Original Research Article

<https://doi.org/10.20546/ijcmas.2021.1002.182>

Comparative Efficacy of *Trichogramma chilonis* Bred on *Corcyra cephalonica* and *Leucinodes orbonalis* (Guenée) Eggs in controlling Shoot and Fruit Borer in Brinjal

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ABSTRACT

Keywords

Trichogramma chilonis, *Corcyra cephalonica* and *Leucinodes orbonalis*

Article Info

Accepted:

15 January 2021

Available Online:

10 February 2021

Laboratory and field experiments were conducted during 2015-17 to study the Comparative efficacy of *Trichogramma chilonis* bred on *Corcyra cephalonica* and *Leucinodes orbonalis* (Guenée) eggs in controlling shoot and fruit borer in brinjal in coastal Odisha. *Trichogramma chilonis* was reared in the eggs of *Corcyra cephalonica* and *Leucinodes orbonalis* for 30 generations and the parasitoid was evaluated in field conditions against Brinjal shoot and fruit borer. It was observed that the parasitoid, when reared on eggs of *L.orbonalis* has shorter life cycle but better efficiency in controlling the pest.

Introduction

Vegetables are cheap sources of vitamins and minerals. They not only help in maintaining good health but also protect the body systems against degenerative diseases. In a developing country like India, where pressure of population on land is continuously increasing, vegetables will play significant role in supplying balanced diet to the general public. As such the scope for expansion of vegetable industry in India is quite promising and therefore cultivation of brinjal as a cheap source of vegetable has a bright future. As far as vegetable production in the world is

concerned, India is the second, next only to China. Brinjal (*Solanum melongena* L.) is a versatile and economically important vegetable among small-scale farmers and low income consumers of the entire universe (FAO, 2000). It is the leading vegetable in the country and ranks first among summer and winter vegetables in terms of total average. Asia has the largest brinjal production which comprises about 90% of the total production area and 87% of the world production (FAO, 2000). Among the states, West Bengal, Odisha, Bihar, Gujarat and Maharashtra are considered as major brinjal growing states in India. In Orissa, the crop is grown over an

area of about 127.7 thousand hectares and its production is being recorded as 1852.2 thousand metric tonnes. However, the productivity of this most common vegetable is about 14.5 t/ha which is comparatively less than that reported in states like West Bengal (18.2 t/ha), Bihar (20.0 t/ha) and Gujarat (15.2 t/ha) (Anonymous, 2005).

Brinjal, an economically important commercial crop, is reported variedly to be infested by more than 36 pests (Regupathy *et al.*, 1997) from the time of its planting to harvest. Among them, brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* Guenee is considered to be the most serious pest of brinjal and it has become a very serious production constraint in all brinjal growing countries (Alam *et al.*, 2003). It inflicts damage to both shoots and fruits (Srinivasan, 2008). The fruit infestation by this pest may be as high as 67% (BARI 1991). It is very difficult to control since it feeds inside the shoots and fruits (Ghosh and Senapati, 2009). The crop is attacked by a large number of Insect-pests (Payal Devi *et al.*, 2015), among them shoot and fruit borer *Leucinodes orbonalis* Guenee (Lepidoptera: Pyralidae) is the key pest throughout Asia (RP Mainali, 2014). In recent years increased use of chemical pesticides by the farmers for combating *L. orbonalis* has made the cultivation of eggplant more costlier and hazardous to farmers as well as consumers in Orissa, majority of the farmers (41.7%) followed a seven to eight spraying schedule to control this borer species and about 56.7% farmers have found it expensive to control *L. orbonalis* through the use of insecticides (George *et al.*, 2002). But sole reliance on chemicals has resulted 'ecocatastrophe' leading to development of resistance in *L. orbonalis* to different insecticides (Tomlin, 2000), pest resurgence (Mishra, 2008), harmful pesticide residue (Prabhat *et al.*, 2000), destruction of beneficial insects and

environmental hazards. Moreover Eggplant is mostly grown on small land holdings and sale of produce harvested almost daily over a 5-6 month period provide the farmers with valuable cash income. Therefore, there is a need to develop appropriate pest management strategies for low input based resource poor farming systems where the crop is grown under rain fed conditions as well as for high input based irrigated crop conditions where the farmers take 2 to 3 crops a years. So management strategies should aim at use of ecologically sound, economically viable and socially acceptable safer alternatives.

Materials and Methods

The investigations were conducted in the Biological laboratory of Entomology Department, College of Agriculture, O.U.A.T., Bhubaneswar and the department experimental farm named Central Farm, located in front of the Agriculture College. The location being is east and south eastern coastal plain agro-climatic Zone, experiences a typical hot and most sub humid climate.

Laboratory rearing of *L. orbonalis*

Biology of *L. orbonails* was studied under laboratory conditions on fruits of Utkal Anushree variety. The laboratory culture was maintained from the field-collected caterpillars were reared in the laboratory to ascertain the relative size of different instars, based upon which the larval stages collected subsequently through periodical sampling, were categorized as larval instar 1 to 5. All the larvae were reared till adult emergence, on sliced potato tubers as suggested by Rajalaxmi *et al.*, (2004). The larvae of different instars as collected from time to time were transferred with the help of fine camel hairbrush on a place of sliced potato tubers individually in plastic specimen trays. Fresh sliced piece of potato was provided to the larvae on every

alternate day. Prior to the rearing of *L. orbonalis* larvae, the acceptance of potato tubers as food by the insect was examined by releasing a few larvae on sliced end of a well washed potato tubers. Infested fruits collected from the experimental field, are kept in different nylon net covered cages (1'x1'x10") each, kept under natural environmental condition in the area of Entomology Department, College of Agriculture, OUAT, Bhubaneswar. Net is used in the cage to allow proper ventilation of air and to avoid rotting of fruits. Each box carries 5- 7 Kg of brinjal fruit below which paper pieces are kept for proper pupation of the matured larvae in the fruits. The matured fifth instar larvae after coming out of the brinjal fruit and twigs moves down and pupate under the paper pieces below. The entire process is monitored on regular basis, the brinjal fruits were changed at periodic intervals, and rotted fruits were removed to avoid fungal growth. Pupae were collected regularly and kept in another cage under laboratory condition. The freshly emerged adult moths from pupae in the cage were collected manually by test tubes and known numbers of male and female moths were transferred to glass jar (20cm x 15cm) in pairs, covered with black colour muslin cloth, for mating and oviposition. The adults were fed with a cotton swab soaked in 10% honey solution provided as source of food for the adult moths during oviposition. The muslin cloth was examined daily for egg laying and the eggs were parasitized by *Trichogramma chilonis* card in polycovers under controlled temperature and humidity in the laboratory. The entire process of fresh collection of pupae to adult moth to oviposition in fresh glass jars covered by black new muslin cloth then collection of eggs and parasitisation by *Trichogramma* card were repeated from time to time on different dates and the data was recorded to study the extent of parasitisation by *Trichogramma chilonis* in subsequent generations to conclude as one of the effective

biocontrol agent against brinjal shoot and fruit borer. The parasitoid of *T.chilonis* reared on *C.cephalonica* and *L.orbonalis* were evaluated in field trials during 2016 and 2017 against *L.orbonalis*. Brinjal variety Utkal Anushree was grown in plots of 0.25 acre and plots were taken 40 meters apart for prevention of parasitoids migrating between plots. There were eight treatments as follows:

T₁-*Trichogramma* @ 50,000 / ha on *Corcyra cephalonica*,

T₂- *Trichogramma* @ 75,000 / ha on *Corcyra cephalonica*,

T₃- *Trichogramma* @ 1,00,000 / ha on *Corcyra cephalonica*,

T₄-*Trichogramma* @ 50,000 / ha on *Leucinodes orbonalis*,

T₅-*Trichogramma* @ 75,000 / ha on *Leucinodes orbonalis*,

T₆-*Trichogramma* @ 1,00,000 / ha on *Leucinodes orbonalis*,

T₇ - Treated with Insecticide Flubendiamide+Rynaxypyr

T₈- Control

After application of the treatments 4 m² area in each plot was selected as replication and ten such replications were taken in each plot for taking observations as shoot and fruit borer incidence.

Results and Discussion

Shoot infestation before treatment varied from 14.21% to 20.18% in different treatments. Fifteen days after treatment (DAT) the infestation was lowest (9.61 %) in T₇ (Insecticidal treatment) followed by

T₆(9.62%), T₃(12.01), T₅(12.02%), T₄(12.27%), T₂(13.88%) and T₁(14.56%) respectively as against 20.66% in untreated control. Similarly at 30DAT shoot infestation was lowest in T₇(7.52%) followed by T₆(7.53%), T₃(10.81%), T₅(11.49%), T₄(11.52%), T₂(12.17%) and T₁(12.31%) respectively as against 19.13% in untreated control. Similar trend was recorded at 45 DAT, 60DAT, 75DAT and 90DAT. At 45DAT percent of shoot infestation ranges from lowest at T₇(5.34%) followed by T₆(5.36%), T₃(10.03%), T₄(10.30%), T₅(10.81%), T₂(11.85%), T₁(12.05%), at 60DAT lowest shoot infestation was recorded at T₇(4.64%) followed by T₆(4.65%), T₄(9.04%), T₅(9.11%), T₃(9.24%), T₂(11.19%), T₁(11.64%), at 75DAT lowest recorded was at T₇(2.94%), T₆(2.96%), T₄(7.63%), T₅(8.81%), T₃(8.99%), T₂(10.23%), T₁(11.21%), and at 90DAT lowest recorded shoot infestation was in T₇(1.01%) followed by T₆(1.04%), T₅(5.19%), T₄(5.61%), T₃(6.10%), T₂(7.76%), T₁(8.54%) against untreated control at 45,60,75,90DAT was 19.05%, 15.18%, 11.36%, 9.61% respectively.

Percentage reduction of shoot infestation was maximum in T₇ that is 89.49% followed by T₆(89.17%), T₅(45.99%), T₄(41.62%), T₃(36.52%), T₂(19.25%) and T₁(11.13%) respectively.

Similar trend was recorded on shoot infestation during Kharif of 2016-2017. Shoot infestation before treatment varied from 14.24% to 20.02% in different treatments. Shoot infestation percentage at 15DAT ranged lowest at T₇(17.75%) followed by T₆(17.72%), T₃(14.24%), T₄(16.22%), T₂(16.28%), T₁(17.13%), T₅(18.36%) against 20.02% untreated control, at 30DAT lowest T₇(19.97%), T₆(9.98%), T₄(12.10%), T₃(12.17%), T₅(12.67%), T₂(13.19%) and T₁(14.24%) against 20.43% untreated control,

at 45DAT lowest infestation in T₇(5.20%), T₆(5.22%), T₃(10.08%), T₄(10.12%), T₅(10.60%), T₂(11.66%), T₁(12.13%) against untreated control 19.19%, at 60DAT lowest percent of shoot infestation is in T₇(4.27%) followed by T₆(4.28%), T₅(9.02%), T₃(9.16%), T₄(9.23%), T₂(11.07%), T₁(11.49%) against untreated control 17.39%, at 75 DAT lowest percent infestation was found in T₇(2.80%) followed by T₆(2.81%), T₄(7.83%), T₃(8.74%), T₅(8.75%), T₂(10.12%), T₁(10.19%) against untreated control 14.18% and at 90DAT percentage of shoot infestation lowest recorded at T₇(1.17%) followed by T₆(1.18%), T₄(5.59%), T₅(5.62%), T₃(6.67%), T₂(7.26%) and T₁(8.69%) against 9.73%(untreated control). Percentage reduction of shoot infestation against the untreated check was highest in T₇ with 87.98% followed by was T₆(87.87%), T₅(62.24%), T₄(42.55%), T₃(34.53%), T₂(25.39%) and T₁(10.69%) respectively.

Studies on the biology of *T.chilonis* bred on eggs of *C.cephalonica* and *L.orbonalis* indicated that all the life stages of *T.chilonis* liked egg-larval, pupal and adult stages were shorter in duration when bred on eggs of *L.orbonalis*, this may be due to smaller egg size, have been earlier described by Chowdhury *et al.*, (2016).

The effect of *T.chilonis* reared on eggs of *C.cephalonica* and *L.orbonalis* in controlling shoot and fruit borer in brinjal indicated that, *T.chilonis* reared on the eggs of *L.orbonalis* could control the borer more efficiently than the ones which were reared on the eggs of *C.cephalonica*. Release of 50000 each/ha of *T.chilonis* reared on eggs of *C.cephalonica* and *L.orbonalis* reduced the shoot infestation to the extent of 11.13, 41.62% and 10.69, 42.55% respectively in 2016-2017 indicating the superiority of *T. chilonis* bred on the eggs of *L. orbonalis* (Table 1–4)

Table .1 Comparative effect of *T.chilonis* bred on eggs of *C.cephalonica* and *L.orbonalis* in brinjal shoots during 2015-16

Treatments	Shoot infestation (%)							% Reduction Of shoot infestation over control
	Pre treatment	15 DAT	30 DAT	45 DAT	60 DAT	60 DAT	90 DAT	
T ₁	17.16 (4.14)	14.56 (3.82)	12.31 (3.51)	12.05 (3.47)	11.64 (3.41)	11.21 (3.35)	8.54 (2.92)	11.13
T ₂	16.89 (4.29)	13.88 (4.68)	12.17 (3.48)	11.85 (3.44)	11.19 (3.35)	10.23 (3.20)	7.76 (2.79)	19.25
T ₃	14.21 (3.76)	12.01 (3.46)	10.81 (3.29)	10.03 (3.17)	9.24 (3.04)	8.99 (2.99)	6.10 (2.47)	36.52
T ₄	16.92 (4.03)	12.27 (3.50)	11.52 (3.39)	10.30 (3.21)	9.04 (3.01)	7.63 (2.76)	5.61 (2.37)	41.62
T ₅	18.01 (4.24)	12.02 (3.46)	11.49 (3.39)	10.81 (3.29)	9.11 (3.02)	8.81 (2.97)	5.19 (2.28)	45.99
T ₆	17.14 (4.14)	9.62 (3.11)	7.53 (2.74)	5.36 (2.38)	4.65 (2.16)	2.96 (1.72)	1.04 (1.01)	89.17
T ₇	17.20 (4.15)	9.61 (3.11)	7.52 (2.74)	5.34 (2.31)	4.64 (2.15)	2.94 (1.71)	1.01 (1.00)	89.49
T ₈	20.18 (4.49)	20.66 (4.54)	19.13 (4.37)	19.05 (4.36)	15.18 (3.89)	11.36 (3.38)	9.61 (3.1)	
SE(m))±	0.24	0.47	0.54	0.67	0.57	0.55	0.69	
CD(p=0.05)	0.73	1.42	1.63	2.03	1.73	1.67	2.10	

Figures in parentheses are $\sqrt{\text{values}}$.

Table.2 Comparative effect of *T.chilonis* bred on eggs of *C.cephalonica* and *L.orbonalis* in brinjal shoots during 2016-17

Treatments	Shoot infestation (%)							% Reduction of shoot infestation over control
	Pre treatment	15 DAT	30 DAT	45 DAT	60 DAT	60 DAT	90 DAT	
T ₁	17.73 (4.21)	14.24 (3.77)	12.39 (3.52)	12.13 (3.48)	11.49 (3.39)	10.19 (3.19)	8.69 (2.95)	10.69
T ₂	16.28 (4.03)	13.19 (3.63)	12.13 (3.48)	11.66 (3.41)	11.07 (3.33)	10.12 (3.18)	7.26 (2.69)	25.39
T ₃	14.24 (3.77)	12.17 (3.49)	10.38 (3.22)	10.08 (3.17)	9.16 (3.03)	8.74 (2.96)	6.37 (2.52)	34.53
T ₄	16.22 (4.03)	12.10 (3.48)	11.66 (3.41)	10.12 (3.18)	9.23 (3.04)	7.83 (2.80)	5.59 (2.36)	42.55
T ₅	18.36 (4.28)	12.67 (3.56)	11.13 (3.37)	10.60 (3.26)	9.02 (3.00)	8.75 (2.99)	5.62 (2.37)	62.24
T ₆	17.72 (4.21)	9.98 (3.16)	7.10 (2.66)	5.22 (2.28)	4.28 (2.07)	2.81 (1.68)	1.18 (1.09)	87.87
T ₇	17.75 (4.21)	9.97 (3.16)	7.08 (2.66)	5.20 (2.28)	4.27 (2.07)	2.80 (1.67)	1.17 (1.08)	87.98
T ₈	20.02 (4.47)	20.43 (4.52)	19.40 (4.40)	19.19 (4.38)	17.35 (4.16)	14.18 (3.77)	9.73 (3.12)	
SE(m)± CD(p=0.05)	0.15 045	0.45 1.36	0.57 1.72	0.69 2.10	1.95 2.90	0.69 2.10	0.67 2.03	

Figures in parentheses are $\sqrt{\text{values}}$.

Table.3 Comparative effect of *T.chilonis* bred on eggs of *C.cephalonica* and *L.orbonalis* in brinjal fruits during 2015-16

Treatments	Fruit infestation (%)											% Reduction of shoot infestation over control
	Pre treatment	50 DAT	60 DAT	70 DAT	80 DAT	90 DAT	100 DAT	110 DAT	120 DAT	130 DAT	140 DAT	
T ₁	35.85 (36.81)	33.60 (35.43)	33.19 (35.18)	31.44 (34.10)	30.20 (33.34)	28.04 (31.95)	26.86 (31.24)	26.19 (30.79)	24.78 (29.87)	21.81 (27.83)	19.27 (26.06)	73.11 (58.76)
T ₂	34.79 (36.15)	32.26 (34.63)	30.12 (33.27)	27.56 (31.69)	27.19 (31.44)	25.40 (30.26)	22.22 (28.11)	22.03 (27.97)	20.85 (27.13)	20.66 (27.06)	18.73 (25.62)	73.86 (59.28)
T ₃	36.11 (36.33)	32.01 (34.45)	30.57 (33.58)	26.86 (31.24)	23.74 (29.13)	23.33 (28.86)	21.81 (27.83)	19.70 (26.35)	19.12 (25.92)	19.36 (26.13)	17.50 (24.73)	75.58 (60.40)
T ₄	34.80 (36.15)	31.16 (33.95)	29.82 (33.09)	29.13 (32.65)	27.66 (31.69)	24.17 (29.47)	24.01 (29.33)	22.67 (28.45)	22.03 (27.97)	18.73 (25.62)	16.06 (23.66)	77.64 (61.75)
T ₅	35.23 (36.39)	30.08 (33.71)	27.66 (31.75)	24.19 (29.47)	24.01 (29.33)	21.78 (27.83)	21.40 (27.56)	18.62 (25.55)	15.41 (23.11)	16.40 (23.89)	14.98 (22.71)	79.10 (62.80)
T ₆	37.50 (37.76)	28.44 (32.20)	26.20 (30.79)	22.85 (28.38)	19.77 (26.35)	19.58 (26.26)	16.68 (24.12)	16.33 (23.81)	15.11 (22.87)	12.72 (20.88)	9.67 (18.15)	86.51 (68.44)
T ₇	37.52 (37.76)	28.42 (32.20)	26.19 (30.79)	22.83 (28.52)	19.76 (26.35)	19.56 (26.21)	16.65 (24.04)	16.31 (23.81)	15.10 (22.87)	12.70 (20.88)	9.66 (18.12)	86.52 (68.44)
T ₈	40.19 (39.35)	43.10 (41.03)	47.03 (43.28)	51.39 (45.80)	55.16 (47.98)	60.46 (51.06)	64.12 (53.19)	67.00 (54.94)	69.16 (56.29)	70.31 (56.98)	71.66 (57.80)	
SE(m)± CD(p=0.05)	(0.48) (1.45)	(0.60) (1.82)	(0.36) (1.10)	(0.43) (1.30)	(0.92) (2.78)	(0.48) (1.45)	(0.85) (2.58)	(0.77) (2.33)	(0.70) (2.12)	(0.70) (2.12)	(0.53) (1.61)	

Figures in parentheses are $\sqrt{}$ values.

Table.4 Comparative effect of *T.chilonis* bred on eggs of *C.cephalonica* and *L.orbonalis* in brinjal fruits during 2016-17

Treatments	Fruit infestation (%)											% Reduction Of shoot Infestation Over control
	Pre treatment	50 DAT	60 DAT	70 DAT	80 DAT	90 DAT	100 DAT	110 DAT	120 DAT	130 DAT	140 DAT	
T ₁	35.60 (36.63)	33.24 (35.18)	33.02 (35.06)	31.14 (33.83)	30.12 (33.27)	28.09 (32.01)	26.73 (31.11)	26.12 (30.72)	25.01 (30.00)	22.08 (28.04)	21.30 (27.49)	69.24 (56.29)
T ₂	34.56 (36.03)	32.35 (34.70)	30.41 (33.46)	27.39 (31.55)	27.04 (31.31)	25.17 (30.13)	22.42 (28.25)	22.16 (28.11)	20.43 (26.85)	20.05 (26.56)	17.14 (24.43)	75.26 (60.20)
T ₃	36.13 (36.93)	32.12 (34.51)	30.42 (33.46)	26.03 (30.66)	23.52 (29.00)	23.81 (29.20)	21.88 (27.90)	19.59 (26.28)	19.14 (25.92)	17.21 (24.50)	15.46 (23.19)	77.68 (61.82)
T ₄	34.43 (35.91)	31.22 (33.96)	29.16 (32.71)	29.46 (32.90)	27.01 (31.31)	24.63 (29.73)	24.02 (29.33)	22.81 (28.52)	22.23 (28.11)	18.33 (25.33)	15.44 (23.11)	77.71 (61.82)
T ₅	35.12 (36.33)	30.98 (32.27)	27.05 (31.31)	24.89 (29.93)	24.01 (29.33)	21.87 (27.90)	21.36 (27.56)	18.52 (25.48)	15.56 (23.26)	15.30 (23.03)	12.10 (20.36)	82.53 (65.27)
T ₆	37.15 (37.58)	28.46 (32.20)	26.17 (30.79)	22.77 (28.52)	19.46 (26.21)	19.68 (26.35)	15.84 (23.42)	15.37 (23.11)	15.07 (22.79)	12.64 (20.79)	9.67 (18.12)	86.04 (68.03)
T ₇	37.17 (37.58)	28.43 (32.20)	26.15 (30.79)	22.76 (28.52)	19.44 (26.13)	19.65 (26.28)	15.83 (23.42)	15.35 (23.03)	15.06 (22.79)	12.62 (20.79)	9.66 (18.02)	86.05 (68.11)
T ₈	39.78 (39.11)	42.13 (40.46)	46.23 (42.82)	50.31 (45.17)	54.23 (47.41)	59.61 (50.53)	63.89 (53.07)	66.19 (54.45)	68.53 (55.86)	69.62 (56.54)	69.26 (56.35)	
SE(m)± CD(p=0.05)	0.36 1.10	0.85 2.58	0.66 2.00	1.04 3.15	0.73 2.21	0.85 2.58	0.72 2.18	0.73 2.21	0.92 2.78	0.73 2.21	0.36 1.10	

Figures in parentheses are $\sqrt{\text{values}}$.

Similarly at 75000/ha rate of release, the reduction was 19.25,45.99% and 25.39,62.24% in 2012-13 and 2013-14 respectively, again proving the supremacy of *L. orbonalis* bred *T. chilonis*. Similar trend was also found when 100000 parasitoids were released /ha and the reduction in 2012-13 and 2013-14 were 36.52, 89.17% and 34.53, 87.87% respectively. This result completely demonstrated that *T. chilonis* bred on the eggs of *L. orbonalis* is significantly superior in respect of control of the brinjal shoot and fruit borer over *T.chilonis* bred on the eggs of *C.cephalonica*. The result of fruit infestation also confirmed superiority *T.chilonis* bred on the eggs of *L.orbonalis* by reducing the fruit infestation to the tune of 77.64,79.10 and 86.51% in 2012-13 and 77.71, 82.53 and 86.04% in 2013-14 as against 73.11, 73.86 and 75.58% in 2012-13 and 69.24, 75.26 and 77.71% in 2013-14 when the parasitoid was bred on eggs of *C.cephalonica*. Our observation agrees with the study conducted by Ranjith *et al.*, (2018), This may be due to the continuous breeding of the parasitoid for over 30 generations in the eggs of *L.orbonalis*. Previously attempts have been made successfully by Jalali *et al.*, (2006), Jalali *et al.*, (2016) for production of temperature tolerant *Trichogramma* by subjecting the parasitoid continuously to high temperature and high insecticide concentrations gradually. Similar attempts have been made here to produce a strain of *Trichogramma chilonis* exclusively adopted to the brinjal shoot and fruit borer.

Acknowledgement

The authors gratefully acknowledge the help rendered by the Head of the Department, Department of Entomology, College of Agriculture, OUAT, Bhubaneswar for providing necessary laboratory and field facilities for conducting the experiments.

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How to cite this article:

Mou Biswas, Ipsita Mishra and Subhalaxmi Roy. 2021. Comparative Efficacy of *Trichogramma chilonis* Bred on *Corcyra cephalonica* and *Leucinodes orbonalis* (Guenée) Eggs in controlling Shoot and Fruit Borer in Brinjal. *Int.J.Curr.Microbiol.App.Sci*. 10(02): 1524-1533. doi: <https://doi.org/10.20546/ijcmas.2021.1002.182>