Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

J E Z S Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2020; 8(1): 1281-1286

Received: 08-11-2019
Accepted: 12-12-2019

Lakshman Chandra Patel
Department of Agriculture Entomology, College of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Agril. Farm Gate 1, Kalna Road, Burdwan, West Bengal, India

Corresponding Author:
Lakshman Chandra Patel
Department of Agriculture Entomology, College of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Agril. Farm Gate 1, Kalna Road, Burdwan, West Bengal, India

Field efficacy of a mix formulation, emamectin benzoate 0.25 + cartap hydrochloride 7.5 GR against *Scirpophaga incertulas* in paddy

Lakshman Chandra Patel

Abstract
Comparative field efficacy of emamectin benzoate + cartap hydrochloride was judged against *Scirpophaga incertulas* in paddy during kharif 2017 and winter 2017-18. Seven treatments (3 different doses of emamectin benzoate + cartap hydrochloride, cartap hydrochloride, emamectin benzoate, chlorantraniliprole + thiamethoxam and untreated control) were applied to find out percent reduction of damage, yield, benefit cost ratio (B:C) and safety to natural enemies. Emamectin benzoate + cartap hydrochloride @ 9 kg/ha resulted highest reduction of dead heart (97.5%) and white ear (93.4%) over control. It was at par with 7.5 kg/ha resulting respective reduction by 96.7 and 92.8%. The highest yield measuring 44.7 and 45.4 q/ha & B:C with 10.5 and 12.8 respectively during kharif, 2017 and winter, 2017-18 were also obtained in Emamectin benzoate + cartap hydrochloride @ 9 kg/ha. Again, it was statistically at par with 7.5 kg/ha in respect to yield (43.6 and 44.7 q/ha) and B: C (11.1 and 14.3), respectively. In both doses, no detrimental effect was noticed against available natural enemies of insects. Considering highest B:C, the lower dose @ 7.5 kg/ha could be recommended for economic use in rice for effective control of *S. incertulas*.

Keywords: Cartap, efficacy, emamectin benzoate, paddy, *Scirpophaga incertulas*

Introduction
Rice (*Oryza sativa* L.) belonging to the family Graminae, is one of the most important food crops not only in India but in world too (Kumar *et al.*, 2015) [11]. West Bengal is the largest rice producing state in India. In the fiscal year 2016, the state produced about 15.8 million tonnes of rice over 5.5 million hectare cultivable area followed by 12.5 million tonnes from 5.9 million hectare in Uttar Pradesh (Anon, 2018) [2]. Three seasons' paddy cultivation *viz.* autumn, kharif and winter are practiced under diverse rice growing irrigated or rainfed situations (Raut *et al.*, 2017) [25].

One of the main causes of low yields of rice in the tropical Asian countries is due to damages by the insect pests (Matteson, 2000) [16]. In India, about 30% yield loss is reported by attacking 20 major pests among reported 100 pests in rice (Cramer, 1967 [6]; Pathak and Dhaliwal, 1981 [21]; Atwal and Dhaliwal, 2005 [3] and Mondal *et al.*, 2017) [17]. It has happened due to over use of nitrogenous fertilizers, modern varieties, year-round cultivation, mono cropping, non-judicious use of insecticides etc. (Gupta *et al.*, 2002) [9]. Among them, farmers are mostly worried for yellow stem borer (YSB) (*Scirpophaga incertulas* Walker) as a regular destructive, dominating and monophagous key insect pest of rice in all crop seasons throughout India (Dhaliwal *et al.*, 1996 [7], Mahar *et al.*, 1985) [15]. The larva by feeding inside the stem can produce dead heart in vegetative stage and white ear head at reproductive stage. Such damage is positively correlated with remarkable yield loss (Rahman *et al.*, 2004) [24]. An annual yield loss of 5 – 10% has reported by Pathak and Khan (1994) [22]. In case of heavy infestation with more than 5 white ear head per hill can cause 80% yield loss (Pallavi *et al.*, 2018a) [19]. Severe infestation by YSB often results in complete crop failure (Kushwaha, 1995) [13].

As there is no full proof method to get rid of YSB either through a resistant variety or through certain biological agents, the judicious use of insecticides becomes unavoidable (Pallavi *et al.*, 2018b) [20]. Paddy farmers still date mostly rely on various chemicals for management of YSB throughout the country. Indiscriminate use of these resulted in reduction of natural enemies, environmental pollution and residues in seeds etc. New molecules are now emerging as a viable component of IPM strategies in all crops in view of their good efficacy to pest control and safety to non target organisms (Sachan *et al.*, 2018) [27].

It is generally a continuous process to assess the field efficacy of time to time developed new different synthetic insecticides against any major insect. This process has been carried out against YSB by Khan and Khaliq (1989) [10]; Kushwaha (1995) [13]; Saljoqi *et al.* (2002) [28]; Prasad and Prasad (2006) [23]; Sasmal *et al.* (2007) [29]; Chatterjee and Mondal (2014) [5], Longkumar *et al.* (2017) [14]; Pallavi *et al.* (2018b) [20]; Sachan *et al.* (2018) [27]. The pre-mixed formulated new insecticide may be more effective in reducing the damage, cost effective and comparatively safer to natural enemies (Roy *et al.*, 2017) [26]. Keeping in view of the above, in the present study, an attempt has been made to evaluate the efficacy of another new molecule emamectin benzoate 0.25 + cartap hydrochloride 7.5 GR against YSB in transplanted rice.

Materials and Methods

The present field experiment was carried out at instructional farm of College of Agriculture, BCKV, Farm Gate 1, Kalna Road, Burdwan, W.B., India for two seasons i.e. kharif 2017 and winter 2017-18. Seven treatments including one untreated control with three replications for each were followed in a randomized block design. The paddy variety 'Shatabdi (IET 4786)' was grown at a spacing of about 20 x 15 cm in each plot size of about 5 m x 5m. The recommended agronomic practices for fertilizers and other intercultural operations were maintained for raising it. Treatments were applied for two times at 20 days interval for both the seasons. The first application was given at 35 days after transplanting.

The incidence of yellow stem borer (YSB) was recorded for dead heart (Early stage i.e. vegetative stage) and white ear head (Late stage i.e. grain filling stage) for both the seasons. Observation on dead heart was recorded before application as well as 5, 10 and 15 days after each application. But, observation on white ear head was made at final grain filling stage (before harvest). The percent incidence of damage made by YSB was calculated by counting the number of damaged tillers and total number of tillers per hill. The percent reduction in dead heart as well as in white ear head over control was also worked out for the different treatments. Observation both for dead heart and white ear head was taken from ten randomly selected hills per plot. Yield was also recorded from each plot separately and it was converted into q/ha. To judge the safety of different insecticides on natural enemies, population of dragonflies/plot and spiders/hill was counted at immediate before and 10 days after application of treatments. Last instars nymph of dragonfly crawling up on the plant from water was considered for their population counting. All these data on crop damage (dead heart and white ear head), yield and natural enemies were subjected to analysis of variance after making necessary transformation. Treatment wise incremental cost benefit (C:B) ratio was also calculated.

Results and Discussions

Insecticidal efficacy against *Scirpophaga incertulas*

Pre-treatment observations on kharif paddy, 2017 recorded statistically at par 5.3 to 5.8% dead hearts by *S. incertulas* (Table 1). The data taken at 5, 10 and 15 days after each of two round applications indicates that all insecticides were found effective and significantly superior over untreated control. The most effective treatment was emamectin benzoate 0.25% + cartap hydrochloride 7.5% GR @ 9 kg/ha that resulted 97.6 and 93.6% reduction respectively in dead hearts and white ears over control. It was significantly at par with its immediate lower dose @ 7.5 kg/ha resulting 96.8 and 92.9% reduction in same damages. The other effective treatments in descending order of efficacy for respective reduction of dead hearts and white ears over untreated control were chlorantraniliprole 0.5% + thiamethoxam 1% GR @ 6 kg/ha (89.8 and 76.9%), emamectin benzoate 0.25% + cartap hydrochloride 7.5% GR @ 6 kg/ha (84.0 and 75.9%), cartap hydrochloride 4% GR @ 18.75 kg/ha (82.7 and 68.7%) and emamectin benzoate 5% SG @ 0.22 kg/ha (68.0 and 60.3%).

The similar trend to reduce dead hearts and white ears was also depicted in winter paddy, 2017-18 (Table 2). Pre-treatment incidence of dead hearts varied at par level from 6.1 to 6.5%. After two round applications of insecticides in treated plots, the mean percent infestation of white ears per hill varied significantly from 1.4 to 8.5. Whereas, it was highest as 20.8% per hill in untreated plot. Accordingly, the maximum mean reduction of dead hearts (97.4%) and white ears (93.3%) over control was recorded in emamectin benzoate 0.25% + cartap hydrochloride 7.5% GR @ 9 kg/ha. This was statistically very close with it's another dose @ 7.5 kg/ha reducing 96.6% dead hearts and 92.6% white ears. The next descending orders of treatments to reduce dead hearts and white ears respectively over untreated control were chlorantraniliprole 0.5% + thiamethoxam 1% GR @ 6 kg/ha (88.7 and 75.4%), emamectin benzoate 0.25% + cartap hydrochloride 7.5% GR @ 6 kg/ha (83.9 and 74.3%), cartap hydrochloride 4% GR @ 18.75 kg/ha (82.9 and 67.4%) and emamectin benzoate 5% SG @ 0.22 kg/ha (69.0 and 59.0%). The reduction (75.4%) of white ears over untreated control in chlorantraniliprole 0.5% + thiamethoxam 1% GR @ 6 kg/ha was statistically at par with 74.3% in emamectin benzoate 0.25% + cartap hydrochloride 7.5% GR @ 6 kg/ha.

The pooled data (Table 3) obtained from two seasons indicated the highest reduction of dead heart (97.5%) and white ear (93.4%) in emamectin benzoate 0.25% + cartap hydrochloride 7.5% GR @ 9 kg/ha followed by statistically at par respective reductions of 96.67 and 92.77% by the same @ 7.5 kg/ha. The next best reduction in dead heart (89.2%) and white ear (76.2%) was obtained in chlorantraniliprole 0.5% + thiamethoxam 1% GR @ 6 kg/ha. The lowest dose (6 kg/ha) of emamectin benzoate 0.25% + cartap hydrochloride 7.5% GR resulted respective reduction in dead heart and white ear by 83.9 and 75.1%. The lowest reduction of dead heart (68.5%) and white ear (59.6%) was observed in emamectin benzoate 5% SG @ 0.22 kg/ha followed by cartap hydrochloride 7.5% GR @ 9 kg/ha resulting respective reduction by 82.6 and 68.1%.

Effect of different insecticides on yield and economics

For both seasons of experiment, the observations on the grain yield revealed significantly higher than untreated control in all the treatments except emamectin benzoate 5% SG @ 0.22 kg/ha. The highest yield 44.7 and 45.4 q/ha respectively during kharif, 2017 (Table 4) and winter, 2017-18 (Table 5) was obtained by the treatment emamectin benzoate 0.25% + cartap hydrochloride 7.5% GR @ 9 kg/ha. It was statistically at par with its next lower dose @ 7.5 kg/ha, where respective yield was 43.6 and 44.7 q/ha. The next best yield (39.9 and 37.1 q/ha) was recorded in chlorantraniliprole 0.5% + thiamethoxam 1% GR @ 6 kg/ha, followed by cartap hydrochloride 4% GR @ 18.75 kg/ha (37.9 and 36.8 q/ha) and emamectin benzoate 0.25% + cartap hydrochloride 7.5% GR @ 6 kg/ha (35.8 and 36.7 q/ha). Among the treatments, the lowest yield (33.2 and 33.1 q/ha) was noticed in emamectin

benzoate 5% SG @ 0.22 kg/ha, followed by significantly at par yield (32.5 and 30.4 q/ha) from untreated control.

The analysis of cost effectiveness of the different treatments apropos untreated control (Table 4 and 5) revealed the highest extra returns per ha of Rs. 21960/- (B:C = 10.5) during kharif, 2017 and Rs. 26892/- (B:C = 12.8) during winter, 2017-18 in emamectin benzoate 0.25% + cartap hydrochloride 7.5% GR @ 9 kg/ha followed by respectively of Rs. 19998/- (B:C = 11.1) and Rs. 25740/- (B:C = 14.3) in same treatment with its lower dose @ 7.5 kg/ha. The next best extra return of Rs. 13446/- with B: C = 5.6 (kharif 2017) and Rs. 11970/- with B: C = 5.0 (winter 2017-18) was obtained in chlorantraniliprole 0.5% + thiamethoxam 1% GR @ 6 kg/ha. The extra return per ha was lowest of Rs. 1422/- (B:C = 1.3) during kharif 2017 and Rs. 4734/- (B:C = 4.2) during winter 2017-18 in emamectin benzoate 5% SG @ 0.22 kg/ha followed by cartap hydrochloride 4% GR @ 18.75 kg/ha (Rs. 5994/- with B: C = 4.0 and Rs. 11376/- with B: C = 7.6) and emamectin benzoate 0.25% + cartap hydrochloride 7.5% GR @ 6 kg/ha (Rs. 9792/- with B: C = 6.1 and Rs. 11556/- with B: C = 7.2).

Effect of different insecticides on Natural Enemies

No détrimental effect was noticed by any Treatment on avalable Natural enemies in the Field (Table 6). Their population were significantly at par level with control at pre and post application of each treatment. The pre-treatment distribution of dragonflies per plot varied from 0.83 to 0.94 (kharif, 2017) and 0.93 to 0.98 (winter, 2017-18). On 10th day after spray, the respective population/plot ranged from 0.83 to 0.97 and 0.90 to 0.96. Similarly, the pre-treatment population of spiders per hill varied from 0.85 to 0.94 (Kharif, 2017) and 0.81 to 0.90 (winter, 2017-18). On 10th day after spray, the respective population per hill ranged from 0.85 to 0.96 and 0.83 to 0.96.

No report is available in literature apropos efficacy of premix formulation of emamectin benzoate 0.25% + cartap hydrochloride 7.5% GR for management of *S. incertulas* of paddy. The credit of first time report for the same goes to only the present author. But, the efficacy on sole use of emamectin benzoate and cartap hydrochloride has already been reported earlier. Kundu *et al.* (2018) [12] recorded around 93% reduction in dead heart over control by emamectin benzoate 5 SG @ 0.22 kg/ha, although it was only 68.5% in present case. Similarly, cartap hydrochloride 4 G recorded 6.9% dead heart and 6.9% white ear and was better than untreated check (11.4% and 12.5%) (Fakruddin *et al.*, 2017) [8]. It has more or less similarity with the present findings of reduction in dead heart (82.6%) and white ear (68.1%). The observation (2.9% dead heart and 2.6% white ear) made by Bhaskaran *et al.*, 2013 [4] with Chlorantraniliprole + Thiamethoxam is also in support with reduction in dead heart (89.2%) and white ear (76.2%) in present experiment.

The treatment wise benefit on yield and economics of paddy obtained in the present experiment is more or less in accordance with the earlier workers (Kundu *et al.* 2018 [12]; Sachan *et al.* 2018 [27]; Abro *et al.* 2013 [1]; Bhaskaran *et al.* 2013 [4]; Omprakash *et al.* 2017 [18]; Fakruddin *et al.* 2017 [8]).

In present experiment, safety of dragonflies and spiders to all the treatments might be due to their soil application except foliar spraying of emamectin benzoate 5 SG. Such safety is in agreement with earlier work of Kundu *et al.* 2018 [12] who also proved non detrimental effect of Novaluron 5.25% + Emamectin Benzoate 0.9% SC on above cited same natural enemies of yellow stem borer at any treatment level.

Table 1: Efficacy of emamectin benzoate 0.25% + cartap hydrochloride 7.5% GR and other insecticides against Yellow Stem Borer (*Scirpophaga incertulas* Walk.) infesting rice during Kharif, 2017

Treatments	Formulation Dose (kg/ha)	Pre-count	Mean incidence of Dead heart (%)/ hill						Mean reduction of dead heart (%) over control	Mean incidence of White ear (%) / hill	Reduction of white ear (%) over control
			After First Application			After Second Application					
			5 DAA	10 DAA	15 DAA	5 DAA	10 DAA	15 DAA			
Emamectin benzoate 0.25% + Cartap hydrochloride 7.5% GR	6	5.6 (13.7)	4.3 (12.0)	4.2 (11.8)	4.4 (12.2)	3.3 (10.4)	3.1 (10.1)	2.3 (8.7)	84.0	4.7 (12.5)	75.9
Emamectin benzoate 0.25% + Cartap hydrochloride 7.5% GR	7.5	5.4 (13.4)	3.3 (10.5)	3.2 (10.3)	3.8 (10.6)	1.5 (6.9)	1.4 (6.7)	0.5 (3.9)	96.8	1.4 (6.7)	92.9
Emamectin benzoate 0.25% + Cartap hydrochloride 7.5% GR	9	5.5 (13.5)	3.2 (10.22)	3.0 (10.0)	3.2 (10.4)	1.4 (6.78)	1.3 (6.5)	0.3 (3.3)	97.6	1.3 (6.4)	93.6
Cartap hydrochloride 4% GR	18.75	5.8 (13.9)	4.7 (12.5)	4.5 (12.3)	4.7 (12.6)	3.8 (11.30)	3.7 (11.1)	2.5 (9.0)	82.7	6.1 (14.3)	68.7
Emamectin benzoate 5% SG	0.22	5.8 (13.9)	5.6 (13.7)	5.3 (13.2)	5.1 (13.0)	5.0 (12.9)	4.7 (12.5)	4.6 (12.3)	68.0	7.8 (16.2)	60.3
Chlorantraniliprole 0.5% + Thiamethoxam 1% GR	6	5.5 (13.6)	4.3 (12.0)	4.2 (11.8)	4.4 (12.1)	3.3 (10.5)	3.2 (10.3)	1.5 (6.9)	89.8	4.5 (12.3)	76.9
Untreated control	-	5.3 (13.3)	5.8 (14.0)	6.0 (14.2)	6.4 (14.6)	9.6 (18.0)	12.2 (20.4)	14.2 (22.1)	-	19.5 (26.2)	-
SEM(±)		NS	0.12	0.15	0.17	0.34	0.38	0.35	-	0.37	-
CD at 5%		NS	0.37	0.48	0.52	1.05	1.18	1.10	-	1.14	-

Figures in the parentheses are angular transformed values; DAA Days after application

Table 2: Efficacy of emamectin benzoate 0.25% + cartap hydrochloride 7.5% GR and other insecticides against Yellow Stem Borer (*Scirpophaga incertulas* Walk.) infesting rice during winter, 2017-18

Treatments	Formulation Dose (kg/ha)	Pre-count	Mean incidence of Dead heart (%)/hill						Mean reduction of dead heart (%) over control	Mean incidence of White ear (%) / hill	Reduction of white ear (%) over control
			After First Application			After Second Application					
			5 DAA	10 DAA	15 DAA	5 DAA	10 DAA	15 DAA			
Emamectin benzoate 0.25% + Cartap hydrochloride 7.5% GR	6	6.3 (14.5)	4.8 (12.6)	4.5 (12.3)	4.8 (12.7)	3.5 (10.8)	3.3 (10.5)	2.5 (9.0)	83.9	5.4 (13.4)	74.3
Emamectin benzoate 0.25% + Cartap hydrochloride 7.5% GR	7.5	6.4 (14.7)	3.8 (11.2)	3.6 (11.0)	3.8 (11.3)	1.7 (7.5)	1.5 (7.1)	0.5 (4.1)	96.6	1.5 (7.1)	92.6
Emamectin benzoate 0.25% + Cartap hydrochloride 7.5% GR	9	6.1 (14.3)	3.6 (11.0)	3.4 (10.6)	3.7 (11.0)	1.6 (7.3)	1.5 (6.9)	0.4 (3.6)	97.4	1.4 (6.8)	93.3

Cartap hydrochloride 4% GR	18.75	6.4 (14.6)	4.9 (12.8)	4.7 (12.5)	5.0 (12.9)	4.1 (11.7)	3.8 (11.3)	2.7 (9.4)	82.5	6.8 (15.1)	67.4
Emamectin benzoate 5% SG	0.22	6.5 (14.8)	5.8 (14.0)	5.5 (13.5)	5.3 (13.3)	5.1 (13.1)	4.9 (12.8)	4.7 (12.5)	69.0	8.5 (17.0)	59.0
Chlorantraniliprole 0.5% + Thiamethoxam 1% GR	6	6.3 (14.5)	4.8 (12.6)	4.5 (12.2)	4.8 (12.6)	3.6 (10.9)	3.4 (10.6)	1.7 (7.5)	88.7	5.1 (13.1)	75.4
Untreated control	-	6.3 (14.5)	6.6 (14.9)	7.0 (15.3)	7.3 (15.6)	10.5 (18.9)	12.5 (20.7)	15.2 (22.9)	-	20.8 (27.2)	-
SEM (±)		NS	0.15	0.18	0.20	0.33	0.36	0.40	-	0.39	-
CD at 5%		NS	0.47	0.58	0.63	1.04	1.12	1.25	-	1.22	-

Figures in the parentheses are angular transformed values; DAA- Days after application

Table 3: Treatment wise overall reduction in damage by *Scirpophaga incertulas* on paddy (Pooled of Kharif, 2017 and winter, 2017-18)

Treatments	Formulation Dose (kg/ha)	Percent (%) reduction of dead heart over control			Percent (%) reduction of white ear over control		
		Kharif, 2017	Winter, 2017-18	Mean	Kharif, 2017	Winter, 2017-18	Mean
Emamectin benzoate 0.25% + Cartap hydrochloride 7.5% GR	6	84.0	83.9	83.9	75.9	74.3	75.1
Emamectin benzoate 0.25% + Cartap hydrochloride 7.5% GR	7.5	96.8	96.6	96.7	92.9	92.6	92.8
Emamectin benzoate 0.25% + Cartap hydrochloride 7.5% GR	9	97.6	97.4	97.5	93.6	93.3	93.4
Cartap hydrochloride 4% GR	18.75	82.7	82.5	82.6	68.7	67.4	68.1
Emamectin benzoate 5% SG	0.22	68.0	69.0	68.5	60.3	59.0	59.6
Chlorantraniliprole 0.5% + Thiamethoxam 1% GR	6	89.8	88.7	89.2	76.9	75.4	76.2
Untreated control	-	-	-	-	-	-	-

Table 4: Yield and economics of emamectin benzoate 0.25% + cartap hydrochloride 7.5% GR and other insecticides for managing YSB of rice during Kharif, 2017

Treatments	Formulation dose (kg/ha)	Yield (q/ ha)	Cost of inputs in Rs. / ha (Cost of insecticide + Cost of labour for application)	Extra yield (q/ ha) over untreated control (yield in treatment - yield in untreated control)	Value of additional yield (Rs. /ha)	Cost Benefit Ratio (C: B)
Emamectin benzoate 0.25% + Cartap hydrochloride 7.5% GR	6	35.8	1500.00	3.3	5994.00	1: 4.0
Emamectin benzoate 0.25% + Cartap hydrochloride 7.5% GR	7.5	43.6	1800.00	11.1	19998.00	1: 11.1
Emamectin benzoate 0.25% + Cartap hydrochloride 7.5% GR	9	44.7	2100.00	12.2	21960.00	1: 10.5
Cartap hydrochloride 4% GR	18.75	37.9	1612.50	5.4	9792.00	1: 6.1
Emamectin benzoate 5% SG	0.22	33.2	1125.00	0.8	1422.00	1: 1.3
Chlorantraniliprole 0.5% + Thiamethoxam 1% GR	6	39.9	2400.00	7.5	13446.00	1: 5.6
Untreated control	-	32.5	-	-	-	-

Market rates: Paddy = Rs.1800/ q^1; Emamectin benzoate 0.25% + Cartap hydrochloride 7.5% GR = Rs. 200/ Kg; Cartap hydrochloride 4% GR = Rs. 70 / Kg; Emamectin benzoate 5% SG = Rs. 3750 / Kg; Chlorantraniliprole 0.5% + Thiamethoxam 1.0% GR = Rs. 350 / Kg; Labour charge for application = Rs. 300/ ha

Table 5: Yield and economics of emamectin benzoate 0.25% + cartap hydrochloride 7.5% GR and other insecticides for managing YSB of rice during Winter, 2017-18

Treatments	Formulation Dose (kg/ha)	Yield (q/ ha)	Cost of inputs in Rs. /ha (Cost of insecticide + Cost of labour for application)	Extra yield (q/ ha) over untreated control (yield in treatment - yield in untreated control)	Value of additional yield (Rs / ha)	Cost Benefit Ratio (C: B)
Emamectin benzoate 0.25% + Cartap hydrochloride 7.5% GR	6	36.7	1500.00	6.3	11376.00	1: 7.6
Emamectin benzoate 0.25% + Cartap hydrochloride 7.5% GR	7.5	44.7	1800.00	14.3	25740.00	1: 14.3
Emamectin benzoate 0.25% + Cartap hydrochloride 7.5% GR	9	45.4	2100.00	14.9	26892.00	1: 12.8
Cartap hydrochloride 4% GR	18.75	36.8	1612.50	6.4	11556.00	1: 7.2
Emamectin benzoate 5% SG	0.22	33.1	1125.00	2.6	4734.00	1: 4.2
Chlorantraniliprole 0.5% + Thiamethoxam 1% GR	6	37.1	2400.00	6.7	11970.00	1: 5.0
Untreated control	-	30.4	-	-	-	-

Market rates: Paddy = Rs.1800/ q^1; Emamectin benzoate 0.25% + Cartap hydrochloride 7.5% GR = Rs. 200/ Kg; Cartap hydrochloride 4% GR = Rs. 70 / Kg; Emamectin benzoate 5% SG = Rs. 3750 / Kg; Chlorantraniliprole 0.5% + Thiamethoxam 1.0% GR = Rs. 350 / Kg; Labour charge for application = Rs. 300/ ha

Table 6: Effect of emamectin benzoate 0.25% + Cartap hydrochloride 7.5% GR and other insecticides on Natural enemies of rice stem borer during Kharif, 2017 and winter, 2017-18

Treatments	Formulation Dose (kg/ha)	Dragonfly/25 m^2				Spiders/hill			
		Kharif, 2017		Winter, 2017-18		Kharif, 2017		Winter, 2017-18	
		Pre-count	10 DAA	Pre-count	10 DAA	Pre-count	10 DAA	Pre-count	10 DAA
Emamectin benzoate 0.25% + Cartap hydrochloride 7.5% GR	6	0.90 (1.18)	0.93 (1.20)	0.93 (1.20)	0.90 (1.18)	0.85 (1.16)	0.90 (1.18)	0.81 (1.14)	0.87 (1.17)
Emamectin benzoate 0.25% + Cartap hydrochloride 7.5% GR	7.5	0.85 (1.16)	0.83 (1.15)	0.97 (1.21)	0.92 (1.19)	0.88 (1.18)	0.91 (1.19)	0.84 (1.16)	0.86 (1.16)
Emamectin benzoate 0.25% + Cartap hydrochloride 7.5% GR	9	0.93 (1.20)	0.90 (1.18)	0.96 (1.21)	0.95 (1.20)	0.93 (1.20)	0.87 (1.17)	0.86 (1.17)	0.96 (1.21)
Cartap hydrochloride 4% GR	18.75	0.94 (1.20)	0.97 (1.21)	0.95 (1.20)	0.92 (1.19)	0.90 (1.18)	0.94 (1.20)	0.88 (1.17)	0.83 (1.15)
Emamectin benzoate 5% SG	0.22	0.83 (1.15)	0.87 (1.17)	0.98 (1.22)	0.96 (1.21)	0.89 (1.18)	0.85 (1.16)	0.87 (1.17)	0.89 (1.18)
Chlorantraniliprole 0.5% + Thiamethoxam 1% GR	6	0.92 (1.19)	0.90 (1.18)	0.97 (1.21)	0.93 (1.20)	0.94 (1.20)	0.96 (1.21)	0.90 (1.18)	0.86 (1.16)
Untreated control	-	0.94 (1.20)	0.97 (1.21)	0.95 (1.20)	0.95 (1.20)	0.91 (1.19)	0.93 (1.20)	0.81 (1.14)	0.94 (1.20)
SEM (±)	-	0.04	0.07	0.09	0.08	0.05	0.07	0.08	0.08
CD (P = 0.05)	-	NS	NS	NS	NS	NS	NS	NS	NS

DAA= Days after application; Figures in the parentheses are square root transformed values (X + 0.5)

Conclusion

It is evident from the present investigation that emamectin benzoate 0.25% + cartap hydrochloride 7.5% GR @ 7.5 to 9.0 kg/ha was found most effective as well as at par with each other against rice yellow stem borer (*Scirpophaga incertulas* Walk.). Whereas, its lower dose @ 7.5 kg/ha was found much suitable with highest benefit cost ratio in both seasons of experiment. Therefore, this newly introduced insecticide @ 7.5 kg/ha could be recommended for economic use in rice for effective control of yellow stem borer.

Acknowledgement

The author is grateful to M/S Adama India Pvt. Ltd., Hyderabad for supplying sample of chemical emamectin benzoate 0.25% + cartap hydrochloride 7.5% GR (MAIRM 21) along with all financial help.

References

1. Abro GH, Syed TS, Shah AH, Cui J, Sattar M, Awan MS *et al*. Efficacy and economics of different insecticides against stem borers, *Scirpophaga incertulas* (Walker) in rice crop. Pakistan Journal of Zoology. 2013; 45(4):929-933.
2. Anon,https://www.indiatoday.in/education-today/gk-current-affairs/story/top-10-rice-producing-states-in-india-rice-production-and-area-under-cultivation, 2018, 1343024-2018-09-18.
3. Atwal AS, Dhaliwal GS. Agricultural pests of south Asia and their management. Kalyani Publishers, New Delhi, 2005, 181-182.
4. Baskaran RK, Murali KT, Sasikumar G. Field efficacy of Virtako 40 WG (Chlorantraniliprole 20% + Thiamethoxam 20%) against major insect pests of rice. Pesticie Research Journal. 2013; 25(2):140-145.
5. Chatterjee S, Mondal P. Management of rice yellow stem borer, *Scirpophaga incertulas* Walker using some biorational insecticides. Journal of Biopesticides. 2014; 7:143-147.
6. Cramer HH. Plant protection and world crop protection. Pflanzeschutz Nachar. 1967; 20(1):524.
7. Dhaliwal GS, Arora R. An estimate of yield losses due to insect pests in Indian agriculture. Indian Journal of Ecology. 1996; 23:70-73.
8. Fakruddin P, Chakraborty A, Chowdhury S. Efficacy of certain newer insecticides against yellow stem borer, *Scirpophaga incertulas* (walker) in paddy. The Bioscan. 2017; 12(1):313-316.
9. Gupta SP, Pandey US, Pandey V, Mishra CH. Screening of rice cultivars under wet condition against major insect pests of rice. Shashpa. 2002; 9(2):189-190.
10. Khan I, Khaliq A. Field evaluation of some granular insecticides for the control of rice stems borers. Pakistan Journal of Scientific and Industrial Research. 1989; 32(12):824.
11. Kumar A, Misra AK, Satyanarayana P, Kumar J. Population dynamics and management of yellow stem borer (*Scirpophaga incertulas* Walker) with insect sex-pheromone trap. International Journal of Plant Protection. 2015; 8(1):157-161.
12. Kundu SS, Chettri D, Chatterjee S, Mukhopadhyay AK. Evaluation of Novaluron 5.25% + Emamectin benzoate 0.9% SC against yellow stem borer (*Scirpophaga incertulas*) on rice. Journal of Entomology and Zoological Studies. 2018; 6(3):789-792.
13. Kushwaha KS. Chemical control of rice stem borer, *Scirpaphaga incertulas* (Walker) and leaf folder *Cnaphalocrocis medinalis* Guenee on Basmati. Journal of Insect Science. 1995; 8(2):225-226.
14. Longkumer IY, Singh KI, Singh A. Efficacy of eco-friendly insecticides against yellow stem borer under kharif rice-crop-ecosystem of Manipur valley. Pharma Innovation. 2017; 6(11):19-21.
15. Mahar MM, Bhatti IM, Dhuyo AR. Stem borer infestation and yield loss relationship in rice and cost benefits of control. Fifth National Seminor on Rice and Production. Kalashakaku, 1985; 23-25.
16. Matteson PC. Insect pest management in tropical Asian irrigated rice. Annual Review of Entomology. 2000; 45:549-574.
17. Mondal D, Ghosh A, Roy D, Kumar A, Shamurailatpam D, Bera S *et al*. Yield loss assessment of rice (O*ryza Sativa* L.) due to different biotic stresses under system of

rice intensification (SRI). Journal of Entomology and Zoological Studies. 2017; 5(4):1974-1980.
18. Omprakash S, Venkataiah M, Laxman S. Comparative efficacy of some new insecticides against rice yellow stem borer, *Scirpophaga incertulas* Walker under field conditions. Journal of Entomology and Zoological Studies. 2017; 5(5):1126-1129.
19. Pallavi D, Sharanabasappa, Megaladev P. Seasonal fluctuation of yellow stem borer *Scirpophaga incertulas* (walker) on paddy and its relationship between trap catches with weather parameters. International Journal of Current Microbiology. Applied Science. 2018; 7(9):3575-3584.
20. Pallavi D, Sharanabasappa, Girijesh GK. Evaluation of newer insecticide molecules against rice stems borer *Scirpophaga incertulas* on paddy. International Journal of Chemical Studies. 2018b; 6(2):2551-2554.
21. Pathak MD, Dhaliwal GS. Trends and strategies for rice insect problems in tropical agriculture. IRRI, Research Paper series no. 64. 1981, 15.
22. Pathok MD, Khan ZR. Insect pests of rice. International Rice Research Institute, Los Banos, Philippines, 1994, 5.
23. Prasad R, Prasad D. Account of insect pest's problem in rice-system in Rachi. Indian Journal of Entomology. 2006; 68(3):240-246.
24. Rahman MT, Khalequzzaman M, Khan MAR. Assessment of infestation and yield loss by stem borers on variety of rice. Journal of Asia Pacific Entomology. 2004; 7(1):89-95.
25. Raut AM, Satpathi CR, Krishnaiah. Management of rice yellow stem borer *Scirpophaga insertulas* (Walker) using different formulations of insect sex pheromone in West Bengal. Journal of Pure Applied Microbiology. 2017; 11(1):549-558.
26. Roy D, Chakrabborty G, Sarkar PK. Comparative efficacy, non-target toxicity and economics of seven novel pre-mixed formulations against *Maruca testulalis* G. and *Aphis craccivora* K. infesting cowpea. Journal of Environmental Biology. 2017; 38:603-609.
27. Sachan SK, Kashyap AK, Sharma R, Verma KD, Singh HR. Efficacy of some novel insecticides against yellow stem borer, *Scirpophaga Incertulas* (Walker) in Basmati Rice. Journal of Pharmacology and Phytochemistry. 2018; 1:195-197.
28. Saljoqi AUR, Khan M, Abdullah K, Latif A. Evaluation of fipronil for the management of rice stem borer. Sarhad Journal of Agriculture. 2002; 18(1):59-61.
29. Sasmal A, Bhattacharya DK, Nanda LR. Ecofriendly management of rice leaf folder and case worm in Odisha. National symposium on sustainable pest management of safer environment organized by OUAT, Bhubaneswar, India, 2007, 33-34.