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Research Article

Evaluation of Resistance and Yield Losses of New Rice Genotypes to Rice Blast in the Field in Burkina Faso

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ABSTRACT

This work aimed to evaluate in the field the level of resistance of twelve (12) new rice genotypes (KBR2, KBR4, KBR6, KBR8, KBR9, KBR11, KBR12, KBR13, KBR15, KBR17, KBR28, KBR42) and yield losses due to rice blast caused by Magnaporthe oryzae in Burkina Faso. The experimental setup used was a randomized block with three (03) replications. The parameters evaluated were leaf and panicle severity, leaf and panicle incidence, grain yield and yield loss rate. Results showed that genotypes KBR15 and KBR17 were resistant to leaf blast at the Dî and Bama sites. Genotypes KBR12 and KBR13 recorded the best grain yields over the two production campaigns at the Dî and Bama sites respectively. Genotypes KBR28 and KBR42 recorded the highest 1000-grain weight and the lowest yield loss on both sites, respectively.

In view of these results, the KBR15 and FKR17 genotypes can be used as a means of varietal control of rice leaf blast in rice fields in Burkina Faso.

Keywords: *Oryza sativa L, Magnaporthe oryzae, Severity, Incidence, Burkina Faso*

INTRODUCTION

Rice is an important cereal crop in Burkina Faso. Its production faces several constraints, including fungal diseases that contribute to yield reduction, increase production costs through control measures and jeopardize food security (Yang *et* al., 2020; Kassankogno et al., 2015). Among these diseases, rice blast, caused by *Magnaporthe oryzae* and considered the most serious fungal disease due to the devastating nature of its damage, its wide distribution spectrum and the extension of a large number of physiological races of the causal organism (Couch & Kohn, 2002), is the subject of numerous (Deepack et al., 2022; Dong et al., 2020).

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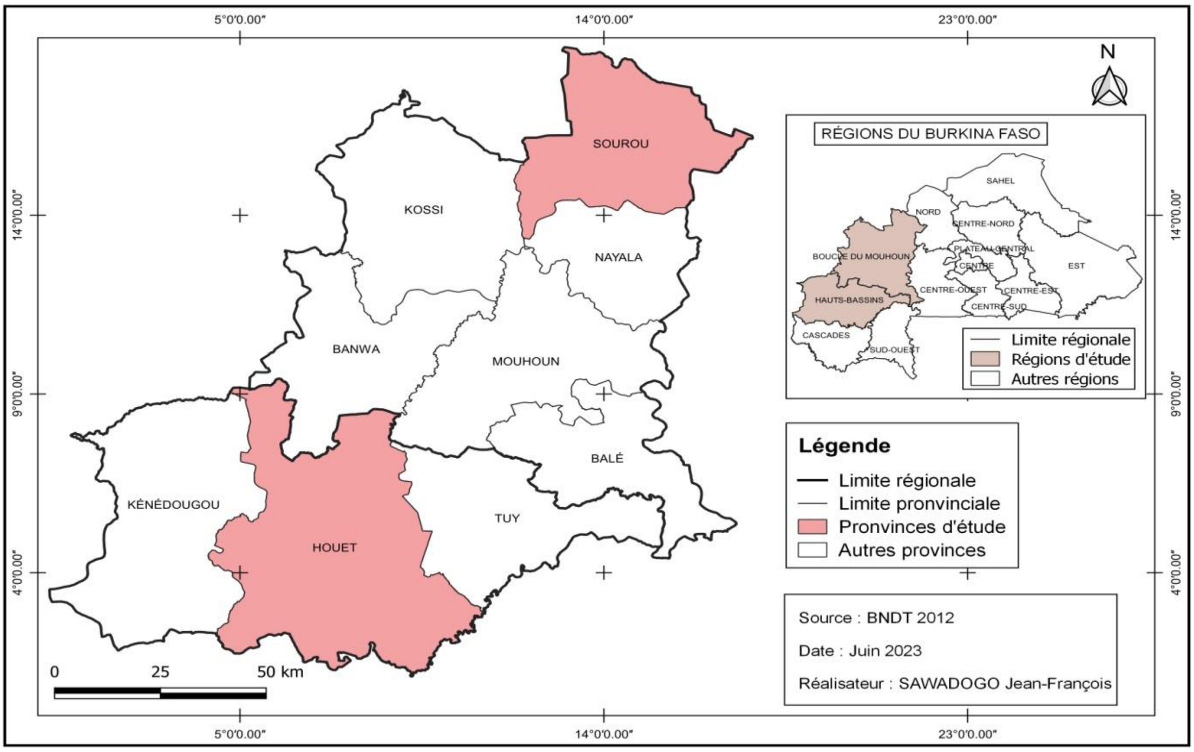
In areas where it is endemic, this disease attacks first the foliage and then the panicles, leading to yield losses of up to 60%, depending on edapho-climatic conditions and crop growth (Mobambo et al., 1994). To eradicate this disease, several control methods have been explored, including the use of synthetic chemicals, which has successfully increased yields (Nunez et al., 2006). This method remains costly, and its use also has disastrous repercussions on the environment and human health (Deguinej & Ferron, 2006). This is why varietal control is recognized as the most practical and economical method of managing blast (Suh et al., 2009).

MATERIALS AND METHODS

Study sites

The tests were carried out on the rice-growing sites of the Dî plain in the Sourou Valley and the Bama plain in the Kou Valley, known for their previous infestation by rice blast. The Vallée du Kou is located 30 km from Bobo-Dioulasso in the rural commune of Bama at an altitude of 300 m above sea level between longitude 04°22'W and latitude 11°22'N. It extends over one thousand two hundred (1200) hectares (ha) with total water control (Sontié, 2006). The climate is typical of southern Sudan, with annual rainfall ranging from 1100 to 1200 mm (Yameogo et al., 2013). The Di irrigated plain is located in northwest Burkina Faso, 326 km from Bobo-Dioulasso. It covers an area of 2,240 ha with total water control. The area lies at an altitude of 277 m above sea level, between longitude 3°20'W and latitude 13°18'N. The climate is typical of northern Sudan, with annual rainfall ranging from 600 to 900 mm (Zougrana, 2022).



Card 1 : Location of the study sites

Biological materials

The biological material used is made up of twelve (12) rice varieties that have been tested under irrigated conditions. These are KBR2, KBR4, KBR6, KBR8, KBR9, KBR11, KBR12, KBR13, KBR15, KBR17, KBR28 and KBR42. These varieties were selected at Kamboinsin and Farako-Bâ.

Fertilizers used

The fertilizers used were NPK (15-15-15) and urea (46%N). NPK was applied at a rate of 300 kg/ha at transplanting. Urea was applied as a top dressing at a rate of 150 kg/ha in two fractions: 1/3 at 15 days after transplanting and 2/3 at panicle initiation.

Experimental setup

The tests were set up on the rice-growing plains of Bama and Di during the wet cropping seasons of 2020 and 2021 in farmers' fields where the disease had been observed during previous cropping seasons. The experimental setup was a randomized block with three replications separated from each other by a distance of 1 m. Each elementary plot had a surface area of 4 m^2 separated from each other by a distance of 0.5 m.

Collected data

Several parameters were collected at each site to assess the different genotypes' degree of resistance or susceptibility.

- ***Leaf incidence*** was assessed at $21^{ième}$, $35^{ième}$, $49^{ième}$ and $63^{ième}$ JAR JAR on 10 plants chosen at random on the two diagonals of each elementary plot. It was calculated by counting the number of infected leaves out of the total number of leaves according to the following formula

$$IF = \sum_{i=1}^{n} \left(\frac{xi + \cdots + x\,i+1}{X}\right) \text{x } 100.$$

n = number of replicates, xi = number of diseased leaves and X = total number of leaves.

- ***Disease severity (S)*** was assessed on the 10 plants chosen to evaluate the foliar incidence of the disease and at the same periods. It is expressed as a percentage of diseased leaf area. Each genotype's resistance level to leaf and panicle blast was assessed using the IRRI (2002) rating scale.

- ***Paddy yield***: Each elementary plot was harvested at maturity. The panicles were dried and dehulled, and the seeds were weighed at 14% moisture content. The average yield per genotype was determined by calculating the average paddy yield of the three elementary plots of each genotype tested.

- ***Loss rate:*** This quantifies or evaluates the proportion of paddy yield lost to disease, especially neck blast, which directly affects the quality of panicular grains. It is calculated according to the following formula:

$$\textbf{Pertes}\ (\%) = \frac{\textbf{PNV(g)} - \textbf{PV(g)}}{\textbf{PT}}\ \textbf{x}\ \textbf{R}^2\textbf{x100}$$

where PNV is the weight of untanned paddy reduced to a moisture content of 14% ; PV is the weight of winnowed paddy reduced to a moisture content of 14%; PT is the total weight of paddy per elementary plot; R^2 is the coefficient of determination obtained from the linear regression of gross losses on leaf incidence at the 5% probability threshold.

Data analysis

Microsoft Excel 2010 was used for data entry and to calculate the incidence, severity and growth rate of BLS. Statistica 7.1 software was used for ANOVA tests and to establish the correlation between severity and performance. Means were compared using the Fisher test with a threshold of 5%.

RESULTS

Behaviour of genotypes to blast disease: Severity and incidence

Table 1 shows the severity, leaf incidence and, panicle incidence and resistance level of the genotypes at the Bama and Dî sites. Analysis of variance shows a highly significant difference between the genotypes studied. The results showed that KBR6 recorded the highest percentage of diseased leaf area in 2020 and

2021 at the Dî and Bama sites, respectively 36.67% and 49.67% in 2020 and 27.33% and 48.33% in 2021. At the Dî site, the lowest severities were recorded by genotypes KBR17 in 2020 (4.67%) and KBR15 in 2021 (5.33%). At the Bama site, genotypes KBR15 and KBR17 each recorded 7.33% of diseased leaf area in 2020 and 2021, respectively. The susceptible control recorded 51.33% in 2020 and 43.33% in 2021 on the Dî plain, and 56.33% in 2020 and 51.53% in 2021 on the Bama plain.

As for leaf incidence, genotypes KBR2, KBR6 and the susceptible control reached 100% diseased leaves at the Dî site. At the Bama site, genotypes KBR2, KBR4, KBR6, KBR11 and KBR12 as well as the control recorded 100% of leaves affected by leaf blast. The lowest leaf incidences were recorded by KBR11, with values of 61.27% in 2020 and 9.29 in 2021 at the Dî site. KBR17 recorded 86.87% of diseased leaf area at the Bama site in 2020, while KBR13 recorded 83.83% in 2021.

The lowest incidence of panicular blast was recorded by KBR 42, i.e. 7.49% in 2020 and 9.49% in 2021 on the Dî plain, and 9.35% in 2020 and 8.99% in 2021 on the Bama plain. KBR17 recorded the highest impacts on both sites: 27.49% in 2020 and 26% in 2021 on the Dî site, and 35.85% in 2020 and 32.99% in 2021 on the Bama site. The sensitive control recorded 44.56% in 2020 and 38.5% in 2021 on the Dî plain, then 59.31% in 2020 and 48.99% in 2021 on the Bama site. Depending on their level of resistance or susceptibility, genotypes KBR2, KBR4, KBR6 and KBR13 were moderately susceptible to leaf and panicle blast at the Dî site. They were susceptible to panicular blast at the Bama site. On the other hand, genotypes KBR9, KBR11, KBR15, KBR17, KBR28 and KBR42 proved moderately resistant to leaf blast at both sites. They were moderately susceptible to panicle blast on both sites, except for KBR42, which proved moderately resistant to the disease.

Determination of paddy yield, loss rate and thousand-grain weight.

Table 2 shows paddy yields by genotype, the rate of yield loss due to blast and the weight per thousand grains at the sites during the two consecutive years of experimentation. Analysis of variance showed a highly significant difference between genotypes. Results showed that KBR12 recorded the highest paddy yield at the Dî site, with 7569 kg/ha in 2020 and 7295 kg/ha in 2021, while genotypes KBR9 and KBR13 recorded the highest paddy yields at the Bama site, with 6803 kg/ha in 2020 and 7338 kg/ha in 2021 respectively. The control recorded the lowest yields with 3114 kg/ha and 4475 kg/ha, respectively in 2020 and 2021 on the Dî plain, and 3775 kg/ha and 3246 kg/ha, respectively in 2020 and 2021 on the Bama plain.

The highest loss rates were recorded by KBR6 on the Dî site, with loss percentages of 11.62% in 2020 and 9.05% in 2021. On the Bama site, KBR9 recorded 9.56% loss with losses in 2020, while KBR6 recorded 12.70% in 2021. The lowest loss rates were observed on KBR42, with 3.86% loss in 2020 and 2.13% in 2021 on the Dî site, and 1.66% in 2020 and 2.93% in 2021 on the Bama site. As for thousand (1000) grain weights, KBR12 recorded the highest values in 2020 at the Dî and Bama sites, with 24.61g and 26.74g, respectively. In 2021, KBR28 recorded the highest 1000-grain weights at the Dî and Bama sites, at 25.96g and 26.61g, respectively.

Table 1 : Severity and panicle incidence of rice genotypes at different sites

Genotypes	Dî Plain								Bama Plain							
	Severity			Leaf incidence		Panicular incidence			Severity			Leaf incidence		Panicular incidence		
	2020	**2021**	***RL***	**2020**	**2021**	**2020**	**2021**	***RL***	**2020**	**2021**	***RL***	**2020**	**2021**	**2020**	**2021**	***RL***
KBR2	33,33^{bc}	25,5^{d}	***MS***	100^{a}	100^{a}	17,99^{f}	14,49^{g}	***MS***	49,67^{b}	41,67^{c}	***MS***	100^{a}	100^{a}	33,30^{c}	39,59^{b}	***S***
KBR4	31,67^{c}	26,67^{cd}	***MS***	100^{a}	86,17^{f}	19,99^{de}	12,92^{h}	***MS***	49,5^{b}	41,67^{c}	***MS***	100^{a}	100^{a}	23,45^{f}	31,99^{de}	***S***
KBR6	36,67^{ab}	27,33^{bc}	***MS***	100^{a}	100^{a}	26,99^{b}	21,49^{d}	***MS***	49,67^{b}	48,33^{b}	***MS***	100^{a}	100^{a}	35,39^{bc}	27,89^{f}	***S***
KBR8	17,44^{ef}	12,33f^{g}	***MR***	91,59^{ef}	98,55^{b}	11,49^{i}	9,99^{i}	***MS***	25,62^{d}	20,75^{e}	***MS***	96,88^{b}	100^{a}	19,44^{g}	15,78^{j}	***MS***
KBR9	18,33^{de}	10,5^{g}	***MR***	83,76^{g}	100^{a}	13,49^{hi}	19,00^{e}	***MS***	23,33^{e}	21,78^{e}	***MR***	89,88^{cd}	88,89^{e}	29,79^{d}	23,80^{g}	***S***
KBR11	10,87^{hi}	6,33^{h}	***R***	69,76^{i}	61,27^{h}	9,29^{gh}	7,77,^{i}	***MS***	9,33^{g}	13,87^{g}	***MR***	100^{a}	100^{a}	25,92^{e}	29,00^{ef}	***S***
KBR12	16,33^{f}	15,67^{ef}	***MR***	100^{a}	89,13^{de}	17,49^{f}	24,50^{b}	***MS***	26,67^{d}	18,33^{f}	***MS***	100^{a}	95,44^{c}	15,54^{h}	12,92^{k}	***MS***
KBR13	31,67^{c}	25,5^{d}	***MS***	96,44^{bc}	100^{a}	18,49^{ef}	14,99^{g}	***MS***	33,33^{c}	38,67^{d}	***MS***	88,67^{d}	83,83^{f}	29,73^{d}	17,99^{ij}	***S***
KBR15	10,5^{i}	5,33^{i}	***R***	92,57^{de}	89,68^{de}	22,49^{c}	23,99^{c}	***MS***	7,33^{h}	9,67^{h}	***R***	95,03^{b}	91,78^{d}	26,82^{e}	18,99h^{i}	***S***
KBR17	4,67^{k}	6,67^{h}	***R***	78,55^{h}	88,01^{e}	27,49^{b}	24,00^{c}	***MS***	9,33^{g}	7,33^{j}	***R***	86,87^{e}	100^{a}	35,85^{bc}	32,99^{cd}	***S***
KBR28	8,88^{j}	6,67^{h}	***R***	94,89^{cd}	90,57^{cd}	19,99^{de}	14,99^{f}	***MS***	11,53^{f}	9,77^{h}	***MR***	96,93^{b}	100^{a}	11,14^{i}	17,99^{ij}	***MS***
KBR42	11,33^{gh}	10,87^{g}	***MR***	87,01^{f}	80,11^{g}	7,49^{j}	9,49^{i}	***MR***	7,67^{h}	8,67^{i}	***R***	89,71^{cd}	98,33^{b}	9,35^{i}	8,99^{l}	***MR***
FKR64	51,33^{a}	43,33^{a}	***S***	100^{a}	100^{a}	44,56^{a}	38,50^{a}	***S***	56,33^{a}	51,53^{a}	***S***	100^{a}	100^{a}	59,31^{a}	48,99^{a}	***TS***
Pr > F	**<0,0001**	**<0,0001**		**<0,01**	**<0,0001**	**<0,0001**	**<0,0001**		**<0,0001**	**<0,0001**		**<0,0001**	**<0,0001**	**<0,0001**	**<0,0001**	

RL = Resistance level, **R** = Resistant, **MR** = Moderately resistant, **MS** = Moderately sensitive, **S** = Sensitive,

Values with the same letter in the same column are not statistically different at the 5% probability level using the Fisher test.

Table 2: Paddy yield, loss rate and weight of 1000 grains

Genotypes	Dî Plain						Bama Plain					
	Yield (kg/ha)		Loss rate (%)		Weight 1000 grains (g)		Yield (kg/ha)		Loss rate (%)		Weight 1000 grains (g)	
	2020	**2021**	**2020**	**2021**	**2020**	**2021**	**2020**	**2021**	**2020**	**2021**	**2020**	**2021**
KBR2	6536^{bc}	6767^{d}	6,09^{f}	5,27^{g}	24,07^{bc}	24,74^{c}	5658^{f}	6618^{e}	7,74^{c}	4,39^{f}	24,24^{d}	25,90^{ab}
KBR4	5457^{f}	7097^{ab}	10,23^{bc}	7,53^{cd}	24,11^{bc}	24,98^{bc}	6154^{c}	7211^{b}	9,56 ^{b}	10,34 ^{c}	26,05^{b}	24,79^{cd}
KBR6	5809de	5848^{h}	11,62^{a}	9,05^{a}	23,88^{c}	24,85^{c}	5995^{e}	6757de	6,55^{e}	12,70^{b}	25,45^{c}	25,24^{b}
KBR8	6628^{bc}	6585^{e}	6,25^{f}	7,25^{d}	23,04^{d}	23,76^{de}	6148^{c}	7333^{a}	5,84^{f}	3,45^{g}	23,59^{e}	24,66^{cd}
KBR9	7067^{ab}	6128^{f}	6,10^{f}	7,91^{cd}	21,12^{g}	22,28^{g}	6803^{a}	7173^{b}	4,42^{g}	7,43^{d}	22,92^{f}	22,80^{f}
KBR11	5845de	5935^{gh}	6,98^{e}	6,93^{e}	21,64f^{g}	23,05^{f}	5035^{h}	6227^{b}	6,04^{ef}	10,72^{c}	23,61^{e}	23,88^{e}
KBR12	7569^{a}	7295^{a}	5,83^{g}	4,85^{h}	24,61^{a}	25,53^{ab}	6179^{c}	6805^{cd}	4,66^{g}	3,58^{g}	26,74^{a}	25,32^{b}
KBR13	6038^{cd}	6145^{f}	6,98^{e}	5,93^{f}	22,08^{e}	23,59^{e}	6008^{d}	7338^{a}	3,52^{h}	6,89^{de}	24,22^{d}	24,45^{d}
KBR15	5754^{e}	6075^{fg}	5,77^{g}	5,16^{gh}	20,69^{h}	23,13^{f}	5950^{e}	5725^{h}	2,80^{i}	4,60^{f}	24,55^{d}	24,15^{de}
KBR17	6164^{cd}	6805^{cd}	7,21^{de}	7,48^{d}	22,50^{e}	23,68^{de}	5435^{g}	6155^{g}	2,70^{i}	3,33^{g}	23,38^{e}	25,16^{b}
KBR28	5728^{e}	5815^{h}	4,88^{h}	4,19^{h}	24,70^{a}	25,96^{a}	6554^{b}	6393^{f}	7,13^{c}	6,44^{e}	26,69^{a}	26,61^{a}
KBR42	5401^{f}	6958^{bc}	3,86^{i}	2,13^{i}	24,36^{b}	25,58^{ab}	6038^{d}	6205^{g}	1,66^{j}	2,93^{h}	26,67a	25,64^{b}
FKR64	3114^{g}	4475^{i}	9,77^{c}	8,01^{bc}	23,89^{c}	25,65^{ab}	3775^{i}	3246^{i}	10,82^{a}	16,09^{a}	26,47^{a}	26,50^{a}
Pr > F	**<0,0001**	**< 0,0001**	**< 0,0001**	**< 0,0001**	**< 0,01**	**<0,0001**	**< 0,0001**	**< 0,0001**	**< 0,0001**	**< 0,0001**	**< 0,0001**	**< 0,0001**

Values with the same letter in the same column are not statistically different at the 5% probability level using the Fisher test.

DISCUSSION

Results showed a variation in leaf and panicle incidence severity between genotypes and different sites. On the Dî and Bama plains, genotypes KBR9, KBR11, KBR15, KBR17 and KBR28 were resistant to leaf blast, but susceptible to panicle blast. This situation can be explained by the anatomy of the two organs (leaf and panicle). According to Louvel and Bidaux (1977), the leaf and panicle are two organs with different anatomy. These two organs, therefore react differently to a pathogen. This explains the difference in severity between these two plant organs. The genes carried by these varieties are resistant to leaf attack but not to panicle attack. Bonman et al., (1991) studied the behaviour of certain rice varieties against blast in Korea and the Philippines for over a decade. Their work revealed rice varieties susceptible to leaf blast and resistant to neck blast. The behavior of these varieties resembles that of KBR17, which is inversely resistant to leaf blast and susceptible to neck blast in our study. The genotype of these plants determines the behavior of a population of host plants towards a pathogen. Indeed, according to Lepoivre (1989), there is a genotypic difference between the varieties used in our experiment, which explains the difference in behavior towards blast. Resistant varieties have genes that slow the development of the epidemic and keep parasite pressure low (Abadassi**,** 1989). Susceptible varieties, on the other hand, lack resistance genes, which means they cannot slow the progress of the epidemic. According to Van Der Plank (1974), plants have two forms of resistance to pathogen attack: vertical and horizontal. The former is specific and monogenic, delaying the onset of the epidemic but not slowing its progression, while the latter is polygenic and reduces the epidemic's progression. The variability in the behavior of genotypes towards the pathogen is related to the intrinsic capacity of each genotype on the one hand, and the interaction between the molecules of the parasite and its host on the other (Kassankogno et al., 2021). According to Grist (1975), resistance to blast may be due to the plant's silica or nitrogen composition. Nitrogen increases intercellular spaces, thus favoring fungal development in tissues, while silicon, by strengthening cell walls, reduces fungal penetration of host cells. According to the same author, susceptibility to blast is proportional to leaf nitrogen content, and inversely proportional to leaf silica content.

In general, leaf and panicle blast were more severe at the Bama site than at Dî. It is possible that more virulent strains of *Magnaporthe oryzae* exist at Bama than at Dî. This difference in the behavior of the same rice plant in the face of leaf and neck blast at different sites has been reported in the work of Bouet (2008) and Bouet *et al.* (2006). Work carried out by Kassankogno (2016), revealed a difference in behavior between several genotypes on different sites vis-à-vis leaf blast under conditions of natural disease pressure in the field.

Grain yield, loss rate and thousand kernel weight varied from one genotype to another and from one site to another. Indeed, genotypes KBR4 and KBR6 recorded low yields with very high loss rates. This could be explained by the degree or earliness of panicle attack by the disease. Work by Louvel (1977) has shown that the extent of yield losses caused by blast depends on the earliness of panicle attack. For this author, blast does not affect yield when panicular neck attacks occur at maturity. Also, according to Sy and Séré (1996) and Pandé (1997), late panicular neck attacks that occur at grain maturity have no impact on yield.

Some genotypes, such as KBR12, recorded good yields and thousand (1000) kernel weights with low loss rates at both sites. These results support those of Ouazzani (2001), according to whom the impact of disease on yield depends not only on the intensity of damage but also on the nature of the organs affected and the period at which the attack occurs (Gnago et al., 2017). According to Gnancadja et al. (2005), the disease damages the more leaf surface or panicle, the more the number of solid grains decreases. The low yield losses could be explained by these genotypes' high photosynthetic activity, enabling them to synthesize the carbohydrates needed for grain filling (Sarrah et al., 2004).

CONCLUSION

This study aimed to assess the resistance level of twelve (12) genotypes and yield losses due to rice blast, and revealed that the KBR15 and KBR17 genotypes were resistant to rice blast at both sites. These genotypes can be recommended to growers as a means of varietal control against rice blast in Burkina Faso rice fields and in varietal improvement programs.

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Conflict of interests:

The authors have not declared any conflict of interest.

Authors' contributions:

OS conceived the project and carried out the research and fieldwork. KAI participated in the supervision of field activities and drafting of the manuscript, ZS participated in the data analysis and correction of the manuscript, SB participated in the correction of the manuscript. SA and KK were involved in supervising the work and correcting the manuscript.

REFERENCES

Abadassi, J. (1989). Etude de la résistance spécifique à la pyriculariose (*Pyricularia oryzae* Cav.) de quelques variétés de riz (*Oryza sativa* L.). Mémoire DEA: Amélioration des plantes : Université de Rennes I. 55 p.

Bouet, A. (2008). Contribution à la lutte contre la pyriculariose, maladie fongique du riz : *Oryza sativa* L. (Poaceae) en Côte d’Ivoire : caractéristiques de la population de l’agent pathogène : *Magnaporthe grisea* (Hebert) Barr (Ascomycetaceae) et méthodes d’évaluation variétale pour la résistance à la pyriculariose foliaire et à la pyriculariose du cou. Thèse de doctorat unique, Université de Cocody-Abidjan, p.122.

Bouet, A., Vales, M., et Keli ZJ. (2006). Evaluation de la résistance de variétés de riz (*Oryza* sp.) à la pyriculariose du cou au champ. *Agronomie Africaine*, *18*(2), 165-173.

Couch, BC. et Kohn, LM. (2002). A multilocus gene genealogy concordant with host preference indicates segregation of a new species, *Magnaporthe oryzae*, from M. grisea. *Mycologia*, *94*, 683-693.

Deepak, CA., Hethana, C. & Rajendra, S. (2022). Rice Blast Disease in India : Present Status and Future Challenges. In M. Huang (Éd.), Integrative Advances in Rice Research. IntechOpen. https://doi.org/10.5772/intechopen.98847.

Deguinej, P., & Ferron, P. (2006). Protection des cultures, préservation de la biodiversité, respect de l’environnement. *Cahiers Agricultures*, *15*(3), 307-311.

Dong, L. Liu, S., Kyaing, MS., Xu, P. & Yang, Q. (2020). Identification and Fine Mapping of Pi69(t), a New Gene Conferring Broad- 210 Spectrum Resistance Against *Magnaporthe oryzae* From *Oryza glaberrima* Steud. *Frontiers in Plant Science*, *11*, 1190. https://doi.org/10.3389/fpls.2020.01190.

Gnago, AJ., Kouadio, KT., Tia, VE., Kodro, AP. & Goulivas, AV. (2017). Évaluation de deux variétés de riz (CK73 et CK90) à la Toxicité Ferreuse et à quelques contraintes biotiques à Yamoussoukro (Côte d'Ivoire). *Journal of Applied Biosciences 112*, 11035-11044.

Gnancadja, ALS., Hannin, S., Ouazzani, AT., Badoc, A. & Douira, A. (2005). Impact de la mycoflore de la feuille paniculaire du riz sur le rendement en grains. Bulletin- Société de Pharmacie de Bordeaux *144*, 225-236.

Grist, DH. (1975). Rice. 5e edition. Tropical agriculture series. New York. PP. 340-382.

IRRI (2002). Standard evaluation system for rice. Philippines : International Rice Research Institute, *Manila, Philippines*, 56 p.

Kassankogno, AI. (2016). Diversité génétique, pathologique de *Magnaporthe oryzae* (Couch), agent de la pyriculariose du riz au Burkina Faso et au Togo et méthodes de gestion durable de la maladie. Thèse de doctorat. Sciences biologiques appliquées. Phytopathologie. 198p.

Kassankogno, AI., Saibou, A., Ouedraogo, I., Ouedraogo, L., & Sankara, P. (2015). Caractéristiques morphologique et phénotypique des isolats de *Magnaporthe grisea* du Burkina Faso et du Togo. *Afrique Science, 11*(4), 361-377.

Kassankogno, AI., Sidibé, G., Guigma, A.K. & Koïta, K. (2021). Caractérisation des symptômes foliaires et évaluation du pouvoir pathogène de quelques isolats de *Curvularia lunata* sur trois variétés de riz (*Oryza sativa* L) produites au Burkina Faso. *Afrique Science 19*(4), 106 – 117.

Lepoivre, P. (1989). Epidémiologie des maladies parasitaires des végétaux. In traité de pathologie végétale. Les presses agronomiques de Gembloux. Belgique. PP. 323-360.

Louvel, D., & Bidaux, J.M. (1977). Observations de nouveaux symptômes pathologiques sur des variétés précoces de riz en Côte d'Ivoire. *L'Agronomie Tropicale (1975)*, 32 (3), numéro spécial L'IRAT et l'amélioration du sorgho : 257-261.

Mobambo, KN., Baboy, L., Ruhigwa, B. & Loma, T. (1994). Réactions de quelques varieties de riz à la pyriculariose à Yangambi – Zaïre. *Tropicultura*, *12*(1), 22-24.

Nunez, YO., Salabarria, IS., Collado, IG. & Hernandez-Galan, R. (2006). The antifungal activity of widdrol and its biotransformation by *Colletotrichum gloeosporioides* (penz) Penz. et Sacc. and *Botrytis cinerea* Pers. Fr. *Journal. Agriculture. Food Chemistry*. *54*, 7517–7521.

Ouazzani, TA. (2001). Etude des relations entre différents champignons foliaires du riz : virulence, interactions compétitives, contamination et mesures de lutte biologique et chimique. Thèse d'Etat, Faculté des Sciences, Université Ibn Tofaïl, Kénitra, 183 p.

Pandé, HK. (1997). Systèmes améliorés de riziculture pluviale. FAO. Rome. 111 P.

RAPILLY, F. (1991) L'épidémiologie en pathologie végétale : mycoses aériennes. INRA 317 p.

Sarah, AM. (2004). Potentiel de détection par fluorescences induites par UV et effets sur la photosynthèse des acides jasmonique, salicylique et benzothiadiazole. Université du Québec à trois-rivières. Canada. 167pp.

Sato, H., Andom, I., Hirabayashi, H., Takeuchi, Y., Arase, S., & Nemoto, H. (2008). QTL analysis of brown spot resistance in rice (*Oryza sativa* L.). *Breeding Science 58*, 93-96. https://doi.org/10.1270/jsbbs.58.93

Shaner, G., Finney, RE. (1977). The effect of nitrogen fertilization on expression of slow-mildewing resistance in Knox wheat. *Phytopathology*, 76:1051-1056.

Sontie, F. (2006). Etude des conflits autour de la ressource eau dans la région de Diarradougou et Bama (Vallée du Kou), groupe EIER- ETSHER, direction des etudes et des services academiques 252 p.

Suh, JP., Roh, JH., Cho, YC., Han, SS., Kim, YG. & Jena, KK. (2009). The Pi40 gene for durable resistance to rice blast and molecular analysis of Pi40-advanced backcross breeding lines. *Phytopathology*, *99*, 243-250.

Sy, AA. & Séré, Y. (1996). Manuel de formation en pathologie du riz. ADRAO. Imprint design. Royaume-Uni. 76 P.

Van Der Plank, JE. (1974). Résistance des plantes aux maladies. ACCT. Paris. 204 P.

Yameogo, PL., Segda, Z., Dakouo, D. & Sedogo, MP. (2013). Placement profond de l'urée (PPU) et amélioration de l'efficacité d'utilisation de l'azote en riziculture irriguée dans le périmètre rizicole de Karfiguela au Burkina Faso. *Journal of Applied Biosciences 70*, 5523-5530. Available at: https://doi.10.4314/jab.v70i1.98749.

Yang, F., Zhang, J., Zhang, H., Ji, G., Zeng, L., Li, Y., Yu, C. & Chen, W. (2020). Bacterial Blight Induced Shifts in Endophytic Microbiome of Rice Leaves and the Enrichment of 223 Specific Bacterial Strains With Pathogen Antagonism. *Frontiers in Plant Science*, 11,963.https://doi.org/10.3389/fpls.2020.00963

Zougrana, S. (2022). Etude des facteurs épidémiologiques de la bactériose à stries foliaires translucides du riz causée par *Xanthomonas oryzae* pv. *oryzicola* et identification de méthodes de lutte adaptées aux conditions de culture au Burkina Faso. Thèse de doctorat. *Sciences biologiques appliquées*. Phytopathologie. 198p