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Effect of maize grain diet and egg density on the development and emergence of *Corcyra cephalonica* (Stainton)

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Abstract
The milled grains of maize (*Zea mays* L.) prepared to rear and maintain the rice moth, *Corcyra cephalonica* under laboratory conditions. Each culture containing 225 g of grains were infested with 375, 750, 1125, 1500 freshly (0-24 h old) eggs of *C. cephalonica.* Adult emergence of *C. cephalonica* was highest 91.31 per cent from the egg density of 375 eggs/225 g maize while lowest emergence 36.15 per cent of rice moth was from egg density of 1500 egg/225 g grains. The peak emergence from grains infested with egg density of 375 eggs/225 g grains occurred during 51-60 days after infesting the grains, but with 1125 and 1500 eggs density, the peak emergence was 81-90 days after infesting. The first and last moth emerged with egg density of 375 and 750 eggs/225 g grains was 30 and 131, 31 and 141 days, respectively, after infesting the grains. In case of egg density of 375 and 750 eggs/225 g grains 50 and 80 per cent of moth emergence was observed up to 60 to 70 days and 70 to 80 days, respectively after infesting the grains. While with the egg density of 1125 and 1500 eggs/225 g grains, 50 and 80 per cent emergence was observed up to 90 to 100 days and 100 to 110 days, respectively, after infesting the grains.

Keywords: *Corcyra cephalonica*, development, egg density**,** emergence pattern, grains, maize, rearing

Introduction
Predators, parasitoids and microorganisms are naturally controlling the insect pests, among them, parasitoids have a major role in agricultural ecosystem (Bhandari, 2014) [3]. Of the effective bio-control agents, the egg parasitoid, *Trichogramma* is considered as the most important, particularly for augmentation. But, the number of eggs destroyed by natural *Trichogramma* is not sufficient to combat the pest from reaching the economic threshold level. So, its mass rearing and release for augmentation is vital. Mass rearing of *Trichogramma* requires the rearing of its host. The typically rearing of a species of moth can produce enough eggs on which the wasps may be developed. The rice moth, *Corcyra cephalonica* (Stainton) and the Mediterranean flour moth *Ephestia kuehniella* Zeller are easily and inexpensively reared on wheat, rice or other cereals and their eggs are commonly used to rear *Trichogramma* (Morrison *et al.,* 1976) [10]. Besides, some entomopahothegic nematodes such as *Steinernema feltiae* are also reared on the larvae of *Corcyra cephalonica* (Kumar and Murthy, 2000) [8]. Besides its beneficial uses in mass rearing of natural enemies, it is also serious pest of rice, wheat, sorghum, maize, cocoa, peanuts, almonds, dates, groundnut, cotton seeds, coffee, spices and cocoa beans, cashews, raisins and millet (Mbata, 1989; Harita *et al*., 2000) [9, 5]. The larvae damage the stored grains by feeding under silken webs. When infestation is high, the entire stock of grains may be converted into a webbed mass and ultimately a characteristic bad smell develops and the grains are rendered unfit for human consumption (Alam, 1965) [1]. Due to the unavailability of egg masses of different borers throughout the year for mass production of *T. chilonis*, sufficient numbers of *C. cephalonica* eggs are essential. All the activities in life are dependent on the type and quality of food material of an individual. Keeping all these points in view, an attempt has been made to study the optimum egg density of *Corcyra cephalonica* on maize grain by studying the variation in development and emergence pattern of *C. cephalonica* on maize grains with different.

Materials and methods
The present studies were carried out in the biological control laboratory of the Department of Entomology, Chaudhary Charan Singh Haryana Agricultural University, Hisar

(Latitude 29º to 29-25´ N, longitude 75-25´E, altitude 215 meter above sea level). The studies were conducted from September, 2003 to January, 2004 at 30±1º C and 75±5 per cent relative humidity in a BOD Incubator and relative humidity was maintained by making saturated sodium chloride solution (Winston and Bates, 1960) [15]. The fresh (0-24 h) eggs of rice moth of *Corcyra cephalonica* for infesting grains/media were taken from culture being maintained in the biological control laboratory of the Department of Entomology for observation on developmental period and emergence rate of *C. cephalonica*. The milled grains (3-4 pieces) maize (*Zea mays* L.) milled/crushed and sterilized in hot air over at 110ºC for two hours. After cooling, the grains, were sprayed and properly mixed with 0.1 per cent formalin, to prevent the growth of mould as well as to increase the grain moisture lost due to heat sterilization. Then in was mixed with 2.5 per cent w/w yeast powder and streptomycin sulphate @ 0.5 g/3 kg of media grains. The rearing media (maize grains, 225 g) was put in glass jar (16 x 10.5 cm) making a layer of 1.5 inch thick. Then each culture containing 225 g of grains were infested with 375, 750, 1125, 1500 freshly (0-24 h old) eggs of *C. cephalonica.* Each culture was replicated four times. The jars with charged media/grains placed in the incubator were observed daily for moth emergence after 25 days of placement. The adult emerged were recorded daily and moths were collected in vials and placed in oviposition cages till the last emergence. The number of adult emerged also recorded daily from each jar and development period was calculated. Time period from infestation of grains with eggs to emergence of adults was considered as developmental period. So on the basis of these parameters, developmental period, moth emergence, emergence pattern and optimum number of eggs required to infest per unit of grains were worked out. On the basis of the number of *C. cephaonica* eggs infested and number of adult moth emerged, rate of emergence was calculated in percentage as follows (Bordoloi, 1994):

$$\text{Adult emergence} = \frac{\text{Number of adults emerged}}{\text{Total number of eggs inoculated}} \times 100$$

Results and discussion

Developmental period

The data presented in Table 1 revealed that the developmental period of *C. cephalonica* was shortest of (55.07±0.83) days with range of 30-131 days with egg density of 375 eggs/225 g grains while the developmental period of (94.14 ± 0.81) days with range of 43-149 days was longest with egg density of 1500 eggs/225 g maize grains. The developmental period of (70.38 ± 0.66) days with range of 31-141 days and (88.64 ± 0.093) days with range of 36-146 days was found with egg density of 750 and 1125 eggs/225 g grains, respectively. The difference in the developmental period of *C. cephalonica* in the four different egg density were significant. Rao (1954) reported the same developmental period of 55.5 (43.76) days when infested with egg density of 100 eggs/100 g of feed material. However, Sharma *et al.* (1978) [14] reported the developmental period of 39.72 and 45.29 days for male and female, respectively, on maize grains infested with 20 larvae/100 g of food material. Ram *et al.* (2003) [12] reported the developmental period of rice moth of 40 days reared on maize grains when infested with egg density of 0.5 CC/3 kg.

Table 1: Effect of egg density on developmental period and adult emergence of *Corcyra cephalonica* on maize grains

S. No.	Egg density (per 225 g grains)	Developmental period (days)		Adult emergence (%)
		Range	Average	
1.	375	30-131	55.07 ± 0.083	91.31 (72.89)
2.	750	31-141	70.38 ± 0.66	70.71 (57.20)
3.	1125	36-146	88.64 ± 0.93	64.21 (53.23)
4.	1500	43-149	94.14 ± 0.81	35.15 (36.34)
	C.D. (P = 0.05)		2.55	2.089
	S.E. (m)		0.82	0.670

Figures in parentheses are the angular transformed values.

Adult emergence

The data in Table 1 showed that the adult emergence of *C. cephalonica* was highest 91.31 per cent from the egg density of 375 eggs/225 g maize while lowest emergence 36.15 per cent of rice moth was from egg density of 1500 egg/225 g grains. The emergence of 70.71 and 64.21 per cent was observed with egg density of 750, 1125 egg/225 g maize, respectively. There was a significant difference in the emergence rate of *C. cephalonica* in all four different egg density. Sharma *et al.* (1978) [14] reported the moth emergence of 93.3 and 81.67 per cent on sorghum and maize, respectively, when infested with 20 larvae/100 g feed/. However, Raj and Ramakrishnana (1978) [11] reported the emergence of 42 and 65.9 per cent when infested with egg density of 2700 and 1350 eggs per kg of crushed sorghum. In contrary, Jalali and Singh (1992) [7] reported the moth recovery of 84.6, 45.5 and 12.9 per cent with egg density of 250, 1500 and 2000 eggs/kilogram. The total developmental period occupied, 41 to 59 days with an average of 41.95±2.68 days on foxtail millet as reported by Jagdish *et al.,* (2009) [6]. According to Allotey and Azalekor (2000) [2] the mean developmental period was ranged from 33.2±0.2 to 45.3±1.8 days confirmed the findings of the present investigation where the period ranged from 37.83-56.17 days in different rearing media.

Emergence and per cent emergence pattern under different egg density

Emergence and per cent emergence pattern of rice moth from maize grains with different eggs density are presented in Table 2 and 3, respectively. The peak emergence from grains infested with egg density of 375 eggs/225 g grains occurred during 51-60 days after infesting the grains, while with egg density of 750 eggs/225 g grains, the peak emergence was observed during 61-70 days after infesting the grains. But with 1125 and 1500 eggs density, peak emergence was during 81-90 days after infesting.

Table 2: Emergence pattern of *Corcyra cephalonica* moth from maize grains infested with different egg density.

Days after infesting	Average number of moth emerged with different egg density at different intervals				
	Egg density per 225 g grains				
	375	**750**	**1125**	**1500**	**Total**
30-40	24.75	11.75	0.75	0.00	37.24
41-50	65.25	30.50	16.25	4.00	116.00
51-60	140.25	122.75	27.25	15.50	305.72
61-70	67.25	152.75	89.50	29.50	339
71-80	19.25	103.25	120.25	72.25	315
81-90	10.00	39.50	152.50	117.75	319.72
91-100	6.50	33.50	143.00	131.00	524
101-110	4.25	11.50	73.00	60.25	241
111-120	2.50	7.75	66.00	47.50	190
121-130	1.75	4.25	17.50	25.50	102
131-140	0.75	1.75	12.25	17.25	69
141-150	0.0	1.25	4.75	6.75	27
Total	342.48	520.44	723	527.16	

Table 3: Emergence pattern (%) of *Corcyra cephalonica* moth from maize grains infested with different egg density.

Days after infesting	% Average number of moth emerged with different egg density at different intervals			
	Egg density per 225 g grains			
	375	**750**	**1125**	**1500**
30-40	6.84	2.25	0.10	0.10
41-50	24.87	8.11	2.35	0.75
51-60	63.64	31.70	6.12	3.69
61-70	82.23	61.04	18.49	9.29
71-80	87.56	80.88	35.13	22.99
81-90	92.88	88.47	56.22	45.32
91-100	95.64	94.90	82.22	70.17
101-110	97.44	97.11	86.09	90.61
111-120	98.61	98.60	92.55	95.44
121-130	99.30	99.47	97.64	98.71
131-140	99.79	99.75	99.34	100.00
141-150	100.00	100.00	100.00	100.00

The first and last moth emerged with egg density of 375 and 750 eggs/225 g grains was 30 and 131, 31 and 141 days, respectively, after infesting the grains. While with 1125 and 1500 egg density, the first and last moth emergence was 36 and 146, 143 and 149 days, respectively (Table 1). The emergence of 50 and 80 per cent of moth with egg density of 375 and 750 eggs/225 g grains was observed up to 60 and 70 days and 70 and 80 days, respectively after infesting the grains. While the 1125 and 1500 eggs density, 50 and 80 per cent emergence was observed up to 90 and 100 days and 100 and 110 days, respectively, after infesting the grains. Thus, the present studies are confirmed by Ram *et al.,* (2003) [12] reported when grains infested @ 0.05 CC/3 kg grains, the peak emergence up to 62 days after infesting the grains and for 50, 75 and 90 per cent emergence, it took 64, 81, 91 days after infesting the grains. Jalali and Singh (1992) [7] observed the peak emergence during 81-90 and 111-120 days with egg density of 1500, 3000 egg/kg, respectively, while with egg density of 5000 egg/kg, the peak emergence was during 121-130 days after infesting the grains. Further, they reported the first moth emergence on 45th day with egg density of 1500 and 300 egg/kg of grains while with 5000 egg/kg grains, first moth emerged on 51st day.

Conclusion

The milled grains of maize culture containing 225 g of grains infested with 375, 750, 1125, 1500 freshly (0-24 h old) eggs of *C. cephalonica* shows highest (91.31%) emergence in case of 375 eggs/225 g maize while lowest (36.15 %) from 1500 egg/225 g grains. The peak emergence *i.e.* 51-60 days after infesting the grains also recorded from 375 eggs/225 g grain, but with 1125 and 1500 eggs density, the peak emergence was 81-90 days after infesting. The first and last moth emerged with egg density of 375 and 750 eggs/225 g grains was 30 and 131, 31 and 141 days, respectively, after infesting the grains. The first and last moth emerged with egg density of 375 and 750 eggs/225 g grains was 30 and 131, 31 and 141 days, respectively, after infesting the grains. While with 1125 and 1500 egg density, the first and last moth emergence was 36 and 146, 143 and 149 days, respectively.

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