A Study on Bio-efficacy of Dinotefuran 20% SG against Brown plant hopper *Nilaparvatha lugens* (Stall) on paddy *Oryza sativa* L

Abstract

In rice cultivation, the Brown plant hopper causes damage to growth of plants by sucking cell sap and it causes in drying of plants and crop fields this effects on plant growth and turns into yellow color later brown. In order to overcome this kind of damage particularly in rice cultivation, a field trial was conducted during kharif 2017 at Agricultural Research Station Gangavathi to the assess the bio-efficacy of Dinotefuran 20% SG against brown plant hopper Nilaparvatha lugens (Stall) on paddy. The results revealed that, the new insecticide Dinotefuran 20% SG 40 g a.i./ha showed lowest population of 0.86 and 0.73, 0.67 and 0.57 BPH/hill at 3, 7,10 and 15 days after spray (DAS) respectively and this treatment was significantly superior over rest of the treatments. Further, it was on par with lower dose of Dinotefuran 20% SG @ 30 g a.i./ha which is recorded 1.63, 1.60, 1.49 and 1.42 BPH/hill at 3, 7, 10 days and 15 DAS respectively, followed by standard check buprofezin @187.5g a.i./ha recorded 1.63, 1.90, 2.05and 2.15 and BPH/hill at 3, 7,10 and 15 DAS respectively. Another insecticide imidacloprid @ 22.5g a.i./ ha was found inferior to all other treatments by harbouring4.43,4.53, 4.76 and 4.87 BPH/hill, where as the untreated control recorded highest BPH population of 21.70 to 25.64 BPH/hill through out the observational period from one day before to 15 DAS respectively. The maximum additional yield was 22.37 % was recorded over control (64.28 q/ha) was found in case of Treatment 4 (T4) with an incremental benefit cost ratio of 3.72.

Key words: *Brown Plant hopper,Nilaparvatha lugens,bio-efficacy and Paddy*

Introduction:

A study on the efficacy of Insecticide emerged in the year 1960's especially for species of plant and leaf hoppers, the chemicals such as organophospahte, cyclodiene and organochlorine carbamate were the main insecticides used for controlling these hoppers among chemical methods. The Brown Plant hopper is sucking pest and is known as significant pests in Asia especially in rice growing area (Rao *et al.*, 2003). Rice is staple food crop due this reason there was long term evolution on efficacy of insecticides studies were discovered and still going on. The insect has capacity to develop fastest growth particularly in tropical areas, it can complete 12 generations within in single year and it is categorized as migratory pest (Cheng J, 2009). Conversely, nearly 100 species of insects including more than 20 economic pests are competent to damage to rice plants (Rahaman *et al* 2016, Pathak. M.D. and Dhaliwal. G.S.1981). Insect pests continue to pose threat to rice farming and they are major constraints to rice production and coexist with rice growth (Savary S *et al* 2000 and Nirmala B and Muthuraman P, 2016, Dhawan *et al.*, 2011,Pasalu and Katti, 2006, and Alam and Das, 2017). Hence, under these dynamic situations of both insect damage and climatic conditions, monitoring plan health will be always challenging task. This has to addressed with due care in order to stabilize the both yield and plant health in future.

Rice *Oryza sativa* a cereal crop, belong to the family Graminae is one of the most important staple food crop in the world. for more than half of the world population. Rice constitutes 55 per cent of total cereal production and 52 per cent of the total food grain production in India (Saxena. R.C and Singh. R.K.2003). Rice is the major staple food in many developing countries. It is an important crop because it contains high nutritive value each 100 gm of rice is consists of energy 1,527 KJ (365 Kcal) and carbohydrate around 76.7gm as major nutrition. Other edible form of rice used as puffed rice, rice flakes, rice wafers and canned rice. The by-products of rice starch is largely used in beverage industries. Brown plant hopper is major pests across the country especially in irrigated rice where intensive paddy cropping is being done. Three species of plant hoppers reported on rice are white backed plant hopper (WBPH), *Sogotella furcifera* (Horvath), Smaller brown plant hopper (SBPH), *Laodelphax striatellus* (Fallen) and brown plant hopper (BPH) *Nilaparvath lugens* (Stall). First and third of these are of economic importance. Brown plant hopper is the most destructive pest of rice in Uttar Pradesh, Madhya Pradesh, West Bengal, Andra Pradesh, Karnataka and Tamil Nadu (Chung *et al*.,1982, Liu *et al*., 2003).

The plant hopper suck the plant sap from the phloeum vessels through their proboscis. Due to this plant will be wilting with outer most leaves will dry first and then the entire plant dries up- a symptom often called "hopper burn" (Patcharin,2011). BPH and WBPH casuses huge crop loss in grain yield ranging from 10 - 70 per cent (Kulshreshta, 1974) and 35 – 95 per cent (Sindhu, 1970), respectively. Hence these two pests combination (BPH &WBPH) have been emerged as the number one pest which limit the rice production in India. Among the major pests brown plant hopper constitutes one of the most important causing substantial yield losses. Uses of chemical insecticides forms one of the effective management practices and an important Integrated Pest management (IPM) component besides cultural and Biological methods of pest control. Synthetic insecticides are proved tobe the only option where we can rely for critical management of insect pests reaching on or beyond ETL level (Singh.S.P., 2000) indiscriminate use of broad spectrum of chemical insecticides also reduce the biodiversity of natural ecosystem their by reduce the natural enemies population and induce out break of secondary pests and imbalanced the natural eco-system results in resurgence of brown plant hopper. But still chemical control forms the first line of defence.(I.C.Pasalu *et al*.,2002). So there is a need to evaluate the new groups, new formulations of insecticides and their combinations for their effect on target and non target insects (Whalon *et al*.,2008). There fore present investigation was carried out to evaluate new insecticide molecules against BPH infesting rice.

Materials and methods: Field trial conducted during *kharif* 2017 at Agricultural Research Station Gangavathi to assess the bio-efficacy of Dinotefuran 20% SG against brown plant hopper *Nilaparvatha lugens* (Stall) on paddy for the variety Sona Masuri (BPT-5204). There were totally 7 treatments among them Dinotefuran 20% SG at 4 different concentrations viz., @ 20g, 25g, 30g, and 40g were tested and these were compared with Imidacloprid 17.8 SL @ 22.5g, standard check Buprofezin 25% SC @187.5g and control. Further, to assess the grain yield and benefit-cost ratio of different treatments were also calculated. The per cent increase in yield was calculated by following formula and it was adopted by Matharu and Tanwar (2020). Economics of different treatments was analyzed, using the cost of insecticide, its application cost and other charges etc. during the field trial . The data on grain yield per hectare and its prevalent market price were used to work out the benefit derived from each treatment / ha. Based on Incremental benefit in yield over control and the cost involved, Incremental Cost Benefit Ratio (ICBR) was worked out to establish economic ranking of various treatments.

Increase of yield (%) = Yield in treatment-Yield in control/Yield in Control X100.

Fourty days'old seedlings of rice BPT 5204 were transplanted in the plots measuring 15.75sqm, arranged in Randomized Block Design, at a spacing of 20 X 10 cm. The recommended N:P:K @ 120:60:60 Kg/ha were applied to the crop. The entire amount of P_2O_5 and K_2O and one fourth of the N_2 were given as basal and rest of N_2 was given in two splits. Irrigation was provided as per requirement of the crop. Other crop production measures were taken as usual. The crop was inspected daily for observing the incidence of rice hoppers. The crop was infested by five species of leaf and plant hoppers (Table 2) of which only Brown plant hopper (BPH), *Nilaparvata lugens* was found at above ETL level. The population of other species was scanty. The insecticidal spraying was given with the help of an high volume knapsack sprayer using 500 litres of water. The spraying was done at about eighty one days after transplanting when the population of BPH reached the ETL (20 insects/hill) in most of the plots; the second spraying was given after 10 days of the first spray. Five randomly selected hills were selected in each treatment plots. Each treatment was replicated thrice in randomized complete block design (RCBD). Observations were taken at one day, three day and seven days, tendays and fifteen days after spray. Treatment wise yield was also recorded and subjected to statistical analysis.

Table 1: Name of the insecticides tested along with their dosages and manufacturers.

Treatments. No.	Insecticide	Dosage (g a.i. / ha	Manufacturer
T1	Dinotefuran 20% SG	20 g	P. I. Industries Ltd
T2	Dinotefuran 20% SG	25 g	P. I. Industries Ltd
T3	Dinotefuran 20% SG	30 g	P. I. Industries Ltd
T4	Dinotefuran 20% SG	40g	P. I. Industries Ltd
T5	Imidacloprid 17.8% SL	22.5g	Bayer Crop Care India Ltd.
T6	Buprofezin 25% SC	187.5 g	Syngenta India Ltd.
T7	Control	-	-

Table 2: Incremental Cost-Benefit Ratio of Dinotefuran treatments and its combinations against *Nilaparvatha lugens* (Stall) in paddy (2017)

Treatments	Yield (q/ha)	Increase in yield over Control (%)	Additional cost due to application of insecticide (Rs/ha)	Additional returns from Produce over Control (Rs/ha)	Additional net profit from Produce over Control (Rs/ha)	Incremental benefit cost ratio	Rank
T1	70.95	10.38	1400	6136.4	4736.4	3.38	IV
T2	72.33	12.52	1600	7406	5806	3.63	III
T3	74.9	16.52	2100	9770.4	7670.4	3.65	II
T4	78.66	22.37	2800	13229.6	10429.6	3.72	I
T5	70.33	9.41	1600	5566	3966	2.48	V
T6	67.51	5.02	1300	2971.6	1671.6	1.29	VI
T7*	64.28	-	-	-	-	-	-

***Control Treatment (T7)**

Table 3: Number of BPH(adults and nymph/hill in different treatments and dosages along with yield

Treatments	Dosage g/ha	BPH/hill Kharif 2017 (1st spray)						BPH/hill Kharif 2017 (2nd spray)						Yield qt/ha
		ADBS	3DAS	7DAS	10DAS	15DAS	%ROC	ADBS	3DAS	7DAS	10DAS	15DAS	%ROC	
T1 Dinotefuran 20% SG	20	20.42 (4.52)	4.37 (2.08)	3.87 (1.95)	3.25 (2.06)	3.11 (2.02)	87.88	19.25 (4.50)	2.83 (1.67)	3.12 (1.78)	3.04 (2.01)	2.93 (1.99)	89.34	70.95
T2 Dinotefuran 20% SG	25	21.27 (4.60)	2.53 (1.58)	2.27 (1.51)	2.18 (1.78)	2.06 (1.75)	91.97	10.69 (3.42)	1.80 (1.34)	1.76 (1.34)	1.66 (1.63)	1.51 (1.58)	94.51	72.33
T3 Dinotefuran20% SG	30	19.37 (4.38)	1.63 (1.27)	1.60 (1.26)	1.49 (1.57)	1.42 (1.55)	94.47	2.22 (1.79)	1.17 (1.07)	1.25 (1.11)	1.18 (1.47)	1.06 (1.43)	96.15	74.90
T4 Dinotefuran20% SG	40	22.00 (4.57)	0.86 (0.93)	0.73 (0.85)	0.67 (1.29)	0.57 (1.25)	97.98	0.93 (1.39)	0.63 (0.77)	0.82 (0.92)	0.70 (1.30)	0.62 (1.27)	97.75	78.66
T5 Imidacloprid 17.8 SL	22.5	21.50 (4.63)	4.53 (2.35)	4.43 (2.23)	4.76 (2.19)	4.87 (2.20)	82.73	7.41 (2.90)	3.34 (1.82)	3.47 (1.86)	3.32 (2.07)	3.34 (1.82)	87.85	70.33
T6 Buprofezin 25% SC	187.5	23.37 (4.83)	1.90 (1.37)	2.06 (1.75)	2.53 (1.58)	3.87 (1.95)	84.91	17.93 (4.35)	2.93 (1.99)	3.11 (2.02)	3.24 (2.06)	3.25 (2.06)	88.74	67.51
T7 Control	----	21.70 (4.66)	22.6 (4.85)	23.5 (4.76)	24.18 (5.01)	25.64 (5.16)	-----	64.58 (8.09)	18.23 (4.28)	25.97 (5.09)	26.73 (5.26)	27.48 (5.33)	------	64.28
S.em±			0.10	0.12	0.24	0.21		0.46	0.14	0.46	0.06	0.11		0.28
CD @ 5%		NS	0.31	0.36	0.76	0.65		1.45	0.43	1.45	0.20	0.36		599. 11
CV			4.08	5.45	7.82	6.58		4.61	6.05	4.61	3.11	3.68		4.72

Values in parentheses are √x+1 transformed values

Table 4:Effect of insecticides on natural enemies associated with *Nilaparvata lugens* during kharif 2017-18

Treatments	Dosage	Pre-treatment					15 days after treatment 1st Spray				15 days after treatment 2nd spray			
	g or ml a.i/ha	BPH/hill	MB/hill	Spider/hill	BPH/MB	BPH/Spider	BPH/hill	Mean MB/hill	BPH/MB	Mean Spider/hill	BPH/hill	Mean MB/hill	BPH/MB	Mean Spider/ hill
T1 Dinotefuran 20% SG	20	20.42 (4.62)	3.07 (201)	3.06 (2.00)	6.65	6.67	3.11 (2.02)	2.23 (1.79)	1.39	3.43 (2.06)	19.25 (4.50)	2.65 (1.91)	7.26	3.43 (2.09)
T2 Dinotefuran 20% SG	25	21.24 (4.71)	2.93 (1.98)	3.30 (2.06)	7.25	6.43	2.06 (1.75)	1.71 (1.64)	1.20	3.14 (1.92)	10.69 (3.42)	1.50 (1.58)	7.12	3.14 (1.98)
T3 Dinotefuran 20% SG	30	19.37 (4.50)	3.12 (2.03)	2.70 (1.87)	6.20	7.17	1.42 (1.55)	1.26 (1.50)	1.12	3.11 (1.97)	2.22 (1.79)	1.47 (1.57)	1.51	3.14 (1.98)

T4 Dinotefuran 20% SG	40	21.33 (4.70)	3.01 (2.00)	2.59 (1.84)	7.30	8.23	0.57 (1.25)	0.98 (1.40)	0.58	3.02 (1.99)	0.93 (1.39)	1.44 (1.56)	0.64	3.02 (1.93)
T5 Imidacloprid 17.8 SL	22.5	21.50 (4.71)	3.27 (2.06)	3.55 (2.13)	6.57	6.05	4.87 (2.20)	0.51 (1.22)	9.54	2.35 (1.81)	7.41 (2.90)	0.62 (1.27)	11.95	2.35 (1.76)
T6 Buprofezin 25% SC	187.5	23.37 (4.93)	2.83 (1.95)	3.02 (1.93)	8.25	7.73	3.87 (1.95)	0.85 (1.36)	4.55	3.59 (2.05)	17.93 (4.35)	0.97 (1.40)	18.48	3.59 (2.14)
T7 Control	----	21.70 (4.74)	2.81 (1.95)	3.16 (1.94)	7.72	6.86	25.64 (5.16)	3.02 (2.00)	8.49	3.59 (2.08)	64.58 (8.09)	6.64 (2.76)	9.72	3.59 (2.14)
S.em± CD CV		2.18 NS 17.78	0.05 0.17 6.52	1.00 NS 56.73			0.21 0.65 6.58	0.05 0.17 6.52		0.89 NS 48.60	0.46 1.45 4.61	0.12 0.38 9.75		0.69 NS 37.82

Values in parentheses are √x+1 transformed values

Results and Discussion: The insecticides were tested under field condition on the basis of number of BPH per hill. It is clear from the result that the brown plant hopper population did not vary significantly among the treatments before the application of insecticides. At 3 day after spraying of the Dinotefuran 20% SG at 40 and 30 g ai/ha recorded lowest number of BPH per hill followed by Buprofezin. Upto 15 days after 1^{st} spray Dinotefuran 20% SG at 40 and 30 g a.i/ha maintained the brownplant hopper under normal limit. Highest per cent reduction of BPH @97.98 was recorded by Dinetofuran 20SG @40 g both at 1^{st} spray followed by next higher dose Dinotefuran 20SG @30g recorded 94.47 per cent reduction over control at 1^{st} spray. Same trend was noticed after 2^{nd}spray also. In both the sprayings population of brown plant hopper considerably reduced after 3 day of spraying and continued even after 15 days. Lowest population was recorded in Dinotefuran 20% SG at 40 and 30g ai/ha which were statistically at par through out the observation. Dinotefuran 20% SG and 30 g ai/ha were recorded as the best treatments over Imidacloprid and Buprofezin. The grain yield in the treatment Dinotefuran 20% SG @ 40g a.i./ha recorded significantly highest yield of 78.66q/ha followed by Dinotefuran 20% SG @ 30g a.i./ha (74.90q/ha) and buprofezin @ 187.5g a.i./ha (67.51q/ha) in the lower dose of Dinotefuran 20% SG@ 20g a.i./ha and imidacloprid @ 22.5g a.i./ha recorded yield of 70.95 and 70.33q/ha respectively. The lowest yield of 64.28q /ha was recorded in the untreated control.

The results of the present study are on par with the findings in the management of BPH namely Kharbade *et al*., (2015), Wang *et al*., (2008), Shashank *et al*., (2012) and Kumar *et al*., (2017) Further, several reports in the literature indicated the effectiveness of insecticides for management of BPH such as Kendappa *et al*., 2005; Hegde and Nidagundi, 2009; Suri *et al*., 2012) and Konchada *et al*., (2017) also studied different dose of insecticides and its impact on control over BPH and also on grain yield of rice.

Effect of insecticides on natural enemies associated with Brownplant hopper: population of natural enemies viz., mired bug and spider found to be moderate to good throughout the experimental period. Fluctuations in the population level of mired bug and spider population noticed among all the insecticidal treatments. It was mainly due to toxicity of insecticides that implies the survibality of natural enemies. Population of mired bug was found to be highly dependent on the availability of brown planthopper for preying. The population of spiders and the mired bug is directly proportional to brown plant hopper population noticed on crop. The population of natural enemies was more with availability of brown plant hopper and vice versa in untreated plot. It is evident from the table 4 that mean number of mired bug per hill after 15 days after first spray was comparatively low in all insecticide treated plot than the untreated control plot. Considerable increase in mired bug population ratio was maintained in dinetofuran treated plot that implies its safety to mired bug. Same trend was noticed after the second spray also. Table 4 showed that up to 15 days after both sprays there was no significant effect of insecticides on the mean number of spider populations.

Incremental Cost-Benefit Ratio

The study has made an attempt to analyse the Incremental Cost-Benefit Ratio of Dinotefuran treatments and its combinations against *Nilaparvatha lugens* (Stall) in paddy in the year 2017. The findings of Incremental benefit in yield and cost over control are presented in table.4 . The results are based on prevailing costs of inputs and market selling price of rice (BPT-5204 @ Rs. 920/q), the Incremental Cost Benefit Ratio (ICBR) was carried out to analyse the economics of different treatments. The data presented in (Table no. 4) indicated that, the treatment (T4) was the most economically viable treatment recording highest ICBR (3.72) due to its high yield and additional returns over the control which stands 1st rank among all the treatments. The second rank was observed in treatment (T3), the per cent increase in the yield was 16.52% over the control with incremental benefit cost ratio was 3.65. and least incremental benefit cost ratio was found in case of treatment (T6). These are two treatment found highest in yield and cost in the study period.

CONCLUSION

In Asia and Pacific regions, the Brown planthopper Nilaparvata lugens (Stål) is a major sucking pest of rice and reasoned as a major threat to rice production. There is need to know the observations on the life-history and bionomics of this pest, which is a prerequisite for developing and implementing effective chemical control measures. The control strategy that has been proven effective against brown plant hopper Nilaparvatha lugens (Stall) using Dinotefuran 20% SG on paddy. The experimental results clearly indicates that the Dinotefuran 20% SG@ 40 g a.i./ha effectively controlled Brown Planthopper on rice. This treatment showed better performance than its lower dosages and the standard checks i.e. buprofezin 25% SC @ 187.5g a.i. and imidacloprid 17.8% SL @ 22.5g a.i. It is concluded that, Dinotefuran 20% SG@ 40g a.i./ha may be recommended for the control of Brown Plant hopper on rice in Northeastern Dry Zone and areas having similar geographical and climatic conditions. Further, the treatment (T4) was the most economically viable treatment observed the highest ICBR (3.72) due to its high yield and additional returns over the control which stands 1st rank among all the treatments. Hence, keeping in view its cost-efficacy and effective control of BPH, the same is recommended to farmers for its suitable incorporation towards pest management of Nilaparvatha lugens (Stall) in paddy.

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