develop		all samples did not develop	
4th instar	1-2	1.79c	2	2.07bc	2-3	2.33b	2	2.00bc	2-4	3.00a				
5th instar	1-2	1.90a	1-3	1.96a	2	2.19a	2	2.00a	2-4	2.50a				
6th instar	2	1.93a	1-3	1.83a	1-2	1.81a	2	2.00a	2	2.00a				
Total larval period	10-13	11.14b	10-14	12.79ab	11-13	13.18ab	15	15.00a	12-14	13.00ab				
Pupa	7-12	9.00a	8-11	9.18a	8-10	8.67a	adult did not emerge		adult did not emerge					
Adult Longevity	2-7	5.14a	3-7	4.68a	3-4	3.33b								
Female	2-7	4.89	3-7	4.63	3-4	3.25								
Male	4-7	5.33	3-6	4.75	3-4	3.50								
Total developmental period	23-31	28.62a	26-34	30.18a	26-29	27.33b								
Weight (mg) of 6th instar larva		60.02a		50.44a		50.03a		12.00b		30.30ab				
Pre-oviposition period (mated)	2-3	2.75a	2-3	3.00a										
Pre-oviposition period (unmated)			2.67a		2.80a									
Fecundity (no. eggs laid)	60-92	62.00a	83	83.00a										



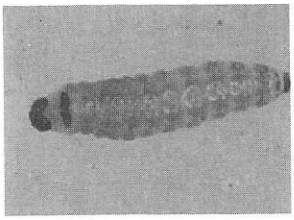
Egg (50x)



1st instar larva (40x)

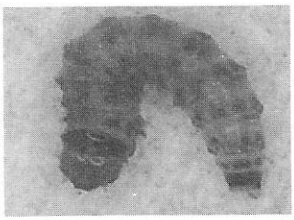


Female moth

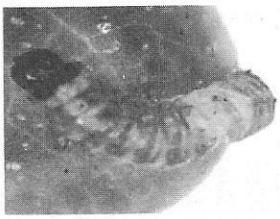


2nd instar larva (40x)

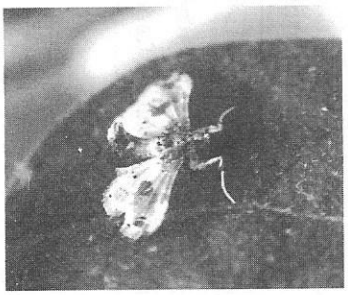
3rd instar larva (30x)



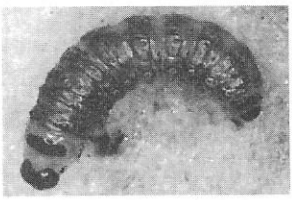
4th instar larva (30x)



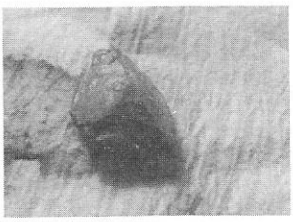
5th instar larva (30x)



male moth



6th instar larva (30x)



Pupa (30x)

Figure 2. Different developmental stages of eggplant fruit and shoot borer, *Leucinodes orbonalis* Guenee.

Pupa. The color of the pupal case was dependent on the crop where the EFSB larva was reared. EFSB larva reared on eggplant had brown to light brown pupal case; on potato, tomato and pole sitao, light brown to yellowish brown pupal case; on black nightshade, pinkish brown pupal case. There were no significant differences in the durations of the pupal period among individuals reared on the test crops where some EFSB adults emerged. The EFSB reared on tomato and pole sitao that reached pupation had some abnormalities and did not emerge into adult moths.

Adult. The sex of the insect can be determined by the arching of the abdomen and shape of the abdominal tip. Females usually have blunt and wider abdominal tip and slightly arched abdomen when at rest while the males have pointed abdominal tip arched prominently. Generally, the females are bigger than the males. In terms of longevity of adult moths, those emerged from eggplant and black nightshade did not significantly differ but lived longer than the moths from white potato.

SUMMARY AND CONCLUSION

Greenhouse and laboratory experiments were conducted at the Entomology Laboratory of the Institute of Plant Breeding-Crop Science Cluster, College of Agriculture, UP Los BaHos from December 2005 until May 2006 to determine the host range of *L. orbonalis* and compare the life history and ovipositional preference of the pest for selected potential alternate hosts.

Seven crops were tested as ovipositional and food hosts of EFSB, namely: eggplant (*Solanum melongena* Linneaus), black nightshade (*S. nigrum* Linneaus), white potato (*S. tuberosum* Linneaus), tomato (*Lycopersicon esculentum* Mill.), okra (*Abelmoschus esculentus* Moench,), sweet potato (*Ipomoea batatas* (Linneaus) Lam. and pole sitao (*Vigna sinensis* (L.) Savi.

The ovipositional preference of EFSB was determined through a free-choice test. When given a choice, EFSB deposited its egg on eggplant but not on other crops, mostly on the lower leaf surface of the topmost and middle leaves. No eggs were laid on other host plants offered.

The comparative life histories of EFSB were investigated by rearing the insects separately and continuously on specific test plants until death. *L. orbonalis* successfully completed its life cycle on eggplant as well as on black nightshade and white potato. The insect fed on the berry of black nightshade and tuber of white potato. Sweet potato and okra were not good food hosts as no insects survived beyond two days and 12 hours, respectively. The EFSB reared on tomato and pole sitao were able to complete larval development, but produced abnormal pupae.

Moths that were successfully reared out from eggplant and black nightshade did not differ significantly in longevity, but lived longer than those moths that emerged from white potato. The weights of the sixth instar larvae continuously reared on each crop did not differ significantly although the weights of the larvae in descending order were: eggplant > black nightshade > white potato > tomato > pole sitao. There were differences in body pigmentation of the larvae fed with different crops. Larvae reared on pole sitao and tomatoes were darker than those reared on eggplant, black nightshade, or white potato.

As a whole, results of the study showed that the most suitable alternate food host of *L. orbonalis* is the black nightshade. This wild eggplant species is present year-round in the field. However, although eggplant and black nightshade may be both present, the EFSB preferred to feed on eggplant. It is also implied that in the absence of eggplant, EFSB may still be reared in the laboratory using the black nightshade as food host.

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DISCLAIMER

The contents and views are the responsibility of the authors and do not necessarily reflect the views of USAID or the United States Government.

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