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# GROWTH PARAMETERS AND FORAGE YIELD OF TWO GRAIN SORGHUM (*Sorghum bicolor* L. Moench) VARIETIES UNDER DIFFERENT PLANTING DATES AND AGES OF HARVEST IN SHIKA

**[1]Munza, B. M., [2]Hassan, M. R., [3]Tanko, R. J., [2]Yashim, S. M., [4]Abashi, T. J., [4]Sulim, P. Y. and [4]Alkali, G. Z.**

[1]Department of Animal Science, University of Maiduguri, Maiduguri, Nigeria
[2]Department of Animal Science, Ahmadu Bello University, Zaria.
[3]National Animal Production Research Institute, Ahmadu Bello University, Zaria.
[4]Bauchi State College of Agriculture, Bauchi.
Correspondence: bellomunza@gmail.com; +2347038737250

**ABSTRACT**
To determine the influence of sorghum variety, planting dates and ages of harvest on growth parameters and forage yield of grain sorghum (*Sorghum bicolor* L. Moench) in Shika, Nigeria, an experiment was conducted in split plots in the National Animal Production Research Institute, Shika, Nigeria. The experimental treatments comprised of two sorghum varieties (SAMSORG-16 as $V_1$ and SAMSORG-17 as $V_2$), three planting dates (15$^{th}$ June, 30$^{th}$ June and 14$^{th}$ July as $P_1$, $P_2$ and $P_3$) and three ages of harvest (6, 10 and 14 weeks after sowing as $C_1$, $C_2$ and $C_3$), respectively. Results showed that plant height of sorghum bicolor significantly ($P<0.05$) differed between variety with higher values in Samsorg-16. Plant height, number of leaves and leaf area index (LAI) decreased ($P<0.05$) from 15$^{th}$ June to 14$^{th}$ July planting date. However, there was a significant increasing trend ($P<0.05$) in these parameters as ages of harvest advanced from 6 to 14 week after sowing (WAS). Significant ($P<0.05$) interaction effect between variety and planting date was observed for plant height. Similarly, significant ($P<0.05$) interaction effect was observed in the number of leaves and LAI. There was non-significant ($P>0.05$) effect of variety on fresh and dry forage yields. Fresh and dry forage yields declined from 54.73 and 10.49 t/ha to 30.72 and 6.11 t/ha from 15$^{th}$ June to 14$^{th}$ July planting dates, respectively. Whereas fresh and dry forage yields increased from 12.22 and 1.37 t/ha to 58.94 and 14.47 t/ha as ages of harvest increased from 6 to 14 WAS, respectively. Based on the results of this study, it can be concluded that livestock farmers in Northwest Nigeria could grow Samsorg-16 and Samsorg-17 for forage which could be harvested at 14 WAS for better forage yield.

**Keywords:** Age of harvest, sorghum, variety and planting date.

## INTRODUCTION

Increased population growth and inability of rangelands to support livestock needs lead agronomists to pay more attention to cultivation of forage plants (Joorabi *et al*., 2015). Sorghum has good characteristics such as high yield and tillering potential, rapid growth and high nutrient contents. It has a number of morphological and physiological characteristics that contribute to its adaptation which make it most considered in arid and semi-arid regions of the world (Ayub *et al.*, 2007; Munza *et al*. 2018).

Genotype or variety plays an important role in determining yield of sorghum. For example, late maturing cultivars are likely to have higher biomass yield than early maturing ones, since the stem components and number of leaves are higher (Taylor *et al*., 1974; Munza, 2017). Sorghum is used for both grain and forage; while some varieties are grown solely for grain, others have been developed for forage production, and some varieties are dual-purpose (Harada *et al*., 2000). SAMSORG-16 and SAMSORG-17 are grain sorghum varieties with released names SSV2 (FBL) and KSV3 (SK.5912), respectively (Aba *et al*., 2004). They are potential forage crops that are adapted to Northern and Southern Guinea Savanna zones of Nigeria. SAMSORG-16 has a maturity period of 165 – 175 days for grain whose seed colour is white with a grain potential yield of 2.5 – 3.5 ton/ha. SAMSORG-17 popularly known as Short Kaura has a maturity period of 165-175 days for grains whose seed colour is yellow with a potential grain yield of 2.5-3.5 ton/ha (Aba *et al*., 2004). The agronomic and forage potential of these sorghum varieties is encouraging. For example, Munza *et al*. (2018) reported a plant height of 77.89 cm, number of leaves of 8.03, leaf area index of 2.06 and fresh and dry forage yields of 38.06 and 9.06 t/ha, respectively for SAMSORG-16 at Shika, Nigeria.

Planting date influences seed germination in sorghum through environmental temperature and soil available (Vanderlip, 1993), vegetative and reproductive success (Prasad *et al*., 2008), as well as yield and yield components (Diawara, 2012). Jones and Johnson (1991) reported that effect of stress due to environmental factors on final yield of sorghum may depend upon genotype and growth stages in which it occurs. Deciding on early or late planting depends on a farmer's ability to deal with the risk of poor crop establishment with early planting or the effect of water or heat stress at reproductive stages with late planting. Heiniger *et al*. (1997) stated that early planting may result in an unfavorable soil environment, which may affect emergence rate, and results on poor stand establishment and possibly replanting. Delaying the planting date until soil conditions are nearer the optimum for early plant growth and development may be a management strategy useful in overcoming these problems (Diawara, 2012).

Age of harvest plays an important role in yield determination. Generally, total dry matter increases as harvesting is delayed, especially when harvesting occurs between vegetative and booting stage (66% DM) (Munza, 2017). During early growth stages of a forage crop, leaves yields double those of stems but at later stages the situation changes and stems yields are twice those of leaves (Nelson and Moser, 1994; Munza, 2017). In a study to determine the effect of plant spacing and stage of harvest on forage yield and quality of grain sorghum, Munza *et al*. (2018) found that plant height, number of leaves and leaf area index increased significantly as the stage of harvest advanced from 6 to 12 weeks after sowing (WAS).

Large variability exists in sorghum growth and development in response to planting date and hybrid selection (Diawara, 2012). The objective of this research was to determine the influence of sorghum variety, planting dates and ages of harvest on growth parameters and forage yield of grain sorghum in Shika, Nigeria.

## MATERIALS AND METHODS

### Experimental site and location

The experiment was conducted during the 2018 raining season at the Experimental Farm of the Feeds and Nutrition Research Programme, National Animal Production Research Institute (NAPRI), Shika. The farm is located on Latitude $11^0$ 12' N, Longitude $07^0$ 33' E at an altitude of 660 m above sea level, along Zaria-Funtua Road in the Northern Guinea Savannah zone of Nigeria (Ovimaps, 2017). The climate is characterized by a defined wet and dry season. Wet season starts from April to early May and ends in late September to early October while the dry season lasts from October to April. The total annual rainfall ranges from 748.6 – 1156.7 mm with a long-term average of 1058.60 mm. Maximum air temperature of $35.16^0$C are recorded in May and minimum air temperature of $11.5^0$C recorded in December/January and relative humidity of approximately 70% during the rainy season (IAR, 2017). Weather observations taken at IAR meteorological station is shown in Table 1.

Table 1: **Meteorological distribution of the experimental location in 2018**

| | Max Air Temp (°C) | Min Air Temp (°C) | Relative Humidity (%) | Rainfall (mm) | Sunshine (Hours) |
|---|---|---|---|---|---|
| January | 39.48 | 15.35 | 15.7 | 0 | 7.89 |
| February | 34.48 | 18 | 12.74 | 0 | 7.43 |
| March | 34.71 | 24.06 | 28.19 | 25.3 | 6.48 |
| April | 39.47 | 25.8 | 40.67 | 2.2 | 7.8 |
| May | 35.16 | 24.16 | 56.1 | 81.3 | 7.83 |
| June | 31.4 | 23.2 | 70.47 | 133.3 | 7.12 |
| July | 30.84 | 22.94 | 75.94 | 218.4 | 5.9 |
| August | 30.55 | 21.9 | 78.12 | 268.8 | 6.68 |
| September | 31.62 | 25.45 | 71.19 | 229.2 | 6.51 |
| October | 33.23 | 18.23 | 55.68 | 61.6 | 6.55 |
| November | 33.83 | 12.8 | 21.93 | 0 | 5.39 |
| December | 32.1 | 14.58 | 19.39 | 0 | 8.86 |

Source: IAR, 2019

The soil consists of 60% sand, 14% clay and 26% silt giving rise to sandy loam while the organic carbon was 0.94%. The pH value recorded was 5.20 and 4.20 for $H_2O$ and 0.01M $CaCl_2$, respectively which shows that the soil is slightly acidic in nature. Typically with tropical soils, the soil of the experimental site is low in both total nitrogen (0.140%) and available phosphorus (21.53 ppm). The exchangeable cations present in the soil samples are $Ca^{2+}$, $Mg^{2+}$, $K^+$ and $Na^+$ which are needed for growth and development in plants. Also the soil has cation exchange capacity, exchangeable acidity and electrical conductivity of 8.20, 0.80 cmol/kg and 0.030 dsm, respectively.

**Experimental design, treatments and source of experimental materials**

A land area measuring 35m x 18m (0.063ha) was used for the trial. The land was ploughed and harrowed with tractor drawn implements and ridged with two work bulls to provide a clean seedbed and to enhance early seed germination. The experiment was laid in a split plot design with a factorial arrangement (2 x 3 x 3) consisting of two sorghum varieties (SAMSORG-16 as $V_1$ and SAMSORG-17 as $V_2$), three planting dates (15$^{th}$ June, 30$^{th}$ June and 14$^{th}$ July as $P_1$, $P_2$ and $P_3$) and three ages of harvest (6, 10 and 14 weeks after sowing as $C_1$, $C_2$ and $C_3$), respectively.

Grain sorghum seeds were obtained from the Institute for Agricultural Research (IAR), Zaria. SAMSORG-16 and SAMSORG-17 varieties were preferred to other varieties, because of their adaptability to the environment of the study and forage yield potentials (Aba *et al*., 2004; Munza, 2017). Five (5) seeds were planted on ridges at 2 cm depth at plant spacing of 15 x 85 cm using the planting dates and later thinned to two (2) plants/stand after twelve (12) days so as to have a uniform plant population of (13,333 stands/ha). A uniform dose of 120 kg/ha NPK (20:10:10) was applied to grain sorghum seedlings at 2 and 5 weeks after sowing as first and second doses, respectively. Weeding was done manually as the need arises.

**Data collection on plant growth parameters and yield components**

Seedling emergence was monitored at 4 days after sowing. Germination count was done at 12 days after sowing. Data on yield and crop phenology was measured at 6, 10 and 14 weeks after sowing (WAS) on primary growth. Five (5) plants were randomly sampled per plot and tagged for measurements of various agronomic parameters using the standard procedure as reported by Tarawali *et al.* (1995).

***Plant height:***

The plant height of grain sorghum was determined by measuring from the base of the plant to where the last leaf on the stem emerges with the aid of a 200cm ruler on 5 randomly selected stands per plot.

***Number of leaves per plant:***

The number of leaves on the 5 randomly selected and tagged plants per plot was counted and the mean number of leaves per plant was determined from each plot at 6, 10 and 14 WAS.

***Leaf area index (LAI):***

Leaf area was measured using the method described by Stickler *et al*. (1961), i.e LA = length of the lamina x the largest width x a factor (0.747). The means were later recorded. The leaf area index was determined from the ratio of leaf per plant to the unit area of land covered by each plant (Watson, 1952).

$$LAI = \frac{Leaf\ Area\ per\ Plant\,(cm)}{Area\ of\ Ground\ per\ Plant\ (cm)}$$

***Forage yield:***

This was determined at four (4) weeks interval directly by harvesting the fresh forage within each sub-plot in a 1m$^2$ quadrat at 15cm above the ground using a hand sickle. The total fresh forage and sub samples (150-200g) were weighed in the field using a sensitive weighing scale and sub-samples were oven dried at 65$^0$C for 48 hours and reweighed to estimate dry matter yield.

Dry matter production was calculated as: (Total FW x (DWss/FWss)) x 10 = Dry matter kg/ha. (Tarawali *et al.*, 1995) where:

Total FW = Total fresh weight from 1 m$^2$ in (g)

DWss = Dry weight of the sub-sample in (g)

FWss = Fresh weight of the sub-sample in (g)

**Statistical analysis and model**

Data on growth parameters and forage yield were analyzed using Repeated Measures ANOVA of SAS (2005). Significant treatment means were compared using Duncan's Multiple Range Test (Duncan, 1955).

$$Y_{ijk} = \mu + A_i + B_j + C_k + (A*B)_{ij} + (B*C)_{jk} + (A*C)_{ik} + (A*B*C)_{ijk} + E_{ijk}$$

Where:

$Y_{ijk}$ = is the record of observations for dependent variables

μ= is the population mean

$A_i$ = effect of sorghum variety (i = 1 and 10);

$B_j$ = effect of planting dates (j = 15$^{th}$ June, 30$^{th}$ June and 14$^{th}$ July);

$C_k$ = effect of ages of harvest (k = 6, 10 and 14 WAS);

$(A*B)_{ij}$ = effect of variety and planting date;

$(B*C)_{jk}$ = effect of planting date and age of harvest;

$(A*C)_{ik}$ = effect of variety and age of harvest;

$(A*B*C)_{ijk}$ = effect of variety, planting date and age of harvest;

$E_{ijk}$ = random error assumed to be normally and independently distributed.

## RESULTS AND DISCUSSION

**Growth parameters of grain sorghum as influenced by variety, planting dates, ages of harvest and their interactions**

Variety had no effect ($P>0.05$) on number of leaves and leaf area index (LAI) (Table 2). Plant height was significantly ($P<0.05$) affected by variety and $V_1$ (Samsorg-16) had significantly higher plant height than $V_2$ (Samsorg-17) which could be attributed to tall nature of the variety.

There was significant ($P<0.05$) planting dates effect on plant height, number of leaves and LAI (Table 2). Plant height was higher at $P_1$ (15$^{th}$ June) which was at par with $P_2$ (30$^{th}$ June) and lower at $P_3$ (14$^{th}$ July). The first planting date ($P_1$) led to significantly higher number of leaves and LAI than $P_2$ and $P_3$ which were statistically similar. Early planting might have had more environmental resources for growth hence more leaves per plant and wider LAI. Yu and Tuinstra (2001) stated that early planting of grain sorghum allows for a longer growing season and for more efficient use of environmental resources (e.g rainfall). This agrees with Clark (1997) who reported that favorable temperature and rainfall during May and early June contribute to excessive vegetative growth. Radiation interception and photosynthesis are of major importance in yield determination due to their role in dry matter production (Diawara, 2012).

Ages of harvest had significant ($P<0.05$) effect on plant height, number of leaves and LAI (Table 2). Plant height, number of leaves and LAI increased with advancement in age of harvest. Increase in plant height, number of leaves and LAI as harvesting age was delayed from $C_1$ (6 WAS) to $C_3$ (14 WAS) might be due to the increase in physiological activities of the plant since sorghum is a C4 plant which utilizes sunlight energy, nutrients and water resources differently compared to C3 plants such as rice. The increase in LAI is expected due to increased photosynthetic ability and increased light interception as a result of leaf area and position etc. This agrees with the findings of Ishiaku (2016) and Munza *et al*. (2018) who reported increase in plant height, number of leaves and LAI as the stage of harvest advanced.

**Table 2: Growth parameters of grain sorghum as influenced by variety, planting dates, ages of harvest and their interactions**

| Treatment | Plant Height (cm) | Number of Leaves (no.) | LAI |
|---|---|---|---|
| *Variety* | | | |
| $V_1$ | $239.19^a$ | 13.06 | 6.12 |
| $V_2$ | $156.14^b$ | 13.09 | 6.03 |
| SEM | 11.69 | 0.48 | 0.56 |
| P-value | <0.001 | 0.910 | 0.774 |
| *Planting Date* | | | |
| $P_1$ | $211.12^a$ | $13.73^a$ | $7.06^a$ |
| $P_2$ | $199.08^a$ | $12.69^b$ | $5.47^b$ |
| $P_3$ | $182.79^b$ | $12.80^b$ | $5.68^b$ |
| SEM | 7.79 | 0.32 | 0.37 |
| P-value | 0.004 | 0.004 | 0.002 |
| *Age of Harvest (WAS)* | | | |
| $C_1$ | $79.99^c$ | $9.63^c$ | $3.13^c$ |
| $C_2$ | $205.98^b$ | $12.26^b$ | $6.12^b$ |
| $C_3$ | $307.02^a$ | $17.33^a$ | $8.97^a$ |
| SEM | 7.79 | 0.32 | 0.37 |
| P-value | <0.001 | <0.001 | <0.001 |
| *Interactions* | | | |
| V x P | 0.019 | 0.070 | 0.089 |
| V x C | <0.001 | 0.688 | 0.969 |
| P x C | 0.248 | <0.001 | 0.005 |
| V x P x C | 0.288 | 0.568 | 0.951 |

$^{abc}$Means with different superscripts within columns differed significantly at $P<0.05$, SEM = standard error of mean, LAI = leaf area index, WAS = weeks after sowing, $V_1$ = SAMSORG-16, $V_2$ = SAMSORG-17, $P_1$ = 15th June, $P_2$ = 30th June, $P_3$ = 14th July, $C_1$ = 6 WAS, $C_2$ = 10 WAS, $C_3$ = 14 WAS

**Variety and planting date interaction on plant height (cm) of grain sorghum**

Significant interactions between variety and planting dates were observed on plant height (Table 3). Variety one ($V_1$, Samsorg-16) planted on 15th June ($P_1$) had significantly higher plant height which was at par with $V_1P_2$ (Samsorg-16, 30th June) and $V_1P_3$ (Samsorg-16, 14th July) followed by $V_2P_1$ (Samsorg-17, 15th June) and $V_2P_2$ (Samsorg-17, 30th June) which are similar while lower plant height was obtained in $V_2P_3$ (Samsorg-17, 14th July). The significant interaction effect of variety and planting dates observed in this study could be attributed to the positive correlation existing between variety and planting. It was revealed by Diawara (2012) that it is not just getting the right variety but the appropriate date of planting the variety. This agrees with Caravetta *et al*. (1990) who reported that growth components in sorghum were affected by genotype and environmental conditions. It also concurs with Diawara (2012) who reported significant variety and planting date interaction in grain yield and its components.

**Table 3: Variety and planting date interaction on plant height (cm) of grain sorghum**

| | Variety | |
|---|---|---|
| Planting Date | $V_1$ | $V_2$ |
| $P_1$ | $241.62^a$ | $180.62^b$ |

| | | |
|---|---|---|
| $P_2$ | 239.57$^a$ | 158.58$^b$ |
| $P_3$ | 236.37$^a$ | 129.21$^c$ |

$^{abc}$Means with different superscripts within a column or row differed significantly at ($P<0.05$), $V_1$ = SAMSORG-16, $V_2$ = SAMSORG-17, $P_1$ = 15th June, $P_2$ = 30th June, $P_3$ = 14th July

**Variety and age of harvest interaction on plant height (cm) of grain sorghum**

Significant interactions between variety and ages of harvest were observed on plant height (Table 4). Variety one ($V_1$, Samsorg-16) harvested at 14 WAS ($C_3$) had significantly higher plant height than all other treatment combinations. This could be attributed to the positive correlation existing between plant height and age of harvest i. e the more harvest age is delayed the more the plant height and the varietal difference. This agrees with Munza *et al*. (2018) who reported higher plant height for Samsorg-16 at 12 WAS in Nigeria.

**Table 4: Variety and age of harvest interaction on plant height (cm) of grain sorghum**

| | Variety | |
|---|---|---|
| Age of Harvest | $V_1$ | $V_2$ |
| $C_1$ | 86.97$^d$ | 73.01$^d$ |
| $C_2$ | 241.18$^b$ | 170.78$^c$ |
| $C_3$ | 389.42$^a$ | 224.62$^b$ |

$^{abc}$Means with different superscripts within a column or row differed significantly at ($P<0.05$),$V_1$ = SAMSORG-16, $V_2$ = SAMSORG-17, $C_1$ = 6 WAS, $C_2$ = 10 WAS, $C_3$ = 14 WAS, WAS = weeks after sowing.

**Planting dates and ages of harvest interactions on number of leaves and LAI of grain sorghum**

Significant interactions between planting dates and ages of harvest were observed on number of leaves and LAI (Table 5). Higher number of leaves and LAI were obtained at 15th June planting date and 14 WAS age of harvest ($P_1C_3$) than all other treatment combinations. Sorghum yield response to time of planting and soil water storage were associated with difference in leaf area development (Muchow *et al*., 1994). This might be due to enough time for the treatment combination to utilize the available environmental resources. The number of leaves and leaf dimensions are functions of variety, growth stage but also depend on the growing conditions, planting date inclusive (Diawara, 2012).

**Table 5: Planting date and age of harvest interaction on number of leaves and LAI of grain sorghum**

| | Age of Harvest | | | | | |
|---|---|---|---|---|---|---|
| | Number of Leaves (no.) | | | LAI | | |
| Planting Date | $C_1$ | $C_2$ | $C_3$ | $C_1$ | $C_2$ | $C_3$ |
| $P_1$ | 10.30$^e$ | 11.50$^d$ | 19.40$^a$ | 4.23$^d$ | 6.12$^c$ | 10.84$^a$ |
| $P_2$ | 9.80$^{ef}$ | 11.90$^d$ | 16.37$^b$ | 3.06$^{de}$ | 5.72$^c$ | 7.63$^{bc}$ |
| $P_3$ | 8.80$^f$ | 13.37$^c$ | 16.23$^b$ | 2.11$^e$ | 6.52$^c$ | 8.43$^b$ |

$^{abc}$Means with different superscripts within a column or row differed significantly at ($P<0.05$), LAI = leaf area index, $P_1$ = 15th June, $P_2$ = 30th June, $P_3$ = 14th July, $C_1$ = 6 WAS, $C_2$ = 10 WAS, $C_3$ = 14 WAS, WAS = weeks after sowing,

**Forage yield of grain sorghum as influenced by variety, planting dates, ages of harvest and their interactions**

Variety had no significant ($P>0.05$) effect on fresh and dry forage yields (Table 6). The non-significant effect of variety on forage yield observed in this study could be attributed to the robust nature of $V_2$ (Samsorg-17) which complements the tall nature of $V_1$ (Samsorg-16).

Fresh and dry forage yields were significantly ($P<0.05$) affected by planting dates (Table 6). Fresh forage yield was significantly higher at $P_1$ (15th June) than $P_2$ (30th June) which was at par with $P_3$ (14th July). Dry forage yield was higher at $P_1$ (15th June) which was similar with $P_2$ (30th June). This could be due to varietal, environmental or experimental conditions during the study. This agrees with Diawara (2012) who reported reduction in yield and yield components with delayed planting. Planting date affects not only the time from planting to flowering but time from flowering to physiological maturity of grain sorghum (Clark, 1997). Pauli *et al*. (1964) found that the total time from planting to physiological maturity was significantly decreased as planting time was delayed from early May to early June.

It was observed that age of harvest significantly ($P<0.05$) affected fresh and dry forage yields (Table 6). Fresh forage yield was higher at $C_3$ (14 WAS) and similar with $C_2$ (10 WAS) while dry forage yield was higher at $C_3$ than $C_2$ and $C_1$ (6 WAS). This might be attributed to enough time for utilization of the available resources required for dry matter production. Radiation interception and photosynthesis are of major importance in yield determination due to their role in dry matter production. Sorghum yield response to location, time of planting and soil water storage were associated with difference in leaf area development (Muchow *et al*., 1994).

There was non-significant (P>0.05) interaction effect of variety, planting dates and ages of harvest for both fresh and dry forage yields.

**Table 6: Forage yield of grain sorghum as influenced by variety, planting dates, ages of harvest and their interactions**

| Treatment | Fresh Forage Yield (t/ha) | Dry Forage Yield (t/ha) |
|---|---|---|
| *Variety* | | |
| $V_1$ | 44.87 | 9.13 |
| $V_2$ | 38.62 | 7.66 |
| SEM | 7.45 | 1.88 |
| P-value | 0.132 | 0.157 |
| *Planting Date* | | |
| $P_1$ | $54.73^a$ | $10.49^a$ |
| $P_2$ | $39.78^b$ | $8.59^a$ |
| $P_3$ | $30.72^b$ | $6.11^b$ |
| SEM | 4.97 | 1.25 |
| P-value | 0.001 | 0.005 |
| *Age of Harvest (WAS)* | | |
| $C_1$ | $12.22^b$ | $1.37^c$ |
| $C_2$ | $54.06^a$ | $9.36^b$ |
| $C_3$ | $58.94^a$ | $14.47^a$ |
| SEM | 4.97 | 1.25 |
| P-value | <0.001 | <0.001 |
| *Interactions* | | |
| V x P | 0.818 | 0.664 |
| V x C | 0.525 | 0.411 |
| P x C | 0.136 | 0.308 |
| V x P x C | 0.902 | 0.965 |

$^{abc}$Means with different superscripts within columns differed significantly, SEM = standard error of mean, WAS = weeks after sowing, $V_1$ = SAMSORG-16, $V_2$ = SAMSORG-17, $P_1$ = 15th June, $P_2$ = 30th June, $P_3$ = 14th July, $C_1$ = 6 WAS, $C_2$ = 10 WAS, $C_3$ = 14 WAS

## CONCLUSION

Results of this study showed that variety, planting dates and ages of harvest increased growth parameters and forage yield of grain sorghum at Shika, Nigeria. Although Samsorg-16 appeared to have higher growth parameters (plant height, number of leaves and LAI) but the forage yield was essentially the same with Samsorg-17. It can therefore be recommended that livestock farmers in Northwest Nigeria could grow any of the sorghum varieties (Samsorg-16 and Samsorg-17) for forage provided it could be harvested at 14 WAS for better biomass.

**Conflict of interest:** The authors have nothing to disclose.

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## REFERENCES

Aba, D. A., Idem, N. U. A., Marley, P. S. and Maigida, D. N. (2004). *Cereal crops of Nigeria: Principles of production and utilization*. Ade Commercial Press, Zaria. pp: 38-78.

Ayub, M., Nadeem, M. A., Shrar, M. S. and Mmahmood, N. (2002). Response of maize fodder to different levels of nitrogen and phosphorus. *Asian Journal of Plant Science, 1(4): 352-354.*

Caravetta, G. J., Cherney, J. H. and Johnson, K. D. (1990). Within-row spacing influence on diverse sorghum genotypes: I. Morphology. *Agronomy Journal, 82: 206-210*.

Clark, L.E. (1997). Grain sorghum production in the Texas rolling plains. Texas A & M University Agricultural Research and Extension Center at Chillicothe-Vernon. Technical Report, pp: 97-100.

Diawara, B. (2012). Effect of planting date on growth, development, and yield of grain Sorghum hybrids. MSc. Thesis. Department of Agronomy, Kansas State University Manhattan, Kansas. pp: 1-75.

Duncan, D. B. (1955). Multiple range and multiple F-test. *Biometrics, 11: 1-42*.

Harada, H., Yoshimura, Y., Sunaga, Y. and Hatanaka, T. (2000). Variations in nitrogen uptake and nitrate-nitrogen concentration among sorghum groups. *Soil Science Plant Nutrition*, *46(1): 97-104*.

Heiniger, R. W., Vanderlip, R. L. and Welch, S. M. (1997). Developing guidelines for replanting grain sorghum: I. Validation and sensitivity analysis of the SORKAM sorghum growth model. *Agronomy Journal*, *89: 75-83*.

IAR (2017). Institute for Agricultural Research, Ahmadu Bello University, Zaria. Meteorological Data Information of Samaru and its Environs.

IAR (2019). Institute for Agricultural Research, Ahmadu Bello University, Zaria. Meteorological Data Information of Samaru and its Environs.

Ishiaku, Y. M. 2016. Productivity of Forage Sorghum (*Sorghum almum*) intercropped with Lablab (*Lablab purpureus*) and their utilization by growing Red Sokoto bucks in Shika, Nigeria (Unpublished M.Sc. Thesis). Department of Animal Science, Ahmadu Bello University, Zaria, Nigeria. pp: 1-108.

Jones, O. R., and Johnson, G. L. (1991). Row width and plant density effects on Texas high plains sorghum. *Journal of Production Agriculture*, *4: 613-619*.

Joorabi, S., Akbari, N., Chaichi, M. R. and Azizi, K. H. (2015). Effect of sowing date and nitrogen fertilizer on sorghum (*Sorghum bicolor* L. Var. Speed Feed) forage production in a summer intercropping system. *Cercetari Agronomice in Moldova*, *48(3): 63-72*.

Muchow, R. C., Hammer, G. L. and Vanderlip, R. L. (1994). Assessing climatic risk to sorghum production in water-limited subtropical environments II. Effects of planting date, soilwater at planting, and cultivar phenology. *Field Crop Research, 36: 235-246*.

Munza, B. M. (2017). Potential of grain sorghum (*Sorghum bicolor* L. Moench) variety as forage crop: Growth components and nutrient digestibility by growing Red Sokoto goats. MSc. Dissertation, Department of Animal Science, Ahmadu Bello University, Zaria. pp: 1-93.

Munza, B. M., Hassan, M. R., Tanko, R. J., Akpensuen, T. T. and Usman, A. (2018). Forage yield and quality of grain sorghum (*Sorghum bicolor* L. Moench) as influenced by plant spacing and stage of harvest in a Northern Guinea Savanna zone of Nigeria. *Nigerian Journal of Animal Science and Technology*, *1(2): 71-85*.

Nelson, C. J. and Moser, L. E. (1994). Plant factors affecting forage quality. In: Fahey, G. C., Collins, M., Mertens, D. R. and Moser, L. E. (Eds.), *Forage Quality, Evaluation and Utilization*. Madison, United States of America: America Society of Agronomy. pp: 115-142.

Ovimaps, (2017). Ovi location map: Ovi Earth Imagery Data.

Pauli, A. W., Stickler, F. C. and Lawless, J. R. (1964). Developmental phases of grain sorghum (*Sorghum vulgare*, Pers.) as influenced by variety, location, and planting date. *Crop Science*, *4: 10-13*.

Prasad, P. V. V., Ristic, Z. and Staggenborg, S. A. (2008). Impact of drought and heat stress on physiologiacal development, growth and yield processes of crop plants. *Advances in Agricultural Systems Modeling Series*, *1: 301-355*.

SAS. (2005). Statistical Analysis Software (CD-ROM), Version 8.1, SAS Institute Inc., Cary, N.C., USA.

Stickler, F. C., Weavden, S. and Pauli, A. W. (1961). Leaf area determination in grain sorghum. *Agronomy Journal*, *53: 187-188*.

Tarawali, S. A., Tarawali, G., Larbi, A. and Hanson, J. (1995). Methods of evaluation of legumes, grasses and fodder tress for use as livestock feed. *International Livestock Research Institute, Manual*. Nairobi, Kenya, pp: 1-12.

Taylor, A. O., Rowley, J. A., Esson, M. J., Eastin, J. D., and Wallace, R. (1974). Sorghums for conserved feed in Northland. *Proceedings of the Agronomy Society of New Zealand*, *4: 74-78*.

Vanderlip, R. L. (1993). How a sorghum plant develops. Cooperative Extension service. Kansas State University, Manhattan, KS.

Watson, D. J. (1952). The dependence of net assimilation rate on leaf index. *Annals of Botany*, *22: 37-54*.

Yu, J., and Tuinstra, M. R. (2001). Genetic analysis of seedling growth under cold temperature stress in grain sorghum. *Crop Science*, *41: 1438-1443*.