Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2017; 5(5): 722-727

Received: 03-07-2017
Accepted: 04-08-2017

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Bionomics of the rice meal moth, *Corcyra cephalonica* (Stainton) reared under laboratory condition on different diets

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Abstract
The rice meal moth, *Corcyra cephalonica* Stainton is one of the serious insect pests of stored milled rice and other milled cereal products in India. But another economic importance of this insect is that the eggs of these insects are used as diet to mass multiply the bio-agent like *Trichogramma* spp. We studied the biology and bionomics of this pest under controlled laboratory conditions. An experiment was conducted during July 2015 to October 2015 in the Biological Control laboratory, Department of Entomology, IGKV, Raipur at 27 ^{0}C + 20 ^{0}C (and 75+5% RH to study the different diet performance on the biology and bionomics of rice moth, *C. cephalonica*. Five cereals *viz*., rice, wheat, pearlmillet (jowar), sorghum (bajra) and maize were tested solely along with their combinations. The female moth had longer body length and weight as compared to male moth. Both male and female reared on mixed diet with a combination of (rice+jowar+maize) had maximum body weight and body length. There was a high positive co-relation between fecundity and female body weight. The mixed diet of rice +jowar +maize was highly superior, in comparison to others for mass production of *C. cephalonica.* The shortest life cycle was found in the combinations of bajra + jowar + maize up to 35 and 40 days respectively and longest life cycle was found in rice extending of 60 to 70 days.

Keywords: Rice meal moth, *Corcyra cephalonica*, artificial diets

Introduction
The rice moth *Corcyra cephalonica* Stainton is an important insect-pest of different stored products in tropics. It is the major pest of rice, wheat, sorghum, corn (maize), cocoa, peanuts, almonds, dates, groundnut, cotton seeds, coffee, spices and cocoa beans, cashews, raisins and millet (Cox *et al*., 1981; Trematerra, 1983; Allotey and Kumar, 1985; Mbata, 1989; Allotey, 1991a; Johnson *et al*., 1992; Locatelli and Limnota, 1998; Harita *et al*., 2000) [8, 6, 7, 4]. It is one of the most factitious hosts for *Trichogramma* production in several countries of the world (Parra, 1997) [12]. Besides, some entomopahothegic nematodes such as *Steinernema feltiae* are also reared on the larvae of *Corcyra cephalonica* (Kumar and Murthy, 2000) [9]. In India, it is being utilized in various bio-control research developmental and extension units for mass production of number of natural enemies (Jalali and Singh, 1992) [11]. The rearing host diet is potentially of importance to the nutritional quality of host eggs and the survival of *Trichogramma* and other egg parasitoids released into the environment as biological control agent (Hunter, 2003) [10].
Therefore, an attempt has been made to study the variation in biological parameters of *Corcyra cephalonica* in different food grains locally available and their different combinations were prepared to evaluate the quality of rearing media.

Materials and methods
For the experimental purpose the cereals were procured from the market. The insects were reared in plastic basins with mouth covered by muslin cloth and tightly secured jute rope under laboratory condition in the Biocontrol Laboratory, Department of Entomology, IGKV, Raipur (C.G.).
Thirteen treatments of host diets were prepared under three replications each as mentioned in the table given below.

Table 1

S. n.	Treatments	Replication1	Replication2	Replication3
1	RICE (T1)	R1	R2	R3
2	WHEAT(T2)	R1	R2	R3
3	BAJRA(T3)	R1	R2	R3
4	JOWAR(T4)	R1	R2	R3
5	MAIZE(T5)	R1	R2	R3
6	RICE+WHEAT+BAJRA(T6)	R1	R2	R3
7	RICE+WHEAT+JOWAR(T7)	R1	R2	R3
8	RICE WHEAT+MAIZE (T8)	R1	R2	R3
9	RICE+BAJRA+JOWAR(T9)	R1	R2	R3
10	RICE+BAJRA+MAIZE(T10)	R1	R2	R3
11	RICE+JOWAR+MAIZE(T11)	R1	R2	R3
12	WHEAT+BAJRA+MAIZE(T12)	R1	R2	R3
13	BAJRA+JOWAR+MAIZE(T13)	R1	R2	R3

600 grams of grains will be kept in each plastic basin of size diameter (30cm) height (20cm). The grains will be sterilized in hot air over for one hour at 100^0C. After cooling the grains will be powdered coarsely. 5ml of 10% honey solution along with 5gm of yeast and a pinch of Streptomycin will be mixed in each container. Finally the containers will be charged with 0.25cc (about 4500 eggs) of *Corcyra cephalonica.*

Every container will be covered with fine muslin cloth and secured tightly with help of plastic cord. Observations will be recorded after two days onwards to note the hatching of the eggs.

A small representative sample from each treatment will be kept separately in a small petridish to observe and to record the size of the new neonate larvae and the instar wise confirmation will be done by looking at the head capsule. The length and weight of larvae will be recorded per treatment.

For studying the difference in fecundity a pair of newly emerged male and female from each treatment will be kept in separate beakers in three replications. A cotton swab soaked in 10% honey solution will be provided for moths struck to the walls of beaker. Daily record of the number of eggs laid by females will be noted. The total number of eggs laid by a female reared on different diet per treatment will be computed**.**

Fig 1-2: Isolated larvae for biometrical studies

Fig 2-3: Adults of *C. cephalonica*

Fig 4: Eggs of *C. cephalonica*

Fig 5: Fecundity testing

Result and discussion

The experiment was conducted with five different cereals as solo diets along with their combinations comprising thirteen treatments. The cereals used were rice (*Oryza sativa*), wheat (*Triticum astivum*), bajra (*Pennisetum glaucum*), jowar (*Sorghum bicolor*), and maize (*Zea maize*).

1. Effects on the larval weight and larval length of *C. cephalonica* reared on different diets

The weight of *C.cephalonica* larvae was measured at different instars by an electronic balance. An average of ten larvae was taken for each observation. The maximum larval weight recorded at each instar varied significantly except in 1st instar larvae. In the second, third, fourth, and fifth in stars, significant maximum mean larval weights were recorded in the treatment T11 comprising of (rice+jowar+maize) with 5.17mg, 46.00 mg, 68.33mg, and 86.00 mg respectively, while significantly average minimum larval weight was recorded in the treatment T1 of solo rice in all the instars.Ingle *et al.* [7] reported maximum weight of C. cephalonica larvae reared in bajra + groundnut (61.1 mg), bajra + mustard (58.9 mg) and bajra + cotton (57.1 mg). Medium larval weight was recorded in sorghum + groundnut (55.7 mg), sorghum + mustard (53.7 mg) and sorghum + cotton (51.7 mg) and they also recorded lowest larval weight in maize + groundnut (49.7 mg), maize + mustard (48.9 mg) and maize + cotton (46.2 mg). Begum and Quamar reported that larval weight was highest (60.4 mg) in diet D5 (sorghum+millet+maize+groundnut+vitaminE) and moderate larval weight were recorded in diet D2 (sorghum+millet+maize+groundnut) and D3 (sorghum+millet+maize+groundnut+vitaminB) i.e. 58.8 and 51.2 mg respectively. In diet D1 (sorghum+millet+maize) lowest larval weight was recorded (44.4 mg).

Table 2: Effects on the larval weight of *C. cephalonica* reared on different diets

Treatments	1st instar	2nd instar	3rd instar	4th instat	5th instar
T1	0.10	1.23	17.67	23.00	34.00
T2	0.12	5.00	29.33	39.00	44.00
T3	0.13	2.97	20.67	40.33	50.33
T4	0.16	1.37	25.67	35.67	46.67
T5	0.14	4.30	43.67	54.33	80.67
T6	0.12	2.00	31.33	38.67	47.33
T7	0.14	2.00	36.00	40.67	50.00
T8	0.11	3.33	37.00	50.67	48.33
T9	0.12	1.90	26.33	57.67	62.33
T10	0.13	3.37	18.33	44.67	68.33
T11	0.14	5.17	46.00	68.33	86.00
T12	0.12	4.03	26.00	62.00	81.67
T13	0.13	2.17	25.67	64.67	47.00
SEM	0.01	0.26	2.06	3.99	2.71
CV	15.37	14.82	12.11	14.52	18.16
CD	0.03	0.74	6.00	11.61	7.87

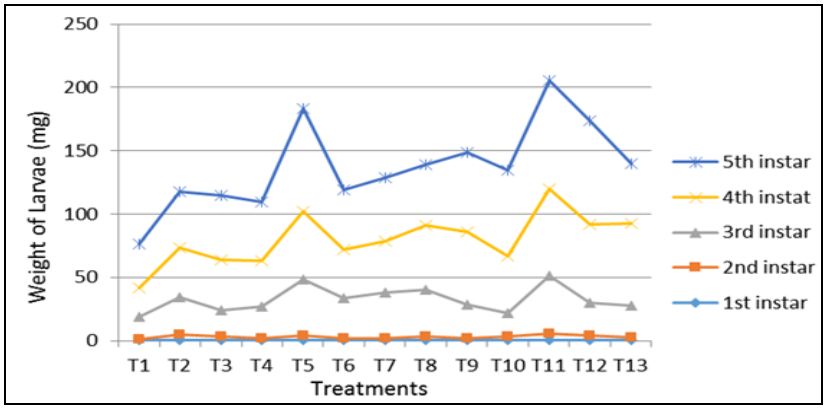

Fig: Effects on the larval weight of *C. cephalonica* reared on different diets

As far as the average larval length at each instar was concerned it varied significantly except in first instar. In the second, third, fourth, and fifth in stars, significant maximum mean larval length were recorded in the treatment T11 comprising of (rice+jowar+maize) with 7.00mm, 9.33mm, 16.67 mm, and 20.33 mm respectively, while significantly average minimum larval length was recorded in the treatment T1 of solo rice in all the instars.

Table 3: Effects on larval length (mm) of *C. cephalonica* reared on different diets

Treatments	1st instar	2ndinstar	3rd instar	4th instar	5th instat
T1	1.93	3.33	6.33	9.67	13.00
T2	1.93	4.67	7.33	11.00	16.67
T3	2.17	5.67	7.00	12.67	16.00
T4	1.83	5.00	7.67	13.33	17.67
T5	2.00	6.33	8.33	15.67	19.33
T6	2.00	3.67	6.67	11.67	19.00
T7	1.33	4.33	8.33	11.00	18.33
T8	2.17	4.00	6.67	11.33	17.33
T9	2.67	5.67	7.00	13.67	16.33
T10	1.67	3.67	6.33	12.00	18.00
T11	2.00	7.00	9.33	16.67	20.33
T12	2.50	4.33	6.00	13.67	19.00
T13	2.00	5.33	7.33	14.33	19.33
SEM	0.32	0.40	0.49	0.77	0.67
CV	27.00	14.40	11.68	10.45	6.58
CD	0.93	1.17	1.42	2.25	1.96

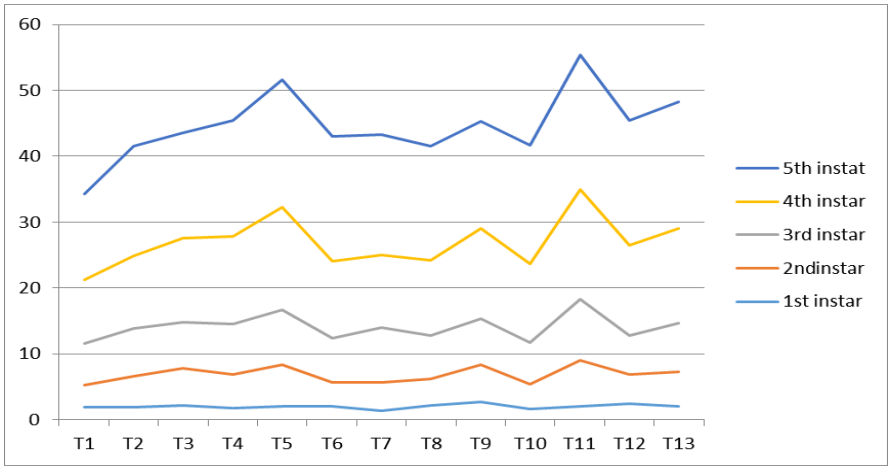

Fig: Effects on the larval length of *C. cephalonica* reared on different diets

2. Effects on the adult weight of *C. cephalonica* reared on different diets.

In the criteria of weight of adults, highest average weight was observed in the treatment T11 (rice+jowar+maize) in both male and female of 27.33mg and 37.00mg respectively and lowest adult weight of male and female was recorded in T1 in solo rice of 15.00mg and 24.33mg respectively.. Similar results also found by Bernardi *et al*., who reported 17.3 mg and 32.3 mg for males and females of C. cephalonica respectively

Table 4: Effects on the adult weight (gm) of *C. cephalonica* reared on different diets.

Treatments	Male	Female
T1	15.00(3.94)	24.33(4.98)
T2	17.33(4.22)	31.33(5.64)
T3	21.00(4.64)	28.67(5.40)
T4	21.33(4.66)	29.67 (5.48)
T5	24.67(5.01)	36.33 (6.07)
T6	17.33(4.22)	27.33(5.27)
T7	18.33(4.34)	29.00(5.43)
T8	22.00(4.74)	30.00(5.52)
T9	21.33(4.67)	30.67(5.57)
T10	22.33(4.78)	27.33(5.27)
T11	27.33(5.28)	37.00(6.12)
T12	23.00(4.84)	33.67(5.84)
T13	21.67(4.70)	32.67(5.76)
SEM	0.11	0.14
CV	4.31	0.40
CD	0.33	4.32

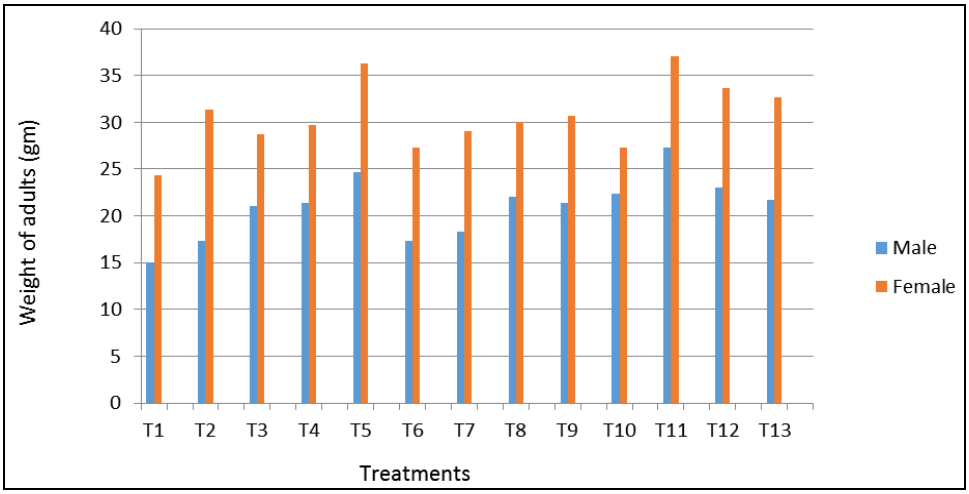

Fig: Effects on the adult weight of *C. cephalonica* reared on different diets.

3. Effects on the fecundity of *C. cephalonica* reared on different diets.

The highest number of eggs laid per female was recorded in T11 (rice+jowar+maize) (348.000 eggs /female) and least number of eggs in T1 (rice) (101.67 eggs /female).Kumar recorded the fecundity of 364.4, 160.2, 111.2, 438.2, 438, 384.4 and 329.6 eggs per female in case of *C. cephalonica* reared on gram, sorghum, wheat, mustard, cotton, sesamum and groundnut, respectively indicating higher egg laying in protein rich media than in cereals alone. Haritha *et al*., [5] recorded average fecundity of 211 eggs per female in case of groundnut.

Table 4: Effects on the fecundity of *C. cephalonica* reared on different diets.

	Number of eggs/female
T1	101.67(9.91)
T2	167.33(12.94)
T3	126.00(11.19)
T4	137.00(11.70)
T5	309.33(17.60)
T6	258.33(16.08)
T7	128.67(11.36)
T8	143.67(11.99)
T9	166.67(12.91)
T10	121.33(11.04)
T11	348.00(18.66)
T12	300.67(17.33)
T13	209.00(14.47)
SEM	0.57
CV	7.35
CD	1.68

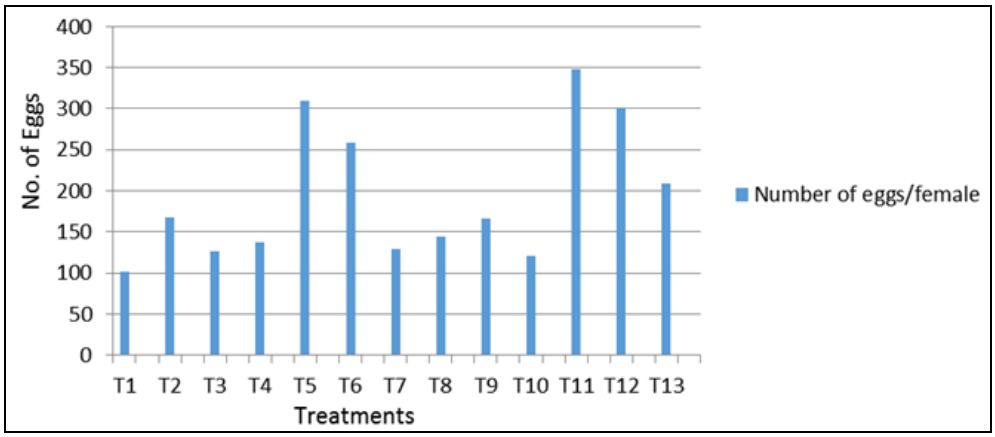

Fig: Effects on the fecundity of *C. cephalonica* reared on different diets.

Conclusion

Thirteen different diets were checked for best rearing diets for *C. cephalonica* and found that heaviest and longest larvae and adults were found in diet containing rice, jowar, maize in equal proportion and lightest and shortest larvae and adults were found in rice.

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