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Performance of rice varieties to Pest management module in West Central Table land zone of Odisha

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ABSTRACT

Studies on effect of weather parameter on population build up of rice insect pest, diseases and their control based on Krishi Gramin Mausam Seva at Regional Research and Technlogy Transfer Station, Chiplima, Odisha revealed that the hybrid rice varieties HASANT grown under foliar spray of rynaxypyr 20 SC (150 ml/ha) at 45 DAT, pymetrozine 50 WG (300 g/ha) at 60 DAT, streptocycline 100 ppm at 30 and 40 DAT, harboured significantly lower population of leaf folder, stem borer and brown plant hopper, less bacterial leaf blight (disease) severity and recorded higher yield (26.5%) compared to those not receiving plant protection measures (5.8 t/ha). The leaf folder, stem borer and brown plant hopper showed significant negative correlation with minimum temperature, relative humidity in afternoon hour and rain fall, while positive correlation with maximum temperature. The yield advantage in different hybrid varieties over high yielding varieties 'Swarna' was 7.5 to 32.9%. Hybrid variety HASANT recorded highest yield (7.3 t/ha) and benefit-cost ratio (2.9), followed by AZ BOLD (6.6 t/ha, 2.6).

1. Introduction

Rice is India's important cereal crop and is the staple food of people of eastern and southern
parts of the country which is cultivated over an area of 44.4 m ha with production of 104.32 m tonnes
(Anonymous, 2017). Rice being the staple food, is extensively grown in Hirakud command areas of West Central Table Land Zone of Odisha. During rainy season, it occupies about 80% of the total cropped area of this zone. The major reasons for low productivity of rice in Odisha are the losses due to insect pest, diseases and weeds. The major insect pests found in rice in this zone are gall midge(*Orseolia oryza)*, Stem borer (*Scirpophaga incertulas*) and brown plant hopper (*Nilaparvata lugens*). Brown plant hoppers (BPH) and stem borer are the important culprit for major economic crop losses. The yield losses due to brown plant hoppers ranges from 10 – 90% and almost 50% of the insecticides used in rice are targeted against this pest alone (Nag *et al.* 2018). In 2017 plant hoppers destroyed almost 1.7 lakh hectares of rice fields in nine districts of Odisha. They attack the crop from late tillering stage to grains hardening stage. BPH tolerant rice varieties and synthetic insecticides are still major method to control insect pests particularly hoppers in rice The extent of rice yield losses due to rice stem borer has been estimated as 20-70% (Chelliah *et al.* 1989). Bacterial leaf blight

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(Xanthomonas oryzae pv *oryzae*) is a potential threat to rice production. It is estimated that it causes more than 70% yield loss under favourable environmental condition (Basso *et al.* 2011).

Indiscriminate use of pesticide has resulted in degradation of our environment while our pest problems like development of resistance, resurgence and pesticide treadmill seem greater than ever (Trivedi and Ahuja, 2011) . There are more and more reports of resistance of pests to pesticide (Alam, 2000). The extent of pesticide residues in the environment is also a matter of great concern. Research results have indicated that food commodities are contaminated with persistent pesticide residues (Arora *et al.,* 2006). Hence there is a urgent need to evolve strategies and technologies that will not only meet increasing demands for food but also those that will enable us to produce more without the problems encountered as stated above. This target can be achieved only with integrated pest management based on weather condition of the zone. Weather parameters play important role in the seasonal abundance and distribution of insect pests in rice (Mandal *et al.* 2011and Nag *et al.*, 2018). Information on the relationship of the prevalence and build-up of different insect pests and their natural enemies with the weather parameters is a prerequisite before formulating a location specific IPM module for management of these pests. For developing any pest management programme for specific agro-ecosystem information on abundance and distribution of pest in relation to weather parameters is a basic requirement (Patel and Shekh, 2006).

A series of high yielding varieties with less susceptibility to major pests have been released from Orissa University of Agriculture and Technology, Bhubaneswar. However 'Swarna' a variety released by Agricultural Research Station, Maruteru, Andhra Pradesh one of the best variety in the past (nineties), are quite susceptible to insect pests now. They are being cultivated extensively in this zone. Hence to evaluate the relative performance high yielding varieties against the field incidence of insect pests under protected condition in West Central Table Land Zone, the present investigation was planned.

2. Materials and methods

The study was conducted during *kharif* 2017 and 2018 at RRTTS, Chiplima, Orissa University of Agriculture & Technology, Odisha, India. The Station is situated at $20^0$21' N latitude and $80^0$55'E longitude in Dhankauda block of Sambalpur district. The climate of the area is warm/sub humid. The temperature varies from as low as 9^0C to as high as 44.2^0C. The mean maximum and the mean minimum temperatures of 40.5^0 C and 13^0C are recorded in the months of May and December, respectively. The soil of experimental field was sandy clay loam, acidic (pH 5.65), low in organic carbon content (0.47%) and available N, P_2O_5 and K_2O content were 242, 9.2 and 155 kg/ha, respectively. Five high yielding rice varieties, HASANT, OR 26, Swarna, Pratikshya and Subarna were tried under protected (module 1) and non protected condition (module 2) against insect pest and yield of rice. The details are as follows

Modules- 1: Pesticides tested against varieties

Sl. No.	Module - 1	Dose/ha
1	Seed treatment with Streptocycline 250 ppm	0.25g/kg seed
2	Chlorantraniprole 0.4 G at 20 DAT	10 kg
3	Spraying of Streptocycline 100 ppm at 30 DAT	50 g
4	Spraying of Streptocycline 100 ppm at 40 DAT	50 g
5	Spraying of Rynaxypyr 20 SC at 45 DAT	150 ml
6	Spraying of pymetrozine 50 WG at 60 DAT	300 g

Modules- 2: Untreated control (No pesticides against BLB and BPH, Recommended dose of fertilizer and other agronomic practices were followed).

The experiment was laid out in factorial randomized block design replicated four times. The FYM was applied @ 5 t/ha with a fertilizer dose 120-60-60 N-P_2O_5-K_2O kg/ha, respectively. All P_2O_5 was applied as basal and N was applied in 3 splits i.e. 50% as basal, 25% at 45 DAT & 25% at 60 DAT while K was applied in two splits, i.e. 50% as basal and 50% at 60 DAT. Rice was transplanted on 27th July of 2017 and 20th July 2018 at 20 X 10 cm spacing. The crop was grown in medium land situation. Plot size was 6 X5 m. The crop was grown with recommended package of practices except plant protection. Rainfall received during the crop growth period was 903 mm (44 rainy days) in 2017 and 1807 mm (59 rainy days) in 2018. Ten panicles were selected randomly to compute the panicle length, panicle weight and number of grains/panicle. Grain and straw yields were recorded on net plot size.

Observations on crop damage by leaf folder was recorded from 10 randomly selected hills leaving the border row from each plot. Light trap was installed in the rice fields during crop growth period from July to November. Mercury vapour lamp (12 w) was used as light source in the trap and was run daily during night. Rice insect pest collected and counted daily throughout the season. Daily meteorological data on temperature, relative humidity and rainfall were recorded during the period of experimentation (Fig. 1). In order to study the impact of meteorological variables simple correlation was carried out on incidence of leaf folder, stem borer and brown plant hopper.

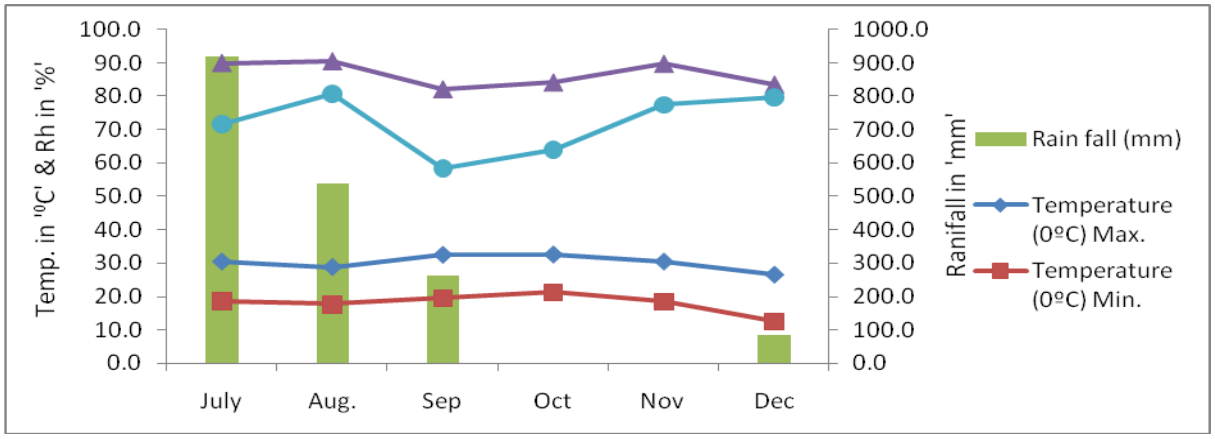

Fig. 1. The weather data of the experimental cite during growing season of crop (avg. of 2 years)

From each plot three sampling units of 1 sq m area were fixed at random and 10 observations were recorded from each sampling unit. BLB disease severity as disease score according to SES scale was recorded and Percent Disease Index (PDI) was calculated using the standard formula.

Percent disease index (PDI) =

$$\frac{\text{Sum of all numerical ratings}}{\text{No. Of observations X maximum rating}} \times 100$$

The data obtained were simply transformed following Gomez and Gomez (1984) to arrive meaningful conclusion.

3. Results and Discussion

The insect pests such as leaf folder, stem borer, brown plant hopper and disease like bacterial leaf blight were appeared in the rice during the crop growth period (Table 1). In general, though all the varieties recorded the incidence of pests, the high yielding varieties had comparatively more susceptible than hybrids

Leaf Folder: The infestation level in different varieties varied from 7.13-10.2% (Table 1), thus exceeding the economic thresh hold limit of 8% calculated for the pest by other workers (Padmavathi *et al.* 2013). The reaction of AZ Bold, AZ 9453 and HASANT to leaf folder was not statistically significant among themselves, but the infestation was lower than that of MTU 1001. Similar observation was recorded by Sachan et al. (2006) and Sekhar et al (2018). Significant reduction in the percent damaged leaf was noticed in protected crop than that of unprotected one. The minimum temperature (-0.692), relative humidity in afternoon hour (-0.776) and rain fall (-0.791) had highly significant negative correlation with leaf folder population, while maximum temperature (0.588) and relative humidity in morning hour (0.388) showed the positive correlation (Table 2).

Stem borer – Stem borer population was recorded during the reproductive stage (Table 1). It was evident from the data that the average population of stem borer per square meter varied from 3.91 to 6.48. None of the varieties was free from stem borer attack. High yielding variety MTU 1001 was found to be least susceptible one to stem borer. Spraying of Rynaxypyr (150 ml/ha)20 SC at 45 DAT significantly reduced the pest population. It was observed that there was a reduction in pest population of 59% in protected crop. Minimum temperature (-0.868), relative humidity in afternoon hour (-0.794) and rainfall (-0.635) exhibited negative significant correlation with pest population, while maximum temperature (0.294) and relative humidity in morning hour (0.313) showed positive correlation (Table 2). Significant influence of minimum temperature was found on light trap catches of Stem borer, because moth movement and population build in a particular area takes place during night. Cooler nights seemed to have favoured Stem borer movement (Bale *et al.* 2001). Similar results on interactive effect of rain fall, relative humidity in afternoon hour and mean minimum temperature on rice Stem borer were also reported by Rehman *et al.* (2002).

Brown plant hopper – The infestation level in different varieties varied from 15.7 to 35.8 per 10 hills (Table 1). Maximum infestation was noticed in Swarna (46.2) followed by MTU 1001 (35.8). HASANT was least affected by brown plant hopper (15.7). There was 31.4% reduction of brown plant hopper incidence in protected crop in comparison to unprotected one. Minimum temperature (-0.856), relative humidity in afternoon hour (-0.743) and rainfall(-0.588) had significant negative correlation with pest population build up, while maximum temperature (0.151) and morning relative humidity (0.333) showed positive correlation. Similar findings were reported by Sarkar *et al.* (2018), who found that the brown plant hopper population was significantly influenced by climatic factors especially rainfall in association with high relative humidity and high temperatures.

Bacterial leaf blight disease severity

The result revealed that, all the varieties differed significantly from each other in their bacterial leaf blight (BLB) severity except HASANT (10.4%) and AZ 6453 (10.9 %). Both these varieties were statistically at par with each other and produced lowest disease severity compared to other varieties. The highest disease severity was observed in Swarna (33.7%) rendering it to be susceptible to the disease where as HASANT and AZ6453 can be categorized as moderately resistant to BLB. While considering the modules, M_1 i.e., spraying of antibiotic (Streptocycline @ 1g/10l water) proved to be effective in reducing the BLB severity compared to M_2 i.e., no spraying. The two modules differed significantly from each other in BLB severity.

Growth and yield attributing character

The tested varieties differed statistically with each other in respect of plant height (Table 3). It was noticed that hybrid variety AZ BOLD produced the tallest plants (116.7cm) and the other hybrids were shorter than this. All the hybrids as well as MTU 1001 and 'SWARNA' produced a high range of effective tillers/hill (8 to 12), which were statistically significant. AZ BOLD and AZ6453 possessed less number of tillers/hill than that of HASANT (12). The longest panicle was found by HASANT (25.2 cm) closely followed by AZ BOLD (24.4 cm). The former hybrid retained significant superiority to the conventional high yielding variety SWARNA (22.7 cm). However, AZ BOLD and AZ 6453 were statistically similar. HASANT obtained the highest filled up grains (224/panicle) but did not differ significantly with AZ BOLD (211/panicle). The conventional high yielding variety (SWARNA) recorded lowest number of grains/panicle (158/panicle). It is noted that the some of the grains of the hybrids were clearly heavier, compared to those of the conventional variety. The highest grain weight (26.8g) was exhibited by AZ BOLD followed by HASANT (26.3 g). The conventional varietiy SWARNA had the lowest (20.7 g) grain weight. Rice hybrid AZ8433 DT took maximum days to flowering (101 days) than other two hybrids. The conventional variety SWARNA and MTU 1001 required 95 and 103 days, respectively for flowering.

Yield and economics

All the hybrid varieties gave higher yield than high yielding varieties (Table 4). The yield advantage in different hybrid varieties over high yielding variety Swarna was 7.5 to 32.9%. Rice variety HASANT recorded the highest yield (7.3 t/ha) followed by AZ Bold (6.6 t/ha). Similar trend was noticed in case of straw yield in different varieties and plant protection measures. Crop brought under plant protection umbrella recorded 26.5% higher yield than that of unprotected one. Identical observations were also recorded by Bhatnagar and Chaudhary (2000) and Mishra and Parida (2004). The highest net return (Rs. 87622/ha) and benefit –cost ratio (2.9) was obtained from AZ8433 DT followed by AZ Bold and AZ 6453. Swarna gave the lowest benefit due to plant protection. About Rs. 29520/- extra profit was obtained from varieties receiving plant protection measures.

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Table-1. Effect of rice varieties and spraying schedule on incidence of insect pests in rice (mean of 2 years)

Varities /Spraying Schedule	Leaf damage (%) leaf folder	Stem borer (No/m^2)	Brown plant hopper (No/10 hill)	BLB severity % (PDI)
Varieties				
HASANT	7.82(2.87)	5.36(2.42)	15.7	10.4
AZ BOLD	7.13(2.74	6.48(2.64)	35.2	19.8
AZ 6453	7.98(2.88)	5.00(2.35)	35.8	10.9
MTU 1001	9.48(3.14)	3.91(2.10)	46.2	22.8
SWARNA	10.20(3.25)	5.59(2.47)	18.8	33.7
SEm (±)	0.05	0.02	1.1	1.7
C.D. (p=0.05)	0.15	0.07	3.2	5.1
Spraying schedule				
M1(Protected)	6.74(2.68)	3.24(1.92)	29.5	15.3
M2(Unprotected)	10.29(3.27)	7.95(2.89)	43.0	25.6
SEm (±)	0.02	0.01	0.7	0.4
C.D. (p=0.05)	0.09	0.06	2.1	1.2

Fig. in parentheses indicate corresponding angular values

Table 2. Relationship between the weather parameters and incidence of insect pests in rice (mean of 2 years)

Weather parameter	Correlation with population build up (r)		
	Leaf folder	Stem borer	Brown plant hoppr
Max. temp. (^{0}C)	0.588*	0.294	0.151
Min. temp. (^{0}C)	-0.692**	-0.868**	-0.856**
R.H. (%) Morn.	0.388	0.313	0.333
R.H. (Afternoon)	-0.776**	-0.794**	-0.743**
Rainfall (mm)	-0.791**	-0.635**	-0.588*

*, ** Significant at P = 0.05 and 0.01, respectively

Table 3. Growth and yield attributing character and days to flowering of different varieties and spraying schedule of rice (mean of 2 years)

Treatments	Plant height (cm)	Tillers/ hill	Panicle length (cm)	Test wt (g)	Grains/ panicle	Days to 50% flowering
Varieties						
HASANT	110.0	12	25.2	26.3	224	101
AZ BOLD	116.7	10	24.4	26.8	211	92
AZ 6453	113.3	9	23.9	23.9	184	93
MTU 1001	117.8	10	23.8	23.9	186	95
SWARNA	106.9	8	22.7	20.7	158	103
SEm (±)	1.9	0.5	0.4	1.2	3.9	-
C.D. (p=0.05)	6.4	1.6	1.3	4.0	13.1	-
Spraying schedule						
M1(Protected)	116.5	11	24.7	26.0	246	
M2(Unprotected)	109.4	9	23.3	22.6	181	-
SEm (±)	1.5	0.3	0.3	0.4	1.6	-
C.D. (p=0.05)	4.7	1.1	0.8	1.3	5.1	-

Table 4. Yield and economics of rice varieties and spraying schedule of rice (mean of 2 years)

Treatments	Grain yield (t/ha)	Straw yield (t/ha)	Cost of cultivation (Rs./ha)	Net return (Rs./ha)	B:C ratio
Varieties					
HASANT	7.3	7.9	45300	87622	2.9
AZ BOLD	6.6	6.9	45300	74508	2.6
AZ 6453	5.3	6.6	45300	51241	2.1
MTU 1001	5.2	5.7	44200	50056	2.1
SWARNA	4.9	5.3	44200	44679	2..0
SEm (±)	0.3	0.4	-	5817	0.1
C.D. (p=0.05)	1.1	1.2	-	19266	0.4
M1(Protected)	6.8	7.3	45860	76381	2.7
M2(Unprotected)	5.0	5.7	43860	46861	2.1
SEm (±)	0.2	0.2	-	4295	0.1
C.D. (p=0.05)	0.8	0.6	-	13707	0.3