



E-ISSN: 2320-7078

P-ISSN: 2349-6800

www.entomoljournal.com

JEZS 2020; 8(6): 925-929

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Received: 16-08-2020

Accepted: 02-10-2020

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Bioecology of castor capsul borer (*Conogethes punctiferalis* Guen.), in South West Haryana

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Abstract

Castor (*Ricinus communis* L) is one of the ancient oilseed crops grown in India. The castor capsule borer *C. punctiferalis*, (Guen.), recorded as most important pest of castor because it influence the quality as well as quantity of the seeds by feeding upon the castor capsules and destroying the internal seed. The egg of castor capsule borer was found singly or in groups of 4 to 7 on the inflorescence and surface of capsules. The incubation period varied from 4.0 to 5.0 days in different generations. The caterpillar moulted four times before pupation leading to five larval instars. The total larval period ranged from 15.0-20.0 days with an average of 17.5±2.07 days. The temperature ranged from 29.7 to 36.7 °C and relative humidity 71.0 to 85.0 percent during the larval period. The pupal period ranged from 9.0 to 11.0 days (mean 10.25±1.00 days). The male moth was smaller than female, male survived for 5.0 to 6.0 days and female survived for 6.0 to 7.0 days. The sex ratio of male and female was 1:1.2 in field conditions. The duration of life cycle in case of male was 34.00 to 73.00 days and in case of female 35.0 to 76.0 days in different generations.

Keywords: Capsule, inflorescence, incubation, generations, sex ratio

Introduction

Castor (*Ricinus communis* L.) is an important non-edible oilseed crop, which belongs to family *Euphorbiaceae* and locally known as arandi. Castor oil is used for deriving a number of industrial products viz. dye, detergents, plastic, printing ink, ointment, polishes, surface paints, adhesives, lubricants and hydraulic fluids. In Haryana, particularly in south-west region, farmers are growing castor as an alternative crop of mustard and cotton to overcome the problem of losses caused by stem rot disease in mustard and whitefly damage in cotton, respectively.

More than 107 species of insects and six species of mites are recorded on castor at different phenological stages (Lakshminarayana and Raouf, 2005) [8]. The most important pests are castor shoot and capsule borer (*Conogethes punctiferalis* Guen.), castor hairy caterpillar (*Euproctis lunata* Wlk.) and castor semilooper (*Achaea janata* L.) (Vora *et al.*, 1984) [15]. The castor capsule borer is probably the most important pest of castor because it directly reduces the yield and quality of the seeds by feeding upon the castor capsules and destroying the internal seed (Patel and Gangrade, 1971) [9]. Larvae of this moth are typically polyphagous, attacking more than 120 wild and cultivated plants (Sekiguchi, 1974 [12], Thyagaraj *et al.*, 2003 [13]). Yield loss of 19.0 to 85.0 per cent has been reported in castor due to semilooper and capsule borer (Singh *et al.*, 1992) [10]. Gaur (2014) [6] reported that insect pests viz. castor semilooper (*Acanthodelta janata* L), castor hairy caterpillar (*Euproctis lunata* Walker), castor capsule borer (*Dichocrosis punctiferalis* Guenee) and leaf hopper (*Empoasca flavescens* Fabr) were recorded as major pests of castor in south west Haryana during 2012 and 2013. Gaur and Deswal (2014) [5] reported 4.0 to 9.0 percent fruit infestation in guava crop by this pest in south-west Haryana.

Materials and Methods

Studies on the "Bioecology of castor capsule-borer, *Conogethes punctiferalis* Guenee (Lepidoptera: Pyralidae)" were carried out during 2015-16. in laboratory of Chaudhary Charan Singh Haryana Agricultural University, Regional Research Station, Bawal, district Rewari. Bawal is located in Rewari district at 28° 08' N latitude and 76° 58' E longitude with an altitude of 245 meters above MSL. The insect culture was raised by collecting various larval stages from the stray castor plant as well as from guava fruits.

The infested fruits of guava and capsules of castor were placed in glass jar having castor capsules. The adults formed from these larvae were released in glass chimneys (10 cm dia, and 30 cm h) for mating and oviposition. Newly hatched larvae were reared on fresh capsules in glass jar of (15 cm dia, 21 cm h). These jars were covered with muslin cloth. Fresh capsules were provided as feed when old ones dried or eaten by the larvae. After pupation, pupae were transferred to specimen tubes (10.2 cm×2.5 cm) separately for adult emergence which were used for further studies. Observations on the development of various stages of the insect were recorded daily. The various biological parameters of *C. punctiferalis* were studied under the laboratory conditions on castor (DCH-177) shoot and capsules from August 2015 to May 2016. The food for larvae was obtained from the same hybrid of castor, which was sown in the research area of Regional Research Station, Bawal. Ten pairs (10 male and 10 female) of freshly emerged adults were released into glass chimneys (10 cm dia, and 30 cm h) for mating and oviposition in the laboratory. The glass chimneys were provided with castor inflorescence and immature capsules held in a vial containing water. Observations on pre ovipositional, oviposition, post oviposition period and fecundity/female were made on ten pairs of newly emerged male and female adults. As *C. punctiferalis* larva is an internal borer, it is difficult to find exuviae so, Dyar's law was used to find out the moulting. In this manner numbers of larval instars were recorded. The grown up larvae were allowed to pupate in the specimen tube (10.2 cm×2.5 cm). The total larval and pupal durations were also recorded. Insect larvae were killed in hot water and preserved in 70 percent alcohol for recording body measurements.

Results and Discussion

The freshly laid eggs of castor capsule-borer *C. punctiferalis*, (Guen.) were pale whitish in appearance and turned reddish prior to hatching. The eggs were round, oval in shape and firmly glued to the surface of the castor capsules. The eggs were found singly or in groups of 4 to 7 on the inflorescence and surface of capsules. The egg length varied from 0.57 to 0.66 mm with an average of 0.62 ± 0.03 mm and width 0.46 to 0.53 mm with an average of 0.49 ± 0.03 mm. The present findings on egg stage are more or less similar to the findings of Bilapate and Talati (1978) [2] and Ganesh *et al.*, (2013) [4]. The incubation period varied from 4.0 to 5.0 days with an average of 4.48 ± 0.4 days. These findings are in close agreement with Umbarkar and Patel (2014) [14] who reported the average incubation period of 4.16 days. However, Stanly *et al.*, (2009) [11] reported that incubation period of *C. punctiferalis* varied from 2.0 to 4.0 days which slightly differed with the results of present investigation. The variation in the incubation period can be attributed to the rearing temperature, relative humidity and food given to the larvae of *C. punctiferalis* during the period of investigations. Wang and Cai (1997) [16] also reported a significant difference in average incubation period of *C. punctiferalis* which varied from 4.1 to 9.3 days under varied temperature and relative humidity.

The egg hatchability varied from 70.0 to 83.0 percent with an average of 76.0 ± 4.47 percent. The number of eggs laid per female ranged from 54 to 71 and its hatchability from 70 to 83 percent. However, Ganesha *et al.*, (2013) [4] reported that fecundity of *C. punctiferalis* varied from 80 to 110 eggs which differed with the results of present investigations. The

variation in fecundity can be attributed to different rearing conditions during the period of investigations. The results in relation to the egg hatchability of *C. punctiferalis* are in agreement with earlier workers Doddabasappa *et al.*, (2014) [3] who reported hatchability from 72.80 to 88.55 percent on castor.

During its larval period, the caterpillar moulted four times before pupation leading to five larval instars. The width of head capsule of consecutive larval instars was 0.32 to 0.41 mm (mean 0.36 ± 0.04 mm), 0.48 to 0.54 mm (mean 0.51 ± 0.05 mm), 0.68 to 0.77 mm (mean 0.74 ± 0.04 mm), 1.05 to 1.14 mm (mean 1.10 ± 0.09 mm) and 1.60 to 1.70 mm (mean 1.65 ± 0.09 mm). According to Dyar's law, head width increased in a regular progression in successive instars by 1.4 times. The ratio of measurements of head capsule for the II to I, III to II, IV to III and V to IV were 1.42, 1.45, 1.48 and 1.51, respectively (Table 2). The results in relation to the number of instars of *C. punctiferalis* are in agreement with earlier workers (Patel and Gangarde, 1971 [9], Ganesha *et al.*, 2013 [4] and Umbarkar and Patel, 2014 [14]) who recorded five instars in *C. punctiferalis* larvae. First instar larva was light brown in colour with light brown mouth parts and head capsule. The full grown first instar larva measured from 1.20 to 1.80 mm with an average of 1.56 ± 0.15 mm in length and 0.20 to 0.25 mm with an average of 0.23 ± 0.03 mm in breadth. The first larval instar lasted for 2.0-3.0 days with an average of 2.3 ± 0.48 days. The second instar larva was light brown with dark brown mouth parts and head capsule. The second instar ranged from 3.80-5.10 mm (mean 4.69 ± 0.4 mm) in length and 0.70-0.95 mm (0.83 ± 0.04 mm) in breadth. The second larval instar lasted for 2.0-3.0 days with an average of 2.5 ± 0.53 days (Table 3). The later three instars of the castor capsule borer were light brown with dark brown head capsule and mouth parts. The sclerites of the body were black in colour and distinctly visible. The larvae hang on with a fine silken thread when disturbed. The third instar ranged from 7.30-9.40 mm (mean 8.33 ± 0.78 mm) in length and 1.35-1.80 mm (1.63 ± 0.20 mm) in breadth (Table 1). The third larval instar lasted for 3.0-4.0 days with an average of 3.4 ± 0.58 days. The fourth instar ranged from 13.50-15.00 mm (mean 14.34 ± 0.47 mm) in length and 2.25-2.85 mm (mean 2.56 ± 0.20 mm) in breadth. The fourth larval instar lasted for 4.0-5.0 days with an average of 4.5 ± 0.53 days. The fifth instar ranged from 17.20-19.6 mm (mean 18.51 ± 0.81 mm) in length and 3.10-3.95 mm (mean 3.56 ± 0.27 mm) in breadth. The fifth larval instar lasted for 4.0-5.0 days with an average of 4.3 ± 0.56 days. The total larval period ranged from 15.0-20.0 days with an average of 17.5 ± 2.07 days. The temperature ranged from 29.7 to 36.7 °C and relative humidity 71.0 to 85.0 per cent during the larval period. The present results on the larval size slightly differed with that of Ganesha *et al.*, (2013) [4] who measured first, second, third, fourth and fifth larval stage as 1.48×0.17 , 3.38×0.37 , 5.55×0.86 , 11.45×1.59 and 15.49×2.46 mm, respectively. The variation in the larval sizes can be attributed to the rearing temperature, relative humidity, food provided and space availability in the rearing jars during the period of investigations. The total larval period ranged from 15 to 20 days with an average of 17.50 days. The present results fall in line with the results of Bilapate and Talati (1977) [1] who reported total larval period of *C. punctiferalis* was 15 days when it reared on castor. However, the present results on the total larval period differed with the work of Doddabasappa *et al.*, (2014) [3] who recorded the average larval period 26.6, 32.4 and 31.0 days when it was

reared on spineless spike, compact and spiny loose type of castor, respectively. This might be due to the variation in techniques adopted during rearing of *C. punctiferalis*, temperature and test food.

The final instar larva came to the outer surface of the capsule, spun loose cocoon, inside which turn into pre-pupa. The pre-pupa was also seen inside the capsule as well as in the shoot of castor. The colour of the pre-pupa was light greenish. The Pre-pupal stage varied from 14.0-16.0 mm with an average of 14.75 ± 0.62 mm in length and 4.0-5.2 mm with an average of 4.57 ± 0.35 mm in breadth. The pre-pupa lasted for 1.0-2.0 days with an average of 1.85 ± 0.46 days. The pre-pupal period of *C. punctiferalis* was 1.0 to 2.0 days in August to September and 2 to 3 days in October to January (Patel and Gangarde 1971) [9] and average pre-pupal period was 1.92 days (Umbarkar and Patel, 2014) [14] which is almost similar to the present finding.

The freshly converted pupa was reddish and obtect. Pupa measured 11.00 to 13.30 mm with an average of 12.11 ± 0.87 mm in length and 4.80 to 6.00 mm with an average of 5.45 ± 0.51 mm in breadth (Table 1). The pupal period ranged from 9.00 to 11.00 days (mean 10.25 ± 1.00 days). The average pupal mortality varied from 5.0 to 7.0 percent. The temperature ranged from 29.7 to 36.7 °C and relative humidity 71.0 to 85.0 percent during the pupal period. Ganesha *et al.*, (2013) [4] reported that the average pupal period was 10.5 days which is similar to the present findings.

Emergence of moths occurred mostly during the evening hours. The adult moth was medium sized, brownish yellow with a number of dark spots on all over the body. The sex of insects could be easily determined by the examination of the external genitalia. Generally, female moths were bigger in size, having bulged abdomen with tuft of black hairs at the tip and male moths were smaller in size without tufts of hairs in the abdominal tip. The male moth was smaller than female, being 9.80 to 12.50 mm (mean 11.52 ± 0.97 mm) in body length and 20.50 to 23.00 mm (mean 21.9 ± 0.7 mm) in wing expanse. The female was ranged from 10.20 to 13.85 mm (mean 12.51 ± 1.27 mm) in body length and 22.00 to 25.00 mm (mean 23.4 ± 1.24 mm) in wing expanse. The adult longevity data (Table 3) indicated that male survived for 5.0 to 6.0 days (mean 5.5 ± 0.39 days) and female survived for 6.0 to 7.0 days (mean 6.48 ± 0.4 days). The similar observations with respect to adult longevity were made by Stanly *et al.*, (2009) [11] who reported the average adult longevity, 5.15 ± 0.37 and 6.20 ± 0.77 days in case of male and female, respectively when it was reared on castor.

The observations on the sex ratio of male and female were also recorded. Out of 50 laboratory reared insect population, female were 26 and male 24 and male to female ratio was 1:1.1. However, in the field collected pupae, the female were 28 and male 22 and male to female ratio was 1:1.2. These findings are in agreement with Doddabasappa *et al.*, (2014) [3] who reported that the sex ratio of *C. punctiferalis* was 1:1.4, 1:1.09 and 1: 1.1 when reared on spineless spike, compact spiny and spiny loose type of castor, respectively.

The pre-oviposition period ranged from 2.0 to 3.0 days with an average of 2.2 ± 0.42 days. The present findings on pre-oviposition period are more or less similar to the finding of Doddabasappa *et al.*, (2014) [3] who reported that average pre-oviposition period of *C. punctiferalis* was 2.4, 2.4 and 2.2

days on spineless spike, compact spiny and spiny loose type of castor, respectively. The oviposition period varied from 2.0 to 3.0 days with an average of 2.73 ± 0.41 days. These findings are in close conformity with Ganesha *et al.*, (2013) [4] who reported that average oviposition period was 2.76 days. The post oviposition period ranged from 1.0 to 2.0 days with an average of 1.6 ± 0.39 days. The present findings are in agreement with the Umbarkar and Patel (2014) [14] who reported the post oviposition period of *C. punctiferalis* was 2.2 days. The number of eggs laid per female were 54 to 71 with a mean of 62.5 ± 6.22 and percent hatchability ranged from 70 to 83 with an average of 76 ± 4.47 . The temperature ranged from 29.7 to 36.7 °C and relative humidity 71.0 to 85.0 per cent during these periods.

Mating took place in tail to tail position which lasted for 30 to 60 minutes. During this process, both remained quite. On slight disturbance, the two sexes could be separated. Most of the moths (70%) mated during night hrs i.e. between 19.01 to 22.00 hrs. However, in few (30%) cases mating were also observed from 22.01 to 01.00 hrs.

The duration of life cycle in case of male was 34.0 to 44.0 days (mean 38.4 ± 3.57 days) in the first generation, 41.0 to 53.0 days (mean 47.3 ± 3.19 days) in the second generation, 47.0 to 55.0 days (mean 50.6 ± 3.31 days) in the third generation and 64.0 to 73.0 days (mean 68.6 ± 3.53 days) in 4th generation. In females, it varied from 35.0 to 45.0 days (mean 40.7 ± 3.8 days) in the first generation, 43.0 to 55.0 days (mean 49.6 ± 3.94 days) in the second generation, 49.0 to 58.0 days (mean 53.6 ± 3.13 days) in the third generation and 67.0 to 76 days (mean 71.5 ± 3.98 days) in 4th generation (Table 4). The more or less similar observations were made by Bilapate (1977) [1], Jacob (1991) [7] who reported that *C. punctiferali* took 34 to 46, 33 to 52 and 25 to 40 days, respectively on different hosts.

Table 1: Measurements of different developmental stages of *C. punctiferalis* under laboratory condition n = 20

Stage	Length (mm)		Breadth (mm)	
	Range	Mean±S.D.	Range	Mean±S.D.
Egg	0.57-0.66	0.62±0.03	0.46-0.53	0.49±0.03
Larva				
1 st instar	1.20-1.80	1.56±0.15	0.20-0.25	0.23±0.03
2 nd instar	3.80-5.10	4.69±0.40	0.70-0.95	0.83±0.04
3 rd instar	7.30-9.40	8.33±0.78	1.35-1.80	1.63±0.20
4 th instar	13.50-15.00	14.34±0.47	2.25-2.85	2.56±0.20
5 th instar	17.20-19.60	18.51±0.81	3.10-3.95	3.56±0.27
Pre-pupa	14.00-16.00	14.75±0.62	4.00-5.20	4.57±0.35
Pupa	11.00-13.30	12.11±0.87	4.80-6.00	5.45±0.51
Adult male	9.80-12.50	11.52±0.97	*20.50-23.00	*21.90±0.70
Adult female	10.20-13.85	12.51±1.27	*22.00-25.00	*23.40±1.24

*With wing expanse

Table 2: Width of head capsule of different larval instars of *C. punctiferalis* under laboratory condition n = 20

Instar	width (mm)		Ratio of head capsule width in two consecutive instars
	Range	Mean±S.D.	
1	0.32-0.41	0.36±0.04	-
2	0.48-0.54	0.51±0.05	1.42
3	0.68-0.77	0.74±0.04	1.45
4	1.05-1.14	1.10±0.09	1.48
5	1.60-1.70	1.65±0.09	1.51

Table 3: Duration of different developmental stages of *C. punctiferalis* n = 10

Stage	Duration (days)	
	Range	Mean±S.D.
Incubation Period	4.0-5.0	4.48±0.40
1 st instar	2.0-3.0	2.30±0.48
2 nd instar	2.0-3.0	2.50±0.53
3 rd instar	3.0-4.0	3.40±0.58
4 th instar	4.0-5.0	4.50±0.53
5 th instar	4.0-5.0	4.30±0.56
Total larval period	15.0-20.0	17.50±2.07
Pre-pupa	1.0-2.0	1.85±0.46
Pupa	9.0-11.0	10.25±1.00
Adult male	5.0-6.0	5.50±0.39
Adult female	6.0-7.0	6.48±0.40
Total life cycle (Male)	34.0-44.0	38.40±3.57
Total life cycle (Female)	35.0-45.0	40.70±3.80
Temperature (°C)	29.7-36.7	32.40
Relative humidity (%)	71.0-85.0	77.60

Table 4: Total duration of the Life cycle of *C. punctiferalis* in the different generations under laboratory conditions n = 10

Generation	Duration (days)				Temperature (°C)		Relative humidity (%)	
	Male		Female		Range	Mean	Range	Mean
	Range	Mean±S.D	Range	Mean±S.D				
First	34-44	38.4±3.57	35-45	40.7±3.8	29.7-36.7	32.4	71-85	77.6
Second	41-53	47.3±3.19	43-55	49.6±3.94	20-32.5	26.5	66-84	72.0
Third	47-55	50.6±3.31	49-58	53.6±3.13	12-22.8	17.8	73-84	79.7
Fourth	64-73	68.6±3.53	67-76	71.5±3.98	11.6-20.8	16.3	76-88	83.5

**Fig 1:** Male and Female of *C. punctiferalis*

Conclusion

On the basis of results it is concluded that eggs *C. punctiferalis*, (Guen.) were round, oval shaped firmly glued to the surface of the castor capsules. The incubation period varied from 4 to 5 days in different generations. There were five larval instars of *C. punctiferalis*, (Guen.) and total larval period ranged from 15 to 20 days. The pupa was reddish, oblong and turned dark brown and reddish brown towards the emergence of the adults. Pupal period ranged from 9 to 11 days. The adults were brownish yellow with a number of dark spots on all over the body. The male survived for 5 to 6 days and female for 6 to 7 days. There was a slight difference in sex ratio, being in favor of female. The duration of life cycle in case of male was 34 to 73 days and in female 35 to 76 days in different generations.

Acknowledgment

I would like to express my great appreciation to Dr. Ram Karan Gaur for his valuable suggestion during the planning and development of this research work. His willingness to give his time so generously has been very much appreciated. The authors would like to thank the staff of CCS HAU, RRS, Bawal for providing facilities and hospitality during the research work.

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