Resistance genes and gene pyramids controlling rice blast pathogen populations in eight African countries

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Abstract

Background

The behavior of rice varieties under natural environments in fields often differs from the expected one. For developing varieties, breeders give then a particular importance to multi-local field screening to confirm the resistance of their germplasm. We assembled 81 accessions e.g. blast differential, traditional and improved varieties and tested them for resistance to blast (*Pyricularia grisea*) in eight African hot spots under different ecologies. We thus expected to identify accessions and genes or gene pyramids that provide durable resistance locally or across sites.

Methods

81 accessions (e.g. blast differential, traditional and improved varieties were tested in hot spots in Benin, Burkina Faso, Côte d'Ivoire, Madagascar, Mali, Rwanda, Togo and Uganda for resistance to leaf and neck blast. An Alpha design (randomized incomplete block) with four replications was used. Correlation between leaf blast and neck blast severity and between incidence and severity were analyzed.

Results:

From 2013 to 2016, multi-local screening tests were conducted at yje selected sites. Among the 81 rice accessions tested, seven accessions were consistently susceptible while 12 were resistant across locations and seasons. Interestingly, effective individual resistance genes (R genes) or gene pyramids efficient across the sites were identified. In addition, we noticed on some sites, changes in the responses of some rice accessions to the disease from one season to the other. Responses of some accessions also showed great variations from one site to another. In addition, several accessions sharing the same resistance genes exhibited different responses to blast. Regarding the neck blast, only fewer accessions could be assessed as very susceptible ones died at early stages. Although differential responses were observed in the four sites considered for the analysis, several accessions consistently resisted. In addition, results showed that leaf and neck blast resistances were correlated.

Conclusions

Results obtained provide useful information on the tested germplasm resistance. In addition, it was possible to identify resistant accessions and sometimes the R genes associated which were effective locally or across sites. Results also showed shifts in pathogenicity of the pathogen populations over seasons and sites. Finally, breeders can now use this valuable information for sustainable blast resistance breeding.

Background

Genetic control through the use of resistant varieties is undoubtedly the most economically efficient and environmentally friendly way to control diseases. Theoretically, it seems obvious that the development of resistant varieties with pyramid of resistant genes (R genes) capable of resisting blast is an option to have good yield [4, 5]. However, given the great genetic variability of *P. grisea* in space and time, resistance failures are encountered in the development programs for resistant varieties [6].

Therefore, one of the challenges for rice breeders and plant pathologists is to identify the resistance genes that hold consistently over time and in all environments. Thus, several collaborative programs to create blast differential varieties by incorporating R genes in a common rice susceptible background were conducted. This is the case, for example, of the monogenic lines developed by a collaborative initiative that involved the International Rice Research

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Authors' information (optional)

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Tables

Table 1: Characteristics of the sites where each trial was conducted in the eight countries.

Countries	Trial no.	Site	Ecology	GPS coordinates	Date	Temperature**	Rainfall**	Relative humidity**	Disease scored
						Mini-maxi or mean in °C	Mini-maxi or mean in mm	Mini-Maxi in %	
Benin	1	Calavi	Upland	N06°25’133’’E002°19’665’’	Jun-Nov 13	25.9-27.5	0.5-118	81.2-86.0	Leaf/Neck
	2		Lowland	N06°25’322’’E002°19’604’’	Nov 13-Apr 14	27.5-29	25.4-107	78.0-82.0	Leaf/Neck
	3		Lowland	N06°25’322’’E002°19’604’’	May-Oct 14	26.0-28.0	109-235	81.0-87.0	Leaf/Neck
Togo	4	Kovié	Irrigated	N06°22’283’’E01°06’024’’	Oct 13-Feb 14	27.8-29 .6	4.2-159.0	72.0-79.0	Leaf/Neck
	5		Irrigated	N06°22’283’’E01°06’024’’	Jun-Oct 14	25.8-27.8	65.7-215.9	80.1-83.5	Leaf/Neck
Mali	6	Longorolla	Upland	N11°23'08.9"W05°39'42.6"	Jul-Oct 13	-*	283.0-355.0	-	Leaf/Neck
	7		Upland	N11°23'08.9"W05°39'42.6"	Jul-Oct 14	-	40.8-93.8	-	Leaf/Neck
Cote d’Ivoire	8	M’bé	Upland	N7°51'23.09"W5°06'43.98"	Jul-Oct 14	26.7-24.4	58.1-408.5	88.0-88.4	Leaf/Neck
	9		Upland	N7°51'23.09"W5°06'43.98"	May-Oct 15	19.4-35.2	45.2-298.0	58.4-100.0	Leaf/Neck
Burkina Faso	10	Farako-bâ	Upland	N11°09'23"W004°33'24"	Jul-Oct 14	29.9-31.1	46.8-322.0	85.9-89.7	Leaf/Neck
Madagascar	11	Ivory	Upland	S19°33’20.3’’E46°24’52.7’’	Nov 14-Mar 15	22.7-25.7	12-615	49.2-89.8	Leaf/Neck
	12	Ivory	Upland	S19°33’44.9’’E046°24’77.0’’	Dec 15-Mar 16	-	-	-	Leaf/Neck
Uganda	13	Namulonge	Upland	N00°31’30’’E32°36’54’’	Oct 14-Mar 15	23.0-26.0	52.0-152	53.8-68.8	Leaf/Neck
Rwanda	14	Kirimburi P8	Irrigated	S 1°17’27.65’’ E 30°18’.55.61	Nov 14-Apr 15	21.7-32.2	827	60.8-81.5	Leaf