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Research Application Summary

Resistance to blast in interspecific finger millet progenies

Akech, V.[1], Ojulong, H.[2], Okori, P.[1, 2] & Biruma, M.[3]
[1] Department of Agricultural Production, School of Agriculture, College of Agricultural and Environmental Sciences, Makerere University, P. O. Box 7062, Kampala, Uganda
[2] International Crops Research Institute for the Semi-Arid Tropics
[3] National Semi-Arid Resources Research Institute (NaSARRI), Serere, Uganda
Corresponding author: akechviolet5@gmail.com

Abstract

Blast disease caused by *Magnaporthe grisea* (anamorph-*Pyricularia grisea* (Cooke) Sacc.) is the single most destructive disease of finger millet (*Eleusine coracana*) causing substantial yield losses to the crop. Infection of the neck and head by the blast pathogen inhibit grain formation, causes shrivelling of grains, and in extreme cases causes yield losses up to 90%. A study was conducted to identify new blast resistant sources among the F_4 (derived from *E. kigeziensis x E. coracana* (Pese 1)*, E. africana x E. coracana (*Seremi 1*) and E. africana x E. coracana (*Seremi 3*))* interspecific finger millet progenies and to exploit such broad sources of genetic variation and potential for increased finger millet productivity. Significant differences among the F_4 progeny for all the three forms of blast disease were found, with the highest mean square of variance being for neck blast, followed by head blast and least leaf blast. Two lines were resistant to all the three forms of blast disease, 13 lines were resistant to neck blast and head blast and moderately resistant to leaf blast; six lines were resistant to neck and head blast but susceptible to leaf blast. No lines showed total immunity (highly resistant) and high susceptibility to the leaf blast disease.

Key words: *Eleusine coracana,* interspecific, *Magnaporthe grisea*, resistance, Uganda

Résumé

La pyriculariose, maladie causée *par Magnaporthe grisea* (anamorphe-*Pyricularia grisea* (Cooke) Sacc.), est la seule maladie la plus destructrice de l'éleusine (*Eleusine coracana*), provoquant des pertes importantes de rendement pour la culture. L'infection du nœud et de la panicule par l'agent pathogène de la pyriculariose inhibe la formation des grains, provoque le dépérissement des grains, et dans les cas extrêmes entraîne des pertes de rendement allant jusqu'à 90%. Une étude a été menée afin d'identifier de nouvelles sources résistantes à la pyriculariose parmi les F_4 (dérivées d'*E. kigeziensis x E. coracana* (Pese 1), *E. africana x E. coracana* (Seremi 1) et *E. africana x E. coracana* (Seremi 3) progénitures interspécifiques de l'éleusine afin d'exploiter de telles larges sources de variation et le potentiel génétique d'augmenter de la productivité de l'éleusine. Des différences significatives ont été observées entre les progénitures F_4 pour toutes les trois formes de la pyriculariose, avec le carré moyen le plus élevé de la variance étant pour la pyriculariose du nœud, suivie par la pyriculariose de la panicule et la moins prononcée étant la pyriculariose foliaire. Deux lignées étaient résistantes à toutes les trois formes de la pyriculariose, 13 lignées étaient résistantes à pyriculariose du nœud et de la panicule, et modérément résistante à la pyriculariose foliaire; six lignées étaient résistantes à la pyriculariose du nœud et de la panicule, mais sensible à la pyriculariose foliaire. Aucune des lignées n'a montré une immunité totale (très résistante) et une haute sensibilité à la pyriculariose foliaire.

Mots clés: *Eleusine coracana*, interspécifique, *Magnaporthe grisea*, la résistance, l'Ouganda

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Background

Finger millet (*Eleusine coracana*)is grown in almost all agro-ecological areas of Uganda, but production is concentrated in the east, north and southwest agro-ecologies of the country; in these regions it is a basic staple food playing a very important role in meeting dietary needs (Oryokot, 2001). Blast disease caused by *Magnaporthe grisea* (anamorph- *Pyricularia grisea* (Cooke) Sacc.) is a major problem and the most destructive disease of finger millet causing substantial yield losses to the crop. It has been reported to occur in all finger millet growing areas of East Africa (Wanyera, 2007; Kisandu *et al*., 2007). Most cultivated landraces are susceptible with grain yield losses of up to 60% (Obilana and Manyasa, 2002). Also, most of the cultivars grown by farmers are un-improved, with low grain yields and are susceptible to blast disease. Blast resistance is often evaluated in the field in hot spot areas under natural infection (Nagaraja, 2010). However this sometimes provides opportunity for escapes leading to spurious resistance being identified (Thakur *et al.,* 2009). To avoid disease escape artificial inoculation either in the field or in the greenhouse is carried out. The objective of this study was to identify interspecific progeny lines that are potentially resistant to the finger millet blast disease in Uganda.

Literature summary

Magnaporthe grisea is spread by air and seed with seed transmission being significant through seed movement (Takan *et al*., 2004). The pathogen reproduces both sexually and asexually and is identified based on its morphological growth pattern and spore shape. The fungus produces greyish mycelium with conidiophores arising singly or in groups on the affected part. The disease is polycyclic producing millions of conidia (spores) within a short period (1 or 2 days) when conditions are conducive (Ruiz, 2003). Conidia are produced and released during periods of high relative humidity (>89 % RH), and optimal temperature of 25-28°C and germinate within a few hours (Ruiz, 2003). Subsequently, infection takes place by development of an appressorium at temperatures of 16-25°C, which generates high turgor pressure and physical force, allowing the fungus to break the host cuticle and invade plant tissue within 10 hours (Talbot, 2003). The symptoms of finger millet blast disease include diamond shaped, greyish white lesions bordered by a brown margin that develop on leaves and black lesions on the inflorescence (Holt, 2000). Seedlings may die under epidemic conditions, and empty fingers and broken pedicels may result in mature plants. The same pathogen can affect three sites of the plant, i.e., leaf, neck and head causing leaf, neck and head blast, respectively. Neck and head blast are more destructive than leaf blast, and reactions to these two phases of the disease are important parameters for identifying sources of resistance to blast (Takan *et al*, 2004; Nagaraja *et al*., 2010).

Study description

The experiment was conducted at Makerere University Agricultural Research Institute (MUARIK) in 2014. The materials that were used for this study were F_4 families from three previously generated interspecific crosses of allotetraploids wild types (*E. kigeziensis* and *E. africana*) and locally adapted susceptible and resistant finger millet cultivars (*E. corocana*); 32 families of *E. kigeziensis* x Pese 1, two families *E. africana* x Seremi 1 and 14 families of *E. africana* x Seremi 3. The experiment was established following the Alpha lattice design; five seedlings of each accession were tested in four replications (5 seedlings/ pot). Seedlings were raised in 15-cm diameter plastic pots (5 seedlings/pot) filled with sterilized soil-sand-farm yard manure mix (2:1:1 by volume) in a greenhouse bay. At 30 days after planting, these were transferred into the humidity chamber set at a temperature of 21^{o} c and humidity of e" 90% for 24 hours before inoculation. Humidity was maintained high by misting three times a day and placing water troughs around the room. *M. grisea* was cultured from diseased samples collected from finger millet fields. The pathogen was isolated and purified through single-spore culture and maintained on oatmeal agar (OMA) for further use. The conidial concentration in the suspension was adjusted to 1 x 10^{5} ml^{-1} for the inoculation. The 31 day-old seedlings were inoculated by spray inoculation using an atomizer. Blast severity was recorded at 7 days, 14 days and 21 days after inoculation using a 1-3.5 progressive scale (Takan *et al*, 2002) (Table 1).

Neck blast severity was assessed based on the relative lesion size on the neck on a 1 to 5 progressive ratings scale developed by Babu *et al*. (2012) where, 1 = no lesions to pin head size of lesions on the neck region, 2 =0.1 to 2.0 cm size of typical blast lesion on the neck region, 3 = 2.1 to 4.0 cm, 4 = 4.1 to 6.0 cm, and 5 = >6.0 cm size of typical blast lesion on the neck region. The 1-5 rating scale was classified into four infection types (i.e., 1.0-2.0 =

Table 1. Disease severity ratings for foliar/leaf blast

Severity score	Percent severity	Status
1.0-1.4	0-5%	HR
1.5-1.9	6-10%	R
2.0-2.4	11-20%	MR
2.5-2.9	21-30%	S
3.0-3.5	Ã31	HS

HR=highly resistant; S = Susceptible; HS= highly susceptible; R= Resistant; MR= moderately resistant

resistant; 2.1-3.0 = moderately resistant; 3.1-4.0 = susceptible and 4.1-5.0 =highly susceptible). Data were recorded in the greenhouse at physiological maturity on five randomly selected individual plants of each accession, four times at weekly interval. The finger blast severity estimate was recorded as visual percentage of blasted florets across all tillers of a plant on the same five randomly selected plants that were earlier rated for the neck blast severity in each row four times at weekly intervals (Babu *et al*., 2012). Blast disease severity means were separated using Fisher's protected Least Significant Difference (LSD) test at $P < 0.05$.

Research application

Analysis of variance showed significant differences among the F_4 progeny for all the three forms of blast disease with neck blast having the highest mean square of variance, followed by head blast and least leaf blast. All the lines (100%) were resistant to neck blast with a range of 1.0- 1.8. Head blast severity ranged from 1.8 to 2.4 compared to 1.9 for the resistant check Gulu E and 3.4 for the susceptible check E11. Twenty lines (42%) were rated resistant and 28 (58%) were moderately resistant. No line was completely immune (highly resistant) and susceptible to head blast (Table 2). Two lines (25a and 25 c-b) were resistant to all the three forms of blast disease, 13 lines (8b, 6b, 8a, 24b, 22b, 22a, 21b, 20b, 19c, 19c-b, 17b, 13c-b, 13a) were resistant to neck blast and head blast and moderately resistant to leaf blast; and six lines (14c, 20c, 22c-b, 23a, 28a, 5b) were resistant to neck and head blast but susceptible to leaf blast

Over 50% of test lines were resistant to leaf, neck and head blast under artificial inoculation. This high percentage of resistance offer a good source of genes for resistance to blast. Resistant genotypes developed symptoms slowly, perhaps indicative of reduced disease development commonly associated with multi gene based systems (horizontal resistance) (Van der Plank, 1963). If this is true then the slow blasting genotypes identified in this study have long term resistance and may withstand the high blast pathogen variability that is prevalent in Uganda (Takan *et al*., 2012).

Table 2. Table summarizing the reaction of accessions to blast

Category	Number of F4 accessions		
	LB	NB	HB
HR	00	00	00
R	05	48	20
MR	37	00	28
S	06	00	00
HS	00	00	00

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