Relative Efficacy of Acetamirpid + Fipronil Combination Formulation Against BPH (*Nilaparvata lugens* Stal) & GLH (*Nephotettix virscens* Distant) in Rice

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Rice is the staple cereal crop consumed by more than 50% of world population. Its production can directly show influence on once nation's food security, including Indian subcontinent. Nowadays the rice crop is subjected to major damage by sucking pests, especially *Nilaparvata lugens* (Stal) (brown plant hopper) and *Nephotettix virscens* (Distant) (green leaf hopper). These pests are reported to cause an annual losses of 10-70% of grain yield. Further, these pests are reported to show resistance conventional insecticides and even the new groups of insecticides also reported to show less efficacy after few repeated applications. Keeping these constraints in view, an experiment was conducted to study the efficacy of combination insecticide formulation (acetamiprid + fipronil) in comparision to their corresponding sole insecticidal treatment. Eight test insecticides viz., acetamiprid 15 + fipronil 60 WDG, imidacloprid, acetamiprid, fipronil in two formulations 5SC & 80WG, monocrotophos, chlorpyriphos were assessed. The results showed that during *kharif* 2013, acetamiprid + fipronil treated plots are experienced low average insect pest population of BPH (2.02) & GLH (2.33) by the end of 2nd spray and per cent reduction over control for BPH and GLH was 87.71and 88.15 respectively which is higher than any other insecticidal treatment under study. Further, imidacloprid and acetamiprid were reported as next best chemicals followed by fipronil 5SC and 80WG. The same scenario was observed during kharif 2014 which emphasizes that acetamiprid + fipronil combination will give effective results for management of BPH & GLH than their corresponding individual insecticidal applications.

Keywords: Brown plant hopper, green leaf hopper, bio-efficacy, neonicotinoids, phenyl pyrazole.

Rice (*Oryza sativa* L.) is one of the important cereal crops of the world and forms staple food for more than 50 per cent population making it as king of cereals. Rice crop is extremely versatile and adaptive with a temperature range throughout the crop cycle is between 21^{0}C to 37^{0}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, due to modern agriculture production practices involving use of synthetic fertilizers has made rice to attract more insect pests. Of the several insect species recorded as pests of rice, brown plant hopper, *Nilaparvata lugens* Stal. (Homoptera: Delphacidae) and green leaf hopper *Nephotettix virescens* (Distant) (Hemiptera: Cicadellidae) are predominant and assumed major pest status. They suck sap directly from the growing plants and the affected plants become chlorotic with prominent drying of leaves ultimately resulting in the death of plants. This feeding damage is commonly

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referred as 'hopper burn', which begins in patches, but spreads rapidly as the hoppers move from dying plants to adjacent plants. In addition to direct feeding damage, *N. lugens* serves as the vector of rice grassy stunt virus, rice ragged stunt virus and *N. virescens* transmits tungro and yellow leaf virus. Outbreak of these pests often leads to total loss of the rice crop, if no effective 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). 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 these sucking pests. However, the intensive and continuous cultivation of rice with excessive use of nitrogenous fertilizers has paved the congineal 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 detrimental 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, thiomethoxam and acitamiprid (Krishnaiah *et al*., 2006). 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 also led to resurgence of sucking pests of rice. Keeping these points in view, an experiment was conducted at Institute of Agricultural Sciences, Banaras Hindu University to compare the efficacy of certain new insecticide combinations with the sole application of corresponding insecticides as standards against the two major sucking pests of rice (BPH and GLH).

MATERIALS AND METHODS

The experiment was conducted during *kharif* 2013 and Swarna-sub1 which is flood tolerant version of the popular variety Swarna (MTU 7029) was choosen for this study. Pure seeds of the test variety were sown in nursery beds at the rate of 15 kg per 200 m^2 and proper care was taken as per the recommendations to maintain the nursery. Summer ploughing was given with the aim of exposing different stages harmful insect pests and under-ground reproductive parts of weeds. Twenty one day old seedlings were transplanted in the experimental plots at a spacing of 20 × 15 cm. The fertilizers were applied at the rate of 120:60:60 Kg N, P_2O_5 and K_2O in the form of urea, single super phosphate and muriate of potash. Full dose of phosphorous and potash and half dose of nitrogen were applied as basal dose. Rest of the nitrogen were applied in two equal doses, first at 25 days after transplanting and second at 55 days after transplanting. Pests were monitored at regular intervals and when pest population reached the economic threshold level, insecticidal sprays were given. The insecticidal spray solution of desired concentration as per each treatment was freshly prepared every time at the experimental site just before the start of spraying operation. A measured required quantity of insecticide was mixed with a little quantity of water and stirred well, after which the remaining quantity of water was added to obtain the required concentration of the spray fluid. In case of soluble concentrates, the required quantities were first taken and mixed with a little quantity of water to dissolve and then the remaining quantity of water was added to obtain desired concentration and stirred well.

The pest population was taken into account in phases i.e., before spray and after spray. The observations were recorded from randomly selected 10 hills in each treatment plot and observation were taken one day prior to insecticidal application and 1^{st},7^{th} and 14^{th} day after application. The number of motile (adult and nymphs) stages of leafhopper and plant hoppers on all the 10 hills was recorded. The total count was averaged and expressed in per hill basis.

RESULTS AND DISCUSSION

Influence of insecticidal treatments on *N .lugens Kharif 2013*

First spray

The average number of insects recorded in various experimental plots including control one day prior to the spray was in a range of 10.33 to 12.66 / 10 hills (Table-1). Acetamiprid + fipronil

Table 1. Effect of insecticidal treatments against *N.lugens* in rice ecosystem (*Kharif*- 2013)

Treatments	Dose (g a.i./ha)	Avg. no. of adults & nymphs per 10 hills: 1st spray: 1 DBS	1st spray: 1DAS	1st spray: 7DAS	1st spray: 14 DAS	1st spray: Overall mean	1st spray: % Reduction over control	2nd spray: 1 DBS	2nd spray: 1DAS	2nd spray: 7DAS	2nd spray: 14 DAS	2nd spray: Overall mean	2nd spray: % Reduction over control
Imidacloprid 17.8 SL	25	10.66* (3.42)**	8.66 (3.10)^{c}	4.66 (2.37)^{e}	6.66 (2.76)^{d}	6.66	54.92	7.00* (2.82)**	5.33 (2.51)^{d}	2.66 (1.91)^{e}	4.00 (2.23)^{e}	4.00	79.67
Fipronil 5SC	50	12.33 (3.65)	10.33 (3.36)^{b}	7.00 (2.82)^{d}	9.66 (3.26)^{c}	9.00	39.09	10.00 (3.31)	8.33 (3.05)^{c}	5.33 (2.51)^{d}	7.33 (2.88)^{d}	7.00	64.41
Acetamiprid 20 SP	35	10.33 (3.36)	8.33 (3.05)^{c}	4.00 (2.23)^{e}	6.33 (2.70)^{d}	6.22	57.89	7.33 (2.88)	5.00 (2.44)^{d}	2.33 (1.82)^{e}	3.66 (2.15)^{e}	3.66	81.37
Acetamiprid 15 + Fipronil 60 WDG	35	12.66 (3.69)	5.66 (2.58)^{d}	2.66 (1.91)^{f}	5.00 (2.44)^{e}	4.44	69.94	6.33 (2.70)	3.00 (2.00)^{e}	1.33 (1.52)^{f}	2.66 (1.91)^{f}	2.33	88.15
Fipronil 80 WG	50	12.33 (3.65)	10.66 (3.41)^{b}	7.33 (2.88)^{cd}	9.00 (3.16)^{c}	9.00	39.09	9.66 (3.26)	8.66 (3.10)^{c}	5.66 (2.58)^{d}	8.00 (3.00)^{d}	7.44	62.16
Chlorpyriphos 20 EC	250	12.00 (3.60)	11.66 (3.55)^{ab}	9.66 (3.26)^{b}	11.00 (3.46)^{b}	10.77	27.06	11.66 (3.55)	10.66 (3.41)^{b}	9.00 (3.16)^{b}	11.00 (3.46)^{b}	10.22	48.02
Monocrotophos 36 SL	500	11.66 (3.55)	10.33 (3.36)^{b}	8.00 (3.00)^{c}	10.00 (3.31)^{bc}	9.44	36.06	11.33 (3.51)	9.00 (3.16)^{c}	7.00 (2.82)^{c}	9.66 (3.26)^{c}	8.55	56.49
Control	-	12.33 (3.65)	12.66 (3.69)^{a}	15.00 (4.00)^{a}	16.66 (4.20)^{a}	14.77	-	17.00 (4.24)	17.33 (4.28)^{a}	19.33 (4.50)^{a}	22.33 (4.83)^{a}	19.66	-
SE(m)	-	-	0.05	0.05	0.05	-	-	-	0.05	0.07	0.06	-	-
C.D.	-	-	0.17	0.18	0.18	-	-	-	0.18	0.22	0.19	-	-

*Mean of three replications, **Figures in the parenthesis are Square root transformed values, DBS- Days before spray, DAS – Days after spray

Table 2. Effect of insecticidal treatments against *N. lugens* in rice ecosystem (Kharif- 2014)

Treatments	Dose (g a.i./ha)	Avg. no. of adults & nymphs per 10 hills											
		1st spray						2nd spray					
		1 DBS	1DAS	7DAS	14 DAS	Overall mean	% Reduction over control	1 DBS	1DAS	7DAS	14 DAS	Overall mean	% Reduction over control
Imidacloprid 17.8 SL	25	10.01	7.68	5.63	7.02	6.78	56.17	7.36	5.61	3.03	4.21	4.28	78.53
		(3.16)^{cd}	(2.94)^{d}	(2.58)^{c}	(2.81)^{d}			-2.88	(2.58)^{d}	(2.00)^{e}	(2.29)^{e}		
Fipronil 5SC	50	10.68	9.35	8.68	10.02	9.35	39.52	10.48	8.64	5.62	7.53	7.26	63.59
		-3.41	(3.21)^{c}	(3.10)^{b}	(3.32)^{bc}			-3.36	(3.10)^{c}	(2.58)^{d}	(2.91)^{d}		
Acetamiprid 20 SP	35	11.68	8.01	5.35	6.68	6.68	56.79	7.69	5.35	2.64	3.96	3.98	80.03
		-3.16	(3.01)^{d}	(2.51)^{c}	(2.76)^{d}			-2.94	(2.51)^{d}	(1.91)^{e}	(2.22)^{e}		
Acetamiprid 15 +	35	11.85	4.68	4.01	5.35	4.68	69.73	6.78	3.28	1.71	2.78	2.59	87.02
Fipronil 60 WDG		-3.58	(2.37)^{e}	(2.27)^{d}	(2.51)^{e}			-2.78	(2.06)^{c}	(1.65)^{f}	(1.92)^{f}		
Fipronil 80 WG	50	11.01	9.68	9.31	9.55	9.51	38.46	10.03	9.13	6.23	8.35	7.9	60.38
		-3.47	(3.26)^{c}	(3.21)^{b}	(3.26)^{c}			-3.32	(3.18)^{c}	(2.66)^{d}	(3.05)^{b}		
Chlorpyriphos 20 EC250		12.01	11.88	10.35	11.35	11.13	28.03	12.03	11.86	9.54	11.22	10.87	45.5
		-3.61	(3.58)^{b}	(3.36)^{b}	(3.51)^{b}			-3.6	(3.56)^{b}	(3.26)^{b}	(3.50)^{cd}		
Monocrotophos 36 SL 55.36		500	10.68	10.01	9.35	10.35	9.9	35.94	11.69	9.58	7.36	9.78	8.91
		-3.41	(3.16)^{cd}	(3.21)^{b}	(3.36)^{bc}			-3.55	(3.25)^{c}	(2.88)^{c}	(3.27)^{c}		
Control	-	12.01	12.88	15.68	17.02	15.46	-	17.49	17.69	19.71	22.45	19.95	-
		-3.74	(3.82)^{a}	(4.08)^{a}	(4.24)^{a}			-4.29	(4.32)^{a}	(4.55)^{a}	(4.85)^{a}		
SE(m)	-	-	0.05	0.05	0.06	-	-	-	0.07	0.05	0.06	-	-
C.D.	-	-	0.18	0.15	0.2	-	-	-	0.2	0.16	0.19	-	-

*Mean of three replications, **Figures in the parenthesis are Square root transformed values, DBS- Days before spray, DAS – Days after spray

Table 3. Effect of insecticidal treatments against *N. virescens* in rice ecosystem (*Kharif*- 2013)

Treatments	Dose	Avg. no. of adults & nymphs per 10 hills											
		1st spray						2nd spray					
	(g a.i./ha)	1 DBS	1DAS	7DAS	14 DAS	Overall mean	% Reduction over control	1 DBS	1DAS	7DAS	14 DAS	Overall mean	% Reduction over control
Imidacloprid 17.8 SL	25	12.44*	8.81	3.93	5.66	6.13	52.39	6.33*	4.04	2.33	3.33	3.23	80.33
		(3.66)**	(3.13)[c]	(2.22)[e]	(2.58)[e]			(2.70)**	(2.24)[d]	(1.82)[e]	(2.07)[d]		
Fipronil 5SC	50	10.21	8.13	4.92	6	6.35	50.7	7	5.55	3	4.33	4.29	73.88
		-3.34	(3.02)[c]	(2.43)[d]	(2.64)[de]			-2.82	(2.55)[c]	(2.00)[d]	(2.30)[c]		
Acetamiprid 20 SP	35	11.33	8.23	3.7	5.4	5.78	55.15	6	4.33	2	3	3.11	81.08
		-3.51	(3.03)[c]	(2.16)[e]	(2.52)[e]			-2.64	(2.30)[d]	(1.73)[e]	(2.00)[d]		
Acetamiprid 15 +	35	12.01	5.61	2.3	5.21	4.37	66.05	5.66	2.62	1.11	2.33	2.02	87.71
Fipronil 60 WDG		-3.6	(2.57)[d]	(1.81)[f]	(2.49)[e]			-2.58	(1.89)[e]	(1.45)[f]	(1.82)[e]		
Fipronil 80 WG	50	10.41	8.27	5.07	6.66	6.67	48.24	7.33	5.87	3.33	4.66	4.62	71.9
		-3.37	(3.04)[c]	(2.46)[d]	(2.76)[d]			-2.88	(2.61)[c]	(2.07)[d]	(2.37)[c]		
Chlorpyriphos	11.58	10.66	8.03	9.66	9.45	26.63	10	8.67	6.33 (2.70)[b]	7.33	7.44	54.72	
20 EC	250		-3.54	(3.41)[ab]	(3.00)[b]	(3.41)[b]			-3.31	(3.10)[b]		(2.88)[b]	
Monocrotophos	500	12.33	10.28	6	7.66	7.98	38.04	8.33	6.67	4.00 (2.23)[c]	5	5.22	68.23
36 SL		-3.65	(3.35)[b]	(2.64)[c]	(3.10)[c]			-3.05	(2.76)[c]		(2.44)[c]		
Control	-	11.33	11.66	12.66	14.33	12.88	-	15	15.33	16.33	17.66	16.44	-
		-3.51	(3.55)[a]	(3.69)[a]	(3.91)[a]			-4	(4.04)[a]	(4.16)[a]	(4.32)[a]		
SE(m)	-	-	0.05	0.05	0.05	-	-	-	0.07	0.05	0.05	-	-
C.D.	-	-	0.16	0.17	0.17	-	-	-	0.21	0.16	0.18	-	-
	-	-	0.16	0.17	0.17	-	-	-	0.21	0.16			

*Mean of three replications, **Figures in the parenthesis are Square root transformed values, DBS- Days before spray, DAS – Days after spray

Table 4. Effect of insecticidal treatments against *N. virescens* in rice ecosystem (*Kharif*- 2014)

Treatments	Dose	Avg. no. of adults & nymphs per 10 hills											
		1st spray						2nd spray					
	(g a.i./ha)	1 DBS	1DAS	7DAS	14 DAS	Overall mean	% Reduction over control	1 DBS	1DAS	7DAS	14 DAS	Overall mean	% Reduction over control
Imidacloprid 17.8 SL	25	12.15	9.34	4.81	6.12	6.76	49.84	6.97	4.58	2.31	3.35	3.41	79.55
		-3.62	(3.21)^{c}	(2.41)^{d}	(2.66)^{d}			-2.8	(2.35)^{d}	(1.81)^{e}	(2.07)^{d}		
Fipronil 5SC	50	9.89	8.65	5.8	6.48	6.98	48.21	6.64	5.86	3.48	4.66	4.67	72.04
		-3.28	(3.10)^{c}	(2.63)^{c}	(2.72)^{d}			-2.76	(2.61)^{c}	(2.11)^{d}	(2.37)^{c}		
Acetamiprid 20 SP	35	11	8.76	4.58	5.76	6.37	52.73	5.93	4.23	2.69	3.61	3.51	78.97
		-3.46	(3.12)^{c}	(2.36)^{d}	(2.59)^{d}			-2.63	(2.29)^{d}	(1.91)^{e}	(2.13)^{d}		
Acetamiprid 15 + F	35	11.87	6.14	3.18	5.61	4.98	63.05	5.85	2.87	1.32	2.56	2.25	86.52
ipronil 60 WDG		-3.57	(2.65)^{d}	(2.04)^{e}	(2.58)^{d}			-2.61	(1.95)^{e}	(1.52)^{f}	(1.86)^{e}		
Fipronil 80 WG	50	10.12	8.79	5.94	7.15	7.29	45.85	7.97	6.56	3.67	4.87	5.03	69.84
		-3.33	(3.12)^{c}	(2.63)^{c}	(2.83)^{cd}			-2.98	(2.73)^{c}	(2.13)^{d}	(2.39)^{c}		
Chlorpyriphos 20 EC250		11.28	11.19	8.9	10.02	10.04	25.49	10.65	8.85	6.71	7.71	7.76	53.53
		-3.5	(3.48)^{ab}	(3.15)^{b}	(3.32)^{b}			-3.41	(3.13)^{b}	(2.77)^{b}	(2.94)^{b}		
Monocrotophos 36 SL 66.69		500	12.67	10.8	6.87	8.02	8.56	36.43	8.97	6.98	4.42	5.28	5.56
		-3.69	(3.45)^{b}	(2.78)^{c}	(3.00)^{c}			-3.15	(2.80)^{c}	(2.32)^{c}	(2.50)^{c}		
Control	-	11.17	12.19	13.54	14.68	13.47		14.75	15.51	16.61	17.96	16.69	
		-3.47	(3.62)^{a}	(3.81)^{a}	(3.95)^{a}			-3.96	(4.08)^{a}	(4.20)^{a}	(4.32)^{a}		
SE(m)	-	0.05	0.06	0.07	0.07			0.08	0.1	0.11	0.18		
C.D.	-	0.15	0.19	0.17	0.22			0.26	0.23	0.16	0.21		

*Mean of three replications, **Figures in the parenthesis are Square root transformed values, DBS- Days before spray, DAS – Days after spray

treated plots recorded a lowest mean count of 5.66 insects per 10 hills and differed significantly from the average number of insects observed in rest of the insecticidal treated plots during one day after treatment. Among insecticidal treatments, the highest average number of insects were recorded on chlorpyriphos as 11.66 per 10 hills.

On 7th day after spray, average number of insects was again lowest in acetamiprid + fipronil (2.66) treated plots and differed significantly from rest of all treatments. The pest population in plots treated with sole acetamiprid and imidacloprid were observed to be at par with an average number of insects as 4.00 and 4.66 per 10 hills, respectively. The average number of insects per 10 hills observed in fipronil 5SC (7.00) and fipronil 80WG (7.33) treated plots was relatively high and were statistically at par with each other. The population in, fipronil 80 WG treated plots was statistically at par from the average number of insects observed in monocrotophos (8.00) treated plots and highest number of insects per 10 hills was observed with plots treated with chlorpyriphos (9.66). On 14th day after spray acetamiprid + fipronil treated plots still recorded lowest mean counts of 5.00 insects per 10 hills and differed significantly from the rest of the treatments.

The overall mean of average number of insects per 10 hills after first insecticidal spray was shown in increasing order as: acetamiprid + fipronil (4.44) < acetamiprid (6.22) < imidacloprid (6.66) < fipronil 5 SC, fipronil 80WG (9.00) < monocrotophos (9.44) < chlorpyriphos (10.77).

Second Spray

A day before the spray, the mean population of *N. lugens* in different test plots was in a range of 6.33 to 17.00 / 10 hills. A significant reduction in the average number of insects was observed on 7th day in all insecticide treated plots and in acetamiprid + fipronil treated plots lowest number of 1.33 insects per 10 hills was recorded. The average number of insects observed in plots treated with sole acetamiprid (2.33) and sole imidacloprid (2.66) were also comparatively low and the values were statistically at par. A moderate field efficacy of insecticides in, plots treated with fipronil 5SC (5.33) and fipronil 80WG (5.66) was recorded that do not differ significantly in number of insects observed. Monocrotophos treated plots recorded a mean population of 7.00 insects per 10 hills and observed to have a significant difference with plot treated with chlorpyriphos that recorded a higher mean number of 9.00 insects per 10 hills.

Even on 14th day after spray, a significantly low insect population per 10 hills was observed in acetamiprid + fipronil treated plots recording 2.66 and highest number of 11.00 insects per 10 hills was observed from chlorpyriphos treated plot.

The overall mean population of insects per 10 hills after second insecticidal spray was shown in increasing order as: acetamiprid + fipronil (2.33) < acetamiprid (3.66) < imidacloprid (4.00) < fipronil 5 SC (7.00) < fipronil 80WG (7.44) < monocrotophos (8.55) < chlorpyriphos (10.22).

Furthermore, per cent reduction of pest population over control after second spray was observed to be highest in acetamiprid+fipronil treated plots (88.15), followed by acetamiprid (81.37), imidacloprid (79.67), fipronil 5 SC (64.41), fipronil 80WG (62.16), monocrotophos (56.49) and chlorpyriphos (48.02).

Kharif 2014

First spray

During *Kharif* 2014, an average number of *N. lugens* recorded one day before spray was in a range of 10.01 to 12.01 per 10 hills (Table-2). However, a day after spraying acetamiprid + fipronil treated plots recorded a lowest insects pest counts of 4.68 per 10 hills and differed significantly from the average number of insects observed in rest of the insecticidal treated plots.

After 7 days of insecticidal sprays, acetamiprid + fipronil treated plots were observed to have a low average insect pest population of 4.01 per 10 hills which is significantly different with rest of the insecticide treated plots and followed by acetamiprid (5.35) and imidacloprid (5.63) and were statistically at par with each other. The average number of insects per 10 hills in plots treated with fipronil 5SC, fipronil 80WG and monocrotophos 36SL was 8.68, 9.31 & 9.35 respectively which do not differ significantly. The chlorpyriphos treated plot was observed to have a high pest population of 10.35 per 10 hills.

Even, on 14th day after spray, acetamiprid+ fipronil treated plots were observed to have a low insect pest load of 5.35 insects per 10 hills and differed significantly from the rest of treatments.

The overall mean of average number of insect pests per 10 hills after first insecticidal spray was in order as shown: acetamiprid + fipronil (4.68) < acetamiprid (6.68) < imidacloprid (6.78) < fipronil 80WG (9.35) < fipronil 5 SC (9.51) < monocrotophos (9.90) < chlorpyriphos (11.35).

Second Spray

A day before spray, average number of insects were observed to be in a range of 6.78 to 17.49 / 10 hills (Table-2). A significant reduction in the average number of insects was observed on 7th day in all insecticide treated plots. A low average of 1.71 insects per 10 hills was observed in acetamiprid + fipronil treated plots which differ significantly with the rest of insecticide treated plots. The average number of insects observed in plots treated with acetamiprid (2.64) and imidacloprid (3.03) were also low and observed to be statistically at par. The mean pest population in, plots treated with fipronil 5SC (5.62) and fipronil 80WG (6.23) also did not differ significantly. Monocrotophos treated plots recorded 7.36 insects per 10 hills and differed significantly from plots treated with chlorpyriphos with 9.54 insects per 10 hills. Even after 14th day of spray, a low average insect population of 2.78 insects per 10 hills was observed in acetamiprid + fipronil treated plots.

The overall mean population of insects per 10 hills after second insecticidal spray was shown in increasing order as: acetamiprid + fipronil (2.59) < acetamiprid (3.98) < imidacloprid (4.28) < fipronil 5 SC (7.26) < fipronil 80WG (7.90) < monocrotophos (8.91) < chlorpyriphos (10.87).

The per cent reduction over control was observed to be highest in acetamiprid+fipronil treated plots (87.02), followed by acetamiprid (80.03), imidacloprid (78.53), fipronil 5 SC (63.59), fipronil 80WG (60.38), monocrotophos (55.36) and chlorpyriphos (45.50).

Thus, the experimental findings revealed that the treatment acetamiprid + fipronil was most effective against *N. lugens* and significantly superior over the other insecticidal treatments. The second best chemical were the two neonicotinoids acetmaiprid and imidacloprid followed by fipronil 5SC & 80 WG, a phenyl pyrazole. These results are in close concurrence with the results obtained in the study of Firake and Karnatak. (2010), in which imidacloprid was found to be effective when compared with fipronil. Monocrotophos being a systemic insecticide proved to be effective than chlorpyriphos. Acetamiprid + fipronil as a combination of neonicotinoid and phenyl pyrazole proved to be effective as it posses the different mode of action of both groups. Bhanu *et al.* (2008) reported acetamiprid in combination with chlorpyriphos was effective against paddy insect pests than whenapplied individually.

Influence of insecticidal treatments against *N. virescens* on rice

Kharif 2013

First spray

The average number of *N. virescens* recorded one day prior to the spray was in a range of 10.21 to 12.44 / 10 hills (Table-3). However, a day after spraying the acetamiprid + fipronil treated plots recorded a lowest insect pest counts of 5.61 per 10 hills and differed significantly from the average number of insects observed in rest of the insecticidal treated plots. On the other hand a high average of 10.66 insects per 10 hills was recorded in the plots treated with chlorpyriphos. In acetamiprid + fipronil treated plots during 7th day after spray, a lowest number of 2.30 insects per 10 hills was observed. The number of insects was also low in plots treated with acetamiprid (3.70) and imidacloprid (3.93) that was observed to be significant. Average number of insects per 10 hills observed in fipronil 5SC (4.92) and fipronil 80WG (5.07) treated plots was also statistically at par. However, monocrotophos treated plots were observed to have 6.00 insects per 10 hills and differs significantly with highest number of insects observed in plots treated with chlorpyriphos (8.03).

The overall mean insects per 10 hills after first insecticidal spray was found to be lowest in acetamiprid + fipronil with 4.13 and the rest of treatments are in the order as shown: acetamiprid (5.78) < imidacloprid (6.13) < fipronil 5 SC (6.35) < fipronil 80WG (6.67) < monocrotophos (7.98) < chlorpyriphos (9.45).

Second spray

On 7th day, a significant reduction in the average number of *N. virescens* was observed in all insecticide treated plots after the second spray. In acetamiprid + fipronil treated plots, an average number of 1.11insects were observed per 10 hills followed by acetamiprid (2.00) and imidacloprid (2.33) as the average number of insect recorded in them were statistically at par. The plots treated with fipronil 5SC (3.00) and fipronil 80WG (3.33) do not differ significantly in terms of number of insects observed. The plots treated with monocrotophos had 4.00 insects per 10 hills and observed to have a significant difference from plot treated with chlorpyriphos with 6.33 insects per 10 hills. However, the pest load in all insecticidal treated plots was significantly low compared to the average population of 16.33 per 10 hills observed in control plots.

A significantly low population of *N. virescens* per 10 hills even after 14th day was observed in acetamiprid + fipronil (2.33) treated plots and a highest number of 7.33 insects per 10 hills were observed from chlorpyriphos treated plots.

The overall mean of average number of insects per 10 hills after second insecticidal spray was shown in increasing order as: acetamiprid + fipronil (2.02) < acetamiprid (3.11) < imidacloprid (3.23) < fipronil 5 SC (4.29) < fipronil 80WG (4.62) < monocrotophos (5.22) < chlorpyriphos (7.44).

Further, the per cent reduction over control (Table-3)was observed to be highest in acetamiprid+fipronil treated plots (87.71), followed by acetamiprid (81.08), imidacloprid (80.33), fipronil 5 SC (73.88), fipronil 80WG (71.90), monocrotophos (68.23) and chlorpyriphos (54.72).

Kharif 2014

First spray

A day prior to the spray, an average number of *N. virscens* was in a range of 12.67 to 9.89 / 10 hills (Table-4). However, a day after spraying, acetamiprid + fipronil treated plots recorded a lowest insects pest counts of 6.14/10 hills and differed significantly from the average number of insects observed in rest of the insecticidal treated plots. In acetamiprid + fipronil treated plots during 7th day after spray, a lowest number of 3.18 insects per 10 hills was observed. The number of insects per 10 hills were observed to be non-significant in plots treated with acetamiprid (4.58) and imidacloprid (4.81) as well as with fipronil 5SC (5.80) and fipronil 80WG. However, monocrotophos treated plot were observed to have 6.87 insects per 10 hills and differed significantly with number of insects observed in plots treated with chlorpyriphos (8.90).

The overall mean of average number of insects per 10 hills after first insecticidal spray was found to be lowest in acetamiprid + fipronil with 4.98 and the rest are in the order as shown: acetamiprid (6.37) < imidacloprid (6.76) < fipronil 5 SC (6.98) < fipronil 80WG (7.29) < monocrotophos (8.56) < chlorpyriphos (10.04).

Second spray

A significant reduction in the average number of insects was observed on 7th day after spray in all insecticide treated plots. In acetamiprid + fipronil treated plots, an average number of 1.32 insects per 10 hills was observed followed by acetamiprid (2.69) and imidacloprid (2.31) as the average number of insect recorded in them were statistically at par (Table-4). The plots treated with fipronil 5SC (3.48), fipronil 80WG (3.67) do not differ significantly in number of insects observed. The plots treated with monocrotophos had 4.42 insects per 10 hills and observed to have a significant difference from plot treated with chlorpyriphos with 6.71 insects per 10 hills. Nevertheless, the pest population in all the insecticidal treated plots was significantly low compared to the pest load in control plots recording an average of 17.96 insects per 10 hills after the two sprays.

A significantly low population of *N. virescens* per 10 hills even on 14 days after acetamiprid + fipronil spray was observed recording 2.56 and highest number of 7.71 insects per 10 hills was observed from chlorpyriphos treated plots.

The overall mean of average number of insects per 10 hills after second insecticidal spray (Table-4) in increasing order are: acetamiprid + fipronil (2.25) < imidacloprid (3.41) < acetamiprid (3.51) < fipronil 5 SC (4.67) < fipronil 80WG (5.03) < monocrotophos (5.56) < chlorpyriphos (7.76).

The per cent reduction in accordance over control was observed to be highest in acetamiprid+fipronil treated plots (86.52), followed by acetamiprid (78.97), imidacloprid (79.55), fipronil 5 SC (72.04), fipronil 80WG (69.84), monocrotophos (66.69) and chlorpyriphos (53.53) treated plots.

The results obtained in the above investigation revealed that the acetamiprid + fipronil as most effective insecticidal formulation against GLH followed by imidacloprid, acetamiprid and fipronil 5SC & 80WG, monocrotophos and chlorpyriphos. These results are strongly supported by work of Lakshmi *et al.* (2010) and Krishnaiah *et al*. (2004) who reported that imidacloprid exhibited a better persistent toxicity against GLH than fipronil. Obviously when these two chemicals i.e., neonicotinoid + phenyl pyrazole used in combination may show persistent toxicity which may last long than their sole application.

CONCLUSION

Bio-efficacy of insecticidal treatments against BPH and GLH in paddy showed that Acetamiprid 15 + Fipronil 60 WDG formulation was first best insecticidal treatment followed by sole treatment of Acetamiprid 20SP and Imidacloprid 17.8SL were observed as second best insecticidal treatments among the insecticides tested. These results show that the combination insecticide Actamiprid15% + Fipronil 60% WDG can be incorporated in integrated pest management as this combination product also showed persistent toxic effects than their corresponding sole insecticidal treatments.

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