



## Research Article

## Influence of seasons and inoculum dosages on the production efficiency of *Corcyra cephalonica* Stainton

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**ABSTRACT:** *Corcyra cephalonica* is a laboratory host used for multiplication of parasitoids, predators and entomopathogens. The present study is aimed to understand the effect of seasons and inoculum dosages of *Corcyra* eggs on the production efficiency. Egg production ranged from 3.1 to 5.8 cc per box during the different seasons and minimum production being recorded during dry months. The dosages tested were 0.5, 0.25 and 0.125 cc of *Corcyra* eggs / rearing box. Maximum per cent moth emergence (83.5%), shorter developmental duration (40.4 days) and higher fecundity (467 no.) of emerged moths were recorded in the boxes with 0.125 cc (2000 eggs) inoculum. Validation of experiments indicated that compared to the boxes with 0.5 cc inoculum, a 2.15, 1.44, 1.35 and 1.49 times increase in average production per box from 0.125cc infested boxes more during monsoon, post monsoon, dry and summer months, respectively. The data generated can be utilized for improving the protocol for mass rearing of *Corcyra cephalonica*.

**KEY WORDS:** *Corcyra cephalonica*, mass production, rearing boxes.

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### INTRODUCTION

In India, the rice meal moth *Corcyra cephalonica* (Stainton) is mass produced as a laboratory host for rearing several natural enemies. *Corcyra* culture is used in the production of egg parasitoids especially trichogrammatids, egg – larval parasitoids like *Chelonus blackburni*, larval parasitoids like *Gonizous nephantidis*, *Bracon hebetor*, *Bracon bravicornis*, *Bracon krikpatricki* etc. and predators like Chrysopid larvae and Anthocorid bugs. *C. cephalonica* larvae are also used to trap the soil pathogens and nematodes and mass production of entomopathogenic nematodes (Kumar and Murthy, 2000; Jalali *et al.*, 2003). Attempts were been made to standardize the rearing protocols for *C. cephalonica* through modifications in the larval diet ingredients, dosages of infesting, semi mechanized systems of larval rearing and moth collection, mechanized cleaning of eggs and standardization of storage conditions (Parshad, 1975; Jalali and Singh, 1989, 1992; Kumar and Jalali, 1993; Kumar and Kumar, 2002; Sathpathy *et al.*, 2003; Jalali *et al.*, 2007 Manjunath, 2013). Considering the number of eggs of *C. cephalonica* which is used for charging the rearing medium, actual number of moths emerging from each box was observed to be very low. The present study was taken

up to record the biological parameters of *C. cephalonica* in the existing production system during different seasons and attempts were made to improve the protocol for higher production especially during dry / summer months.

### MATERIALS AND METHODS

#### Regularly adopted system of production

*Corcyra* rearing boxes measuring 20 x 30 x 45 cm made of 12mm plywood covered with lid with six holes (diameter 1”); each hole covered with fine brass mesh (100 mesh) both externally and internally. Three replications were maintained per month, each replication comprised of 10 boxes each. Each box was 1/4<sup>th</sup> filled with a diet mixture of broken sorghum / bajra (2.5 kg); 75 gm coarse groundnut seed powder; 5 gm of yeast and 0.7 gm of streptomycin sulphate which was mixed thoroughly. Inoculum of *Corcyra* eggs was added @ 0.5 cc (= 8000 no.) per box. Infesting (charging) was done at monthly intervals during the four seasons viz. dry (December to February), summer (March to May), monsoon (June to August), post monsoon (September to November). Moth collection was done using a domestic vacuum cleaner which was attached to a moth collection drum so that the moths were collected directly into

the ovipositional cage (Kumar and Jalali, 1993). Adults were provided with cotton swabs soaked in 50% diluted honey mixed with Evion (2 capsules for half litre of 50% diluted honey) and water. Egg collection and cleaning was done every day. Moths were collected from the first day of emergence till the last day. Biological parameters recorded, were duration from the day of infesting to first adult emergence (egg to adult), number of moths collected per box (number of moths collected every day till the last moth emerged in each box), percent adults emerged from the infested *Corcyra* boxes (calculated based on total number of moths which emerged from the total number of *Corcyra* eggs used for infesting each box), fecundity per female (50% of moths which emerged were females and total number eggs collected was divided by number of females emerged from each box to calculate the fecundity) and number of cc of *Corcyra* eggs collected per box (considering 1 cc = 16000 eggs; total number of eggs were divided by 16000 and converted to cc) and recorded.

#### Testing different infestation dosages and influence on biological parameters

Experiment was conducted after reviewing the results of the first experiment to study effect of different dosages of infestation i.e. 0.5 cc (8000 eggs), 0.25 cc (4000 eggs) and 0.125 cc (2000 eggs) of *Corcyra* eggs were used as inoculums in each box (holding the same composition and quantity of diet mixture). Five replications with ten boxes per replication were maintained for each dosage and the experiment was conducted during the four seasons. Laboratory conditions and procedure of moth and egg collection remained the same as in the first experiment. Biological parameters like – duration of days from the day of infesting *Corcyra* box to first adult emergence, average moth collection per box, percent adult emergence, morphological parameters like total body length, abdominal length and total body weight of *Corcyra cephalonica* moths and fecundity were also recorded. Sex differentiation of female and male was done based on labial palpi and body size (Ayyar, 1934). Total body length was measured considering tip of labial palpi and total body weight was measured using an electronic balance. Fecundity was calculated by selecting five pairs adults per replication released into a small ovipositional unit (pearl pet jar measurements - 15 cm height; 9.5 cm diameter bottom fixed with mesh (size 100 mesh) and 7.5 cm lid opening covered with double layered black long cloth) and nine replications per treatment were setup. Cotton swabs of 50% diluted honey mixed with Evion (2 capsules for half litre of 50% diluted honey) and water were provided in the ovipositional containers as adult feed. Eggs were collected at 24 hour intervals and recorded till the death of the last moth in each replication.

#### Validation of results

Validation of the above was done by comparing the higher dosage of 0.5 cc (8000 eggs) per box to the lower dosage of 0.125 cc (2000 eggs) per box with five replications per treatment per month and total of 15 boxes per season. Average yield of *Corcyra* eggs in terms of cc per box were recorded.

Data recorded from the experiments was subjected to analysis of variance. Validation experiment data was subjected to two – way analysis of variance. Critical difference values were calculated and used for comparisons.

## RESULTS AND DISCUSSION

#### Regularly adopted system of production

Temperature and relative humidity recorded during different seasons of study in the *Corcyra* production unit is mentioned in the Table 1 along with the experimental results. Additional moisture was provided during initial days of dry and summer seasons either by placing water soaked gunny bags on the floor or flooding the floor of the rearing room with water during the peak summer.

Minimum duration from the day of infesting the *Corcyra* boxes till the first adult emergence was recorded as 68.7 days during monsoon, which was however, on par with that recorded during summer (71 days). Developmental time was significantly extended during 'dry' period (83 days) which was however, on par with summer and post monsoon (79.5 days) periods. Moth collection during post monsoon was maximum (2101 no. per box) which was statistically at par with the moth collection during monsoon and summer seasons values being 1959 and 1670 no. respectively. Compared to the post monsoon collection, it was significantly lower (1339) during dry period. Percent adult emergence per box ranged from 16.7 to 26.3 - highest being during the post monsoon season (26.3) which was statistically at par with that recorded during monsoon and summer seasons (24.5 and 20.9% respectively) while lowest adult emergence was recorded during the dry season (16.7). Fecundity ranged between 73.8 to 87.4 per female and no significant difference was observed in the fecundity recorded during the four seasons. Number of cc of *Corcyra* eggs collected per box during different seasons was statistically significant. Collections during post monsoon, monsoon and summer were at par with each other {5.8 (92800 no.), 5.2 (83200 no.) & 3.8 (60800 no.) cc respectively} while egg collection was significantly low during summer {3.1 (49600 no.) cc} (Table 1). Sathpathy *et al.*, 2003 has observed percent adult emergence (ranging from 14.42 – 82.08) and fecundity per female (ranging from 23.18 to

495.71 of population reared on the sorghum based diets while comparing different diet combinations for *C. cephalonica* in the experimental culturing units. Adult emergence of 37.04% was recorded in a sorghum based diet by Kumar and Kumar (2002) in the experimental small rearing units which is higher than what was recorded in the current study. They also recorded less average developmental time from egg to adult (50.12 days) when tested on the sorghum based diet in comparison to that recorded in the present study.

(43.1 days) while an extended developmental period of 50.5 days was recorded in the boxes with 0.5 cc inoculum. Continuous moth emergence was recorded for 123.6 and 120.9 days, respectively, from the boxes infested with 0.125 and 0.25 cc, respectively which were at par with each other, while the corresponding value was 114.2 days in the boxes infested with 0.5cc eggs. The percent adult emergence was highest (83.5) in the boxes infested with the lowest dosage (0.125cc) and this was significantly higher in comparison

**Table 1. Biological parameters of *Corcyra cephalonica* in the mass rearing system during different seasons {0.5 cc *Corcyra* eggs ((8000 eggs) as inoculums per box}**

Seasons	Duration from day of infesting the <i>Corcyra</i> boxes till the first adult emergence (days)	Average moth collection per box	Adults emerging from infested <i>Corcyra</i> eggs (%)	Fecundity per female	No. of cc of <i>Corcyra</i> eggs collected per box (number of eggs)
Dry (23.1 to 29.6°C temperature; 22.0 to 72.3 % RH)	83 <sup>b</sup>	1339.4 <sup>b</sup>	16.7 <sup>b</sup>	73.8	3.1 <sup>b</sup> (49600 no.)
Summer (23.5 to 33.0°C temperature; 24.7 to 88.3 % RH)	71 <sup>ab</sup>	1670.1 <sup>ab</sup>	20.9 <sup>ab</sup>	79.4	3.8 <sup>ab</sup> (60800 no.)
Monsoon (24.9 to 30.5°C temperature; 56.0 to 86.3 % RH)	68.7 <sup>a</sup>	1959.3 <sup>ab</sup>	24.5 <sup>a</sup>	87.4	5.2 <sup>a</sup> (83200 no.)
Post monsoon (22.7 to 30.9°C temperature; 37.0 to 79.7 % RH)	79.5 <sup>b</sup>	2100.9 <sup>a</sup>	26.3 <sup>a</sup>	86.5	5.8 <sup>a</sup> (92800 no.)
CD (P = 0.01)	8.85	730.22	6.77#	N. S.	2.07
F Value	11.43	4.11	4.16	1.28	9.09
P value	0.003	0.049	0.047	0.346	0.006
df	3, 8	3, 8	3, 8		3, 8

# CD (P = 0.05)

Considering the various parameters evaluated, it was evident that monsoon and post monsoon periods were ideal for *Corcyra* production, thus indicating that there is a need to increase the humidity in the rearing facility during dry and summer months. The provision of additional humidity through water soaked gunny bags or flooding the floor were inadequate to improve humidity to the required level. Thus there is a need to install a humidifier which can create humidity level of up to 70% in the whole rearing room.

#### Testing different infestation dosages and influence on biological parameters

Our investigations and earlier ones indicate that the per cent adult emergence from the infested *Corcyra* boxes is less than 50% leading to wastage of more than 50% of the eggs used for infestation. To resolve the above issue, three dosages i.e. 0.5, 0.025 and 0.125 cc (8000, 4000 and 2000 eggs, respectively) per box were tested. Duration from the day of inoculating *Corcyra* eggs till the emergence of first adult was 40.4 days in the boxes infested with 0.125 cc which was on par with the boxes infested with 0.25 cc

to the boxes with higher dosages, wherein 51.2 and 29.8 of adult emergence were recorded. There was no significant differences in the morphometrics (total body length, abdominal length and weight) of male and female moths which emerged from the boxes with three inoculums dosages. Total body length, abdominal length and body weight of the females which emerged from boxes infested with three dosages ranged between 13.6 - 14.4 mm, 5.7 - 6 mm and 23 - 30 mg, respectively. The total body length, abdominal length and body weight of the males which emerged from boxes infested with three different dosages ranged from 11 to 12 mm, 5 to 5.3 mm and 17 to 20 mg, respectively. Fecundity of the females ranged from 279 to 467 eggs in the three treatments. Fecundity was significantly higher in the boxes with lower dosages of 0.125 cc and 0.25 cc per box (467 and 458 respectively) in comparison to those which emerged from the boxes inoculated with 0.5cc eggs (279) (Table 2).

Earlier studies reported on the optimum egg - medium ratios relevant for small scale production. Jalali and Singh

(1992) reported a dosage of 1500 eggs: one kilogram of sorghum diet as the best treatment based on the increased fecundity and moth emergence. A semi-automatic device for mass production of *C. cephalonica* using stacked galvanized trays covered with a perforated polythene cover was developed by Manjunath (2013). He recorded that average moth emergence per tray was 76.6% and 25.9% respectively at egg: diet ratios of 1 egg: 1 gm and 2 eggs: 1 gm respectively. Bernardi *et al.*, (2000) compared different artificial diets for rearing *Corcyra* and recorded the weight of female and males ranging between 21.38 to 33.73 mg and 12.22 to 17.33 mg respectively and mean fecundity as 304.21. These results are corroborating with the present study. Bhandari *et al.*, (2014) studied the effect of different diets {of four cereals: corn, rice, millet and wheat (solely and mixed with groundnut)} on biology of *Corcyra cephalonica* under laboratory conditions by infesting in ratio of 1egg: 15gm of diet. They recorded early and maximum moth emergence from corn + groundnut diet (48.24 days and 94.67% respectively) followed by millet + groundnut diet (50.63 days and 89.7% respectively). Senthil Nathan *et al.*, (2006) recorded *Corcyra* adult emergence of 92.5, 70.4, 70.4 and 68.0 % from the plastic troughs comprising finger millet (*Eleusine coracana* L. Gaertn), soft white wheat (*Triticum aestivum*, L.), short grained white rice (*Oryza sativa* L.) and durra sorghum (*Sorghum bicolor* L. Moench) diets, respectively infested with *Corcyra* eggs. The current investigation reveals that a ratio of 0.125 cc: 2.5kg of medium is optimum for large scale rearing of *C. cephalonica*.

## Validation of results

The experiment on the effect of different dosages of inoculum on *Corcyra* production was validated during the four seasons (Table 3). The temperature and humidity conditions during the different seasons were as recorded in Table 1. Maximum yield of *Corcyra* eggs harvested from higher dosage boxes was 7.10 cc during post monsoon followed by 6.62 cc, 5.35 cc and 3.77 cc during monsoon, dry and summer respectively. Yield from lower dosage boxes was varying from 5.6 cc during summer to 14.2 cc during monsoon season and it was 10.21 cc and 7.20 cc during the post monsoon and dry seasons, respectively. Irrespective of the seasons, the yield of *Corcyra* eggs per box was significantly higher from boxes with lower inoculums dosage of 0.125 cc (9.32 cc) compared to that from boxes with higher inoculums (5.71 cc). Irrespective of the dosages, highest production was during monsoon (10.43 cc) followed by post monsoon (8.65 cc), while significantly lower production of 6.29 and 4.69 cc, was recorded during dry and summer months respectively. In the interaction treatments the highest production was during monsoon and post monsoon months when the lower dosage of inoculums was used. Significant increase in fecundity and provision of the optimum egg: medium ration has led to an increase in yield per box. The earlier dosage of 0.5 cc per box is now modified and accordingly 0.5 cc can be used to charge four rearing boxes. This protocol can thus be utilised by insectaries for optimum utilisation of *Corcyra* eggs as inoculums and also for improving the overall production system.

**Table 2. Biological attributes of *Corcyra cephalonica* in a mass rearing system: rearing boxes infested with different dosages of eggs**

Dosages of <i>Corcyra</i> eggs	Duration from day of infesting the <i>Corcyra</i> boxes till the first adult emergence (days)	Number of days of moth emergence (days)	Average no. of moths collected per box (no. of eggs used for infesting) #	Percent Adult emergence (a/b x 100)	Fecundity of the single female (log transformed values)
0.5 cc	50.5 <sup>b</sup>	114.2 <sup>b</sup>	2383.1 (8000)	29.8 <sup>c</sup>	279 (2.38) <sup>b</sup>
0.25 cc	43.1 <sup>ab</sup>	120.9 <sup>a</sup>	2047.2 (4000)	51.2 <sup>b</sup>	458 (2.64) <sup>a</sup>
0.125 cc	40.4 <sup>a</sup>	123.6 <sup>a</sup>	1669.2 (2000)	83.5 <sup>a</sup>	467 (2.63) <sup>a</sup>
CD (P = 0.01)	8.63	5.13		8.73	0.23*
F Value	5.59	13.49		147.36	4.30
P value	0.009	≤0.0001		≤0.0001	0.03
df	2, 27	2, 27		2, 27	2, 24

# not subjected to analysis; CD (P = 0.05)

**Table 3. *Corcyra cephalonica* eggs harvested during different seasons**

Seasons	Average yield of <i>Corcyra</i> eggs (cc) per box during different seasons at two dosages of inoculum (Total number of eggs in parenthesis)		<i>Corcyra</i> eggs collected per box in cc (Total number of eggs in parenthesis) Mean (B factor)
	0.5 cc <i>Corcyra</i> eggs (8000 eggs) infested / box	0.125 cc <i>Corcyra</i> eggs (2000 eggs) infested / box	
Dry (23.4 to 28.1°C temperature; 29.8 to 78.6% RH)	5.35 <sup>cd</sup> (85600)	7.20 <sup>c</sup> (115200)	6.29 <sup>c</sup> (100640)
Summer (25 to 31.9°C temperature; 33 to 76% RH)	3.77 <sup>d</sup> (60320)	5.60 <sup>cd</sup> (89600)	4.69 <sup>D</sup> (75040)
Monsoon (23.1 to 31°C temperature; 49.7 to 79% RH)	6.62 <sup>c</sup> (105920)	14.20 <sup>a</sup> (227200)	10.43 <sup>A</sup> (166880)
Post monsoon (24 to 29°C temperature; 48 to 83.3% RH)	7.10 <sup>c</sup> (113600)	10.21 <sup>ab</sup> (163360)	8.65 <sup>B</sup> (138400)
<i>Corcyra</i> eggs collected per box in cc (Total number of eggs in parenthesis) Mean (A factor)	5.71 <sup>B</sup> (91360)	9.32 <sup>A</sup> (149120)	

CD of A factor at 1% = 1.29; F = 33.0 & P = ≤0.0001; degrees of freedom = 3, 1, 3, 16  
 CD of B factor at 1% = 1.84; F = 66.73 & P = ≤0.0001; degrees of freedom = 3, 1, 3, 16  
 CD of A x B factor at 1% = 2.57; F = 9.61 & P = 0.0007; degrees of freedom - 3, 1, 3, 16

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