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Sujay Hurali
AICRIP, ARS, Gangavathi, UAS, Raichur, Karnataka, India

Guruprasad
College of Agriculture, UAS, Dharwad, Karnataka, India

Vinoda
AICRIP, ARS, Gangavathi, UAS, Raichur, Karnataka, India

Eurekha
College of Agriculture, Raichur, UAS, Raichur, Karnataka, India

H Mahantashivayogayya
AICRIP, ARS, Gangavathi, UAS, Raichur, Karnataka, India

BG Masthanareddy
AICRIP, ARS, Gangavathi, UAS, Raichur, Karnataka, India

SB Gowdar
AICRIP, ARS, Gangavathi, UAS, Raichur, Karnataka, India

Honnayya
College of Agriculture, UAS, Dharwad, Karnataka, India

Ravi Biradar
AICRIP, ARS, Gangavathi, UAS, Raichur, Karnataka, India

Pramesh D
AICRIP, ARS, Gangavathi, UAS, Raichur, Karnataka, India

Mahantesh
AICRIP, ARS, Gangavathi, UAS, Raichur, Karnataka, India

Corresponding Author:
Sujay Hurali
AICRIP, ARS, Gangavathi, UAS, Raichur, Karnataka, India

Bio-efficacy of Profenophos 50% Ec against lepidopteran and sucking pests of rice

Sujay Hurali, Guruprasad, Vinoda, Eurekha, H Mahantashivayogayya, BG Masthanareddy, SB Gowdar, Honnayya, Ravi Biradar, Pramesh D and Mahantesh

Abstract
A field experiment was carried out to evaluate the bioefficacy of profenophos 50% EC against leaf folder, *Cnaphalocroris medinalis*, stem borer *Scirphophaga incertulas* and green leafhopper, *Nephotettix spp.* on paddy. In the present experiment the efficacy of three doses of profenophos *viz.*, 800, 1000 and 1200 ml/ha, cartap hydrochloride 50% SP @1000 g/ha, fipronil 5% SC @1000g/ha, monocrotophos 36% SL 1250 ml/ha and chlorpyrifos 20% EC1250 ml/ha were studied. The results confirm that cartap hydrochloride was the best treatment in reducing leaf folder (0.56 leaf folder/hill) and stem borer (0.55 dead heart/hill) whereas profenophos @ 1200 ml/ha was found superior in reducing leafhopper population effectively (96.33 hoppers/hill).

Keywords: Cartap hydrochloride, dinotefuran, green leafhopper (GLH), paddy, planthoppers, profenophos

Introduction
Rice is obtained from paddy grain and it is a staple food for people all over the East, South and Southeast Asia (Anon, 2018) [1]. Rice crop is extremely versatile and adaptive with a temperature range throughout the crop cycle is between 21˚C to 37˚C. As far as India is concerned it can be grown in almost all agro-climatic zones, soil varieties and altitudes ranging from sea level to 3000 meters above mean sea level. Among the various constraints of rice abiotic factors *viz.*, temperature, rainfall, humidity and other climatic conditions affect the plant growth and ultimately crop yield. However, current agriculture production practices involving apply of synthetic fertilizers have made rice to attract more insect pests. Over 100 species of insect pests attack rice ecosystem in various stages of the crop, in which Brown planthopper *Nilaparvata lugens* (Stal) (BPH), white-backed planthopper *Sogatella furcifera* (Hoverth) (WBPH), green leafhopper *Nephotettix virescens* (Distant) (GLH), yellow stem borer *Scirpophaga incertulas* and leaf folder *Cnaphalocoris medinalis* are the major insect pests of paddy (Noor and Hussain, 2016) [10]. The outbreak of these pests habitually leads to the entire loss of the rice crop, if no effectual control measures are taken up. The loss in grain yield ranges from 10% in moderately affected fields to 70% in those fields which are severely affected (Kulshreshtha, 1974) [8]. Several cultural practices such as planting of rice with wider spacing, nutrient and water management and conservation of natural enemies, etc., have been suggested for effective management of these sucking pests. However, the intensive and continuous cultivation of rice with excessive use of nitrogenous fertilizers has paved the congenial conditions for pest population outbreaks thus compelled the farmers to use insecticides for their suppression. In many rice-growing areas of India, insecticides failed to give the desired level of control of the pest because of the development of resistance to insecticides and their negative impact on natural enemies due to which the pest has become unmanageable in several regions of India. These sucking pests of rice have also become resistant to some newer insecticides like imidacloprid, thiamethoxam and acetamiprid (Krishnaiah *et al*., 2003) [6] This scenario of resistance has forced farmers to apply these broad-spectrum insecticides in heavy doses against recommended due to which diversity of natural enemies has been reduced and led to the resurgence of sucking pests of rice. Keeping these points in view, an experiment was conducted in Agriculture Research Station, Gangavathi, University of Agricultural Sciences, Raichur, Karnataka to compare the relative efficacy of profenophos 50% EC against other insecticides.

Material and Methods

An experiment was carried out at Agricultural Research Station, during *kharif* 2015 in a randomized block design with eight treatments and three replications. Sprays were taken up based on seasonal occurrence and Economic Threshold Level (ETL) of stem borers, leaf folder and green leafhopper (GLH). The treatment details were given below.

Table 1: Details of the treatments

Sl. No.	Treatments detail	Formulation (g or ml/ha)
1	Profenophos 50% EC	800
2	Profenophos 50% EC	1000
3	Profenophos 50% EC	1200
4	Cartap hydrochloride 50% SP	1000
5	Fipronil 5% SC	1000
6	Monocrotophos 36% SL	1250
7	Chlorpyriphos 20% EC	1250
8	Untreated control	-

Observations

Observations were made on 10 hills per plot and count both nymphs and adults for GLH and number of folded leaves per 10 hills per plot and per cent dead heart and white ear was taken, before the imposition of the treatment and 7, 10 and 15 days after each spray and presented as an average number of insects per hill and also per cent reduction over control was calculated by the use of Abbott's / Henderson and Tilton formula for per cent damage reduction over control after each spray. Further, these data were subjected to square root/ angular transformation and applied the statistical tool for analysis.

Results and discussion

The results were subjected to statistical analysis, the results were mentioned in the below table. The values transformed into arcsine and angular transformation, then per cent reduction over control was calculated after each spray. The details of the experimental results were given below.

Stem borer, *Scirpophaga incertulus* Walker

From the results, it was confirmed that the per cent dead heart was uniform over the treatment and reached ETL, which is ranged from 6.33 to 6.64 per cent dead heart per hill (Table 2). After the insecticide treatment, there was a reduction in the dead heart was found in all the treatment but minimum dead heart (3.64%) was observed in the plot treated with cartap hydrochloride 50% SP @ 1000 ml per ha as compared to 6.97 per cent in untreated check at 7 days after the first application, this was followed by profenophos 50% EC @ 1200 ml per ha (3.96%) and profenophos 50% EC @ 1000 ml per ha (4.10%) (Table 2). After the 15 days of the first spray, it confirmed that cartap hydrochloride 50% SP @ 1000 ml per ha was significantly reduced, dead heart (65.87%) effectively, but this was followed by profenophos 50% EC @ 1200 ml per ha (61.23%). A similar trend was noticed during the second spray also. cartap hydrochloride 50% SP @ 1000 ml per ha reduced dead heart symptoms to 92.62 per cent over the untreated control after 15 days of the second spray. But the profenophos 50% EC @ 1200 ml per ha was also found to be superior which is equally able to reduce dead heart symptom 86.32 per cent reduction over control 15 days after the second spray (Table 2). The data on per cent white ear heads due to stem borer attack was recorded at pre harvesting stage. Significantly lowest per cent white earhead was recorded in cartap hydrochloride 50%SP @ 1000ml per ha (2.03%) with 81.42 per cent reduction over control followed by profenophos 50% EC @ 1200ml per ha (2.79% with 74.47% ROC) Whereas, the higher per cent white ear head was recorded in untreated check (10.93%) (Table 2). These results were confirmed with the result of Krishnamoorthy *et al*., 2012 [7]; Srinivasan *et al*., 2012 [14] and the result of Kartikeyan *et al*., 2012 [5] testing of the efficacy of a new insecticides combination (flubendiamide + buprofezin) against rice stem borer. Singh *et al*. (2012) [13] support the present findings to confirm that nuvacron (monocrotophos 36 WSC) was observed as the most effective chemical with minimum stem borer infestation (0.50% DH & 0.27% WEH) and also Chakraborty (2011) [2] also reported that numerically least damage was noted for imidacloprid 17.8 SL (100 ml/ha), followed by carbofuran 3G (30 kg/ha), fipronil 0.3G (750 ml/ha), monocrotophos 36 WSC (1125 ml/ha), profenophos 50% EC (500 ml/ha), bifenthrin 10% EC (500 ml/ha) and chlorpyriphos 20% EC (1875 ml/ha)

Leaf folder *Cnaphalocrocis medinalis* Guenee

Leaf folder population were reached ETL before the insecticides treatment which is ranged from6.47 to 6.77 leaf folder larvae per hill (table 3). Reduction in the leaf folder population was observed only after the imposition of the treatments. The cartap hydrochloride 50% SP @ 1000 ml per ha recorded significantly less leaf folder larvae per hill (3.71%) as compared to 7.10 larvae per hill in untreated check at 7 days after first application this was followed by profenophos 50% EC @ 1200 ml per ha (4.04 larvae/hill). Among the recommended formulations doses, profenophos 50% EC @ 1200 ml per ha proved their efficacy in suppressing the leaf folder population even at 15 days after the first spray with 61.10 per cent reduction over control, which is almost equal to the treatment cartap hydrochloride 50% SP @ 1000 ml per ha which is 65.79 per cent reduction over control. After the second spray leaf folder population was effectively reduced, cartap hydrochloride 50% SP @ 1000 ml per ha was found superior (0.56 leaf folder/hill) with 92.62 reduction over control which is almost equal to profenophos 50% EC @ 1200 ml per ha (1.03 leaf folders per hill) with 86.44 per cent reduction over control at 15 days after second spray (Table 3). These results are in agreement with Sandhu and Dhaliwal (2016) who reported that flubendiamide 39.35% SC an anthranilic diamide group, was effective than fipronil 0.3 G and cartap hydrochloride 4% G. However, Bhanu and Reddy (2008) reported that the two formulations of flubendiamide *viz*., flubendiamide 20 WDG @ 25 *g.a.i./ha* and flubendiamide 48 SC @ 24 *g.a.i./ha* were effectively controlled the leaf folder. Flubendiamide 20 WDG @ 25 *g.a.i./ha* and flubendiamide 48 SC @ 24 *g.a.i./ha* were effective controlling leaf folder population.

Leafhopper *Nephotettix nigropictus* Stal

Before the imposition of insecticides, the population of leafhopper was uniform and crossed the economic threshold level which ranged from 8.61 to 9.93 leafhopper per hill (table 4). However, variation was observed only after the imposition of the treatments. Significantly least number of green leafhoppers per hill was recorded in the recommended formulation dose of profenophos 50% @ 1200 ml per ha recorded significantly less number of leafhopper (3.74 leafhoppers/hill) as compared to 10.29 leafhoppers per hill in untreated check at 7 days after the first spray but it was at par with its middle formulation dosage 1000 ml per ha. The recommended formulation dose of profenophos 50% EC @

1200 *ml* per ha proved their efficacy in suppressing the leafhopper population even at 15 days after the first spray with 78.31 per cent reduction over control. A similar trend was noticed at 7, 10 and 15 days after the second spray also. formulation dose of profenophos 50%EC @ 1200 *ml* per ha was found to be effective and superior treatments in reducing leafhopper populations (0.50 leafhoppers per hill) with 96.33 per cent reduction over control followed by profenophos 50% EC @ 1000 *ml* per ha (0.52 leafhopper per hill with 96.19% ROC), profenophos 50% EC @ 800 *ml* per ha (0.93 leafhoppers per hill with 93.19% ROC) at 15 days after second spray (Table 4). The present research findings regarding green leafhopper (GLH) incidence indicated that all the insecticides tested were effective in restricting the GLH population to 15 DAS compared to untreated control. Ramu *et al.* (2005) [11] noticed that the maximum reduction of GLH was recorded with imidacloprid @ 0.25 ml/l with 84.54% decrease over control. Shashank *et al*. (2012) [12] observed that buprofezin @ 0.20 kg a.i./ha registered the highest reduction in GLH population (75.08%). According to Vinothkumar (2014) [15] imidacloprid 17.8 SL @ 30 *g a.i./ha* and buprofezin 25 SC @ 200 *g a.i./ha* were highly effective in checking the population of green leafhopper by registering almost cent per cent control after three rounds of spray.

Impact on Yield

There was an increase in yield noticed in all the treatments except the untreated control (Table 5). but the highest yield was noticed in the plot treated with cartap hydrochloride 50% SP @ 1000 ml/ha (65.06 q/ha) and it was followed by profenophos 50% EC @ 1200 ml/ha recorded 60.30 q/ha yield. From this, it can be advisable to use profenophos 50% EC @ 1200 ml/ha in the place of cartap hydrochloride. The lowest yield was noticed in the untreated plot (32.46 q/ha). Mahal *et al*. (2008) [9] demonstrated that all the tested doses of fipronil 80 WG gave significantly better yield than control. Dhawan *et al*. (2010) [3, 4] also reported that yield was at par with different doses of thicyclam hydrogen oxalate 4G and check insecticide.

Table 2: Bio-efficacy of profenophos 50% EC against *S. incertulas* on paddy during *kharif* – 2015

Sl. No	Treatment details	Dose (gm or ml/ha)	Per cent dead heart/hill										
			First application					Second application					
			1 DBS	7 DAS	10 DAS	15 DAS	% ROC	1 DBS	7 DAS	10 DAS	15 DAS	% ROC	White Earhead (%)	% ROC
T_1	Profenophos 50% EC	800	6.38 (17.37)	4.50 (12.25)	4.01 (10.88)	3.78 (10.26)	46.91	3.78 (10.26)	2.65 (7.21)	2.04 (5.54)	1.92 (4.70)	74.26	5.12 (9.21)	53.13
T_2	Profenophos 50% EC	1000	6.64 (18.07)	4.10 (11.15)	3.57 (9.71)	2.97 (7.93)	59.28	2.97 (7.93)	2.04 (5.54)	1.44 (3.92)	1.18 (3.20)	84.18	3.38 (7.79)	69.07
T_3	Profenophos 50% EC	1200	6.35 (17.26)	3.96 (10.08)	3.55 (9.47)	2.76 (7.52)	61.23	2.76 (7.52)	1.93 (4.23)	1.27 (2.37)	1.02 (1.71)	86.32	2.79 (6.94)	74.47
T_4	Cartap hydrochloride 50% SP	1000	6.44 (5.56)	3.64 (9.88)	2.97 (8.10)	2.43 (7.25)	65.87	2.43 (7.25)	1.41 (3.82)	0.80 (2.16)	0.55 (1.52)	92.62	2.03 (5.99)	81.42
T_5	Fipronil 5% SC	1000	6.33 (17.25)	4.44 (12.19)	4.30 (11.03)	3.37 (9.10)	52.66	3.37 (9.10)	2.56 (6.24)	1.89 (5.17)	1.54 (4.48)	79.35	4.25 (8.67)	61.11
T_6	Monocrotophos 36% SL	1250	6.51 (17.68)	6.37 (15.23)	5.18 (14.58)	4.54 (12.10)	36.23	4.54 (12.10)	3.89 (9.01)	3.67 (6.83)	3.19 (6.64)	57.23	7.72 (11.25)	29.36
T_7	Chlorpyriphos 20% EC	1250	6.58 (17.88)	4.69 (12.74)	4.28 (11.61)	4.02 (10.91)	43.53	4.02 (10.91)	2.74 (7.45)	2.11 (5.75)	2.06 (5.01)	72.38	5.20 (9.31)	52.42
T_8	Untreated control	--	6.48 (17.61)	6.97 (18.91)	7.03 (19.09)	7.12 (19.36)	-	7.12 (19.36)	7.33 (20.04)	7.41 (20.11)	7.46 (20.17)	-	10.93 (13.70)	-
S.Em ±			0.20	0.29	0.50	0.31		0.31	0.47	0.42	0.32		2.28	
CD (p=0.05)			NS	1.33	1.65	1.84		1.84	2.72	3.14	3.30		0.74	
CV %			10.61	9.37	8.72	11.73		11.73	8.54	10.47	9.39		8.83	

NS= Non-significant; Values are mean of three replications; DBS=Day before spray; DAS= Day after spray; Figures in the parenthesis are arc sign transferred value.
ROC-Reduction over Control

Table 3: Bio-efficacy of profenophos 50% EC against *C. medinalis* on paddy during *kharif* – 2015

Sl. No	Treatment details	Dose (gm or ml/ha)	Larvae/hill									
			First application					Second application				
			1 DBS	7 DAS	10 DAS	15 DAS	%ROC	1 DBS	7 DAS	10 DAS	15 DAS	%ROC
T_1	Profenophos 50% EC	800	6.50 (17.69)	4.59 (12.47)	4.08 (11.08)	3.85 (10.45)	46.89	3.85 (10.45)	2.70 (7.35)	2.08 (5.64)	1.96 (4.79)	74.21
T_2	Profenophos 50% EC	1000	6.77 (18.40)	4.18 (11.35)	3.64 (9.89)	3.03 (8.07)	58.20	3.03 (8.07)	2.08 (5.64)	1.46 (3.99)	1.20 (3.26)	84.21
T_3	Profenophos 50% EC	1200	6.47 (17.58)	4.04 (10.26)	3.62 (9.65)	2.82 (7.66)	61.10	2.82 (7.66)	1.97 (4.31)	1.30 (2.41)	1.03 (1.74)	86.44
T_4	Cartap hydrochloride 50% SP	1000	6.56 (5.67)	3.71 (10.07)	3.03 (8.25)	2.48 (7.38)	65.79	2.48 (7.38)	1.44 (3.89)	0.81 (2.20)	0.56 (1.55)	92.62
T_5	Fipronil 5% SC	1000	6.45 (17.57)	4.52 (12.42)	4.38 (11.23)	3.43 (9.27)	52.68	3.43 (9.27)	2.61 (6.36)	1.93 (5.27)	1.57 (4.57)	79.34
T_6	Monocrotophos 36% SL	1250	6.63 (18.01)	6.49 (15.51)	5.28 (14.85)	4.62 (12.32)	36.27	4.62 (12.32)	3.96 (9.17)	3.74 (6.95)	3.25 (6.77)	57.23
T_7	Chlorpyriphos 20% EC	1250	6.70 (18.22)	4.77 (12.98)	4.36 (11.83)	4.09 (11.11)	43.58	4.09 (11.11)	2.79 (7.59)	2.15 (5.85)	2.10 (5.10)	72.36

T_8	Untreated control	--	6.60 (17.94)	7.10 (19.26)	7.16 (19.45)	7.25 (19.72)	-	7.25 (19.72)	7.47 (20.42)	7.55 (20.48)	7.60 (20.55)	-
S.Em ±			0.76	1.35	1.68	1.87		1.87	2.77	3.20	3.37	
CD (p=0.05)			0.25	0.32	0.54	0.32		0.32	0.50	0.43	0.36	
CV %			10.80	9.55	8.88	11.95		11.95	8.70	10.66	9.56	

NS= Non-significant; Values are mean of three replications; DBS=Day before spray; DAS= Day after spray; Figures in the parenthesis are arc sign transferred value.
ROC-Reduction over Control

Table 4: Bio-efficacy of profenophos 50% EC against *N. nigropectis* on paddy during *kharif* – 2015

Treatment	Product name	Dose (a.i gm or ml/ha)	Leafhopper/ hill									
			First application					Second application				
			1DBS	7 DAS	10 DAS	15 DAS	%ROC	1DBS	7 DAS	10 DAS	15 DAS	%ROC
T_1	Profenophos 50% EC	800	8.80 (2.28)	4.87 (1.74)	4.12 (1.62)	3.85 (1.70)	69.75	3.85 (1.70)	2.51 (1.33)	1.61 (1.11)	0.93 (0.91)	93.19
T_2	Profenophos 50% EC	1000	8.61 (2.27)	4.67 (1.71)	3.31 (1.49)	3.21 (1.65)	74.78	3.21 (1.65)	1.96 (1.21)	1.03 (0.96)	0.52 (0.73)	96.19
T_3	Profenophos 50% EC	1200	9.73 (2.40)	3.74 (1.55)	2.99 (1.41)	2.76 (1.53)	78.31	2.76 (1.53)	1.71 (1.13)	0.96 (0.92)	0.50 (0.72)	96.33
T_4	Cartap hydrochloride 50% SP	1000	9.36 (2.36)	6.94 (2.32)	6.01 (2.17)	5.65 (2.74)	55.61	5.65 (2.74)	4.34 (1.86)	2.69 (1.39)	1.80 (1.62)	86.82
T_5	Fipronil 5% SC	1000	8.72 (2.28)	6.51 (2.00)	5.34 (1.89)	5.07 (2.04)	60.17	5.07 (2.04)	3.97 (1.69)	2.37 (1.28)	1.55 (1.11)	88.65
T_6	Monocrotophos 36% SL	1250	9.55 (2.37)	5.24 (1.80)	4.46 (1.65)	4.31 (1.79)	66.14	4.31 (1.79)	2.78 (1.41)	1.86 (1.17)	1.14 (0.95)	91.65
T_7	Chlorpyrifos 20% EC	1250	9.17 (2.33)	5.99 (1.92)	5.24 (1.80)	5.02 (2.03)	60.56	5.02 (2.03)	3.89 (1.59)	2.36 (1.27)	1.54 (1.10)	88.72
T_8	Untreated control	--	9.93 (2.43)	10.29 (2.46)	11.98 (2.64)	12.73 (2.73)	-	12.73 (2.73)	13.15 (2.77)	13.58 (2.81)	13.66 (2.82)	-
	S. Em ±		0.10	0.10	0.13	0.15		0.15	0.09	0.09	0.08	
	CD (p=0.05)		0.30	0.32	0.35	0.46		0.46	0.29	0.27	0.23	
	CV %		3.76	3.57	4.03	3.52		3.52	4.02	3.30	3.17	

NS= Non-significant; Values are mean of three replications; DBS=Day before spray; DAS= Day after spray; NS= Non-significant; Figures in the parenthesis are $\sqrt{x+1}$ transferred value.

Table 5: effect of profenophos 50% EC on grain yield of paddy

Treatment	Product name	Dose (a.i gm or ml/ha)	Yield (q/ha)
T_1	Profenophos 50% EC	800	57.40
T_2	Profenophos 50% EC	1000	58.46
T_3	Profenophos 50% EC	1200	60.30
T_4	Cartap hydrochloride 50% SP	1000	65.06
T_5	Fipronil 5% SC	1000	54.72
T_6	Monocrotophos 36% SL	1250	56.14
T_7	Chlorpyrifos 20% EC	1250	52.99
T_8	Untreated control	--	32.46

Conclusion

From the present experiment, it was confirmed that cartap hydrochloride was the best treatment in reducing major pests of paddy and this was on par or followed by the higher dose of profenophos 50% EC which also reduced leaf folder population effectively. Profenophos 50% EC @ 1200 ml/ha reduced the population of leafhopper effectively than any other treatment. The yield was maximum in the plot treated with cartap hydrochloride but it was followed by profenophos at a higher dose. so it is advised to use profenophos to control the major paddy pests.

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