

Research Application Summary

Bacterial leaf streak disease of Rice: A silent constraint to Rice production in Uganda

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Abstract

Bacterial leaf streak disease (BLS) caused by *Xanthomonas oryzae* pv *oryzicola* is one of the emergent biotic constraints to rice production in Africa. The disease, which can cause yield loss of up to 60% on susceptible cultivars, was observed in Uganda in the rice growing districts of Namutumba, Butaleja and Iganga in 2014. As such there is limited data on the distribution of bacterial leaf streak disease in rice growing areas of Uganda. Using a systematic sampling survey, 176 rice fields at tillering to panicle initiation stages in 14 rice growing districts of Uganda were assessed for the prevalence of BLS disease. Results show a high prevalence of bacterial leaf streak disease, where 71.4% of the districts surveyed had the disease. Data collected also revealed significant differences ($P < 0.001$) in BLS incidence and severities between the districts surveyed. The results further indicated that rice fields where improved varieties and clean seeds were planted had very low incidences and severity. The high prevalence of BLS disease in the rice growing districts may be due to existence of highly virulent BLS pathogens, favourable environment (high humidity and warm temperature) and cultivation of susceptible local rice genotypes. Poor rice residue management, poor field hygiene and utilization of home saved rice seeds by majority of the farmers could also account for the wide occurrence of BLS disease since these lead to the build-up of primary inoculum. For sustainable management of this disease, there is need to create awareness on the wide occurrence of BLS disease in Uganda, educate farmers on management of the disease, understand the population structure of BLS pathogen in Uganda and identify genetically stable sources of resistance to the pathogen under Uganda's conditions.

Key words: Bacterial leaf streak, prevalence, rice, *Xanthomonas oryzae* pv *oryzicola*, Uganda

Résumé

La maladie bactérienne des feuilles du riz causée par *Xanthomonas oryzae* pv *oryzicola* est l'une des contraintes biotiques émergentes à la production de riz en Afrique. La maladie, qui peut entraîner une perte de rendement allant jusqu'à 60% chez les cultivars sensibles, a été observée en Ouganda dans les districts rizicoles de Namutumba, Butaleja et Iganga en 2014. On dispose de données limitées sur la distribution de La maladie bactérienne des

feuilles du riz en Ouganda. A l'aide d'une enquête systématique d'échantillonnage, 176 champs de riz ont été évalués pour la prévalence de La maladie bactérienne des feuilles du riz. Les résultats montrent une forte prévalence de la maladie, où 71,4% des districts évalués avaient la maladie. Les données recueillies ont également révélé des différences significatives ($P < 0,001$) dans l'incidence et les sévérités de La maladie bactérienne des feuilles du riz entre les districts étudiés. Les résultats indiquent en outre que les rizières où les variétés améliorées et les semences propres ont été plantées ont eu des incidences et une gravité très faibles. La forte prévalence de la maladie dans les districts rizicoles peut être attribuée à l'existence de pathogènes agents de la maladie hautement virulents, à un environnement favorable (humidité élevée et température chaude) et à la culture de génotypes de riz locaux sensibles. Une mauvaise gestion des résidus de riz, une mauvaise hygiène sur le terrain et l'utilisation de graines de riz stockées par la majorité des agriculteurs pourraient également expliquer la présence importante de la maladie bactérienne des feuilles du riz, car ils conduisent à l'accumulation d'inoculum primaire. Pour la gestion durable de cette maladie, il est nécessaire de sensibiliser la population à l'ampleur de La maladie bactérienne des feuilles du riz en Ouganda, d'éduquer les agriculteurs sur la gestion de la maladie, de comprendre la structure de la population du pathogène en Ouganda et d'identifier des sources de résistance génétiquement stables au pathogène sous les conditions de l'Ouganda.

Mots clés: La maladie bactérienne des feuilles du riz, la prévalence, le riz, *Xanthomonas oryzae pv oryzicola*, Ouganda

Background

Rice (*Oryza sativa*) is a staple food for more than half of the world's population, providing 21% of global human per capita energy and 15% of per capita protein (IRRI, 2016). However rice yield and production in Uganda is still low mainly due to diseases, labour shortage, limited capital, and inefficient equipment for rice cultivation and processing (Odogola, 2006). Among the rice diseases, bacterial leaf streak (BLS) caused by *Xanthomonas oryzae pv oryzicola*, was recently observed in Uganda mainly in the rice growing districts of Butaleja, Iganga and Namutumba (Afolabi *et al.*, 2014). Bacterial Leaf Streak disease has potential of affecting entire fields leading to yield losses of up to 32% under favourable conditions (Sukchawalit, 2001). This level of loss could threaten Uganda's food security and livelihoods of rice farming communities. The BLS pathogen is favoured by high humidity and warm temperature especially at 28°C. Although the weather patterns in Uganda are variable, most rice production areas are characterized by high relative humidity and warm temperature, making it ideal for the development of bacterial leaf streak disease. It is likely that the BLS disease is widely spread in Uganda. This study was therefore done to assess the occurrence of BLS in Uganda. Studies on genetic diversity of *Xanthomonas oryzae pv oryzicola* revealed that different strains exist within the pathogen population (Niño-liu *et al.*, 2006 and Wonni *et al.*, 2014). The BLS pathogen, *Xanthomonas oryzae pv oryzicola* is seed transmitted and is a hemibiotroph in terms of its mode of nutrition (Jepson, 1990). Details of the genetic diversity of this pathogen in Uganda is still unknown.

Literature search

Bacterial leaf streak (BLS) disease of rice is caused by *Xanthomonas oryzae* pv *oryzicola* (Swings *et al.*, 1990). The disease is a major constraint to rice production in humid tropical and subtropical areas of Asia and Africa (Nino-liu *et al.*, 2006). Symptoms begin with small, water-soaked lesions anywhere along the leaf between the veins (Jepson, 1990; Niño-liu *et al.*, 2006). The pathogen *Xanthomonas oryzae* pv *oryzicola* is a rod-shaped, round-ended, Gram-negative bacteria (Swings *et al.*, 1990). In Uganda, BLS disease was first observed in 2014 (Afolabi *et al.*, 2014) in the major rice growing districts of Namutumba, Butaleja and Iganga. However, prevalence of the disease in these districts and elsewhere in rice growing districts in Uganda has not been documented. There is therefore a need to map the distribution of BLS disease in Uganda so as to facilitate development of sustainable management package for it.

Study description

The study was conducted between May - August 2016 through a field survey. Fifteen major rice growing districts (MAAF and UBOS, 2010) of Uganda were chosen for the study. These were selected to ensure that all agro-ecological zones were represented. In each district, 15 rice fields at tillering to panicle initiation stages were selected. These fields were selected from at least three sub counties in each district. The survey routes followed major roads leading to different trading centers with sampling sites separated by 2 - 7 km. Way points for each of the sampled fields were generated using a GPS and recorded. In each of the fields visited, data were collected on disease incidence by making a zig zag walk in the entire field and observing ten hills of rice at every 20 paces. The number of BLS infected rice hills were counted, recorded and later expressed as a percentage. For BLS severity, 20 leaf samples with typical BLS symptoms were randomly collected and the lengths of lesions on each leaf measured and computed as a percentage of the total length of the leaf.

Results

Data from the survey revealed a high prevalence of BLS disease in the major rice growing districts of Uganda with varying levels of incidence and severity. Majority of the districts surveyed, 71.4% had bacterial leaf streak. No disease was recorded in fields surveyed in Apac, Kasese, Lamwo and Lira districts.

Within the districts, there was high variability in BLS incidence and severity. The highest BLS incidence recorded was 85% in Bugiri, but Iganga (71.0%) and Butaleja (80.5%) also had high disease incidence. Generally, it was observed that BLS incidence and severity were high in lowlands where fields are flooded with water.

Table 1: Summary of BLS incidence and severity in 14 rice growing districts of Uganda

Districts	BLS incidence				BLS severity			
	Mean (%)	Minimum (%)	Maximum (%)	Standard error	Mean (%)	Minimum (%)	Maximum (%)	Standard error
Amuria	1.23	0.00	13.50	4.51	4.42	0.00	48.60	6.29
Apach	0.00	0.00	0.00	4.31	0.00	0.00	0.00	6.02
Bugiri	44.38	0.00	85.00	3.62	65.46	0.00	93.60	5.06
Butaleja	31.87	0.00	80.50	3.86	53.60	0.00	75.50	5.38
Iganga	19.03	0.00	71.00	3.86	46.97	0.00	68.20	5.38
Kanungu	11.00	0.00	44.00	5.28	27.96	0.00	78.70	7.37
Kasese	0.00	0.00	0.00	4.73	0.00	0.00	0.00	6.59
Kayunga	18.93	0.00	53.50	3.86	39.42	0.00	80.20	5.38
Lamwo	0.00	0.00	0.00	4.51	0.00	0.00	0.00	6.29
Lira	0.00	0.00	0.00	3.74	0.00	0.00	0.00	5.21
Nakaseke	7.79	0.00	37.50	4.31	18.38	0.00	55.60	6.02
Pallisa	7.73	0.00	48.00	3.86	37.61	0.00	72.00	5.38
Rukungiri	16.62	1.50	48.00	7.47	48.65	39.20	69.50	10.42
Soroti	0.17	0.00	1.50	3.86	8.93	0.00	68.30	5.38

It was also observed that the BLS disease occurrence was high on plants during reproductive stages. Surprisingly in the Northern Uganda districts of Lira, Apach and Lamwo, BLS incidence was zero, yet the environment growing conditions and age of rice in surveyed fields were similar with Bugiri, Butaleja and Iganga districts where incidence was very high.

Research application

The wide occurrence of BLS disease in Uganda may be in part due to the fact that the BLS pathogen, *X. oryzae* pv *oryzicola* is seed transmitted (Jepson, 1990). Uncontrolled movement of seed within the country would thus disseminate the disease to other areas. The bacteria is also a hemibiotroph, facilitating its survival in rice residue during off seasons. Non- occurrence of BLS in certain districts could also mean that other than environment, other factors could be influencing disease development. These factors could be varietal or pathogen related. These require further investigation.

Information that has been generated from this research can be used to guide decision making on sustainable BLS management. It can be used to formulate a regulatory framework and resource allocation towards BLS management. Agricultural scientists can also use the findings from this study to design further research on BLS disease in Uganda. Extension officers in public service, private and civil society organizations can use the information for creating awareness amongst farmers on the existence of BLS disease, its potential damage and management options.

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