resulted in higher yields of greengram as reported by Prasad *et al.* (1990) and Iruthayaraj *et al.* (1988). The yield difference produced by the irrigation layouts, was not significant. Among varieties Co.12 had an increased yield over Co.11 by 12.3 per cent.

Increased haulm yield was recorded at 0.6 IW/CPE ratio. Among irrigation layouts, though the effect was not significant, higher haulm yield was registered at normal furrows. Regarding varieties, Co.12 (V.2) had more haulm yield than that of Co.11 (V.1). The increased leaf area index and dry matter production might have resulted in increased haulm yield.

Crude fibre content is a genetic trait and it was not significantly affected by irrigation levels and layouts. The variety Co.11 had the fibre content of 2.02 per cent.

Total water requirement

The total water used under different irrigation combinations varied from 184 mm to 344 mm.

The water use efficiency is expressed in terms of economic produce obtained for unit quantity of water used. The water use efficiency was higher at the irrigation level of 0.30 IW/CPE (I_1) than 0.45 IW/CPE (I_2) and 0.60 IW/CPE (I_3). Irrigations at lower regime of I_1 recorded the maximum water use efficiency of 292 kg pods per ha cm of water used. This was due to less water consumption in the treatment than 0.45 and 0.60 IW/CPE ratios. With regard to irrigation layouts, paired row furrow 90 cm (L_3) recorded higher WUE than paired row furrow 60 cm (L_2) and normal furrow (L_1). Saving of water in L_3 over L_1 was 28 per cent and L_2 recorded a saving of 24 pe cent as compared to L_1. Among varieties, V_2 (Co.12) was found to be better than V_1 in recording higher water use efficiency.

It is concluded that the treatment 0.6 IW/CPE scheduled at an interval of 20 days and 12 days for monsoon and summer season, respectively, with an irrigation depth of 5 cm accounting for a cumulative pan evaporation of 8.33 cm is useful in areas of adequate water availability. Regarding irrigation layouts, paired (double) row furrow - 90 cm performed better than paired (double) row furrow - 60 cm and normal furrows. Among varieties, Co.12 wass considered better than Co.11. The net income was also the highest under 0.6 IW/CPE ratio with the variety Co.12 under paired (double) row furrow of 90/2 = 45 x 15 cm.

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THE BIOLOGY OF POMEGRANATE FRUITBORER, *Deudorix isocrates*

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ABSTRACT

The biology of pomegranate fruitborer, *Deudorix isocrates* was studied at the Horticultural Research Station, Yercaud, Tamil Nadu. The females laid the eggs on flowers, fruits, stem, stalk and on leaves either singly or in groups of 2 to 7. The total developmental period from egg to adult emergence ranged from 33 to 41 days with 5 larval instars. The egg, larva, prepupa and pupal periods ranged from 4 to 7, 19 to 25, 2 to 3 and 7 to 10 days respectively. The adult longevity, preoviposition and oviposition period varied from 7 to 11, 3 to 5 and 3 to 6 days with an average fecundity of 31.4 eggs/female. The life table studies indicated that the net reproductive rate (Ro) was 14.68 and the mean generation time (Tc) was 44.72 days.

KEY WORDS : Pomegranate, biology, fruitborer, life table

The anar butterfly, *Deudorix isocrates* (Fabricius) is a serious pest of pomegranate causing 40 to 90 per cent damage in different parts of the country. Various workers have studied the biology of pomegranate fruitborer and reported varying ranges of life cycle. In order to manage the pest effectively, experiments were conducted at the Horticultural Research Station, Yercaud to study the biology and life table under our conditions.

MATERIALS AND METHODS

All biological studies were taken up in the laboratory with temperatures ranging from 11.7 to 27.2 °C and relative humidity from 54.5 to 64.2 per cent during July to November '93. The larvae of *D. isocrates* were collected from infested fruits and reared in plastic containers. Fresh fruits were provided for larval feeding and development. Immediately after adult emergence, the males and females were separated and a pain of butterflies were released on a plant having flowers and / or fruits, covered with a transparent muslin cloth of 120x 120x 120 cm. Ten such pairs were released separately and maintained for egg laying. Absorbent cotton soaked in 50 per cent sugar syrup was provided within the cage for adult feeding. The adults were maintained until the completition of their oviposition.

The eggs were brought to the laboratory along with flowers or fruits and reared in plastic containers (32 cm dia. x 14 cm height) covered with muslin cloth. The hatching of eggs was observed daily. Immediately after hatching, each larva was transferred to a separate container containing 15 days old fruits for feeding. The fruits were changed at 7 days interval. Observations were made on the number of larval instars, larval period, pre pupal period, pupal period and adult longevity of male and female. Immediately after emergence of adults, they were released in a cage containing cotton soaked in 50 per cent sugar syrup as food.

Twenty larvae were examined daily for the increase in head capsule width. The head capsule

Table 1. Biology of pomegranate fruitborer, *Deudorix isocrates*

Developmental Stage	Duration (days)/ (Mean ± SD)	Measurement		
		length (mm) / (range)	breadth (mm) / (range)	Wet weight (g)
Incubation period	4.0 - 7.0 (5.7 ± 0.78)	Diameter 1.04 + 0.02		-
Larva - I	2.0 - 3.0 (2.5 ± 0.53)	4.26 (3.6 - 4.9)	0.98 (0.8 - 1.1)	upto 0.001
Larva - II	3.0 - 5.0 (3.9 ± 0.57)	6.03 (4.8 - 7.0)	1.41 (1.0 - 1.7)	0.001-0.007
Larva - III	3.0 - 5.0 (4.1 ± 0.57)	10.12 (6.5 - 13.0)	2.27 (1.5 - 3.0)	0.007-0.070
Larva - IV	4.0 - 7.0 (5.7 ± 0.95)	15.34 (12.0 - 18.0)	3.91 (2.7 - 4.8)	0.058-0.205
Larva - V	5.0 - 8.0 (6.6 ± 0.84)	19.89 (17.0-22.5)	6.20 (4.5 - 7.5)	0.171-0.330
Total	19.0-25.0 (22.8 ± 1.78)	-	-	-
Prepupa	2.0 - 3.0 (2.2 ± 0.40)	-	-	-
Pupa	7.0 - 10.0 (8.3 ± 0.90)	-	-	-
Egg to adult	33.0 - 41.0 (39.1 ± 2.39)	-	-	-
Adult longevity - Male	7.0 - 9.0 (7.9 ± 0.70)	-	-	-
Female	7.0 - 11.0 (9.0 ± 1.10)	-	-	-
Fecundity / Female	17.0 - 46.0 (31.4 ± 8.69)	-	-	

width of the larvae was measured by placing it on a glass slide and by pressing the head gently with a cover slip under binocular research microscope equipped with caliberated eyepiece micrometer upto the third instar. In case of fourth and fifth instars, the moulted head capsule was used and its width was measured following the method suggested by Dyer (1890).

The life table studies were carried out at HRS, Yercaud under laboratory conditions using the susceptible variety Ganesh. Initially the larvae collected from the field were utilized for culturing of fruitborer. Observations were made daily from the time of hatching of eggs till the emergence of adults which provided the values for the life table (1x). The life table was prepared according to the method of Birch (1948) and eloborated by Atwal and Bains (1974).

RESULTS AND DISCUSSION

Biology

The female laid eggs on flowers, fruits (base, middle, top, calyxcup), stem, stalk and on leaves either singly or in groups of 2 to 7. They were laid before or after flower opening and on fruits of different stages. The eggs were shiny white, more or less round with numerous reticulations. A female laid 17 to 46 eggs with an average of 31.4. The incubation period varied from 4 to 7 days (Table 1). The fecundity of the fruitborer was higher than that recorded by Kabre and Moholkar (1992) (16.0 / female) but the incubation period was comparatively lower (7 to 10 days) than the studies made by Lal (1952).

Larval instars

There are five larval instars based on the head capsule measurements which is in confirmity with the report of Thirumurugan (1992) as against only four larval instars as stated by Kabre and Moholkar (1992). The first instar larvae bored inside the flowers or developing fruits. The larva was light brown in colour, hairs were distributed all over the body. The larva was found to feed initially on seeds. After moulting, the larva entered into second instar and found to feed on seeds and pulp. The faecal matter was pushed out through the entrance hole and found sticking around the bore hole. The third instar larva turned into dark brown in colour. The bore hole was bigger in size and the posterior end of the abdomen was seen through the bore hole.

Table 2. Width of head capsule in different larval instars of fruitborer

Larval instar	Width of head capsule (mm) (Mean ± SD)	Rate of increase in width compared to proceeding instar
First	0.4357 ± 0.0176	-
Second	0.7370 ± 0.0151	1.6815
Third	1.1932 ± 0.0274	1.6190
Fourth	1.7904 ± 0.0299	1.5005
Fifth	2.3891 ± 0.0492	1.3344

The larva attained the maximum growth during the fourth instar period and the excreta was pushed out of the entry holes as dry pellets or wet faecal matter which stuck around the holes. This could create an offensive smell and the fruit became unfit for human consumption. The fifth instar larva was stout, dark brown in colour with short hairs and whitish patches all over the body. The larva while feeding could create lot of mess and offensive smelling fluid oozed out from the entrance hole. Sometimes, the holes could be plugged with the anal end of the larva.

The affected fruits were subjected to attack by the fungus and bacteria, resulting in rotting of fruits. The size of the bore holes was found to increase when the larval stages advanced. The total larval period lasted for 19 to 25 days with a mean of 22.8 days. Pupation took place inside the calyxcup or on the skin of the fruit. The cocoon was formed with the help of fine silken strands. The pupal period ranged from 7 to 10 days. Thirumurugan (1992) also reported the larval and pupal periods from 17 to 22 and 8 to 11 days respectively. However, Kabre and Moholkar (1992) recorded the total larval period as 15.7 days. Variations in the larval and pupal periods ranging from 18 to 47 days and 7 to 34 days were reported by Lal (1952) and 15 to 45 days and 8 to 30 days by Vijaya Angadi (1991) respectively and the differences might have been due to variations prevailed in the weather conditions.

The adult butterfly was medium sized, the male was glossy bluish violet with a tail (blue with

white tip) of 4 mm length in the hind wing. Wing expanse was 38 to 42 mm. The female was bluish violet with conspicuous orange patch on the fore wings. The wing expanse of female was 43 to 47 mm. The adult longevity of male and female was 7 to 9 and 7 to 11 days and the duration from egg to adult emergence took 33 to 41 days which were comparable with the findings of Kabre and Moholkar (1992) with 50, 6.1 and 11.2 days respectively.

Larval instars

Based on the head capsule widths, five larval instars were fixed. The average rate of increase of the width of head capsule was 1 : 1. 33 to 1:1.68 which is in accordance with the Dyer's Law (1890). The rate of increase was maximum from first to second instar and then gradually reduced when the larva moulted from third instar onwards (Table 2). The range of head capsule width from first to fifth instar has been shown in fig. 1.

Life table

The studies made on the life table of fruitborer revealed that the preoviposition, oviposition and incubation periods ranged from 3 to 5, 3 to 6 and 4 to 7 days respectively and it took a minimum of 8 days and a maximum of 17 days from the period of adult emergence to the emergence of first instar larvae. This period of 8 to 17 days considered to be fairly long period that could be advantageously used in the pest management, since the egg stage is the weak link because of exposed nature after noticing the activity of adult butterfly

The survival of immature stages (1 x) from egg to adult emergence was 1.00. The oviposition started on 42 nd day. The first female mortality was recorded on 46th day and last female died on 53 rd day. The adult longevity ranged from 7 to 11 days and the number of eggs laid by a female ranged from 17 to 46. The male : female ratio varied from 1 : 09 to 1:1.9. The adult attained the greatest mean progeny production per day (m x) of 6.8 on 45 th day. Eight days after oviposition, the reproduction ceased. The net reproductive rate (R_o) representing the total female births was 14.68 (lx.mx) (Table 3) and the mean generation time (T_c) was 44.72 days. This generation time marks the possibility of the occurrence of upto four broods in the fruiting season of pomegranate i.e. from April- May to

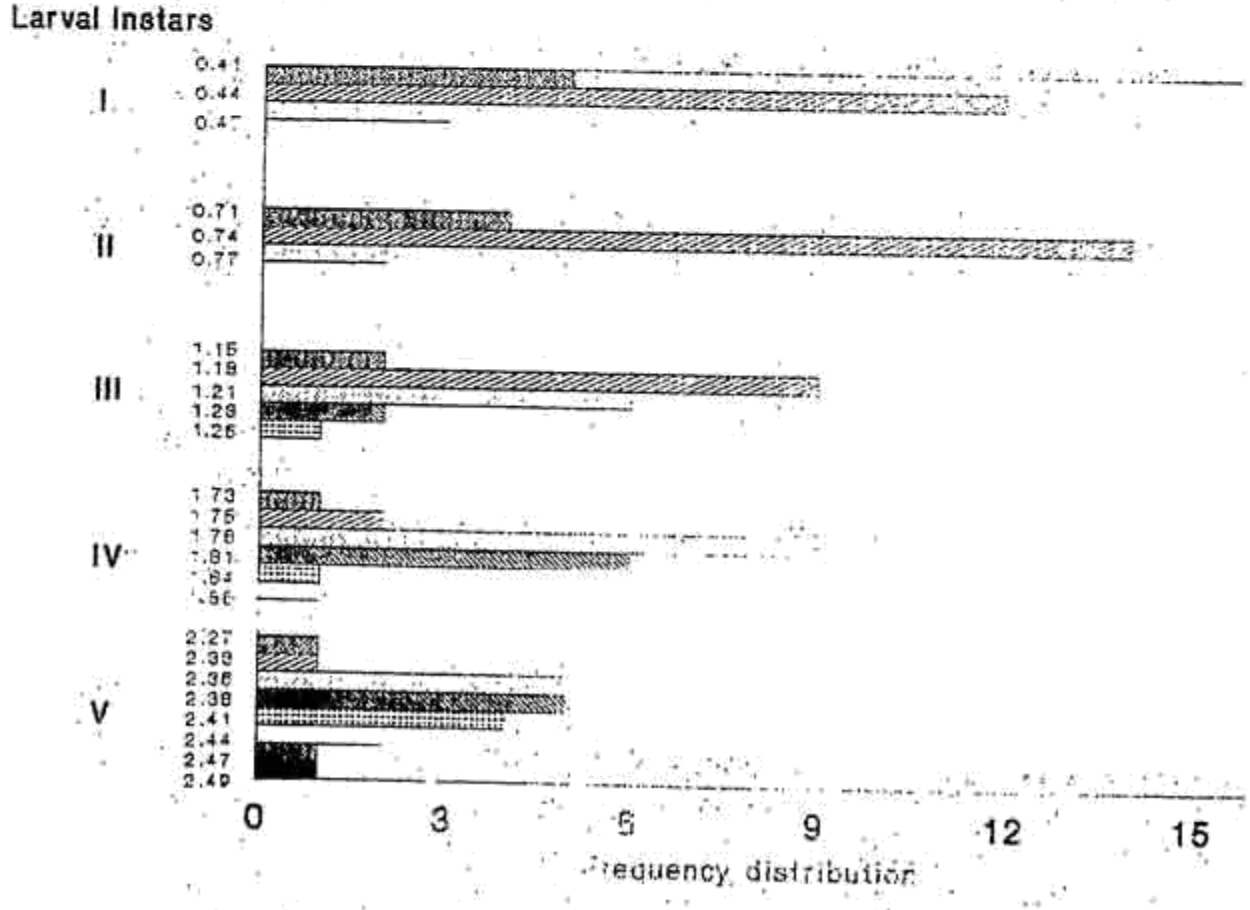

Fig. 1. Frequency distribution of head capsule width in different instars of *D. isocrates*

Table 3. Age specific fecundity life table (for females) of *Deudorix isocrates*

Pivotal age (days) x	Survival of females at age x lx	Age schedule for female births at age m mx	lx.mx	x.lx.mx
38	1.0	- Immature stages -		
39	1.0	- Preoviposition period -		
40	1.0	- Preoviposition period -		
41	1.0	- Preoviposition period -		
42	1.0	0.1	0.10	4.20
43	1.0	0.9	0.90	38.70
44	1.0	5.6	5.60	246.40
45	0.8	6.8	5.44	244.80
46	0.6	3.3	1.98	91.08
47	0.4	1.2	0.48	22.56
48	0.3	0.4	0.12	5.76
49	0.2	0.3	0.06	2.94
50	0.1	0.0	0.00	0.00
51	0.1	0.0	0.00	0.00
			Σ 14.68	656.44

October-November. The innate capacity for increase (rm) was 0.062311 while the finite rate of increase () was 1.0643 female/day. The doubling time (DT) of the population was 11.89 days. The population could multiply 1.547 times per week (Table 4) which necessitate an effective monitoring and management in order to contain the pest effectively.

Table 4. Generation time, innate capacity for increase and finite rate of increase in numbers of *D. isocrates* on pomegranate

Parameter	Values
Mean length of generation Tc (day) Σ x.lx.mx/Ro	44.72
Innate capacity for increase in numbers (calculated)	
$rm = \frac{\log_e Ro}{TC}$	0.06
Corrected rm	0.06231
Corrected generation time (days) = $\frac{\log_e Ro}{TC}$	43.11
Finite rate of increase λ = antilog e^{rm} / female / day	1.0643
Weekly multiplication of population = $(e^{rm})^7$	1.547
Doubling time (DT) days = Log 2 / Log λ	11.89

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INFLUENCE OF WEATHER FACTORS ON RETAINABILITY AND EGG LAYING OF *Chrysoperla carnea* ADULTS UNDER COTTON ECOSYSTEM

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ABSTRACT

Retainability and egg laying of *Chrysoperla carnea* adults were observed over a period of 5 weeks under cotton ecosystem. Using weather factors, correlations and multiple regression analysis were worked out to identify the factors influencing the retainability and egg laying. Multiple correlation studies revealed that a significant positive association exist between the retainability and egg laying of the adults *C. carnea* under maximum relative humidity with aphid population and significant negative association was also observed with maximum temperature and wind speed. Hence, multiple regression analysis led to the conclusion that a decrease in maximum temperature increases the per cent retainability of *C. carnea* adults.

KEY WORDS : *Chrysoperla carnea*, cotton, weather parameters, correlations.