USE OF SOME FUNGICIDES IN THE MANAGEMENT OF INFECTION LEVELS OF BLAST ON RICE VARIETIES PLANTED AT DIFFERENT DATES ON YIELD

***E. A. Maji and E. D. Imolehin.**
Department of Research Operations, Rice Research Programme
National Cereals Research Institute, Badeggi PMB 8, Bida Niger State.
*Corresponding author's e-mail: adejoh_ojone@yahoo.com

Abstract

Separate assessments were carried out to determine the effects of fungicide usage, varieties and planting date, on rice blast disease, caused by *Pyricularia grisea* (Cooke) sacc, [= *Magnaporthe grisea* (Hebert) Barr] in the hydromorphic upland site, Badeggi Niger State Nigeria. The four rice varieties were Faros 53, 54, 55, and 56. The results showed that Faro 55 was moderately resistant to leaf and neck blast, with the lowest percentage unfilled grains per panicle. Faro 53 reacted moderately susceptible to neck blast. Faro 54 was moderately susceptible to leaf and neck blast, while Faro 56 showed a highly susceptible reaction to both leaf and neck blast, and a 31% plants population death due to the blast disease. With respect to planning dates (May 16, June 4 and July 22), plants sown in June had the highest leaf blast severity, neck blast incidence, and the lowest yield. Seven fungicides (four are recommended for use in rice in Nigeria : flusilazol, difenoconazole, difenokonazole+propikonazole, and carbendazim (6.2%) + mancozeb (73..8%) and three generally used ones (menefoxam (4%0 + mancozeb (64%), chlorothalonyl, and metalaxyl) which were evaluated against the rice blast disease, showed that the recommended fungicides for use in rice, were more effective in suppressing blast and protecting yield, compared to the other fungicides.

KEYWORDS: AUNDPC, Field trial, Rice blast, Pyricularia grisea, Susceptibility, Resistance

Introduction

Rice blast, caused by the fungus *Pyricularia grisea* (Cooke) Sacc. [= *Magnapothe grisea* (Hebert) Barr} is one of the most devastating disease of rice (Oryza sativa L.) worldwide. In Nigeria, the disease has been reported causing severe damage to plant in many parts of the country. Significant losses of 1,781 ha, 1084 ha, 624 ha, 395 ha, and 200 ha due to severe infection of blast were recorded in the States of Jigawa, Kano, Nassarawa, Ebonyi, Niger and Sokoto, respectively (Maji and Imolehin, 2003). There is a tendency that the disease has become increasingly important, reflected by the most recent data indicating that 10,604 ha and 11,929 ha of rice field throughout the country were damaged by blast in 2009 and 2010, respectively (Maji and Imolehin, 2010).

Blast can infect most parts of the plant: leaf, collar, node, internodes, neck and other panicle, but rarely infect leaf sheath (IRRI 2010). Blast infection can cause yield loss up to 80%, depending on inoculums pressure, crop growth stage at infection, prevailing climate conditions, varietal susceptibility, and cultural practices (Groth, 2006; Prabhu et al., 2006). Environment with frequent and prolonged dew period and with cool temperature in the day time are most favourable to blast, especially in upland and rain-fed environments in the tropics and subtropics (IRR, 2010). Besides that, lack of flooding during planting season also predisposes plants to blast infection (Lee et al., 2003; Singh et al., 2004).

Rice cultivars have different reactions to blast disease, ranging from susceptible to resistant. However, very few rice cultivars available currently are resistant to the disease. Recently, the disease has been reported infecting newly released highly-yielding cultivars are mildly resistant to leaf blast but more susceptible to head blast (Tangdiabang & Pakki, 2006).

Early planting date can help susceptible cultivars escape from severe infection of leaf blast but can be infected by head blast at the onset of panicles. However, if susceptible cultivars are planted later in the season, the plants can be severely infected by both leaf and head blight. When epidemic starts early, in late sown plantings plant growth and development are severely affected, resulting in death of many plants (Filippi & Prabu, 1997). Fungicides have been used effectively to control blast but the effectiveness of particular fungicides could vary from place to place or season to season. Farmers are advised to rotate the fungicides used to prevent the fungus from developing resistance against those fungicides (Tangdiabang & Pakki, 2006: Maji and Shaibu, 2012). Therefore, information about effective fungicides with different modes of action should be available to farmers.

In order to achieve an effective and

sustainable control of the blast disease, a management strategy integrating the use of resistant cultivar, appropriate planting date, and fungicide must be developed. Therefore, the objectives of the current study were to determine: 1) the response of four rice cultivars to the leaf and neck blast severities and percent of unfilled grains; 2) the effects of three different planting periods on the leaf and neck blast severities and crop yield; and 3) the effect of seven fungicide formulations on the leaf and neck blast severities and crop yield.

Materials and Methods

Blast infection on Four Rice Varieties

A field survey was conducted to assess leaf blast severity and neck blast incidence on four rice varieties: Faros 53, 54, 55 and 56. The varieties were chosen because they comprised of approximately 70% of rice plantation in the study site at the time of the survey. The study was conducted from July to September 2012 in farmer's fields in the States of Niger, Nassarawa, Kano and Sokoto. The study site was an upland ecology about 40 ha of rice plantation encompassing four villages: Sabo daga, Barki sale, Bagauda lake and Gidan alaji. In each village, four fields individually planted with each of the four cultivars, with about the same age of 25 to 35 days after planting (DAP), were selected for disease observation. Field sizes ranged from 0.25 to 0.5 ha. The villages were as replications in this study. None of those farmers applied fungicides, but they applied insecticides to control other pests such a rice leafhopper and stem borers.

To assess leaf blast severity (LBS), twenty rice hills in each field were randomly selected from central rows of the field. Six tillers per hill and four fully expanded leaves on each tiller were observed to assess leaf blast severity. Leaf blast was evaluated three times, on 30, 37, and 44 DAP. Percentages of diseased leaf area were estimated visually (Bonman et al., 1991). These percentage values were then subjected to the formula below to assess the area under disease progress curve (AUDPC) (Shaner & Finney, 1977). Varietal reactions to leaf blast was determine using Standard Evaluation System (SES) Scales, 0-9 (where 0= no lesion development and 9=all leaves dead). A cultivars was classified as resistant (R) when the ranking was from 0 to 2 (i.e. no symptoms to non-sporulation), moderately susceptible (MR) with ranking from 3 to 4 (small lesion surrounded by necrosis with little sporulation), moderately susceptible (MS) with ranking from 4 to 5 (typical spindle- shaped lesions, 3 mm or larger, sporulation heavily), and susceptible (S) with it ranked from 5 to 9 (more than 25% leaf area covered by spores to dead leaf) (Chaudary, 2001; Maji and Imolehin, 1995).

Neck blast incidence (NBI) was

scored seven days before harvested by randomly observation 200 panicles per variety in each location. Percent of neck blast was determined by counting the number of panicles showing severe neck blast symptoms (scores from 7 to 9) (IRRI, 2011) for each cultivars. Percent with neck blast was calculated using the formula below (Greer & Webster, 2001): NBI= A/B ×100%

Where, A= the number of panicles with severe neck blast (scores from 7 to9); B= the number of panicles observed for each cultivars per location (200 panicles). Based on

the blast incidence, cultivars or lines were classified as resistant (R) with 0-15%; moderately resistant (MR) with 15.1-30%; moderately susceptible (MS) with 30.1-50%; or susceptible (S) with 50.1-100% (Puri et al., 2009).

Planting Date Effect

A field experience was conducted to determine the effect of planting date on leaf blast severity and neck blast incidence. Rice var. Faro 56, a susceptible cultivar was planted at three different dates: May 16, June 4 and July 22 2012. No fungicide was applied on the experimental site. Fertilizers were applied in accordance with the local recommendations. Insecticides were applied as necessary, mainly to control leafhoppers and stem borers. Planting date treatments were arranged in a completely randomized design with seven replications. Each replication consisted of a plot with ten rows wide and 15 m long, and planting space of 25 × 25 cm. there was a bare space of 1.5 m between plot s. the experimental plots were surrounded by farmers field with rice var. Faro 56, which were heavily infected by blast. Leaf blast severity was scored on 30, 37 and 44 DAP for each planting date treatment. The percentages of disease leaf area were visually estimated on 20 randomly selected hills per plot, which were then subjected to AUDPC assessment formula (Nasruddin and Amin, 2012).

Neck blast severity was evaluated seven days before harvest by random observation of 100 panicles per plot, while percentage neck blast evaluation was determined by counting the number of panicles showing neck blast symptoms with scoring 7 to 9, among the 100 sample plants in each plot.

Fungicide Effect

A field experiment was conducted to determine the effect of fungicide applications on LBS, NBI, and rice yield. Seedlings Faro 56 were planted on June 1, 2012 and fertilizers were applied following local recommendations. Insecticides were also applied as necessary to control leafhoppers and stem borers. Treatment consisted of seven fungicides and their application rates in accordance with recommendations by the manufacturer. Fungicide applications were conducted on 35 and 49 DAP, using hand sprayers. Fungicide treatments consisted of seven formulations (Table 1) and were arranged in a randomized complete block design with three replications. Each replication consisted of a plot with eight rows, 10m long, a planting space of 20 ×20 cm, and a bare space of 1.5m between plots. The experimental plots were surrounded by farmer's plantations with 30 DAP old of Faro 56, which were heavily infected by leaf blast. Leaf blast severity was scored at 42, 49, and 56 days after transplanting. Percentage diseased leaf area was visually estimated on 20 randomly selected hills per plot for AUDPC estimation using formula by (Shaner & Finney, 1977).

Table 1. Fungicides with manufacturers, active ingredients, and dosage rates) used in the study

Fungicides	Manufacturer	Active ingredient	Dosage rate
Nustar 400 EC	Dupont Indonesia	Flusilazol	0.6 ml
Score 250 EC	PT. Syngenta Indonesia	Difenokonazole	1.0 ml
Arytop 300 SC	Dupont Indonesia	Difenokonazole +Propikonazole	0.8ml
Delsen MX-80 WP	PT. Syngenta Indonesia	Carbendazim (6.2%)+ mancozed (78.8%)	2.0g
Ridomil 14/64 WG	PT. johny Jaya makmur	menefoxam (4%)+mancozeb (64%)	5.0g
Wendry 75 WP	PT. Multi Sarana Indotani	Chlorothalonyl	1.5g
Starmyl 25 WP	PT. Multi Sarana Indotani	Metalaxyl	0.8g

Dosage rate per liter of water; Recommended for use in rice. Other fungicides tested were for experimental purpose only.

Neck blast severity was scored seven days before harvest, by randomly observing 100 panicles per plot. For neck blast evaluation, while percentage neck blast was determined by counting the number of panicles showing neck blast symptoms among 100 sample plants in each plot using the formula by (Greer & Webster, 2001).

Crop yield was assessed by randomly collecting 50 panicles per plot at harvest time. The panicles were dried under the sun for three days (about 20h) before the grain were removed from panicles. Grain weight and the number of unfilled grains per panicles were then determined.

Statistical Analysis

Analysis of variance (ANOVA) was used to determine the effects of cultivar, planting date, or fungicides on LBS or NBI. For the fungicide and planting date trials, ANOVA was also performed to determine the effects of fungicide on the yield. The percent data were arcsine-transformed before being subjected to ANOVA. When significant differences were detected, mean were separated using Tukey's test at 5% probability level.

Results and Discussion

Blast Infection on Four Rice Varieties

Under field conditions with abundant inoculums sources and without fungicides applications, leaf blast severity, NBI, and percent of unfilled grains were significantly affected by cultivar (Table2). Average AUDPC on Faro 56 was significantly higher, followed by Faro 54, Faro 53, and Faro 55. Based on leaf blast scoring, the varieties: Faro 55 and Faro 53, Faro 54, Faro 56 can respectively be described as moderately resistant, moderately susceptible, and completely susceptible. Varieties reactions to neck blast were similar to their reaction to leaf blast, except Faro 53 that reacted as moderately susceptible to neck blast. The percentages of unfilled grains were significantly lower on Faro 54 and Faro 53 compared to Faro 56 but still significantly higher than Faro 55. Thirty one percent of plant population in the Faro 56 plots died due to the disease, while no plants died in plots of other varieties.

Table 2. Reactions of four rice varieties: Faro 56, Faro 54, Faro 53, and Faro 55 to blast,

Expressed as values of AUDPC, NBI, and percentage unfilled grains

Leaf blast		**Neck blast**		
Rice Varieties	AUDPC (% day)	Average Score/ Reaction	Percent incidence /Reaction	Percent of unfilled grains
Faro 56	727.8a	6.0/S	73.0a/S	64.5a
Faro 54	56.3b	4.1/MS	43.3b/MS	31.4b
Faro 53	30.2c	2.3/MR	30.0bc/MS	22.3b
Faro 55	14.3c	2.5/MR	21.0c/MR	13.6c

Numbers in same column followed by same letters are not significantly different (P=0.05, Tukey's test). Percent data arcsine–transformed, before being subjected to ANOVA Plant reactions: S=susceptible, MS =moderately susceptible, MR= moderately resistant, R=resistant.

The experiment site was a rain-fed area, about 10 m above sea level. The area had experienced severe blast incidence for the last two years prior to initiation of the study, but the disease had never before been reported as causing serious damage in the area. Our results indicate that the problem might stem from the introduction of a highly susceptible rice variety, Faro 56, which was introduced to the area four years before the study was conducted (Nasruddin and Amin, 2012). Since its introduction it had become popular among farmers because of its high-yielding potential, and the fact that about 50% of the area was planted with the variety at the time of the study. Before the introduction of Faro 56, most farmers planted Faro 55, Faro 54, and Faro 53. The current study results show that Faro 55 and Faro 53 are moderately resistant and Faro 54 is moderately susceptible to blast. These cultivars have been planted for many years in the experimental area without serious damage by blast. They seemed to have partial resistance, controlled by multiple genes, against the diseases, offering more stable form of resistance (Monosalva etal., 2009). However, the results also showed relatively high neck blast incidence and percent unfilled grains which might be caused by the intense pressure of inoculum coming from the Faro 56 plants . The Faro 55 is categorized as moderately resistant against the best disease (Nasruddin and Amin, 2012) but there is no previous information available about how Faro 53, Faro 54, and Faro 56 react to blast disease.

Planting Period Effect (May 16, June 4 and July 22)

Planting date treatment effects were significant for all traits measured in the experiment (Table 3). Total AUDPC values for the three observation dates showed that plants transplanted on June 4 had significantly higher infection rate and percent unfilled grains compared with those planted six week earlier (May 16) or six weeks later (July 22). There were no significant differences in AUDPC values and NBI between plants planted in June 4 and July 16. However, percent empty grains were significantly lower than the other planting periods. Average weight of filled grains was the highest on the plants planted in May, followed by July, and then June. No significant differences in the yield weight between plants transplanted on May and July but they were significantly higher than those planted in June.

Table 3. Average of AUDPC, NBI, and percentage unfilled grains of Faro 56 planted at different planting period

Planting date	Total AUDPC (% day)	Percent of neck blast	Percentage of unfilled grains	Yield (mg/10 panicles)
15 May 2012	107a	21a	21b	1,340b
1 June 2012	311b	48b	49c	880a
16 July 2012	198b	10a	5a	1,224b

Numbers in same column followed by same letters are not significantly different (P=0.05, Turkey's test) percent data were arcsine-transformed before being subjected to ANOVA.

Similarly, planting period treatments affected AUDPC values for each of the three observations (Table 3).

Fungicides Effect

Effects of different fungicide formulations on LBS are presented in Tables 3 and 4. On all observation dates,flusilazol, difenoconazole, difenoconazole+propiconazole, and carbendazim 6.2%+mancozeb 64% consistently showed lower AUDPC values compared to the other treatments. These were followed by menefoxam 4%+mancozeb 64%, chlorothalonyl, and metalaxyl whose AUDPC values were not significantly different from each other but significantly lower than the untreated control.

Table 4. Average AUDPC values of leaf blast for fungicides treatments on 42, and 56 DAP

Fungicide	Dosage (ml/liter of Water)	AUDPC values (%day) of LB			
		42 DAP	49 DAP	56 DAP	TOTAL
Fluilazol	0.6	43.3c	11.3c	0.9 c	55.5c
Difenoconazole	1.0	51.1c	9.3c	1.0c	61.4c
Difenokonazole+propikonazole	0.8	52.2c	13.9c	3.8c	69.9c
Carbendazim+mancozeb	2.0	50.4c	32.3c	3.7c	86.4c
Menefoxam+mancozeb	5.0	122.6b	62.9b	35.0b	250.8b
Chlorothalonyl	1.5	112.1b	83.9b	44.3b	240.3b
Metalaxyl	0.8	137.4ab	61.5b	57.1b	256.0b
Control	-	156.1a	253.2a	259.0a	668.3a

Numbers in same column followed by same letter are not significantly different (P=0.05,Turkey's test).

For the NBI, percentage unfilled grains, and weight of filled grains were significantly affected by the fungicide formulations (Table 5). Flusilazol, difenoconazole, and difenoconazole+propiconazole were effective in suppressing NBI and percentage unfilled grains. In this experiment, carbendazim 6.2%+mancozeb 64% was less effective in controlling neck blast than leaf blast. All fungicide treatments had higher yield than the control treatment. The highest yield were obtained from plants treated with flusilazol, difenoconnazole, and difenoconazole+propiconazole; followed by carbendazim 6.2%+manefoxam 4%+mancozeb 64%,metalaxyl, and chlorothalonyl.

Table 5. Neck blast incidence (NBI), percentage unfilled grain weight per 10 panicles for all fungicide treatments

Fungicide	Rate (ml/liter of water)	NBI	Percent of unfilled grains/panicle	Grain weight/10 panicles (mg)
Flusilazol	0.6	9.3c	5.0c	1,450a
Difenoconazole	1.0	13.3c	6.2c	1,325a
Difenokonazole+propikonazole	0.8	15.9c	4.2c	1,510a
Carbendazim+mancozeb	2.0	44.8b	46.7b	843b
Menefoxam+mancozeb	5.0	57.1b	51.0b	650c
Chlorothalonyl	1.5	44.4b	48.6b	575c
Metalaxyl	0.8	40.0b	50.0b	725c
Control	-	94.0a	82.0a	320d

Numbers in same column following by same letters are not significantly different (P=0.05, Turkey's test). Percent date were arcsine transformed before being subjected to ANOVA.

In this study flusilazol, difenoconazole, difenoconazole+-propiconazole, and carbendazim 6.2%)+manacozeb 64% was less effective in controlling neck blast incidence and showed lower yield compared to flusilazol, difenoconazole, and difenoconazole+propiconazole (Nasruddin and Amin, 2012).

The yield of plants treated with flusilazol, difenoconazole and difenoconazole+propiconazole were 4.5,4.1 and 4.7 times higher than yield of the untreated plants, respectively. Fungicides with the active ingredients of difenoconazole and difenoconazole+propiconazole were effective in suppressing the blast disease (Ghazanfar et al., 2009).

Conclusion

These results demonstrated that Faro 55 was moderately resistant to leaf and neck blasts, with Faro Faro 53 being moderately resistant to leaf blast but moderately susceptible to neck blast, and without fungicide application, up to 31% of the plants died due to the disease. Planting early in the season when inoculums source was low and planting late in the season when humidity was low helped plants escape serious damages due to blast infection.

Planting in the middle of the season predisposed plant to severe infection, because of the availability of abundant inoculums sources and high humidity levels in the experimental area. It can be concluded that when planting circumstances warrant fungicide use, flusilazol, difenoconazole, difeoconazole+propiconazole, and carbendazim 6.2%+mancozeb 64% should be used alternately to suppress the disease and to prevent or at least slow down the pathogen from developing resistance against those fungicides.

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