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Research article

Relative efficiency of some chemical fungicides used for the control of rice blast (*Magnaporthe oryzae* b. Cauch) in Jigawa State, Nigeria

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Abstract

Rice blast is a worldwide problem in rice and is dangerous because of its yield loss potential ranging up to 100% under favorable conditions. The disease is generally considered the most important worldwide disease in all the rice growing regions of the world and has been reported in more than 102 countries across the globe. The aim of this research was to determine the relative efficiency of Five fungicides used for the control of rice blast viz., Z-force (Mancozeb 80% WP), Dress force (Imidacloprid 20%, Metalaxyl-M 20% and Tebuconazole 2%), Seed care (Imidacloprid 10%, Thiram 10% WS), Blast force (Isoprothiolane 40% WP) and Hexacal (50g Hexaconazole per liter) under *in-vivo* conditions. The experiment was conducted in pots and laid out in Completely Randomized Design (CRD) design with 3 replications, 5 treatments and control. During the research, it was observed that low incidence of disease (ID) was recorded in all the five fungicides (treatments) used compared with control pots which record highest percent disease incidence of rice blast disease. This connotes that all the five fungicides were effective in the control of rice blast *in-vivo.*

Keywords; Fungicides; Incidence of Disease; *In-vivo;* Rice Blast

Introduction

It is beyond any reasonable doubt that Rice (*Oryza sativa* L.*)* ranks first among its counterparts cereal food crops in the world, both in terms of land area put to cultivation and its economic importance for, it is a food crop that feeds more than two third of the world population (FAO, 2017; 2018). Over three billion people on earth are fed by rice for which reason it acquired so many names. Long ago, NRC (2013) reported that Rice has the potential to improve nutrition as it supply almost 60% of the dietary energy and protein derived from plants boost food security, foster rural development and support sustainable land care. Demand for rice is expected to be increasing continuously in the coming years, at least up until 2035. According to a comprehensive study conducted by the Food and Agricultural Policy Research Institute (FAPRI), the world's demand for milled rice can be expected to rise to 496 million tons in 2020, from 439 million tons in 2010 (FAO, 2017; FAO, 2018).

In Nigerian context, the Federal Govt. had since 2018 banned the importation of rice into the country. Nigerians now have to increase rice production to meet the demands of the country's teeming population of over 200 million persons (FAO, 2018; Hadiza *et al*., 2022). However, rice is a special crop as it does not thrive in many agricultural fields. It does best in swamp, Wet lands or waterlogged soils free from biotic and abiotic stresses. This has actually made its production a little bit difficult. And even in areas where it is produced under irrigation in northern Nigeria, the crop suffers from the emergence of some deadly diseases (Hadiza *et al*., 2022) which if not properly checked, may reduce the production of this crop commercially. One major disease reported on rice in Jigawa state of Nigeria is rice blast which was found to be associated with other diseases in the area notably sheath blight, spot and others (Hadiza *et al.*, 2022). Although there seem to be no any report of this nature from Kano and Katsina states, some pockets of the pathogens might be there in isolated cases or has not been exploited yet from these areas.

Rice blast is a worldwide problem in rice and is dangerous because of its yield loss potential ranging up to 100% under favorable conditions (Luo *et al.,* 1998; Kato *et al.,* 2007). The disease is generally considered the most important worldwide disease in all the rice growing regions of the world and has been reported in more than 85 countries. It is also the most important fungal disease in both upland and lowland rice (Bonman, 1991; Mae *et al*., 1997).

Blast can infect rice from the seedling stage through maturity and can cause complete loss of seedling in seedbed and epidemic in the field. Infection results in lesions on most of the plant including leaves, leaf collar, stems, and nodes, internodal parts of culms, panicles and grain. Although *Pycularia oryzae* infect all foliar tissues, infection of the panicle can lead to complete loss of grain. The disease may also called leaf blast, collar rot, node blast panicle blast or rotten neck blast depending on the portion of the rice plant infected (Nguyen *et al*., 1997). Symptoms develop on all above ground plant parts. Lesions or spots are the most common symptom, which are usually 1-1.5 cm long and 0.3-0.5 cm wide (NCR, 2013).

Rice blast epidemics are often more severe in temperate and sub-tropical ecosystems, especially when effective management strategies are not implemented (Bhat *et al.,* 2013). Losses due to blast include severe reductions in yield, milling, and the cost of applying fungicides. Unlike most rice diseases blast is very explosive and can completely destroy a crop in a very short time (Kirubakaram *et al*., 2009). The severity of the damage depends on the part of the plant affected and on the cultivar. Leaf infection reduces photosynthetic area and may eventually result in plant death. Panicle infection reduces yield and therefore this involves important economic losses (Dewar, 1993).

Blast epidemics are mainly dependent on climatic conditions, crop management practices, such as nitrogen inputs or water supply, and cultivar susceptibility (Fukai *et al*., 1999). Although nutrition plays a vital role in the control of diseases, some farming practices may cause nutrition imbalances resulting to disease development (Kamoshita *et al*., 2000). In the same vein, it was earlier reported that excess nitrogen encourages disease and this enhances the increase of inoculums levels (Kutama *et al*., 2013). On the contrary Fukai *et al*. (1999) and Price *et al*. (2002) observed that low nitrogen also led to disease increase resulting from weak plants that lacked sufficient defense against disease. The aim of this study is to assess the relative efficiency of some commonly used fungicides in the control of rice blast disease *in-vivo*.

Materials and Methods

Experimental site

The experiment was conducted at Biological garden, Federal University Dutse, Jigawa state, during 2021 rainy season in completely randomized design (CRD) design with 3 replications and 5 treatments and control to evaluate different fungicide effects against rice blast disease under field condition using pot experiment.

Pot preparation;

The soil used was sterilized clay-loam soil, size of the pot used was 30cm length and 17cm breadth plastic pot. The pots were filled with the soil mixture after creating a small hole at the bottom of the pot to allow passage of water so as to minimize water logging and allow air passage. The pots were watered and allowed to stand for a day before transplanting of the rice seedling.

Experimental Design

The experiment was set up in a Completely Randomized Design (CRD) with three replications and control. The experiment was conducted to test the efficacy of five fungicides (Z-force (Mancozeb 80% WP), Dress force (Imidacloprid 20%, Metalaxyl-M 20% and Tebuconazole 2%), Seed care (Imidacloprid 10%, Thiram 10% WS), Blast force (Isoprothiolane 40% WP) and Hexacal (50g Hexaconazole per liter) as treatment against rice blast pathogen, for each treatment; there were three different concentrations with three replications and one control. The pots were arranged as each treatment per row with its control making a total of 50 pots.

Transplanting of Rice Seedling

Twenty five days old seedlings of an improved high yielding rice variety FARO 44 (Sippi) commonly known as Jamila in Hausa were transplanted as two seedlings per pot. Irrigation was used throughout the experiment as a water supply to the plants two times daily for proper growth and development (Hadiza *et al*., 2020).

Inoculation of test organism (*P. oryzae)* Foliar inoculation

Inoculation of pathogen was carried out at one week after transplanting (1WAT) of the seedling, spores suspensions were made in sterilized distilled water. The spore concentration was adjusted to 10^6 spores per ml with use of Haemocytometer. The seedlings were inoculated with *Pyricularia oryzae* by the use of hand sprayer and two times sprays were made for effective inoculation.

Agronomic practice

The agronomic practices were followed as per package of practices for raising the crop (Singh *et al.,* 2019). NPK (20:10:10) fertilizer at 60kg per hectare were applied at 1.5 gram per pot, and weed were control by direct removing as it appears (George, 1997, Kumar *et al*., 2014).

Application of Fungicides

The different fungicides tested are listed in Table 1 below. Total of two (2) sprays were given, first at appearance of the disease as prophylactic spray and second at two weeks after the first spray, the control pots were sprayed using normal water.

Data Collection

The following data were collected at 2 weeks after second spray of the fungicides (treatments). The data includes Incidence (%) of the disease (ID), Height of the plant, Number of leaves and Number of panicle/spikes

Determination of Disease Parameters

Incidence of Disease

The observations on occurrence of leaf blast were recorded as percent incidence of disease (ID) at two weeks after the second or final spray (2WAFS) by using 0-9 scale as given by IRRI (1996).

Height of the plant

Plant heights were measured using a meter rule. The measurements were taken at two weeks after the final spray (2WAFS) of the fungicides (treatments). Height was measured by holding a meter stick (ruler) from the bottom to the tip of the tallest rice plant. This is done by gently grabbing all the rice plant in the pot with single hand, and carefully raising the plant up to determine the tallest leaf from the plants in the pot. The ruler is then placed on the soil surface close to the rice plant and the measurement of the tallest rice plant in the pot was taken. The record of the tallest plant was measured from each pot and the average was calculated from three replication of all the fungicides concentration.

Number of leaves

The number of leaves of the plants found in each pot was counted at two weeks after final spray of the treatment fungicides. All the leaves of each plant in a pot were counted and the average was calculated from the three replication of all the fungicides concentration.

Number of panicle/spike

Number of panicle/spikes of the plants found in each pot was counted at two weeks after the final spray of the fungicides. To achieve this, the entire rice plants in the pot are held in position with one hand and the number of spikes produced by the plants was counted. The record of the number was recorded on the data sheet, and the average was calculated from the three replication of all the different fungicides concentration.

Table 1: List of fungicides used in the experiment

Treatment	Chemical name	Trade name	Concentration applied
T1	Mancozeb 80% WP.	Z- force	C1(10000) C2(1000) C3(100)
T2	Imidacloprid 20% + Metalaxyl-M 20% + Tebuconazole 2% WS	Drees force	C1(10000) C2(1000) C3(100)
T3	Imidacloprid 10% + Thiram 10% WS	Seed care	C1(10000) C2(1000) C3(100)
T4	Isoprothiolane	Blast force	C1(10000), C2(1000), C3(100)
T5	50g Hexaconazole per litre	Hexacal	C1(10000), C2(1000), C3(100)

Data analysis

The data were analyzed using one way Analysis of Variance (ANOVA) and the means were separated using LSD and Duncan multiple range test at 5% probability level.

Results

In – vivo efficacy of different fungicides against Rice Blast disease caused by *Magnaporthe oryzae*

The result showed that, the highest percent disease intensity was recorded on the control plants (65.5%, 64.72%, 58.42%, 79.35% and 62.47%), followed by the T_4 (blast force) at 100ppm in which 40.91% were recorded. The lowest percent disease intensity were recorded at 10,000ppm of treatment two T_2 (Imidacloprid 20%+ Metalaxyl-M 20% + Tebuconazole 2% WS) was 11.22%, treatment one $T_{1=}$ Z-force (Mancozeb), as 12.35%, treatment three T_3= Seed care (Imidacloprid 10% + Thiram 10% WS) was 15.97%, respectively, (Table 4.5.1). The lowest significant difference was 5.681% at 5% level

Table 2: Efficacy of different fungicides on percent disease intensity (PDI) of rice blast disease

Treatments/Fungicides	Concentrations of the fungicides (part per milions/ppm)			
	100	1000	10000	Control
T_1 = Z- force	29.48	19.71	12.35	65.50
T_2 = Dress force	31.20	15.97	11.22	64.72
T_3 = Seed care	31.87	16.37	12.53	58.42
T_4 = Blast force	40.91	22.31	15.97	79.35
T_5 = Hexacal	30.37	21.40	20.80	62.47
LSD	5.681			

The results in Table 3 showed that, the highest plant height was 121cm and were recorded at concentration of 1000ppm of treatment two T_2= Dress force (Imidacloprid 20%+ Metalaxyl-M 20% + Tebuconazole 2% WS), followed by the T_4= Blast force (Isoprothiolane 40% WP) at 10,000ppm conc. Where the control plants recorded lower plant height (77.3cm, 85.0cm, 71.7cm, 71.0cm and 70.3cm). The lowest plant height was 63.9cm were recordedat 100ppm concentration of treatment five T_5= Hexacal (50g Hexaconazole per litre). In treatment one $T_{1=}$ Z-force (Mancozeb), and treatment three T_3= Seed care (Imidacloprid 10% + Thiram 10% WS) showed that there was no any statistical differences in plant height among the three different concentrations (Table 6).

Table 3: Effect of different fungicides on plant height

Treatments/Fungicides	Concentrations of the fungicides at part per milions/ppm			
	100	1000	10000	Control
T_1 = Z- force	81.00	86.60	84.60	77.30
T_2 = Dress force	87.00	121.30	95.50	85.00
T_3 = Seed care	84.00	95.80	94.20	71.70
T_4 = Blast force	87.70	92.80	107.20	71.0
T_5 = Hexacal	63.90	88.20	95.80	70.30
LSD	23.52			

Table 4 below showed that there was a significant difference on the number of leaves produced by the plant in each pot. The highest number of leaves 42 and 38 was produced by T2 (Dress force) and T4 (Blast force) at 10000ppm, the lowest number of leaves were produced in the control pots of T5 (Hexacal) with 12 leaves and T1 (Z- force) which has average of 15 leaves and the T3 (Seed care) with 16 leaves, respectively.

Table 4: Effects of different fungicides on the number of leaves produced by plants per pot

Treatments/Fungicides	Concentrations of the fungicides at part per millions/ppm			
	100	1000	10000	Control
T_1 = Z- force	18.00bc	23.00b	27.67b	14.67c
T_2 = Dress force	22.67b	27.67b	42.00a	20.00bc
T_3 = Seed care	17.67bc	23.67b	30.00b	16.00c
T_4 = Blast force	28.67b	34.67ab	38.00a	21.33bc
T_5 = Hexacal	22.33b	27.00b	31.67b	12.00c
LSD	6.605			

Means with the same alphabet in a column are significantly different according to Duncan Multiple range test

The result from Table 5 showed that, there were significant difference at 5% level of significance on the average number of panicle/spikes produce by the fungicides treated plants at different concentration and control plant which produce the least number of spikes.

Table 5: Efficacy of different Fungicides on the number of spikes produce by the rice per pot.

Treatments/Fungicides	Concentrations of the fungicides at part per milions/ppm			
	100	1000	10000	Control
T_1 = Z- force	3.33	9.00	8.67	1.00
T_2 = Dress force	5.67	7.67	10.00	3.33
T_3 = Seed care	6.33	7.00	10.33	1.67
T_4 = Blast force	4.33	7.67	10.67	3.33
T_5 = Hexacal	3.67	7.67	10.33	2.33
LSD	1.997			

Means with the same alphabet in a column are significantly different according to Duncan Multiple range test.

Discussion

In – vivo effect of different fungicides against Rice Blast disease caused by *Magnaporthe oryzae*

Effect of different fungicides on percent disease intensity (PDI) of rice blast disease

The experiment showed that, low percent disease incidence (PDI) were recorded in all the five (5) different fungicides (treatments) used compared control pots which record higher percent disease intensity of rice blast disease. Also, there was a significant difference in the percent disease incidence among the different fungicides (Table 4.) compared to untreated plots all the chemicals studied effectively controlled the disease. The control efficiency was to the tune of 40 to 84 per cent in different treatments. The right times of application coupled with the use of effective chemical able to check the growth of fungus were the reason for control. The data supports the findings of Rohilla and Singh (1999).

Chemical evaluation against control of blight revealed that from time to time and place to place, different chemicals has given good response for controlling the disease. Jamaluddin *et al.* (2012) found that Thiophanate methyl and Dibutyl Phthalate had given better control of disease under Haryana conditions. In endemic situations like ponnampet, Coorg district, Karnataka seed treatment with Pyroquilon and Tricyclozole were effective in controlling seedling blast in nursery. On the contrary, the incidence of neck blast was very high and was to the tune of 82.5 per cent in the control plot. Different chemicals treated plots varied in checking the disease. Among the ruling fungicides, Tilt 25 EC applied plots did not show its effectiveness on the disease as it controlled only 5 percent in comparison to control. The plots of new formulation chemicals effectively controlled the neck blast disease also compared to ruling fungicides. Between two chemicals Nativo 75WG 0.4g once again showed significant control of this disease (77.8 %) over other chemicals. The results corroborate the findings of Jamal Uddin *et al.* (2012).

Effect of different fungicides on plant height

Plant height is an agronomic trait which can be used as good indicators during disease screening test as it can be used to determine the level of resistance in rice plant. It is also responsible for final reduction in grain yield (Bonman *et al*., 1991). In a research conducted by Jamaludden *et al*. (2012), it was reported that plant height showed positive and highly significant correlation reproductive trait of wheat (*Triticum aestivum*) as it influences photosynthesis which could bring about changes in grain yield.

Effects of different fungicides on the number of leaves produced by plants per pot

The table on the average mean of number of leaves showed that there is significant difference at 0.05 level of significance between the treatments (fungicides) concentration and the control. This finding suggest that, the control plant produce the least number leaves due to the impact of the rice blast pathogen (*M. oryzae*) which used to effect and reduce the leaf production by causing more damage on the plant compared to the treated plant. This report was line with findings of Singh *et al*. (1986) who suggested that, commonly used management\ method to deal with rice blast disease are fungicides. All the treatments evaluated under field condition showed significant differences in blast disease reduction and yield parameters. This collaborates with work of Abdullahi *et al.* (2021). The results are supported by the work of Rossman et al. (1990) who reported that application of Tebuconazole 50% + Trifloxystrobin 25% (WG) was found most effective in controlling leaf blast as it controlled to the extent of 84 per cent compared to control.

Effect of different Fungicides on the number of spikes produced by the rice per pot.

The result from the Table 5, showed that, there were significant difference at 5% level of significance on the average number of panicle/spikes produce by the fungicides treated plants at different concentration and control plant which produce the least number of spikes. This findings report that, the control plants would produce a very low yield hence it has least or no spikes produced as the yield component. All the treatments evaluated under pot condition showed significant differences in blast disease reduction as well as healthy panicle (spike) production, and it has higher grain yield. Among the treatments used in the experiment treatment T_2 (dress force) which consist of fungicides combination of Imidacloprid 20% + Metalaxyl-M 20% + Tebuconazole 2% (WS) at 10,000ppm conc. produced the higher number of spikes, this indicate that, it will produce higher yield.The result was supported by the work of (Mohan *et al*., 2011 and Nirmalkar *et al*., 2017) who’s reported that, tebuconazole 50% + trifloxystrobin 25% (WG) and tebuconazole 25.9% (EC) were found most effective against the leaf and neck blast of paddy rice under field condition as it showed significant difference in blast disease reduction and grain yield.

Conclusion

The study showed that all the five fungicides used were effective in the control of rice blast. However, of all the five fungicides used in the study, Dress force showed the highest efficiency at all concentrations, hence can be used to effectively manage the diseases in the field

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