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Standardization of egg inoculum for mass production of *Corcyra cephalonica*

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Abstract
Investigations were carried out to increase the production of *Corcyra cephalonica* egg for mass rearing of different bio control agents. Seven treatments of different egg dosages inoculated at 0.10 cc (2000 eggs), 0.125 cc (2500 eggs), 0.15 cc (3000 eggs), 0.20 cc (4000 eggs), 0.25 cc (5000 eggs), 0.50 cc (10000 eggs), 0.60 cc (12000) eggs) per basket containing 2.5 kg milled sorghum were studied to find out number of adult emergence and egg production by them. Result revealed that maximum moth emergence 2211 per basket was recorded in the baskets inoculated with egg dosage of 0.15 cc (3000 eggs) followed by 0.125 (2500 eggs), 0.20(4000 eggs), 0.25 (5000 eggs), 0.50 (10,000eggs), 0.60 cc (12,000 eggs) were 1834, 1577, 1506, 1469 and 1341 moths emerged per basket respectively. Whereas minimum moth 1152 emerged in the basket inoculated with egg dosage of 0.10cc (2000 eggs). Insect fitness, behaviour, survival, fecundity, and metabolism can all be strongly impacted by the quality of the diet and competition for food supplies. High density population and dietary stress during the larval growth stage, in particular, may cause numerous morphological and physiological changes that affect adult characteristics, lengthen the larval period, reduce fecundity, pupal weight, and body mass of the insect, and cause fewer moths to emerge in baskets with more eggs. So as per investigation initial inoculating dose for the mass production of *C. cephalonica* should be 0.15 cc (3000 eggs) per basket. The amount of eggs laid by female C. cephalonica was much more than the initial dosage of 0.15 cc (3000 eggs) per basket 15.08 cc eggs per basket. In baskets with 0.10 cc (2000 eggs), where 7.29 cc of eggs per basket were reported, there was notably less egg production.

Keywords: Moth emergence, *Corcyra cephalonica*, egg production

Introduction
The factitious host Rice moths, *C. cephalonica* has been effectively and widely utilized in biological control for the mass rearing of numerous agents like egg parasitiods (*Trichogramma australian Girault*, *Trichogramma chilonis ishii*, *T. riley*, *T. pretiosum riley*, *T. japonicum)*, egg larval parasitioids (*Chelonus blackburnicameron*), larval parasitiods *Bracon hebetor fabricius*, *Apaneteles angaleti (*Musebeck), *Goniozus nephantidis* (Muesebeck) and insect predators like *Chrysoperla zastrowisillemi* (Esbenpetersen), *Blaptostethus pallescens poppies* and *Mallada boniensis* (okomata) (Sitanandam *et al.* 2013) [23]. On the larvae of the *Corcyra cephalonica*, entomopathogenic nematodes like a *Steinernema feltiae* have been effectively maintained. (Kumar and Murthy 2000) [10]. It is a cheap mass-produced item that is healthy, non-cannibalistic, and resistant to diseases in popular culture (Manjunath 2014) [12]. The efficient mass production of natural enemies is essential for biological control programmes, especially those incorporating novel and inoculative releases (Van Lenteren 2012) [19]. The commercial facilities all over the world that generate massive quantities of Trichogramma spp. use *Corcyra cephalonica* as an effective laboratory host for the mass growing of these egg parasitoids. (Sithanantham *et al.* 2013) [18]. The mass production of rice moth eggs is crucial for the productive and cost-effective use of Trichogrammatidae. The establishment of alternative laboratory hosts becomes a requirement for the bulk production of predators and parasitoids under laboratory conditions when the original host is absent or scarce. Numerous attempts have been made to modify the *Corcyra cephalonica* mass raising technique (Lalitha and Ballal 2015, Chaudhari and Senapati 2015) [11, 3]. A number of insects, including coccinellids, lacewing bugs, heteropterans, and egg parasitiods of the genus *Trichogramma*, have been known to feed on the eggs of various lepidopterans, including *Corcyra cephalonica* (Stainton), *Sitotroga cerealella* (oliver), and *Ephestia kuehniellazeller* (Declercq 2013) [21]. For the best possible larval nutrition, egg doses, and automated moth collection system (Bernardi *et al.* 2000; Manjunath 2014) [1, 12].

The dose of the egg used for the primary infestation of the breeding substrate has a considerable impact on the total number of moths produced and the number of eggs laid by these moths. The most crucial factor is that host eggs are necessary for the mass raising, processing, and eventual release of Trichocard in the field. Fitness of parasitoids plays a vital part in the effective management of pests, and good quality host eggs are necessary for this. (Farahani *et al*., 2016; Grenier *et al*., 1986; Peverieri *et al*., 2015) [6, 7, 14]. Hence the present research was conducted to estimate the moth emergence and egg production per basket which were utilized for rearing of *Corcyra cephalonica.*

Material and Method

The present study on standardization of egg inoculum for mass production of *Corcyra cephalonica* was carried out at Bio control laboratory, College of Agriculture Nagpur. The experiments were carried by using a completely randomized experimental design with 7 different treatment replicating 3 times.

Rearing of *Corcyra cephalonica*

The Bio control lab at the College of Agriculture in Nagpur provided the culture of *C. cephalonica*, which was kept there under controlled conditions at a constant 27–30 °C temperature and 70–1% relative humidity (RH) in total darkness. On sorghum grains, the test bug *C. cephalonica* culture was kept alive. Assuming 1.0 cc = 20000 eggs per basket (Jalali and Singh 1989) [9], seven treatments with various egg dosages inoculated at 0.10 cc (2000 eggs), 0.125 cc (2500 eggs), 0.15 cc (3000 eggs), 0.20 cc (4000 eggs), 0.25 cc (5000 eggs), 0.50 cc (10000 eggs), and 0.60 cc (12000 eggs) per basket were examined. By hand counting and using a measuring cylinder, the volume of eggs was determined. Various egg volumes were used to vaccinate the baskets, and then the baskets were secured with different egg volumes were placed in baskets that had tight lead fittings and a fine mesh centre. The moths that had emerged after 40 days were regularly gathered and moved into an egg-laying room with good design. The eggs were hand counted after being passed through a 30 grit sieve to eliminate moth scales. In order to calculate the number of moths that emerged from each basket and the amount of eggs produced, each treatment was performed three times.

Statistical analysis

Data recorded during present study on standardization of egg inoculum for mass production of *Corcyra cephalonica* were statistically analyzed by using OPSTAT software which is available online on Hissar Agricultural University, Hissar

Results and Discussion

Number of *Corcyra cephalonica* moth emerged per basket in different treatments

The results on no. of moths emerged per basket are presented in Table 1. Significantly higher number of moths emerged 2211 and 1834 per basket were recorded in the basket inoculated with egg dosage of 0.15 (3000 eggs) and 0.125 cc (2500) respectively followed by 0.20 (4000), 0.25 (5000) and 0.50 cc (10,000) where 1577, 1506 and 1469 moth per basket were emerged, respectively which were at par with each other whereas egg dosage of 0.50 cc (10,000), 1469 moths per basket was also found at par with egg dosage of 0.60 cc (12,000) were 1341 moths per basket was emerged. Significantly lower moth emergence was recorded in the baskets with egg dosage of 0.10 cc (2000 eggs) 1152 moths per basket. According to a several studies insects' fitness, behaviour, survival, fecundity, and metabolism (Hooper *et al.* 2003; Boggs and Freeman *et al*. 2005; Melanie *et al*. 2004) [8, 2, 13] can all be strongly impacted by the quality of their food (Manjunath 2014) [12] and the competition for food supplies. High population density and nutritional stress during developmental phases, particularly during the larval growth stage, may result in several morphological and physiological changes that have an impact on adult features. (Dmitriew and Row 2007; Rhainds *et al*. 2002) [5, 15]. It could decrease an insect's body mass, pupal weight, and fecundity by lengthening the larval stage. Sharma *et al*. 2016 [22] reported that significantly higher number of moths per box was recorded in the boxes inoculated with egg dosage of 0.20 cc which is in agreement with our present findings 0.15 cc (3000) eggs dosage per basket resulted in higher moth emergence, whereas significantly lower moth emergence was recorded in the baskets inoculated with egg dosage of 0.125 cc which is in line with our present findings at 0.10 cc egg dosages (2000 eggs) resulted in lower moth emergence. Lalitha and Ballal (2015) [11] studied influence of seasons and inoculum dosage on the production efficiency of *C. cephalonica* Stainton with the egg dosage of 0.5, 0.25 and 0.125 cc and recorded higher moth emergence with the egg dosage of 0.125 cc which again is in agreement to our present findings. In the present study, there was a gradual increase in moth emergence with decrease in the dosage from 0.60 cc (12,000) to 0.15 cc (3000), there after a sharp decline in emergence of moths was recorded. According to Wu (2002), the best results of *C. cephalonica* rearing was obtained by sprinkling 0.3 g eggs on 2 kg diet which produce 3571 to 4337 adults moth. Sathpathy *et al* (2002) [16] studied the improvement in fecundity of *C. cephalonica* through optimization of egg density and found adult emergence was lower in higher egg densities which is in agreement with our findings.

Table 1: Effect of *Corcyra cephalonica* egg inoculum dosage on moth emergence.

Tr.no	Treatment details	Egg inoculum	Number of moth emerged per basket			Mean
			R_1	R_2	R_3	
T_1	0.10cc	2000	1056 (32.49)	1260 (35.49)	1140 (33.76)	1152 (33.91)
T_2	0.125cc	2500	1879 (43.34)	1833 (42.81)	1790 (42.30)	1834 (42.82)
T_3	0.15cc	3000	2250 (47.43)	2140 (43.26)	2243 (47.36)	2211 (47.01)
T_4	0.20cc	4000	1698 (41.20)	1525 (39.05)	1508 (38.83)	1577 (39.69)
T_5	0.25cc	5000	1553 (39.40)	1495 (38.66)	1470 (38.34)	1506 (38.80)
T_6	0.50cc	10000	1588 (39.84)	1449 (38.06)	1372 (37.04)	1469.66 (38.31)
T_7	0.60cc	12000	1328 (36.44)	1327 (36.42)	1368 (36.98)	1341 (36.61)
F test						Sig.
SE (□m)						0.582
C.D.@ 5%						1.782

*Fig in parentheses are square root transformed value.

Effect of *Corcyra cephalonica* egg inoculum on total egg production

The results on total egg production per basket in different treatments presented in Table 2. The quantity of eggs laid by females *C. cephalonica* was significantly higher 15.08 cc eggs per basket inoculated with initial dosage 0.15 cc (3000 eggs) per basket proceeded by egg dosage of 0.125 cc (2500 eggs), 0.20 cc (4000 eggs) and 0.25 cc (5000 eggs) were 12.92cc, 11.06 cc and 10.21 cc eggs per basket were respectively at par which each other. Egg dosage of inoculated 0.50 cc recorded 8.50 cc eggs per basket which is found at par to egg dosage of 0.60 cc recorded with 7.70 cc eggs per basket. Significantly lower egg production was recorded in the baskets with 0.10 cc (2000 eggs) where in 7.29 cc eggs per basket were recorded. Earlier Sharma *et al* (2016) [22] reported higher egg collection of eggs by the initial egg dosage of 0.20 cc eggs per basket is in agreement with our present findings. Lalitha and Ballal (2015) reported that significantly higher egg laying by rice moth emerged from *Corcyra* rearing basket with lower dosage of 0.125 cc and 0.25 cc as compared to the boxes inoculated with higher dosage of 0.50 cc eggs which is similar to our presents findings. High population density and dietary stress during phases of development, particularly during the larval growth stage, may result in several morphological and physiological changes that have an impact on adult features (Rhainds *et al*. 2002; Dmitriew and Row 2007) [15, 5]. Which may prolong larval period reduce egg laying capacity, pupal weight and body mass of insect**.** Satpathy *et al*. (2002) [16] studied the improvement in egg laying capacity of *Corcyra cephalonica* through increasing of egg density and recorded maximum egg production in lowest egg density and there was gradual decline in the fecundity with increasing egg charging rate per basket. Egg density had significant effect on productivity ratio. The productivity ratio in the lowest egg density was higher over that higher egg density. This results collaborated with our present findings.

Table 2: Effect of *Corcyra cephalonica* egg inoculum dosage on total egg production

Tr.no	Treatment details	Egg inoculum	Number of eggs per basket (CC)			Mean
			R_1	R_2	R_3	
T_1	0.10cc	2000	6.60	7.97	7.21	7.29
T_2	0.125cc	2500	13.24	12.91	12.61	12.92
T_3	0.15cc	3000	15.35	14.61	15.29	15.08
T_4	0.20cc	4000	11.91	10.7	10.58	11.06
T_5	0.25cc	5000	10.54	10.14	9.97	10.21
T_6	0.50cc	10000	9.19	8.38	7.94	8.5
T_7	0.60cc	12000	7.56	7.56	7.99	7.7
F test						Sig.
SE(□m)						0.582
C.D.@ 5%						1.782

Conclusions

Obtained mean number of moths emerged from different treatments ranged between 1152 and 2211. The highest number (2211) of moths emerged in the treatment with egg dosage of 0.15 cc (3000) eggs per basket. The Lowest number of moths (1152) emerged in the treatment with egg dosage of 0.10 cc (2000) eggs per basket. The moth production increased with declined in egg dosage from 0.60 cc (12,000 eggs) to 0.15 cc (3000 eggs) per basket, further it decreases. The total egg production per basket in different treatments ranged from 7.29 cc to 15.08 cc eggs. The treatment with egg dosage of 0.15 cc (3000 eggs) recorded significantly highest 15.08 cc egg production among all treatments. The data recorded during present study may be utilized for improving the availability of *Corcyra* egg for preparation of trichocard in offseason for field release and mass rearing of *Corcyra*.

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