

Biology and biorational management of ginger shoot borer, *Conogethes punctiferalis* Guenee

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Abstract

An investigation conducted on the biology of ginger shoot borer, *Conogethes punctiferalis* Guenee during 2014 Kharif at College of Horticulture, Bidar, Karnataka revealed that mean pre oviposition, incubation, larval and pupal period were 1.40 ± 0.13 , 2.65 ± 0.16 , 11.34 ± 1.91 and 10.50 ± 0.84 d, respectively. The mean ovipositional period and fecundity was 2.75 ± 0.29 and 95.69 ± 10.22 d, respectively. whereas, viability of eggs ranged from 72.79 - 88.54 per cent with an average of 83.54 ± 5.08 per cent. Total developmental period of *C. punctiferalis* occupied 26.28 ± 0.55 d. Adult longevity ranged from 8.01 to 9.44 and 9.01 to 10.64 d in case of male and female with a mean of 8.60 ± 0.51 and 9.40 ± 1.96 d, respectively. The efficacy of different insecticides viz., Deltamethrin 2.8 EC, Karanja oil, Emamectin benzoate 5 WSG, Neemazal 10000 ppm, Azadirachtin 1500ppm, Garlic crude extracts (5%), Citronella oil was evaluated against *Conogethes punctiferalis*. Significant difference was recorded in all the treatments as compared to the control. The Emamectin benzoate 5 WSG and Deltamethrin 2.8 EC recorded lower cumulative shoot damage and higher yield. Among the botanicals Karanja oil registered significantly lower shoot damage and higher yield.

Key Words: Biology, *Conogethes punctiferalis*, ginger, management.

Introduction

Ginger (*Zingiber officinale* Rosc.) is an important spice and medicinal crop grown world over. India is the leading producer of ginger with an area of 1.58 lakh hectares and production of 7.45 lakh tones (Jayshree *et al.*, 2015). Ginger cultivation in India is beset with spectrum of problems among which insect pests are the major ones. More than 30 species of insects have been reported to infest the crop in India including under storage, among which, shoot borer (*Conogethes punctiferalis* Guenee.) is most serious production constraint (Devasahayam and Koya, 2004). Female moth oviposits round and light yellow coloured eggs on tender unopened leaf, the neonate after emerging from the egg scrapes the chlorophyll content of leaf. Larvae in the later stages bore in to the shoot and feed on the inner core resulting in the 'dead heart' symptoms. The larva usually matures before it reaches the rhizome and leaves the stem to pupate. Occasionally it arrives at rhizome and damages it (Chong *et al.*, 1991). There will be significant reduction in the yield when more than 45% of the shoots in clump are

damaged by pest (Koya *et al.*, 1986). The shoot borer can be managed by spraying Malathion (0.1%) at 21 days intervals during to July to October. The spraying is to be initiated when the first symptom of pest attack is seen on the margins on the pseudostem (Jayshree *et al.*, 2015). However, an intensive spray of chemicals can lead to the residues in the produce and become cause for health concern. Further, there is acute shortage of information regarding biology and management of shoot borer.

Hence, an investigation was undertaken to generate the data and document results regarding the biology and management of the pest.

Materials Methods

Biology of Shoot borer, Conogethes punctiferalis

To study the biology of *C. punctiferalis* at College of Horticulture, Bidar during 2014 field collected larvae were used for initiating the insect culture. The larvae were reared on fresh leaves in plastic container (90 cm × 30 cm × 45 cm). Fresh leaves were provided every alternate day. After

pupation, pupae were transferred to specimen tubes for adult emergence used for further studies. Ten pairs (10 male and 10 female) of freshly emerged adults were released into the insect rearing cage (35 × 45 × 20 cm) for mating and oviposition. The cage was provided with leaves held in a beaker containing water. Cotton wads soaked in 10 % honey solution served as food for the adults. The leaves containing the freshly laid eggs were transferred to petri dishes for hatching. The emerged larvae were provided with fresh leaves. Rearing was continued till adult emergence.

Detailed biology was studied in laboratory on fresh ginger leaves. Observations on the incubation period, number of moults, duration of each instar, size, pupal period and total developmental period were recorded. Freshly hatched larvae were transferred with camel hair brush to ginger leaves in a plastic box. At each rearing 20 larvae were individually observed, fresh leaves were provided every alternate day. Daily observations were made at six h interval. As *C. punctiferalis* larva is an internal borer, it is difficult to find cast head capsule. So Dyar's law was used to find out the moulting. Number of larval instars was recorded. The grown up larvae were allowed to pupate in the specimen tube (102 mm×25 mm). The total larval and pupal duration were also recorded.

For recording longevity and fecundity, ten pairs of moths emerged on the same day were enclosed in ginger leaves in wire mesh cage (0.3 m³). Observations on the mating behavior, oviposition, fecundity and adult longevity were made on moths maintained separately for studies and the observations were continued for five generations. Fresh leaves were provided daily. The eggs laid on leaves were counted and recorded daily until death of the female moth.

Management of Shoot borer, Conogethes punctiferalis

An experiment was conducted during *Kharif* 2014 and 2015 at College of Horticulture, Bidar, Karnataka in Randomized Block Design with a plot size of 3m X 1m. Humnabad Local ginger cultivar was sown at a spacing of 20cm X 30cm (rhizome to rhizome X row to row) and the crop was raised by following recommended package practices for the region (Anonymous, 2013) except spray of insecticides against insect pests. Seven insecticides *viz.*, Deltamethrin 2.8 EC, Emamectin benzoate 5 WSG, Karanja oil, Neemazal 10000ppm, Azadirachtin 1500ppm, Garlic crude extract (5%) and Citronella oil with different modes of action were evaluated along with the untreated control against shoot borer. The

spraying was initiated when the first symptom of pest attack was seen on the top most leaf in the form of feeding marks on the margins. Observations on shoot damage were recorded a day before and 5 days after spray in each treatment and were worked out to percentage. Total 5 sprays were taken up at 20 days interval during July to October. The experiment was replicated three times. The data was subjected to statistical analysis (ANOVA) to determine the significance of treatments. The means were compared by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984) at P=0.05.

At harvest, the rhizome yield in each plot was recorded and computed to hectare basis, the percent increase over control was computed as follows.

Yield increase over control (%)

$$= \frac{\text{Yield in treatment} - \text{yield in control}}{\text{Yield in control}} \times 100$$

Results and Discussion

Biology of Shoot borer, Conogethes punctiferalis

The freshly laid eggs were pale yellow and oval in outline and firmly glued to the surface. The eggs were deposited singly on leaves and cotton wads provided for oviposition. The egg length varied from 0.58 – 0.66 mm with an average of 0.62 ± 0.01 mm and width varied from 0.44-0.50 mm with a mean of 0.45 ± 0.01 mm (Table 1).

The egg turned dark yellow on second day, pink eye spots appeared at the anterior end of the egg. Later, an additional brown spot appeared between them indicating the developing mandibles prior to hatching, the dark brown coloured head and prothoracic shield of young curled up larva were visible through the transparent egg shell. The incubation period in laboratory varied from 2.34 to 3.01 days with an average of 2.65 ± 0.16 days (Table 2). These results are in line with Bilapate and Talati (1978), who recorded the egg size as 0.59 mm and 0.39 mm in length and width, respectively. The incubation period varied from 2.65 ± 0.16 d in close agreement with the observations made by Patel and Gangrade (1971) and Stanley *et al.* (2009).

According to Dyar's law, numbers of larval instars were fixed at five. The head width increased in a regular geometrical progression in successive instars by 1.4 times i.e., first instar 0.14 mm to fifth instar 0.65 mm (Table 4). During its larval period, the caterpillar moulted four times and thus there were five

Table 1: Morphometrics of life stages of Ginger shoot borer (n=20)

Insect stages	Length (mm)		Width (mm)	
	Range	Mean \pm SD	Range	Mean \pm SD
Egg	0.58-0.66	0.62 \pm 0.01	0.44-0.50	0.45 \pm 0.01
I instar	1.39-1.55	1.47 \pm 0.07	0.14-0.19	0.16 \pm 0.01
II instar	3.09-3.65	3.37 \pm 0.14	0.34-0.39	0.36 \pm 0.01
III instar	5.29-5.84	5.54 \pm 0.23	0.83-0.89	0.85 \pm 0.02
IV instar	11.00-11.81	11.44 \pm 0.25	1.49-1.69	1.58 \pm 0.06
V instar	15.19-16.09	15.48 \pm 0.30	2.34-2.59	2.45 \pm 0.09
Pre Pupa	13.19-13.79	13.41 \pm 0.23	2.44-2.74	2.58 \pm 0.10
Pupa	11.09-12.01	11.46 \pm 0.29	2.59-2.84	2.71 \pm 0.07
Adult				
male	9.49-13.49	11.90 \pm 1.21	19.09-24.49	21.96 \pm 1.80
Adult				
female	8.49-13.19	11.01 \pm 1.51	19.34-23.69	21.05 \pm 1.45

larval instars. The period occupied by each instar was recorded along with their size (Table 1) and period (Table 2).

Table 2: Duration of Life stages of Ginger shoot borer (n=20)

Insect stages	Duration (days)	
	Range	Mean \pm SD
Incubation period	2.34-3.01	2.65 \pm 0.16
I instar	1.74-2.51	2.34 \pm 0.86
II instar	2.24-3.01	2.29 \pm 0.64
III instar	1.26-3.31	2.09 \pm 0.84
IV instar	2.49-2.76	2.29 \pm 0.91
V instar	2.00-3.26	2.59 \pm 0.58
Total larval period	11.24-12.51	11.34 \pm 1.91
Pre pupal period	2.24-2.89	2.44 \pm 0.20
Pupal period	9.49-12.01	10.50 \pm 0.84
Total developmental period	25.59-27.26	26.28 \pm 0.55

The newly hatched larvae actively moved on the surface of leaves for 10-12 minutes to find suitable feeding site. The first instar larva was minute, light brown in colour, except for the head and prothorax. The sclerites of the body were dark brown in colour. The larvae were broad at the end and tapered towards the caudal end. Black spots were seen all over the body but they were less visible.

The first instar larval length ranged from 1.39-1.55 mm with an average of 1.47 \pm 0.07 mm and width ranged from 0.14 - 0.19 mm with an average of 0.16 \pm 0.01 mm (Table 1). As the caterpillar completed its

first moult, it grew in size and the abdomen became more or less cylindrical in shape. The first instar larval duration ranged from 1.74-2.51 days with an average of 2.34 \pm 0.86 days (Table 2).

The second instar larvae were light brown with eye spots and dark mandibles. Within 2-3 h after moult, the colour of the head and prothorax changed to dark brown and body became light brown with brown sclerites. The larval length ranged from 3.09-3.65 mm with an average of 3.37 \pm 0.14 mm and width ranged from 0.34-0.39 mm with an average of 0.36 \pm 0.01 mm (Table 6). The second instar larval duration ranged from 2.24-3.01 d with an average of 2.29 \pm 0.64 d (Table 2).

The later three instars of the ginger shoot borer were similar to earlier instars in colour and morphological characters except the size. The larvae of these three instars were light brown with dark brown head, prothoracic shield and sclerites. The spots on the body were deep dark and distinctly visible. The larvae hang on with a fine silken thread when disturbed.

The larval length of third instar ranged from 5.29-5.84 mm with an average of 5.54 \pm 0.23 mm and width ranged from 0.83-0.89 mm with an average of 0.85 \pm 0.02 mm (Table 1). The third instar larval duration ranged from 1.26-3.31 d with an average of 2.09 \pm 0.84 days (Table 2). The larval length of fourth instar ranged from 11.0-11.81 mm with an average of 11.44 \pm 0.25 mm and width ranged from 1.49-1.69 mm with an average of 1.58 \pm 0.06 mm (Table 1). The fourth instar larval duration ranged from 2.49-2.76 d with an average of 2.29 \pm 0.91 d (Table 2).

The larval length of fifth instar ranged from 15.19-16.09 mm with an average of 15.48 \pm 0.30 mm and width ranged from 2.34-2.59 mm with an average of 2.45 \pm 0.09 mm (Table 1). The fifth instar larval duration ranged from 2.00-3.26 days with an average of 2.59 \pm 0.58 d (Table 2).

In the laboratory total larval period ranged from 11.24-12.51 d with an average of 11.34 \pm 1.91 d (Table 2). The total larval period was reported to be 12.73 d when it reared on castor (Bilapate and Talati, 1978), 25-40 d on cardamom in Karnataka (Krishnamurthy *et al.*, 1989), 17 d as reported by Gour and Sriramulu (1992) which were similar to the observations in present investigation, however, the slight variation in relation to other authors may reveal the effect of host plant and locality of the insect. Kadoi and Kaneda (1990) reported that fully grown larva occupied 32 d on apples and 16 d on fresh maize. The colour of the

pre-pupa was light greenish with distinct dark brown spots over the body. The Pre-pupal length (Table 1) varied from 13.19-13.79 mm with an average of 13.41 ± 0.23 mm and width ranged from 2.44-2.74 mm with an average of 2.58 ± 0.10 mm, pre-pupal period lasted for 2.24 to 2.89 d with an average of 2.44 ± 0.20 d (Table 2). The freshly formed pupa was greenish with brown compound eyes. Later the pupa turned light brown with dark brown compound eyes. Before emergence pupa turned to dark brown and had seven pairs of spiracles. The first pair was located on mesothorax antero-laterally and remaining six pairs on third to eighth abdominal segments on lateral sides.

Pupal length varied from 11.09- 12.01 mm with an average of 11.46 ± 0.29 mm and width varied from 2.59-2.84 mm with an average of 2.71 ± 0.07 mm (Table 1). Pupal period lasted for 9.49-12.01 d with an average of 10.50 ± 0.84 d (Table 2). Total developmental period varied from 25.59-27.26 d with an average of 26.28 ± 0.55 (Table 2) d. This result is comparable with Bilapate and Talati (1978), who reported the pupal duration of 7-9 days. Gour and Sriramulu (1992) reported pupal period of 8 d, while Kang *et al.* (2004) reported pupal period of 9 to 11 d.

Premating period ranged from 2.39- 2.94 days with an average of 2.66 ± 0.18 d and pre oviposition period ranged from 1.21-1.64 d with an average of 1.40 ± 0.13 d. Oviposition period ranged from 2.29-3.19 days with an average of 2.75 ± 0.29 d.

Fecundity ranged from 80-111 eggs/female with a mean of 95.69 ± 10.22 eggs. Viability ranged from 72.79-88.54 % with an average of 83.54 ± 5.08 % (Table 3). Total developmental period of *C. punctiferalis* occupied 26.28 ± 0.55 d. However, it was lower (15-21 d) than that observed by Sloan (1945) on cardamom and on maize (15 d) as recorded by Krishnamurthy *et al.* (1989). The variations observed may be due to the change in host and weather factors. The developmental period in the present study is more or less in conformity with the reports of Krishnamurthy *et al.* (1989).

The adult moths are medium sized brownish yellow with a number of dark spots on wings. Female moths were bigger in size, having bulged abdomen with tuft of hairs. Length of the adult male ranged from 9.49-13.49 mm with an average length of 11.90 ± 1.21 mm and width ranged from 19.09-24.49 mm with an average of 21.96 ± 1.80 mm. Length of the adult female ranged from 8.49-13.19 with an average of 11.01 ± 1.51 and width ranged from 19.34-23.69 mm with an

Table 3: Adult longevity and fecundity of Ginger shoot borer

Insect stages	Period	
	Range	Mean \pm SD
Pre mating period (days)	2.39-2.94	2.66 ± 0.18
Pre oviposition period (days)	1.21-1.64	1.40 ± 0.13
Oviposition period (days)	2.29-3.19	2.75 ± 0.29
Fecundity (no. of eggs/female)	80.00-111.00	95.69 ± 10.22
Viability of eggs (%)	72.79-88.54	83.54 ± 5.08
Male adult longevity (days)	8.01-9.44	8.60 ± 0.51
Female adult longevity (days)	9.01-10.64	9.40 ± 1.96

average of 21.05 ± 1.45 mm (Table 1).

Male adult longevity ranged from 8.01-9.44 d with an average of 8.60 ± 0.51 d. Female adult longevity ranged from 9.01- 10.64 d with an average of 9.40 ± 1.96 days (Table 3). Bilapate and Talati (1978) reported longevity of female and male moths to be 15.80 ± 2.50 d and 14.00 ± 3.80 d, respectively. This variation may be due to change in weather conditions. During the present study fecundity of a female moth ranged from 80 to 111 with an average of 95.69 ± 10.22 eggs.

Table 4: Head capsule width of ginger shoot borer larvae (n=20)

Instar	Head capsule width (mm)		Ratio
	Range	Mean \pm SD	
I instar	0.08 - 0.21	0.14 ± 0.02	-
II instar	0.15 - 0.31	0.21 ± 0.04	1.45
III instar	0.23 - 0.44	0.31 ± 0.06	1.39
IV instar	0.31 - 0.67	0.45 ± 0.09	1.42
V instar	0.44 - 0.96	0.65 ± 0.14	1.41

Management of Shoot borer, *Conogethes punctiferalis*

Among the different chemicals tested Emamectin benzoate 5 WSG was significantly superior by recording 10.28, 10.44, 10.91, 10.96 and 11.07 per cent cumulative shoot damage (Table-5) after successive sprays, further, it also registered highest rhizome yield 196.70 q/ha (Table-5) during *Kharif* 2014. The Deltamethrin 2.8 EC was next best chemical with 10.70, 10.89, 11.13, 11.34 and 11.35 per cent cumulative shoot damage (Table -5) with yield of 186.33q/ha (Table-5). Untreated control registered highest shoot damage (13.68, 13.86, 13.94, 14.06 and 14.51 per cent) and lowest rhizome yield 142 q/ha

Table 5: Effect of different insecticides on shoot borer in Humnabad Local variety during *Kharif*, 2014

Treatments	Shoot damage (%)		Cumulative shoot damage (%)				Rhizome	
	A day before spray	After I Spray	After II Spray	After III Spray	After IV Spray	After V Spray	Yield (q/ha)	% increase over control
T1- Deltamethrin 2.8 EC	9.80(18.24)	10.70 ^e (19.09)	10.89 ^f (19.28)	11.13 ^g (19.46)	11.34 ^g (19.64)	11.35 ^g (19.73)	186.33 ^b	31.22
T2- Emamectin benzoate 5 WSG	9.92(18.34)	10.28 ^d (18.72)	10.44 ^d (18.81)	10.91 ^d (19.28)	10.96 ^d (19.37)	11.07 ^e (19.46)	196.70 ^a	38.52
T3- Karanja oil** @5 ml/litre	9.87(18.34)	11.29 ^g (19.64)	11.63 ^g (19.91)	11.81 ^g (20.09)	11.95 ^g (20.27)	12.03 ^g (20.27)	183.00 ^c	28.87
T4- Neemazal** 10000 ppm @ 3 ml/litre	9.93(18.34)	12.00 ^g (20.27)	12.15 ^g (20.44)	12.68 ^h (20.88)	12.81 ^g (20.96)	12.83 ^g (20.96)	166.68 ^c	17.38
T5- Azadirachtin** 1500ppm	10.04(18.44)	12.27 ^{bc} (20.53)	12.60 ^{cd} (20.79)	12.73 ^b (20.88)	12.87 ^{bc} (21.05)	13.00 ^{bc} (21.13)	161.74 ^f	13.90
T6- Garlic crude extracts (5%)	9.87(18.24)	12.60 ^b (20.79)	12.88 ^c (21.05)	13.04 ^b (21.13)	13.41 ^b (21.47)	13.44 ^b (21.47)	159.66 ^g	12.44
T7- Citronella oil** @5 ml/litre	10.03(18.44)	11.77 ^c (20.09)	11.85 ^{de} (20.18)	12.12 ^c (20.36)	12.25 ^{cd} (20.53)	12.47 ^{cd} (20.70)	174.71 ^d	23.04
T8- Untreated Control	9.80(18.24)	13.68 ^a (21.72)	13.86 ^a (21.89)	13.94 ^a (21.89)	14.06 ^a (22.06)	14.51 ^a (22.38)	142.00 ⁱ	-

Note: Figures in parentheses are arc sine transformed values used for statistical analysis

**Formulated product

Table 6: Effect of different insecticides on shoot borer and in Humnabad Local variety during *Kharif*, 2015

Treatments	Shoot damage (%)		Cumulative shoot damage (%)				Rhizome	
	A day before spray	After I Spray	After II Spray	After III Spray	After IV Spray	After V Spray	Yield (q/ha)	% increase over control
T1- Deltamethrin 2.8 EC	8.77(17.26)	9.73 ^g (18.15)	9.85 ^f (18.34)	10.47 ^h (18.91)	10.92 ^g (19.28)	11.35 ^f (19.73)	181.00 ^b	31.40
T2- Emamectin benzoate 5 WSG	9.23(17.66)	9.48 ^h (17.95)	9.67 ^g (18.15)	10.26 ^f (18.72)	10.86 ^g (19.28)	11.23 ^g (19.55)	191.40 ^a	38.95
T3- Karanja oil** @5 ml/litre	8.90(17.36)	10.32 ^f (18.72)	10.85 ^e (19.28)	11.23 ^g (19.55)	11.55 ^f (19.91)	12.20 ^e (20.44)	179.70 ^b	30.45
T4- Neemazal** 10000 ppm @ 3 ml/litre	8.98(17.46)	10.95 ^d (19.37)	11.22 ^g (19.55)	11.75 ^g (20.09)	12.39 ^g (20.62)	12.51 ^g (20.70)	162.65 ^d	18.08
T5- Azadirachtin** 1500ppm	9.61(17.66)	11.69 ^c (20.00)	11.98 ^c (20.27)	12.60 ^d (20.79)	13.07 ^c (21.22)	13.30 ^c (21.39)	157.39 ^e	14.26
T6- Garlic crude extracts (5%)	8.83(17.26)	11.98 ^b (20.27)	12.27 ^b (20.53)	12.91 ^c (21.05)	13.59 ^b (21.64)	13.63 ^b (21.64)	155.52 ^e	12.90
T7- Citronella oil** @5 ml/litre	9.10(17.56)	10.53 ^c (18.91)	11.15 ^d (19.55)	11.50 ^d (19.82)	11.95 ^c (20.27)	12.20 ^c (20.44)	169.60 ^c	23.12
T8- Untreated Control	8.80(17.26)	12.40 ^a (20.62)	12.66 ^a (20.88)	13.48 ^a (21.56)	13.88 ^a (21.89)	14.08 ^a (22.06)	137.75 ^g	-

Note: Figures in parentheses are arc sine transformed values used for statistical analysis.

**Formulated product

(Table-5). Among the botanicals Karanja oil was significantly superior by registering 11.29, 11.63, 11.81, 11.95 and 12.03 percent cumulative shoot damage and higher yield of 183.00q/ha (Table-5). Similar trend was observed during *khariif* 2015.

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