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Effect of Sowing Dates on Growth and Yield of Grain Sorghum (*Sorghum bicolor* L. Moench.) in Akure, South West, Nigeria

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Abstract: A field experiment was conducted during the cropping seasons of 2019 and 2020 at The Federal University of Technology Akure Teaching and Research Farm to determine the effect of sowing dates and variety on the growth and seed yield of grain sorghum (*Sorghum bicolor* L. Moench.) under rain-fed conditions. Treatments consisted of four sowing dates: 5th June 2019; 30th June 2019; 13th June 2020; and 11th September 2020, and five sorghum varieties (SAMSORG-44, ZAUNA-INUWA, DEKO, CSR-01 AND SK-5912). The experimental design was a randomized complete block in a split-plot arrangement replicated four times with a sowing date assigned to the main plots and varieties in the subplots. The main plot size was 15 m by 6 m and the subplot was 3 m by 5 m. Data were collected on seedling emergence, number of days to 50 % flowering, number of days to 95% maturity, plant height, panicle length, stem girth, panicle weight, 1000 seed- weight and total grain weight (grain yield). The data collected were subjected to analysis of variance (ANOVA) and means were separated using Tukey's Honest Significant Difference. Results showed that plants sown on the first sowing dates of 2019 recorded higher means for plant height and number of days to flowering than those sown on the second date. In 2020 plants sown on the first sowing dates were also significantly taller, and flowered later, but gave higher means of 1000 seed weight than those sown on the second date: The performance of the varieties in both sowing dates was similar in 2019 but in 2020 their responses were varied. Sowing dates are concluded to influence grain yield and some yield components of sorghum.

Keywords: *Sorghum bicolor*, Sowing Date, Yield Components, Grain Weight

1. Introduction

Sorghum (*Sorghum bicolor* L. Moench) belongs to the tribe *Andropogenae* of the grass family *Poaceae*. Sorghum originated from East Africa (Ethiopia) from there it was disseminated to other regions of the world [1]. It is one of the most important cereals grown worldwide, ranking fifth after rice, wheat, maize, and barley [2]. In sub-Saharan Africa (SSA), it ranks second in importance after maize [3]. Sorghum comprises the main food source from which over half a billion people in developing countries derive sustenance [4]. Sorghum is well adapted to hot and dry areas which gives it an edge over other crops in such harsh environments. Consequently, the importance of the crop is now being realized in most African countries given the unprecedented changes due to climate [5]. The various use of sorghum includes; grain, forage, sweet/syrup, biomass and ethanol production.

It is the most widely cultivated and most important crop in the savanna regions of Nigeria [6]. It can be grown under variable rainfall conditions and also a wide range of soils [7]. However, more than 95% of the total sorghum produced in Nigeria is from the Northern Region. Being a semi-arid (Savanna) crop, its success or failure is mainly dependent on

the pattern of rainfall. According to Awopetu, marginal rainfall as low as 50-63 cm annually can support sorghum cultivation, provided sowing is synchronized with even moisture distribution [8]. Although early sowing is known to guarantee higher yield, the crop is often known to be prone to pest and disease attacks [9]. In addition, delay in sowing would reduce the yield potential of the crop. Consequently, a major critical problem is determining appropriate sowing dates for the crop. As 89% of cereal production in sub-Saharan Africa is rain-fed [10].

Although several studies project a negative net effect of climate change on cereal yields, the actual direction of change in any given area may depend on the concerned crop physiology and the current climatic condition under which it is grown, as different species have a different base and optimum temperatures for development [11-13]. The morphological characteristics change with genotype and growing conditions. This morphological feature includes the stem, inflorescence, grain and glumes [14]. Production of sorghum in the derived savanna of South West Nigeria is not significant, accounting for 1% of the total production [15]. This is attributable to the farmer's lack of knowledge of the crop, particularly with regard to sowing periods. Currently, there is little or no information on variable sowing dates for the crop in South Western Nigeria. Therefore, this research was conducted to determine a suitable date for sowing Sorghum in the South West region of Nigeria.

2. Materials and Methods

2.1. Experimental Location

The experiment was conducted at the Teaching and Research Farm of the Federal University of Technology, Akure (FUTA), in 2019 and 2020. The Teaching and Research Farm is located at an altitude of 332 m above sea level and 7°16'N, 5°12'E in the rainforest zone of southwestern Nigeria [16]. It has an annual rainfall of between 1200 mm-1500 mm and means temperature of 27°C. The rainy season runs between Mid-March to Mid-November with a bimodal pattern, while the dry period runs from late November to the beginning of March [16]. The soil type of the area was sandy clay loam.

2.2. Experimental Materials

The sowing materials were obtained from International Crops Research Institute for The Semi-Arid Tropics and the five varieties used were SAMSORG-44, ZAUNA-INUWA, DEKO, CSR-01 AND SK-5912.

2.3. Experimental Set-Up

The experiment was laid out in a split-plot design with two replications each year. Treatments consisted of four sowing dates: 5th June 2019; 30th June 2019; 13th June 2020; and 11th September 2020, and five sorghum varieties (SAMSORG-44, ZAUNA-INUWA, DEKO, CSR-01 AND SK-5912). Sowing dates were assigned the main plot while variety was the assigned sub-plot. The Plots were four rows each, 5 metres long and spaced 0.75 m apart. Spacing was 30 cm (intra-row) giving 16 hills per row, sowing depth was 2 cm, and seeds were overplanted on each hill but thinned to two plants per hill two weeks after sowing. N. P. K (20:10:10) fertilizer was applied at sowing and 30 kg/ha urea at 50 days after planting.

2.4. Growth and Yield Measurement

In each plot data was taken on the following characters:

1) *Plant height (cm)*: The average of the lengths of four random plants per row, (each measured from the base of the plant to the flag leaf in centimetres).
2) *Number of days to 50% flowering*: The number of days from the sowing dates to the day when 50% of the plants in a plot flowered.
3) *Number of days to 95% maturity*: The number of days from sowing dates to the day when 95% of the panicles in a plot reached physiological maturity, as monitored by the appearance of black glumes on the kernels.
4) *Number of panicles per plot*: The total number of panicles (heads) in each plot and for each variety at harvest.
5) *Panicle length (cm)*: The average length of four randomly selected plants in a row was measured from the base of the panicle to the tip of the panicle and measured in centimetres.
6) *Panicle weight per plot (kg)*: The weight of the total number of panicles per plot at harvest and measured in kilograms.
7) *1000 Seed weight (g)*: The weight was obtained by weighing 1000 grains per plot using electronic balance and measuring in grams.
8) *Total grain weight (kg)/grain yield per plot (kg)*: This was obtained by weighing the total number of harvested grains after threshing (converted to yield in kg per hectare).

2.5. Statistical Analysis

The data collected were subjected to Analysis of variance (ANOVA) using the MINITAB 17th Edition Statistical Package and means were separated using Tukey's Honest Significant Difference at a 5% level of probability.

3. Results and Discussion

The effects of two sowing dates in 2019 on eight characters in sorghum are presented in Table 1. Significant differences between the sowing dates were observed in some of the characters studied. Plants sown on the first sowing dates (5th June 2019) recorded significantly higher mean plant height and numbers of days to 50% flowering than those sown on the second sowing dates (30th June 2019) but had lesser maturity period and 1000 seed weight. Means for the other three characters were statistically similar between the two sowing dates. However, plants sown on the first date had higher mean panicle weight and total grain weight (grain

yield) than those sown on the second date.

In 2020, plants sown on the first date had significantly higher means than those sown on the second date in all characters except panicle length (Table 2), where they both had statistically similar means. Varieties responded differently to the effect of the sowing date in 2019 on two characters (Table 3). These were plant height and number of days to 95% maturity for plant height, only CSR-01 recorded significantly different means for both sowing dates with plants sown on the first date having higher means than those sown on the second date. A similar trend occurred in other varieties but the means were not statistically significant. For three varieties namely SK-5912, ZAUNA-INUWA and DEKO, plants sown on the earlier date recorded a significantly lower mean number of days to maturity than those sown on the second date. There were no differences between the sowing dates with regard to other characters. (Table 4). In 2020, the variety responses varied in some characters. SK-5912 varieties that were sown in the earlier sowing date recorded significantly higher means in all traits except for panicle length where the means for both sowing dates were statistically the same. For variety ZAUNA-INUWA, significantly higher means were recorded for plant height, days to 50% flowering, days to 95% maturity, panicle weight and 1000 seed weight on the first sowing date when compared to the second date. This means for other traits were not statistically different. DEKO recorded significantly higher means for plant height and flowering on the first date. However, the mean stem girth was significantly lower. For other traits, the means of both sowing dates were statistically the same. For genotype CSR-01, significantly higher means were recorded in the first sowing dates for three characters. These were plant height, number of days to 50% flowering and number of days to 95% maturity. In genotype SAMSORG-44, the means of all characters were statistically similar except for plant height, the number of days to 50% flowering and the number of days to 95% maturity. In both cases, the means of the traits on the first sowing date were higher than those sown on the second sowing date.

Table 1. *Effect of sowing dates on the performance of sorghum in 2019.*

Sowing Dates	Plant height	No of days to 50% flowering	No of days to 95% Maturity	No of panicles	Panicle weight (kg)	Panicle length (cm)	Total grain weight / grain yield (kg)	1000 SEED WEIGHT (g)
1	353.51a	79.95a	131.63b	40.3a	3.66a	28.76a	2.7a	28.98b
2	277.86b	66.65b	147.79a	45.8a	3.06b	28.32a	2.31a	31.12a

Means with different alphabets in a column differed significantly at 5% level of probability according to Tukey's HSD.
Sowing dates 1 = 5th June 2019
Sowing dates 2 = 30th June 2019

Table 2. *Effect of sowing dates on the performance of sorghum in 2020.*

Sowing Dates	Plant height	No of days to 50% flowering	No of days to 95% Maturity	No of panicles	Panicle weight (kg)	Panicle length (cm)	Total grain weight / grain yield (kg)	1000 SEED WEIGHT (g)
1	117.27a	92.47a	124.02a	39.05a	1.43a	27.75a	0.52a	43.14a
2	81.30b	67.73b	78.60b	9.48b	0.53b	27.41a	0.18b	33.64b

Means with different alphabets in a column differed significantly at 5% level of probability according to Tukey's HSD.
Sowing dates 1 = 13th June 2020
Sowing dates 2 = 11th September 2020

Table 3. *Sowing date and variety interaction for sorghum in 2019.*

Sowing Dates	Varieties	Plant height (cm)	No of days to 50% flowering	No of days to 95% Maturity	No of panicles	Panicle weight (kg)	Panicle length (cm)	1000 SEED WEIGHT (g)	Total grain weight / grain yield (kg)
1	SK-5912	292.10b	87.50a	146.00b	42.50a	3.43a	29.75a	29.43a	2.55a
1	ZAUNA-INUWA	368.23ab	80.75ab	146.25b	43.00a	3.45a	28.08a	27.21a	2.63a
1	DEKO	350.58ab	74.75ab	110.63e	43.25a	3.65a	27.00a	28.18a	2.73a
1	CSR-01	442.38a	78.50ab	129.00cd	39.75a	3.48a	27.90a	30.10a	2.55a
1	SAMSORG-44	321.38b	78.25ab	126.25d	33.00a	4.30a	31.00a	30.00a	3.50a
2	SK-5912	291.15b	69.75ab	165.25a	46.25a	2.45a	29.95a	31.56a	2.55a
2	ZAUNA-INUWA	267.90b	68.25ab	165.00a	47.75a	3.85a	28.08a	31.23a	3.03a
2	DEKO	288.83b	62.50b	129.85cd	42.75a	2.63a	27.00a	29.15a	1.90a
2	CSR-01	255.08b	66.00ab	141.33bcd	48.00a	3.53a	26.20a	32.05a	2.75a
2	SAMSORG-44	286.35b	66.75ab	137.50bcd	44.25a	2.85a	30.40a	31.60a	2.20a
1*2	Means	315.7	73.3	139.7	43.0	3.36	28.54	30.05	2.55

Where 1= 1st sowing dates, 2= 2nd sowing dates, means with different alphabets in a column differed significantly at 5% level of probability according to Tukey's HSD.

Table 4. *Sowing date and variety interaction for sorghum in 2020.*

Sowing Dates	Varieties	Plant height (cm)	No of days to 50% flowering	No of days to 95% Maturity	No of panicles	Panicle weight (kg)	Panicle length (cm)	1000 SEED WEIGHT (g)	Total grain weight / grain yield (kg)
1	SK-5912	137.50a	99.75a	135.50a	34.75b	2.75a	36.08a	47.41a	1.30a
1	ZAUNA-INUWA	117.65ab	92.25a	136.25a	101.25a	3.03a	33.30a	46.40ab	0.64b
1	DEKO	109.28abcd	87.00a	102.25bc	32.25b	0.60b	20.33b	43.23abc	0.26c
1	CSR-01	112.10ab	90.00a	123.75ab	19.00bc	0.53b	25.23ab	42.20abc	0.24c
1	SAMS ORG-44	109.83abc	93.33a	122.33ab	8.00c	0.27b	23.83ab	36.48bcd	0.15c
2	SK-5912	82.60bcde	68.67b	79.00cd	16.00bc	0.58b	28.90ab	30.85d	0.17c
2	ZAUNA-INUWA	72.73de	67.25b	78.25d	16.63bc	0.86b	32.15ab	29.99d	0.35bc
2	DEKO	68.00e	68.00b	79.00cd	2.00c	0.25b	32.30ab	34.80cd	0.20c
2	CSR-01	73.28cde	67.75b	78.75d	5.75c	0.28b	23.68ab	35.62cd	0.09c
2	SAMSORG-44	109.90ab	67.00b	78.00d	7.00c	0.70b	20.05b	36.95bcd	0.08c
1*2	Means	99.3	80.1	101.3	24.2	0.98	27.57	38.39	0.34

Key: for sowing dates, 1= 1st sowing dates, 2= 2nd sowing dates, Means with different alphabets in a column differed significantly at 5% level of probability according to Tukey's HSD.

Response of sorghum to sowing date in both 2019 and 2020 was similar in a number of traits from the results obtained. Sowing in the later dates was observed to have resulted in a reduction in plant height and panicle weight. Flowering was observed to have occurred early in both years. The delayed flowering period observed in the earlier sowing date may have occurred as a result of increased or prolonged rainfalls during the growth period this could have extended the vegetative growth and may also account for the observed increased plant height in both years. The higher panicle weight and grain yield obtained from plants sown on the first sowing date may also be explained by the fact that the plants had sufficient time for good vegetative growth and photosynthesis. This may have enhanced floral growth and development and thus resulted in better yield as shown in both years. Results of similar patterns were obtained by Bandiougou who reported that sowing dates had an effect on grain yield and yield components of grain sorghum [17]. Interaction of sowing date and genotypes did not show any significant effect in 2019 whereas in 2020 significant interactions were observed for the number of days to 95% maturity, plant height, 1000 seed weight and total grain weight (grain yield). The significant variation observed in these traits could be explained by the variation in their genetic make-up [18]. However, SK-5912 recorded the highest 1000 seeds weight, and total grain weight and had the highest number of days to 50% flowering in the two sowing dates for 2020. According to Saini *et al*. date of planting often has a direct effect on the length of the growing season and this will correspondingly affect varieties of different maturity groups [19]. Hence, plants sown in the early dates of this experiment seem to have longer growing periods, year notwithstanding. In addition, plants sown on the second date were observed to have matured earlier than ones planted on the first date, this may be explained by the fact that they had lesser moisture from precipitation and thus flowered earlier than those sown on the second date.

4. Conclusion

Grain yield and some yield components of sorghum, namely: plant height, days to flowering, days to maturity and panicle weight were significantly influenced by sowing dates. However, the effects on the traits vary greatly depending on the genotypic make-up of the variety.

5. Recommendation

DEKO showed superior performance for earliness in flowering and maturity across the sowing dates while SK-5912 and ZAUNA-INUWA showed superior performance for growth and grain yields across the sowing dates. Therefore, DEKO is recommended as an early flowering variety, while Sk-5912 is recommended for high-yielding variety.

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