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Response of Rice Varieties to Brown Spot Disease of Rice at Paklihawa, Rupandehi

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Abstract

Brown Spot is the emerging disease of Rice in marginal and low fertility areas which causes significant yield loss. An experiment was conducted at Agronomy Farm of the Institute of Agriculture and Animal Science (IAAS), Paklihawa, Rupandehi in a randomized complete block design with three replications. Poonam variety showed maximum disease severity which is 51.47% and minimum was seen in Kabeli (24.94 %). Maximum mean AUDPC (657.3) on leaf was recorded in Poonam while minimum mean AUDPC (324) was recorded in Radha-4. Highest yield was recorded in Radha-4 (5.420 ton/ha) and lowest yield was recorded in varieties Mithila (2.34 ton/ha). Similarly, highest test weight was recorded in variety Radha-4 (18.18gm) and lowest was recorded in Sabha Mansuli (9.397gm). Variety Radha-4 could be used as a source of resistant varieties in breeding program and Poonam can be regarded as a tolerant variety of rice towards brown spot disease.

Keywords: *Varieties, Brown spot, AUPDC, Economic yield, Test weight*

1. Introduction

Rice (*Oryza sativa L.*) is the third most important crop of the world after wheat and maize as per the acreage and in the first place in Asia. In Nepal, rice is top most crops in terms of area (55% of cultivated land). It is cultivated in 1.48 million hectare of land producing 5.04 million tons of rice with average productivity of 3.394 ton/ha (MoAD, 2014). In Rupandehi district, rice was cultivated in area of 70,500 ha, which gives production 329500 mt, productivity 4.674 t/ha in 2013/14. Rice is grown mainly in the Terai region and contributes to the livelihood of a majority of farm households in the area.

Brown spot is one of the most important diseases of rice worldwide. The disease is caused by the fungus *Bipolaris oryzae*, common in both rain-fed and upland rice production systems (Singh & Singh, 2000). The loss caused by the disease affects both yield and grain quality (Savary e*t al*., 2000). It caused Bengal Famine in 1942, with yield loss of 50-90%, which resulted in death of 2 million people due to starvation. The pathogen infects the coleoptiles (causing blighting), leaves (forming oval, dark brown to purplish-brown spots) and damages the photosynthetic activities, ultimately killing the leaf. The reduction in yield can be as high as 45% in severe infection and 12% in moderate infection (IRRI, 2012). The disease is also known as poor rice farmer's disease because it occurs mostly in deficient and poor soils (Agrawal, 1989; Mia, 1998; Zadoks, 2002). The disease has been noted to reduce yields from 6 to 90% in Asia (Padmanabhan, 1973; Estrada, 1984; Mew and Gonzales, 2002).

Bipolaris oryzae is seed borne. It can also survive on infected rice straw and stubble. It spreads from plant to plant in the field by airborne spores. Seedling infection occurs when infected seeds are sown with prevailing low temperature of 18-22 ^{0} c. The rapid spread and development of the disease is favored by continuous rains and cloud weather and higher day temperature i.e. 28-30^0 c. Optimum temperature for leaf infection range from 22 to 30^{0}c and relative humidity of over 92% (Percich *et al.*, 1997). For infection to occur the leaf must be wet for 8-24 hours. The major thrust of disease control has been through breeding resistant cultivars. The emergence of new races is a constant threat. The use of fungicides is costly and environment unfriendly. Similarly, fungicides use becomes even less favorable in the future result of restrictions in their use (Hovmoller, 2001). Use of resistant varieties is a simple, effective, safe and economical means of controlling rice diseases. Resistant genotypes help to stabilize yields. Resistant levels should be updated each year for each variety. In such contest, identification of genotypes/ varieties would be good alternatives to manage brown spot.

2. Materials and Methods

2.1 Collection of Seeds:

For the experimental purpose various local cultivars of rice varieties were collected from the local farmers and agro vet and a total of 12 available varieties were selected.

2.2 Site of study:

The field experiment was conducted at Agronomy farm of Institute of Agriculture and Animal Science (IAAS), Paklihawa campus, Bhairahawa, Nepal located at 27º 29' Latitude, 83º 27' Longitude and 105 m above the sea level. It has humid subtropical climate. The maximum and minimum temperature recorded throughout the experiment was 37.2º C in June and 16 ºC in November respectively with relative humidity ranging from 78% to 90%. Maximum rainfall was recorded in August (433.7mm).

2.3 Experimental design:

The experiment was conducted with Randomized Complete Block Design (RCBD) with 12 treatments and 3

replications. Individual treatment plot was 1 m^2 (1m X 1m) with row to row spacing of 20 cm and plant to plant spacing 20 cm. Replication spacing is made 1 m and treatment spacing of 50 cm with the field margin of 1m all sides, thus the total length of experimental design was 19.5m and breadth of 7m with gross area of 136.5 m^2.

2.4 Nursery Bed preparation and Sowing:

Nursery bed was prepared closer to the main field with length of 6.4m and breadth 2.4m. Individual varieties were provided with 1 m^2 bed area in each replication .Individual plot were divided into 10 rows of seed each 10 cm apart. Bed preparation was done in July 3rd 2015 and seed sowing was done in July 5th 2015 at the rate of 40 kg/ha. The seeds were soaked overnight in water for sowing the next day. Line sowing was practiced and the bed was filled with water.

2.5 Main Field preparation and transplantation:

The land was thoroughly ploughed and levelled. It was watered properly and the experimental design was set up. The seedlings were allowed to remain in the bed for 14 days and then seedlings from individual plot were collected separately and transplanted to the main field in July 24th, 2015.Seedlings were transplanted according to the RCB design. Three seedlings were maintained per hill. Chemical fertilizers were applied at the rate of 100 kg N, 30 kg P_2O5 and 30 kg k_20 per ha which was given through Urea, DAP and Potash as recommended by MoAD. A single manual weeding was carried out in 2015 august 21st i.e. 27th Day after Transplanting (DAT). Two irrigations were done in the field in water deficit condition. The field was mainly under rain fed condition.

2.6 Plant protection:

The field was heavily infested with Rice leaf roller (*Cnaphalocrocis medinalis)* which was controlled by the foliar application of Cypermethrin and Chlorpyriphos @ 3 ml/ ltr of water in 58th DAT.

2.7 Harvesting, threshing and yield:

Harvesting was done manually. Threshing was done when the grains were dried. The grains were collected and weighed for each individual plot for obtaining the seed yield/plot. Total yield per hectare was calculated using the formula:

$$\text{Total Yield (tons per hectare)} = \frac{\text{yield per plot (1sq.m(Kg))} \times 10{,}000}{1000}$$

The threshed grains were winnowed and 1000 seed weight was taken.

2.8 Disease assessment

Randomly selected ten tillers were tagged from each plot for disease scoring. Disease was recorded from all sample tillers. Starting with the appearance of the first brown leaf spot disease symptoms, tagged tillers within each plot was visually evaluated for percentage foliar infection (severity) at six days interval. A total of five scorings were done from September 21 to October 15, 2015. The effect of disease (severity) on rice variety was integrated into area under disease progress curve (AUDPC). Disease scoring was done by using standard disease rating scale of IRRI (2002) (Table 1). Percentage disease intensity was calculated using the following formula:

$$\text{Disease intensity \%} = \frac{\text{Sum of all numerical ratings} \times 100}{\text{No.of plants observed} \times \text{maximum rating}}$$

Area under disease progress curve (AUDPC) gives a quantitative measure of disease development and intensity of disease (Reynolds and Neher, 1997), and it helps to categorize varieties under different level of resistance. Calculation of the area under disease-progress curve (AUDPC) entails repeated disease assessments. It also summarizes the progress of disease severity along a time period and was estimated using the following formula as given by Campbell and Madden (1990).

$$\text{AUDPC} = \sum_{i=1}^{n-1} (Y_{i+1} + Y_i)\ 0.5\ (T_{i+1} - T_i)$$

Where,

Yi = brown leaf spot disease severity on the i^{th} date

Ti = date on which the disease was scored

n = numbers of dates on which disease was scored

Table 1. Standard disease rating scale

Disease rating	Disease severity	Host response
0	Spots are not present.	Highly resistant (HR)
1	Small brown speaks of pin point size on lower leaves.	Resistant (R)
2	Small roundish necrotic brown spots, about 1-2 mm in diameter, with a distinct brown margin. Spots are mostly focused on lower leaves.	Moderately resistant (MR)
3	Spot type same as in 2, but significant number of spots on the upper leaves.	Moderately susceptible (MS)
4	Typical susceptible brown spot, 3 mm or larger infecting less than 4% of the leaf area.	Moderately susceptible (MS)
5	Typical susceptible brown spot, 3 mm or larger infecting 4-10 % of the leaf area.	Moderately susceptible (MS)
6	Typical susceptible brown spot, 3 mm or larger infecting 11-25 % of the leaf area.	Susceptible (S)

7	Typical susceptible brown spot, 3 mm or larger infecting 26-50% of the leaf area.	Susceptible (S)
8	Typical susceptible brown spot, 3 mm or larger infecting 51-75% of the leaf area.	Highly susceptible (HS)
9	Typical susceptible brown spot, 3 mm or larger infecting more than 75% of the leaf area.	Highly susceptible (HS)

2.10 Statistical analysis

Data entry and processing was carried out using MS-excel 2010 program. The data were processed to fit into MSTATC (Freed and Scott, 1986) software for analysis. DMRT was done at 5% level of significance for mean comparison from the reference of Gomez and Gomez (1984) and was applied to identify the most resistant varieties. Ms-Word was used for report writing.

3. Results and Discussion

3.1 Disease severity (%) and AUDPC on leaves

AUDPC on leaves were calculated as total and per day AUDPC values. The varieties varied significantly in AUDPC values in all 5 observation dates. AUDPC values increased with time of observation in all the varieties. There was highly significant difference among 12 varieties of rice in terms of AUDPC and disease severity %. Highest and lowest values of total AUDPC and AUDPC per day were seen on variety Poonam and Radha-4 i.e. 657.3 and 324 respectively. Varieties Dhanrekha (466.7) and Sarju 52 (466.3) did not differ significantly for mean values of AUDPC and were found to be moderately resistant to brown spot. Also other varieties Sabha (443.3), Motisabha (448) and Golden (447.7) are similar for mean values of AUDPC.

The variation in disease increment might be due to variation in susceptibility of cultivar to the pathogen.

Based on the mean AUDPC values on leaves of the different varieties of rice, a scale of mean AUDPC value was proposed to categorize the cultivars into 5 levels as shown in the table below:

Table 2. Resistant category for twelve different varieties of rice based on mean AUDPC values on leaves

Mean AUDPC Values	Resistant Category	Code
0 – 200	Highly Resistant	HR
201 – 400	Resistant	R
401-600	Moderately Resistant	MR
601-800	Susceptible	S
801- 1000	Highly Susceptible	HS

Table 3. Mean AUDPC values (leaves) on 12 different rice varieties during June to November, 2015 at Paklihawa, Bhairahawa

Treatments	Disease severity (%)	Total AUDPC on Leaves	AUDPC per day on leaves	Resistant Category
1. Sabha	27.85^{DE}	443.3^{BC}	17.732^{BC}	MR
2. Mithila	42.95^{ABC}	648.3^{A}	25.932^{A}	S
3. Dhanrekha	36.92^{BCD}	466.7^{B}	18.668^{B}	MR
4. Motisabha	33.36^{CDE}	448^{BC}	17.92^{BC}	MR
5. Kabeli	24.94^{E}	360.7^{D}	14.428^{D}	R
6. Sarju 52	31.54^{DE}	466.3^{B}	18.652^{B}	MR
7. Sabitri	33.23^{CDE}	429.3^{C}	17.172^{C}	MR
8. Poonam	51.48^{A}	657.3^{A}	26.292^{A}	S
9. Ramdhan	33.37^{CDE}	420.7^{C}	16.828^{C}	MR
10. Radha-4	26.85^{DE}	324^{E}	12.96^{E}	R
11. Sonum	44.80^{AB}	630^{A}	25.2^{A}	S
12. Golden	35.33^{BCD}	447.7^{BC}	17.908^{BC}	MR
SEM (±)	3.014	8.887	0.356	
LSD	8.838	26.07	1.042	
CV %	14.48	3.22	0.128	
Probability	0.0001^{**}	0.000^{**}	0.000^{**}	

AUDPC: Area Under Disease Progress Curve, HR: Highly Resistant, R: Resistant, MR: Moderately Resistant, S: Susceptible, HS: Highly Susceptible, CV: Coefficient of Variation, LSD: Least Significant Difference. Means followed by the same letters in a column are not significantly different by DMRT at 5% level of significance; SEM (±) indicates standard error of mean.

3.2 Test Weight and Total seed yield

Seed yield varied significantly among the cultivars. Maximum seed yield was recorded in Radha-4 (5.42 ton/ha) and lowest mean total yield was recorded in Mithila (2.34 ton/ha). However, the yield of Radha-4 (5.42ton/ha) and Poonam (5.16 ton/ha) did not differ significantly. Maximum test weight was recorded in variety Radha-4 (18.18gm) followed by Sarju 52 (17.76gm) and least was recorded in Sabha (9.397gm). However, test weight of variety Dhanrekha (11.54gm) and variety Motisabha 11.73(gm) did not differ significantly. Similarly, highest biomass yield excluding root was found in variety Sabitri (15.63 tons /ha) and lowest biomass yield was recorded in variety Sabha (10.65 tons /ha). However, biomass yield of Mithila (11.54 tons/ ha) and Dhanrekha (11.63 tons / ha) did not vary significantly.

Table 4. Test weight (gm), Total seed yield (ton/ha), and Biomass yield (ton/ha) on 12 rice varieties during June to November, 2015 at IAAS, Paklihawa, Bhairahawa

Treatments	Grain yield (t/ha)	Test weight (gm)	Biomass (t/ha)
1. Sabha	9.397^{F}	3.773^{BCD}	10.65^{E}
2. Mithila	13.23^{BCD}	2.34^{G}	11.54^{DE}
3. Dhanrekha	11.54^{E}	2.443^{FG}	11.63^{DE}
4. Motisabha	11.73^{E}	2.747^{EFG}	12.16^{BCDE}
5. Kabeli	12.20^{DE}	4.54^{AB}	14.09^{ABC}
6. Sarju 52	17.76^{A}	3.357^{CDEF}	12.01^{CDE}
7. Sabitri	12.77^{CDE}	3.457^{CDE}	15.63^{A}
8. Poonam	12.38^{DE}	5.16^{A}	14.28^{AB}
9. Ramdhan	14.21^{B}	3.467^{CDE}	14.13^{ABC}
10. Radha-4	18.18^{A}	5.42^{A}	14.57^{A}
11. Sonum	12.63^{CDE}	3.92^{BC}	13.62^{ABCD}
12. Golden	13.73^{BC}	2.81^{DEFG}	14.95^{A}
SEM (±)	0.3979	0.319	0.6678
LSD	1.167	0.9103	1.959
CV %	5.18	17.48	8.72
Probability	0.0000^{**}	0.0000^{**}	0.0003^{**}

CV: Coefficient of Variation, LSD: Least Significant Difference. Means followed by the same letters in a column are not significantly different by DMRT at 5% level of significance; SEM (±) indicates standard error of mean.

3.3 Regression Analysis

Total AUDPC and Economic yield

There was a highly significant (P≤0.05), negative, linear relationship between mean total AUDPC of leaves to economic yield (ton/ha). According to the coefficient of determination, about 2.8% variation in mean value of economic yield (ton/ha) was due to total AUDPC on leaves and remaining portion was due to other factors. Similar result was found by Aluko *et.*, al. (1992) on screening of rice genotypes against Brown spot.

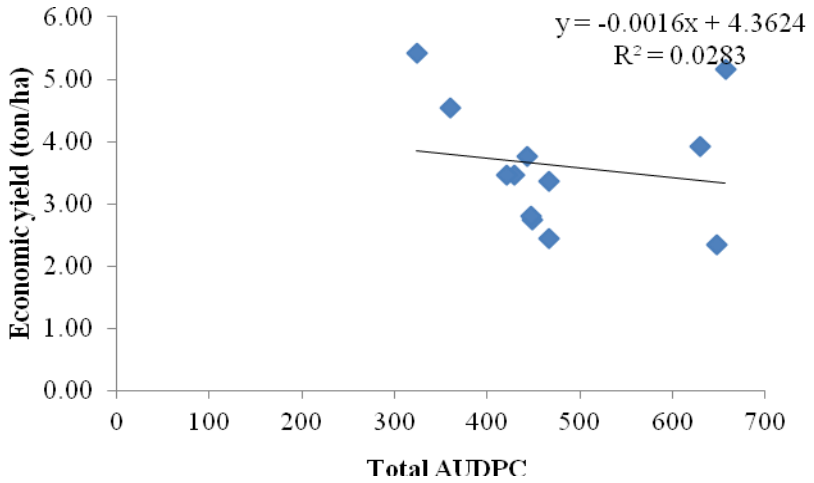

Figure 1: Estimated linear relationship between mean values of Total AUDPC on leaves and economic yield (gm) of 12 varieties of rice at IAAS, Paklihawa, Bhairahawa, 2015

Total AUDPC and Test weight

There was a highly significant (P≤0.05), negative, linear relationship between mean total AUDPC of leaves to test weight (gm). According to the coefficient of determination, about 7% variation in mean value of test weight (gm) was due to total AUDPC on leaves and remaining portion was due to other abiotic factors. Similar result was found by Chen *et. al.* (2012) on control of stripe rust of winter wheat with foliar fungicide.

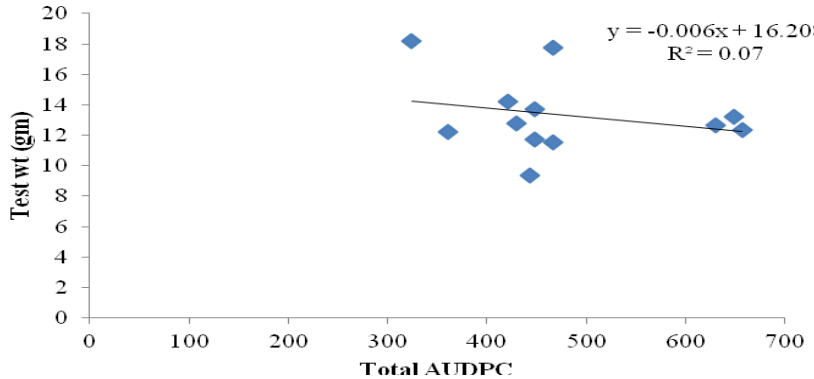

Figure 2: Estimated linear relationship between mean values of Total AUDPC on leaves and test weight (gm) of 12 varieties of rice at IAAS, Paklihawa, Bhairahawa, 2015

4. Summary

Poonam variety also showed the maximum disease severity of 51.47% and kabeli had the lowest disease severity of 24.94%. From analysis of variance it was found that there was highly significant difference in both grain yield and test weight for 12 different varieties. Economic yield of varieties ranged from 2.210 to 5.420 ton/ha .Highest economic yield was found in radha-4 (5.420 ton/ha) and lowest in Mithila (2.23 ton/ha). The AUDPC value showed that Radha-4(324) was the resistant variety followed by kabeli (360.7). Poonam (657.3) was the susceptible variety of rice followed by Mithila (648.3) and Sonam (630). Similarly radha-4 was the variety with highest test weight of 18.18gm and lowest test weight of 9.397 was observed in Sabhamansuli.

5. Conclusion

Among the 12 varieties screened, Poonam , Mithila and Sonam were found to be susceptible to brown spot but Poonam being a susceptible variety didn't show considerable yield loss in comparison to Mithila and Sonam .So Poonam can be regarded as a tolerant variety of rice towards brown spot disease. Also Radha -4 and Kabeli were found to be resistant in reference to the disease severity and yield. Hence Radha -4 variety of rice can be recommended for cultivation under the climatic condition of Rupandehi district.

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