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Field Efficacy of certain Newer Insecticides and their Combination Products against some Major Insect Pests of Rice

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ABSTRACT

A field experiment was conducted to evaluate the efficacies of some newer insecticides and their combination products against major insect pests in rice ecosystem at Agriculture College Farm, Bapatla during *Kharif,* 2009-10. Among the newer insecticides flubendiamide 480 SC (0.072%), fipronil5 SC (0.0063%), ethiprole 10 SC (0.0075%), imidacloprid 17.8 SL(0.0067%), spinosad 48 SC(0.012%), betacyfluthrin 25 EC (0.03%) and their combination products *viz*., flubendiamide 36% +fipronil 30% 66WG (0.0065%), imidacloprid 40% +ethiprole 40% 80WG (0.02%), imidacloprid+ betacyfluthrin 100 EC (0.006%), betacyfluthrin+chlorpyriphos 262.5 EC (0.08%) were used for the experiment and Chlorpyriphos 20 EC (0.05%) as a standard check. When tested against GLH and BPH, Ethiprole, imidacloprid and betacyfluthrin+ chlorpyriphos were found to be significantly effective by recording highest per cent reduction of populations. Chlorpyriphos, Betacyfluthrin, imidacloprid+ ethiprole and fipronil resulted in moderate efficacies against both the sucking pests. Flubendiamide was found to be the most effective treatment against leaf folder among all the treatments both in terms of per cent reduction of larval population and mean per cent reduction of leaf damage. Chlorpyriphos and spinosad were found to be moderately effective against leaf folder damage. Imidacloprid+ betacyfluthrin, imidacloprid+ ethiprole, ethiprole and imidacloprid were the least effective treatments against rice leaf folder. The plots treated with betacyfluthrin+ chlorpyriphos, ethiprole, fipronil and flubendiamide alone recorded higher grain yields (5.26 t/ha,5.17 t/ha, 5.05 t/ha and 4.94 t/ha respectively).

Key words : Betacyfluthrin + chlorpyriphos, BPH, Ethiprole, Flubendiamide, GLH, Imidacloprid, Leaffolder, Rice.

Rice is the staple food for more than sixty per cent of the world's population and the total area under rice cultivation in India is 44.6 million hectares with a production of 90 million tonnes (Ghule *et al*., 2008). In Andhra Pradesh, rice is grown in an area of 4.38 million hectares, with a production of 14.21 million tonnes and a productivity of 3.23 tonnes per hectare (Directorate of Economics and Statistics, 2008). The overall loss due to insect pest damage in rice was estimated at 25% (Dhaliwal *et al*., 2004). About 300 species of insects have been reported to attack rice crop in India out of which 20 have been found to be the major pests (Pathak, 1977; Arora and Dhaliwal 1996) causing 21 to 51 per cent yield loss (Singh and Dhaliwal, 1994). Among the most economically important insect pests, Rice Yellow Stem Borer, *Scirpophaga incertulas* (YSB), Gall midge, *Orseola oryzae*, Leaf Folder, *Cnaphalocrocis medinalis*, Green Leaf hoppers, *Nephotettix virescens* (GLH), Brown Plant hoppers *Nilaparvata lugens* (BPH), are more predominant in rice growing areas of peninsular India. In this context, newer generation lower molecular dose insecticides and their combination products need to be evaluated for their efficacies as of late, they are gaining more momentum in the market.

MATERIAL AND METHODS

A field trial was conducted during Kharif 2009-10 in the agricultural college farm, Bapatla to evaluate the efficacy of certain newer insecticides and their combinations (as detailed in Table-1) against major insect pests of rice (with variety, BPT 5204)*i.e.*, green leafhoppers, brown planthoppers and leaf folders during the crop period.After thorough field preparation and puddling, nursery was raised on 24-08-09 and adopted all the recommended practices of the crop at the nursery stage.Transplanting was done with thirty days old seedlings @ 2-3 seedlings/hill by adopting a spacing of 20 × 15 cm in a plot size of 28m^2 with the help of

a marked rope. The experiment was laid out in a simple randomised block design (RBD) with twelve treatments replicated thrice including the untreated check. Twelve insecticidal treatments were investigated in the present study of which 7 were individual insectcides, 4 were insecticidal combinations and an untreated control. Chlorpyriphos 20 E C was used as a standard check for the experiment.The concentrations of the different treatments were selected and prepared as per the standard recommendations. Measured quantities of selected insecticides and their combinations were sprayed with a hand compression knapsack sprayer. After every application of each of the treatments, the sprayer was thoroughly washed and rinsed twice with water and used for further applications.

Observations and data were recorded on the insect pests (GLH, BPH &Leaffolder) when the population exceeded their respective ETLs as pre-treatment population counts before imposing the treatments. Observations were taken from 10 randomly tagged hills in each plot at one day before spraying and 3rd, 7th and 10th day after treatment. In case of plant and leafhoppers (population/ hill) both nymphs and adults were counted on the randomly selected 10 hills/plot, with regard to leaffolder incidence, data on number of larvae on tagged10 hills/plot was taken at one day before spraying and 3rd, 7th and 10th day after treatment and then per cent population reduction was calculated. Number of damaged leaves or folded leaves in terms of Average Damaged Leaves (ADL/ hill) was counted on the selected 10hills/ plot and accordingly per cent leaf damage reduction was calculated. The percentage reduction of the populations in each count was calculated by using modified Abbott's formula as given by Srivastava and Mathur (1962).

$$\text{Percent population reduction} = 1 - \left[\frac{a}{c} \times \frac{b}{d}\right] \times 100$$

Where,
a Post treatment population in treatment
b Post treatment population in untreated check
c pretreatment population in treatment
d Pretreatment population in untreated check

The data on the pest populations was converted to log values and percent reductions into angular transformed values whereas per cent leaf damage was transformed into square root transformation and subjected to ANOVA in simple RBD analysis. Finally, the data on yield was obtained from the plots of respective treatments by excluding two border rows in each plot and yield per hectare was calculated.

RESULTS AND DISCUSSIONS

The overall mean efficacy after two sprays revealed that ethiprole (79.21%) was the most effective insecticide among all the treatments against green leafhoppers. Imidacloprid was the next best treatment recording 72.20 per cent reduction over control. This was followed by Betacyfluthrin+ Chlorpyriphos with 68.74 per cent reduction of leafhopper population. Chlorpyriphos (53.73%), Betacyfluthrin (51.77%) and imidacloprid+ ethiprole (51.45%) were found to be moderately effective which recorded more than 50 per cent reduction of leafhopper population over untreated control and were on par with each other. The treatments next in the decreasing order of efficacy were imidacloprid+ betacyfluthrin (48.90%), fipronil (47.87%) and flubendiamide+ fipronil (40.82%) of which the former two treatments were at par. Flubendiamide (33.61%) and Spinosad (32.60%) were the least effective among all the treatments in both the sprays. However, all the treatments were significantly superior over the untreated control in reducing the GLH population.Very few reports are available regarding the efficacy of ethiprole on leafhoppers. However, the present result was in conformity with Sahithi and Misra (2006) who revealed that ethiprole 10SC @ 50 g a.i./ha recorded significantly lowest population of GLH/clump (0.8) with 89.7% reduction over control. Manjunatha and Sivanna (2001) who reported the efficacy of RIL 18 20 (imidacloprid) against rice green leafhopper at different dosages *i.e.* 100 and 400 ml/ha and observed 61.25 and 80.45 per cent mortalities of GLH respectively. Imidacloprid 200 SL was found effective in controlling hoppers on rice by recording lowest populations of GLH (9.4 per 10 hills) (DRR Progress report, 2001). Kumar and Dikshit (2001) also reported that imidacloprid was very effective against BPH, WBPH and GLH on rice. There is no supporting literature available to compare the

Table 1. Particulars of insecticidal Treatments evaluated against major insect pests of rice during *kharif*, 2009-10.

Treat No.	Common name	Trade name	Formula-tion	Dosage (ml org/lt)	Source of supply
1	Flubendiamide	Fame	480 SC	0.15	Bayer India Ltd., Mumbai
2	Fipronil	Regent	5 SC	1.25	Aventis Crop Science Ltd., Mumbai
3	Spinosad	Tracer	48 SC	0.25	De-Nocil Crop Protection Ltd., Mumbai
4	Imidacloprid	Confidor	17.8 SL	0.37	Bayer India Ltd., Mumbai
5	Ethiprole	—	10 SC	0.75	Bayer India Ltd., Mumbai
6	Betacyfluthrin	Bull dock	25 EC	1.25	Bayer India Ltd., Mumbai
7	Flubendiamide 36%+ Fipronil 30%	—	66 WG	0.1	Bayer India Ltd., Mumbai
8	Imidacloprid 40%+ Ethiprole 40%	—	80WG	0.25	Bayer India Ltd., Mumbai
9	Imidacloprid +Betacyfluthrin	Solomon	300 OD	0.02	Bayer India Ltd., Mumbai
10	Betacyfluthrin+ Chlorpyriphos	Bull dock star	262.5 EC	0.3	Bayer India Ltd., Mumbai
11	Chlorpyriphos	Dursban	20 EC	2.5	Nagarjuna Fertilizers and Chemicals Ltd., Hyderabad
12	Untreated check	—	-	-	

efficacy of betacyfluthrin+ chlorpyriphos on GLH. However, the effectiveness of this chemical combination on other sucking pests such as thrips was recorded by Krishnaiah*et al.,* (2003) who concluded that betacyfluthrin 12.5 g a.i. + chlorpyriphos 250 g a.i./ha 262.5 EC @ 393 g a.i./ ha was effective against rice thrips by recording 9.5 ADL/10 hills and was superior over monocrotophos 36 WSC @ 500 g a.i./ha with 15.5 ADL/10 hills against 22.7 ADL/10hills in untreated control.Similarly, the present findings on the efficacy of betacyfluthrin and imidacloprid+ ethiprole on GLH are quite new. However, their effectiveness on other sucking pests was supported earlier by Sinha and Sharma (2007) who recorded that Betacyfluthrin 25 SC @ 18.5 g a.i./ha was effective in the control of leafhopper on okra as it was recorded 1.00 hoppers/leaf against untreated control (5.13 hoppers/leaf).

The cumulative mean efficacy of the three observations recorded at 3 DAT, 7 DAT and 10 DAT after two sprays inferred that ethiprole (80.14%) recorded highest reduction of BPH population and remained significantly superior over all the other treatments and was followed by imidacloprid which recorded 74.06 per cent reduction over control. Fipronil with 49.49 per cent reduction was on par with imidacloprid+ ethiprole.Chlorpyriphos (47.79%) was next and at par to fipronil. The next treatments in the decreasing order of efficacy were imidacloprid+ betacyfluthrin (34.89%) followed by spinosad (30.73%) and flubendiamide+ fipronil (29.30%), both being at par. Flubendiamide was the least effective treatment among all the treatments with 26.63 per cent reduction of BPH population over control.These results are in concurrence with the findings of Varma *et al.,* (2003) who reported that ethiprole 10EC @ 50 g a.i./ha was found effective against planthoppers (31.5 BPH and 8.8 WBPH/10 hills) compared to check insecticide, monocrotophos (994 BPH and 405 WBPH/10hills). Mishra (2005) also observed that ethiprole 10SC @ 50 g a.i./ha showed superior control of brown planthopper in rice and the control efficiency was 95.03% reduction over the control during Kharif seasons of both 2003 and 2004. Kumaran *et al,* (2007) reported that ethiprole 10 SC @ 50 g a.i./ha reduced 67.95 per cent of

Table 2. Mean Cumulative efficacy of treatments against rice GLH, *N.virescens* during *kharif*, 2009-10.

Trt. No	Treatments	Doseml or g/lt	Pre treatment population/ 10 hills	Per cent Reduction of Population			Overall Efficacy
				3DAT	7DAT	10DAT	
T1	Flubendiamide 480 SC (Fame)	0.15	100.00 (2.00)	41.10^{i} (39.87)	31.36^{f} (34.05)	28.36^{g} (32.16)	33.61^{g} (35.43)
T2	Fipronil 5SC (Regent)	1.25	92.83 (1.97)	54.72^{g} (47.71)	48.55^{d} (44.17)	40.35^{de} (39.42)	47.87^{f} (43.78)
T3	Spinosad 45SC (Tracer)	0.23	95.83 (1.98)	42.63^{i} (40.76)	32.11^{f} (34.47)	23.06^{h} (28.69)	32.60^{g} (34.81)
T4	Imidacloprid 17.8 SL (Confidor)	0.37	71.67 (1.86)	78.53^{b} (62.40)	73.48^{b} (59.01)	64.58^{b} (53.48)	72.20^{b} (58.18)
T5	Ethiprole 10 SC (Ethiprole)	0.75	71.33 (1.85)	84.68^{a} (66.96)	81.36^{a} (64.42)	71.58^{a} (57.80)	79.21^{a} (62.88)
T6	Betacyfluthrin 25EC (Bull Dock)	1.25	86.17 (1.94)	65.36^{d} (53.95)	48.01^{d} (43.85)	41.95^{d} (40.36)	51.77^{de} (46.02)
T7	Flubendiamide 36% + Fipronil 30% 66 WG	0.10	94.67 (1.98)	49.52^{h} (44.73)	38.67^{e} (38.45)	34.28^{ef} (35.83)	40.82^{f} (39.71)
T8	Imidacloprid 40%+ Ethiprole 40% 80 WDG	0.25	88.00 (1.94)	62.66^{e} (52.34)	53.68^{cd} (47.11)	37.99^{e} (38.01)	51.45^{de} (45.83)
T9	Imidacloprid + Betacyfluthrin 100 EC (Confidor Ultra)	0.02	96.33 (1.98)	57.61^{f} (49.38)	49.66^{d} (44.81)	39.43^{de} (38.90)	48.90^{e} (44.37)
T10	Betacyfluthrin + Chlorpyriphos 262.5 EC (Bulldock Star)	0.30	79.67 (1.90)	76.01^{c} (60.68)	71.72^{b} (57.89)	58.50^{c} (49.89)	68.74^{c} (56.01)
T11	Chlorpyriphos 20EC (Dursban)	2. 50	88.67 (1.95)	62.44^{e} (52.20)	54.72^{c} (47.71)	44.04^{d} (41.58)	53.73^{d} (47.14)
T12	Untreated Check	-	115.17 (2.06)	0.00^{j}	0.00^{g}	0.00^{i}	0.00^{h}
	F test		Sig.	Sig.	Sig.	Sig.	Sig.
	SEm±		0.011	0.581	0.947	1.027	0.703
	CD (P=0.05)		0.033	1.075	2.78	3.013	2.062

Figures in the parentheses are angular transformed values
Sig : Significant NS : Non-significant
Figures in the parentheses under pre treatment values are log transformed values
Means followed by a common letter in a column are not significantly different from each other by LSD.

Table 3. Mean Cumulative efficacy of treatments against rice BPH, *N. lugens*during *kharif*, 2009-10.

Trt. No	Treatments	Doseml or g/lt	Pre treatment population/ 10 hills	Per cent Reduction of Population			Overall Efficacy
				3DAT	7DAT	10DAT	
T1	Flubendiamide 480 SC (Fame)	0.15	75.67 (1.88)	32.44^{i} (34.70)	25.84^{g} (30.54)	21.61^{g} (27.69)	26.63^{i} (31.06)
T2	Fipronil 5SC (Regent)	1.25	70.00 (1.85)	56.09^{f} (48.50)	49.84^{de} (44.91)	42.55^{d} (40.71)	49.49^{ef} (44.71)
T3	Spinosad 45SC (Tracer)	0.23	76.17 (1.88)	34.89^{hi} (36.17)	31.18^{fg} (33.92)	26.13^{f} (30.71)	30.73^{h} (33.64)
T4	Imidacloprid 17.8 SL (Confidor)	0.37	49.83 (1.70)	82.28^{b} (65.12)	75.30^{b} (60.23)	64.59^{b} (53.49)	74.06^{b} (59.39)
T5	Ethiprole 10 SC (Ethiprole)	0.75	50.17 (1.70)	86.64^{a} (68.60)	82.50^{a} (65.28)	71.27^{a} (57.60)	80.14^{a} (63.54)
T6	Betacyfluthrin 25EC (Bull Dock)	1.25	65.00 (1.81)	66.60^{d} (54.70)	56.11^{d} (47.90)	40.09^{de} (38.21)	55.27^{d} (47.80)
T7	Flubendiamide 36% + Fipronil 30% 66 WG	0.1	71.67 (1.86)	37.43^{h} (37.72)	28.69^{fg} (32.38)	21.77^{fg} (27.81)	29.30^{hi} (32.77)
T8	Imidacloprid 40%+ Ethiprole 40% 80 WDG	0.25	67.67 (1.83)	62.91^{de} (52.49)	54.09^{d} (47.35)	42.98^{d} (40.96)	53.33^{de} (46.91)
T9	Imidacloprid + Betacyfluthrin 100 EC (Confidor Ultra)	0.02	67.50 (1.83)	45.69^{g} (42.53)	32.83^{f} (34.92)	26.16^{f} (30.72)	34.89^{g} (36.20)
T10	Betacyfluthrin + Chlorpyriphos 262.5 EC (Bulldock Star)	0.3	56.67 (1.75)	75.15^{c} (60.11)	66.39^{c} (54.57)	52.76^{c} (46.59)	64.77^{c} (53.59)
T11	Chlorpyriphos 20EC (Dursban)	2. 50	62.17 (1.79)	60.37^{ef} (51.00)	45.75^{e} (42.56)	37.18^{e} (37.57)	47.77^{f} (43.72)
T12	Untreated Check	-	87.33 (1.94)	0.00^{j}	0.00^{h}	0.00^{h}	0.00^{j}
	F test		Sig.	Sig.	Sig.	Sig.	Sig.
	SEm±		0.012	0.864	1.372	0.996	0.869
	CD (P=0.05)		0.036	2.534	4.026	2.921	2.549

Figures in the parentheses are angular transformed values
Sig : Significant NS : Non-significant
Figures in the parentheses under pre treatment values are log transformed values
Means followed by a common letter in a column are not significantly different from each other by LSD.

Table 4. Mean Cumulative Efficacy of treatments against rice Leaf folder, *C. medinalis* during *kharif*, 2009-10

Trt. No	Treatments	Doseml or g/lt	Pre treatment population/ 10 hills	Per cent Reduction of Population			Overall Efficacy
				3DAT	7DAT	10DAT	
T1	Flubendiamide 480 SC (Fame)	0.15	26.00 (1.41)	80.82[a] (64.04)	74.55[a] (59.70)	62.31[a] (52.13)	73.56[a] (59.41)
T2	Fipronil 5SC (Regent)	1.25	32.00 (1.51)	71.21[b] (57.56)	63.67[c] (52.95)	51.36[b] (45.78)	62.08[c] (52.00)
T3	Spinosad 45SC (Tracer)	0.23	32.67 (1.51)	61.06[c] (51.40)	52.95[d] (46.69)	41.71[c] (40.20)	51.91[d] (46.09)
T4	Imidacloprid 17.8 SL (Confidor)	0.37	36.50 (1.56)	31.43[f] (33.98)	22.38[g] (28.06)	18.74[d] (25.41)	24.18[h] (29.34)
T5	Ethiprole 10 SC (Ethiprole)	0.75	36.67 (1.56)	34.05[f] (35.69)	23.49[g] (28.91)	19.05[d] (25.57)	25.53[gh] (30.31)
T6	Betacyfluthrin 25EC (Bull Dock)	1.25	30.00 (1.48)	68.43[b] (55.82)	65.32[bc] (53.94)	49.82[b] (44.90)	61.19[c] (51.47)
T7	Flubendiamide 36% + Fipronil 30% 66 WG	0.10	35.67 (1.55)	51.20[d] (45.69)	44.27[e] (41.70)	36.96[c] (37.41)	44.14[e] (41.63)
T8	Imidacloprid 40%+ Ethiprole 40% 80 WDG	0.25	38.17 (1.58)	38.87[e] (38.55)	26.85[fg] (31.14)	19.75[d] (26.10)	28.49[fg] (32.19)
T9	Imidacloprid + Betacyfluthrin 100 EC (Confidor Ultra)	0.02	39.33 (1.59)	43.68[e] (41.37)	30.72[e] (33.65)	20.45[d] (26.73)	31.61[f] (34.19)
T10	Betacyfluthrin + Chlorpyriphos 262.5 EC (Bulldock Star)	0.30	27.00 (1.43)	80.05[a] (63.48)	70.41[ab] (57.09)	59.40[a] (50.42)	69.95[b] (56.77)
T11	Chlorpyriphos 20EC (Dursban)	2. 50	31.17 (1.49)	61.88[c] (51.88)	57.52[d] (49.33)	47.96[b] (43.83)	55.79[d] (48.33)
T12	Untreated Check	-	40.83 (1.61)	0.00[g]	0.00[h]	0.00[e]	0.00[i]
	F test		Sig.	Sig.	Sig.	Sig.	Sig.
	SEm±		0.016	0.975	1.078	1.214	0.678
	CD (P=0.05)		0.047	2.861	3.161	3.56	2.253

Figures in the parentheses are angular transformed values
Sig : Significant NS : Non-significant
Figures in the parentheses under pre treatment values are log transformed values
Means followed by a common letter in a column are not significantly different from each other by LSD.

Table 5. Mean Cumulative Efficacy of treatments against rice Leaf folder's ,*C. medinalis*damage during *kharif*, 2009-10.

Trt. No	Treatments	Doseml or g/lt	Damaged leaves/ hill	Mean per cent leaf damage			Overall Efficacy
				3DAT	7DAT	10DAT	
T1	Flubendiamide 480 SC (Fame)	0.15	3.23 (1.93)	3.43^{a} (1.98)	4.25^{a} (2.18)	5.53^{a} (2.46)	4.41^{a} (2.22)
T2	Fipronil 5SC (Regent)	1.25	3.52 (2.00)	3.80^{bc} (2.07)	4.90^{b} (2.32)	6.17^{b} (2.58)	4.95^{b} (2.33)
T3	Spinosad 45SC (Tracer)	0.23	3.93 (2.11)	4.73e (2.29)	5.72^{d} (2.49)	7.07^{d} (2.75)	5.84^{d} (2.52)
T4	Imidacloprid 17.8 SL (Confidor)	0.37	4.93 (2.33)	5.90^{gh} (2.53)	7.48^{f} (2.83)	9.70^{g} (3.19)	8.68^{h} (3.06)
T5	Ethiprole 10 SC (Ethiprole)	0.75	5.22 (2.39)	6.27^{ghi} (2.60)	8.20^{g} (2.95)	10.13^{h} (3.26)	8.18^{g} (2.95)
T6	Betacyfluthrin 25EC (Bull Dock)	1.25	3.43 (1.98)	3.87^{c} (2.09)	4.35^{a} (2.20)	5.63^{a} (2.48)	4.62^{a} (2.26)
T7	Flubendiamide 36% + Fipronil 30% 66 WG	0.10	4.37 (2.21)	5.30^{f} (2.41)	6.65^{e} (2.67)	8.00^{e} (2.92)	6.64^{e} (2.67)
T8	Imidacloprid 40%+ Ethiprole 40% 80 WDG	0.25	5.20 (2.39)	6.73^{i} (2.69)	8.65^{h} (3.02)	10.53^{h} (3.32)	8.66^{h} (3.03)
T9	Imidacloprid + Betacyfluthrin 100 EC (Confidor Ultra)	0.02	4.87 (2.32)	5.87^{g} (2.52)	7.62^{f} (2.85)	9.18^{f} (3.11)	7.58^{f} (2.84)
T10	Betacyfluthrin + Chlorpyriphos 262.5 EC (Bulldock Star)	0.30	3.27 (1.94)	3.48^{ab} (2.00)	4.40^{a} (2.21)	5.50^{a} (2.45)	4.49^{a} (2.23)
T11	Chlorpyriphos 20EC (Dursban)	2. 50	3.65 (2.04)	4.30^{d} (2.19)	5.28^{c} (2.40)	6.67^{c} (2.68)	5.46^{c} (2.44)
T12	Untreated Check	-	5.60 (2.47)	7.30^{j} (2.79)	9.42^{i} (3.15)	11.68^{j} (3.49)	9.44^{i} (3.15)
	F test		Sig.	Sig.	Sig.	Sig.	Sig.
	SEm±		0.029	0.029	0.019	0.016	0.019
	CD (P=0.05)		0.086	0.087	0.057	0.048	0.057

Figures in the parentheses are angular transformed values
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Figures in the parentheses under pre treatment values are log transformed values
Means followed by a common letter in a column are not significantly different from each other by LSD.

BPH population when compared to untreated control. Sekh *et al.,* (2007) also reported that Ethiprole @ 37.5 and 50 g a.i./ha recorded 99.9 and 100% reduction of BPH population. Krishnaiah *et al*., (2004) confirmed that ethiprole 10 SC was the best performer recording the highest persistent toxicity value at lowest concentration of 25 ppm against BPH (2700 PT value).

With regard to rice leaf folder, the overall mean efficacy of the three observations recorded at 3 DAT, 7 DAT and 10 DAT after two sprays indicated that flubendiamide was found to be the most effective treatment among all with 73.56 per cent reduction of larval population and 4.41 mean per cent leaf damage. Betacyfluthrin+Chlorpyriphos was the next best treatment with 69.95 per cent

reduction of larval population and 4.49 mean per cent leaf damage. Fipronil and betacyfluthrin were at par with each other with 62.08 and 61.19 per cent reduction of larval population and 4.95 and 4.62 mean per cent leaf damage. Next in the decreasing order of efficacy were chlorpyriphos and spinosad with 55.79 and 51.91 per cent reduction of larval population and 5.46 and 5.84 mean per cent leaf damage and both were at par. Flubendiamide+fipronil was next best with 44.14 per cent reduction of population and 6.64 mean per cent damaged leaves. Among the other treatments, imidacloprid+ betacyfluthrin recorded 31.61 per cent reduction of larval population with 7.58 mean per cent leaf damage and was at par with imidacloprid+ ethiprole (28.49 and 8.66%). Ethiprole was at par with imidacloprid+ ethiprole with 25.53 per cent reduction of larval population and 8.18 mean per cent leaf damage. Imidacloprid, being at par with ethiprole was the least effective treatment of all with 24.18 per cent reduction of larval population and 8.68 mean per cent leaf damage. These results were in agreement with the findings of Mishra (2008) who stated that flubendiamide 20WDG @ 25 g a.i./ha recorded significantly lower leaf folder incidence (1.43%) and was superior to the untreated control (4.87%) at 10 days after spray and registered 69.65% population reduction over untreated control and Sekh *et al.,* (2007) who revealed that leaf folder damaged leaves were recorded as 1.66 and 0.97 per hill in the flubendiamide 480 SC @ 24 and 30 g a.i./ha treated plots. Javaregowda and Krishna Naik (2005) reported that flubendiamide 20WDG @ 25 and 50 g a.i./ha recorded 0.61 and 0.44 damaged leaves by leaf folder at 7 DAT, 0.45 and 0.24 damaged leaves per hill at 14 DAT. The effectiveness of flubendiamide on other lepidopteran pests such as the boll worm complex on cotton(Tomar *et al.,*2005 and Udikeri *et al.,* 2008), and fruit borer larvae in chillies (Ameta and Ajay kumar, 2008 and Tatagar *et al.,* 2009) was also reported. The plots treated with Betacyfluthrin+chlorpyriphos recorded highest grain yield (5.26 t/ha) followed by fipronil (5.17 t/ha) and ethiprole (5.05 t/ha). Imidacloprid + ethiprole (3.86 t/ha) recorded lowest yield among all the treatments.

The present investigations revealed that the scope and utility of newer generation insecticides at lower doses like ethiprole against sucking insect pests of paddy and flubendiamide against rice leaffolder have great potential in rice IPM programmes. Similarly, Betacy fluthrin+ chloropyriphos followed by fipronil and ethiprole proved to be efficacious in managing the lepidopteran insect pest, i.e., rice leaf folder studied under this investigation by recording higher yields.

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