Evaluation of Performance of Sorghum Varieties for Growth and Yield Attributes in Turare, Dutsin-Ma, Sudan Savanna, Katsina State Nigeria.

Ati, H.M.
Department of Crop Production and Protection
Federal University Dutsin-Ma
Corresponding author: ahassana@fudutsinma.edu.ng

Abstract

The success of Sorghum varieties introduced to a location is tightly linked to the uses, environmental condition and farmers' preferences. Also, grain and stover quality needs special attention to enhance the market value. The farmers in Turare village are predominantly sorghum and millet farmers. They cultivate the same varieties of sorghum which are low yielding land races. Experiments were conducted in 2017 and 2018, nine varieties of sorghum were planted in the Agroforestry farm layout of Federal University Dutsin-Ma with the aim of determining the varieties that are high yielding, early and farmers' preference varieties so that the varieties that are high yielding and preferred by farmers can be multiplied and distributed to the farmers. Four landraces from the local community and five hybrids from Institute for Agricultural Research, Ahmadu Bello University Zaria were used for the study. Complete Randomized Block Design was used for experimental design and the Sorghum varieties were allocated to plots using Random Table Number. In both years, the farmers (male and female) preferred Samsurg 45 and 46 because of their earliness and high yield. Also, the local varieties, Maibakincona and Yargidanwudu have high performance in both years. CSR01 and CSR02, Zago and Jandawa performed poorly in yield and are late varieties. Though Samsorg 40 had high yield but not as high as Samsorg 45, 46, Maibakincona and Yargidanwudu. The study concludes that Samsorg 45 and 46 have a better attribute of early maturity and yield. Also, the local varieties, Maibakincona and Yargidanwudu have high performance in both years and can be improved upon in terms of yield and earliness. This research was conducted in order to compare the performance of the hybrids varieties with the local varieties that the farmers are used to in the area so as to advise the local farmers to use the varieties with the highest performance. This will relatively translate to higher income for the farmers.

Key words: Farmers, Preference, Improved, Varieties, and Yield

Introduction

Sorghum (*Sorghum bicolor (L.) Moench*) is one of the most important cereal crops widely grown for food, feed, fodder, forage and fuel in the semi-arid tropics of Asia, Africa, the Americas and Australia (Beum, *et al.* ,2010; Reddy and Reddy, 2018). Sorghum is the dietary staple of more than 500 million people in more than 30 countries. It is grown on 42 million ha in 98 countries in Africa, Asia, Oceania and the Americas. Nigeria, India, USA, Mexico, Sudan, China and Argentina are the major sorghum producers in the world (Available from: http://faostat.fao.org/site/567 /default.aspx# ancor [cited 2009 February 3]). Grain is mostly used for food (55%), consumed in the form of flat breads and porridges (thick or thin) and is an important feed grain (33%), especially in the Americas. Stover is an important source of dry fodder for dry season maintenance rations for livestock, especially in Asia (Beum, *et al.*, 2010).

Despite these importance of Sorghum, productivity remains low in Nigeria; IAR and other cereals research organizations have developed and released many improved varieties of Sorghum to raise productivity; This notwithstanding, the cultivation of landraces/local varieties still persist among smallholder farmers across Nigeria, particularly in Turare community of Katsina State. Introduced cultivars had high yield potentials but their grains lacked quality and were not well appreciated (Yapi *et al.,* 2000); Information about similarities and differences in growth and yield performances between landraces and the improved varieties of Sorghum is inadequate. Evaluating sorghum landraces and improved varieties has become necessary to identify their strengths and weaknesses for further improvement in adoption.

The existing collections represent about 80% of the variability present in the crop (Eberhart *et al.*, 1997). Since the establishment of ICRISAT in 1972, germplasm sources have been screened and utilized in the development of high yielding male-sterile lines (CK 60, 172, 2219) and restorers (IS 84, IS 3691, IS 3541). They have been valuable sources for incorporating shoot fly and stem borer resistance (IS 1082, IS 2205, IS 5604, IS 5470, IS 1054, IS 18432, IS 18417, IS 18425), midge resistance (DJ 6514, IS 3443), multiple disease resistance (IS 3547, IS 14387,), Striga resistance (IS 18331, IS 2221), drought tolerance (IS 12611, IS 69628), high lysine content (IS 11167, IS 11758), stalk sweetness (IS 20963, IS 15428), forage quantity and quality (IS 1044, IS 1059) and salinity tolerance (IS 164, IS 19604) (Reddy *et al.*, 2008).

Research carried out on sorghum has been minimal because growers are mostly poor farmers growing their own food for sustenance rather than economic purposes. However, with world population increasing, it is becoming essential to make the most of what resources (land and water) are available for growing food. With improvements, sorghum can become the "Global Grain of the Future" because it is highly efficient in utilizing resources and its market opportunity as an energy resource (Maunder, 2006).

In Africa, sorghum is grown under diverse ecologies predominantly with varieties tolerant to Striga. International Sorghum and Millet (INTSORMIL) and ICRISAT worked together to develop acid soil–resistant genotypes for growing in Latin America. In Australia, the main focus is on developing tolerant cultivars to sorghum midge and drought. In the United States, sorghum is grown in 14 states. The US Department of Agriculture and sorghum checkoff fund the sorghum research program for genetic enhancement of sorghum grown for feed, fodder, and fuel. INTSORMIL has projects in 20 developing countries in Africa and America and focuses on improving the production in these areas. In Europe, sorghum is cultivated for cattle feed, while broomcorn types are used for industrial uses in paper making. Thus, sorghum meets the diverse requirements of people across the globe and crop improvement programs are well placed catering to the needs of growers (Reddy and Reddy, 2018). ICRISAT is a major repository of germplasm, with a total of 36,774 accessions from 90 countries (Reddy *et al.*, 2008). New varieties of sorghum from ICRISAT have now resulted in India producing 7 tons per hectare (Srinivas, 2016).

Most sorghum research has focused on quality improvement rather than yield, This research seek to compare the differences in the performance between improved varieties and land races and to select the varieties that are suitable for cultivation in Turare village as environment plays a large factor in both quality

improvement and yield (Maunder, 2006). The yielding ability of any crops are determined by genotype, time of sowing, environmental factors and management practices where it is used to grow (Ajeigbe *et al.*, 2018a, b). As reported by Akinseye (2015), the difference in yield potential of the two sorghum varieties tested was attributed to genetic make-up of the varieties. For instance, early maturing variety is an improved local landrace, targeted to more drier areas with potential yield <2000 kg/ha under good production management while medium maturing variety is an improved hybrid, targeted dual purpose for grain (approx. 3500 kg/ha) and fodder for livestock feed.

Future research opportunities include creating better yields in stressful and low-input environments, development of production control techniques (general education on production), nutritional improvement such as increased digestibility and protein quality, and ethanol production (Carter, *et al.*, 2006 and Maunder, 2006). Private industry research already focuses on grain quality for meeting the needs of modern society, including snack foods, alchol production and non-gluten foods (National Sorghum Producers, 2006). Diseases are usually not a problem with sorghum unless there is high rainfall and humidity, but pests cause significant damage. The most destructive pests are birds, who consume the grain. Other pests include corn earworms, aphids, and moth larvae. Resistance to striga, which are parasitic plants, is also a major area of need (Carter, *et al.*, 2006).

METHODOLOGY
Experimental site
The research was conducted in Agroforestry farm layout, Federal University Dutsin-Ma, Katsina State, Nigeria. Dutsin-Ma lies between latitude 12º 27' and 22"N and longitude 7º 30' and 83"E. The daily minimum and maximum temperatures range from 32ºC to 43ºC. Dutsin-Ma, in Katsina State experiences unim odal rainfall pattern with an annual rainfall of about 1100 mm, attaining a single peak in August. Dry season lasts for a minimum of seven months (November-May) while the wet season spans June to October.

Materials: Nine Sorghum varieties inclusive of five improved varieties from Institute of Agricultural Research, Zaria (Samsorg 40, 45 and 46, CSR01 and CSR02) and four land races from the local community (Yargidanwudu, Zago, Jandawa and Maibakicona) Turare villege Dutsin-Ma, Katsina State constituted the sorghum planting materials assessed.

Experimental Design
The field evaluation was done using Complete Randomized Block Design (CRBD) in three replications. The ridges were five meters long and four rows represent a plot with inter row spacing of 75cm and intra row spacing 30cm. Seeds were allocated to plots using random table number.

Pre-planting Operations
Ridges were prepared using tractor. There were three (3) replications with each replication consisting of nine (9) plots and each plot consists of four (4) ridges of 5 m length.

Planting
Few seeds were sown per hill with Inter row spacing was 75 cm while intra row spacing was 30 cm and the plants were thinned down to two plants per stand two weeks after sowing. Pre-emergence herbicide Retachlor was applied to the farm immediately after planting at the rate of 250ml/15 liter of water.

Cultural Practices
N:P:K (15:15:15) compound fertilizer at the rate of 4 bags /hectare was applied to the plants two weeks after sowing and urea at the rate of 2 bags /hectare was used as top dress at six weeks after sowing .

Manual weeding of the farm was done 21 days after sowing and pesticide, Cypherdiforce 250ml / 15 liter of water was applied to the plants to treat against stemborer.

Data Collection and Analysis
The sampling methods used was to take the average of the measurements of three randomly selected plants.

Data collected include:
(1) Day to 50% flowering (DF50): the number of days for 50% of the plants per plot to flower.
(2) Plant height (PH): the distance between the ground level to the apex of the panicles measured in centimetres at maturity being averaged from three randomly chosen

plants.

(3) Panicle length (PL): distance between the bases of the panicle to the tip in centimetres being averaged from three randomly chosen panicles

(4) Panicle circumference (PanCir): circumference of the panicle (girth) being averaged from three randomly chosen panicles.

(5) Panicles per plot (PP): Total number panicle per plot counted at harvest

(6) Panicle weight (PW): panicle weight in kilograms per plot before threshing.

(7) Grain weight per plot (GW): grain weight in Kilograms per plot after threshing.

Statistical Analysis System (SAS) *SAS 9.13 was used to analyze the data collected.*

Results

The results of the experiment are presented in table 1. The significance level is at P<0.05. Form the table, there were significant differences in the Grain weight per plot across the varieties used in this research and also highly significant differences in the Days to 50% flowering, Panicle circumference and Threshing percentage across the varieties. There were no significant differences in the rest of the traits across varieties.

Number of hills established

Number of hills established (from the highest to the least) ranges from 31.2 (Samsorg 46) to 23 (Maibakicona) hills.

Seedling vigor

Samsorg 46 performed best with the score 4.3 while Maibakicona that had the lowest score of 3. The rest varieties did not show any significant difference in their vigor scores.

For Days to 50% flowering

The number of days ranges from 100 days to 61 days. Zago had the highest number of days (100 days) to 50% flowering while Samsorg 40 had the least number of days (61 days) to Days to 50% flowering.

Plant height

The plant heights ranges from 332.7 cm to 210.9 cm. Zago was the tallest while Samsorg 40 the shortest. The rest were not significantly different in their height.

Panicle length

The Panicle length ranges from 34.1cm (Jandawa and Zago) to 18.5cm (CSR 01). The rest did not show significant difference in their Panicle lengths.

The number of panicle harvested

The number of panicle harvested ranges from 96(Samsorg 46) to 54(CSR 02).

Panicle circumference

For panicle circumference, Samsorg 40, and Maibakicona have the longest Panicle circumference of 13.5cm, followed by Samsorg 45 (13.2) then Jandawa with 12.6, Yargidanwudu (12.1), Zago (10.4), CSR 02 (9.7) and CSR 01(9.1) which has the shortest Panicle circumference.

Panicle weight per plot

Panicle weight per plot ranges from 3627g to 1327g. Samsorg 45 has the heaviest panicle weight (3627) while CSR 02 has the least weight 3627g.

Grain weight per plot

Samsorg 45 has heaviest grain weight per plot (1932g) followed by Samsorg 46 (1932g) then Maibakicona (1236g), Yargidanwudu (1233g), Samsorg 40 had 1081g, Zago had 947g, Jandawa had 717g, CSR 01 had 347g and CSR 02 had 323g. CSR 02 (323g) had lowest grain weight per plot.

1000 seeds weight

CSR 02 has heaviest 1000 seeds weight (29g), followed by Samsorg 45 (26g), CSR 01, Yargidanwudu, Zago and Jandawa weighed 25g each, Samsorg 40 weighed 24g, Samsorg 46 and Maibakicona weighed 23g each and have the lowest weight of 1000 seeds.

Table 1: Combine Performance of Sorghum Accessions in 2017 and 2018

SOURCE OF VARAITION	NHE	VGR	D50%fl w	PHT	PNLE	NPH	CIR	PNLA P	PWP/g	GWP/g	WTS/g	Th%
DESIGNATION												
SAMSORG 46	31.2	4.3a	80c	265.6bc	23.1ab	96	10.1bcd	3	3555a	1680ab	23	48ab
CSR 02	30.7	3.7ab	99c	297.2ab	26.3ab	54	9.7cd	2	1327b	323d	29	28e
CSR 01	29.7	3.5ab	99a	255.6bc	18.5b	62	9.1d	2	1346b	347d	25	29de
SAMSORG 40	27.8	3.8ab	61e	210.9c	22.9ab	80	13.5a	3	2570ab	1081bcd	24	43bc
ZAGO	27.2	3.2ab	100a	332.7a	33.6a	69	10.4bcd	2	2561ab	947bcd	25	37cd
JANDAWA	26.8	3.3ab	90b	309.2ab	34.1a	65	12.6ab	2	1975ab	717cd	25	37cd
SAMSORG 45	26.3	4ab	75d	262.2bc	21.4ab	66	13.2a	3	3627a	1932a	26	54a
YARGIDANWUDU	25	3.7ab	91b	315.7ab	22.2ab	68	12.1abc	2	2875ab	1233abc	25	53a
MAIBAKICONA	23	3b	91b	288.8ab	20.2b	59	13.5a	2	2599ab	1236abc	23	55a
P of F	**0.6**	**0.0462**	**<.0001**	**<.0001**	**0.0022**	**0.0992**	**0.002**	**0.0553**	**0.0024**	**<.0001**	**0.4902**	**<.0001**
YEAR												
2017	36.7	3.9	73.9	260.2	22.6	101.2	8.7	1.6	1966.7	1202.2	23.3	56.5
2018	18.3	3.4	100.5	303.8	26.9	36.7	13.2	2.9	3018.9	907.5	26.3	29.3
P of F	**<.0001**	**0.0134**	**<.0001**	**<.0001**	**0.0251**	**<.0001**	**<.0001**	**<.0001**	**0.0007**	**0.0105**	**0.0255**	**<.0001**

Means within a column having a similar letter(s) are not statistically different at p<0.05 using Tukey HSD Test.

Where, NHE = Number of hills established; Vgr = Seedling vigor; D50%F = Days to 50% flowering; PHT= Plant height; PNLE= Panicle length, NPH=Number of panicle harvested; CIR=Panicle circumference; PNLAP= Panicle appreciation; PWP/g = Panicle weight per plot (g); GWP= Grain weight per plot (g); WTS= Weight of 1000 seeds; Th%= Threshing percentage.

Discussions

The results of this research involving five varieties of sorghum from IAR, Zaria and four land races from Turare village were used in this study. The relative performance of these varieties is discussed in this section.

Samsorg 40, Samsurg 45 and Samsorg 46 varieties have higher yields than the yields of the local varieties used, performed best in seedling vigor, number of panicles harvested and panicle weight per plot and were early in both years. This was expected because Samsurg 45 and Samsorg 46 varieties were improved varieties. These hybrids were also judged to be were nutritionally high sorghum varieties. They were three times higher in iron content (Showkat, *et al*., 2016), it was envision that they will be a boost for farmers as well as the malnourished populations, especially children in Nigeria. They also exhibit extra earliness and heavier panicle and grain weight compared to the local varieties used in this research. Thus are able to maintain their superior performance in spite of different environmental conditions though, Cooper, *et al*., 2008 stated that production of rain-fed grain crops is projected to be negatively affected through projected higher and more variable temperatures, changes in rainfall patterns and increased occurrences of extreme events such as droughts and floods. These qualities will allow farmers to adapt better to climate change though, Gebrekiros *et al* (2016) said that in addition to the biotic and abiotic challenges, climate change is expected to influence the sorghum area and its importance globally. With the current level of greenhouse gas emissions and the associated temperature rise, the areas suitable for sorghum are likely to increase by 9% globally, but many areas currently suitable for sorghum will be lost.

CSR 01 and CSR 02 though an improved varieties performed poor due to climatic and soil variation in the area because they are high yielding varieties in IAR, Zaria, where I got them. They were earlier in the first trial but become late in the following year. In fact in the first year, CSR 01 and CSR 02 performed better in all the traits studies than the following year. Though the yield were poor in both years. The result indicated that Turare environment may not be suitable for the cultivation of CSR 01 and CSR 02. According to Gebrekiros *et al*., 2016, although, there is a general understanding of the impact of climate change and variability on agricultural crops, the spatial and temporal variability of these impacts remains uncertain. Also, the results of Folorunso, *et al*., 2020 confirmed that rainfall and temperature could be a limiting environmental factors for sorghum productivity in semi-arid areas.

The local varieties, Maibakinkona , Yargidanwudu ,Jandawa and Zago were better in their performance in both years than CSR 01 and CSR 02 but poor when compare with Samsurg 45 and Samsorg 46 varieties. However, two of the local varieties, Maibakinkona and Yargidanwudu have high yield and performed better than Sansorg 40 in both years. This indicated that improving both varieties can boost their performance which may lead to higher yield hence, improved means of livelihood and food security for the farmers.

Conclusion

There were significant differences in yield, earliness and agronomic traits between the local varieties and the improved varieties. Samsorg 45 and Samsorg 46 performed very well in agronomic traits and yield than the local varieties the villagers were used to. Samsorg 45 and Samsorg 46 were advantageous to the farmers not only for their early maturity but also for their high yield. These attributes will enhance the market demand of these varieties and will, no doubt, be relatively translated to higher income of the farmers. Also, among the local varieties, Yargidanwudu and Maibarkicona have yields and good agronomic traits. Among the nine varieties used in this research, four varieties inclusive of two improved varieties (Samsorg 45 and Samsorg 46) and two local varieties (Yargidanwudu and Maibarkicona) were selected for their yields and agronomic triats.

Recommendation

Base on the findings of this study, it is

noteworthy to say that there is the possibility of improving Yargidanwudu and Maibarkicona for better qualities/performance for the farmers since they are high yielding. This will increase the farmers' turn over and improve their means of livelihood. Samsorg 45 and Samsorg 46 are varieties with most impressive yield hence they can be multiplied and supplied to the farmers to boost their sorghum production and as a mean of food availability and security.

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