Molecular diversity patterns observed in WCA pearl millet

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is the staple cereal grain for the hottest, driest regions of sub-Saharan Africa and South Asia where rainfed agriculture is workable. It is also grown in more humid regions on light-textured soils that possess low fertility and water-holding capacity, as well as low pH, and/or high levels of aluminium saturation. This stress-tolerant crop is better adapted than other cereals to these harsh environments. Pearl millet landrace varieties were developed by farmers and their ancestors over 5000 years. Improved open-pollinated varieties have been developed by plant breeding programs over the past 50 years. Both varieties are highly variable and exhibit tremendous differences in traits, such as flowering time, plant height, and yield components (panicle numbers, panicle size, grain size).

West and Central Africa (WCA) is the primary centre of origin and diversity of pearl millet. This diversity, however, is neither fully understood nor fully accessible or efficiently used by plant breeders or farmers. We can improve the efficiency of plant breeding efforts by characterising this diversity and exploiting these crop genetic resources so as to develop higher yielding pearl millet varieties with more stable on-farm performance.

During the project ‘Mobilizing Regional Diversity’, relationships of 199 pearl millet accessions from all over WCA were characterised using 16 SSR markers. After isolation of bulk DNA from a representative sample of seedlings of each accession (based on seed lots used for field characterisation studies), each of the 199 DNA samples was characterised with these markers. A total of 117 marker variants were detected.

Relationships between the pearl millet accessions were then calculated on the basis of differences in marker variants present for each pair of accessions. The most similar pair of accessions was two medium-early flowering landraces from Niger with very long panicles. The two least similar accessions were the extra-early flowering landrace ‘Nata’ from Burkina Faso and an early flowering landrace from Mali. Graphical displays showing the relationships between accessions were then produced (for example, neighbour-joining trees, see Fig. 1). Such graphical displays, especially when combined with passport information, field characterisation information and/or information on performance of crosses between accessions, can improve our understanding of the genetic relationships between the accessions and the opportunities for exploiting them in applied plant breeding.

**Geographic differentiation**

Colour coding a tree of marker-based relationships by geographic origins of the pearl millet accessions reveals patterns of geographic differentiation (Fig. 1). Landrace accessions from Niger and Benin each tend to form a relatively compact group, while another group includes mostly accessions from Senegal and Mauritania (interspersed with some from Burkina Faso). Accessions from Burkina Faso, Mali and Nigeria, and improved open-polllinated varieties are distributed across several clusters. There was too little data to indentify clear patterns for accessions originating from other countries.
Figure 1. Neighbour-joining tree based on variation detected using 16 molecular markers that shows geographic differentiation of 199 pearl millet landraces and improved open-pollinated varieties from WCA. Note positions of standards (Tift 23DB and 863B) and several other accessions.

Merging results from this marker-based genetic diversity analysis with those from the multi-location characterisation study and from the heterosis studies that were implemented in the course of this project will generate information that can improve the efficiency of pearl millet breeding programs targeting harsh crop-livestock production environments. For example, there are several genetically distinct clusters of accessions in each maturity class that might be used to form heterotic groups for breeding higher-yielding hybrid pearl millet varieties for present and future production environments in WCA. In contrast, most of the accessions with very long panicles appear to be closely related (and are primarily landrace accessions from Niger). Now we need to convert this data and information into knowledge that can be used to breed better pearl millet varieties and hybrids that will address farmers’ needs throughout WCA.

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