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SCREENING LOWLAND RICE VARIETIES FOR RESISTANCE TO BROWN SPOT DISEASE IN ENYONG CREEK RICE FIELD IN AKWA IBOM STATE OF NIGERIA

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ABSTRACT

Twelve lowland rice varieties (BG 90-2, Cisadane, FARO 12, FARO 15 (early maturing), FARO 15 (late maturing), IR 5, ITA 123, ITA 306, MAS 2401, Suakoko 8 and TOS 2578) were planted in 2008 and 2009 growing seasons in Enyong creek rice field in Akwa Ibom State. The varieties were screened for resistance to brown spot disease under natural infection conditions. Disease severity was assessed by counting the total number of spots per plant and by measuring the diameter of the spots. Data were collected at 6, 9 and 12 weeks after transplanting. Using number of spots per plant as parameter for assessing brown spot severity, results showed that ITA 123 and Suakoko 8 recorded the lowest number of spots and Cisadane and IR 5, the highest. Taking size of spots per plant as another parameter, the smallest spots were observed in ITA 123 and Suakoko 8 and the largest in ITA 212 and IR 5. Evaluation of resistance of the varieties showed that of the twelve varieties screened, two (ITA 123 and Suakoko 8) representing 16.67% were resistant, three (ITA 306, ITA 212 and BG 90-2) or 25.00% were moderately susceptible, six (FARO 15 (early maturing), TOS 2578, MAS 2401, FARO 12, FARO 15 (late maturing) and IR 5 or 50.00% were susceptible and one (Cisadane) or 8.33% was highly susceptible. No variety was found to be highly resistant, that is, completely free of spots. The two resistant varieties,ITA 123 and suakoko 8, are recommended to rice farmers in this agroecology.

KEY WORDS: Screening, Rice Varieties, Resistance, Brown Spot, Enyong Creek.

INTRODUCTION

Enyong creek is a major lowland rice-producing area in Akwa Ibom State of Nigeria. The large scale cultivation of lowland rice in the creek dates back to the 1970's. Since then, low incidences of brown spot disease of the crop have been recorded but without any effort by the resource-poor rice farmers in the area to control it (Personal communication, Enyong creek rice farmers). In the past thirty years, there has been a gradual build up of inoculum load in the creek resulting in the devastation of rice crop by the disease lately.

There are twelve lowland rice varieties currently cultivated in the creek. Regrettably, no work has been done previously in the area to evaluate these varieties for their reaction to brown spot. This presents to the farmers the problem of choosing appropriate varieties for production purposes. The problem could have been averted if the varieties had been screened for their reaction to the disease and resistant varieties recommended to farmers.

Brown spot has been reported in all rice growing areas of the world (Ou, 1985; Mehrotra and Aggarwal, 2003; IRRI, 2009). The disease affects seedings in the nursery as well as mature plants in the field (Baruah *et. al.,* 1980; Zadoks, 2002). Symptoms of the disease appear on the coleoptiles, leaf sheaths, and the glumes but occur most commonly on the leaf blades (Zadoks, 2002; Mehrotra and Aggarwal, 2003). The development of the disease is favoured by temperature of 25-30^{0}C, relative humidity of more than 90% and high doses of nitrogen (Ou, 1985; Zadoks, 2002).

Brown spot causes both quantitative and qualitative losses (IRRI, 2009). These losses result from poor germination of infected seeds since the pathogen, *Bipolaris oryzae* may be seed borne (Mehrotra and Aggarwal, 2003). Besides, infection of the leaves reportedly results in the reduction of the effective leaf area for photosynthesis while attack on the grains accounts for loss in the weight of grains ranging from 4.6 – 29.0% (Mehrotra and Aggarwal, 2003). In Bengal (India), outbreak of the disease in 1942 is reported to have recorded losses in yield of 50-90%, resulting in the death of two million people (Pandmanobhan, 1973; Zadoks, 2002, Mehrotra and Aggarwal, 2003). In Florida (United States of America), brown spot is one of the most important rice diseases recording yield losses of 16-40% (Datnoff and Lentini, 2003). Savary *et. al.* (2000) reported that brown spot accounts for 5% yield loss in all lowland rice production in South and Southeast Asia.

There are many specific methods of brown spot control. These include proper crop nutrition, avoidance of water stress, the use of disease-free seeds for planting and fungicidal spray (Moletti *et. al.,* 2000; Zadoks, 2002; Mew and Gonzales, 2002; Cortesi and Guiditta, 2003; Mandal and Jha, 2008). Be as it may, the use of resistant varieties represents the most economical means of controlling the disease (Mew and Gonzales, 2002; Zadoks, 2002). The economic value of resistant plants is equated with the saved costs of fungicides, time and labour (Gustafon, 1984). The

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practice is also compatible with other disease control measures in an integrated control approach (IITA, 1987).

Considerable differences exist in susceptibility to brown spot among rice varieties (Datnoff and Lentini, 2003), indicating the need to evaluate proven varieties for their reaction to the disease in the various agroecological rice zones of Nigeria. The results of this study will assist the rice farmer in his choice of lowland rice varieties for planting. The objective of this study was to identify resistant rice varieties to brown spot in Enyong creek for recommendation to rice farmers in the area.

MATERIALS AND METHODS

Location of study area

The field experiment was conducted at Enyong creek rice field (Lat. 5^0 03' - 5^0 27'N and Long. 7^0 39' - 7^0 56'E) at the northern part of Akwa Ibom State in southeastern Nigeria. The mean annual rainfall in this area is about 2000mm and falls between March and November with peaks in bimodal (July and September) pattern. The mean relative humidity is 78% and mean diurnal temperature is 30^0C (NAKSRDP, 1994; Okoji, 1995).

Soil Analysis

Soil samples were collected at a depth of 0 - 15cm from the experimental field before planting in each year. Representative samples of the soil were analysed and results were obtained for the different parameters using appropriate methods.

Source of rice seeds

Seed samples of lowland rice varieties were obtained from Enyong creek rice field. The varieties were BG 90-2, Cisadane, FARO 12, FARO 15 (early maturing), FARO 15 (late maturing), and IR 5. Others included ITA 123, ITA 212, ITA 306, MAS 2401, Suakoko 8 and TOS 2578.

Nursery raising

Twelve nursery beds, each 2m x 1m and 0.1m high were prepared on the nursery site. A path 0.5m wide separated one bed from the other. Nursery planting took place in June of two consecutive years, 2008 and 2009. Some viable seeds weighing 0.1kg of each rice variety were broadcast in the nursery bed assigned to the variety. The nursery beds were thereafter covered with a light much to obscure the planted seeds from birds and rodents and observed daily for germination of the seeds.

Experimental Design

The field experiment was laid out in a randomized complete block (RCB) design and each treatment was replicated four times. The size of the experimental field was 23.5m x 7.5m and consisted of 48 plots each of which measured 1.5m x 1.5m. Sampling for assessment of disease severity was carried out in a sampling area of 1.2m x 0.9m per plot.

Field transplanting

Field transplanting took place in July of each year, at which time the seedlings were four weeks old in the nursery, 25-35cm tall and had developed 4-5 leaves. Transplanting was carried out in rows at a spacing of 30cm between rows and 30cm within rows using a forked stick. A table of random numbers was used to assign the rice varieties to the plots. Two seedlings were planted per hill giving a plant population in each plot of 50 plants per variety. The seedlings were left to grow to maturity and observed for natural development of brown spot disease symptoms. Weeding was by hand pulling and was done twice in each growing season.

Disease assessment

Twenty plants of each rice variety were randomly selected from a sampling area 1.2m x 0.9m or 1.08m^2 in the middle of each plot and tagged, and the following parameters were observed and recorded: (i) number of spots per plant, obtained by counting the total number of spots per plant and obtaining the mean for each variety (ii) size of spots per plant, obtained by measuring the diameter of each spot at its widest portion using a transparent ruler. Ten randomly chosen spots on each tagged plant were measured and the mean obtained. Data on both number and size of spots were collected at 6, 9 and 12 weeks after transplanting.

STATISTICAL ANALYSIS

Field data obtained from the study were subjected to analysis of variance (ANOVA) and means were separated and compared using Fischer's least significant difference (F - LSD) test at 5% probability level.

RESULTS

Soil Analytical Results

The physical and chemical properties of the soil of the experimental field are given in Table 1. The soil consisted of high percentage of clay and was identified as clay soil. The pH (H_20) of the soil was fairly acidic and the organic matter content was relatively high. Total nitrogen content of the soil for each year was considered low but was in conformity with the range (0.02 – 1.16%) given by Moormann (1980) for soils of Southern Nigeria. The soil had low concentration of exchangeable bases. The exchangeable acidity was relatively high and this impacted on the percentage base saturation causing it to be high.

Table 1: Physical and chemical properties of soil of the experimental field

Soil properties	2008	2009
Physical properties		
Sand (%)	13.60	13.50
Slit (%)	24.10	24.30
Clay (%)	62.30	62.20
Textural class	Clay	Clay
Chemical properties		
pH (H_2O)	4.23	4.14
Organic matter (%)	3.35	3.35
Total N	0.14	0.06
Available P (mg/kg)	6.18	6.16
Ca (meq/100g)	2.55	2.50
Mg (meq/100g)	1.28	1.30
K (meq/100g)	0.09	0.09
Na (meq/100g)	0.07	0.06
Exchangeable acidity (meq/100g)	3.35	3.32
ECEC (meq/100g)	7.34	7.27

Disease Assessment

Table 2 shows the variability in resistance among the twelve lowland rice varieties. Evaluation of resistance was based on disease severity using the rank-sum method. Using number of spots per plant as parameter for assessing disease severity, two varieties ITA 123 (4.25) and Suakoko 8 (10.10) recorded the lowest number of spots/plant among the varieties tested. Number of spots/plant for the above varieties were significantly ($p \leq 0.05$) lower than values recorded for TOS 2578 (98.32), FARO 15 (early maturing) (97.86), BG 90-2 (65.25), ITA 212 (32.50), and ITA 306 (26.68). However, the highest number of spots/plant were observed in Cisadane (151.88), IR 5 (132.25), FARO 15 (late maturing) (123.75), FARO 12 (121.63) and MAS 2401 (112.50).

Using size of spots per plant as another parameter, the smallest lesion per plant was recorded in ITA 123 (1.89mm), Suakoko 8 (2.42mm), ITA 306 (2.54mm), FARO 12 (2.58mm), FARO 15 (early maturing) (2.67mm) and Cisadane (2.84mm), therefore, spot sizes increased from 3.08mm to 3.55mm as observed in TOS 2578 (3.08mm) MAS 2401 (3.16mm) and BG 90 – 2 (3.55mm). The largest spot sizes were recorded in ITA 212 (7.65mm), IR 5 (6.00mm) and FARO 15 (late maturing) (5.68mm) (Table 2).

Of the twelve varieties evaluated, two varieties (ITA 123 and Suakoko 8) were resistant to brown spot disease representing 16.67% of the total number of varieties screened; three (ITA 306, ITA 212 and BG 90-2) or 25.00% were moderately susceptible, six (FARO 15(S), TOS 2578 MAS 2401, FARO 12, FARO 15(L) and IR 5) or 50% were susceptible and one variety (Cisadane) or 8.33% was highly susceptible to brown spot (Fig. 1). No variety was found to be highly resistant to brown spot disease that is, completely free of spots.

Table 2: Evaluation of lowland rice varieties for resistance to brown spot disease

Varieties	Ns	D_N	Ss	Ds	R	Grd.
ITA 123	4.25	- 77.16	1.89	- 1.78	- 78.94	RS
Suakoko 8	10.10	- 71.31	2.42	- 1.25	- 72.56	RS
ITA 306	26.68	- 54.73	2.54	- 1.13	- 55.86	MS
ITA 212	32.50	- 48.91	7.65	3.98	- 44.93	MS
BG 90 - 2	65.25	- 16.16	3.55	- 0.12	- 16.28	MS
FARO 15 (E)*	97.86	16.45	2.67	- 1.00	15.45	SS
TOS 2578	98.32	16.91	3.08	- 0.59	16.32	SS
MAS 2401	112.50	31.09	3.16	- 0.57	30.52	SS
FARO 12	121.63	40.22	2.58	- 1.09	39.13	SS
FARO 15 (L)**	123.75	42.34	5.68	2.01	44.35	SS
IR 5	132.25	50.84	6.00	2.33	53.17	SS
Cisadane	151.88	70.47	2.84	- 0.83	69.64	HS
Grand mean	81.41		3.67			
LSD(0.05)	3.18		0.15			

* = early maturing
** = late maturing
Ns = mean no. of spots/plant; D_N = deviation from grand mean of no. of spots/plant; Ss = mean size of spots/plant; Ds = deviation from grand mean of size of spots/plant; R = rank – sum for each variety; Grd = susceptibility grading using rank-sum: RS = resistant, MS = moderately susceptible, SS = susceptible, HS = highly susceptible.

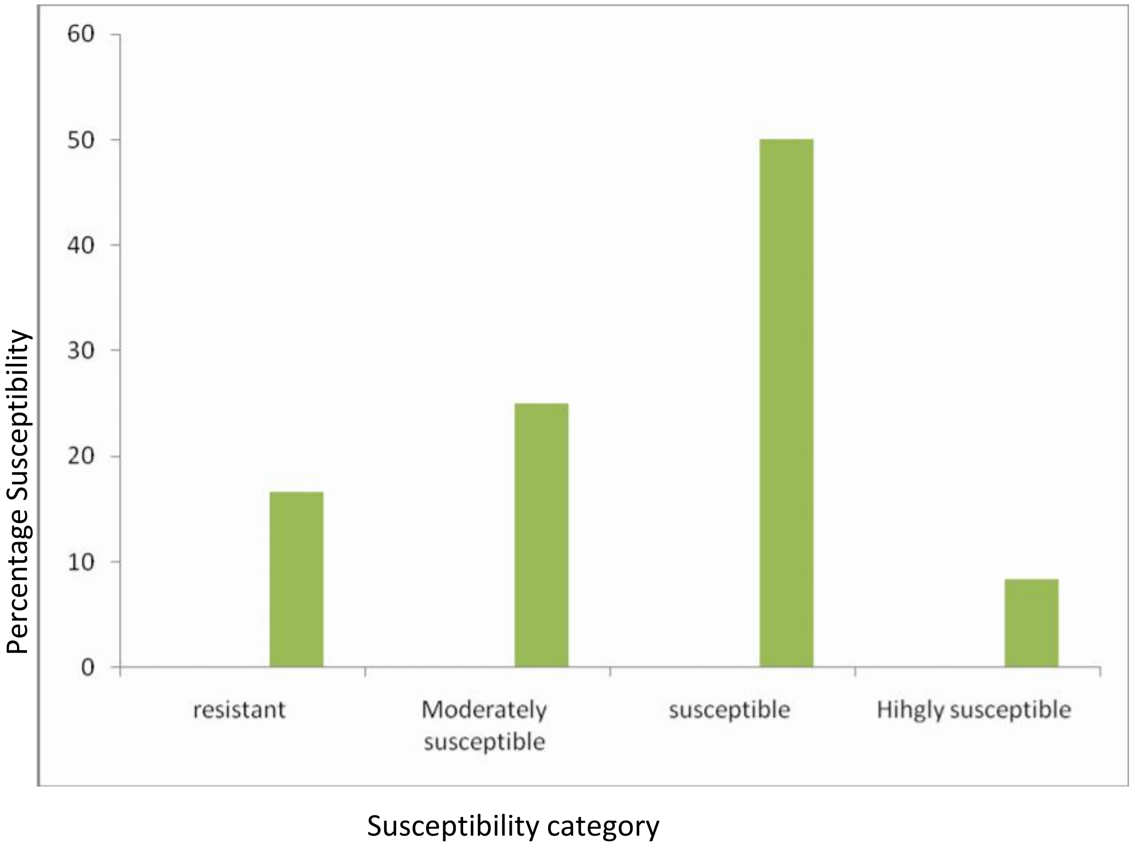

Fig. 1: Resistance variability among lowland rice varieties in Enyong creek rice field

Resistant: ITA 123 and Suakoko 8
Moderately susceptible: ITA 306, ITA 212 and BG 90 – 2
Susceptible: FARO 15(E), TOS 2578, MAS 2401, FARO 12, FARO 15(L) and IR 5
Highly susceptible: Cisadane.

DISCUSSION

Spots on the screened rice varieties consisted of dead tissues and were most commonly seen on the leaves. Their presence, according to Kranz *et. al.,* (1978), could reduce the leaf area of the plant, which in turn could affect the photosynthetic activities of the rice plant. Webster and Gunnell (1992) reported that spots may range in size from 5-14mm in brown spot susceptible rice varieties. Therefore, the spot sizes of 5.68 – 7.65mm observed in susceptible varieties in this study were within the range given by the source cited above. Spots on FARO 15 (late maturing) (5.68mm), IR 5 (6.00mm) and ITA 212 (7.65mm) were larger than those on other susceptible varieties. The relatively large spots observed on these varieties may have affected the respiratory activity of the plant by producing changes in the physical and chemical equilibrium of the protoplasm (Kranz *et. al.,* 1978). This could result in a reduction in growth and yield of the affected plant. It is therefore advantageous to screen for varieties that are low in number and size of spots. This is because the lower the number and size of spots, the lower the extent of disruptions in the physiological activities of the plant (Owolade *et. al.,* 2005).

Size of spots on the resistant rice varieties in this work ranged from 1.89 – 2.42mm. This finding is at variance with IRRI's (2009) report that spots on resistant varieties are pinhead sized. Differences in varietal susceptibility to brown spot have been reported by Datnoff and Lentini (2003). These differences suggest the presence of genetic diversity within the germplasm hence the need to evaluate proven varieties for their reaction to the disease. Evaluation of the twelve rice varieties using a modified rank-sum method of Kang (1988) showed that ITA 123 and Suakoko 8 were resistant to brown spot. This result is a departure from the report by Sato *et al.,* (2008) that no major genes with resistance to brown spot have been known and that only rice varieties with partial resistance have been identified.

Field observation of the two resistant lowland rice varieties revealed that they had other desirable agronomic qualities. ITA 123 was short-statured, early maturing and high tillering while Suakoko 8 was stiff – strawed, resistant to lodging and produced long plump grains. MAS 2401 is the most widely cultivated variety in the creek. Besides being susceptible to brown spot, the variety was found to be long maturing (24 weeks) and very tall hence highly prone to lodging. ITA 123 and Suakoko 8 which showed resistance to brown spot disease are recommended to rice farmers in Enyong creek of Akwa Ibom State.

CONCLUSION

Results of this study show that two lowland rice varities, ITA 123 and Suakoko 8 recorded the lowest number of spots/plant and the smallest spot size/plant. On the contrary, Cisadane variety, gave the highest number of spots/plant while ITA 212 recorded the largest spot size/plant. Curiously, MAS 2401, easily the most widely cultivated variety in the creek did not fare better both in number and size of spots. Results further show that of the twelve lowland rice varieties currently cultivated in Enyong creek rice field, more than two-thirds of them showed different levels of susceptibility to brown spot. This result indicates that brown spot is an important disease of lowland rice in the creek. It is hereby recommended to rice farmers in Enyong creek that ITA 123 and Suakoko 8 should replace all other varieties cultivated in the creek as from the next planting season for greater economic return for the farmer.

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