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Occurrence of Rice Blast disease caused by *Magnaporthe oryzae* B.Cauch in Jigawa State, Nigeria

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Abstract
The aim of this research was to determine the presence of rice blast disease in the three major rice producing Local Government Areas of Jigawa state (Hadejia, Kaugama and Auyo) in 2020 (Rainy and Dry seasons) with the object of determining the incidence; distribution and severity of the disease. The survey was conducted two times; rainy season and dry season during which at least fifty one (51) rice fields (replicated two times) and selected purposively, were surveyed in each season for blast symptoms. Results of the survey have shown that the disease occurred at varying disease incidences (%) and severities. The disease symptoms appeared more on rice cultivated in Kaugama (16.3%) than in both Auyo (12.6%) and Hadejia (12.5%) Local Government Areas and more in the dry season than in the rainy season thus indicating a significant difference (p<0.05) in the study areas and across the seasons. However, careful observation on the agronomic practices in the three study areas have shown that about 50 % of the fields surveyed in Kaugama were weedy, poorly fertilized, waterlogged and with other disease symptoms such as blight and spots. This might have been the reason for the relatively higher incidence and severity of the disease in Kaugama rice fields. Farmers should be informed of the danger of abandoning rice fields to become bushy as this might cause the disease to escalate to an uncontrollable stage.

Keywords; rice blast, incidence, severity, survey, Jigawa state

INTRODUCTION

Of the different cereal staple crops grown across the world, Rice (*Oryza sativa* L.) ranks first both in terms of land area put to cultivation and its economic importance as it is a food crop that feeds more than two third of the world population. Over three billion people on earth are fed by rice for which reason it acquired so many names. Long ago, NRC (1996) 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). Asian countries are the most rice producers worldwide while countries in Africa, Latin America, and the Middle East have shown considerable increase in rice consumption and demand. The top producers of rice in 2017 are India, China, Indonesia, Bangladesh and Thailand with total production of 43.2, 30.35, 12.16, 12.00 and 9.65 millions of hectares respectively (FAO, 2017).

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During its cycle, rice is affected by so many diseases that reduce the productivity and quality of the grains. More than 80 diseases of rice caused by different pathogens, including fungi, bacteria, virus and nematodes, were registered in the literature, in different countries (Tsedaley *et al*., 2016; Filippi and Prabhu., 2006). Major Rice diseases include, Rice ragged stunt, Sheath Blight, Rice Blast and Tungro (Obilo *et al*., 2012). Diseases of rice are the most important factors that tremendously reduce the crop yield production and quality. The rice crop in Nigeria is affected by many diseases. Many fungal pathogens attack on the rice plant at different stages of its growth, some of them causing diseases at seedling stage, at flowering while some are in epidemic form. Rice blast is one of the most devastating diseases that can cause high grain yield losses in farmers field (Ashtiani *et al*., 2012 and Charles *et al*., 2015).It is fungal disease caused by *Magnaporthe oryzae B.Cauch (*anamorph*: Pyricularia oryzae* cavara) (Couch *et al*., 2005,Cauch & Kohn, 2002). It belongs to family *Magnaporthaceae:* order *Mangnaporthales*: class *Sordariomycetes:* phylum, Ascomycota and kingdom, fungi.

Many interacting environmental factors were responsible for the high yield losses due to blast as up to 80% have been recorded in some rice fields (Idowu *et al*., 2013) and usually occur when the environmental conditions are optimum and favor the pathogen, that is high relative humidity (85% and above), high or excessive nitrogen fertilizer application, presence of dew and drought stress, human cultural practices which have direct impact on disease epidemic situation and many other factors.

In Nigeria, rice blast disease was first recorded in Port Harcourt (River state) in 1956 (Awoderu *et al*., 1972) and later in Badeggi (Niger state) in 1958 and Irrua in 1963. Since then blast has been reported whenever and wherever rice is grown. However, there is no any report of the status of this disease in any part of the rice producing parts of Jigawa state. It is also a common knowledge that the Federal Government of Nigeria has banned the importation of rice into the country. With this therefore, more acreages are put to rice cultivation both irrigated and rain fed. According to the American Plant Health Instructor (2007), rice blast has never been eliminated from a region in which rice is grown, and a single change in the way in which rice is grown or in the way resistance genes are deployed can result in significant disease losses even after years of successful management. Jigawa state is one of the largest rice producing state in northern Nigeria. Also, millions of people in Nigeria and the world over depend on rice as a staple food. A crop failure, for any reason, poses a real threat of starvation. This disease is a model that demonstrates the seriousness, elusiveness, and longevity of some plant diseases. Therefore, there is need to investigate on the most important rice disease; the blast in order to obtain base line information on the status of rice blast disease in Jigawa state with the aim of preventing its epidemy. Therefore the aim of this study was to determine the incidence, distribution and severity of rice blast disease in Jigawa state.

MATERIAL AND METHODS

The survey

Rice fields with symptoms of rice blast and related diseases were surveyed in Jigawa State in three local government areas where rice is grown or cultivated, during the year 2020 dry season (irrigation scheme) as well as wet/rainy season. The study area is located in the northern part of Nigeria, and it is among largest rice producing state of the country. Jigawa state is located at coordinates: 12^{o}00′N9^{o}45′E. The state is situated in the Sudan Savannah region of Nigeria. The survey covered the important rice growing areas under irrigation within Jigawa state Viz; Auyo, Hadejia and Kaugama L.G.As. However, another the survey was conducted during the rain-fed/wet season which also covered thess important areas of

Rice cultivation in the state, the field were selected using purposive (non probability) simple random design.

Sampling/sampling technique

Fifty (50) rice fields replicated two times were visited / selected randomly for the survey, using purposive sampling (non probability) technique described by Kutama *et al.* (2010a & b) in each of the three local government areas under study. The survey was done in the form of "N" pattern, i.e from one angle through the centre end of the field to the subsequent upper angle. In each field, 50 rice plants were observed thoroughly for the symptoms of blast. Similarly, other disease symptoms were investigated on each farmer's field visited (Kutama *et al*., 2014; Bhaskar *et al*., 2018).

Disease Incidence

The percent disease incidence (%) for each selected rice farm and or field was calculated out from each selected rice field. Percentage disease incidence (PDI) was determined using the following formula as demonstrated by Yasin *et al.* (2018).

$$PDI=\frac{Total\ Number\ of\ Plants}{Number\ of\ Plants\ Examined}\ X100$$

Disease Severity

The severity of the disease was estimated by checking the proportion of infection on the Rice plant observed in each selected plant in the field to assess the severity of Blast disease per plant. The severity rating was determined using 1-11 disease rating scale as suggested by Kutama *et al*. (2013), thus;

1 = no visible symptoms
2 = 1-10% leaf areas covered
3 = 11-20% leaf areas covered
4 = 21-30% leaf areas covered
5= 31-40-% leaf areas covered
6= 41-50-% leaf areas covered
7= 51-60-% leaf areas covered
8= 61-70-% leaf areas covered
9= 71-80-% leaf areas covered
10= 81-90-% leaf areas covered
11= 91-100-% leaf areas covered
5 = >50% leaf areas covered with necrotic lesions.

Severity grades were converted into Percentage Severity Index (PSI) for analysis using the formula suggested by Warren and Nicholson (1975):

$$PSI=\frac{Snr}{Npr \times Mss} \times 100$$

Where;
Snr = sum of numerical rating
Npr = number of plants rated
Mss = maximum severity scale of rice blast

The disease symptoms on the leaves and panicles were taken into considerations during the assessment.

Farm Practices and agricultural status of the farm

During the survey, some routine farm practices and agricultural status of the farm were determined which included; farm size estimate of the farm, soil status (whether weeded or weedy), soil texture, fertilizer application status and presence of other disease symptoms or pests.

Data analysis

The field survey data for rice blast disease (incidence and severity) were analyzed using ANOVA and the results were interpreted. Mean disease incidence and severity of each rice field surveyed were used to make quantitative comparison between the two seasons among the three locations of the surveyed areas. The agronomic practices and other disease symptoms data were used for the correlation analysis.

RESULTS

Survey

The result of the survey conducted in the three rice producing local government areas of jigawa state showed that Rice blast disease was present only in some of the fields. From the results it is clear that the percentage of the disease incidence (%) and severity (%) were low in the surveyed areas and in both the two seasons. The highest disease incidence in dry season was (16.3%) recorded from Kaugama, and the highest mean percentage disease incidence discovered in the wet season was recorded at Hadejia with 10.1% disease incidence (Table 1).

Table 1: Mean Disease Incidence of Rice Blast Disease (%) of Jigawa State in Dry and Wet season, 2020.

Treatment (season)	% Disease Incidence in Dry and Wet season within the three locations		
	Auyo	Hadejia	Kaugama
Dry	12.6	12.5[a]	16.3[a]
Wet	9.4	10.1[b]	9.4[b]
LSD	**4.36**	**2.39**	**2.34**

However, the disease incidence in the three areas of rice production of Jigawa state was within a range of 9.0% and 17.0% which shows that the disease has not reached an epiphytotic stage but it is still spreading as it was found in all the local government areas visited.

On the other hand, the highest percentage disease severity (32.9) was recorded at Kaugama, and the lowest percentage disease severity (18.4 and 18.8) was also recorded at Auyo and Kaugama, respectively (Table 2).

Table 2: Mean percent Disease Severity (%) of Rice Blast Disease of Jigawa State in Dry and Wet season, 2020.

Treatment (season)	% Disease Severity in Dry and Wet season within the three local Govt.		
	Auyo	Hadejia	Kaugama
Dry	25.3[a]	24.4	32.9[a]
Wet	18.4[b]	20.2	18.8[b]
LSD	**4.36**	**4.66**	**4.67**

Farm Practices, agricultural status of the farm and presence of other diseases

The results of the survey have shown that rice was grown on clay –loam/ clay soils in most of the farmers' fields surveyed, and that on very few of the fields was rice grown on sandy-loam soils. Table 3 and Table 4; showed the average percentage of fields with clay loam soil types and that of sandy loam soils types of the surveyed locations during the dry and wet season.

In the same vein, the results of this survey showed that there was less effort by the farmers toward weeds management as observed in different farmers' fields of the surveyed areas. During the dry season survey about 30% of the farmers' fields in Auyo local government were weedy; and 70% were weeded, very clean. However, in Hadejia, 52% of the rice fields surveyed were weedy and 48% were weeded. Similarly, (64%) of farmers' fields in Kaugama were weedy and (36%) were weeded as shown in Table 3. However, during the wet season survey about (48%) of the farmers' fields in Auyo local government were weedy; and (52%) were weeded, in Hadejia (54%) of the rice fields were weedy and (46%) were weeded, likewise (56%) of farmers' fields in Kaugama were weedy and (44%) of the rice fields were weeded (Table 4).

Table 3: nature of Soil, weed. And fertilizer status of the surveyed rice fields in dry season (irrigation schemes) of Jigawa state, 2020.

Soil, weed and fertilizer status	Number of fields observed in Local Govt. areas:		
	Auyo	Hadejia	Kaugama
Clay loam soil	80%	74%	68%
Sandy-loam soil	20%	26%	32%
Clean weeded, fertilized and water logged	26	17	10
Bushy. Yellow plants and water logged	10	16	12
Weeded, Yellow plants and partially water logged	09	07	08
Bushy, Yellow plants and partially water logged	05	10	20
Total No. of fields surveyed	50	50	50

Table 4: Farm Practices and agricultural status of the surveyed rice fields in dry season (Rainy season) of Jigawa state, 2020.

Agronomic practice	Number of field per local Govt. area		
	Auyo	Hadejia	Kaugama
Clay loam	80%	74%	68%
Sandy-loam	20%	26%	32%
Weeded, fertilized and water logged	22	20	20
Bushy, Yellow plants and water logged	22	22	25
Weeded, unfertilized and partially water logged	04	03	02
Bushy, Yellow plants and partially water logged	02	05	03
Total No. of fields surveyed	50	50	50

The results showed that about 80% of farmers' rice fields in Auyo local government were clay-loam soils and 20% of the fields have sandy-loam soil type. In Hadejia local government, 74% of the rice fields were clay- loam and 26% of the fields were sandy-loam, while in Kaugama local government clay- loam soils covered 68% of the famer's fields and 32% of the fields were sandy-loam soil type, respectively.
The results of the survey in Tables 5 and 6 have shown that diseases such as Sheath blight (32.50%), Rust & Blight (18.70%) and Wilting & Yellowish (13.30%) were highly prevalent on both rice and weeds around the fields surveyed.

Table 5: Other disease symptoms present in the Rice fields surveyed during dry season irrigation, 2020

Other diseases symptom	**Number of field per locations**		
	Auyo	**Hadejia**	**Kaugama**
Sheath blight	10	18	20

Wilting and Yellowish / Yellow leaves	06	06	08
Rust and Blight	06	10	12
No Disease	17	05	04
Pest (nematodes)	11	11	06

Table 6: Other disease symptoms present in the Rice fields surveyed during wet season (rain fed) 2020

Other diseases symptom	Number of field per locations		
	Auyo	Hadejia	Kaugama
Sheath blight	10	10	11
Wilting and Yellowish / Yellow leaves	07	11	10
Rust and Blight	10	15	17
No Disease	19	10	07
Pest (nematodes)	04	04	05

DISCUSSION

The Survey

The study comprised of a comprehensive survey of the occurrence of rice blast disease in three major rice producing local govt. areas of Jigawa state. The result on the occurrence of this disease in the rice producing areas was not very high and this might be due to so many interacting factors of the disease epidemiology. Example, the seed or rice cultivar grown in the three areas was predominantly the FARO44, or common variety called ***Jamila*** in Hausa because of their high yielding potentials. However, these varieties were highly susceptible to rice blast. Sometimes continues use of even resistant variety may lead to the existence of rice blast in the resistant variety not to talk of susceptible variety. This is contained in the reports of Zhou *et al*. (2007) and Joa˜o and Nunes (2011) that the evolution of the pathogen, resulting in the emergence of new variants/races, makes those resistant cultivars, carrying resistance genes without specificity against the new types, become susceptible to blast. This is a common event in rice cultivars and depends largely on how much the newly released resistant cultivars are adopted by farmers, and come to occupy major proportions of areas of a given region, state or country. This process is known as breakdown in cultivar resistance. This means, most rice cultivars are susceptible to rice blast diseases including the so called resistant varieties.

Many of the fields visited showed very low or no symptoms of the blast disease. This suggest that the disease is of low economic importance but widely distributed in Jigawa state rice fields and this corroborated with the report of Bhaskar *et al.* (2018) who revealed that the incidence of rice blast was highly varied among the cultivars rather than the locations. Another possible reason for low incidence and low severity of the disease could be due to less inoculums level particularly in the surveyed locations, so that the disease can occur where ever blast spores are present. Similar report was made by David *et al*. (2012) that spores produced as the primary inoculum on the overwintering tissues produce the initial infections on young seedlings when the spores that are deposited on leaves, germinate and invade leaf tissues. According to them therefore, disease severity is often correlated with the amount of infested material.

Farm Practices, agricultural status of the farm and presence of other diseases

There seemed to be a relationship between the soil type and the incidence and severity of the disease under study. In this study, rice blast disease was present in nearly all the sandy- loam soils, and absent in some of the clay -loam /clayed textured soils. Different types of soils have different water holding capacity, fertility, pH and as such pathogen survival. This result is at par with the findings of David *et al.* (2017) that rice blast occur in areas with low soil moisture, frequent and prolonged period of rain shower, and cool temperature in the day time. In upland rice, large day-night temperature differences that cause dew formation on leaves and overall cooler temperature favor the development of the disease. Hironori Koga *et al.* (2005) demonstrated that the susceptibility of rice plants to the rice blast fungus; *Magnaporthe grisea* is increased by cold stress. However, the mechanism of this phenomenon is unknown (Shafuullah *et al*., 2011). According to Joa˜o and Nunes (2011) upland environments are most affected by the disease where there is a large production of dew on the leaf surface, which favors the development of the pathogen. The water layer, in irrigated environments, serves as a thermal barrier that prevents heat loss from the soil, during the night, restricting dew formation.

It has been reported that severe epidemics of blast in rice cultivation are generally associated with wet weather. Long periods of rain are more prone to cause infection than short periods of heavy rain. Low solar radiation as well as overcast skies also favor the disease establishment and spread (Shafuullah *et al*., 2011). Higher weeds infestation reduces air movement around the fields/ crop canopy, and increases air humidity which leads to increased leaf- wetness and higher possibility of spore germination and development of pathogen. This is similar to the report of Shafaullah *et al.* (2011) that the rice blast disease severity on different varieties /lines were having significant correlation with environmental variables (maximum temperature, minimum Temperature, rain fall and relative humidity). And to vindicate this, Singh and Bhatt (2006) had earlier demonstrated that good cultural practices including; altering planting dates, removal of crop residues, weeds management, planting of disease free seeds /resistant variety can serve as important options in preventing rice blast disease. The main cultural practices used to control the rice blast, in upland environments, are the following: good soil preparation with deep ploughing, which reduces the possibility of stress in plants by water deficit, uniformity in planting, use of healthy seeds, restricted use of nitrogen topdressing and seeding at the appropriate time. Technical indications for blast control in irrigated environments, essentially, are very similar to those of the upland (Joa˜o and Nunes, 2011).

CONCLUSIONS

This study has clearly showed that rice blast disease occurrence in Jigawa state rice producing local government areas was generally low but spatially distributed among the farmers' fields. However, this is the first report of rice blast diseases in rice producing areas of jigawa state. Therefore, farmers need to be informed so that some control measures or strategies are quickly put in place in order to stop the disease from reaching uncontrollable or epiphytotic stage.

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