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Dr. PD Ghoghari
Main Rice Research Centre, Navsari Agricultural University, Navsari, Gujarat, India

NK Kavad
Prof., Main Rice Research Centre, Navsari Agricultural University, Navsari, Gujarat, India

Dr. VA Patil
Main Rice Research Centre, Navsari Agricultural University, Navsari, Gujarat, India

Correspondence
Dr. PD Ghoghari
Main Rice Research Centre, Navsari Agricultural University, Navsari, Gujarat, India

Evaluation of insecticides against rice gundhi bug, *Leptocorisa acuta* (Thunberg) in South Gujarat

Dr. PD Ghoghari, NK Kavad and Dr. VA Patil

Abstract
An experiment was conducted during *kharif* 2014 to 2016 at Main Rice Research Centre, Navsari Agricultural University, Navsari to évaluated some newer insecticides against rice gundhi bug, *Leptocorisa acuta* (Thunberg) in South Gujarat. Among all the insecticides tested, treatment of emamectin benzoate 5 WSG 0.015% @ 3 gm/litre was found the most effective in controlling rice gundhi bug and it was at par with the treatment of imidacloprid 17.8 SL 0.05% @ 3 ml/10 litres. The next best treatment was novaluron 10 EC 0.01% @ 1.0 ml/litre, rynaxypyre 20 SC 0.004 @ 0.2 ml/litre and profenophos 50 EC 0.05% @ 1 ml/litre in terms of reduction of rice gundhi bug populations in both sprays. The highest grain yield of rice was recorded in the treatment of emamectin benzoate 5 WSG 0.015% @ 3 gm/litre (6109 kg/ha) and it was at par with the treatment of imidacloprid 17.8 SL 0.05% @ 3 ml/10 litres (5882 kg/ha). The next treatment was followed by novaluron 10 EC 0.01% @ 1.0 ml/litre (5711 kg/ha) and rynaxypyre 20 SC 0.004 @ 0.2 ml/litre (5607 kg/ha). As far as straw yield, the treatment of emamectin benzoate 5 WSG 0.015% @ 3 gm/litre (7212 kg/ha) was recorded highest straw yield and it was at par with the treatment of imidacloprid 17.8 SL 0.05% @ 3 ml/10 litres (6998 kg/ha). In terms of BCR the treatment of imidacloprid 17.8 SL 0.05% @ 3 ml/10 litres (1:2.29) was found most superior among all treatments and it was followed by emamectin benzoate 5 WSG 0.015% @ 3 gm/litre (1:2.02) over the rest of the treatments.

Keywords: Rice gundhi bug, *Leptocorisa acuta* (Thunberg), efficacy, newer insecticides

Introduction

Rice is an important crop of the world. It is staple food for more than 60% of worlds' population. Rice is one of the most important food crops of India. Total 148.36 million hectares area of the world under rice cultivation and 519.86 million tons annual grains production. In India, rice is grown in 44.40 million hectares in diverse ecological condition with an annual production of 104.80 million tones and productivity of 2462 kg/ha [1]. There are different problems responsible for lower productivity of rice. Out of these, insect pests, diseases and weeds are major problems responsible for lower yields of rice in India. The rice plant is attacked by more than 100 species of insects and 20 of them can cause serious economic loss [2]. Insect pests like stem borer (SB), leaf folder (LF), rice skipper (SKP), gall midge (GM), gundhi bug (GB), brown plant hopper (BPH) white-backed plant hopper (WBPH) and sheath mite (Sh.m) cause serious damage to rice crop which is responsible for reducing rice yield. Rice Gundhi bugs, *Leptocorisa acuta* (Thunberg) found in all rice environments. They are common in rainfed and upland rice. Gundhi bugs preferred flowering and milking stage of the crop growth. At present, rice gundhi bug, L. *acuta* (Thunberg) another more important pest of rice caused damage by feeding on the sap of milky grain and turns them chaffy. L. *acuta* (Thunberg) is responsible for lower quality of grains as well as quantity losses. L. *acuta* (Thunberg) (Hemiptera: Coreidae) is typically found during the flowering stage of the rice crop which coincides with rainfall and high humidity at the beginning of the wet season [3]. Nymphs and adults use their piercing-sucking mouthparts to feed on developing rice grains. It sucks the sap from the peduncle, tender stem and milking grains making them to turn chaffy. These bugs prefer to feed when the host plants are young at a time when the starches within the grains are not yet fully formed. Total 15 species of various bugs reported to infest rice crop in India, rice gundhi bugs, *Leptocorisa acuta* (Thunberg) are considered serious pest [4]. Chemical control is still considered as the first line of defense in rice pest control. Hence, application of various granular and liquid spray type insecticidal formulations gives effective control of rice pests [5, 6].

Insecticides, *viz*; phorate and quinalphos gave effective control of rice gundhi bugs [7]. Various chemical insecticides have been recommended to control the rice bugs [8]. Insecticide like imidacloprid 17.8% @ 300g/ha treatment recorded lowest percentage of gundhi bug damage (7.16%) and they also recorded the highest grain yield in the treatment imidacloprid 17.8% @ 300g/ha were 5280 kg/ha and 5210 kg/ha in variety Jaya during 2011 and 2012, respectively in West Bengal [9]. The treatment of cartap hydrochloride 4% GR were recorded the average number of gundhi bugs 7.08/5 sweep nets and grain yield 7.19 t/ha during *kharif*-2016 in Varanasi region of Uttar Pradesh [10]. Among the tested insecticides, though monocrotophos, triazophos and rynaxypyre were found best to control gundhi bugs in the rice ecosystem [11]. The treatment of thiamethoxam 25 WG @ 100 g/ha was recorded 7.73 gundhi bugs/hill and recorded the highest gross returns of Rs. 89773.75 per ha in Karnataka [12]. Judicious use of insecticides and alternation of chemicals with different mode of action are suggested to reduce insecticide resistance. So, the newer insecticide molecules with diversified mode of action against this pest will significantly play a vital role in the insecticide resistance management. Whereas, in Gujarat last five to six years damage due to *L. acuta* (Thunberg) in rice is increasing day by day. Keeping these conditions in view present study was focused on bio-efficacy of newer insecticides group along with the conventional insecticides against *L. acuta* (Thunberg) of rice. Therefore, the present study was proposed to manage rice gundhi bugs and obtained good quality of rice.

Materials and Methods

The field experiment was laid out in randomized block design during *kharif* 2014 to 2016 with three replications at Main Rice Research Centre, Navsari Agricultural University, Navsari, Gujarat, India. There were eight treatments including untreated control. The rice variety, GNR-3 was used for the experiment. The spacing was 20 X 15 cm whereas the gross plot size was 5.4 X 3.6 m^2 with the net plot size, 5.1 X 3.2 m^2. The crop was transplanted when the seedlings were 22 days old. All the recommended agronomic packages of practices were followed to raise the crop in good condition. The experiment was laid out in randomized block design (RBD) with eight treatments viz., T_1: spiromesifen 240 SC 0.024% @ 1 ml/ litre, T_2: emamectin benzoate 5 WSG 0.015% @ 3 gm/litre, T_3: novaluron 10 EC 0.01% @ 1 ml/litre, T_4: rynaxypyre 20 SC 0.004 @ 0.2 ml/litre, T_5: profenophos 50 EC 0.05% @ 1 ml/litre, T_6: imidacloprid 17.8 SL 0.005% @ 3 ml/10 litre, T_7: chlorpyriphos 20 EC 0.04% @ 2 ml/litre and T_8:control (Untreated). The first spray of insecticides was applied at the time of pest appearance and second spray of various insecticide treatments was given at 15 days after the first spray. The observations of rice gundhi bugs (no. of adult/10 hills) were recorded before spray and 1 Days after Spraying (DAS) and 3 DAS after first and second spray, respectively. The yield data on grain and straw were recorded plot wise (kg per plot) and were converted as on hectare basis after harvest. For gundhi bugs, the population counts were taken on number of nymph or adults/10 hills per plot at the time of pest appearance and before spray and 1 Days after Spraying (DAS) and 3 DAS after first and second spray, respectively. The data were collected and statistical analysis was carried out. The data were subjected to square root transformation and analysis of variance (ANOVA) performed.

Results and Discussions

Effectiveness of insecticides

The result (Table-1) indicated that in the year 2014 in first spray number of gundhi bugs/hill at 1 DAS in the treatment of emamectin benzoate 5 WSG 0.015% @ 3 gm/litre was found the lowest gundhi bugs (2.14 gundhi bugs/hill) and it was at par with the treatment of imidacloprid 17.8 SL 0.005% @ 3 ml/10 litre (2.79 gundhi bugs/hill) and also it was followed by the treatment of novaluron 10 EC 0.01% @ 1 ml/litre (3.81 gundhi bugs/hill), rynaxypyre 20 SC 0.004 @ 0.2 ml/litre (4.80 gundhi bugs/hill), chlorpyriphos 20 EC 0.04% @ 2 ml/litre (5.16 gundhi bugs/hill) and spiromesifen 240 SC 0.024% @ 1 ml/litre (6.45 gundhi bugs/hill). Whereas in first spray number of gundhi bugs/hill at 3 DAS in the treatment of emamectin benzoate 5 WSG 0.015% @ 3 gm/litre was found the lowest gundhi bugs (1.80 gundhi bugs/hill) and it was at par with the treatment of imidacloprid 17.8 SL 0.005% @ 3 ml/10 litre (2.50 gundhi bugs/hill) and also it was followed by the treatment of novaluron 10 EC 0.01% @ 1 ml/litre (3.46 gundhi bugs/hill), rynaxypyre 20 SC 0.004 @ 0.2 ml/litre (3.81 gundhi bugs/hill), chlorpyriphos 20 EC 0.04% @ 2 ml/litre (4.40 gundhi bugs/hill) and spiromesifen 240 SC 0.024% @ 1 ml/ litre (5.82 gundhi bugs/hill). As far as in second spray in same year same trends were observed regarding gundhi bugs infestation. In the year 2014 and Table-1 in second spray number of gundhi bugs/hill at 1 DAS in the treatment of emamectin benzoate 5 WSG 0.015% @ 3 gm/litre was found the lowest gundhi bug population (3.14 gundhi bugs/hill) than the other treatments. The treatment of imidacloprid 17.8 SL 0.005% @ 3 ml/10 litres was recorded 4.40 gundhi bugs/hill in first spray. But in second spray number of gundhi bugs/hill at 3 DAS in the treatment of emamectin benzoate 5 WSG 0.015% @ 3 gm/litre was found the lowest gundhi bugs/hill (2.14 gundhi bugs/hill) and it was at par with the treatment of imidacloprid 17.8 SL 0.005% @ 3 ml/10 litre (2.50 gundhi bugs/hill) and also it was followed by the treatment of novaluron 10 EC 0.01% @ 1 ml/litre (3.15 gundhi bugs/hill), rynaxypyre 20 SC 0.004 @ 0.2 ml/litre (4.40 gundhi bugs/hill), chlorpyriphos 20 EC 0.04% @ 2 ml/litre (4.45 gundhi bugs/hill) and spiromesifen 240 SC 0.024% @ 1 ml/litre (5.82 gundhi bugs/hill) in second spray (Table-1). Rath *et al.*, [9] reported that imidacloprid 17.8% @ 300g/ha treatment recorded lowest percentage of gundhi bug damage (7.16%). Thus, the present findings are more or less in conformity with the earlier report.

Table 1: Evaluation of insecticides against gundhi bug in paddy (2014)

Sr. No.	Treatments	Rate (g or ml/litre)	[First spray] No. of gundhi bug (gundhi bug/10 hills)			[Second spray] No. of gundhi bug (gundhi bug/10 hills)			Grain Yield kg/plot	Grain Yield kg/ha	Straw Yield kg/plot	Straw Yield kg/ha
			B. S.	1 DAS. **	3 DAS**	B.S.	1 DAS. **	3 DAS. **				
1	Spiromesifen 240 SC 0.024% @ 1 ml/ litre	1	10.67	2.54 (6.45)	2.41 (5.82)	10.00	2.79 (7.79)	2.41 (5.82)	9.52	5835	10.90	6678
2	Emamectin benzoate 5 WSG 0.015% @ 3 gm/litre	0.3	9.67	1.46 (2.14)	1.34 (1.80)	9.67	1.77 (3.14)	1.46 (2.14)	10.57	6474	11.93	7312
3	Novaluron 10 EC 0.01% @ 1 ml/litre	1	11.00	1.95 (3.81)	1.86 (3.46)	9.67	2.27 (5.16)	1.77 (3.15)	9.74	5966	11.50	7046
4	Rynaxypyre 20 SC 0.004 @ 0.2 ml/litre	0.2	10.33	2.19 (4.80)	1.95 (3.81)	10.00	2.41 (5.82)	2.03 (4.40)	9.68	5931	11.37	6964
5	Profenophos 50 EC 0.05% @ 1 ml/litre	1	11.00	2.41 (5.82)	2.19 (4.80)	10.33	2.67 (7.13)	2.27 (5.16)	9.64	5904	11.07	6781
6	Imidacloprid 17.8 SL 0.005% @ 3 ml/10 litre (Check)	0.3	10.00	1.67 (2.79)	1.58 (2.50)	9.33	2.03 (4.40)	1.58 (2.50)	10.10	6188	11.67	7148
7	Chlorpyriphos 20 EC 0.04% @ 2 ml/litre (Check)	2	11.00	2.27 (5.16)	2.03 (4.40)	10.00	2.54 (6.45)	2.11 (4.45)	9.67	5927	11.27	6903
8	Control (Untreated)	-	10.00	3.63 (13.20)	3.85 14.81)	14.00	3.93 (15.50)	4.10 (16.81)	6.75	4136	8.43	5167
	SEm±		0.61	0.09	0.08	0.98	0.07	0.09	0.48	-	0.29	-
	C.D. at 5%		NS	0.27	0.26	NS	0.22	0.27	1.47	-	0.88	-
	C.V.%		10.03	6.74	7.08	16.38	5.01	6.82	8.87	-	4.58	-

Where, DAS=days after spray. B.S. = before spray

** Figures outside the parenthesis are √x+0.5 transformed value while figures in the parenthesis are original values or re-transformed value.

In the year 2015 result indicated that in first spray number of gundhi bugs/hill at 1 DAS in the treatment of emamectin benzoate 5 WSG 0.015% @ 3 gm/litre was found the lowest gundhi bugs/hill (2.14 gundhi bugs/hill) and it was at par with the treatment of imidacloprid 17.8 SL 0.005% @ 3 ml/10 litre (2.50 gundhi bugs/hill) (Table-2). In first spray the next best treatments were novaluron 10 EC 0.01% @ 1 ml/litre (3.46 gundhi bugs/hill), rynaxypyre 20 SC 0.004 @ 0.2 ml/litre (4.84 gundhi bugs/hill), chlorpyriphos 20 EC 0.04% @ 2 ml/litre (5.48 gundhi bugs/hill), and spiromesifen 240 SC 0.024% @ 1 ml/litre (6.15 gundhi bugs/hill). But in first spray at 3 DAS number of gundhi bugs/hill in the treatment of emamectin benzoate 5 WSG 0.015% @ 3 gm/litre was found the lowest gundhi bugs/hill (1.00 gundhi bugs/hill) and it was at par with the treatment of imidacloprid 17.8 SL 0.005% @ 3 ml/10 litre (1.11 gundhi bugs/hill) (Table-2). In second spray in same year, same trends were observed for rice gundhi bugs infestation. Thus, the data in second spray, number of gundhi bugs/hill at 1 DAS in the treatment of emamectin benzoate 5 WSG 0.015% @ 3 gm/litre was found the lowest gundhi bug population (2.79 gundhi bugs/hill) and it was at par with the treatment of imidacloprid 17.8 SL 0.005% @ 3 ml/10 litre (3.46 gundhi bugs/hill). But in second spray number of gundhi bugs/hill at 3 DAS in the treatment of emamectin benzoate 5 WSG 0.015% @ 3 gm/litre was found the lowest gundhi bugs/hill (2.14 gundhi bugs/hill) and it was at par with the treatment of imidacloprid 17.8 SL 0.005% @ 3 ml/10 litre (2.79 gundhi bugs/hill) and novaluron 10 EC 0.01% @ 10 ml/litre was found to be having less gundhi bugs/hill (3.14 gundhi bugs/hill) (Table-2). The present studies were also supported by Singh [7] and Padhan and Raghuraman [10] who reported granular insecticides were the best insecticides which recorded significantly lower numbers of rice gundhi bugs population. Thus, the result obtained though present investigations are in agreement with earlier workers.

Table 2: Evaluation of insecticides against gundhi bug in paddy (2015)

Sr. No.	Treatments	Rate (g or ml /litre)	[First spray] No. of gundhi bug (gundhi bug/10 hills)			[Second spray] No. of gundhi bug (gundhi bug/10 hills)			Grain Yield kg/plot	Grain Yield kg/ha	Straw Yield kg/plot	Straw Yield kg/ha
			B. S.	1 DAS. **	3 DAS**	B.S.	1 DAS. **	3 DAS. **				
1	Spiromesifen 240 SC 0.024% @ 1 ml/ litre	2	8.67	2.48 (6.15)	2.20 (4.84)	8.33	2.74 (7.51)	2.27 (5.16)	10.30	6311	10.93	6697
2	Emamectin benzoate 5 WSG 0.015% @ 3 gm/litre	0.3	8.00	1.46 (2.14)	0.88 (1.00)	7.33	1.67 (2.79)	1.46 (2.14)	11.43	7004	13.10	8027
3	Novaluron 10 EC 0.01% @ 1 ml/litre	1	9.67	1.86 (3.46)	1.46 (2.14)	9.00	2.04 (4.02)	1.77 (3.14)	11.03	6759	12.21	7482
4	Rynaxypyre 20 SC 0.004 @ 0.2 ml/litre	0.2	8.67	2.20 (4.84)	1.77 (3.14)	8.33	2.41 (5.81)	2.20 (4.84)	10.86	6654	12.10	7414
5	Profenophos 50 EC 0.05% @ 1 ml/litre	1	9.33	2.41 (5.81)	2.03 (4.12)	9.33	2.61 (6.81)	2.34 (5.48)	10.73	6574	11.43	7004
6	Imidacloprid 17.8 SL 0.005% @ 3 ml/10 litre (Check)	0.3	9.33	1.58 (2.50)	1.05 (1.11)	8.67	1.86 (3.46)	1.67 (2.79)	11.16	7267	12.56	7696
7	Chlorpyriphos 20 EC 0.04% @ 2 ml/litre (Check)	2	8.67	2.34 (5.48)	2.11 (4.45)	8.33	2.55 (6.50)	2.11 (4.45)	10.79	6593	12.07	7396
8	Control (Untreated)	-	8.67	3.29 (10.80)	3.63 (13.20)	10.67	3.63 (13.20)	3.76 (14.20)	7.97	4884	9.22	5649
	SEm±		0.71	0.09	0.12	0.82	0.12	0.11	0.50	-	0.54	-
	C.D. at 5%		NS	0.30	0.38	NS	0.36	0.32	1.52	-	1.62	-
	C.V.%		14.02	7.79	11.37	16.14	8.32	8.31	8.26	-	7.93	-

Where, DAS=Days after spray. BS= before spray

** Figures outside the parenthesis are √x+0.5 transformed value while figures in the parenthesis are re-transformed value.

In the year 2016, result indicated that in first spray, number of gundhi bugs/hill at 1 DAS in the treatment of emamectin benzoate 5 WSG 0.015% @ 3 gm/litre was found the lowest gundhi bugs/hill (2.76 gundhi bugs/hill) and it was at par with the treatment of imidacloprid 17.8 SL 0.05% @ 0.3 ml/ litre (3.46 gundhi bugs/hill) and in the treatment of novaluron 10 EC 0.01% @ 1.0 ml/litre (4.12 gundhi bugs/hill) in first spray (Table-3). As far as in second spray in same year same trends were observed regarding gundhi bugs infestation. But in first spray number of gundhi bugs/hill at 3 DAS in the treatment of emamectin benzoate 5 WSG 0.015% @ 3 gm/litre was found the lowest gundhi bugs/hill (1.49 gundhi bugs/hill) and it was at par with the treatment of imidacloprid 17.8 SL 0.005% @ 3 ml/10 litre (2.14 gundhi bugs/hill). In second spray number of gundhi bugs/hill at 1 DAS in the treatment of emamectin benzoate 5 WSG 0.015% @ 3 gm/litre was found the lowest gundhi bug population (3.46 gundhi bugs/hill) and it was at par with the treatment of imidacloprid 17.8 SL 0.005% @ 3 ml/10 litre (4.16 gundhi bugs/hill). As far as considering second spray, number of gundhi bugs/hill at 3 DAS in the treatment of emamectin benzoate 5 WSG 0.015% @ 3 gm/litre was found the lowest gundhi bugs/hill (1.80 gundhi bugs/hill) and it was at par with the treatment of profenophos 50 EC 0.05% @ 1.0 ml/litre (2.38 gundhi bugs/hill) and the treatment of imidacloprid 17.8 SL 0.005% @ 3 ml/10 litre (2.44 gundhi bugs/hill) (Table-3). Whereas remaining treatments were superior over control. Rath *et al.* [9] reported that imidacloprid 17.8% @ 300g/ha treatment recorded lowest percentage of gundhi bug damage (7.16%). Misra [8], Padhan and Raghuraman [10] as well as Singh [11] reported that among the tested insecticides, though granular insecticide and rynaxypyre were found best to control gundhi bugs in the rice ecosystem. Thus, the present findings are more or less similar with the earlier reports.

Overall in pooled data in Table-4 the result indicated that in first spray, number of gundhi bugs/hill at 1 DAS in the treatment of emamectin benzoate 5 WSG 0.015% @ 3 gm/litre was found the lowest gundhi bugs/hill (2.34 gundhi bugs/hill) and followed by the treatment of imidacloprid 17.8 SL 0.05% @ 0.3 ml/ litre (2.93 gundhi bugs/hill) and treatment of novaluron 10 EC 0.01% @ 1.0 ml/litre (3.80 gundhi bugs/hill). But in first spray, number of gundhi bugs/hill at 3 DAS in the treatment of emamectin benzoate 5 WSG 0.015% @ 3 gm/litre was found the lowest gundhi bugs/hill (1.33 gundhi bugs/hill) and followed by the treatment of imidacloprid 17.8 SL 0.05% @ 0.3 ml/ litre (1.88 gundhi bugs/hill) and treatment of novaluron 10 EC 0.01% @ 1.0 ml/litre (2.76 gundhi bugs/hill) (Table-4). As far as in second spray same trends were recorded in 1 DAS and 3 DAS. The result indicated that in second spray, number of gundhi bugs/hill at 1 DAS in the treatment of emamectin benzoate 5 WSG0.015% @ 3 gm/litre was found the lowest gundhi bugs/hill (3.14 gundhi bugs/hill) and followed by the treatment of imidacloprid 17.8 SL 0.05% @ 3 ml/10 litre (3.92 gundhi bugs/hill) and treatment of novaluron 10 EC 0.01% @ 1.0 ml/litre (4.71 gundhi bugs/hill) (Table-5). But in second spray, number of gundhi bugs/hill at 3 DAS in the treatment of emamectin benzoate 5 WSG 0.015% @ 3 gm/litre was found the lowest gundhi bugs/hill (2.02 gundhi bugs/hill) and it was at par with the treatment of imidacloprid 17.8 SL 0.05% @ 3 ml/10 litre (2.56 gundhi bugs/hill) and also it was followed by the treatment of novaluron 10 EC 0.01% @ 1 ml/litre (3.14 gundhi bugs/hill), rynaxypyre 20 SC 0.004 @ 0.2 ml/litre (4.50 gundhi bugs/hill), chlorpyriphos 20 EC 0.04% @ 2 ml/litre (4.71 gundhi bugs/hill) and spiromesifen 240 SC 0.024% @ 1 ml/litre (6.01 gundhi bugs/hill) (Table-5). The lowest gundhi bugs were recorded in the treatment of thiamethoxam 25 WG @ 100 g/ha (7.73 gundhi bugs/hill) reported by Girish and Balikali [12]. Thus, past worker's findings are more or less in agreement with present findings.

Table 3: Evaluation of insecticides against gundhi bug in paddy (*Kharif*-2016)

Sr. No.	Treatments	Rate (g or ml /litre)	[First spray] No. of gundhi bug (gundhi bug/10 hills)			[Second spray] No. of gundhi bug (gundhi bug/10 hills)			Grain Yield kg/plot	Grain Yield kg/ha	Straw Yield kg/plot	Straw Yield kg/ha
			B. S.	1 DAS. **	3 DAS**	B.S.	1 DAS. **	3 DAS. **				
1	Spiromesifen 240 SC 0.024% @ 1 ml/ litre	2	9.33	2.80 (7.84)	2.04 (4.16)	9.67	2.80 (7.79)	2.68 (7.18)	6.05	3705	9.90	6066
2	Emamectin benzoate 5 WSG 0.015% @ 3 gm/litre	0.3	9.33	1.66 (2.76)	1.22 (1.49)	9.67	1.86 (3.46)	1.34 (1.80)	7.90	4841	10.27	6291
3	Novaluron 10 EC 0.01% @ 1 ml/litre	1	10.00	2.03 (4.12)	1.66 (2.76)	9.67	2.20 (4.84)	1.77 (3.14)	7.20	4412	10.00	6127
4	Rynaxypyre 20 SC 0.004 @ 0.2 ml/litre	0.2	9.33	2.34 (5.48)	1.86 (3.46)	10.00	2.48 (6.15)	2.11 (4.45)	6.90	4230	9.83	6025
5	Profenophos 50 EC 0.05% @ 1 ml/litre	1	9.67	2.67 (7.13)	2.11 (4.45)	9.67	2.67 (7.13)	1.54 (2.38)	6.30	3864	9.70	5944
6	Imidacloprid 17.8 SL 0.005% @ 3 ml/10 litre (Check)	0.3	9.67	1.86 (3.46)	1.46 (2.14)	9.33	2.04 (4.16)	1.56 (2.44)	7.53	4616	10.03	6148
7	Chlorpyriphos 20 EC 0.04% @ 2 ml/litre (Check)	2	10.00	2.61 (6.81)	1.95 (3.81)	10.00	2.61 (6.81)	2.27 (5.16)	6.87	4210	9.80	6005
8	Control (Untreated)	-	9.67	3.39 (11.50)	3.85 (14.80)	12.33	3.93 (15.45)	4.18 (17.50)	5.88	3605	9.67	5923
	SEm±		0.75	0.14	0.12	0.89	0.10	0.12	0.12	-	0.19	-
	C.D. at 5%		NS	0.43	0.36	NS	0.30	0.36	0.36	-	NS	-
	C.V.%		13.53	10.09	10.15	15.39	6.64	9.02	2.99	-	3.40	-

Where, DAS=Days after spray. BS= before spray

** Figures outside the parenthesis are $\sqrt{x+0.5}$ transformed value while figures in the parenthesis are re-transformed value.

Table 4: Evaluation of insecticides against gundhi bug in paddy in first spray (Pooled)

Sr. No.	Treatments	Before spray (BS) No. of gundhi bug/10 hills				1 Days after spray (DAS) No. of gundhi bug/10 hills*				3 Days after spray (DAS) No. of gundhi bug/10 hills*			
		2014	2015	2016	Pooled	2014	2015	2016	Pooled	2014	2015	2016	Pooled
T_1	Spiromesifen 240 SC 0.024% @ 1 ml/ litre	10.67	8.67	9.33	9.56	2.54 (6.45)	2.48 (615)	2.80 (7.84)	2.61 (6.81)	2.41 (5.82)	2.20 (4.84)	2.04 (4.16)	2.22 (4.93)
T_2	Emamectin benzoate 5 WSG 0.015% @ 3 gm/litre	9.67	8.00	9.33	9.00	1.46 (2.14)	1.46 (2.14)	1.66 (2.76)	1.53 (2.34)	1.34 (1.80)	0.88 (1.00)	1.22 (1.49)	1.15 (1.33)
T_3	Novaluron 10 EC 0.01% @ 1 ml/litre	11.00	9.67	10.00	10.22	1.95 (3.81)	1.86 (3.46)	2.03 (4.12)	1.95 (3.80)	1.86 (3.46)	1.46 (2.14)	1.66 (2.76)	1.66 (2.76)
T_4	Rynaxypyre 20 SC 0.004 @ 0.2 ml/litre	10.33	8.67	9.33	9.44	2.19 (4.80)	2.20 (4.84)	2.34 (5.48)	2.24 (5.20)	1.95 (3.81)	1.77 (3.14)	1.86 (3.46)	1.86 (3.46)
T_5	Profenophos 50 EC 0.05% @ 1 ml/litre	11.00	9.33	9.67	10.00	2.41 (5.82)	2.41 (5.81)	2.67 (7.13)	2.50 (6.25)	2.19 (4.80)	2.03 (4.12)	2.11 (4.45)	2.12 (4.50)
T_6	Imidacloprid 17.8 SL 0.005% @ 3 ml/10 litre (Check)	10.00	9.33	9.67	9.67	1.67 (2.79)	1.58 (2.50)	1.86 (3.46)	1.71 (2.93)	1.58 (2.50)	1.05 (1.11)	1.46 (2.14)	1.37 (1.88)
T_7	Chlorpyriphos 20 EC 0.04% @ 2 ml/litre (Check)	11.00	8.67	10.00	9.89	2.27 (5.16)	2.34 (5.48)	2.61 (6.81)	2.14 (4.58)	2.03 (4.40)	2.11 (4.45)	1.95 (3.81)	2.03 (4.12)
T_8	Control (Untreated)	10.00	8.67	9.67	9.44	3.63 (13.20)	3.29 (10.80)	3.39 (11.50)	3.44 (11.81)	3.85 (14.81)	3.63 (13.20)	3.85 (14.80)	3.78 (14.30)
	SEm±	0.61	0.71	0.75	0.36	0.09	0.09	0.14	0.06	0.08	0.12	0.12	0.07
	C.D. at 5%	NS	NS	NS	NS	0.27	0.30	0.43	0.18	0.26	0.38	0.36	0.19
	C.V.%	10.03	14.02	13.53	-	6.74	7.79	10.09	-	7.08	11.37	10.15	-
	Y x T SEm ±				0.69				0.11				0.11
	C.D.at 5%				NS				NS				NS
	C.V.%				12.47				8.43				9.54

Where, DAS=Days after spray. BS= before spray

* Figures outside the parenthesis are √x+0.5 transformed value while figures in the parenthesis are re-transformed value.

Grain and straw yield

The results on grain and straw yield of paddy affected by different treatments recorded and indicated in Table-1, 2, 3 and 4. The result indicated that the effect of different treatments was found to be significant during all the individual years as well as in pooled result. All the treatments were found significantly superior over control for grain and straw yield of paddy during 2014, 2015 and 2016. On pooled basis of grain yield, treatment of emamectin benzoate 5 WSG 0.015% @ 3 gm/litre was found the highest grain yield (6109 kg/ha) and it was followed by the treatment of imidacloprid 17.8 SL 0.05% @ 0.3 ml/ litre (5882 kg/ha). Rath *et al.,* [9] reported that imidacloprid 17.8% @ 300g/ha treatment recorded the highest grain yield in the treatment imidacloprid 17.8% @ 300g/ha were 5280 kg/ha and 5210 kg/ha in variety Jaya during 2011 and 2012, respectively in West Bengal. Padhan and Raghuraman [10] reported that the treatment of cartap hydrochloride 4% GR were recorded grain yield 7190 kg/ha during *kharif*-2016 in Varanasi region of Uttar Pradesh. Thus, the present findings are more or less similar with the earlier reports. For considering straw yield, emamectin benzoate 5 WSG 0.015% @ 3 gm/litre was found the highest straw yield (7212 kg/ha) and it was at par with the treatment of imidacloprid 17.8 SL 0.05% @ 0.3 ml/ litre (6998 kg/ha). While, remaining treatments were found superior over control (Table 6).

Table 5: Evaluation of insecticides against gundhi bug in paddy in second spray (Pooled)

Sr. No.	Treatments	Before spray (BS) No. of gundhi bug/10 hills				1 Days after spray (DAS) No. of gundhi bug/10 hills*				3 Days after spray (DAS) No. of gundhi bug/10 hills*			
		2014	2015	2016	Pooled	2014	2015	2016	Pooled	2014	2015	2016	Pooled
T_1	Spiromesifen 240 SC 0.024% @ 1 ml/ litre	10.00	8.33	9.67	9.33	2.79 (7.79)	2.74 (7.51)	2.80 (7.79)	2.78 (7.73)	2.41 (5.82)	2.27 (5.16)	2.68 (7.18)	2.45 (6.01)
T_2	Emamectin benzoate 5 WSG 0.015% @ 3 gm/litre	9.67	7.33	9.67	8.89	1.77 (3.14)	1.67 (2.79)	1.86 (3.46)	1.77 (3.14)	1.46 (2.14)	1.46 (2.14)	1.34 (1.80)	1.42 (2.02)
T_3	Novaluron 10 EC 0.01% @ 1 ml/litre	9.67	9.00	9.67	9.44	2.27 (5.16)	2.04 (4.02)	2.20 (4.84)	2.17 (4.71)	1.77 (3.15)	1.77 (3.14)	1.77 (3.14)	1.77 (3.14)
T_4	Rynaxypyre 20 SC 0.004 @ 0.2 ml/litre	10.00	8.33	10.00	9.44	2.41 (5.82)	2.41 (5.81)	2.48 (6.15)	2.44 (5.96)	2.03 (4.40)	2.20 (4.84)	2.11 (4.45)	2.12 (4.50)
T_5	Profenophos 50 EC 0.05% @ 1 ml/litre	10.33	9.33	9.67	9.78	2.67 (7.13)	2.61 (6.81)	2.67 (7.13)	2.65 (7.02)	2.27 (5.16)	2.34 (5.48)	1.54 (2.38)	2.38 (5.67)
T_6	Imidacloprid 17.8 SL 0.005% @ 3 ml/10 litre (Check)	9.33	8.67	9.33	9.11	2.03 (4.40)	1.86 (3.46)	2.04 (4.16)	1.98 (3.92)	1.58 (2.50)	1.67 (2.79)	1.56 (2.44)	1.60 (2.56)
T_7	Chlorpyriphos 20 EC 0.04% @ 2 ml/litre (Check)	10.00	8.33	10.00	9.44	2.54 (6.45)	2.55 (6.50)	2.61 (6.81)	2.57 (6.61)	2.11 (4.45)	2.11 (4.45)	2.27 (5.16)	2.17 (4.71)
T_8	Control (Untreated)	14.00	10.67	12.33	12.33	3.93 (15.50)	3.63 (13.20)	3.93 (15.45)	3.83 (14.70)	4.10 (16.81)	3.76 (14.20)	4.18 (17.50)	4.01 (16.10)
	SEm±	0.98	0.82	0.89	0.47	0.07	0.12	0.10	0.05	0.09	0.11	0.12	0.06
	C.D. at 5%	NS	NS	NS	NS	0.22	0.36	0.30	0.15	0.27	0.32	0.36	0.18
	C.V.%	16.38	16.14	15.39	-	5.01	8.32	6.64	-	6.82	8.31	9.02	-
	Y x T SEm ±				0.89				0.10				0.11
	C.D.at 5%				NS				NS				NS
	C.V.%				16.01				6.74				8.13

Where, DAS=Days after spray. BS= before spray

* Figures outside the parenthesis are √x+0.5 transformed value while figures in the parenthesis are re-transformed value.

Table 6: The effect of insecticides on yield parameters of rice (Pooled)

Sr. No.	Treatments	Grain yield (Kg/plot)				Grain yield (Kg/ha)	Straw yield (Kg/plot)				Straw yield (Kg/ha)
		2014	2015	2016	Pooled		2014	2015	2016	Pooled	
T_1	Spiromesifen 240 SC 0.024% @ 1 ml/ litre	9.52	10.30	6.05	8.62	5282	10.90	10.93	9.90	10.58	6483
T_2	Emamectin benzoate 5 WSG 0.015% @ 3 gm/litre	10.57	11.43	7.90	9.97	6109	11.93	13.10	10.27	11.77	7212
T_3	Novaluron 10 EC 0.01% @ 1 ml/litre	9.74	11.03	7.20	9.32	5711	11.50	12.21	10.00	11.24	6887
T_4	Rynaxypyre 20 SC 0.004 @ 0.2 ml/litre	9.68	10.86	6.90	9.15	5607	11.37	12.10	9.83	11.10	6801
T_5	Profenophos 50 EC 0.05% @ 1 ml/litre	9.64	10.73	6.30	8.89	5447	11.07	11.43	9.70	10.74	6581
T_6	Imidacloprid 17.8 SL 0.005% @ 3 ml/10 litre (Check)	10.10	11.16	7.53	9.60	5882	11.67	12.56	10.03	11.42	6998
T_7	Chlorpyriphos 20 EC 0.04% @ 2 ml/litre (Check)	9.67	10.79	6.87	9.11	5582	11.27	12.07	9.80	11.04	6765
T_8	Control (Untreated)	6.75	7.97	5.88	6.87	4210	8.43	9.22	9.67	9.11	5582
	SEm±	0.48	0.50	0.12	0.24	-	0.29	0.54	0.19	0.25	
	C.D. at 5%	1.47	1.52	0.36	0.68	-	0.88	1.62	NS	0.72	
	C.V.%	8.87	8.26	2.99	-	-	4.58	7.93	3.40	-	
	Y x T SEm ±				0.41	-				0.37	
	C.D.at 5%				NS	-				NS	
	C.V.%				7.91	-				5.89	

Where, DAS=Days after spray. BS= before spray

Economics

The economics is calculated by considering the profit increase over control of different treatments (Table-7). The treatment of imidacloprid 17.8 SL 0.005% @ 3 ml/10 litre registered higher net income (Rs.71946/ha) and BCR (1:2.29) followed by emamectin benzoate 5 WSG 0.015% @ 3 gm/litre with net income (Rs. 71684/ha) and BCR 1:2.02. However, the treatment of novaluron 10 EC 0.01% @ 1 ml/litre (Rs. 67759/ha), chlorpyriphos 20 EC 0.04% @ 2 ml/litre (Rs. 67087/ha), rynaxypyre 20 SC 0.004 @ 0.2 ml/litre (Rs. 66245/ha), profenophos 50 EC 0.05% @ 1 ml/litre (Rs. 63725/ha and spiromesifen 240 SC 0.024% @ 1 ml/ litre (Rs. 60291/ha) recorded less net income than treatment of imidacloprid 17.8 SL 0.005% @ 3 ml/10 litre and emamectin benzoate 5 WSG 0.015% @ 3 gm/litre. Girish and Balikali [12] reported that the treatment of thiamethoxam 25 WG @ 100 g/ha was recorded the highest gross returns of Rs. 89773.75 per ha in Karnataka. Thus, past worker’s findings are in agreement with present findings.Therefore considering consistant efficacy, yield and economics of treatments imidacloprid 17.8 SL 0.005% @ 3 ml/10 litre and emamectin benzoate 5 WSG 0.015% @ 3 gm/litre are recommended to manage gundhi bugs of rice and to produce more yield of rice in South Gujarat.

Conclusion

Rice gundhi bug, *Leptocorisa acuta* (Thunberg) is a serious pest of rice in South Gujarat. On the basis of the study it can be concluded that apply two sprays of emamectin benzoate 5 WSG 0.015% (3 gm/litre) or imidacloprid 17.8 SL 0.005% (3 ml/10 litre) for effective management of rice gundhi bugs and to harvest higher grain and straw yield. The first spray should be given at appearance of pest and the remaining one spray at 15 days after first spray.

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Table 7: Economics of insecticidal treatment to control rice gundhi bug.

Sr. No.	Treatments	Total Spray	Quantity ml or g./ha	Cost (Rs./ha)	Labour cost (Rs/ha)	Pesticides cost (Rs./ ha)	Total cost (Rs/ha)	Yield (Kg/ ha)		Income (Rs/ha)		Gross Income (Rs/ha)	Net Income (Rs/ha	Increase Over control	BCR
								Grain	Straw	Grain	Straw				
T_1	Spiromesifen 240 SC 0.024% @ 1 ml/ litre	2	500	2250	356	2606	33106	5282	6483	73948	19449	93397	60291	17105	1:1.82
T_2	Emamectin benzoate 5 WSG 0.015% @ 3 gm/litre	2	1500	4800	178	4978	35478	6109	7212	85526	21636	107162	71684	28498	1:2.02
T_3	Novaluron 10 EC 0.01% @ 1 ml/litre	2	500	2000	356	2356	32856	5711	6887	79954	20661	100615	67759	24573	1:2.06
T_4	Rynaxypyre 20 SC 0.004 @ 0.2 ml/litre	2	100	1800	356	2156	32656	5607	6801	78498	20403	98901	66245	23059	1:2.03
T_5	Profenophos 50 EC 0.05% @ 1 ml/litre	2	500	1420	356	1776	32276	5447	6581	76258	19743	96001	63725	20539	1:1.97
T_6	Imidacloprid 17.8 SL 0.005% @ 3 ml/10 litre (Check)	2	150	540	356	896	31396	5882	6998	82348	20994	103342	71946	28760	1:2.29
T_7	Chlorpyriphos 20 EC 0.04% @ 2 ml/litre (Check)	2	1000	500	356	856	31356	5582	6765	78148	20295	98443	67087	23901	1:2.14
T_8	Control (Untreated)	0	0	0	0	0	32500	4210	5582	58940	16746	75686	43186	0	1.33

Cost of Insecticides

1. Spiromesifen 240 SC	Rs. 2250/500 ml	Labour cost: Rs. 178/day
2. Emamectin benzoate 5 WSG	Rs.1600/500 gm	Grain: Rs. 14.00/kg
3. Novaluron 10 EC	Rs.2000/500 ml	Straw: Rs.3.00/kg

4. Rynaxypyre 20 SC	Rs. 9000/500 ml
5. Profenophos 50 EC	Rs. 1420/500 ml
6. Imidacloprid 17.8 SL	Rs. 1800/500 ml
7. Chlorpyriphos 20 EC	Rs. 250/500 ml

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