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CHARACTERIZATION OF LANDRACE SORGHUM LINES FOR UTILIZATION IN HYBRID PARENT DEVELOPMENT

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Abstract

Challenge in hybrid sorghum development for the Nigerian environment remains the identification of suitable seed parents, constrained most particularly by non-appropriate indigenous sources of stable male-sterility maintenance on the female parents. To achieve this goal, defined "functional" heterotic parental-pools is required to create new and diverse hybrid parents for sustainable hybrid development. To explore availability of male–sterility inducing cytoplasm, an exploratory landrace Sorghum collection across Kano and Jigawa states of Nigeria in May 2014 were carried out to identify lines that are suitable for conversion to male sterile lines and restorers. Sorghum landrace collected from Kano-Jigawa axis were disaggregated and grouped into 26 Local names with Fara-Fara and Kaura as most common generic names accounting for 30% and 40% respectively. Preliminary characterization during 2014 cropping season evaluation showed that most of the sorghum landraces grown in the Sudan Savannah are white or yellow grain with compact elliptic panicle forms (caudatum type) accounting for 46% as compared to those in Guinea Savannah cultivating white or red grain with loose dropping panicle forms (guinea type). This could be attributed to the fact that those in the Sudan which have relative low rains also have less insect pest compared to those in the Guinea with high rains preferring loose panicle thus avoiding grain mold and insect damage. This implies that Sorghum hybrid parent development should at present target, high yielding white or yellow grains with compact elliptic panicle forms, medium height (2m) and medium maturity (100 days).

Key words: *Sorghum, hybrid, male sterility, landraces*

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INTRODUCTION

Sorghum [Sorghum bicolor (L.) Moench] is the fifth most important cereal crop in the world, but first important cereal in Nigeria. It is the most extensively traditionally grown cereal in the savannas of Nigeria extending from the Southern Guinea, to Sahel Savannah of Nigeria, primarily because of its adaptation to drought. These agro-ecological zones cover at least fifteen States namely Adamawa, Bauchi, Borno, Gombe, Jigawa, Kaduna, Kano, Katsina, Kebbi, Nasarawa, Niger, Benue, Kogi, Kwara, Plateau, Sokoto, Taraba, Yobe and Zamfara States. The country produced 8.5 million tons in 2008, 9.3 million tons in 2009 and 10.0 million tons in 2010 with a projection of being the largest sorghum grain producer in the world (ATA, 2011) by 2020. Sorghum was cultivated on about 10.845 million hectares in 2014 (NEARLS, 2014), representing about 50% of the total area under cereal crop production, and about 13 % of the total arable land in the country.

Millions of rural poor in the dry savannas of Nigeria consume sorghum in their daily diets as staple food where flour is locally processed into 'towo' and non-alcoholic beverage 'kunun-zaki'. In addition to this popularity of sorghum use in traditional dishes, there is now a gradual increase in demand for pre-processed sorghum foods for convenience and in the malting industry. The industrial demand for sorghum is growing with several flour mills in the country having started using it or considering using it in addition to wheat to produce composite flour as well as high energy foods. This is in addition to the increasing demand by malting industries for beverages. This development is expected to increase the demand for sorghum by about 30% in coming years.

Although sorghum is an indigenous crop and exceptionally adapted to the region, the yields are generally less than 1.5t/ha (FAO, 2014). Important factors among which that contribute to these low yields includes; low inputs, poor soil fertility and the non-availability of improved varieties or hybrids with significant yield superiority over farmers' landrace varieties.

The first Guinea-race sorghum hybrid parents were created by joint ICRISAT-IER Mali breeding activities from 2000 to 2008. Hybrids based on these parents have shown average yield advantages of 35% over a large number of on-farm tests, thus providing proof of concept of photoperiod sensitive hybrids for WCA (Rattunde et al., 2013) . However, its suitable only for a single maturity band (100km north-south latitude) for the Guinea-race zone of Senegal, Mali and Burkina Faso, which do not meet the adaptation or grain quality requirements especially for the drier zones of Nigeria growing the durra and caudatum types.

The potential of hybrid sorghum to provide yield advantages under drought stressed conditions in semi-arid areas of Kenya was shown by Haussmann (1998, 2000). Even higher yield advantages were shown with Nigerian germplasm in preliminary on-station testing (Andrews, 1975), although the parental materials have since been lost. Thus, it is in this context that the need to collect germplasm was conceived for the identification of suitable seed parents to develop hybrid sorghum for the Nigerian environment, constrained most particularly by non-appropriate indigenous sources of stable male-sterility maintenance on the female parents.

Several fertility restoration genes for different cytoplasmic male sterility (CMS) systems have been mapped in sorghum (Klein et al., 2005; Jordan et al., 2010, 2011). Currently in Mali the A1-CMS system is being used. The major gene for pollen restoration in the A1-system is the *Rf*1 gene, a pentatricopeptide repeat protein. Mapping new loci would be necessary if these loci are not effective for characterizing restoration capability of WCA germplasm. Genetic markers for fertility restoration would speed up the A and R line development and thus widen the genetic basis for producing more suitable hybrids. Characterization of the Nigeria landrace sorghum lines is aimed at identifying and defining "functional" heterotic parental-pools for utilization in hybrid parent development and thus increase the productivity of sorghum to meet the increasing rural and industrial demand.

Materials and methods

International crop Research Institute for Semi-Arid Tropics (ICRISAT), Nigeria Kano Office, in collaboration with Institute for Agricultural Research, Ahmadu Bello University (IAR/ABU) Zaria facilitated the collection of landrace sorghum in May 2014 within Lat. 7.05118°N - 9.43917°N and Long. 9.27314°E – 12.61084°E, covering some part of Kaduna, Kano and Jigawa states of Nigeria. Collections were done at 30-50Km intervals within the drier Sudan-Sahel agro-ecology were bulk of the sorghum are cultivated. For each entry, seeds were obtained from at least 50-100 random panicles, against which the farmers name, village, grain color, panicle forms and location GPS were recorded. Landrace sorghum line were also assessed from Diversity Trust collection of 2012 for comparison. Landraces collections from Kano-Jigawa axis were desegregated into local names as given by farmers. 372 landrace materials comprising of 59 lines from 2012 Diversity Trust, 270 (Kano-Jigawa) and 43 (Zaria axis) of 2014 BMZ Heterosis project collections were used for this study. It evaluated during 2014 cropping season at Zaria, layout in Alpha Lattice Design on a 1 row plot in 2 replications to assess repeatability. Planting was spaced at 75cm inter-row and intra -row spacing of 30cm between hills. Thinning was carried out 2 weeks after sowing (WAS) with NPK fertilizer 15:15:15 as micro-dose at 6g/hill. Urea (46% N) was split applied at 6 and 10 weeks after sowing to ensure availability of nutrients up-to grain filling. 1st and 2nd weeding was manually done at 2 and 8 WAS respectively. Crop parameters, the key traits for hybrid parents, that were recorded includes; plant height; measured on 5 random plants using graduated 5m height ruler, days to 50% flowering; from days of planting to when 50% of the plants per plot reached anthesis, panicle type; were scored according to sorghum descriptor of IBPGR and ICRISAT (1993), panicle length; of 5 random panicles and grain color based on grain color chart of IBPGR and ICRISAT (1993). Data recorded on excel sheet were analyzed using Genstat (v.14) statistical software.

RESULTS AND DISCUSSION

Disegregation

Sorghum landrace collected from Kano-Jigawa axis which forms bulk of the collection were desegregated and grouped into 26 Local names with Fara-Fara and Kaura as most common generic names accounting for 30% and 40% respectively of landrace variety (Figure 1).

Morphological characters

Preliminary characterization showed that there exists variability within the collected sorghum landraces where majority the those grown in the Sudan Savannah especially from the Kano-Jigawa axis were white *(Farafara)* while those from Zaria axis were the yellow grain *(Kaura)* with compact elliptic panicle forms (caudatum type) accounting for 46% as compared to those in Guinea Savannah cultivating white or red grain with loose dropping panicle forms (guinea type) (Figures 2 and 3).

Most of the collections from Kano-Jigawa were generally early (70-89 days to 50% flowering) to medium (90-110 days to 50% flowering) maturing, associated with short ($\leq$ 2m) or medium ($\geq$ 2.5m) plant height, while collections from Zaria axis and Diversity Trust were generally late and tall which recorded more than 110 days to attain days to 50% flowering and plant height of greater than 3.5m respectively (Figures 4 and 5). This variability in sorghum was earlier observed by Belum et. Al., (2011) while charactering some ICRISAT Mini-core collections, which also the basis for selection.

This could be attributed to the fact that those in the Sudan which have relative low rains requires early maturing varieties compared to those in the Guinea with high rains. Also, either the *Farafara* or *Kaura* types grown in the Sudan ecology with less insect pest is characterized with compact elliptic panicle forms (caudatum type) compared to those in Guinea Savannah cultivating white or red grain with loose dropping panicle forms (guinea type) thus avoiding grain mold and insect damage. This implies that Sorghum hybrid parent development should at present target, high yielding white or yellow grains with compact elliptic panicle forms, medium height (2m) and medium maturity (100 days), for sustainable hybrid sorghum production.

Learning from Belum et al., (2011), sorghum germplasm characterization should be where the source is better adapted or another location where information from the collection site is utilized.

CONCLUSION

Based on morphological characteristics, there is significant variability for grain colour, panicle forms, plant height and days to flowering and maturity among the materials, suggesting high selection probability for crop improvement. There exists variation for local names, though broadly classified into 2 widely popular Farafara and Kaura types. Sorghum improvement therefore will be to concentrate on utilization of desirable traits that may aid in evolving superior improved lines aiming to surpass the present productivity plateau combined with better drought, disease and pest resistance and improved grain quality. However, DNA marker techniques to identify diverse segments of the chromosomes controlling inheritance of fertility restoration genes for different cytoplasmic male sterility will become necessary to facilitate germplasm utilization programs.

RECOMMENDATION

Sorghum hybrid parent development should at present target, high yielding white or yellow grains with compact elliptic panicle forms, medium height (2m) and medium maturity (100 days).

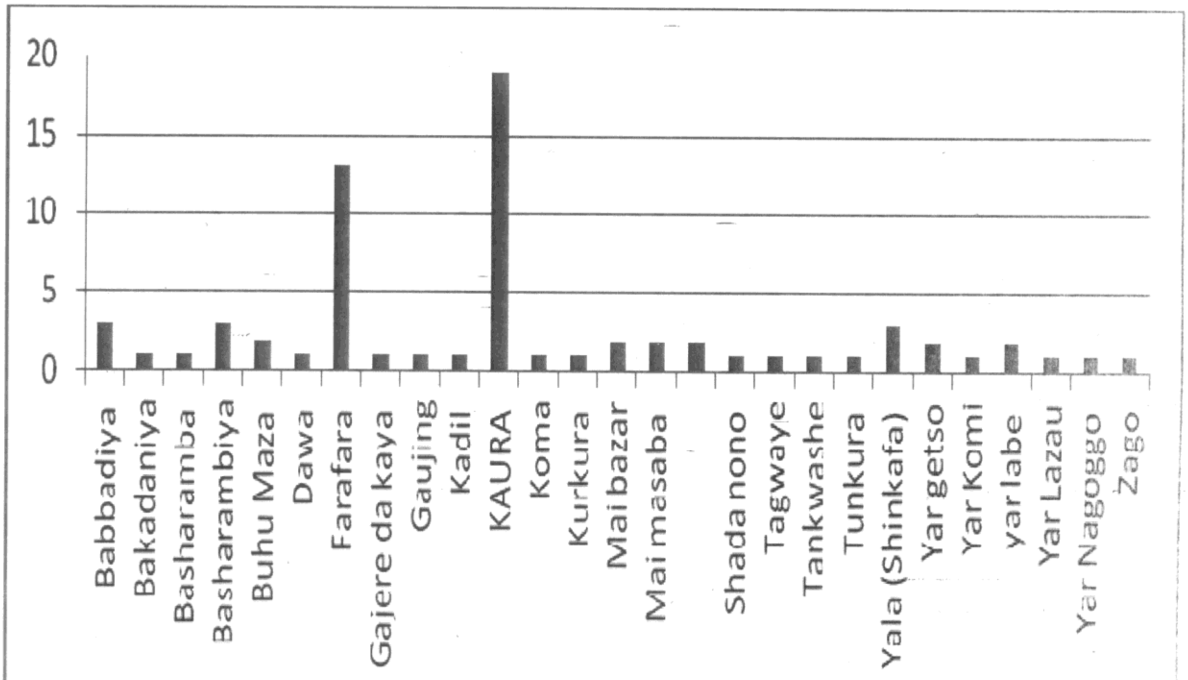

Figure 1. Desegregation of sorghum landrace germplasm collections into Local names in Nigeria.

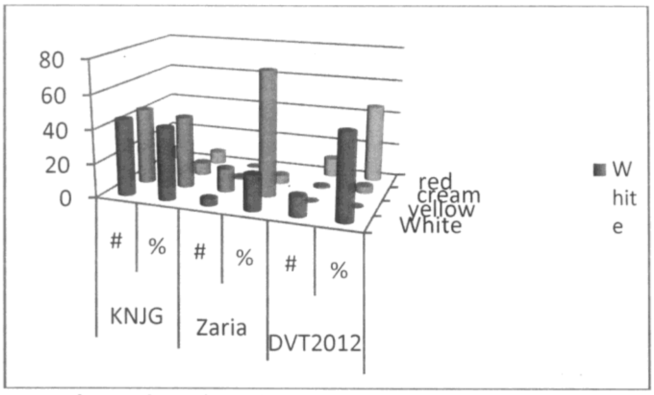

Figure 2. Variability for grain colour of sorghum landrace collections.

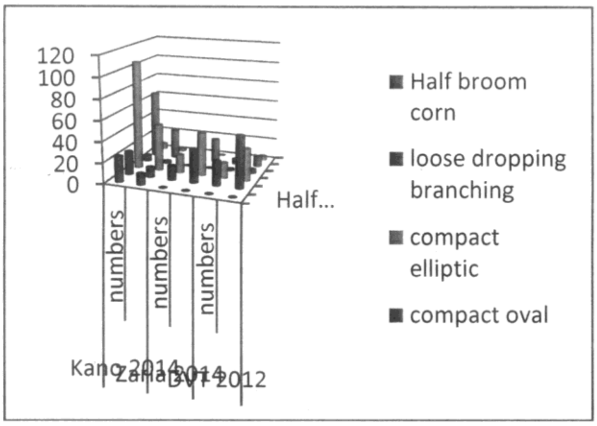

Figure3. Variability for panicle shape of the sorghum landrace collections

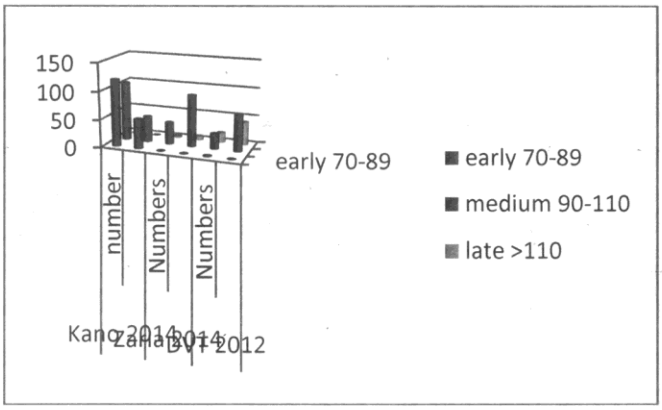

Figure4. Variability for days to 50% flowering of sorghum landrace collections

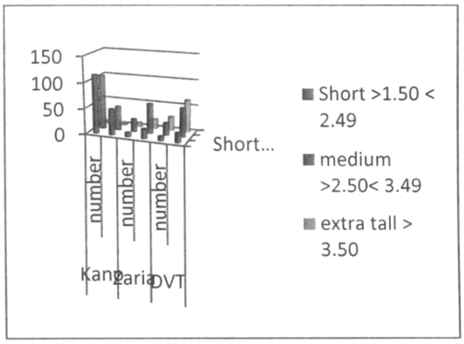

Figure 5. Variability for plant height of sorghum landrace collections

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