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Effect of different temperature regimes on the biology of *Bracon brevicornis* Wesmael (Braconidae: Hymenoptera) on different host larvae

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ABSTRACT

Bhendi or Okra, *Abelmoschus esculentus* (L.) Moench (Malvaceae) is one of the important vegetable crops grown throughout the tropical and warm temperate regions of the world. It is ravaged by many insect pests right from germination to harvest. Among the insect pests, fruit borers *viz*., *Earias* spp. and *Helicoverpa armigera* (Hübner) causes extensive damage to fruits and results in 50 per cent yield loss. Management with biocontrol agents is the most appreciated method for environmental safety. Among the various groups of biocontrol agents, braconid parasitoids are well known for the management of different lepidopteran larvae, including bhendi fruit borer complex. The braconid parasitoid, *Bracon brevicornis* Wesmael was found to be very effective against bhendi fruit borers. However, temperature and host insects play a major role in the developmental biology of the parasitoids which ultimately decides its efficacy. Experiments conducted on the effect of different temperature *viz*., 20, 25, 30 35°C and room temperature, on the developmental biology of *B. brevicornis* on different host larvae *viz*., *E. vittella* and *H. armigera* in comparison with the laboratory host, *C. cephalonica* revealed that the temperature regime of 25°C is highly suitable with a short life cycle of 8.22, 8.27 and 8.07 days respectively followed by room temperature (ranged between 22 to 32°C). Among the host larvae studied, *C. cephalonica* and *E. vittella* were found to be more suitable with maximum number of eggs, grubs, cocoons, adult males and females respectively. *H. armigera* was next in the order of preference recording less number of eggs, grubs, cocoons, and adults. The developmental period was also found to be less in *C. cephalonica* and *E. vittella* followed by *H. armigera*. Though the life cycle is very short at 35°C, the progeny production is comparatively less with more males than females. At 20°C the life cycle is prolonged with minimum progenies yielding more males than females.

Key words: Larval parasitoid, crop pest, *Bracon brevicornis*, *Earias vittella*, *Helicoverpa armigera*

INTRODUCTION

Okra, *Abelmoschus esculentus* (L.) Moench (Malvaceae) is one of the important vegetable crops grown throughout the tropical and warm temperate regions of the world. Bhendi is ravaged by many insect pests right from germination to harvest (Sharma *et al.*, 1997; Jagtab *et al.*, 2007). Sucking pests in the early stage and the fruit borers, *Earias vittella* Fabricius, *Earias insulana* Boisdual and *Helicoverpa armigera* (Hübner) in the later stage causes extensive damage to fruits and results in 69 per cent yield loss (Atwal and Singh, 1990; Mani *et al.*, 2005).

Application of insecticides had been found to provide acceptable solution to tackle these problems (Pawar *et al.*, 1988; Verma, 1989; Priya and Misra, 2007). The chemicals are highly effective, rapid in action, adaptable to most situations and relatively economical. Despite these advantages, the use of chemical pesticides had been ecologically unsafe and harmful to natural enemies.

The use of persistent insecticides acquires special concern on vegetables and fruits with little time lags between treatment and consumption. The increasing concern for environmental safety and global demand for pesticide free food necessitated the search for eco friendly methods of pest management. The alternative to tackle these problems is to develop a biocontrol strategy involving potential natural enemies, which can be successfully incorporated into a sound Integrated Pest Management (IPM) programme. Among the various groups of biocontrol agents, braconid parasitoids are well known for the management of different lepidopteran larvae, including bhendi fruit borer complex. The braconid parasitoid, *Bracon brevicornis* Wesmael was found to be very effective against bhendi fruit borers. However, temperature and host insects play a major role in the developmental biology of the parasitoids which ultimately decides its efficacy. In this context, the present investigation was carried out to find out the effect of temperature on the biology of *B. brevicornis* on different host larvae.

MATERIALS AND METHODS

Culturing of hosts and parasitoids

Culture of *E. vittella* was initiated at Biocontrol Laboratory, Department of Agricultural Entomology, TNAU, Coimbatore. *E. vittella* larvae were collected from bhendi (variety - US Agriseed and Mahyco-10) field and reared on bhendi fruits in the laboratory by following the procedure of Roqaya (2000). *Helicoverpa armigiera* larvae were continuously reared on chick pea based semisynthetic diet. The method standardized by Shorey and Hale (1965) was adopted with modifications which included the addition of carbendazim for mould control. The larval parasitoid *B. brevicornis* was cultured on the larvae of rice moth, *C. cephalonica*. The nucleus culture of the parasitoid was obtained from the Central Plantation Crops and Research Institute (CPCRI), Kayankulam, Kerala. The parasitoids were cultured by Sandwich method following the procedure developed by Jhansi (1984).

Temperature on the biology of *B. brevicornis*

Effect of temperature on the biology of *B. brevicornis,* was studied on the hosts *viz.*, *E. vittella* and *H. armigera* in comparison with laboratory host, *C. cephalonica*. Growth and developmental studies were conducted in a Biotron incubator (NKS systems, Japan) at 20, 25, 30 and 35°C in comparison with room temperature. A pair of freshly emerged parasitoids was confined in a specimen tubes (10 x 2.5 cm) with two host larvae for parasitization. Seven replications were maintained for each treatment. Fourth instar larvae of *E. vittella, H. armigera* and fifth instars of *C. cephalonica* were utilized for the study. After 24 h of parasitization the larvae were kept in a specimen tubes. Observations on the biological parameters of the parasitoids *viz.*, number of eggs laid, egg period, larval period, cocoon formation, pupal period, adult emergence, sex ratio and total life cycle were recorded.

Statistical analysis

The data obtained from laboratory experiments were subjected to an analysis of variance and means were separated by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1994).

RESULTS

The results also revealed that the temperature regime of 25°C is highly suitable with a short life cycle of 8.22, 8.27 and 8.07 days respectively followed by room temperature (ranged between 22 to 32°C). Among the host larvae studied, *C. cephalonica* and *E. vittella* were found to be

Table 1. Effect of temperature on the biology and development of *B. brevicornis* on *E. vittella*, *H. armigera* and *C. cephalonica*

Temperatures	Host insects	Eggs(nos.)	Grubs(nos.)	Cocoons(nos.)	Adult emergence(nos.)	
					Male	Female
20°C	*E. vittella*	5.52(2.45)^{b}	4.52 (2.24)^{b}	4.52 (2.24)^{b}	2.79(1.81)^{b}	2.0(1.58)^{b}
	H. armigera	3.59 (2.02)^{c}	3.04(1.88)^{c}	2.82(1.82)^{c}	1.58 (1.44)^{c}	1.24(1.31)^{c}
	C. cephalonica	7.10(2.75)^{a}	6.25(2.59)^{a}	6.05(2.55)^{a}	3.81(2.07)^{a}	2.25(1.65)^{a}
25°C	*E. vittella*	8.80(3.05)^{b}	7.88(2.89)^{b}	6.68(2.68)^{b}	3.09(1.9)^{b}	3.58(2.02)^{b}
	H. armigera	4.33(2.2)^{c}	4.26(2.18)^{c}	4.16(2.16)^{c}	2.22(1.65)^{c}	1.91(1.55)^{c}
	C. cephalonica	13.42(3.73)^{a}	13.07(3.68)^{a}	13.02(3.68)^{a}	5.74(2.5)^{a}	7.26(2.79)^{a}
30°C	*E. vittella*	4.75(2.29)^{b}	4.35(2.2)^{b}	4.22(2.17)^{b}	2.05(1.6)^{b}	2.22(1.65)^{b}
	H. armigera	4.52(2.24)^{b}	3.83(2.08)^{b}	3.47(1.99)^{b}	1.45(1.39)^{b}	2.00(1.58)^{b}
	C. cephalonica	10.52(3.32)^{a}	9.75(3.2)^{a}	7.28(2.79)^{a}	2.85(1.83)^{a}	4.34(2.2)^{a}
35°C	*E. vittella*	4.78(2.3)^{b}	4.60(2.26)^{b}	4.35(2.2)^{b}	2.41(1.71)^{b}	1.94(1.56)^{b}
	H. armigera	3.74(2.06)^{bc}	2.60(1.76)^{c}	2.30(1.67)^{c}	1.29(1.34)^{c}	1.00(1.22)^{bc}
	C. cephalonica	8.80(3.05)^{a}	7.88(2.89)^{a}	6.68(2.68)^{a}	3.58(2.02)^{a}	3.09(1.9)^{a}
Room temperature*	*E. vittella*	5.84(2.51)^{b}	5.76(2.5)^{b}	5.70(2.49)^{b}	2.53(1.74)^{b}	3.17(1.91)^{b}
	H. armigera	4.96(2.34)^{b}	4.55(2.25)^{b}	4.40(2.21)^{b}	2.09(1.61)^{b}	2.28(1.67)^{b}
	C. cephalonica	12.00(3.53)^{a}	10.78(3.36)^{a}	10.36(3.30)^{a}	4.31(2.19)^{a}	6.06(2.56)^{a}

* Room temperature ranged from 22.6 to 32.86°C. $^{\$}$Mean of seven replications in each treatment, Figures in parenthesis are square root transformed values, In a column, means followed by similar letters are not significantly different ($p \leq 0.05$) by DMRT

Table 2. Effect of temperature on the developmental biology of *B. brevicornis* on *E. vittella*, *H. armigera* and *C. cephalonica*

Treatment*	Host insects	Egg period (hours)	Grub period (days)	Cocoon period(days)	Total life cycle(days)	Adult longevity(days)	
						Male	Female
20°C	*E. vittella*	38.46 ± 0.30	5.42 ± 0.81	7.34 ± 0.63	14.37 ± 1.44	13.46 ± 1.73	11.29 ± 1.79
	H. armigera	40.77 ± 1.71	6.36 ± 1.09	8.36 ± 0.92	15.13 ± 2.65	12.55 ± 1.73	10.78 ± 1.85
	C. cephalonica	37.55 ± 0.35	5.45 ± 0.85	7.33 ± 0.59	13.30 ± 3.11	13.23 ± 1.54	12.31 ± 1.73
25°C	*E. vittella*	24.33 ± 0.47	2.93 ± 1.73	4.28 ± 0.67	8.22 ± 2.40	19.84 ± 1.24	16.26 ± 0.81
	H. armigera	24.99 ± 0.46	2.96 ± 1.36	4.27 ±1.30	8.27 ± 2.78	19.40 ± 1.19	15.29 ± 0.73
	C. cephalonica	24.17 ± 0.57	2.80 ± 1.79	4.27 ± 0.78	8.07 ± 2.57	19.45 ± 1.24	16.74 ± 0.54
30°C	*E. vittella*	25.64 ± 0.38	3.33 ± 0.91	4.53 ± 0.73	8.92 ± 1.64	16.72 ± 1.36	14.48 ± 1.57
	H. armigera	28.04 ±1.17	3.76 ± 1.14	5.54 ±1.64	10.46 ± 1.72	16.93 ± 0.56	14.31 ± 1.47
	C. cephalonica	24.38 ± 0.42	3.34 ± 0.90	4.54 ± 0.65	8.89 ± 1.55	17.33 ± 0.56	15.50 ± 1.47
35°C	*E. vittella*	29.44 ± 0.68	2.25 ± 0.97	3.72 ± 0.54	7.19 ± 1.50	14.78 ± 1.54	12.41 ± 2.54
	H. armigera	30.52 ± 0.67	2.24 ± 0.97	3.69 ± 0.79	7.20 ± 1.75	14.94 ± 1.59	10.59 ± 1.07
	C. cephalonica	32.28 ± 1.13	2.93 ± 1.97	3.77 ± 1.30	7.03 ± 2.35	15.93 ± 1.59	12.84 ± 2.32
Roomtemperature$	*E. vittella*	31.75 ± 0.75	3.24 ± 0.82	4.67 ± 0.62	8.64 ± 1.45	20.29 ± 1.77	15.72 ± 1.82
	H. armigera	34.00 ± 0.72	3.25 ± 0.67	5.14 ± 0.47	9.71 ± 1.14	20.21 ± 1.72	17.57 ± 1.94
	C. cephalonica	29.67 ± 0.80	3.23 ± 1.77	4.96 ±1.71	8.59 ± 1.74	20.32 ± 1.72	18.40 ± 1.57

* Mean of seven replications in each treatment, $ Room temperature ranged from 22 to 32°C.

more suitable with maximum number of eggs (13.42 and 8.80 nos./larva), grubs (13.07 and 7.88 nos./larva), cocoons (13.02 and 6.68 nos./larva), adult males (5.74 and 3.09 nos./larva) and females (7.26 and 3.58 nos./larva) at 25°C, respectively. *H. armigera* was next in the order of preference recording less number of eggs (4.33 nos./larva), grubs (4.26 nos./larva), cocoons (4.16 nos./larva), and adults (2.22 males and 1.91 females/larvae). Room temperature was next in the order with more number of eggs, grubs, cocoons and adults (Table 1). The developmental period was also found to be less at 25°C, in *C. cephalonica* (8.07 days) and *E. vittella* (8.22 days) followed by *H. armigera* (8.27 days) with more female population. Though the life cycle is very short at 35°C, the progeny production is comparatively less with more males than females. At 20°C the life cycle is prolonged with minimum progenies yielding more males than females (Table 2).

DISCUSSION

Host insects play a major role in the developmental biology of the parasitoids. The studies on the biology indicated that the laboratory host, *C. cephalonica* and the natural host, *E. vittella* were more suitable for *B. brevicornis*. This is in consonance with the earlier report of Sharma and Sarup (1982) for *Bracon* spp. on its laboratory host, *C. cephalonica* and natural host, *Chilo partellus* (Swinhoe). Temerak (1983) reported that *B. brevicornis* preferred to parasitize and complete its life cycle on *Earias* spp., *H. armigera*, *P. gossypiella* than other host insects offered. Similarly, Mohanty *et al.* (1998) also reported that the biology of *B. brevicornis* was faster on *C. cephalonica* than other insects. However, progeny production and adult longevity was found to be more on *E.vittella* and *C. cephalonica* followed by *H. armigera*. This may be due to the nutritional value of the host insects (Temerak, 1981; 1983).

Temperature is a critical abiotic factor influencing the dynamics of insects and their natural enemies. Knowledge on adaptations of the natural enemies to climatic conditions plays an essential role in pest management. In biological control, details regarding the adaptations are useful to select natural enemies that are best adapted to conditions favouring target pests (Obrycki and Kcring, 1998). In the present investigation, life cycle of the parasitoid was prolonged at the lowest temperature of 20°C and was shortened at the highest temperature of 35°C with more of male progenies than females. Similar findings were reported against *Bracon kirkpatricki* (Wilkinson) on *Spodoptera exigua* (Hübner) by Engroff and Watson *et al.* (1975). They also reported that minimum fecundity was observed at 20°C and maximum at 25°C. This is in close agreement with our findings. Denlinger and Lee (1998) reported that exposure of either immatures or adults to low temperature interfere with the normal reproductive process, resulting in the production of more males. Hance *et al.* (2007) also reported that climate changes affect species distributions, life histories, community composition and ecosystem function. This corroborates with our present finding, where in the life cycle of *B. brevicornis* was greatly influenced by the change in temperature regimes.

The data obtained in the present investigations were generated under laboratory conditions in which plentiful food was available to the adults and that the parasite and its host were artificially brought together. Similar results under field conditions would be dependent on the presence of adequate nectar sources plus the ability of the parasite to locate a sufficient number of hosts, often under low host-density conditions. Hence, proper timing of release synchronizing with the availability of hosts would ensure successful control of the pests.

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