# Growth and Yield of Sorghum as Influenced by Variety and Planting Date in the Rainforest Zone of Nigeria

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**Abstract**

A field experiment was carried out at the teaching and research farm of Delta State University, Asaba Campus, to determine the influence of three varieties of sorghum and different planting dates on the growth and yield of sorghum. The experiment was a split – plot layout in a randomized complete block design, replicated three times. The main plots were the three varieties (SSV – 2004, KSV- 8 and Samsorg- 41), while the subplots were assigned to the different planting dates (July, August, September and October). Data on growth parameters were collected at three- week interval starting from 3rd weeks after sowing and later on yield parameters after physiological maturity. The results showed that significant differences ($P \leq 0.05$) were observed among the different varieties and planting dates on both growth and yield parameters. The results indicated that variety KSV-8 and August planting proved superior to others both in growth and yield parameters assessed. Variety KSV-8 with 1, 803.7kg and August planting with 2,786.1kg out performed others in $kgha^{-1}$ yield respectively. The result of interaction showed that variety X planting date significantly affected all the yield parameters assessed except yield in kg per hectare. The study thus, recommended that, in the Asaba rain forest zone, variety KSV-8 should be planted in August for maximum productivity of Sorghum.

***Key words:*** *Sorghum, Growth, Varieties, Yield, Planting date.*

## INTRODUCTION

Sorghum (*Sorghum bicolor* (L) Moench) belonging to the grass family Poaceae is an important multi purposes crop grown worldwide. It accounts for 43% of all major food staples in sub-Saharan Africa. It is an important crop for human and animal consumption in many parts of the world (Agbede, Ojeniyi and Adeyemo, 2008). In the savannah and the semi-arid regions of Nigeria, millions of people consume sorghum in their diets as staple foods. These foods are high in energy and nutrition (Obilana, 2001). In the arid region, it is used as a source of energy in the human diet, as it is a starchy-rich food crop (Taylor and Beton, 2002). It contributes more energy and digestible protein to the diets of the sub-Saharan regions than those obtained from root and tuber crops (Aba, Marley, Maigida, 2004).

Grain sorghum growth, development and yield processes are sensitive to environmental factors such as cold, heat and drought stress depending on the growth stage at which the stress occurs (Prasad, Ristic and staggen-borg, 2008). Aba *et al.*. (2004) reported that sorghum should be planted on well prepared seed beds as soon as the rains become established in July. Conley and Weibold (2003) found out that the number of days between planting and flowering decreased as planting was delayed from June to August in Missouri. Khalifa (2009) reported that early date of sowing is the appropriate time for important parameters such as plant height, 1000 – grain weight and grain yield. Bauhmardt *et al.*. (2005) reported that planting date significantly affected grain yield. They further concluded that late planting of sorghum in September lead to failure of the crop to reach physiological maturity. Killgov (2011) reported that early planting had optimum impact on plant height which could be due to long duration of favourable

condition for vegetative growth and photosynthetic activities. Soler, Mama, Zhang, Mason and Hoogenboom, (2008) reported that sorghum must be properly managed to tolerate the effect of cold, heat and drought stress during critical growth stages. Hence the objective of this research is to determine the effect of variety and planting date on the growth and yield of sorghum.

**Materials and Methods**

The field experiment was conducted in the Teaching and Research Farm of Department of Agronomy, Delta State University, Asaba Campus in 2012. Asaba is located at latitude $06^0$ $14^1$N and longitude $06^0$ $49^1$E in the tropical rain forest zone of Nigeria. This location is characterized by rainfall periods of between April and October with mean annual rainfall ranging from 1,500mm to 1,849mm (NIMET, 2011). The experiment was carried out under the randomized complete block design in a split-plot arrangement with three replications. Varieties were assigned to the main plots and planting dates to the subplots. The treatment comprised three varieties of sorghum (SSV-2004, KSV-8 and Samsorg-41) and four planting dates (July, August, September and October). The land was cleared manually and ploughed using local implements. Sorghum seeds were sown at a depth of 2cm and a spacing of 75 cm x 25 cm at the rate of two seeds per stand and later thinned down to one plant per stand leaving the most vigorous seedlings. The plots were weeded three times manually during the experiment. Data were collected from ten middle sorghum stands at three-weeks interval starting from the $3^{rd}$week after sowing on growth, and later on yield parameters. Data collected were subjected to analysis of variance and treatment means were separated using the Duncan Multiple Range Test of SAS (2010).

**Results and Discussion**

The result of the response of plant height and number of leaves of sorghum to different variety and planting dates is presented in Table 1. The result showed that there were significant differences at $P \leq 0.05$ among the varieties and different planting dates except at 3WAS. Variety KSV-8 performed outstanding better than the other varieties with 30.88cm, 46.32cm, 101.41cm and 172.08cm as height across the sampling periods. With respect to planting dates, plants sown in August grew taller than others, with mean values of 32.10cm, 53.33cm, 120.42cm and 147.05cm, while October planting recorded the lowest values of 22.43cm, 32.73cm, 46.20cm and 129.30cm as height respectively throughout the sampling periods (Table I).

The data on the number of leaves of sorghum as affected by variety and planting date as shown in Table 1, indicated that the number of leaves of sorghum gradually increased from $3^{rd}$ to $12^{th}$ week after sowing. There were significant differences at $P \leq 0.05$ among the different varieties and planting dates evaluated. Variety KSV-8 performed significantly better than other varieties in number of leaves with the values of 6.08, 7.62, 9.43 and 11.37, while variety Samsorg-41 recorded the lowest number of leaves of 5.37, 6.23, 6.82 and 7.22 respectively across the sampling periods (Table 1). With regard to planting dates, plants sown in August had the greatest number of leaves with mean values of 6.20, 8.43, 10.10 and 10.68 all through the sampling periods, while plants sown in October had the lowest values of 4.92, 5.90, 7.25 and 8.04 for number of leaves at the different sampling periods respectively.

**Table 1. Effects of varieties and planting dates on plant height (cm) and number of leaves of sorghum**

| Varieties / planting dates | Weeks After Sowing 3 | | 6 | | 9 | | 12 | |
|---|---|---|---|---|---|---|---|---|
| | Plant height (cm) | Number of leaves | Plant height (cm) | Number of leaves | Plant height (cm) | Number of leaves | Plant height (cm) | Number of leaves |
| **Varieties** | | | | | | | | |
| **SSV-2004** | 19.42[b] | 5.57[b] | 33.77[c] | 7.17[b] | 66.67[c] | 8.82[b] | 109.22[c] | 9.70[b] |
| **KSV-8** | 30.88[a] | 6.08[a] | 46.33[a] | 7.62[a] | 101.41[a] | 9.43[a] | 172.08[a] | 11.37[a] |
| **Samsorg-41** | 30.45[a] | 5.37[b] | 43.20[b] | 6.23[c] | 76.33[b] | 6.82[c] | 122.00[b] | 7.22[c] |
| **Planting Dates** | | | | | | | | |
| **July** | 32.10[a] | 6.18[a] | 53.33[a] | 8.18[b] | 90.34[b] | 8.46[b] | 132.32[b] | 10.13[b] |
| **August** | 28.20[a] | 6.20[a] | 47.65[b] | 8.43[a] | 120.42[a] | 10.10[a] | 147.05[a] | 10.68[a] |
| **September** | 26.20[a] | 5.50[b] | 34.92[c] | 6.10[c] | 75.53[c] | 7.80[c] | 130.88[b] | 9.26[c] |
| **October** | 22.43[a] | 4.92[c] | 32.73[c] | 5.90[d] | 46.20[d] | 7.25[c] | 129.30[b] | 8.04[d] |
| **Variety** | N.S | X | N.S | X | N.S | XX | N.S | XX |
| **Planting dates** | N.S | N.S | N.S | N.S | N.S | XX | N.S | N.S |
| **Var .x PD** | N.S | N.S | N.S | N.S | N.S | XX | N.S | N.S |

Means with the same alphabet (s) on the same column under same heading are not significantly different at 0.05 level of probability using DMRT. Legend XX= highly significant, X= significant at P≤0.05, N.S. = Not Significant.

The effects of variety and planting dates on total leaf area and leaf area index of sorghum are shown in Table 2. The results indicated that significant differences (P≤0.05) were observed in total leaf area and leaf area index of sorghum among the different varieties and planting dates evaluated. Data on the effects of variety and planting date on total leaf area of sorghum indicated that total leaf area of sorghum progressively increased with plant age among the different varieties and planting dates used. Variety KSV – 8 proved most superior to the other varieties in total leaf area with 322.20cm$^2$, 1, 257.0cm$^2$, 3, 742.0cm$^2$and 5,041.0cm$^2$ respectively, while variety Samsorg -41 recorded the lowest total leaf area of 191.70cm$^2$, 657.0cm$^2$, 1,502.8cm$^2$, and 2,434.0cm$^2$measurements across the different sampling periods respectively (Table 2). July planting appeared most superior in total leaf area with 410.5cm$^2$ 3, 515.0cm$^2$ and, 4,882.0cm$^2$ at 3$^{rd}$, 9$^{th}$ and 12$^{th}$ WAS respectively, while the lowest total leaf area was observed by plants sown in October with the values of 647.0cm$^2$, 1,985.0cm$^2$ and 3,265.0cm$^2$, at 6$^{th}$ to 12$^{th}$ WAS respectively (Table 2). The effects of interaction showed that variety, planting date X variety had significant interaction (P<0.05) on total leaf area at 9$^{th}$ and 12$^{th}$ WAS respectively (Table 2).

The leaf area index of sorghum measurements as affected by variety and planting date indicated that the leaf area index of sorghum gradually increased from 3$^{rd}$ to 12$^{th}$ weeks after sowing. Variety KSV-8 showed superior performance over others with 0.17cm, 0.67cm, 1.99cm and 3.22cm as leaf area index, while variety Samsorg-41 had the least leaf area index (0.10cm, 0.35cm, 0.80cm and 1.29cm) respectively across the periods. Highest leaf area index of 0.22cm, 0.95cm, 2.88cm and 3.14cm were observed at the different sampling periods respectively for plants sown in August, while October planting recorded lowest leaf area index of 0.03cm, 0.35cm, 0.79cm and 1.69 respectively (Table 2).

**Table 2. Effect of variety and planting date on total leaf area ($cm^2$) and leaf area index of sorghum**

| Varieties / planting dates | ← Weeks After Sowing → | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 3 | | 6 | | 9 | | 12 | |
| | Total leaf Area ($cm^2$) | Leaf area index (cm) | Total leaf area ($cm^2$) | Leaf area index (cm) | Total leaf area ($cm^2$) | Leaf area Index (cm) | Total leaf area ($cm^2$) | Leaf area index (cm) |
| **Varieties** | | | | | | | | |
| **SSV-2004** | 248.1[b] | 0.13[b] | 1,211.0[a] | o.65[a] | 2,926.8[b] | 1.50[b] | 4,810.0[ab] | 2.03[b] |
| **KSV-8** | 322.2[a] | 0.17[a] | 1,257.0[a] | 0.67[a] | 3,742.0[a] | 1.99[a] | 5,041.0[a] | 3.22[a] |
| **Samsorg-41** | 191.7[c] | 0.10[c] | 657.0[b] | 0.35[b] | 1,502.8[c] | 0.80[c] | 2,434.0[b] | 1.29[c] |
| **Planting Dates** | | | | | | | | |
| **July** | 40.5[d] | 0.22[a] | 1,239.0[b] | 0.66[b] | 3,395.8[a] | 1.34[b] | 4,882.0[a] | 2.45[b] |
| **August** | 409.2[a] | 0.22[a] | 1,772.0[a] | 0.95[a] | 3,515.0[a] | 2.88[a] | 4,596.0[a] | 3.14[a] |
| **September** | 199.2[b] | 0.11[b] | 694.0[c] | 0.37[c] | 2,395.4[b] | 0.99[c] | 3,995.0[b] | 1.70[c] |
| **October** | 59.4[c] | 0.03[c] | 647.0[c] | 0.35[c] | 1,985.0[c] | 0.79[c] | 3,265.0[c] | 1.69[c] |
| **Variety** | N.S | N.S | N.S | N.S | XX | XX | X | XX |
| **Planting dates** | N.S | N.S | X | X | X | XX | N.S | N.S |
| **Variety x PD** | N.S | N.S | N.S | N.S | XX | XX | XX | XX |

Means with the same alphabet (s) on the same column under same heading are not significantly different at 0.05 level of probability using DMRT. Legend XX= highly significant, X= significant at $P \leq 0.05$, N.S. = Not Significant.

The findings from the study showed that the growth parameters of sorghum were affected by both the crop variety and planting dates. This outcome is supported by those of Futuless *et al.*. (2011), who reported that variety and planting date affected the height of soybean at maturity. This is also similar to the findings of Muchow *et al.*. (1994) who reported that the number of leaves and leaf dimensions are functions of hybrids, growth stage and on the growing conditions. Uzoma *et al.*. (2010) reported significant difference at $P \leq 0.05$ in plant height due to the effect of variety and planting date. Corroborating the above, Kilgov (2011) reported that early planting had optimum impact on plant height, number of leaves and other growth parameters which could be due to long duration of favourable condition for vegetative growth and photosynthetic activities.

The variations in the plant height and number of leaves of sorghum could be as a result of the differences in the genetic composition of the different varieties. This is in line with the findings of Sajjan *et al.*. (2002); Belum *et al.*. (2007) who reported that the growth characters such as number of leaves, plant, height, leaf area and front production were influenced by the genetic factors of the different varieties. The variation in total leaf area and leaf area index observed among the varieties examined may be attributed to genetic differences, leaf arrangement and photosynthetic activities of the leaves. Similar findings were published Mahmud *et al.*. (2003) who attributed variation in leaf area per plant to genetic constitution of the cultivars. Bashir *et*

*al*.. (2010) observed that late planting shortened the growing period of the plant which resulted to reduced leaf area, panicle length and number of grains per panicle.

The effects of variety and planting date on yield parameters of sorghum are shown in Table 3. It was observed that variety KSV-8 performed significantly better than other varieties evaluated in panicle weight (49.52g), number of grains (1,082.67), weight of grains per panicle (33.83g), 1000 – seed weight (49.52g) and yield ((1,803.7kgha$^{-1}$). This outstanding performance was followed by variety SSV-2004, while lowest values of 45.55g, 1,045.33, 31.63g, 16.28g and 1,683.9kg were observed for variety Samsorg-41 as panicle weight, number of grains, weight of grains/hectare, 1000 – seed weight and yield in kgha$^{-1}$ respectively.

With respect to planting dates, plants sown in August out-yielded other plants in panicle weight (70.28g), number of grains per panicle (1,557.1), weight of grains per panicle (52.28g), 1000 – grain weight (33.44g) and yield in kg per hectare (2,786.1kg). This superiority in yield performance was followed by the July planting, while lowest values of 18.46g and 0.0 respectively were recorded by plants sown in October in all the yield parameters assessed (Table 3). The results showed that significant interactions were observed for planting date in all the variables assessed. Significant interactions ($P \leq 0.05$) were recorded by variety except (1000 – grain weight and yield in kg/ha). Planting date x variety interaction significantly affected all the yield parameters assessed except the kg/ha grain yield.

**Table 3.Effect of variety and planting date on yield parameters of sorghum**

| **Varieties / planting dates** | **Panicle weight**(g) | **Number of grains/panicle** | **Weight of grains** (g) | **100**0 – grain **weight (g)** | **Yield in kg per hectare** |
|---|---|---|---|---|---|
| **Varieties** | | | | | |
| **SSV-2004** | 45.68 [a] | 1,046.25 [a] | 32.02 [a] | 22.02 [a] | 1,707.3 [a] |
| **KSV-8** | 49.52 [a] | 1,082.67 [a] | 33.83 [a] | 22.84 [a] | 1,803.7 [a] |
| **Samsorg-41** | 45.55 [a] | 1,045.33 [a] | 31.63 [a] | 16.28 [b] | 1,684.9 [a] |
| **Planting Dates** | | | | | |
| **July** | 62.32 [a] | 1,447.1 [a] | 48.82 [b] | 32.6 [a] | 2,603.8 [a] |
| **August** | 70.28 [a] | 1,557.1 [a] | 52.28 [a] | 33.44 [a] | 2,786.1 [a] |
| **September** | 36.66 [b] | 1,228.1 [b] | 28.86 [c] | 15.41 | 1,538.0 [b] |
| **October** | 18.46 [c] | 0.0 [c] | 0.0 [c] | 0.0 [c] | 0.0 [c] |
| **Variety** | XX | XX | XX | N.S | N.S |
| **Planting dates** | XX | XX | XX | XX | XX |
| **Variety x PD** | XX | XX | XX | XX | N.S |

*Means with the same alphabet (s) on the same column under same heading are not significantly different at 0.05level of probability using DMRT. Legend XX= highly significant, X= significant at P≤0.05, N.S. = Not Significant.*

This is in accordance with the findings of Yoshoda *et al*.. (1992) who reported a significant difference among cultivars in terms of grain yield. He further stated that the disparity was caused by the differences between the cultivars in terms of the growth period duration, panicle emergency time and number of grains per panicle. Similarly, Ismail and Ali (1996) found significant variety x planting date interaction for plant height, head weight and final grain yield. This is also in line with the findings of Ahmed *et al*.. (2001) who reported that genotypic make up influenced number of seeds per pod and yield of crop. In line with the above, Assefa *et al*.. (2010) reported that early planting resulted in lowest number of pods per plant.

**Conclusion and Recommendation**

It has been established in this study that sorghum growth and yield were highly dependent on environmental conditions such as temperatures and precipitation, and that the most appropriate time of planting sorghum for good growth and yield in the zone is August. Variety KSV-8 and August planting resulted in significantly high growth and yield of sorghum. The study, therefore, recommended that variety KSV-8 should be planted in August when there is sufficient moisture in the soil for vegetative growth and yield of sorghum plant.

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