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BIOLOGY OF DIAPAUSING POPULATION OF PINK BOLLWORM *PECTINOPHORA GOSSYPIELLA* (SAUNDERS)

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ABSTRACT

This study on the comparative biology *Pectinophora gossypiella* (Saunders) was carried out at the University of Agricultural Sciences, Raichur, Karnataka, in insect rearing growth chamber (25± 1°C, 65± 5% RH and photoperiod of 14:10 hr, L: D) during 2018-19. The results revealed that the incubation period was 3.5± 0.82 and 3.05± 0.55 days in non-diapausing and diapausing populations, respectively; a total larval period of 18.60± 2.28 and 19.65± 1.53 days, respectively was observed without any significant difference; and adult longevity of male and female was 9.05± 0.55 and 9.55± 0.83 days, respectively in non-diapausing population, while in diapausimg population it was 9.75± 0.26 and 10.25± 0.43 days. Total life cycle of non-diapausing population was significantly shorter (42.85± 4.99 days) as compared to diapausing one (134.3± 12.91days) with fecundity of 112.34± 10.31 and 104.54± 9.96 eggs, respectively. The longer lifecycle of diapausing population was due to long resting diapausing period ranging from 72 to 108 days.

Key words: *Pectinophora gossypiella*, cotton, diapausing, non-diapusing, incubation, longevity, fecundity, longevity, larval period, lifecycle, photoperiod

Cotton is the most important commercial crop cultivated in >100 countries in 32 million ha (Anon, 2015). A loss to the extent of 2.8 to 61.9 % in seed cotton yield, 2.1 to 47.10 % loss in oil content and 10.70 to 59.20 % loss in normal opening of bolls was caused by the pink bollworm *Pectinophora gossypiella* (Saunders) infestation in non *Bt* cotton (Patil, 2003). Thus, it is one of the most important destructive pests and it is observed for a brief period from January to till the end of the season in April. In the recent past, the pest has been frequently noticed from early flowering. Soon after emergence, the larvae enter the fruiting body. As a result, farmers remain totally ignorant about the damage caused till the boll opening and hence could not exercise any target specific control measures. It has also known to have developed resistance to insecticides and to cry toxin of *Bt* cotton (Li et al., 1997; Sabry et al., 2013; Tabashnik et al., 2004; Mohan et al., 2015). This pest has a typical behaviour of undergoing diapause which help them to adapt different climatic conditions. The larvae hide over unfavorable season inside empty cotton seed in which they are well protected and remain alive for many months during unfavorable climatic condition. Survival of the pest from one season to another is entirely through hibernating larvae in seeds, soils and plant debris. Sharma (1999) reported sticks carrying green bolls; unopened and half opened bolls carried about 82% diapause larvae, while seeds carried about 12% diapausing larvae. Similarly, Singh et al. (1999) from Punjab reported maximum carryover of this pest through the unpickable bolls and seeds. As diapause results in carrying over the infestation from one season to other, a clear understanding of biology of this insect is required and hence the present study.

MATERIALS AND METHODS

The present study on biology of diapausing population of *P. gossypiella* was carried out at the Main Agricultural Research Station, UAS, Raichur, Karnataka. Biology was studied in insect rearing growth chamber (25±1°C, 65± 5% RH and photoperiod of 14:10 hr, L: D) during 2018-19. The infested bolls were collected from the field by plucking damaged bolls and larvae were reared on semi synthetic diet by placing them in a plastic vial (4 cm dia x 5cm height) with a filter paper disc at the bottom and a lid with a mesh window

till their pupation. The plastic vials containing larvae collected were then placed in walk in growth chamber with proper labeling (date and place of collection). Male and female larvae were sexed by observing the presence of testis at 8th abdominal segment of male larvae that are visible outside as black dots which is absent in female larvae. After pupation pupae were sexed based on pupal characters i.e., position of genital and anal openings wherein, the genital anal pores are situated mid-ventrally on the 9th and 10th, 8th and 10th abdominal segments in males and females, respectively. The distance between the genital pore and anal pore affords a good character for the separation of the sexes. In case of female this distance is more than double as compared to male (Dhara Jothi et al., 2010). Such sexed pupae were kept in emergence cages (45×45×60cm) for adult eclosion.

Newly emerged larvae were reared following Sapna et al. (2014), and during rearing the larvae which completed their lifecycle without a resting phase (diapause period) were considered as non-diapausing in contrast to that the larvae which were having a diapause stage. The comparative biology of these diapausing and non-diapausing populations collected were then studied separately in walk in growth chamber at 25°C, 65± 5% RH and photoperiod of 14:10 hr (light: dark) respectively. Observations on the biological stages included- To assess the total number of eggs laid by an individual female, fresh non Bt cotton twig dipped in a vial (4cm dia x 5cm height) of sucrose solution (10%) and ten pairs of adults were released and the twig was observed daily for number of eggs laid. The incubation period was studied by counting the duration between egg laid and the emergence of first instar larva. The newly hatched neonate larvae were transferred to an Eppendorf tube (1.5 ml) containing cotton seed diet and the duration of hatching to pre-pupation was recorded as larval period. The duration of individual instars was recorded by observing the casted skin under microscope. At the later stage of development, the 4th instar larvae spin a tough thick walled, closely woven, spherical cell referred as 'hibernaculum' with no exit hole. The duration between the development of hibernaculum to the pupae formation was recorded as the larval diapause period. Time from pre-pupation to adult eclosion was recorded as pupal period. The newly emerged moths in the cage were given 10% honey solution as food and duration from emergence till their death was recorded as adult longevity. The duration between the release of mating pairs into the mating cage and the oviposition of first egg was recorded as preoviposition period. The duration between the oviposition of first egg to the oviposition of last egg was considered as oviposition period. Statistical analysis with t- test (p=0.05) was used to evaluate the comparative biology between diapausin and non-diapausing populations.

RESULTS AND DISCUSSION

Comparative biology of diapausing and non-diapausing populations revealed that the eggs are white when laid but turned yellowish and finally orange red before hatching; and were flattened oval, sculptured with longitudinal lines; which were laid in axils of petioles, underside of young leaves, under old leaves at the junction of veins or on squares and flowers; incubation period ranged from 3.5± 0.82 and 3.05± 0.55 days in non-diapausing and diapausing populations, respectively which did not differ significantly (Table 1); thus incubation period did not vary; an incubation period of 3.68± 0.09 days at 25°C had been reported (Cacayorin et al., 1992), in India and it was 4 days at 27°C (Shah et al., 2013). The egg period was 4.9± 0.99 days on artificial cotton seed diet (Zinzuvadiya et al. (2017). Syed and Rahman (1960) reported this as 7.37 days. At lower temperature the incubation period is generally higher, Sapna et al. (2014) reported it as 3.77, 3.2 and 1.95 days at 25± 10, 30± 10 and 35± 10°C, respectively. The total larval period varied from 17.70± 2.44 and 18.60± 2.28 days, respectively in non-diapausing vs diapausing ones; and in male and female, respectively it was 18.35± 1.75 and 19.65± 1.53 days, without any significant difference (Table 1). Total larval period ranged from 15 to 21 and 15 to 23 days in male and female, as observed by Zinzuvadiya et al. (2017); Jothi et al. (2015) observed this as 25.10± 0.994 days, and Sapna et al. (2014) as 23.15± 3.23 days at 25°C; 11± 0.64 days observed by Cacayorin et al. (1992) might be due to natural diet differences.

Prepupa was constructed at the base of plastic vial with a white thin cocoon layer rest on it, whereas, diapause larvae constructed a "hibernaculum" similar to that of prepupa but the cocoon layer slightly thicker; prepupal period was 2.75± 0.34 days in non-diapausing ones and a prolonged 93.2± 10.16 days with diapausing ones (Table 1). Zinzuvadiya et al. (2017) observed this as 1.60± 0.52 and 1.65± 0.49 days in male and female, respectively; and Sapna et al. (2014) as 1.95± 0.51 days at 25°C. The period of diapause was 93.2 days, and Khalifa et al. (1975) observed this to be 42- 184 days; it was 60- 116 days by Suresh et al. (2001); Awaknavar (1976) as 56- 120 days; Noble (1969) observed this as 2.5 years; and Ballou (1919) as 33

Table 1. Biology of diapausing and non-diapausing populations of *P. gossypiella*

Population	Non-diapausing		Diapausing		
Biological parameters	Mean± SD	Range	Mean± SD	Range	t-Test ($P_{0.05}$)
Egg incubation period (days)	3.5± 0.82	2.0-4.5	3.05± 0.55	2.5-4.0	0.08 (NS)
Larval stages (days)					
I instar	2.55± 0.44	2.0-3.0	3.15± 0.52	2.5-3.5	
II instar	4.75± 0.59	4.0-5.5	4.70± 0.25	4.5-5.0	
III instar	4.65± 0.78	4.5-5.5	4.95± 0.43	4.5-5.5	
IV instar (days)					
Male	5.75± 0.63	5.0-6.5	5.55± 0.55	5.5-6.5	
Female	6.65± 0.47	6.0-7.5	6.85± 0.33	6.5-7.5	
Total larval period (days)					
Male	17.70± 2.44	15.5-20.5	18.35± 1.75	17-20.5	0.21
Female	18.60± 2.28	16.5-21.5	19.65± 1.53	18-21.5	(NS)
Pre-pupal period	2.75± 0.34	1.5-3.5	NA		NA
Diapause period	NA		93.2± 10.16	72-108	NA
Pupal period (days)					
Male	8.25± 0.54	7.5-9.0	8.05± 0.55	7.0-8.5	0.11
Female	8.45± 0.72	7.5-9.5	8.15± O.24	8.0-8.5	(NS)
Preoviposition period	7.75± 0.54	7.0-8.5	8.85± 0.41	8.5-9.5	0.002* (S)
Oviposition Period	2.05± 0.36	1.5-2.5	2.25± 0.26	2.0-2.5	0.09 (NS)
Fecundity	112.34± 10.31	95-165	104.54± 9.96	85-125	0.04* (S)
Adult longevity (days)					
Male	9.05± 0.55	8.5-10.0	9.75± 0.26	8.5-10	0.06 (NS)
Female	9.55± 0.83	8.5-10.5	10.25± 0.43	8.5-10.5	0.029* (S)
Total Life cycle	42.85± 4.99	35-45	134.3± 12.91	109-148.5	0.006* (S)

*Significance difference (t-test, p=0.05)

months under Washington condition. Adults did not reveal any difference in the diapausing populations, but the longevity of male was 9.05± 0.55 and 9.75± 0.26 days, respectively in non-diapausing and diapausing ones without any significant difference; in female it was 9.55± 0.83 and 10.25± 0.43 days, respectively. Sapna et al. (2014) in Raichur reported that the longevity of male and female as 9 and 9.5 days, respectively; Cacayorin et al. (1992) observed this as 11.70± 0.48 days when reared on cotton seed diet; Sarwar (2017) showed this as 56 and 20 days, respectively. The preoviposition period was 7.75± 0.54 and 8.85± 0.41 days in non-diapausing and diapausing ones revealing significant differences; Sapna et al. (2014) observed this as 8 to 10 days, and Zinzuvadiya et al. (2017) as 8.00± 1.54 days. The number of eggs laid was 112.34± 10.31 (non-diapause) and significantly higher than that of diapause (104.54± 9.96) (Table 1). Zinzuvadiya et al. (2017) reported fecundity of 110.6 eggs, Adkinson et al. (1960) as 98.1-312.2 based on diet. Total lifecycle of non-diapausing population was significantly shorter (42.85±4.99 days) compared to diapausing ones (134.3±12.91 days) (Table 1). Umer et al. (2019) observed this in non-diapausing population as 35 to 45 days and it was 52.31 days as shown by Sapna et al. (2014).

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