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Bioefficacy evaluation of buprofezin 15% + acephate 35% WP against brown planthopper and yellow stem borer in rice

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Abstract

Brown plant hopper and yellow stem borer emerged as the insect pests having potent adaptability to develop resistance against sole insecticides requesting a demand to formulate a mix formulation with different target specificity and mode of action. Field experiments were conducted during *kharif* season of 2013 and 2014 in experimental fields of Krishi Vigyan Kendra, Gangaathi to evaluate the efficacy of ready mixed insecticide (buprofezin 15% + acephate 35% WP) @ 1000, 1250 and 1500 ml per ha against BPH (*Nilaparvata lugens*) and rice yellow stem borer (*Scirpophaga incertulas*) of Rice. Buprofezin 15% + acephate 35% WP @ 1500 ml per ha was found as best effective insecticide against BPH and YSB during both experimental seasons with highest reduction against the test insects. It was found that buprofezin 15% + acephate 35% WP @ 1500 ml per ha showed significant control over other treatments and were also found to be on par safe with natural enemies and expressing no phytotoxicity.

Keywords: Acephate, BPH, buprofezin, rice, WBPH

Introduction

Rice (*Oryza sativa*) is one of the most important food crops in the world and forms the staple diet of billions of people. In India it accounts for more than 40 per cent of the total food grain production. In India, rice is grown in 44.6 million ha under 4 major ecosystems: irrigated (21 million ha), rainfed lowland (14 million ha), rainfed upland (6 million ha) and flood prone (3 million ha) [1]. Among the several abiotic and biotic stresses that affect rice yield, insect pests appears to be the major constraint in rice production throughout the world. Over 800 insect species have been identified damaging either standing or stored rice [5]. In India, rice is attacked by 35 species of insect pests among which 10 are most serious [3]. Yield loss in rice is expected to be more than 30 per in Asia by insect pests [8]. Several species which once were considered minor pests are now considered as major like brown plant hopper, white backed plant hopper, green leaf hopper and leaf folders. Brown plant hopper appeared as a sporadic pest in India during 1958 and 1962 but most severe outbreak occurred in Kerala at the end of 1973 followed by Andhra Pradesh and Tamil Nadu during 1974 [7]. By 1975, considerable damage was reported from 10 states including Andhra Pradesh, Bihar, Haryana, Karnataka, Madhya Pradesh, Orissa, Punjab, Tamil Nadu, Uttar Pradesh and West Bengal. In India in most regions, the peak population is observed during the late rainy season from October to November. Another peak appears during the dry season from April to May in the regions where double cropping is widely practiced [2]. In West Bengal, BPH has posed a serious threat in last twenty years due to wide spread expansion of area under cultivation of high yielding and early maturing improved cultivars. Insecticides are the only tool in the management of plant hopper as well as yellow stem borer that are reliable for emergency. action when insect pest population approaches or exceeds the economic threshold, but it is now being quite difficult to tackle these insects with any single potent insecticide, therefore combination of two insecticides with different mode of action may be helpful. Hence this study was taken to evaluate the bioefficacy of premix insecticide buprofezin 15% + acephate 35% WP against BPH and Yellow Stem borer of rice.

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Material and Methods

Experiment was carried out at Krishi Vigyan Kendra, Gangavati, UAS, Karnataka during *Kharif* 2013-14 and 2014-15 season in a Randomized block design with 7 treatments as listed under Table 1A and 1B with 3 replications. The

treatments were imposed when pest reached ETL level. Observations on per cent dead heart at early stages and white ear at later stages was taken for stem borer incidence and population of brown planthopper was taken at regular intervals.

Table 1A: Treatment Details for Evaluation of bioefficacy:

S. No.	Treatments	Dosage (per ha)	
		a. i. (g)	Formulation (g / ml)
1.	Buprofezin 15% + acephate 35% WP	150 + 350	1000
2.	Buprofezin 15% + acephate 35% WP	187.5 + 437.5	1250
3.	Buprofezin 15% + acephate 35% WP	225 + 525	1500
4.	Buprofezin 25% SC	250	1000
5.	Acephate 75% SP	584	780
6.	Imidacloprid 17.8% SL	25	125
7	Untreated control	-	-

Table 1B: Treatment Details For Evaluation of Phytotoxicity

S. No.	Treatments	Dosage (per ha)	
		a.i. (g)	Formulation (g)
1	Buprofezin 15% + acephate 35% WP *	187.5 + 437.5	1250
2	Buprofezin 15% + acephate 35% WP *	375 + 875	2500
3	Buprofezin 15% + acephate 35% WP *	750 + 1750	5000
4	Control	-	-

*Samples supplied by ADAMA India Pvt. Ltd, Hyderabad.

Method of observation

Brown Planthopper

The observations on brown planthopper was recorded by counting the number hoppers per hill in 10 randomly selected hills in each plot before spray and after 1, 3, 5, 7 and 10 days after the spray after 1st, 2nd and 3rd sprays were imposed at 10 days interval. Per cent corrected mortality was calculated by using modified Abbotts formula (Henderson and Tilton, 1995) mentioned below.

$$\% \text{ Corrected Mortality} = 1 - \frac{\text{No. of insects in control before treatment} \times \text{No. of insects in treatment after treatment}}{\text{No. of insects in control after treatment} \times \text{No. of insects in treatment before treatment}} \times 100$$

Stemborer

The observation on number of dead heart due to stem borer was made at pre-count as well as 3, 5 and 10 days after each application respectively and data were converted into percentage and white ear head at the time of harvest recorded on 10 hills and converted into percentage. The percent incidence (Dead heart/White ears) was calculated as follows;

$$\left[\frac{\text{No. of dead heart / White ears}}{\text{Total no. of tillers/panicles}} \times 100 \right]$$

The data recorded as above were subjected to ANOVA after transforming them to arcsine value. The data on grain yield at maturity were recorded from each individual plot, converted to hectare basis and subjected to ANOVA.

Natural Enemies

Similarly, the observations on the natural enemies like spiders and mirid bugs which were considered to be the major natural enemy's complex of rice ecosystem were recorded before spray, 3 and 10 days after 2nd spray based on numbers in 10 hills selected randomly in each replication.

Phytotoxicity

The observations on phytotoxicity symptoms viz., leaf injury on tips and leaf surface, wilting, necrosis, vein clearing, epinasty, hyponasty etc. were recorded 3, 7 and 10 days after first and second spray following 0-10 visual rating score as mentioned below.

Phytotoxicity rating Scale (PRS)

Crop response/crop injury	Grade
0-00	0
1-10%	1
11-20%	2
21-30%	3
31-40%	4
41-50%	5
51-60%	6
61-70%	7
71-80%	8
81-90%	9
91-100%	10

Results

Efficacy of buprofezin 15% + acephate 35% WP against brown planthopper on rice

The results from the Table 1 showed that before spray, the differences in planthopper numbers were not significant between the treatments indicated that the population of planthoppers distributed uniformly. The difference in planthopper numbers /hill among the treatment were significant at 1,5,7 and 10 days after spray (DAS). All the insecticide treatments were significantly superior in reducing the buildup of planthoppers and recorded lower no. of planthoppers/ hill than untreated control (18.67 hoppers /hill) at one day after the spray. Lowest no. of planthoppers recorded with buprofezin 15% + acephate 35% WP @ 1500 g/ha (13.50 hoppers/hill) followed by buprofezin 15% + acephate 35% WP @ 1250 g/ha (15.67 hoppers/hill) which were at par with each other. Similar trend of efficacy was recorded after each application and at final observation i.e. 10

days after third spray buprofezin 15% + acephate 35% WP @ 1500 g/ha maintained superiority in reducing the hoppers incidence compared to all other treatments followed by buprofezin 15% + acephate 35% WP @ 1250 g/ha which were at par with each other (Table 2).

The per cent (%) corrected mortality of planthoppers at 10 Days After first spray in different treatments was ranged from 20.04 to 46.12 with highest in buprofezin 15% + acephate 35% WP @ 1250 g/ha (46.12) and buprofezin 15% + acephate 35% WP @ 1500 g/ha (40.31). The trend remained same for observations recorded during 10 days after second spray and third spray in which buprofezin 15% + acephate 35% WP @ 1500 g/ha maintained superiority compared to all other treatments followed by buprofezin 15% + acephate 35% WP @ 1250 g/ha (Table 3).

Second season results revealed that, before spray, the differences in plant hopper numbers were not significant between the treatments indicated that the population of planthoppers distributed uniformly. The difference in plant hopper numbers /hill among the treatment were significant at 1,5,7 and 10 days after spray (DAS). All the insecticide treatments were significantly superior in reducing the buildup of plant hoppers and recorded lower no. of plant hoppers/ hill than untreated control (18.73 hoppers /hill) at one day after the spray. Lowest no. of plant hoppers recorded with buprofezin 15% + acephate 35% WP @ 1500 g/ha (8.27 hoppers/hill) followed by buprofezin 15% + acephate 35% WP @ 1250 g/ha (8.53 hoppers/hill) which were at par with each other. Similar trend of efficacy was recorded after each application and at final observation i.e. 10 days after third spray buprofezin 15% + acephate 35% WP @ 1500 g/ha maintained superiority in reducing the hopper's incidence compared to all other treatments followed by buprofezin 15% + acephate 35% WP @ 1250 g/ha which were at par with each other (Table 2a).

The per cent (%) corrected mortality of plant hoppers at 10 Days After first Spray in different treatments was ranged from 32.74 to 55.97 with highest in buprofezin 15% + acephate 35% WP @ 1250 g/ha (55.97) and buprofezin 15% + acephate 35% WP @ 1500 g/ha (51.13). The trend remained same for observations recorded during 10 days after second spray and third spray in which buprofezin 15% + acephate 35% WP @ 1500 g/ha maintained superiority compared to all other treatments followed by buprofezin 15% + acephate 35% WP @ 1250 g/ha (Table 3a).

Efficacy of buprofezin 15% + acephate 35% WP against yellow stem borer on paddy

One day before spray dead heart percentage ranged from 6.79 to 7.53 per hills in various treatments and difference was non-significant. Three days after first spray, among the different chemical treatments, buprofezin 15% + acephate 35% WP @ 1500 g/ha was recorded minimum (5.00) per cent damage per hill and it was on par with buprofezin 15% + acephate 35% WP @ 1250 g/ha (5.14) followed by buprofezin 25 SC @ 800 ml/ha (5.52), acephate 75% SP @ 1000 g/ha (5.60), imidacloprid 17.8% SL @ 125 ml/ha (6.52) and buprofezin 15% + acephate 35% WP @ 1000 g/ha (6.51) respectively. Untreated control recorded highest damage 7.81 per hills. Similar trend of efficacy was recorded after each application and at final observation i.e. 10 days after third spray buprofezin 15% + acephate 35% WP @ 1500 g/ha and buprofezin 15% + Acephate 35% WP @ 1250 g/ha recorded best with 1.89 and 2.05 per cent damage per hill respectively.

Whereas under untreated control condition recorded 15.41 per hill (Table 4).

With respect to white ears, buprofezin 15% + acephate 35% WP @ 1500 g/ha has recorded minimum (2.11) per cent damage white ear and it was on par with buprofezin 15% + acephate 35% WP @ 1250 g/ha (2.25) per cent white ear and were significantly superior to untreated control (13.43 per cent white ear) (Table 4).

During second season, observation taken one day before spray revealed dead heart percentage ranged from 6.13 to 6.53 per hills in various treatments and difference was non-significant. Three days after first spray, among the different chemical treatments, buprofezin 15% + acephate 35% WP @ 1500 g/ha was recorded minimum (4.73) per cent damage per hill and it was on par with buprofezin 15% + acephate 35% WP @ 1250 g/ha (4.82) followed by buprofezin 25 SC @ 800 ml/ha (5.17), acephate 75% SP @ 1000 g/ha (5.23), buprofezin 15% + acephate 35% WP @ 1000 g/ha (5.56) and imidacloprid 17.8% SL @ 125 ml/ha (6.13) respectively. Untreated control recorded highest damage 7.14 per hills. Similar trend of efficacy was recorded after each application and at final observation i.e. 10 days after third spray buprofezin 15% + acephate 35% WP @ 1500 g/ha and buprofezin 15% + acephate 35% WP @ 1250 g/ha recorded best with 0.76 and 0.95 per cent damage per hill respectively. Whereas, under untreated control condition it has reaches up to 12.47 per hill (Table 4a).

With respect to white ears, buprofezin 15% + acephate 35% WP @ 1500 g/ha has recorded minimum per cent white ear (1.21%) and it was on par with buprofezin 15% + acephate 35% WP @ 1250 g/ha (1.65) per cent white ear and were significantly superior to untreated control (11.41 per cent white ear) (Table 4a).

Effect on Natural enemies' population

The natural enemies such as predatory spiders and mirid bugs were observed in all the experimental plots during the trial period and observation were made on the population of these natural enemies from randomly selected 10 plants. It was observed that natural enemy population was reduced in treated plots as compared to untreated control because of prey population was reduced in all treated plots (Table 6 and 6a).

Phytotoxicity

The data regarding phytotoxic effects such as injury on leaf tips, leaf surface, necrosis, Epinasty, hyponasty, wilting and vein clearing at 0, 1, 3, 5, 7 and 10 days after spraying revealed that buprofezin 15% + Acephate 35% WP even at its higher dose did not show any phytotoxicity on Rice during both the seasons (Table 7).

Yield

During first season treatment of buprofezin 15% + acephate 35% WP @ 1500 g/ha recorded the highest yield with 69.32 q/ha and it was found statistically on par with buprofezin 15% + acephate 35% WP @ 1250 g/ha @ (67.68q/Ha). However, all the treatments were found significantly superior over the untreated control which recorded lowest yield i.e. 47.85q/ha (Table 3). The treatment of buprofezin 15% + acephate 35% WP @ 1250 g/ha exhibited the highest Cost - benefit ratio (Table 5).

During second season treatment of buprofezin 15% + acephate 35% WP @ 1500 g/ha recorded the highest yield with 66.40 q/ha and it was found statistically on a par with buprofezin 15% + acephate 35% WP @ 1250 g/ha (64.77/ha).

However, all the treatments were found significantly superior over the untreated control which recorded lowest yield i.e. 345.12 q/ha (Table 3). The treatment of buprofezin 15% + acephate 35% WP @ 1250 g/ha exhibited the highest Cost - benefit ratio (Table 5).

Discussion

The results on efficacy of different treatment schedules of Buprofezin 15% + Acephate 35% WP against Brown plant hopper (BPH) and yellow stem borer of rice has been presented in table 2, 2a, 3 and 3a, 4 and 4a. All the treated plots with chemicals were significantly superior in their performance over that of control plots. Buprofezin 15% + Acephate 35% WP @ 1500 and 1250 ml per ha gave best control among the other treatments against BPH. It was observed that Buprofezin 15% + Acephate 35% WP @ 1500 and 1250 ml per ha reduces the BPH population below ETL level from first day of spraying. Our results are in line with Buprofezin 15% + Acephate 35% WP @ 1500 and 1250 ml per ha gives better control of brown plant hopper [4]. Buprofezin was effective against homopteran insect pests, such as planthopper with very low risks to environment and human beings [10]. A conventional insecticide like acephate belongs to organophosphate class is still being used to suppress the population of brown planthopper and yellow

stem borer. However, this insecticide is only recommended for limited use in rotation with neonicotinoids and buprofezin to control BPH and stem borer which is comparable with the present finding that Buprofezin + Acephate can effectively control the plant hopper and stem borer in rice ecosystem. Buprofezin exhibited good efficacy against *N. lugens*. Buprofezin 25 SC @ 175 g a. i. per ha were found to be effective against brown planthopper alone at 35 locations in India during 2009 [1]. It can be assumed that Acephate, an organophosphate foliar insecticide of moderate persistence with residual systemic activity of about 10-15 days at the recommended use rate when used with chitin synthesis and prostaglandin inhibitor insecticide Buprofezin having hormonal disturbing effect, leading to suppression of ecdysis can effectively exerts a good control against plant hopper and stem borer together with two different mode of action, which was proved in our present experiment. It is evident from the present investigation that there was a significant variation between the ready mixed insecticide Buprofezin 15% + Acephate 35% WP and the conventional insecticides the conventional insecticides Buprofezin, Acephate and Imidacloprid. Therefore it can be concluded that Buprofezin 15% + Acephate 35% WP was very effective against BPH and yellow stem borer in transplanted paddy than the conventional insecticides.

Table 2: Bio efficacy of buprofezin 15% + acephate 35% WP against brown planthopper on Rice

Treatments	Formulation Dose (g or ml)/Ha	Planthopper numbers/hill												
		After First Spray				After Second spray				After Third Spray				
		DBS	1 DAS	5 DAS	7 DAS	10 DAS	1 DAS	5 DAS	7 DAS	10 DAS	1 DAS	5 DAS	7 DAS	10DAS
Buprofezin 15% + Acephate 35% WP	1000	17.33 (4.22)	17.67 (4.26)	14.17 (3.82)	12.67 (3.62)	12.67 (3.63)	12.00 (3.53)	11.33 (3.44)	11.00 (3.39)	11.33 (3.44)	11.17 (3.41)	7.33 (2.80)	7.00 (2.73)	5.33 (2.40)
Buprofezin 15% + Acephate 35% WP	1250	16.83 (4.15)	15.67 (4.02)	12.33 (3.58)	10.33 (3.29)	11.33 (3.44)	10.83 (3.36)	8.50 (2.99)	8.33 (2.97)	8.83 (3.04)	7.50 (2.83)	5.67 (2.45)	2.83 (1.81)	1.07 (1.19)
Buprofezin 15% + Acephate 35% WP	1500	18.50 (4.36)	13.50 (3.74)	10.50 (3.31)	9.17 (3.11)	9.50 (3.16)	9.00 (3.08)	7.33 (2.79)	7.17 (2.76)	7.50 (2.81)	6.83 (2.71)	4.50 (2.22)	2.17 (1.63)	0.67 (1.05)
Acephate 75% SP	1000	17.00 (4.18)	16.83 (4.16)	13.83 (3.78)	12.17 (3.55)	12.17 (3.56)	11.67 (3.48)	10.67 (3.34)	10.33 (3.29)	10.83 (3.36)	10.17 (3.26)	6.67 (2.67)	5.83 (2.50)	4.50 (2.22)
Buprofezin 25 SC	800	18.17 (4.32)	17.00 (4.18)	14.00 (3.80)	12.50 (3.60)	12.33 (3.58)	11.83 (3.51)	11.00 (3.39)	10.67 (3.33)	11.17 (3.41)	10.33 (3.29)	6.83 (2.69)	6.17 (2.58)	4.67 (2.24)
Imidacloprid 17.8% SL	125	18.67 (4.38)	17.83 (4.28)	14.50 (3.87)	12.83 (3.65)	13.00 (3.67)	12.33 (3.58)	11.67 (3.48)	11.33 (3.43)	11.67 (3.48)	11.00 (3.38)	7.67 (2.84)	6.50 (2.64)	6.00 (2.54)
Untreated control	-	17.17 (4.20)	18.67 (4.37)	19.00 (4.41)	19.33 (4.45)	21.83 (4.72)	21.00 (4.64)	21.67 (4.70)	22.33 (4.77)	24.33 (4.98)	25.00 (5.05)	23.00 (4.85)	25.00 (5.05)	26.67 (5.21)
CD at 5% SE(m)		0.39 0.13	0.30 0.10	0.42 0.14	0.36 0.12	0.34 0.11	0.37 0.12	0.41 0.13	0.50 0.16	0.46 0.15	0.32 0.10	0.45 0.14	0.42 0.14	0.36 0.12

DBS – Day before spraying; DAS - Days after spraying *Figures in the parentheses are Square root transformed values $\sqrt{X + 1}$.

* Buprofezin 15% + acephate 35% WP samples supplied by ADAMA India Pvt. Ltd. Hyderabad.

Table 2a: Bio efficacy of buprofezin 15% + acephate 35% WP against brown plant hopper on rice

Treatments	Formulation Dose (g or ml)/Ha	Plant hopper numbers/hill												
		After First spray				After Second spray				After Third spray				
		DBS	1 DAS	5 DAS	7 DAS	10 DAS	1 DAS	5 DAS	7 DAS	10 DAS	1 DAS	5 DAS	7 DAS	10 DAS
Buprofezin 15% + acephate 35% WP*	1000	12.67 (3.69)	10.77 (3.43)	10.17 (3.34)	13.00 (3.74)	13.97 (3.87)	11.67 (3.56)	9.76 (9.83)	9.87 (3.29)	10.14 (3.33)	8.55 (3.08)	6.88 (2.81)	6.17 (2.68)	5.60 (2.56)
Buprofezin 15% + acephate 35% WP*	1250	16.50 (4.18)	8.53 (3.08)	8.13 (3.02)	11.24 (3.50)	11.91 (3.59)	8.00 (3.00)	6.17 (7.98)	6.28 (2.68)	7.17 (2.84)	4.67 (2.35)	2.93 (1.98)	2.13 (1.75)	1.50 (1.58)
Buprofezin 15% + acephate 35% WP*	1500	14.63 (3.94)	8.27 (3.04)	7.73 (2.95)	10.98 (3.46)	11.72 (3.56)	7.93 (2.99)	5.47 (7.63)	5.59 (2.57)	6.02 (2.65)	4.00 (2.23)	2.47 (1.85)	2.00 (1.72)	1.22 (1.49)
Acephate 75% SP	1000	14.30 (3.90)	9.83 (3.29)	9.50 (3.24)	12.33 (3.64)	13.83 (3.85)	11.00 (3.46)	8.48 (9.23)	8.62 (3.10)	9.26 (3.20)	6.92 (2.81)	4.58 (2.34)	3.92 (2.20)	2.50 (1.86)
Buprofezin 25 SC	800	13.90 (3.86)	10.37 (3.37)	10.03 (3.32)	12.67 (3.69)	14.17 (3.89)	11.47 (3.53)	8.93 (9.45)	9.13 (3.18)	8.79 (3.13)	7.50 (2.91)	5.17 (2.45)	4.50 (2.34)	3.50 (2.12)
Imidacloprid 17.8% SL	125	15.07 (4.01)	12.10 (3.62)	13.37 (3.79)	15.87 (4.10)	17.00 (4.24)	14.40 (3.92)	11.92 (10.78)	12.11 (3.61)	13.11 (3.76)	11.40 (3.52)	9.33 (3.21)	8.27 (3.04)	7.33 (2.88)

Untreated control	-	16.67 (4.20)	18.73 (4.44)	22.97 (4.90)	24.50 (5.05)	27.33 (5.32)	28.50 (5.43)	31.02 (16.97)	32.78 (5.80)	35.45 (6.04)	36.97 (6.16)	38.80 (6.31)	40.03 (6.40)	41.27 (6.50)
CD at 5%		NS	0.05	0.12	0.13	0.31	0.19	0.24	0.34	0.29	0.42	0.29	0.39	0.32
SE(m)		NS	0.18	0.04	0.04	0.10	0.06	0.08	0.11	0.09	0.13	0.09	0.17	0.10

DAS – Day before spraying; **DAS** - Days after spraying ; *Figures in the parentheses are Square root transformed values (X + 1).

*Samples supplied by ADAMA India Pvt. Ltd, Hyderabad

Table 3: Bio efficacy of buprofezin 15% + acephate 35% WP against brown planthopper on Rice

Treatments	Formulation Dose (g or ml)/ha	% Corrected Mortality at 10DAS			Grain yield (q/Ha)
		10 DAFS	10 DASS	10 DATS	
Buprofezin 15% + acephate 35% WP*	1000	20.04	8.62	15.02	58.23
Buprofezin 15% + acephate 35% WP*	1250	46.12	36.79	56.12	67.68
Buprofezin 15% + acephate 35% WP*	1500	40.31	32.37	55.31	69.32
Acephate 75% SP	1000	29.84	17.55	34.39	56.42
Buprofezin 25 SC	800	25.59	21.17	23.48	58.24
Imidacloprid 17.8% SL	125	23.22	17.78	16.26	55.52
Untreated control	-	0	0	0	47.85
SE(m)					.058
CD at 5%					1.75

DAS - Days after spraying; **DAFS** – Days After First spray; **DASS** – Days after Second spray; **DATS** – Days After Third Spray.

*Figures in the parentheses are Square root transformed values $\sqrt{(X + 1)}$. *Samples supplied by ADAMA India Pvt. Ltd. Hyderabad.

Table 3a: Bio efficacy of buprofezin 15% + acephate 35% WP against brown plant hopper on rice

Treatments	Formulation Dose (g or ml)/Ha	% Corrected Mortality at 10DAS			Grain yield (q/ha)
		10 DAFS	10 DASS	10 DATS	
Buprofezin 15% + acephate 35% WP*	1000	32.74	62.36	82.14	57.61
Buprofezin 15% + acephate 35% WP*	1250	55.97	79.56	96.32	64.77
Buprofezin 15% + acephate 35% WP*	1500	51.13	80.65	96.63	66.40
Acephate 75% SP	1000	41.00	69.54	92.93	53.59
Buprofezin 25 SC	800	37.82	70.26	89.83	55.63
Imidacloprid 17.8% SL	125	31.19	59.09	80.35	52.71
Untreated control	-	0	0	0	45.12
CD at 5%					3.12
SE(m)					1.03

DAS - Days after spraying; **DAFS** – Days After First spray; **DASS** – Days after Second spray; **DATS** – Days After Third Spray.

*Samples supplied by ADAMA India Pvt. Ltd. Hyderabad

Table 4: Bio efficacy of buprofezin 15% + acephate 35% WP against stem borer on Rice

Treatments	Formulation Dose (g or ml)/Ha	Dead heart (%) / hill									White ears (%)	
		1 st Spray			2 nd Spray			3 rd Spray				
		DBS	3 DAS	5 DAS	10 DAS	3 DAS	5 DAS	10 DAS	3 DAS	5 DAS		10 DAS
Buprofezin 15% + acephate 35% WP*	1000	6.79 (15.08)	6.51 (14.77)	5.71 (13.78)	5.46 (13.46)	5.24 (13.22)	5.05 (12.97)	4.98 (12.89)	4.68 (12.48)	4.13 (11.72)	3.73 (11.14)	3.81 (11.26)
Buprofezin 15% + acephate 35% WP*	1250	7.28 (15.65)	5.14 (13.05)	4.68 (12.42)	4.43 (12.10)	4.17 (11.77)	4.02 (11.56)	3.32 (10.47)	2.99 (9.95)	2.45 (8.98)	2.05 (8.23)	2.25 (8.63)
Buprofezin 15% + acephate 35% WP*	1500	6.87 (15.08)	5.00 (12.86)	4.53 (12.25)	4.30 (11.91)	4.10 (11.64)	3.88 (11.35)	3.17 (10.21)	2.82 (9.65)	2.26 (8.65)	1.89 (7.87)	2.11 (8.35)
Acephate 75% SP	1000	7.53 (15.93)	5.60 (13.63)	5.10 (13.01)	5.32 (13.29)	5.08 (13.01)	4.89 (12.76)	4.86 (12.72)	4.58 (12.36)	4.06 (11.62)	3.68 (11.06)	6.51 (14.78)
Buprofezin 25 SC	800	6.92 (15.21)	5.52 (13.54)	5.09 (13.00)	4.85 (12.65)	4.62 (12.40)	4.41 (12.11)	4.41 (12.09)	4.06 (11.61)	3.50 (10.78)	3.17 (10.24)	5.61 (13.70)
Imidacloprid 17.8% SL	125	7.17 (15.47)	6.52 (14.75)	6.05 (14.19)	5.97 (14.12)	5.79 (13.91)	5.52 (13.59)	5.41 (13.42)	5.10 (13.05)	4.52 (12.27)	4.13 (11.72)	5.93 (14.10)
Untreated control	-	7.23 (15.60)	7.81 (16.23)	8.55 (17.00)	10.77 (19.12)	11.43 (19.76)	12.05 (20.31)	13.41 (21.48)	13.85 (21.85)	14.33 (22.25)	15.41 (23.12)	13.43 (21.5)
CD at 5%		1.84	0.60	1.69	2.08	0.49	0.58	0.50	0.57	0.88	1.17	2.88
SE(m)		0.60	0.20	0.55	0.67	0.16	0.19	0.16	0.18	0.28	0.38	0.47

Figures in the parentheses are arc sin transformation; **DBS** – Day before spray; **DAS** – Days after spraying.

*Testing sample supplied by ADAMA India Pvt. Ltd, Hyderabad

Table 4a: Bio efficacy of buprofezin 15% + acephate 35% WP against stem borer on rice

Treatments	Formulation Dose (g or ml)/Ha	Dead heart (%) / hill									White ears (%)	
		1 st Spray			2 nd Spray			3 rd Spray				
		DBS	3 DAS	5 DAS	10 DAS	3 DAS	5 DAS	10 DAS	3 DAS	5 DAS		10 DAS
Buprofezin 15% + acephate 35% WP*	1000	6.13 (14.32)	5.56 (13.63)	5.38 (13.35)	4.79 (12.65)	4.41 (12.11)	4.38 (12.02)	4.48 (12.22)	4.18 (11.77)	3.29 (10.30)	2.63 (9.32)	3.85 (11.32)
Buprofezin 15% + acephate 35% WP*	1250	6.28 (14.51)	4.82 (12.49)	4.34 (11.95)	3.77 (11.19)	3.67 (11.00)	3.35 (10.49)	2.82 (9.66)	2.49 (8.97)	1.62 (6.77)	0.95 (5.46)	1.65 (7.38)
Buprofezin 15% + acephate 35% WP*	1500	5.87 (13.87)	4.73 (12.37)	4.20 (11.77)	3.63 (10.98)	3.60 (10.85)	3.22 (10.26)	2.67 (9.39)	2.32 (8.69)	1.43 (6.42)	0.76 (4.97)	1.21 (6.32)
Acephate 75% SP	1000	6.53 (14.81)	5.23 (13.05)	4.77 (12.56)	4.65 (12.46)	4.58 (12.32)	4.22 (11.78)	4.36 (12.06)	4.08 (11.61)	3.23 (10.21)	2.56 (9.19)	4.23 (11.87)
Buprofezin 25 SC	800	5.92 (14.03)	5.17 (12.98)	4.76 (12.54)	4.18 (11.80)	4.12 (11.67)	3.74 (11.08)	3.91 (11.40)	3.56 (10.85)	2.67 (9.27)	2.00 (8.12)	3.75 (11.17)
Imidacloprid 17.8% SL	125	6.17 (14.31)	6.13 (14.21)	5.72 (13.77)	5.30 (13.30)	5.29 (13.28)	4.86 (12.70)	4.91 (12.79)	4.60 (12.35)	3.69 (10.96)	3.02 (9.99)	4.55 (12.32)
Untreated control	-	6.23 (14.41)	7.14 (15.39)	8.55 (17.00)	9.10 (17.56)	9.77 (18.22)	10.43 (18.84)	11.00 (19.37)	11.55 (19.87)	11.91 (20.19)	12.47 (20.68)	11.41 (19.74)
CD at 5%		2.02	1.32	1.77	1.91	0.77	0.74	0.43	1.28	1.82	1.16	1.55
SE(m)		0.65	0.43	0.58	0.62	0.25	0.24	0.14	0.42	0.59	0.38	0.73

Figures in the parentheses are arc sin transformation; DBS – Day before spray; DAS – Days after spraying.

*Testing sample supplied by ADAMA India Pvt. Ltd, Hyderabad

Table 5: Cost - Benefit Ratio of buprofezin 15% + acephate 35% WP in rice

Treatments	Formulation Dose (g or ml)/Ha	Cost of inputs (Cost of insecticide/ha + Cost of labour for spraying/ha)	Rice yield (Q/ha)	Extra yield over untreated control (yield in treatment - yield in untreated control)	Value of additional yield (Rs.)	Cost - Benefit Ratio
Buprofezin 15% + acephate 35% WP	1000	3150.00	58.23	10.38	15051.00	1:4.78
Buprofezin 15% + acephate 35% WP	1250	3712.50	67.68	19.83	28750.50	1:7.75
Buprofezin 15% + acephate 35% WP	1500	4275.00	69.32	21.47	31131.50	1:7.28
Acephate 75% SP	1000	3150	56.42	8.57	12426.50	1:3.94
Buprofezin 25 SC	800	3900	58.24	10.39	15065.50	1:3.86
Imidacloprid 17.8% SL	125	1485	55.52	7.67	11121.50	1:7.49
Untreated control	-		47.85	-	-	-

Market rates :buprofezin 15% + acephate 35% WP -750Rs/kg, buprofezin 25% SC – Rs 1250/litre, acephate 75% SP–Rs750/kg, Imidacloprid 17.8% SL –Rs 1560/litre, Price of Rice/ quintal – 1450, Labour cost - Rs 300/Ha.

Table 5a: Cost - Benefit Ratio of buprofezin 15% + acephate 35% WP in rice

S. No	Treatments	Formulation g or ml/ha	Cost of inputs (Cost of insecticide/ha + Cost of labour for spraying/ha)	Rice yield (Kg/ha)	Extra yield over untreated control (yield in treatment - yield in untreated control)	Value of additional yield (Rs.)	Cost Benefit Ratio
1	Buprofezin 15% + acephate 35% WP*	1000	3150.00	57.61	12.49	16237.00	1 : 5.15
2	Buprofezin 15% + acephate 35% WP*	1250	3712.50	64.77	19.65	25545.00	1 : 6.88
3	Buprofezin 15% + acephate 35% WP*	1500	4275.00	66.40	21.28	27664.00	1 : 6.47
4	Acephate 75% SP	1000	3150	53.59	8.47	11011.00	1 : 3.50
5	Buprofezin 25 SC	800	3900	55.63	10.51	13663.00	1 : 3.50
6	Imidacloprid 17.8% SL	125	1485	52.71	7.59	9867.00	1 : 6.64
7	Untreated control	-		45.12	-	-	-

Market rates :buprofezin 15% + acephate 35% WP - 750 Rs/kg, buprofezin 25% SC – Rs 1250/litre, acephate 75% SP–Rs 750/kg, Imidacloprid 17.8% SL –Rs 1560/litre, Price of Rice/ quintal – 1300, Labour cost - Rs 300/Ha.

Table 6: Influence buprofezin 15% + acephate 35% WP on natural enemies of Brown planthopper and stem borer on Rice

	Treatments	Dose (g.a.i./ha)	No. of Spiders/10 hills**			No. of Mirid bugs/10 hills**		
			Before spray	3 days after 2 nd spray	10 days after 2 nd spray	Before spray	3 days after 2 nd spray	10 days after 2 nd spray
1	Buprofezin 15% + Acephate 35% WP	1000	2.67 (1.77)	1.09 (1.26)	1.46 (1.40)	14.67 (3.87)	9.77 (3.18)	13.86 (3.78)
2	Buprofezin 15% + Acephate 35% WP	1250	2.44 (1.71)	0.91 (1.19)	1.57 (1.43)	16.43 (4.11)	8.42 (2.97)	12.12 (3.55)
3	Buprofezin 15% + Acephate 35% WP	1500	2.33 (1.68)	1.00 (1.21)	1.53 (1.42)	16.73 (4.15)	8.33 (2.96)	11.64 (3.45)
4	Acephate 75% SP	1000	2.76 (1.81)	0.40 (0.94)	0.86 (1.17)	16.59 (4.13)	9.07 (3.07)	11.56 (3.45)
5	Buprofezin 25 SC	800	2.88 (1.84)	0.99 (1.22)	1.38 (1.37)	17.88 (4.29)	8.48 (2.98)	11.21 (3.40)
6	Imidacloprid 17.8% SL	125	2.53 (1.74)	1.20 (1.29)	1.59 (1.44)	17.67 (4.26)	9.20 (3.11)	11.56 (3.47)
7	Untreated control	-	2.57 (1.75)	1.43 (1.38)	1.67 (1.46)	18.03 (4.30)	20.29 (4.56)	22.14 (4.76)
	Sem±		0.06	0.08	0.09	0.11	0.21	0.23
	CD @ 5%		0.19	0.24	0.27	0.35	0.64	0.7
	CV		6.1	11.15	11.06	4.72	10.94	10.58

*Figures in the parentheses are square root transformed values $\sqrt{X + 0.5}$ **Table 6a:** Influence buprofezin 15% + acephate 35% WP on natural enemies of brown plant hopper on rice

Treatments	Formulation (g or ml/ha)	Average no. of natural enemies / 10 hills*			
		Season II: Kharif – 2015			
		Spiders		Miridbugs	
		Before spray	10 DAS	Before spray	10 DAS
Buprofezin 15% + acephate 35% WP*	1000	0.93 (1.19)	0.93 (1.20)	0.90 (1.18)	0.92 (1.19)
Buprofezin 15% + acephate 35% WP*	1250	0.97 (1.21)	0.97 (1.21)	0.92 (1.19)	0.95 (1.20)
Buprofezin 15% + acephate 35% WP*	1500	0.96 (1.21)	0.96 (1.21)	0.95 (1.20)	0.93 (1.20)
Acephate 75% SP	1000	0.96 (1.21)	0.95 (1.20)	0.92 (1.19)	0.91 (1.19)
Buprofezin 25 SC	800	0.92 (1.19)	0.98 (1.22)	0.96 (1.21)	0.90 (1.18)
Imidacloprid 17.8% SL	125	0.94 (1.20)	0.97 (1.21)	0.93 (1.20)	0.91 (1.19)
Untreated control	-	0.83 (1.14)	0.95 (1.20)	0.95 (1.20)	0.85 (1.16)
CD at 5%		NS	NS	NS	NS
SE(m)		NS	NS	NS	NS

*Figures in the parentheses are square root transformed values $(X + 0.5)$ **Table 7:** Phytotoxicity testing of buprofezin 15% + acephate 35% WP (MAIBA-01) on Rice a) Phytotoxicity data on Chlorosis, Vein clearing, Wilting, Necrosis, Scorching, Epinasty and Hyponasty,

S. No	Treatments	Formulation Dosage (g/ml)/ha	Days of observation				
			1	3	5	7	10
1.	*Buprofezin 15% + Acephate 35% WP	1250	0	0	0	0	0
2.	*Buprofezin 15% + Acephate 35% WP	2500	0	0	0	0	0
3.	*Buprofezin 15% + Acephate 35% WP	5000	0	0	0	0	0
4.	Untreated control	-					

Conclusion

Buprofezin 15% + acephate 35% WP @ 1250 to 1500 g/ha treatment was found to be optimum in reducing the population of brown planthopper and stem borer with higher grain yield without any phytotoxicity symptoms and having on par effect on natural enemies when compared to standard check treatments.

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