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Bio-efficacy of new formulation of carbofuran against major insect pests of rice *Oryza sativa* L.

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Abstract
Bioefficacy of new formulation of carbofuran 3CG were tested in the field condition against stem borer and leaf folder in paddy during *kharif* 2017 and 2018 at Agricultural Research Station, Gangavathi, and Karnataka. The results confirmed that carbofuran 3CG is an effective chemical in reducing the pest population. Three doses of carbofuran 3CG (750, 1500 and 3000 g.a.i/ha) were tested along with the fipronil 5% SC, carbosulfon 25% EC and cartap hydrochloride 4G. among the treatments carbofuran 3CG @ 3000 g.a.i./ha effectively reduced stem borer (2.25 and 2.41% of white ears) and leaf folder infestation (0.34 and 0.37 larvae/hill) and increased grain yield during both the years as compared to untreated check.

Keywords: Bio-efficacy, dead heart, leaf folder, stem borer, white ears

Introduction
Rice (*Oryza sativa* L.) is the second widely grown cereal crop of the world. It is not only the staple food crop of more than half of the world population but also the chief source of dietary energy for the rice eating population of the Asia and South East Asia. India is the 2nd largest producer and consumer of rice just after China contributes 21.19% of total world rice production. Rice production and productivity is severely affected by many biotic and abiotic factors. Insect Pests are the major biotic factors limiting rice productivity. The hot and humid environment of the irrigated rice ecosystem is very conductive for proliferation of insect pests and diseases. More than 175 species of insect pests were reported infesting rice crop at different crop growth stages. Among these, 20 insects are considered as rice pests of economic importance that include stem borers, gall midge, defoliators and vectors like leafhoppers and plant hoppers that cause direct damages and transmit various diseases (Pathak *et al*., 1994) [7]. Eighteen species of rice stern borers have been recorded so far among these five are of economic importance in Asia *viz*., Dark headed stem borer (DHSB), *Chilo polychrysus* (Meyrick); Yellow stem borer (YSB), *Scirpophaga incertulas* (Walker); Pink stem borer (PSB), *Sesamia inferens* (Walker); Stripped stem borer (SSB), *Chilo supressalis* (Meyrick) and White borer (WB), *Scirpophaga innotata* (Walker). Among them, the yellow stem borer (YSB), *S. incertulas* (Walker) (Lepidoptera: Pyralidae) is the dominant species in India and rice plants are most prone to stem borer infestation at the tillering and flowering stages. Stem borer infestation at vegetative stage of crop produces dead heart symptoms while infestation at reproductive stage produces white ear head. Infestation of *S. incertulas* at reproductive stage causes severe yield loss and full potential of the variety cannot be achieved. YSB alone causes 1% to 19% yield loss in early planted and 38% to 80% in late transplanted rice crops. In general yield loss due to insect pests of rice has been estimated about 25% (Dhaliwal *et al*., 2010). For the control of leaf folder and yellow stem borer, many methods have been adopted but insecticides are still playing a key role for its control. Carbofuran is a widely used systemic insecticide applied to soil for control of many insect pests of rice. Its efficacy in rice protection has been clearly demonstrated and its efficiency in use under flooded conditions is improved by direct delivery to the root zone of the rice crop (Pathak *et al*. 1974) [8]. Thus, the potential benefits and disadvantages of controlled-release carbofuran formulations should be distinguishable under the constantly humid conditions of flooded rice culture in view of the

research and development already done. In order to include newer formulation in the package of practices, present studies were conducted and results thus obtained are presented herein. The formulation we taken for the study was carbofuran 3CG in comparison with the commercial pesticide formulations for 2 consecutive years at ARS, Gangavathi.

Material and Methods

Experiment was carried out at Agricultural Research Station, Gangavathi, Karnataka for two seasons during *kharif* 2017 and *kharif* 2018 in a randomized block design with seven treatments and three replications. Treatment details are given in table 1. Insecticides application as soil and sprays were taken up based on seasonal occurrence and Economic Threshold Level (ETL) of yellow stem borer and leaf folder. Observations were made for stem borer by selecting 10 hills from each plot and tagged as observation hills. Recorded observation one day before application of the treatment and 1, 7, 10 and 15 days after application of each spray and the post-treatment white ear heads are recorded at dough stage. Number of dead hearts/white ears and total of tillers/panicle from 10 randomly selected hills were recorded and the per cent incidence (Dead heart/white ears) was calculated as follows;

$$= \left[\frac{\text{No. of dead heart/white ears}}{\text{Total no. of tillers/panicles}} \right] \times 100$$

Table: Details of the treatment

Sl. No.	Treatments detail	Dose (*g.a.i*/ha)	Formulation dosage (kg/ml /ha)
1	Carbofuran 3 CG	750	25
2	Carbofuran 3 CG	1500	50
3	Carbofuran 3 CG	3000	100
4	Fipronil 0.3% G	75	25
5	Carbosulfan 25% EC	250	1000
6	Cartap hydrochloride 4% G	750	18.75
7	Untreated check	-	-

Further, these data were subjected to square root transformation and applied the statistical tool for analysis. The data recorded as above were subjected to ANOVA after transforming them to arcsine value. The data on grain yield at maturity were recorded from each individual plot, converted to hectare basis and subjected to ANOVA.

Impact on natural enemies

The numbers of predatory natural enemies like mirid bugs and spiders were recorded on 10 randomly selected hills at zero day (before first application of insecticidal treatment), 7 and 10 days after each spray and presented as average number per hill. Further, these data were subjected to statistical analysis after transforming them to $\sqrt{x+1}$.

Results and discussion

Stem borer (*Scirpophaga incertulas* Walker)

Before imposition of insecticides, the per cent dead heart was uniform and crossed the economic threshold level which ranged from 4.92 to 5.12 per cent and 5.23 to 5.48 per cent dead heart per hill (Table 1 & 2) during *kharif* 2017 and 2018 respectively. However, variation was observed only after imposition of the treatments. The higher dose of carbofuran 3CG @ 3000 *g.a.i.*/ha recorded significantly less per cent of dead heart as compared to untreated check at 7 days after first application during both the years but it was at par with its middle and lower dosages *viz.*, 1500 and 750 *g.a.i.*/ha, respectively. Similar trend was noticed at 10 and 15 days after first application during both the years. The higher dosages of carbofuran 3CG @ 3000 *g.a.i.*/ha proved their efficacy in suppressing the per cent dead heart even at 15 days after first application. The maximum of 62.11 and 62.01 per cent reduction over control recorded in carbofuran 3CG @ 3000 *g.a.i.*/ha and was at par with same insecticide of 1500 *g.a.i.*/ha followed by fipronil 0.3 GR @ 75*g.a.i.*/ha and carbofuran 3CG @ 750 *g.a.i.*/ha in both the years *kharif* 2017 and 2018 (Table 1 & 2).

Similar trend was noticed at 7, 10 and 15 days after second application also. carbofuran 3CG @ 3000 and 1500 *g.a.i.*/ha were found to be effective and superior treatments in reducing per cent dead heart at 15 days after second application. The higher and middle dosage (3000 and 1500 *g.a.i.*/ha) of carbofuran 3CG recorded maximum per cent reduction over control followed by fipronil 0.3GR @ 75 g.*a.i.*/ha and carbofuran 3CG @ 750 *g.a.i.*/ha. Whereas, least per cent reduction over control was observed in cartap hydrochloride 4G @ 750 *g.a.i.*/ha (Table 1 & 2).

The data on per cent white ear heads due to stem borer attack was recorded at pre harvesting stage. Higher dose (3000 *g.a.i.*/ha) of carbofuran 3CG recorded lowest per cent white ear heads of 2.25 and 2.41 per cent followed by carbofuran 3CG @ 1500 *g.a.i.*/ha (3.04 & 3.25%), fipronil 0.3GR @ 75 *g.a.i.*/ha (4.64 & 4.96%) and carbofuran 3CG@ 750 *g.a.i.*/ha (4.72 & 5.05%). Whereas the higher per cent white ear head was recorded in untreated check (12.14 & 12.99%) during kharif 2017 and 2018 (Table 1 & 2). The results are in line with the earlier authors Aulakh *et al.* (2016) [1] who studied efficacy of granular insecticides. The percent dead heart and white ears were significantly lower in plots treated with granular insecticides. Wakil *et al*. (2001) [15] who reported the efficacy of Furadan, a granular insecticide against stem borer on basmati rice. Singh *et al*. (2009) [13] also proclaimed the efficacy of another granular insecticide against the stem borers. Earlier also some scientists approved the efficacy of insecticides against stem borers (Rath, 2012 and Sarao and Mahal, 2008) [10, 12].

Leaf folder, *Cnaphalocrocis medinalis* Guenee

Population of leaf folder larvae was uniform and crossed ETL before application of insecticides. Variation was not observed at 1 day after first spray. However, variation was noticed at 7 days after first spray, where higher dosage of carbofuran 3CG @ 3000 *g.a.i.*/ha was found to be superior treatment in reducing leaf folder larvae (2.24 & 2.42 larvae/hill) and was followed by carbofuran 3CG @ 1500 *g.a.i.*/ha, fipronil 0.3% GR @ 75 *g.a.i.*/ha and carbofuran 3CG @ 750 *g.a.i.*/ha, respectively during both the years (Table 3 & 4). Significantly higher larval population was noticed in untreated check (4.29 & 4.63 larvae /hill) at 7 days after first application in both the years. Similar trend was noticed at 10 and 15 days after first

application. The highest per cent reduction over control was recorded in carbofuran 3CG @ 3000 *g.a.i.*/ha and it was at par with same insecticide @ 1500 *g.a.i.*/ha. The next best treatments were fipronil 0.3%GR @ 75 *g.a.i.*/ha and carbofuran 3CG @ 750 *g.a.i.*/ha with 57.81 and 57.32 per cent reduction over control, respectively (Table 3 & 4).

Results of second application also revealed the same trend, carbofuran 3CG @ 3000 and 1500 *g.a.i.*/ha were equally effective in suppressing leaf folder larval population as against untreated check during both the years. The other treatements *viz.*, fipronil 0.3% GR, carbofuran 3CG**,** carbosulfan 25% EC and cartap hydrochloride 4G at 75, 750, 250 and 750 *g.a.i.*/ha was also found to be superior over untreated check at 7 days after second application. Similar trend was noticed at 10 and 15 days after second application. The higher dosages carbofuran 3CG @ 3000 and 1500 *g.a.i.*/ha were found to be superior in suppressing the leaf folder larval population effectively during both *kharif* 2017 and 2018. The next best treatments were fipronil 0.3%GR @ 75 *g.a.i.*/ha and carbofuran 3CG @ 750 *g.a.i.*/ha (Table 3 & 4). Over all, all the dosages carbofuran 3CG *viz.*, 3000, 1500 and 750*g.a.i.*/ha were found to be excellent insecticide in suppressing the leaf folder larval population during *kharif* 2017 and 2018 in paddy crop. These observations were corroborated by the findings of Prasad and Premchand (1995) [9] who reported the efficacy of cartap hydrochloride in reducing the leaf folder infestation. Karthikeyan *et al*. (2008) [5] reported that the phosphamidon granules were highly effective in managing *C. medinalis* in rice. Dhawan *et al*. (2010) [3] found that leaf folder incidence was significantly low at all the doses of thiocyclam hydrogen oxalate 4G. Similarly, Kumar *et al*. (2010) [6] and Sontakke and Dash (2000) [14] demonstrated that efficacy of granular formulations leaf folder.

Impact on Yield

Grain yield in all the dosages of carbofuran 3CG was significantly higher when compared to untreated check (26.33 and 27.65 q/ha). Significantly higher grain yield of 58.33 and 61.25 q/ha was recorded in carbofuran 3CG @ 3000 *g.a.i.*/ha during *kharif* 2017 and 2018 respectively, and it was followed by the dosage carbofuran 3CG @ 1500 *g.a.i.*/ha, carbofuran 3CG @ 750 *g.a.i.*/ha and fipronil 0.3%GR @ 75 *g.a.i.*/ha (Table 5). Aulakh *et al.* (2016) [1] concluded that all the granular insecticides increase the grain yield as compared with untreated plots. Dhawan *et al*. (2010) [3] also reported that yield was at par with different doses of thiocyclam hydrogen oxalate 4G and check insecticide.

Impact on natural enemies

In the field trial carried out to evaluate bio-efficacy of carbofuran 3CG at 3000, 1500 and 750 *g.a.i.*/ha in comparison to market sample as well as standard check insecticides against paddy pests in *kharif* -2017 and 2018, the population of natural enemies like predatory mirid bugs and spiders were comparatively low in all the insecticidal treatment when compared with untreated check. However, all treatments were statistically non-significant (Table 6 & 7). These results are corroborate with Reissig *et al.* (1982) [11] who studied the impact of granular insecticides on natural enemies in paddy and found that more number of natural enemies in untreated plot compared to the sprayed plots. Previous studies also demonstrated that insecticides are generalLy more toxic to *C. lividipennis* than spiders (Chiu, 1979) [2].

Based on the two year evaluations it can be concluded that, the granular insecticide carbofuran 3CG @ 3000-750 *g.a.i.*/ha found overall superior in reducing the dead heart, white ear head, leaf folder damage and obtaining the higher grain yield followed by fipronil0.3%GR @ 75 *g.a.i.*/ha. All the insecticidal treatments including standard check recorded lower population of natural enemies (predatory mirid bugs and spiders) compared to untreated check. However, statistically all treatments were found at par.

Table 1: Efficacy of carbofuran 3CG on per cent dead heart by yellow stem borer on paddy during *kharif* 2017

Treatment	Product name	Dose (*g.a.i*/ha)	Per cent dead heart												White ear head (%)
			First application						Second application						
			1DBA	1DAA	7DAA	10DAA	15DAA	%ROC	1DBA	1DAA	7DAA	10DAA	15DAA	%ROC	
T1	Carbofuran 3CG	750	5.12 (13.92)	5.14 (13.97)	3.21 (8.73)	2.77 (7.53)	2.58 (7.01)	53.00	2.94 (7.99)	2.97 (8.07)	1.64 (4.46)	1.16 (3.15)	0.98 (2.66)	82.65	4.72 (9.63)
T2	Carbofuran 3CG	1500	4.89 (13.29)	4.92 (13.37)	2.86 (7.77)	2.35 (6.39)	2.13 (5.79)	61.12	2.42 (6.58)	2.43 (6.61)	1.11 (3.02)	0.67 (1.82)	0.47 (1.28)	91.68	3.04 (7.60)
T3	Carbofuran 3CG	3000	4.96 (13.48)	4.97 (13.51)	2.80 (7.61)	2.29 (6.23)	2.08 (5.65)	62.11	2.36 (6.42)	2.40 (6.52)	1.08 (2.94)	0.61 (1.66)	0.43 (1.17)	92.38	2.25 (6.65)
T4	Fipronil 0.3%GR	75	5.01 (13.62)	5.03 (13.67)	3.16 (8.59)	2.75 (7.48)	2.55 (6.93)	53.55	2.89 (7.86)	2.91 (7.91)	1.57 (4.27)	1.11 (3.02)	0.91 (2.47)	83.89	4.64 (9.59)
T5	Carbosulfan 25%EC	250	5.07 (13.78)	5.01 (13.62)	3.47 (9.43)	3.08 (8.37)	2.91 (7.91)	46.99	3.21 (8.73)	3.19 (8.67)	2.04 (5.55)	1.57 (4.27)	1.33 (3.62)	76.46	7.29 (11.24)
T6	Cartap hydrochloride 4G	750	4.92 (13.37)	4.93 (13.40)	3.61 (9.81)	3.29 (8.94)	3.09 (8.40)	43.71	3.39 (9.22)	3.42 (9.30)	2.11 (5.74)	1.63 (4.43)	1.42 (3.86)	74.86	8.58 (12.50)
T7	Untreated control	-	4.99 (13.56)	5.01 (13.40)	5.36 (14.57)	5.41 (14.71)	5.49 (14.92)	-	5.61 (15.25)	5.62 (15.28)	5.67 (15.41)	5.70 (15.49)	5.65 (15.36)	-	12.14 (15.22)
S Em±			0.03	0.03	0.33	0.41	0.46		0.43	0.43	0.68	0.79	0.82		0.82
CD (p=0.05)			0.10	0.09	1.02	1.27	1.41		1.34	1.33	2.09	2.42	2.54		2.53
CV %			7.56	8.80	8.97	6.72	9.03		8.42	9.47	6.58	8.07	7.23		9.81

Figures in parentheses are arc sine transferred values. DBA=Days before application, DAA=Days after application, %ROC: Per cent Reduction over control

Table 2: Efficacy of carbofuran 3CG on per cent dead heart by yellow stem borer on paddy during *kharif* 2018

Treatment	Product name	Dose (*g.a.i*/ha)	Per cent dead heart												White ear head (%)
			First application						Second application						
			1DBA	1DAA	7DAA	10DAA	15DAA	%ROC	1DBA	1DAA	7DAA	10DAA	15DAA	%ROC	
T1	Carbofuran 3CG	750	5.48 (14.89)	5.50 (14.95)	3.43 (9.34)	2.96 (8.06)	2.76 (7.50)	50.92	3.15 (8.55)	3.18 (8.63)	1.75 (4.77)	1.24 (3.37)	1.05 (2.85)	85.71	5.05 (10.30)
T2	Carbofuran 3CG	1500	5.23 (14.22)	5.26 (14.31)	3.06 (8.31)	2.51 (6.84)	2.28 (6.20)	60.84	2.59 (7.04)	2.60 (7.07)	1.19 (3.23)	0.72 (1.95)	0.50 (1.37)	96.83	3.25 (8.13)
T3	Carbofuran 3CG	3000	5.31 (14.42)	5.32 (14.46)	3.00 (8.14)	2.45 (6.67)	2.23 (6.05)	61.98	2.53 (6.87)	2.57 (6.98)	1.16 (3.15)	0.65 (1.78)	0.46 (1.25)	97.22	2.41 (7.12)
T4	Fipronil 0.3%GR	75	5.36 (14.57)	5.38 (14.63)	3.38 (9.19)	2.94 (8.00)	2.73 (7.42)	51.87	3.09 (8.41)	3.11 (8.46)	1.68 (4.57)	1.19 (3.23)	0.97 (2.64)	86.29	4.96 (10.26)
T5	Carbosulfan 25%EC	250	5.42 (14.74)	5.36 (14.57)	3.71 (10.09)	3.30 (8.96)	3.11 (8.46)	45.77	3.43 (9.34)	3.41 (9.28)	2.18 (5.94)	1.68 (4.57)	1.42 (3.87)	78.43	7.80 (12.03)
T6	Cartap hydrochloride 4G	750	5.26 (14.31)	5.28 (14.34)	3.86 (10.50)	3.52 (9.57)	3.31 (8.99)	42.33	3.63 (9.87)	3.66 (9.95)	2.26 (6.14)	1.74 (4.74)	1.52 (4.13)	76.69	9.18 (13.38)
T7	Untreated control	-	5.34 (14.51)	5.36 (14.34)	5.74 (15.59)	5.79 (15.74)	5.87 (15.96)	-	6.00 (16.32)	6.01 (16.35)	NS 0.00	6.10 (16.57)	NS (0.00)	-	12.99 (16.29)
S Em±			0.03	0.03	0.35	0.44	0.49		0.46	0.46	0.73	0.85	0.88		0.88
CD (p=0.05)			0.11	0.10	1.09	1.36	1.51		1.43	1.42	2.24	2.59	2.72		2.71
CV %			8.09	9.42	9.60	7.19	9.66		9.01	10.13	7.04	8.63	7.74		10.50

Figures in parentheses are arc sine transferred values. DBA=Days before application, DAA=Days after application, %ROC: Per cent Reduction over control

Table 3: Efficacy of carbofuran 3CG on larvae of leaf folder on paddy during *kharif* 2017

Treatment	Product name	Dose (*g.a.i*/ha)	Larvae/hill											
			First application						Second application					
			1DBA	1DAA	7DAA	10DAA	15DAA	%ROC	1DBA	1DAA	7DAA	10DAA	15DAA	%ROC
T1	Carbofuran 3CG	750	4.10 (11.13)	4.11 (11.18)	2.57 (6.98)	2.22 (6.02)	2.06 (5.61)	53.07	2.35 (6.39)	2.38 (6.46)	1.31 (3.57)	0.93 (2.52)	0.78 (2.13)	82.74
T2	Carbofuran 3CG	1500	3.91 (10.63)	3.94 (10.70)	2.29 (6.22)	1.88 (5.11)	1.70 (4.63)	61.27	1.94 (5.26)	1.94 (5.28)	0.89 (2.41)	0.54 (1.46)	0.38 (1.02)	91.59
T3	Carbofuran 3CG	3000	3.97 (10.79)	3.98 (10.81)	2.24 (6.09)	1.83 (4.98)	1.66 (4.52)	62.18	1.89 (5.13)	1.92 (5.22)	0.86 (2.35)	0.49 (1.33)	0.34 (0.94)	92.47
T4	Fipronil 0.3%GR	75	4.01 (10.90)	4.02 (10.94)	2.53 (6.87)	2.20 (5.98)	2.04 (5.55)	53.53	2.31 (6.28)	2.33 (6.33)	1.26 (3.41)	0.89 (2.41)	0.73 (1.98)	83.84
T5	Carbosulfan 25%EC	250	4.06 (11.03)	4.01 (10.90)	2.78 (7.55)	2.46 (6.70)	2.33 (6.33)	46.2	2.57 (6.98)	2.55 (6.94)	1.63 (4.44)	1.26 (3.41)	1.06 (2.89)	77.54
T6	Cartap hydrochloride 4G	750	3.94 (10.70)	3.94 (10.72)	2.89 (7.85)	2.63 (7.15)	2.47 (6.72)	43.73	2.71 (7.37)	2.74 (7.44)	1.69 (4.59)	1.30 (3.54)	1.14 (3.09)	74.77
T7	Untreated control	-	3.99 (10.85)	4.01 (10.90)	4.29 (11.66)	4.33 (11.77)	4.39 (11.94)	-	4.49 (12.20)	4.50 (12.22)	4.54 (12.33)	4.56 (12.40)	4.52 (12.29)	-
SEm±			0.03	0.03	0.31	0.39	0.44		0.41	0.41	0.65	0.75	0.78	
CD (p=0.05)			0.10	0.09	0.97	1.21	1.34		1.27	1.26	1.99	2.30	2.41	
CV %			6.64	7.66	6.77	6.38	7.63		6.15	5.20	6.30	5.82	6.02	

Figures in parentheses are arc sine transferred values. DBA=Days before application, DAA=Days after application, %ROC: Per cent Reduction

Table 4: Efficacy of carbofuran 3CG on larvae of leaf folder on paddy during *kharif* 2018

Treatment	Product name	Dose (*g.a.i*/ha)	Larvae/hill											
			First application						Second application					
			1DBA	1DAA	7DAA	10DAA	15DAA	%ROC	1DBA	1DAA	7DAA	10DAA	15DAA	%ROC
T1	Carbofuran 3CG	750	4.43 (12.02)	4.44 (12.07)	2.78 (7.54)	2.40 (6.50)	2.22 (6.06)	53.16	2.54 (6.90)	2.57 (6.98)	1.41 (3.86)	1.00 (2.72)	0.84 (2.30)	82.78
T2	Carbofuran 3CG	1500	4.22 (11.48)	4.26 (11.56)	2.47 (6.72)	2.03 (5.52)	1.84 (5.00)	61.18	2.10 (5.68)	2.10 (5.70)	0.96 (2.60)	0.58 (1.58)	0.41 (1.10)	91.59
T3	Carbofuran 3CG	3000	4.29 (11.65)	4.30 (11.67)	2.42 (6.58)	1.98 (5.38)	1.79 (4.88)	62.23	2.04 (5.54)	2.07 (5.64)	0.93 (2.54)	0.53 (1.44)	0.37 (1.02)	92.41
T4	Fipronil 0.3%GR	75	4.33 (11.77)	4.34 (11.82)	2.73 (7.42)	2.38 (6.46)	2.20 (5.99)	53.58	2.49 (6.78)	2.52 (6.84)	1.36 (3.68)	0.96 (2.60)	0.79 (2.14)	83.81
T5	Carbosulfan 25%EC	250	4.38 (11.91)	4.33 (11.77)	3.00 (8.15)	2.66 (7.24)	2.52 (6.84)	46.83	2.78 (7.54)	2.75 (7.50)	1.76 (4.80)	1.36 (3.68)	1.14 (3.12)	76.63
T6	Cartap hydrochloride 4G	750	4.26 (11.56)	4.26 (11.58)	3.12 (8.48)	2.84 (7.72)	2.67 (7.26)	43.67	2.93 (7.96)	2.96 (8.04)	1.83 (4.96)	1.40 (3.82)	1.23 (3.34)	74.79
T7	Untreated control	-	4.31 (11.72)	4.33 (11.77)	4.63 (12.59)	4.68 (12.71)	4.74 (12.90)	-	4.85 (13.18)	4.86 (13.20)	4.90 (13.32)	4.92 (13.39)	4.88 (13.27)	-
SEm±			0.03	0.03	0.33	0.42	0.48		0.44	0.44	0.70	0.81	0.84	
CD (p=0.05)			0.11	0.10	1.05	1.31	1.45		1.37	1.36	2.14	2.48	2.60	
CV %			7.17	8.27	7.31	6.89	8.24		6.64	5.61	6.80	6.28	6.50	

Figures in parentheses are arc sine transferred values. DBA=Days before application, DAA=Days after application, %ROC: Per cent Reduction over control

Table 5: Impact of carbofuran 3CG on paddy yield during *kharif* 2017 and 2018

Sl. No	Treatment details	Dose (*g.a.i*/ha)	Yield (q/ha) *(kharif* 2017)	Yield (q/ha) *(kharif* 2018)
1	Carbofuran 3CG	750	51.67 (7.19)	54.95 (7.67)
2	Carbofuran 3CG	1500	55.89 (7.50)	58.68 (7.88)
3	Carbofuran 3CG	3000	58.33 (7.70)	61.25 (8.09)
4	Fipronil 5% SC	1500	52.33 (7.30)	54.25 (7.55)
5	Carbosulfan 25%EC	250	47.33 (6.93)	49.70 (7.28)
6	Cartap hydrochloride 4G	750	45.67 (6.73)	47.95 (7.07)
7	Untreated control	--	26.33 (5.22)	27.65 (5.48)
SEm ±			1.51	1.59
CD AT 5 %			4.53	4.76
CV (%)			7.87	8.26

Table 6: Impact of carbofuran 3CG on natural enemies in paddy ecosystem during *kharif* 2017

Sl. No	Treatment details	Dosage (ml/ha)	No. of mirid bugs/ hill					No. of spiders/ hill				
			First application			Second application		First application			Second application	
			1 DBS	7 DAS	10 DAS	7 DAS	10 DAS	1 DBS	7 DAS	10 DAS	7 DAS	10 DAS
1	Carbofuran 3CG	750	6.65 (2.82)	4.33 (2.31)	5.33 (2.51)	3.67 (2.15)	3.33 (2.06)	6.67 (2.75)	4.67 (2.37)	5.00 (2.44)	3.33 (2.07)	4.33 (2.29)
2	Carbofuran 3CG	1500	7.29 (2.77)	4.67 (2.37)	5.67 (2.58)	3.33 (2.06)	3.00 (1.95)	7.00 (2.82)	5.00 (2.41)	5.33 (2.51)	3.67 (2.15)	4.00 (2.21)
3	Carbofuran 3CG	3000	5.39 (2.56)	3.33 (2.08)	4.00 (2.23)	2.67 (1.90)	2.00 (1.72)	6.33 (2.69)	3.67 (2.15)	4.33 (2.29)	2.33 (1.82)	3.33 (2.06)
4	Fipronil 5% SC	1500	6.96 (2.86)	5.00 (2.44)	4.67 (2.37)	4.00 (2.23)	3.67 (2.14)	7.67 (2.92)	6.00 (2.64)	6.33 (2.70)	4.33 (2.29)	5.67 (2.58)
5	Carbosulfan 25%EC	250	7.91 (2.90)	5.00 (2.43)	6.00 (2.63)	3.67 (2.15)	3.33 (2.06)	7.33 (2.88)	5.67 (2.56)	6.00 (2.62)	4.00 (2.22)	5.33 (2.48)
6	Cartap hydrochloride 4G	750	7.29 (2.93)	4.67 (2.37)	5.33 (2.51)	3.33 (2.06)	3.00 (1.97)	8.00 (2.98)	6.33 (2.68)	6.67 (2.76)	4.67 (2.35)	6.00 (2.63)
7	Untreated control	--	7.91 (3.02)	9.67 (3.25)	10.67 (3.40)	10.67 (3.40)	11.67 (3.54)	8.67 (3.08)	9.67 (3.24)	10.00 (3.30)	10.33 (3.34)	10.33 (3.34)
SEm ±			0.32	0.68	0.69	0.90	1.10	0.25	0.66	0.61	0.90	0.78
CD AT 5 %			0.97	2.05	2.08	2.71	3.29	0.76	1.98	1.83	2.69	2.34
CV (%)			8.04	7.81	7.72	8.63	9.42	11.20	9.12	7.29	9.39	9.85

Values are mean of three replications; DBS=Day before spray; DAS= Day after spray; Figures in the parenthesis are √ x+1 transferred value.

Table 7: Impact of carbofuran 3CG on natural enemies in paddy ecosystem during *kharif* 2018

Sl. No	Treatment details	Dose (*g.a.i*/ha)	No. of mirid bugs/hill					No. of spiders/hill				
			First application			Second application		First application			Second application	
			1 DBS	7 DAS	10 DAS	7 DAS	10 DAS	1 DBS	7 DAS	10 DAS	7 DAS	10 DAS
1	Carbofuran 3CG	750	7.05 (2.99)	4.59 (2.45)	5.65 (2.66)	3.89 (2.28)	3.53 (2.18)	7.47 (3.17)	4.87 (2.60)	5.99 (2.82)	4.12 (2.42)	3.74 (2.31)
2	Carbofuran 3CG	1500	7.73 (2.94)	4.95 (2.51)	6.01 (2.73)	3.53 (2.18)	3.18 (2.07)	8.19 (3.11)	5.25 (2.66)	6.37 (2.90)	3.74 (2.31)	3.37 (2.19)
3	Carbofuran 3CG	3000	5.71 (2.71)	3.53 (2.20)	4.24 (2.36)	2.83 (2.01)	2.12 (1.82)	6.06 (2.88)	3.74 (2.34)	4.49 (2.51)	3.00 (2.13)	2.25 (1.93)
4	Fipronil 5% SC	1500	7.38 (3.03)	5.30 (2.59)	4.95 (2.51)	4.24 (2.36)	3.89 (2.27)	7.82 (3.21)	5.62 (2.74)	5.25 (2.66)	4.49 (2.51)	4.12 (2.40)
5	Carbosulfan 25%EC	250	8.38 (3.07)	5.30 (2.58)	6.36 (2.79)	3.89 (2.28)	3.53 (2.18)	8.89 (3.26)	5.62 (2.73)	6.74 (2.96)	4.12 (2.42)	3.74 (2.31)
6	Cartap hydrochloride 4G	750	7.73 (3.11)	4.95 (2.51)	5.65 (2.66)	3.53 (2.18)	3.18 (2.09)	8.19 (3.29)	5.25 (2.66)	5.99 (2.82)	3.74 (2.31)	3.37 (2.21)
7	Untreated control	--	8.38 (3.20)	10.25 (3.45)	11.31 (3.60)	11.31 (3.60)	12.37 (3.75)	8.89 (3.39)	10.87 (3.65)	11.99 (3.82)	11.99 (3.82)	13.11 (3.98)
S Em ±			0.34	0.72	0.73	0.95	1.17	0.36	0.76	0.78	1.01	1.24
CD AT 5 %			1.03	2.17	2.20	2.87	3.49	1.09	2.30	2.34	3.04	3.70
CV (%)			8.52	8.28	8.18	9.15	9.99	9.03	8.78	8.67	9.70	10.58

Values are mean of three replications; DBS=Day before spray; DAS= Day after spray; Figures in the parenthesis are √ x+1 transferred value.

Reference

1. Aulakh SS, Randhawa HS, Mandeep Singh. Bioefficacy of insecticides for management of stem borer and leaf folder on paddy in Punjab, India. Punjab Agricultural University, Agric. Sci. Digest. 2016; 36(3):224-227.
2. Chiu. Biological control of the brown planthopper. In Brown planthopper: threat to rice production in Asia. IRRI, Los Banos, Philippines. 369, 1979.
3. Dhaliwal GS, Jindal V, Dhawan AK. Insect pest problems and crop losses: Changing trends. Indian J. Ecol. 2010; 37(1):1-7.

4. Dhawan AK, Mahal MS, Sarao PS, Virk JS, Singh R, Kaur R. Efficacy of Thiocyclam Hydrogen Oxalate as Foliar Sprays against Stem borers and Leaf folder in Rice. Indian J Plant Prot. 2010; 38(2):166-169.
5. Karthikeyan KS, Purushothaman P Revi S. Bioefficacy of phosphamidon granules in the management of major rice pests. Indian J Plant Prot. 2008; 36:128-29.
6. Kumar J, Shakil NA, Chander S, Walia S, Shukla L, Parmar BS. Field appraisal of controlled release formulations of cartap hydrochloride against rice leaf folder Cnaphalocrocis medinalis. Indian J Agric. Sci. 2010; 80:405-408.
7. Pathak MD, Verma SK, Khan ZR. Insect pests of rice. IRRI, Manila. 1994; 19:89.
8. Pathak PK, Verma SK, Lal MN. Occurance of insect pests of rice. Directorate of Experiment Station, G. B. Pant University of Agriculture and Technology, Pantnagar, India. 1974; 21(3):69-71.
9. Prasad A, Premchand PD. Evaluation of some newer insecticides for the control of rice leaf folder, Cnaphalocrocis medinalis Guenee. Indian J Entomol. 1995; 57:424-426.
10. Rath LK, Mohapatra RN, Nayak US, Tripathy P. Evaluation of new molecules against yellow stem borer infesting rice. In: National Symposium on Emerging Trends in Pest Management Strategies under Changing Climatic Scenario, OUAT, Bhubaneswar, Odisha. 145, 2012.
11. Reissig WH, Heinrichs SE, Valencia SL. Effects of insecticides on *Nilaparvata lugens* and its Predators: Spiders, *Microvelia atrolineata* and Cyrtorhinus lividipennis. Environ. Entomol. 1982; 11(1):193-199.
12. Sarao PS, Mahal MS. Comparative efficacy of insecticides against major insect pests of rice in Punjab. Pesticide Res. J. 2008; 20:52-58.
13. Singh B, Sarao PS, Mahal MS. Comparative bioefficacy of granular insecticides against major lepidopteron insect pests of Basmati rice in Punjab. J Insect Sci. 2009; 22:431-434.
14. Sontakke BK, Dash AN. Field efficacy of some new granular insecticides against major pests of rice. Indian J Entomol. 2000; 62:353-357.
15. Wakil W, Hasan M, Akbar R, Gulzar A. Evaluation of different insecticides against rice stem borer and rice leaf folder. Pakistan J Agric. Sci. 2001; 38:3-4.