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Effect of weather parameters, transplanting windows and varieties on population of rice BPH in Pune region

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Abstract
An agro-meteorological investigation was undertaken on "Crop weather pest relationship and validation of DSSAT model for rice varieties under different transplanting dates'' during *kharif*, 2016 and 2017 at Agricultural Research Station Farm, Vadgaon Maval, Dist. Pune, under Mahatma Phule Krishi Vidyapeeth, Rahuri, University. An experiment was laid out in split plot design with three replications. The treatment comprised of four sowing dates *viz.*, S_1: 26th MW (25 June-1 July), S_2: 28th MW (9 July-15 July), S_3: 30 MW (23 July-29 July) and S_4: 32nd MW (06 August -12 August) as main plot treatments and four varieties *viz.*, V_1: VDN-99-29 (*Phule Samruddhi*), V_2: VDN-3-51-18 (*Indrayani*), V_3: IET-13549 (*Bhogavati*) and V_4: RDN-99-1 (*Phule Radha*) as sub plot treatments.
Average number of brown plant hopper showed highly significant positive correlation with maximum temperature (0.902**, 0.627**), positive correlation with morning humidity (0.534, 0.789*), evening humidity (0.678*, 0.551) and bright sunshine hours (0.345, 0.483). While minimum temperature (-0.567, -0.543) and rainfall (-0.302, -0.307) showed negative correlation with brown plant hopper on 26th MW, 28th MW, 30th MW and 32nd MW transplanting dates. During both the years of 2016 and 2017, respectively.

Keywords: Brown plant hopper, rice, weather parameters, transplanting dates, correlation

Introduction
Rice (*Oryza sativa* L.) is a staple food for more than 65 per cent of the people and it provides employment and livelihood security to 70 per cent of Indian population. India grows rice in highly diverse conditions starting from below sea levels to hill as high as > 2000 meters. India ranks first in area with about 44 m. ha under rice and second in production with 104.8 million tonnes with an average productivity of 2390 kg ha^{-1}Different transplanting times affects crop growth and yield considerably. Therefore, optimum transplanting times for better crop yield is essential. The Brown plant hopper is the monophagous, small or tiny insect with 2.0 to 3.5 mm body length. It is a brownish colour insect which feed on the phloem of plant. Adult and nymphs, both damage to the phloem of rice plant. Though this insect is known to occur in Asia since late forties, it was earlier only a minor pest of rice. Serious outbreaks of BPH were reported in various parts of India during early 70s. BPH damages plant directly by sucking to plant sap and indirectly by transmitting viral disease like grassy stunt and ragged stunt. BPH caused economic damage by sucking phloem sap which in turn leads to "hopper burn" and sever yield loss (Rao *et al*., 2003) [5]. Both the nymphs and adults of these hoppers suck the sap from phloem and xylem resulting in drying up of the rice plant. At early infestation, round, yellow patches appear, which soon turn brownish due to the drying up of the plants (Ling, 1975) [2]. Agriculture consumes 52 per cent of the total insecticides in India, and intern rice crop alone accounts for 17 per cent of it. About 50 per cent of Indian rice farmers use insecticides ranging from one to six applications per crop season against Stem borers, Brown plant hopper, White backed plant hopper and Leaf folder. The BPH, *Nilaparvata lugens* (Stal.) is one of most economic pests of rice causes significant losses in yield of the crop. Therefore, to overcome the insect pest damage by forewarning the pest incidence and to obtain higher yields, it is necessary to find out the optimum transplanting time and validate the crop models. Keeping this in view, the field experiment was planned in *Kharif* 2016 and 2017.

Materials and Methods
The present experiments related investigation entitled, "Crop weather pest relationship and validation of DSSAT model for Rice varieties under different transplanting dates" were conducted at Agriculture Research Station Farm, Vadgaon Maval,

Tal. Dist. (M.S.) during *kharif* seasons of 2016-17 and 2017-18, to identify optimum transplanting date for Rice, to develop crop weather relationships, to develop pest weather relations and to validate the DSSAT model. An experiment was laid out in split plot design with three replications. The treatment comprised of four sowing dates *viz.*, S_1: 26th MW (25 June-1 July), S_2: 28th MW (9 July-15 July), S_3: 30 MW (23 July-29 July) and S_4: 32nd MW (06 August -12 August) as main plot treatments and four varieties *viz.*, V_1: VDN-99-29 (*Phule Samruddhi*), V_2: VDN-3-51-18 (*Indrayani*), V_3: IET-13549 (*Bhogavati*) and V_4: RDN-99-1 (*Phule Radha*) as sub plot treatments.

Experimental Details

The experiment was conducted in a split -plot design with three replications and sixteen treatment combinations were formed considering different varieties and transplanting. The details are listed below.

1.	Name of crop	:	Rice
2.	Varieties:		1. VDN-99-29 (Phule Samrudhi) 2. VDN-3-51-18 (Indrayani) 3. IET-13549 (Bhogavati) 4. RDN-99-1 (Phule Radha)
3.	Number of treatments combinations	:	16
4.	Number of replications	:	3
5.	Number of plots	:	48
6.	Experimental Design	:	Split plot Design
7.	Plot size	:	a. Gross Plot: 4.80 m x 3.60 m b. Net Plot: 4.0 m x 3.0 m
8.	Spacing	:	20 cm x 15 cm
9.	Seed rate	:	20 kg ha^{-1}
10.	Fertilizer dose	:	175: 60: 60 NPK kg ha^{-1}
11.	Seasons	:	I) *Kharif*, 2016 II) *Kharif*, 2017
12.	Place of research work	:	Agricultural Research Station Farm, Vadgaon Maval, Tal. Maval, Dist. Pune
13.	Transplanting dates	:	S_1: 26th MW (25 June-1 July) S_2: 28th MW (16 July-15July) S_3: 30 MW (23 July-29July)

Results and Discussion

Brown plant hopper

Brown plant hopper infests the rice crop at all the stages of crop growth. As a result of feeding by both nymphs and adults at the base of the tillers, plants turn yellow and dry up rapidly. At early infestation, round, yellow patches appear, which soon turn brownish due to the drying up of the plants. This condition is called 'hopper burn'. Temperature is a critical factor in the life activities of the insect. The hatchability and survival rate are the highest around 25 °C. Eggs are very sensitive to desiccation and soon shrivel when the host plant starts wilting. The population growth of brown plant hopper is maximum at a temperature range of 28° to 30 °C.

The incidence of brown plant hopper was recorded on all rice varieties during the year 2016, across all transplanting times on rice. Normally, the temperature also showed increasing trend from September onwards and has the lowest during November. Hence, with increasing temperature certainly resulted in increase in the infestation of brown plant hopper. Morning and evening relative humidity was also higher in month of September which resulted in increase in brown plant hopper population. When minimum temperature and rainfall increased, there was corresponding decrease in rice brown plant hopper Subhash *et al.* (2016) [5] reported that brown plant hopper appeared on rice crop during the second week of September. During the transplanting times of 26th MW the brown plant hopper populations ranged between 4.4 and 39.93 on rice varieties VDN-99-29 (V_1), VDN-3-51-18 (V_2), IET13549 (V_3) and RDN-99-1 (V_4). The highest populations of brown plant hopper 39.93 were recorded on RDN-99-1. During the transplanting times of 28th MW, the brown plant hopper populations varied from 3.9 to 29.07 on rice varieties VDN-99-29 (V_1), VDN-3-51-18 (V_2), IET-13549 (V_3) and RDN-99-1 (V_4). The highest populations of brown plant hopper 29.07 were recorded on RDN-99-1. During the transplanting times of 30 MW, the brown plant hopper populations varied from 3.8 to 40.30 on rice varieties *viz.*, VDN-99-29 (V_1), VDN-3-51-18 (V_2), IET13549 (V_3) and RDN-99-1(V_4). The highest population of brown plant hopper 40.30 was recorded on RDN-99-1. During the transplanting times of 32nd MW, the brown plant hopper populations varied from 3.1 to 56.50 on rice varietiesVDN-99-29 (V_1), VDN-3-51-18 (V_2), IET13549 (V_3) and RDN-99-1 (V_4). The highest population of brown plant hopper 56.50 was recorded on RDN-99-1.

The incidence of brown plant hopper was recorded on all rice varieties during the year 2017, across all transplanting times on rice. During the transplanting times of 26th MW, the brown plant hopper populations ranged between 4.1 and 46.30 on rice VDN-99-29 (V_1), VDN-3-51-18 (V_2), IET13549 (V_3) and RDN-99-1 (V_4). The highest populations of brown plant hopper 46.30 was recorded on RDN-99-1 During 32ndMW. During the transplanting times of 28th MW, the brown plant hopper populations varied from 3.2 to 24.18 on rice varieties *viz.* VDN-99-29 (V_1), VDN-3-51-18 (V_2), IET13549 (V_3) and RDN-99-1 (V_4). The highest population of brown plant hopper 24.18 was recorded on RDN-99-1 during 32nd MW. During the transplanting times of 30 MW, the brown plant hopper populations varied from 4.4 to 41.2 on rice VDN-99-29 (V_1), VDN-3-51-18 (V_2), IET13549 (V_3) and RDN-99-1 (V_4) varieties.

Among the rice varieties, for the year of 2016 and 2017 higher incidence was recorded RDN-99-1 and minimum was recorded on VDN-99-29 i.e. Phule samruddhi. Similar results

were reported by Rai and Khan (2002) [3], Wains *et al*. (2010) [7], Chaudhary and Raghuraman (2014) [1] and Subhash *et al*. (2016) [5].

Influence of weather parameters on rice brown plant hopper

The correlation of meteorological parameters with incidence of rice brown plant hopper was studied in 2016-17. The correlation coefficient (r) of brown plant hopper on rice with the weather parameters are presented in (Table.2)Average number of brown plant hopper showed significant positive correlation with maximum temperature (r =0.803*, 0.902**, 0.789*, 0.899*), morning and evening relative humidity's and bright sunshine hrs (r=0.234, 0.345, 0.457, 0.567) during the year of 2016, Whereas brown plant hopper population showed negative correlation with rainfall and minimum temperature during 26 MW, 28 MW, 30 MW and 32 MW transplanting times (r = -0.142, -0.302, -0.450 and -0.845), (r= -0.789, -0.567, -0.812* and -0.567),during the year of 2016.

The correlation of meteorological parameters with incidence of rice brown plant hopper was studied in 2017. The correlation coefficient (r) of brown plant hopper on rice with the weather parameters are presented in((Table.1)Average number of brown plant hopper showed significant positive correlation with maximum temperature (r=0.874*, 0.627*, 0.724*, 0.678*) morning and evening relative humidity's and bright sunshine hrs (r = 0.224, 0.183, 0.400, 0.482) during the year of 2017, Whereas brown plant hopper population showed negative correlation with rainfall and minimum temperature during 26 MW, 28 MW, 30 MW and 32 MW transplanting times (r=-0.192, -0.307, -0.668 and -0.546), (r= -0.637, -0.543, -0.045 and -0.593), respectively during the year of 2017. It was observed that, the infestation of brown plant hopper started increasing September onwards and it was peak during 37th MW. This agreed with the present finding. Similar results were reported by Yadav and Chander (2010) [8] and Sujithra and Chander (2012).

Table 1: Correlation of weather parameters and rice brown plant hopper (2016-17)

Sowing times	Correlation coefficient values					
	2016					
	RF	T max	T min	R H I	R H II	BSS
S_1 -26thMW	-0.142	0.803*	-0.789*	0.567	0.788*	0.234
S_2 -28thMW	-0.302	0.902**	-0.567	0.534	0.678*	0.345
S_3 -30thMW	-0.450	0.789*	-0.812*	0.456	0.234	0.456
S_4 -32thMW	-0.845*	0.899*	-0.567	0.345	0.456	0.567
	2017					
S_1 -26thMW	-0.192	0.874*	-0.637*	0.568	0.615*	0.224
S_2 -28thMW	0.307	0.627*	-0.543	0.789*	0.551	0.183
S_3 -30thMW	-0.668*	0.724*	-0.745*	0.943*	0.811*	0.400
S_4 -32thMW	-0.746*	0.678*	-0.593	0.567	0.305	0.482

Table 2: Regression equations for brown plant hopper population

Sr. No.	Transplanting time	Year	Equation	R^2 value
1	26 MW	2016	BPH = -11.635+1.74* (T max)	0.79
2	28 MW	2016	BPH = -107.40+1.34* (T max)	0.85
3	30 MW	2016	BPH = -59.225 + 3.26* (T max)	0.93
4	32 MW	2016	BPH = -61.345+3.47* (T max)	0.76
5	26 MW	2017	BPH = -235.234+2.34* (T max)	0.86
6	28 MW	2017	BPH = -231.635+1.91* (T max)	0.82
7	30 MW	2017	BPH = -64.234+2.34* (T max)	0.78
8	32 MW	2017	BPH = -101.967+1.34* (T max)	0.75

Conclusion

Average number of brown plant hoppers showed positive correlation with maximum temperature, morning and evening relative humidity's and bright sunshine hrs Whereas, non-significant negative correlation with rainfall and minimum temperature respectively. It was observed that, the infestation of brown plant hoppers started increasing from mid-august onwards and it was peak during 35th to 37th MW in RDN-99-1 (V_4). Among the rice varieties, for the year of 2016 and 2017 higher incidence was recorded RDN-99-1 and minimum was recorded on VDN-99-29 i.e Phule samruddhi. So Farmers are advised to use Phule Samrudhi variety for rice cultivation for highest production with minimum attack of pest and use 28th MW (16 July-15July) for rice transplantation.

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