PREVALENCE OF RICE BLAST AND VARIETAL SCREENING IN GHANA

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ABSTRACT

Surveys were conducted in farmers' fields, participatory varietal selection (PVS) nurseries and researchers' fields during 2000-2002 cropping seasons to assess the incidence of rice blast (Pyricularia oryzae) in Ghana. Screenhouse artificial inoculation studies and field trials were also carried out on some of the rice varieties to assess their response to blast. Blast was recorded in 264 fields in the countrywide surveys. The incidence of blast varied considerably across the country and areas of blast scores of 0-3 (low), 4-6 (moderate) and 7-9 (high) have been identified. No blast was observed in Brong Ahafo, Greater Accra and Upper West Regions. Farmers at some of the high blast areas notably Fodome, Hohoe, Santrokofi and Datano reported complete devastation of their rice fields due to blast infection. The survey results suggest that Datano, Hohoe and Nyankpala are blast prone areas and key sites for resistance screening. The PVS rice varieties, with a few exceptions, had low blast severity scores at the key screening sites under natural field conditions, while the improved varieties had shown varying degrees of resistance to the dominant Ghanaian blast lineage representatives under screenhouse conditions. These improved varieties need to be tested sufficiently at other major rice-growing areas across the country to benefit the low-resourced farmers where improved varieties are not available or where local varieties are susceptible to the blast disease.

Keywords: *Major rice-growing areas, rice blast, key blast resistance screening sites*

INTRODUCTION

Rice is becoming increasingly an important staple food consumed throughout Ghana. Per capita consumption has risen from 13.9 kg/year in 1995 to 14.5 in 2000 (MOFA, 2001). Ghana imports 564,000 M T paddy annually compared with domestic production of 180,000 M T.

The area under rice production in Ghana is 130,000 ha, of which 61% is under rainfed upland/hydromorphic ecosystem, 21% under rainfed lowland and inland valleys ecosystem and 18% under irrigated system (MOFA, 1999).

Rice production in Ghana is constrained by a number of biotic factors including diseases, insect pests and weeds. Blast disease caused by the fungus *Pyricularia grisea* (syn. *P. oryzae*) (Rossman *et al.*, 1990) (teleomorph = *Magnaporthe grisea*) (Webster, 1980) is problematic to rice production in both temperate and tropical regions despite extensive research efforts at its control (Teng, 1994). *Pyricularia grisea* is able to infect rice at different stages of growth and adapt to both upland and lowland rice ecosystems (Bonman *et al.*, 1992; Teng, 1994). In the West African sub-region, blast is recognised as a primary constraint to rice production causing 3.2-77.0% yield losses (Notteghem and Baudin, 1981; Fomba and Taylor, 1994; Singh *et al.*, 1998; Chipili *et al.*, 2003).

Rice blast was first reported in Ghana by Bunting and Dade (1925) and later by Dade (1940). It was also observed by Leather (1959) and Piening (1962). It was listed as an important disease by Clerk (1974) and Oduro (2000).

Devastation of some rice varieties by blast was observed in Northern Ghana in 1969 (E. A. Addison, personal communication). Since then various reports by Twumasi (1995; 1998), Twumasi and Adu-Tutu (1995), Nutsugah (1997a; 1997b), Nutsugah and Twumasi (2001) and Nutsugah *et al.*, (2003) have identified the disease as a serious threat to rice production in Ghana. Together with brown spot (*Bipolaris oryzae*), blast disease has again been listed as one of the serious constraints to rice production in the country (Gerken *et al.*, 2001). These reports suggest the need for improved management of blast disease in Ghana if the target set for rice production is to be achieved.

In this paper, we report nationwide surveys conducted during 2000-2002 cropping seasons in all the major rice-growing areas to obtain a more current situation on the incidence of rice blast in Ghana. Screenhouse artificial inoculation studies and field trials carried out on some of the rice varieties grown in the country to identify varieties with resistance to the disease are also reported.

MATERIALS AND METHODS

Disease surveys

In October and November 2000 and May 2001, rice blast surveys were conducted in Asante-Akim and Ejura districts in Ashanti Region and Sefwi and Wassa-Amenfi districts in Western Region during the vegetative stage of the rice plant. In July 2001, more extensive surveys were conducted by a team of scientists from the Savanna Agricultural Research Institute, Crops Research Institute and Horticulture Research International (HRI) on farmers' fields, participatory varietal selection (PVS) nurseries and research trials in seven regions of southern Ghana, namely, Ashanti, Brong Ahafo, Central, Eastern, Greater Accra, Volta and Western Regions. In September and October 2001, surveys were conducted in the northern part of the country covering rice-growing areas of Northern, Upper East and Upper West Regions. Surveys were again conducted in the southern and northern sectors of the country in August and September 2002. Two hundred and sixty-four fields were surveyed for the presence or absence and severity of blast disease.

In all the surveys, each field was visually divided diagonally into four sectors, and 10-20 hills or plants were assessed for the presence or absence of the blast disease. If present, the visual score of incidence and severity was rated according to the International Rice Research Institute (IRRI) scale of 0-9 (IRRI, 1996). Diseased leaves were collected and sent to HRI, UK for MGR586 fingerprint pattern or lineage determination and pathotype analysis. The characterised isolates were used in artificial inoculation studies as described below.

Screenhouse screening

Seeds of some varieties collected from farmers and PVS nurseries (Table 1) were used in the inoculation studies in the screenhouse at the

Table 1. **Rice varieties screened against Ghanaian *Magnaporthe grisea* isolates belonging to different lineages**

Variety	Source/Designation[1]
Viwornu	Local, Hohoe, VR
Mr. Harrow	Local, Aframso, AR
Mr. More	Local, Aframso, AR
Asante-mo	Local, Boama-Dumase, AR
Sika-mo (Tox 3108-56-4-2-2-2)	Improved, Boama-Dumase, AR
Agya-Amoa	Local, Sayerano, WR
Martin	Local, Gbi-Godenu, VR
Digan (IR 12979-24-21)	Improved, NR
IDESSA 46	Improved, NR
IRAT 216	Improved, NR
WAB 450-I-B-P-91-HB (NERICA 4)	Improved, NR
Mendi	Local, NR
Gomba	Local, NR
Agona	Local, NR
WAB 450-I-B-15-7-1-1	Improved, NR
Kleminson	Improved, NR
WAB 515-177-2	Improved, NR
IDESSA 85	Improved, NR
WAB 56-50	Improved, NR
Agosanga	Local, NR

[1] *VR, Volta Region; AR, Ashanti Region; WR, Western Region; NR, Northern Region*

Crops Research Institute, Fumesua, Kumasi. The seeds were primed before being sown in plastic buckets. They were soaked in tap water in beakers over-night. Those that floated on the water surface were discarded and only seeds that sank to the bottom of the beakers were sown. Fifteen seeds were sown per plastic bucket. Six days after germination, the seedlings were thinned to 10 per plastic bucket.

Fifteen isolates of *M. grisea* characterised at IIRI were sub-cultured on Oat Meal Agar (OMA) (Table 2). Conidia of *M. grisea* were examined under a binocular dissecting microscope and their identity confirmed by light microscopy. Conidia were placed on OMA plates containing aureomycin and incubated at room temperature for 14-21 days with 12 hours NUV light and 12 hours dark cycle. The conidia were

Table 2. Details of site, host variety and lineage grouping of *Magnaporthe grisea* isolates from Ghana used in artificial inoculation studies

No.	Code	Variety[1]	Site[2]	Lineage[3]
1	B175	Red rice	Bolgatanga	GH-1
2	B179	Red rice	Bolgatanga	GH-1
3	B159	Tox 3792-10-1-2-1-1-3-2	Hohoe	GH-1
4	B153	Tox 3880-38-1-1-2	Hohoe	GH-1
5	B167	Tox 4004-43-1-2-1	Hohoe	GH-1
6	B164	Tox 728-1	Hohoe	GH-1
7	B157	Digan (IR 12979-24-21)	Hohoe	GH-1
8	B124	WAB 651-B-9-B36	Kwadaso	GH-1
9	B18	Unknown	Tono	GH-4
10	B158	CK 73	Hohoe	GH-2
11	B152	TCA 80-4	Hohoe	GH-2
12	B149	TGR 75	Hohoe	GH-2
13	B161	Tox 3100-37-3-3-2-4	Hohoe	GH-2
14	B202	Red rice	Bolgatanga	GH-1
15	B201	Red rice	Bolgatanga	GH-1

[1]Rice variety or particular type grown at the survey site from which the isolate was obtained,
[2]Location where the variety was collected,
[3]Ghanaian Magnaporthe grisea isolates belonging to different lineages (genetic groups and diversity) based on the similarity of the fingerprint patterns and designated as GH-1, GH-2 and GH-4.

then gently washed with sterile distilled water and the suspensions were passed through cheese-cloth. Gelatin was added to the conidial suspension and conidial concentration of the suspension determined with a haemocytometer and adjusted to 10^5 conidia/ml. The seedlings grown to 3-4 leaf stage (18-21 days after planting) in plastic pots under screenhouse conditions were spray inoculated using HUMBROL spray gun kit with 30 ml aqueous conidial suspension (i.e. 10 ml/plant). The inoculated seedlings were maintained in the screenhouse and observed daily for disease assessment. The plant response was scored visually for lesion type seven days after inoculation. Host reaction was based on a 0-5 scale (Valent *et al.*, 1991). A score of 0 and 1 being recorded as an incompatible (R) reaction and lesion type 2 or greater or if the majority of seedlings exhibited fully sporulating lesions was recorded as a compatible (S) reaction.

Field screening

Rice varieties for evaluation were assembled in April-May each year and sown in June-July. The seeds were sown in rows 25 cm apart with an intra-row spacing of 20 cm in a plot size of

5x2m. The screening was laid out in a randomised complete block design with four replications and eight rows for each variety. Screening was done in selected PVS sites in the Northern (Galenkpegu, Gbulung, Golinga, Nyankpala, Salaga, Tarkpaa and Tolon) and Upper East (Nyorigu and Tambalug) Regions on fields with previous history of blast. Plants were rated for blast incidence and severity using the IRRI scale of 0-9 as above. Although observations were made every four weeks starting from 30 days after sowing until harvest, we report only the last score obtained.

RESULTS AND DISCUSSION

Results of blast surveys across Ghana are presented in Tables 3 and 4. In Ashanti Region, blast was prevalent and severe in the nurseries and on rice plants at the vegetative stage in and around Offinso-Kayera, Anyinasuso (Offinso district), Boama-Dumase (Asante-Akim district), Dromankoma (Ejura/Sekyedumasi district) and Adansi-Praso (Adansi-East district) in decreasing order of severity. The disease occurred on the local variety, Asante-mo, which is popularly grown in most of the localities surveyed. The disease was scarcely found on the improved varieties. No blast was observed in Brong Ahafo Region. In Central Region, blast was found to be devastating on rice plants at the vegetative stage at Treposo, Nkwantanang, Diaso, Brofoyedru/ Bremang and Abora (Upper-Denkyira district). In Agyahamenso, Assin-Akonfudi, Assin-Dompem and Ayamfuri (Assin district), blast was completely absent. This was probably because the variety widely cultivated in the district resembled Sika-mo, an improved variety. In Eastern Region, the disease was present in Otumi, Asikam, Daamang, Nkwantanan and Subi (Kwaebibirim district). Rice blast was conspicuously absent in Abaam, Abodom, Asutsuare, Ekoso and Kpong (Krobo district). In Western Region, blast was very destructive in Sayerano, Datano, Aferi (Sefwi Juabeso-Bia district), Sefwi-Wiawso and Tanoso (Sefwi-Wiawso district), where a popular local variety, Agya-Amoa, is widely grown. At Datano, blast completely destroyed the integrated pest management (IPM) demonstration trial set up by the Ministry of Food and Agriculture (MOFA) in 2001, resulting in no activity in 2002. The blast situation on local varieties at Bibiani was equally destructive. At Adjakaa-Manso (Wassa Amenfi district), blast incidence and severity were very high. In Tarkwa-Nsuaem (Wassa-Fiase district), Asaasetere and Nkroful (Nzema district), blast was absent. In the Volta Region, high incidence and severity of blast occurred in the farmers' fields in and around Hohoe district. Rice fields at Akpafu-Mempeasem, Akpafu-Odomi, Fodome, Gbi-Godenu, Hohoe, Kpoeta and Santrokofi where the local variety, Viwornu, is widely cultivated were highly infected by blast.

In 2002, the status of rice blast in some of the districts visited in southern Ghana was different from the observations made in 2001. In Diaso, the disease incidence was comparatively higher. No blast was observed in Assin district. Blast was not observed in Sefwi, Wassa-Amenfi and Wassa-Fiase districts and in Krobo and Kwaebibirim districts. In Volta Region, while there was no blast incidence at Afife, Kadjebi and Worawora, the situation was different in Hohoe district. Farms at Fodome, Kpoeta, Santrokofi, Gbi-Godenu, Akpafu-Odomi and the vicinity of Hohoe were severely blasted as in the previous year. In Northern Region, there was high incidence and severity at Galenkpegu and Kpachie with isolated incidence at Nyankpala on farmers' and researchers' fields. At Salaga, a key research-screening site grown to an improved variety, Tox 3050, was heavily blasted. There was no blast incidence at Damongo. In Upper East Region, there was severe incidence of blast in farmers' fields at Bawku and PVS nurseries and farmers' fields at Nyorigu. There was no blast at Manga, Navrongo, Tono, Sandema, Wiaga and Fumbisi. Blast disease was not observed in Upper West Region. In all the surveys, it was observed that when blast was present, severity was

Table 3. Survey of rice blast in southern Ghana, 2000-2001 cropping seasons

Location	Variety	Score (0-9)[1]
Ashanti Region		
Adansi-Praso	Red rice	4-6
Adugyama	Sika-mo	-[2]
	Asante-mo	-
Aframso	Mr. More	0-3
	Sika-mo	-
	Mr. Harrow	0-3
Amakom	Asante-mo	-
Anyinasuso	Asante-mo	7-9
Biemso #2	Sika-mo	-
Besease	Sika-mo	-
Boama-Dumase	Sika-mo	-
	Asante-mo	7-9
Bronikrom	Asante-mo	-
Dromankoma	Mr. More/Harrow	4-6
Kasei	Asante-mo	-
Mmoframnfadwen	Asante-mo	-
Nkawie	Asante-mo	-
Nobewam	Sika-mo	-
Offinso-Kayera	Asante-mo	7-9
Tepa	Asante-mo	-
Brong Ahafo Region		
Atebubu	Mr. More	-
Kwame-Danso	Mr. More	-
Goaso	Asante-mo	-
Central Region		
Abora	Local	7-9
Agono-Port	Local	0-3
Agyahamenso	Unknown	-
Assin-Akonfudi	Sika-mo	-

Location	Variety	Score (0-9)[1]
Assin-Dompem	Sika-mo	-
Ayamfuri	Unknown	-
Brofoyedru/Bremang	Unknown	7-9
Diaso	Red rice	7-9
Nkwantanang	Red rice	7-9
Treposo	Aberewa besi (Local)	7-9
Eastern Region		
Abaam	Red rice	-
Abodom	Red rice	-
Asikam	Red rice	4-6
Asutsuare	Sika-mo	-
Daamang	Red rice	4-6
Ekoso	Red rice	-
Kpong	GR-19	-
Nkwantanan	Red rice	4-6
Otumi	Red rice	7-9
Subi	Red rice	4-6
Western Region		
Adjakaa-Manso	Wassa-mo	7-9
Aferi	Agya-Amoa	4-6
Apratu	Unknown	-[2]
Asaasetere	Local	-
Asanta	Local	-
Bibiani	Local	7-9
Datano	Sika-mo	-
	Agya-Amoa	7-9
Juabeso	Agya-Amoa	4-6
Kentenkrobu	Unknown	4-6
Nkroful	Local	-
Nsuansua	Agya-Amoa	7-9
Owuosabroso	Agya-Amoa	0-3
Sayerano	Agya-Amoa	7-9
Sefwi-Wiawso	Agya-Amoa	4-6
Sui-ano #1	Agya-Amoa	4-6
Sui-ano #2	Agya-Amoa	4-6
Tanoso	Red rice	7-9
Tarkwa-Nsuaem	Local	-

Location	Variety	Score (0-9)[1]
Greater-Accra Region		
Dawhenya	GR 21	-
Volta Region		
Afife	Sika-mo	-
Akpafu-Mempeasem	Viwornu	4-6
Akpafu-Odomi	Viwornu	4-6
Akpafu-Todzi	Viwornu	0-3
Fodome	Viwornu	7-9
Gbi-Godenu	Viwornu/Martin	7-9
Golokwati	Viwornu	0-3
Hohoe	Viwornu	7-9
Jasikan	Sika-mo	-
Kadjebi	Sika-mo	-
Kpoeta	Viwornu	4-6
	Perfumed rice	7-9
Santrokofi	Viwornu	7-9
Worawora	Sika-mo	-

[1]Visual scores of leaf blast incidence and severity were rated on the IRRI scale of 0-9 where 0-3 = severity or incidence of 0-5% of affected leaf area, 4-6 = severity or incidence of 6-25% of affected leaf area and 7-9 = severity or incidence of > 25% of affected leaf area and
[2]Blast was not recorded.

highest in the nurseries and young plants and ratoons in the vegetative stage. Thus, seedling blast was recorded at all the low, moderate and high blast areas during these surveys. The results also suggest that, Sefwi, Upper-Denkyira and Hohoe districts in southern Ghana, Nyankpala and Kpachie in Northern Region and Bawku and Nyorigu in Upper East Region can be regarded as blast prone areas. Generally, the incidence and severity of rice blast varied across different locations in different years. It was also observed that where farmers planted local varieties, blast incidence was much higher than where improved varieties were planted. This was probably why some villages and towns in the Upper East Region did not experience blast incidence. In towns such as Navrongo, Sandema and Tono, which are close to Tono Irrigation Project, use of improved varieties such as Tox 3107, Tox 3108 and IR 64 appeared to be common.

These surveys have shown that blast disease occurs in most places where rice is grown in Ghana. During the surveys, it was predicted that the blast disease would devastate the IPM demonstration trials set up by MOFA in Sefwi and some farms in Hohoe district. This occurred in the Hohoe district as predicted, and was reported

Table 4. Survey of rice blast in Northern Ghana, 2000-2001 cropping seasons

Location	Variety	Score (0-9)[1]
Northern Region		
Damongo	Improved	-[2]
Galenkpegu	PVS materials/Local	7-9
Golinga	Agongima	0-3
Kpachie	PVS materials/Local	7-9
Nyankpala	Mendi	7-9
Salaga	Tox 3050	4-6
Upper East Region		
Bawku	Local	7-9
Bolgatanga	Red rice	4-6
Fumbisi	Improved	-
Manga	PVS materials	-
Navrongo	Improved	-
Nyorigu	PVS materials/Local	4-6
Sandema	Improved	-
Tono	Improved	-
Wiaga	Improved	-
Upper West Region		
Babame	Improved	-
Busa	Improved	-
Dorimon	Improved	-
Vieri	Improved	-
Wa	Improved	-

[1]*Visual scores of leaf blast incidence and severity were rated on the IRRI scale of 0-9 where 0-3 = severity or incidence of 0-5% of affected leaf area, 4-6 = severity or incidence of 6-25% of affected leaf area and 7-9 = severity or incidence of > 25% of affected leaf area and*
[2]*Blast was not recorded.*

by the Daily Graphic of February 15, 2002. The Daily Graphic report, however, attributed the disease to drought since blasted rice plants, usually appear scorched, giving the impression that the disease is due to soil moisture stress. However, our survey results suggest that the major cause of rice crop failure in the Hohoe district in 2001 was due not to soil moisture stress but to high incidence and severity of blast. This was because the disease was present in high levels even during the rainy period of the surveys.

The results of this survey supported earlier reports (Twumasi, 1996; Twumasi and Adu-Tutu, 1995; Nutsugah, 1997a; 1997b; Nutsugah and Twumasi, 2001; Nutsugah *et al.*, 2003) that blast is prevalent and widespread in most of the major rice-growing areas of Ghana. Predisposing factors for blast, especially under blast-favourable conditions such as high relative humidity (e.g. cloudy skies and frequent rain), extended duration of leaf wetness and high levels of fertility (Ou, 1985) are found in Volta, Western, Central and Ashanti Regions where high blast severity scores of 7-9 were recorded. Blast was most severe at hot spot areas designated as high blast areas and least severe in low blast areas. It is a continuing problem where blast susceptible varieties or local varieties are widely grown. Due to low-input subsistence food production system of rice farmers, fungicide usage is minimal. Under these conditions, use of resistant varieties in conjunction with appropriate cultural practices is the most viable method of blast control (Fomba and Taylor, 1994; Singh *et al.*, 2000).

Remarkable differences in reaction were noted among the isolates/host combinations in the artificial inoculation conducted in the screenhouse (Table 5). Out of the ten local varieties tested, seven showed compatible reaction to all the 15 isolates of *Magnaporthe grisea*. These were Vivornu, Asante-mo, Agya-Amoa, Mendi, Gomba, Agona and Agosanga. Of the remaining three varieties, Martin showed compatible reaction to nine isolates, while Mr. Harrow and Mr. More exhibited compatible reaction to 12 and 13 isolates, respectively. These results suggest that intensive cultivation of popular varieties Mr. Harrow and Mr. More at Aframso and Martin at Gbi-Godenu for ten or more consecutive years led to their compatibility to the dominant lineages (GH-1 and GH-2) and pathotypes (Chipili *et al.*, 2003). The dynamic nature of the rice blast pathogen in responding to the host genotype and environment might account for a possible explanation for the susceptibility of the local varieties. In places with long history of rice cultivation, lineage and pathotype relationships were found to be more complex (Zeigler *et al.*, 1995). Novel screening strategy based on lineage-exclusion was being tested in various rice-growing regions with a view to prolonging the durability of resistant varieties (Zeigler *et al.*, 1995). The lineage-exclusion method proposes pyramiding genes that are each effective against an entire lineage into a variety so that durable resistance can be achieved (Chipili *et al.*, 2001; Levy *et al.*, 1993; Zeigler *et al.*, 1995). In Ghana, the current emphasis in blast control is on developing rice varieties with adequate levels of resistance in conjunction with sound crop management practices. In order to achieve this, information on genetic and pathotype diversity of the blast pathogen populations and characterisation of key sites suitable for resistance screening have been developed (Chipili *et al.*, 2003). These findings provide a framework for the identification and deployment of lineage- and location-specific resistance sources.

Identification of resistance sources among the ten improved varieties is critical to the development of blast resistance, because in blast prone areas the blast pathogen tends to overcome the resistance in 2-3 growing seasons. These varieties showed varying degrees of resistance to the 15 isolates. Sika-mo showed resistance to 14 isolates while WAB 450-I-B-P-91-HB showed resistance to ten isolates. IDESSA 85 and IRAT 216 showed resistance to nine isolates and WAB 515-177-2, WAB 450-I-B-15-7-1-1 and Digan were resistant to eight isolates. Furthermore, IDESSA 46, Kleminson and WAB 56-50 were resistant to seven isolates. These results clearly identify the need for thorough screening of rice varieties before releasing them to farmers for cultivation.

The study reports the field reaction of rice varieties to blast disease at key screening sites in Northern and Upper East Regions in 2000-2002 rainy seasons as shown in Tables 6-8. None of the material evaluated was free of blast disease, although varying degrees of reactions were recorded. At Gbulung and Tolon, no difference was detected among the varieties for their field reaction to blast disease (Table 6). The blast situation at Galenkpegu, Salaga, Tambalug and Tarkpaa was low with mean severity scores

Table 5. Reaction of some rice varieties artificially inoculated with various *Magnaporthe grisea* isolates[1]

	Blast isolates														
Variety	**B 18**	**B124**	**B149**	**B152**	**B153**	**B157**	**B158**	**B159**	**B161**	**B164**	**B167**	**B175**	**B179**	**B201**	**B202**
Viwornu (Local)	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Mr. Harrow (Local)	R	S	S	S	S	S	S	S	S	S	S	S	S	R	R
Mr. More (Local)	R	S	S	S	S	S	S	S	S	S	S	S	S	R	S
Asante-mo (Local)	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Sika-mo	R	R	R	R	R	S	R	R	R	R	R	R	R	R	R
Agya-Amoa (Local)	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Martin (Local)	R	S	R	R	S	S	S	S	S	S	S	S	R	R	R
Digan	R	S	R	R	S	S	S	R	R	R	S	S	S	R	R
IDESSA 46	S	S	R	R	S	R	R	S	R	R	R	S	S	S	S
IRAT 216	R	S	R	R	R	S	S	R	R	R	S	S	S	R	R
WAB 450-I-B-P-91-HB	R	S	R	R	R	S	R	S	R	R	S	S	S	R	R
Mendi (Local)	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Gomba (Local)	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Agona (Local)	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
WAB 450-I-B-15-7-1	R	S	R	R	R	R	S	R	R	S	S	S	S	S	S
Kleminson	S	S	R	R	S	S	S	R	R	S	S	S	R	R	R
WAB 515-177-2	R	S	R	R	R	S	R	R	S	R	S	S	S	S	R
IDESSA 85	R	S	R	R	S	S	S	S	S	R	R	R	R	R	R
WAB 56-50	S	S	R	R	R	R	S	R	S	R	R	S	S	S	S
Agosanga (Local)	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

[1]*Host responses were scored on a 0-5 scale (Valent et al., 1991) where a score of 0 and 1 being recorded as an incompatible (R) reaction while lesion type 2 or greater was recorded as a compatible (S) reaction.*

Table 6. Blast incidence on rice varieties in nurseries at Gbulung and Tolon during 2000 rainy season

Variety	Score (0-9)[1]/Site Gbulung	Tolon
WAB 450-24-3-2-P-18-HB	1.0	1.0
WAB 450-I-B-P-91-HB (NERICA 4)	1.0	-[2]
IRAT 262	1.0	1.0
WAB 337-1-B-B-7-H4	1.0	1.0
WAB 570-35-53	1.0	-
Digan (IR 12979-24-21)	1.0	1.0
WAB 450-I-B-P-15-7-1-1	-[2]	1.0
Kleminson	1.0	1.0
WAB 586-1-1	1.0	1.0
IRAT 216	1.0	1.0
Kpukpla (Local)	1.0	2.0
WAB 96-5-1	1.0	1.0
WAB 96-11	1.0	-
Mean (13 varieties)	1.0	1.1
LSD (0.05)	0.0	0.53
CV (%)	0.0	33.20

[1]*Visual scores of incidence and severity of leaf blast were rated on the IRRI scale of 0-9; mean of four replicates and*
[2]*Variety was not tested.*

ranging from 1.2-2.9 (Table 7). At Tambalung, the blast severity score was very high on the local varieties; Kpukpla (7.7), Agongima (7.7), Agona (7.5) and Agosanga (7.0). Agongima also had blast severity score of 7.0 at Galenkpegu. The improved varieties had low blast scores of 1.0-4.0 (Table 7). The blast pressure at Nyorigu, Golinga and Nyankpala was slightly higher with mean severity scores of 1.8-3.6 (Table 8). The blast severity scores at Nyorigu was much higher on the local varieties as well; Agosanga (8.5), Agona (9.0), Agongima (5.0), Kukuosum-bog (9.0), Kpukpla (7.0) and Gambiaka (7.0) (Table 8). The high level of susceptibility of the local varieties is not surprising due to their intensive cultivation at the key screening sites. Two of the improved varieties WAB 96-5-1 and WAB 586-1-1 also recorded high blast score of 7.0, suggesting that the blast pressure at the Nyorigu screening site differentiated them as sus-

Table 7. Blast incidence on rice varieties in nurseries at Galenkpegu, Salaga, Tambalug and Tarkpaa during 2001 rainy season

	Score (0-9)[1]/Site			
Variety	Galenkpegu	Salaga	Tambalug	Tarkpaa
WAB 450-24-3-2-P-18-HB	1.0	1.0	3.5	2.0
WAB 450-I-B-P-91-HB (NERICA 4)	1.0	1.0	3.0	1.0
WAB 450-I-B-P-160-HB (NERICA 6)	1.0	1.0	2.0	1.0
WAB 450-I-B-P-163-4-1	1.0	1.0	1.0	1.0
WAB 450-11-1-2-P-41-HB	1.0	1.0	1.0	1.0
WAB 450-I-B-P-38-HB-(NERICA 1)	1.0	2.0	1.0	1.0
WAB 450-I-B-P-163-2-1	1.0	1.0	1.0	1.0
IRAT 262	1.0	1.0	2.0	1.0
WAB 515-13-13A$_1$-8	1.0	1.0	4.0	1.0
WAB 337-1-B-B-7-H4	1.0	1.5	1.0	1.0
WAB 570-35-53	1.0	2.0	1.0	2.0
Digan (IR 12979-24-21)	1.0	1.5	1.5	1.0
WAB 450-I-B-P-15-7-1-1	1.0	1.8	2.0	1.0
Kleminson	1.0	4.0	1.5	1.0
WAB 586-1-1	1.0	1.5	3.5	1.0
IRAT 216	1.0	1.0	-[2]	-[2]
Sika-mo (Tox 3108-56-4-2-2-2)	1.0	1.0	3.0	1.0
Gambiaka (Local)	2.0	1.5	1.0	2.0
Kpukpla (Local)	3.0	-[2]	7.5	1.0
Kukuosumbog (Local)	2.0	-	3.0	1.0
WAB 96-5-1	1.0	-	3.5	2.0
IDESSA 85	1.0	-	1.5	1.0
WAB 96-11	1.0	-	1.0	1.0
Agongima (Local)	7.0	-	7.5	1.0
Agona (Local)	2.0	-	7.5	1.0
Agosanga (Local)	3.0	-	7.0	-
Mean (26 varieties)	1.5	1.4	2.9	1.2
LSD (0.05)	0.0	1.14	1.25	0.0
CV (%)	0.0	56.17	31.10	0.0

[1] *Visual scores of incidence and severity of leaf blast were rated on the IRRI scale of 0-9; mean of four replicates and*
[2] *Variety was not tested.*

Table 8. Blast incidence on rice varieties in nurseries at Nyorigu, Golinga and Nyankpala during 2002 rainy season

Variety	Score (0-9)[1]/Site		
	Nyorigu	Golinga	Nyankpala
WAB 450-24-3-2-P-18-HB	3.0	2.0	3.0
WAB 450-I-B-P-91-HB (NERICA 4)	1.0	2.0	1.0
WAB 450-I-B-P-160-HB (NERICA 6)	1.0	2.0	2.3
WAB 450-I-B-P-163-4-1	1.0	2.0	1.3
WAB 450-11-1-2-P-41-HB	3.0	3.5	1.0
WAB 450-I-B-P-38-HB-(NERICA 1)	3.0	2.5	1.0
WAB 450-I-B-P-163-2-1	1.0	2.0	1.0
IRAT 262	3.0	2.0	1.0
WAB 515-13-13A_1-8	1.0	2.0	1.0
WAB 337-1-B-B-7-H4	1.0	-[2]	1.0
WAB 570-35-53	3.0	2.5	1.5
Digan (IR 12979-24-21)	3.0	2.0	1.0
WAB 450-I-B-P-15-7-1-1	1.0	2.0	2.0
Kleminson	1.0	-	2.3
WAB 586-1-1	7.0	2.0	1.5
IRAT 216	1.0	2.0	1.3
Sika-mo (Tox 3108-56-4-2-2-2)	1.0	-	1.8
Gambiaka (Local)	7.0	-	2.8
Kpukpla (Local)	7.0	2.5	2.5
WAB 450-11-I-I-P31-HB (NERICA 5)	-[2]	2.0	-[2]
Kukuosumbog (Local)	9.0	2.0	2.8
WAB 96-5-1	7.0	-	3.0
IDESSA 85	3.0	-	-
WAB 96-11	3.0	-	2.8
Agongima (Local)	5.0	-	-
Agona (Local)	9.0	-	-
Agosanga (Local)	8.5	-	1.8
Mean (27 varieties)	3.6	2.1	1.8
LSD (0.05)	0.27	0.49	0.94
CV (%)	5.45	16.53	37.95

[1]*Visual scores of incidence and severity of leaf blast were rated on the IRRI scale of 0-9; mean of four replicates and*
[2]*Variety was not tested.*

ceptible varieties. The screening has led to the identification of potential blast resistant varieties with low severity scores of 0.0-3.0. Sika-mo, NERICA 1, NERICA 4, NERICA 5 and NERICA 6 show great potential for use in a host-plant resistance strategy to combat blast disease. These varieties need to be further tested extensively at on-farm levels with farmers employing participatory approaches to validate their performance and enhance varietal diffusion of the improved varieties as replacement for the local varieties.

CONCLUSIONS

Incidence and severity of blast across key rice growing areas in Ghana have been surveyed and areas of blast scores of 0-3 (low), 4-6 (moderate) and 7-9 (high) have been identified. Blast isolates were collected from seven regions (Ashanti, Central, Eastern, Northern, Upper East, Volta and Western), where rice is mostly grown. The survey revealed that where farmers plant local varieties, blast incidence and severity were much higher than where improved varieties were planted. Twenty rice varieties were evaluated under screenhouse conditions against 15 isolates of *Magnaporthe grisea* and some have shown resistance to dominant Ghanaian blast lineage representatives. The field evaluation has led to the identification of potential blast resistant varieties, some of which can be further tested and/or developed for use in Ghana. Deployment of resistant varieties in conjunction with good cultural practices is therefore the most effective and economical way to combat the blast disease.

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