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Biology of pomegranate fruit borer, *Deudorix isocrates* (Fab.) (Lycaenidae: lepidoptera) on pomegranate, *Punica granatum* L

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Abstract

The studies on biology of fruit borer, *Deudorix isocrates* Fabricius on pomegranate as hosts carried out under laboratory conditions revealed that the total developmental period was completed within 67.00 ± 8.67 days through five larval instars on pomegranate. The average longevity of female and male moth was 9.50 ± 1.27 and 8.10 ± 0.88 days when reared on pomegranate. The mean number of eggs laid by female moth developed from larva fed on the fruits of pomegranate was 27.70 ± 3.56 eggs per female. The sex ratio (F/M) of emerged adults was found 1.82: 1, while the mean duration of mating *i.e.* coitus was 76.70 ± 10.84 minutes on pomegranate.

Keywords: Biology, pomegranate, fruit borer, *Deudorix isocrates*

Introduction

Anar butterfly/ fruit borer, *D. isocrates* (Fab.) is a major constraint in the production of appropriate quantity and quality fruits of pomegranate for domestic and export markets. Pomegranate fruit borer is the most widespread, polyphagous and destructive pest with a wide range of host plants *viz.*, pomegranate, citrus, guava, litchi, aonla, wood apple, apple, ber, loquat, mulberry, peach, pear, plum, sapota, tamarind, *etc.* The incidence of sucking insect pests and fruit borer has been reported throughout the year with varying degrees of intensity in Maharashtra and Karnataka (Shevale and Khaire, 1999) [7]. Halleppanwar (1955) [2] reported 100 per cent fruit damage to pomegranate under severe endemic conditions in Karnataka. However, average losses of 40 to 90 per cent have been reported in India (Wadhi and Batra, 1969) [9]. Pomegranate butterfly, *D. isocrates* is one the most obnoxious pest on pomegranate crop incurring about 65 to 70 per cent of yield loss worldwide (Kumar *et al.*, 2017) [5]. Life history studies help to work out efficient pest management strategies, hence it was decided to study biology of this pest on most preferred hosts *i.e.* pomegranate.

Material and Methods**Material used**

Glass jars, Petri-dishes, Filter paper, Muslin cloth, Honey, Cotton swab, Camel hair brush, Hand lens, fruits of pomegranate, Culture of *Deudorix isocrates*, Wooden cages, *etc.* were used during studies.

Maintenance of culture

Larvae and pupae contained in infested fruits were collected from the unsprayed pomegranate field and were kept in cages. After adult emergence, the male and female adults were separated based on their morphological characters, a pair of emerged insects were released in each wooden cage of wire mesh by providing pomegranate branches, fruits and cotton piece soaked in 5 per cent honey solution and another with water.

The freshly laid eggs of *D. isocrates* obtained were used to study the biology. The collected eggs were transferred on pomegranate fruits in cages (5 eggs/5 fruits in one cage). The culture was used in further studies.

The adults emerged (male and female) on the same day were paired in 1:1 proportion in separate cages for determining age specific fecundity. Such ten pairs were kept for laying eggs in cages. The cotton swab dipped into 5 per cent honey solution was placed in cages as food source for moths and pre-oviposition, oviposition period and adult longevity was recorded.

a. Eggs

For studying incubation period the eggs were transferred to moist tissue paper kept in petriplates with a total of 10 eggs in each petriplate and observations on incubation period

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were recorded. The observations on hatching percentage along with the number of eggs laid by each female moth every day till its death were recorded.

b. Larval period and instars

A newly emerged larva was transferred to pomegranate fruit with the help of micro camel hair brush and which was placed on a piece of filter paper seated over moist cotton in 9 cm petridishes. The food was changed once a day until pupation. The cotton swab was kept moist to prevent desiccation of larvae and also to maintain adequate humidity in the petridishes. Ten such petridishes were maintained for the study. The larvae were observed daily for change of instars. The exuvium of the head capsule of larvae left on the infested fruit and change in colour was taken as the indication for the change of instars. The larvae of each instar were carefully observed under binocular microscope for colour and other morphological descriptions. The number of days from emergence of larvae from an egg up to pupal stage was counted to work out larval period. The time required in between two instars was recorded and given as instar wise larval period. The observations of larval instars and larval period were recorded from ten larvae.

c. Pupal period

The colour, size and shape of pupa was studied. The number of days from the termination of larval stage up to the emergence of an adult was counted to record the pupal period. Longevity of adult male and female was studied separately. For adult lifespan, the number of days from emergence of adult till its death was observed. In fecundity studies, total number of eggs laid by each female during its life span were counted while recording the observations on oviposition period. Ten such females were observed and mean fecundity was worked out. The total period for the completion of life cycle and generation was worked out based on the duration of egg, larva, pupa and adult stage. To determine the sex ratio, hundred adults taken in ten petridishes emerging from randomly selected pupa were observed and differentiated into sexes, based on differentiating morphological characteristics.

d. Adult longevity

Longevity of adult male and female was studied separately. For adult lifespan, the number of days from emergence of adult till its death was observed.

e. Fecundity

In fecundity studies, total number of eggs laid by each female during its life span were counted while recording the observations on oviposition period. Ten such females were observed and mean fecundity was worked out.

f. Life cycle

The total period for the completion of life cycle and generation was worked out based on the duration of egg, larva, pupa and adult stage.

g. Sex ratio

To determine the sex ratio, hundred adults taken in ten petridishes emerging from randomly selected pupa were observed and differentiated into sexes, based on differentiating morphological characteristics.

Results and Discussion

The biology of pomegranate fruit borer, *D. isocrates* was studied under laboratory condition on pomegranate hosts and results are presented in Table 1.

Egg and Incubation period

The incubation period of *D. isocrates* under laboratory condition reared on pomegranate ranged between 6 to 9 days with a mean of 7.20 ± 0.92 days (Table 1).

The results were in accordance with the observations of Kumar (2014) who reported the mean incubation period in pomegranate, wood apple and guava were 7.80 ± 0.49 , 11.40 ± 0.60 and 6.00 ± 2.47 days, respectively. Incubation period varies from 6 to 10 days (8.0 ± 0.38 days) on *Citrus sinensis* (Chhetry, 2015)^[1]. Khan (2016)^[4] stated incubation period of fruit borer was 8-10 days with mean 8.80 ± 0.24 days on guava. While on aonla the incubation period of 9.2 ± 0.72 days at temperature of $18.7 - 31.6$ °C and 88.0 per cent RH was reported by Tiwari *et al.* (2007)^[8]. The mean incubation period of 6 to 8 days with mean 7.15 ± 0.10 on pomegranate was reported by Kumar *et al.* (2017)^[5].

Hatching percentage

Hatching percentage of eggs laid by the adult females of *D. isocrates* which were developed from larvae after feeding on pomegranate and guava host was ranged between 86 to 96 per cent with a mean of 92.04 ± 3.93 per cent. Almost the hatching percentage of *D. isocrates* on pomegranate.

Larval period

In total five instars were observed during the growth of *D. isocrates* larvae. The larval duration of first, second, third, fourth and fifth instar of fruit borer on pomegranate was ranged from 4 to 6, 6 to 8, 6 to 9, 5 to 8 and 5 to 7 days.. The mean duration of first, second, third, fourth and fifth instar on pomegranate was 4.80 ± 0.63 , 7.00 ± 0.67 , 6.70 ± 0.95 , 6.40 ± 0.97 and 6.00 ± 0.82 days.

The pomegranate fruit borer *D. isocrates* completed its larval period in five instars. The total larval period ranged between 28 to 36 days with a mean of 30.90 ± 2.33 days on pomegranate.

These results are more or less in the direction of the research conducted by Chhetry *et al.* (2015)^[1] who reported that larval period varies from 24 to 38 days (33.2 ± 1.10) days on *Citrus sinensis*. Kabade and Gangawane (2015)^[3] reported that larval duration ranged from 33 to 38 days with mean of 35.3 ± 1.88 days on *Embllica officinalis*. Total larval period ranged from 17-46 days with mean 31.40 ± 3.09 days on guava (Khan, 2016)^[4]. Kumar *et al.* (2017)^[5] stated the larval duration of first, second, third, fourth and fifth instar of fruit borer on pomegranate was ranged from 5 - 8, 6 - 8, 6 - 9, 5 - 8 and 4 - 7 days with mean duration 6.10 ± 0.15 , 7.20 ± 0.26 , 7.50 ± 0.32 , 6.20 ± 0.35 and 5.90 ± 1.30 days, respectively while total mean 32.9 ± 2.38 days.

Pupal period

The pupal period was ranged between 8 to 33 days with a mean of 28.90 ± 7.37 days on pomegranate under laboratory condition.

The present results are in line with the findings of Kabade and Gangawane (2015)^[3] who reported that pupal period with mean was 14.5 ± 2.7 (10-18) on *Embllica officinalis*. Khan (2016)^[4] observed the pupal period of 7 to 33 days with mean 16.00 ± 2.71 days on guava. Whereas, Kumar *et al.* (2017)^[5] observed pupal period in the range of 9 to 11 days with mean

10.25 ± 0.10 days under laboratory conditions on pomegranate.

Total developmental period

The total developmental period of *D. isocrates* on pomegranate ranged between 43 to 74 days with a mean of 67.00 ± 8.67. The present findings are in confirmity with Khan (2016) [4] who observed total developmental period of 30 to 60 days with mean of 46.50 ± 2.91 days on guava. Whereas, Kumar *et al.* (2017) [5] recorded total developmental period of 52 to 75 days with mean of 63.92±2.87 days on pomegranate.

Adult longevity

The longevity of adult was important not only for its influence on demographics but also because it determines how long the pest will be active. In general, females lived longer than males. In the present investigation the longevity of adult females which were developed from the larvae reared on pomegranate fruits was in the range of 9 to 13 days with a mean of 9.50 ± 1.27 days. While the longevity of adult male ranged between 7 to 10 days with a mean of 8.10 ± 0.88 days. The females were highly active than males before mating and were extremely choosy in selection of male partner for mating.

The present findings are supported by, Chhetry (2015) [1] who stated the adult longevity of male and female was 10 to 12 days (11 ± 0.26 days) and 15 to 18 days (16.75 ± 0.35 days). Khan (2016) [4] reported that adult longevity ranged from 4 to 7 days with average 5.7 days. Whereas, Kumar *et al.* (2017) [5] reported that adult female longevity was 8 to 12 days with a mean of 10.28 ± 0.20 days, while male longevity was 7 to 9 days with a mean of 8.26 ± 0.14 days on pomegranate.

Pre-oviposition and oviposition period

The pre-oviposition period of females which were developed from larvae fed with fruits of pomegranate was in the range of 1 to 2 days with a mean of 1.50 ± 0.53 days. (Table 1) However, the oviposition period ranged from 3 to 5 with a mean of 3.70 ± 0.82 days. Similar results were reported by Tiwari *et al.* (2007) [8] who observed the pre-oviposition period range of 1-2 days (1.2 ± 0.42 days). While oviposition range from 2-5 day (3.6 ± 1.07 days) on *Emblia officinalis*, (Kabade and Gangawane, 2015) [3].

Fecundity

The number of eggs laid by female moth of pomegranate fruit borer developed from larva fed with fruits of pomegranate ranged from 20 to 32 eggs with a mean of 27.70 ± 3.56 eggs per female (Table 1). These results are in consonance with the research conducted by Tiwari *et al.* (2007) [8] and Kabade and Gangawane (2015) [3] who reported the average fecundity of 27.4 ± 3.3 eggs on *Emblia officinalis*.

Sex ratio

The sex ratio (Female/Male) of emerged adults of *D. isocrates* after feeding on pomegranate fruits was found to be 1.82:1 (Table 1). Females outnumbered males and the results are in accordance with Tiwari *et al.* (2007) [8] and Kabade and Gangawane (2015) [3] who observed the average sex ratio of female to male was 1.80:1±0.07. However, Kumar *et al.* (2017) [5] observed the average sex ratio of female to male was 1.75:1±0.10 on pomegranate.

Mating period

Adults developed from larva after feeding on pomegranate

fruits showed different mating durations. The duration of mating *i.e.* coitus ranged between 5 to 85 minutes with a mean of 76.70 ± 10.84 minutes (Table 1). The present findings are more or less corroborate to earlier workers, Sharma *et al.* (2003) who reported the average mating period of 69 ± 9.17 min. Almost similar observations were reported by Tiwari *et al.* (2007) [8] and Kabade and Gangawane (2015) [3], mating period lasted for 67.5 ± 10.06 minutes on *Emblia officinalis*.

Table 1: Biology of fruit borer, *D. isocrates* on pomegranate and guava

S. No.	Developmental stages	Duration (Days)	
		Pomegranate	
		Range	Mean ± S.D
1.	Incubation period	6-9	7.20 ± 0.92
2.	Hatching percentage	86-96	92.04 ± 3.93
3.	Larval period		
	I Instar	4-6	4.80 ± 0.63
	II Instar	6-8	7.00 ± 0.67
	III Instar	6-9	6.70 ± 0.95
	IV Instar	5-8	6.40 ± 0.97
	V Instar	5-7	6.00 ± 0.82
4.	Total larval period	28-36	30.90 ± 2.33
5.	Pupal period	8-33	28.90 ± 7.37
6.	Total developmental period	43-74	67.00 ± 8.67
7.	Adult longevity		
	Female	9-13	9.50 ± 1.27
	Male	7-10	8.10 ± 0.88
8.	Pre-oviposition period	1-2	1.50 ± 0.53
9.	Oviposition period	3-5	3.70 ± 0.82
10.	Mating period (minutes)	55-85	76.70 ± 10.84
11.	Fecundity	20-32	27.70 ± 3.56
12.	Sex ratio (F/M)	1.82:1	--

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