Research Application Summary

Diversity of finger millet for crop improvement in Uganda

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Abstract

Finger millet (*Eleusine corocana* L), though highly nutritious and indigenous to Uganda, has not been fully exploited due to limited breeding efforts, and little information about the diversity existing within the germplasm collection. This has constrained breeding efforts and reduced the role played by finger millet as a food security crop for resource-limited farmers. Developing stable, adaptable, and high-yielding varieties of finger millet that include farmer-preferred traits should significantly increase the adoption and use of finger millet as a basic staple food, and hence reduce malnutrition among the rural poor. Improvement of varieties requires identifying parents with diverse genetic backgrounds. Therefore, the diversity in the existing germplasm needs to be assessed and to expand it as needed in order to enhance future breeding efforts. In this study substantial diversity was documented among both local landraces and introductions, and patterns of similarity were described.

Key words: Breeding, diversity, *Eleusine corocana*, finger millet, germplasm

Résumé

L'éleusine *(Eleusine corocana* L.*)*, bien que très nutritive et indigène en Ouganda, n'a pas été pleinement exploitée à cause des efforts de reproduction limités et peu d'information sur la diversité existant dans les limites de la collection du matériel génétique. Cela a contraint les efforts de reproduction et réduit le rôle joué par l'éleusine en tant qu'une culture de la sécurité alimentaire pour les agriculteurs à ressources limitées. Le développement des variétés stables, adaptables et à haut rendement de l'éleusine, qui incluent les traits privilégiés par les agriculteurs devrait augmenter de manière significative l'adoption et l'utilisation de l'éleusine comme un aliment de base, et ainsi réduire la malnutrition au sein des populations rurales pauvres. L'amélioration des variétés exige l'identification des parents avec diverses origines génétiques. Par conséquent, la diversité dans le matériel génétique existant doit être évaluée et l'élargir au besoin, afin de renforcer les efforts futurs de reproduction. Dans cette étude, la diversité substantielle a été

documentée entre les deux variétés locales et les introductions, et les modèles de similarité ont été décrits.

Mots clés: Reproduction, diversité, *Eleusine corocana*, éleusine, matériel génétique

Background

Finger millet (*Eleusine corocana)* is one of the most important cereals in Uganda. The crop is adapted to many environmental conditions, thus it is grown across all agro-ecological zones of the country The crop is mostly grown under low input conditions. It can also tolerate conditions in marginal areas. Even with limited research, the crop continues to thrive even under changing climatic conditions, and gives a promising yield under farmer conditions. Uganda, as the primary center of diversity (Mehra, 1963a; Phillips, 1972; Liu *et al.*, 2011), is endowed with highly-diverse finger millet land races and germplasm collections, which have not been fully characterized. This has significantly limited the development of high yielding varieties that have other farmer-preferred traits. This study aims to characterize the phenotypic and genetic diversity of finger millet so as to enhance developing varieties with farmer-preferred traits. The specific objectives are to: (1) characterize the phenotypic diversity present among the sampled finger millet accessions; (2) characterize the genetic diversity among the sampled finger millet using simple sequence repeats (SSR) molecular markers, and relate genetic diversity to the origin and to the phenotypic diversity of the accessions; (3) determine the effect of pre- and post- flowering drought tolerance on finger millet; and (4) determine the cross-compatibility of finger millet *Eleusine corocana* L. with *Eleusine africana* and *E. kigezienesis*. Only the characterization of the phenotypic diversity (Objective # 1) is reported here.

Literature Summary

Finger millet is cultivated in diverse eco-geographical areas, where it displays high variability in vegetative, floral and seed morphology. Three eco-geographic races have been identified (Hilu and de Wet, 1976; Upadhyaya *et al.*, 2007). These are the African highland race cultivated in East African highlands, the lowland race grown in the lowlands of Africa and South India, and the Indian race centred in Northeast India. Extensive amounts of finger millet germplasm exist (Bennetzen *et al.*, 2003), thus providing plant breeders with the necessary variation to develop productive, farmer-desired varieties. Fakrudin *et al*. (2004) and Das *et al*. (2007) found high levels of genetic diversity among finger millet genotypes of diverse origin.

Bondale *et al*. (2002) found grain yield per plant to be significantly influenced by finger length and finger width among genotypes from diverse regions of India.

Bedis *et al*. (2006) and Bezaweletaw *et al*. (2006) observed high variability in most finger millet characteristics, including days to flowering and to maturity, plant height, number of productive tillers, main ear length, finger number per ear, and grain yield. These authors also recorded high broad sense heritability for grain yield, indicating the likelihood of genetic advancement from selection. John (2006) reported high genotypic and phenotypic coefficients of variation for number of productive tillers per plant, number of fingers per ear and total dry matter production. He also reported high heritability values, coupled with high expected genetic gain for productive tillers, fingers per ear, test weight, total dry matter and harvest index.

SSR markers have been found useful in uncovering variations in finger millet, which is a self-pollinated crop and shows little or no polymorphism with other types of molecular markers, depending on the degree of variation and the number of alleles generated by a set of primers (Sinha and Pande, 2010). Therefore, properly characterizing the Ugandan germplasm for the different traits of economic importance and identification of molecular markers associated with important traits will ease breeding and hasten the development of varieties with farmer-preferred traits.

Study Description

This study was conducted in Uganda at the National Semi-Arid Agricultural Research Institute (NaSAARI) Serere (1^{o}39'N and 33^{o}27'E, 1038 m a.s.l), It involved two seasons of field evaluation of 400 genotypes, of which 49 are land races, 240 are pedigree lines from Uganda, and 111 are introductions.

Research Application

The morphological characterization showed a lot of diversity within both the Ugandan germplasm and the exotics for all agronomic traits measured, except that the number of primary tillers and the stay green trait were significant in only one group each (Table 1). The exotic germplasm provides Uganda with a unique set of genetic diversity able to be used for improving the local adapted for lacking traits. The variation in these traits will offer an opportunity for potential crop improvement through selective hybridization of parental lines that are genetically very diverse.

Table 1. Morphological characterisation of finger millet accessions for quantitative traits.

Traits	Means		Variance		
	Ugandan	Exotic	Range	Ugandan	Exotic
Dry weight (gm)	71.4	60.4	5 – 280	3292.***	1954.***
Plant height (cm)	48.6	47.7	20.3-78.7	139.2***	153.3***
Days to 50% flowering	68.7	68.7	53-87	24.1***	19.1***
Days to harvest maturity	107	107.1	88 – 139	118.4***	109.3***
Primary tillers	1.1	0.9	0 - 6	1.4*	0.93
Finger length(cm)	7.9	7.9	2.8 -13.2	2.7***	3.4***
Longest finger length (cm)	7.4	7.3	2.7 -11.7	1.9***	2.8***
Leaf rolling	1-5		3.5	1.5**	1.5*
Stay green	1-5		2	1.1	1.4**

(P<0.05)*

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