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Management of brown plant hopper *Nilaparvata lugens* (Brown plant hopper) in rice in Nalgonda and Yadadri Bhuvanagiri districts of Telangana

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Abstract
The study was undertaken to demonstrate the management of Brown plant hopper (BPH), *Nilaparvata lugens* in rice with formation of Alleyways of 20 cm for every 2 metre, recommended dose of nitrogenous fertilizers (100 kg of N/ha), alternate wetting and drying, spraying of Azadiractin (1500 ppm)@ 5ml/l and Spraying of Buprofezin@1.6ml/l for control of brown plant hoppers. Results were compared with farmers practice plots, the BPH population was lower in the demonstrated plots with 5.6, 6.6 and 8.7 adults/ hill at 60 DAT and 13.4, 15.1 and 15.4 adults/hill at 75 DAT with increased yield of 13.2, 5.9 and 5.1 percent during Kharif 2018, Kharif 19 and Kharif *2020* respectively. The benefit cost ratio was higher 2.5:1, 2.67:1 and 1.96:1 in technology demonstrated plot and lower in farmers practice plots with 2.17:1, 2.43:1 and 1.73:1 during kharif 2018, kharif 2019 and kharif 2020 respectively.

Keywords: Frontline demonstrations, rice, brown plant hopper, grain yield, benefit-cost ratio, economics

Introduction

Rice (*Oryza sativa* L) is one of the world's most important food crop for four billion people of the world (Kulagod *et al*., 2011) [8]. The brown plant hopper (BPH), *Nilaparvata lugens* (Stål) (Hemiptera: Delphacidae), is a key economic pest of rice (*Oryza sativa* L.) throughout South, Southeast-Asia, Indo-China and Pacific Islands. It is a monophagous herbivore and affects the rice crop through direct feeding causing nutrient depletion in the plant. Brown plant hopper is one of the major culprits for huge economic crop losses of rice. It attacks the crop from late vegetative stage to grain hardening stage. Both the nymphs and adults suck the sap from the plant resulting in chlorotic, wilting and drying up of rice plant. It is commonly known as 'hopper-burn' which begins in patches but spreads rapidly as the hoppers move from dying plants to adjacent plants (Krishnaiah *et al*.; 2014) [7]. The yield losses due to hoppers ranges from 10% to 90% if timely control measures are not taken up, there may be possibility of total crop loss within a very short period. BPH is also an efficient vector for various rice viruses, including "ragged rice stunt" and "grassy stunt virus" (Bottrell *et al*., 2012) [2]. It can cause significant damage to rice crops, up to 60% loss of grain yield in susceptible cultivars (Cheng *et al.,* 2009). Insecticide induced resurgence is thought to be a prime factor causing *N. lugens* to become a major pest of rice in tropical Asia in the last decade. It is rather widely distributed but is found mainly in South, Southeast, and East Asia. It damages the rice plant by directly feeding on it and by transmitting the grassy stunt disease (Bottrell *et al*., 2012) [2]. The losses due to *N. lugens* in Asia have been estimated at more than $300 million annually (Sandeep *et al*., 2014) [16]. It is often difficult to control this pest due to its high fecundity and its long distance migratory behavior as well as adapting to resistant varieties rapidly (Su *et al.*, 2013) [17]. In the absence of effective natural enemies and their production methods, control of BPH has mainly relied on the application of various chemical insecticides (Endo *et al.*, 2001) [4]. The application of chemical insecticides is most preferred method to control BPH, however, this can inevitably lead to the evolution of resistance and a reduction in effectiveness. BPH has developed resistance to many of the major classes of insecticides i.e; organophosphates, carbamates, pyrethroids, neonicotinoids and phenyl pyrazoles (Matsumura *et al*., 2010) [12]. The evaluation of new insecticides must also be a regular practice so as to search for safer and effective alternatives to minimize the planthoppers damage (Lakshmi *et al*., 2010) [9].
The Frontline demonstrations are an important method of transfer of latest technologies and package of practices in totality to farmers (Hiremath *et al*; 2012) [6] and main objective of this

programme is demonstration of proven crop production technologies and to introduce suitable agriculture practices like seed treatment, spacing, timely sowing, nutrient management, growth hormones, pest and disease management practices, high yielding varieties in the farmer's field on large scale under real farming situations in different agro-climatic regions accompanied with organizing extension programmes for horizontal dissemination of the technologies (Madhushekar *et al*. 2021) [10]. FLD's play a very important role in transfer of technologies and in changing the scientific treatment of the farmers by seeing and believing principle in order to have better impact of the demonstrated technologies for farmers and field level extension functionaries (Sagar *et al*. 2004) [15]. Front Line Demonstrations were conducted at farmer's field, in a systemic manner, to show the improved production technology and convince them about the potential of the technology to enhance the yield.

In this context, suitable region specific IPM strategies were framed to manage this destructive pest, the present frontline demonstration was undertaken to manage *N. lugens* using integrated pest management in Nalgonda and Yadadri Bhuvanagiri districts of Southern Telangana Zone.

Materials and Methods

The present study was undertaken at 30 different farmers' fields of Nalgonda and Yadadri Bhuvanagiri Districts of Telangana in irrigated Black & Red sandy loam soils and cropping pattern followed is rice after rice or mono-cropping of rice. The farmer practice plot treatments imposed are spraying of acephate@1.5 g/l and imidacloprid @0.3 ml/l after noticing *N. lugens* infestation (Farmer practice) or on appearance of BPH incidence. The demonstration plot treatments consist of formation of alleyways, recommended dose of nitrogenous fertilizers, alternate wetting and drying, spraying of Azardiractin (1500ppm) @5ml/l and spraying Buprofezin @1.6ml/l for BPH management as shown in (Table 1).

Table 1: Difference between Demonstrated package of practices and farmers' practice of Rice cultivation

S.no.	Particulars	Demonstration plot	Farmer's practice plot
1.	Alleyways	Formed at every 2 metres distance	Not formed
2.	Recommended dose of N fertilizer	100 kg/ha	Not practiced RDN
3.	Alternate wetting and drying	Practiced	Not practiced
4.	Azadirachtin (1500ppm)	1500 ppm @ 5ml/lit	Applied Acephate @1.5g/l.
5.	Buprofrezin	1.6ml/lit	Applied Imidachloprid @0.3ml/l.

The rice variety grown is BPT 5204 and the frontline demonstrations were conducted for three consecutive years *i.e.* Kharif 2018, Kharif 2019 and Kharif 2020 in an area of 0.4 ha each in 10 locations for each treatment. The nymph/adult population of brown plant hopper was calculated three days after chemical spraying. Data recorded was collected from both check and demo plots. To find out the economic impact of frontline demonstrations on pest incidence, rice yield and cost benefit ratio were calculated. Observations on the BPH incidence was assessed by periodic scouting and hopper burn symptoms. The infestation ratio was determined by no. of hills showing the hopper burn symptoms, counting no. of adults of BPH population/hills. The output was collected from FLDs as well as local control plots from all selected farmers of Rice for analysis and interpretation of the data. The data is interpreted and presented in terms of percentage and the qualitative data were converted into quantitative form and expressed in terms of per cent increased yield. Finally, the grain yield, cost of cultivation, net returns with benefit cost ratio was worked out. Suitable statistical tools were used for computation of the data.

During the cropping period, training programs, diagnostic field visits were made by scientists and Departmental officials from time to time, distribution of leaflets and brochures, guiding farmers through phone in live programmes, and farmer-scientist interaction meetings etc. were organized to create awareness on improved technologies among the farmers.

Results and Discussion

Results revealed that the incidence of *N. lugens* was lower in the demonstrated plot with formation of alleyways, recommended dose of nitrogenous fertilizers, alternate wetting and drying, spraying of Azardiractin 1500 ppm@5ml/l and Buprofezin @1.6ml/l for adult management with 5.6 adults/hill at 60 DAT and 13.4 adults/hill at 75 DAT during K*harif* 2018 followed by low infestation of BPH with 6.6 adults/hill at 60 DAT and 15.1 adults/hill at 75 DAT during *Kharif* 2019 followed by low infestation of BPH with 8.7 adults/hill at 60 DAT and 15.4 adults/hill at 75 DAT during *Kharif* 2020.The higher infestation was observed in farmer practice with 13.4 adults/hill at 60 DAT and 25.2 adults/hill at 75 DAT during k*harif* 2018 followed by high infestation of BPH with 9.5 adults/hill at 60 DAT and 21.2 adults/hill at 75 DAT during *Kharif* 2019 followed by high infestation of BPH with 13.2 adults/hill at 60 DAT and 22.0 adults/hill at 75 DAT during *Kharif* 2020 (Table 02& 03).

The yield was higher in demonstrated plots with 6654 kg/ha, 6470 kg/ha and 5480 kg/ha compared to farmers practice plot 5878 kg/ha, 6110 kg/ha and 5213 kg/ha during K*harif* 2018, *Kharif* 2019 and *Kharif* 2020 respectively. The per cent yield increase in demonstrated plot was 13.2, 5.9 and 5.1 during *Kharif* 2018, *Kharif* 2019 and *Kharif* 2020 respectively (Table 04).

The net returns were higher in demonstrated plots i.e.; Rs.70776/-, Rs.73430/- and Rs.49815/- compared to net returns in farmers practice with Rs.56041/-, Rs.65986/- and Rs. 41028/- during Kharif 2018, 2019 and 2020 respectively.

The cost benefit ratio (BC Ratio) was higher in demonstration plots with 2.5: 1, 2.7:1 and 2.0:1 when compared with farmers practice with 2.2: 1, 2.4:1 and 1.7:1 during *Kharif* 2018, 2019 and 2020 respectively. Therefore, it was concluded that the recommended package of practice in frontline demonstrations can be recommended on large scale to manage Brown plant hopper in rice fields in ensuing cropping seasons wherever similar climatic conditions are prevailing.

Spraying of Buprofezin 25 SC @225 g.ai/ha recorded BPH population of 8.61adults per hill 15 days after first spray and reduction of BPH population of 77.21% over control was oberved (Raghavendra *et al*., 2017) [13]. Results are similar to those who reported, that application of N fertilizers to the rice plants increased the N concentrations both in rice plants and BPH (Mamunur *et al.*, 2016) [11] while application of P and K fertilizers increased their concentrations in plant tissues only but not in BPH. A combination of Neem oil + urea at a ratio of 1:10 when applied 3 times at the basal, tillering and panicle initiation stages gave a superior level of control of brown plant hopper and the findings are in conformity with the findings of Babu *et al.;* 1998. This is mainly because the plants become less succulent which are less preferred by BPH. Cent per cent of *N. lugens* died after exposure to 40 per cent of neem extract, for 72 hours at 30ºC (Salleh *et al.*, 2018) [14]. The results showed that neem extract can be an effective insecticide to prevent the outbreaks of *N. lugens*. The higher infestation of BPH was found in farmers plot which is similar to the farmer practice (28.71/hill) and lowest yield was also observed in farmer's practice (36.14 q/ha) with lowest B:C ratio in farmer practice (1:2.00) (Hasan *et al.*, 2015) [5].

Because of non-adoption of alley ways, applying of high concentrations of urea which enables plant to have luxurious growth & become succulent resulting in heavy incidence of BPH population. The incidence of the pest was severe in the month of September, 2020 to October, 2020 as reported by Sandeep *et al*., 2014) [16]. The incidence of BPH was lowest at early stage of crop and high at tillering stage to grain maturity stage mainly due to the coincidence of late vegetative stage with monsoon rains in September which further flare up the BPH incidence.

BPH Population/hill

		Kharif 2018	Kharif 2019	Kharif 2020
60 DAT	Demo	5.6	6.6	8.7
	Farmer Practice	12.8	9.5	13.2
75 DAT	Demo	13.4	15.1	15.4
	Farmer Practice	25.2	21.2	22

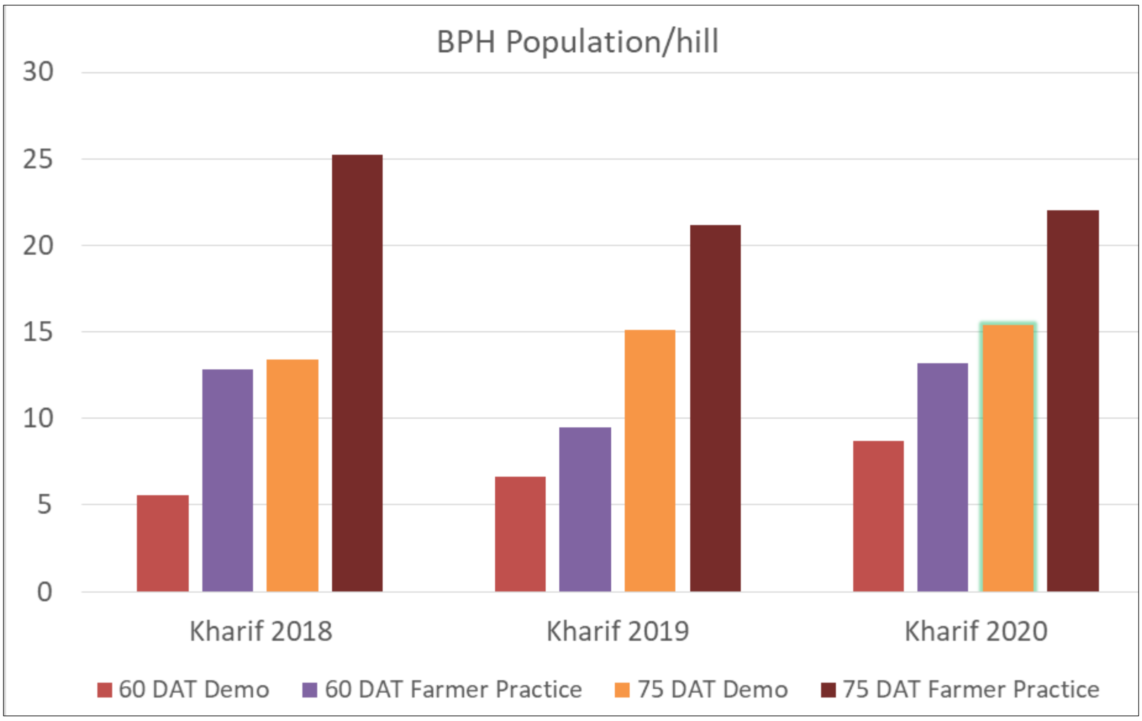

Fig 1: BPH Population/hill

Table 2: Incidence of BPH population on rice during kharif 2018, 2019 and 2020 in Nalgonda and Yadadri bhuvangiri districts

S.no.	Year	BPH population/hill			
		60 DAT		75 DAT	
		Demonstration plot	Farmer Plot	Demonstration Plot	Farmer Plot
1.	Kharif 2018	5.6	12.8	13.4	25.2
2.	Kharif 2019	6.6	9.5	15.1	21.2
3.	Kharif 2020	8.7	13.2	15.4	22.0

Table 3: Yield and Economics in Rice for control of BPH during Kharif 2018, 2019 and 2020

Year	Yield		% yield increase over the control	Cost of cultivation		Gross returns		Net returns		B:C ratio	
	Demonstration plot	Farmer plot	Demonstration plot	Demonstration plot	Farmer plot	Demonstration plot	Farmer plot	Demonstration plot	Farmer plot	Demonstration plot	Farmer plot
2018	6654	5878	13.20	47000	48000	117776	104041	70776	56041	2.51	2.17
2019	6470	6110	5.90	44000	46000	117430	111986	73470	65986	2.67	2.43
2020	5480	5213	5.12	52113	55933	101928	96961	49815	41028	1.96	1.73

Table 4: Incidence of BPH population on rice during kharif 2018, 2019 and 2020 in Nalgonda and Yadadri bhuvangiri districts

Locations	1	2	3	4	5	6	7	8	9	10	Mean
During Kharif-2018 (Demonstration plot)											
Adults/hill during tillering stage	5.8	6.2	4.1	4.9	6.7	6.2	5.8	4.8	6.1	5.6	5.6
Adults/hill during panicle stage	15.2	14.6	13.2	10.1	13.6	13.2	13.5	14.5	14.6	11.4	13.4
During Kharif-2018 (Farmer's plot)											
Adults/hill during tillering stage	13.1	10.9	15.4	12.4	16.1	12.2	11.9	12.6	11.2	11.8	12.8
Adults/hill during panicle stage	25.6	22.3	25.6	27.1	34.5	23.5	22.8	24.1	21.9	24.6	25.2
During Kharif-2019 (Demonstration plot)											
Adults/hill during tillering stage	7.5	5.6	6.7	5.8	7.2	6.2	8.5	7.2	5.7	6.0	6.6
Adults/hill during panicle stage	11.6	16.7	18.1	15.4	11.1	16.4	18.6	14.6	12.8	16.2	15.1
During Kharif-2019 (Farmer's plot)											
Adults/hill during tillering stage	9.5	8.9	11.1	10.1	7.9	8.1	8.6	10.4	9.5	11.3	9.5
Adults/hill during panicle stage	23.2	23.1	29.5	19.5	15.9	17.8	19.5	23.6	20.1	19.6	21.2
During Kharif-2020 (Demonstration plot)											
Adults/hill during tillering stage	9.1	10.2	7.8	8.4	7.1	8.5	9.2	7.9	8.1	11.2	8.75
Adults/hill during panicle stage	16.4	15.4	13.8	14.6	17.1	18.5	16.5	13.5	14.2	13.6	15.4
During Kharif-2020 (Farmer's plot)											
Adults/hill during tillering stage	14.2	13.2	15.2	16.1	13.9	10.2	12.7	9.1	14.2	13.2	13.2
Adults/hill during panicle stage	23.1	20.3	19.7	22.6	26.8	22.3	21.0	19.8	23.5	20.8	22.0

Table 5: Table showing Paired t-test at 5 degrees of freedom & 0.95 confidence levels

Null value considered 0					
Sample estimate				**Confidence 0.95**	
t	**df**	**P-value**	**mean of the differences**	**lower**	**upper**
5.89	5	0.002	6.875	3.874	9.876

Paired t-test: A two sided paired t-test was taken up at 5 degrees of freedom & at 0.95 confidence levels, the t-value obtained is 5.89 with p at 0.002, mean of the difference being 6.875, the t-value 5.89 is greater than 4.77 (p value at 0.002) hence we reject the Null hypothesis and state that we have significant evidence that the average difference in adults per hill during tillering and panicle stage of BPH incidence during 2018-19 to 2020-21 is not zero and there was an average decrease of BPH incidence from 9.876 to 3.874 due to frontline demonstrations or demonstrated package of practice for management of BPH in Rice. The standard deviation for demo is 4.36 and for farmer's practice it is 6.05.

Conclusion

The above findings concluded that, adoption of alley ways, application of recommended dose of nitrogenous fertilizers and spraying of Azadiractin 1500 ppm @ 5ml/l at 60 DAT and Buprofezin@1.6ml/l at 75 DAT showed significant reduction in the pest incidence and recorded higher yield, pest reduction, higher gross returns, higher net returns and higher benefit cost ratio in the demonstration plots compared to farmer's practice. Moreover, the farmers of Nalgonda district witnessed the role of IPM practices in BPH reduction, they are willing to take up the same package on large scale because IPM practices are ecologically sound, economically feasible and culturally easily adoptable in real farming conditions.

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