© 2018 IJSRSET | Volume 4 | Issue 4 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section : Engineering and Technology

# Effects of Varying Forms of *Cassia Tora* on the Growth Performance of Sorghum in Northern Sudan Savanna

**Haruna Yahaya Rawayau*, Abdullahi Rabi'u, Yusuf Abdulazeez, Ibrahim Aminu**
Department of Agricultural Education, Federal College of Education, Katsina, Katsina, Nigeria
**yrawayau@hotmail.com*
*+2348065676266*

## ABSTRACT

A screen house experiment was carried out at the screen house of the Department of Agricultural Education, Federal College of Education, Katsina to assess the effects of different forms of Cassia tora on the growth performance of two different sorghum varieties (ICSVIII and fara fara) grown on top and subsoils of Northern Sudan Savanna. The measured growth parameters were plant height, stem girth, leaf number, leaf area, leaf width, and leaf length all at 4, 6 and 8 WAP. There was a significant effect of different forms of Cassia tora when the measured growth parameters were analyzed using ANOVA. The result of this study showed that freshly crushed (FC) and crushed, dried and ground (CDG) forms of the amendment material were significantly different from the control and chopped, dried and burnt (CDB).

**Keywords:** Cassia Tora, ICSVIII, Fara Fara, Sorghum, Northern Sudan Savanna, Katsina

## I. INTRODUCTION

Sorghum is an important cereal crop across the globe, and a major staple food crop in sub-Saharan Africa, accounting for almost 50% of total food crop around the region. The crop amount to 45.50% of the total cereal land area in Nigeria of which less than 2% is found outside the Savanna zone, however, for the growing needs of the crop for food, feed and raw materials for beverage industries, the cultivation of the crop is being extended across the humid regions (FAO, 2005).

As such, it's important to investigate the better agricultural practices that will ensure sustainable production of the crop across regions of the country, by assessing different soil types and varieties using green manure for sustainable production. It is reported that sorghum yield is low with a harvest of 500-800 kg/ha (NAERLS, 1997), and soil fertility is one of the factors responsible (Abimiku et al., 2002).

Cassia tora is a weed found in the Northern Guinea Savanna, and it's known to contain nutrients that can improve the fertility of soil when applied as green manure (Parson and Cuthbertson, 1992).

The study is aimed at finding the effects of different forms of Cassia tora on growth performance of two sorghum varieties grown under two different soil types, as a way of reducing the over-dependence on inorganic fertilizer.

## II. MATERIALS AND METHODS

A 4x2x2 factorial experiment replicated 3 x was conducted at the screen house of the Department of Agricultural Education, Federal College Education, Katsina, Northwest Nigeria. The experiment was conducted in Randomised Complete Block Design (RCBD). The factors were; Cassia tora forms ($C_1$=control {no amendment}; $C_2$=Chopped, dried and ground; $C_3$=Chopped, Dried and Burnt; and

$C_4$=Freshly crushed), sorghum variety as second factor ($V_1$= ICSVIII; and $V_2$= fara fara) soil type as the third factor ($S_1$= topsoil; and $S_2$= subsoil). Which gives a total of 4x2x2+16 treatments replicated 3 x to have a total of 48 experimental units.

Planting was done at 5 seeds/pot and later thinned to 3 stands/pot. The amendment was done at the recommended rate of 10 t/ha (Dalorima et al., 2017) two weeks to planting. All the growth parameters (plant height, stem girth, leaf area, leaf width, leaf length and leaf number) were recorded at 4, 6 and 8WAP. Data collected were analysed using statistically using Analysis of Variance (ANOVA) with SAS software version 9.4 and Tukey's Least Significant Difference (LSD) in separating the means.

**Table 1.** Physical and chemical properties of the soil and green manure under study

| | Value | | Cassia tora | |
|---|---|---|---|---|
| **Parameters** | **Top Soil** | **Sub Soil** | **Parameters (%)** | **Value** |
| pH ($H_2O$) | 6.1 | 5.8 | N | 2.08 |
| Organic Matter (%) | 0.57 | 0.45 | C | 3.45 |
| Total N (%) | 0.07 | 0.04 | C:N | 1.66 |
| Available P (ppm) | 25 | 15 | K | 1.30 |
| Exchangeable Bases (cmol/kg) | | | P | 0.43 |
| K | 0.10 | 0.03 | Ca | 3.14 |
| Na | 0.05 | 0.03 | Na | 0.01 |
| Mg | 0.4 | 0.03 | Crude Protein | 16.8 |
| Ca | 1.7 | 1.2 | Crude Fibre | 16.8 |
| Particle Size (%) | | | Ash | 15.2 |
| Sand | 68.00 | 78.00 | Dry Matter | 92 |
| Silt | 22.00 | 12.00 | | |
| Clay | 10.00 | 10.00 | | |
| Textural Class (USDA) | Sandy Loam | Sandy | | |

*Source: Field Experiment, 2014*

## III. RESULTS AND DISCUSSION

The pre-planting analysis of the two soil used (top and subsoil) indicated that the topsoil is more fertile than the subsoil which was collected from 30-45 cm below the soil surface, the soil properties are presented in Table 1.

### A. Effects of different forms of Cassia tora, variety and soil type on growth performance of sorghum plant

The analysis (ANOVA) on the data collected at 4, 6 and 8 WAP shows a significant main effect of Cassia tora forms, variety and soil type, with variety having no significant effect for plant height at 4 and 8 WAP, leaf area at 8 WAP and leaf number at 4, 6, 8 WAP.

There was no significant ($p<0.05$) interaction effect between the three factors for this experiment as shown in Table 2.

### B. The main effect of Cassia tora forms on the growth of sorghum plant

Freshly crushed form of Cassia tora ($C_4$) was statistically significant ($p<0.05$) from other forms of green manure, with the highest mean value of 67.71, 99.91, 121.44 for plant height at 4, 6 and 8
WAP respectively, though with higher mean value than crushed, dried and ground (CDG) they were still not significantly different from one another statistically at 6 and 8 WAP with a mean value of 98.21 and 119.33 respectively, and the lowest

mean value was recorded for the control treatment with 28.99,, 52.30 and 78.66 at 4, 6 and 8 WAP in that order as presented in Table 3.

The same pattern was observed for stem girth were freshly crushed form of Cassia tora has the highest mean value of stem girth with 6.10, 9.76, and 11.31 at 4, 6 and 8 WAP respectively, while the control treatment recorded the lowest mean value of 5.20, 6.05 and 4.68 at 4, 6 and 8 WAP respectively. The freshly crushed form was significantly better ($p<0.05$) statistically than other treatments with the exception of crush, dried and ground (CDG) at 6 WAP for stem girth, though with a lower mean value (9.65) than that of freshly crushed (9.76), still were not significantly different from one another as presented in Table 3.

For the leaf length, the freshly crushed form also had the highest mean value of 42.63, 67.73 and 75.64 at 4, 6 and 8 WAP respectively, while the lowest mean value was recorded for the control treatment with a mean value of 20.14, 33.04, and 24.40 in that order as presented in Table 3. It can also be noted that crushed, dried and ground (CDG) form though with lower mean value than the freshly crushed, they still didn't differ significantly ($p<0.05$) from one another at 4, 6 and 8 WAP.

Similar trend was observed for leaf width, where freshly crushed form of Cassia tora has the highest mean value of leaf width with a mean value of 4.24, 6.68, and 7.16 at 4, 6 and 8 WAP respectively, while the lowest mean value was recorded for the control treatment with a mean value of 1.90, 3.24, and 3.74 at 4, 6 and 8 WAP in that order, CDG having a lower mean value at 6 and 8 WAP (6.48 and 6.99), but still not significantly different from the freshly crushed form of the green manure.

Freshly crushed and CDG were significantly better statistically than the control and CDB (crushed, dried and burnt). The highest mean value was recorded for freshly crushed treatment with a mean value of 137.76, 340.22 and 407.22 at 4, 6 and 8 WAP, while the control treatment has the lowest mean value of 29.78, 82.44 and 120.19 at 4, 6 and 8 WAP respectively.

There was also a significant main effect of Cassia tora form on leaf number with freshly crushed having the highest mean value of 7.44, 9.69 and 11.62 at 4, 6 and 8 WAP and significantly different from the control treatment and CDB treatment at 6 WAP, with the control having the least mean value of 5.56, 7.81 and 6.69 at 4, 6 and 8 WAP respectively as presented in Table 3.

### A. The Main Effect of Variety on the Growth of Sorghum Plant

The improved sorghum variety (ISCV111) performed significantly better statistically ($p<0.05$) than the local variety (fara fara) across the growth parameters analysed as presented in Table 3. ICSV111 has higher mean value for plant height with a mean value of 53.15, 90.34 and 113.16 at 4, 6 and 8 WAP in that order, though not significantly different from fara fara at 4 WAP, the fara fara has a mean value of 52.86, 83.82 and 104.93 at 4, 6 and 8 WAP respectively.

Same trend was observed for stem girth, leaf length, leaf width and leaf area, but leaf area at 8 WAP the two varieties were not significantly different from one another though with ICSV111 having higher mean value of 301.21 while fara fara had a mean value of 298.12.

The two varieties didn't differ significantly ($p<0.05$) from one another for leaf number at 4, 6 and 8 WAP even though ICSV111 had higher mean value of 6.75, 8.90 and 11.00 at 4, 6 and 8 WAP respectively, while fara fara has a mean value of 6.65, 8.80 and 10.73 at 4, 6 and 8 WAP respectively as presented in Table 3.

### B. Main Effect of Soil Type on Growth of Sorghum Plant

Topsoil ($S_1$) perform significantly better statistically ($p<0.05$) than subsoil ($S_2$) across all the parameters measured and analysed as presented in Table 3. The

topsoil has higher mean value for plant height with a mean value of 52.93, 90.12 and 111.83 at 4, 6 and 8 WAP respectively, while subsoil has a mean value of 45.70, 84.04 and 106.26 at 4, 6 and 8 WAP in that order.

The same trend was observed in other parameters (stem girth, leaf length, leaf width, leaf area and leaf number), all with topsoil being significantly better statistically than subsoil at 4, 6 and 8 WAP as shown in Table 3.

**Table 2.** A two way ANOVA table showing mean values of sorghum plant height (cm), girth (mm), leaf length (cm), leaf width (cm), leaf area ($cm^2$) and leaf number at different growth stages.

| Treatments | Plant Height | | | Stem Girth | | | Leaf length | | | Leaf Width | | | Leaf Area | | | Leaf number | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4 | 6 | 8 | 4 | 6 | 8 | 4 | 6 | 8 | 4 | 6 | 8 | 4 | 6 | 8 | 4 | 6 | 8 |
| C | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| V | ns | ** | ns | * | * | ** | * | ** | * | ** | ** | * | * | * | ns | ns | ns | ns |
| S | ** | ** | ** | ** | ** | ** | ** | * | * | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| **Interactions** | | | | | | | | | | | | | | | | | | |
| C x V | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| C x S | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| V x S | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| C x V x S | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| CV | 7.32 | 4.01 | 6.30 | 11.48 | 8.51 | 10.76 | 8.13 | 10.24 | 9.61 | 7.92 | 12.82 | 11.78 | 9.30 | 7.86 | 8.97 | 12.77 | 11.85 | 10.06 |

NB: C= *Cassia tora* forms; V= Variety; S= Soil Type; CV= Coefficient of Variation; ns= not significant, *=significant at ≤0.05 level; **= significant at <0.01 level

**Table 3.** Main effects of *Cassia tora* forms, variety and soil type on sorghum plant height (cm), girth (mm), leaf length (cm), leaf width (cm), leaf area ($cm^2$) and leaf number at different growth stages.

| Treatments | Plant Height | | | Stem Girth | | | Leaf length | | | Leaf Width | | | Leaf Area | | | Leaf number | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4 | 6 | 8 | 4 | 6 | 8 | 4 | 6 | 8 | 4 | 6 | 8 | 4 | 6 | 8 | 4 | 6 | 8 |
| *Cassia tora* Forms (S) **LSD** | **3.19** | **4.88** | **6.86** | **0.38** | **0.52** | **0.63** | **4.06** | **3.27** | **3.55** | **0.43** | **0.39** | **0.38** | **24.04** | **32.15** | **36.05** | **0.81** | **0.84** | **0.88** |
| $C_1$ (control) | 28.99d | 52.30c | 78.66c | 2.84d | 5.20c | 6.05d | 20.14c | 33.04c | 42.40c | 1.90c | 3.24c | 3.74c | 29.78c | 82.44c | 120.19c | 5.56c | 7.81c | 9.69b |
| $C_2$ (CDG) | 55.86b | 98.21a | 119.33a | 5.60b | 9.65a | 10.47b | 40.15a | 65.12a | 72.47a | 3.78b | 6.48a | 6.99a | 115.64ab | 317.88a | 381.38a | 7.31a | 9.44a | 11.50a |
| $C_3$ (CDB) | 47.73c | 91.26b | 109.78b | 4.76c | 8.94b | 9.82c | 35.93b | 58.38b | 67.82b | 3.39b | 5.89b | 6.43b | 96.41b | 261.04b | 329.39b | 6.88a | 8.75bc | 10.94a |
| $C_4$ (FC) | 67.71a | 99.91a | 121.44a | 6.10a | 9.76a | 11.31a | 42.63a | 67.73a | 75.64a | 4.24a | 6.68a | 7.16a | 137.76a | 340.22a | 407.22a | 7.44a | 9.69a | 11.62a |
| Variety (V) **LSD** | **1.43** | **2.18** | **3.07** | **0.17** | **0.23** | **0.28** | **1.82** | **1.46** | **1.59** | **0.19** | **0.18** | **0.17** | **10.76** | **14.38** | **16.13** | **0.36** | **0.38** | **0.39** |
| $V_1$ (ICSV111) | 53.15a | 90.34a | 113.16a | 5.30a | 8.84a | 9.93a | 38.80a | 59.88a | 68.00a | 3.72a | 5.93a | 6.44a | 114.68a | 279.53a | 301.21a | 6.75a | 8.90a | 11.00a |
| $V_2$ (Fara Fara) | 52.86a | 83.82b | 104.93b | 4.52b | 8.32b | 9.29b | 31.82b | 54.85b | 63.17b | 3.03b | 5.46b | 5.99b | 78.26b | 237.93b | 298.12a | 6.65a | 8.80a | 10.73a |
| Soil Type (S) **LSD** | **1.43** | **2.18** | **3.07** | **0.17** | **0.23** | **0.28** | **1.82** | **1.46** | **1.59** | **0.19** | **0.18** | **0.17** | **10.76** | **14.38** | **16.13** | **0.36** | **0.38** | **0.39** |
| $S_1$ (Top Soil) | 52.93a | 90.12a | 111.83a | 5.28a | 8.87a | 10.00a | 37.71a | 59.48a | 67.75a | 3.60a | 5.90a | 6.42a | 108.31a | 274.72a | 337.40a | 7.13a | 9.23a | 11.23a |
| $S_2$ (Sub Soil) | 45.70b | 84.04b | 106.26b | 4.54b | 8.29b | 9.22b | 32.91b | 55.25b | 63.93b | 3.15b | 5.49b | 6.01b | 84.63b | 242.74b | 301.94b | 6.28b | 8.43b | 10.50b |

NB: Means with the same letter within same column of either of the treatments are not significantly different; CDG (Crushed, Dried and Ground); CDB (Crushed, Dried and Burnt); FC (Freshly Crushed); LSD (Least Significant Difference)

## IV. DISCUSSION

The performance of the test crop (Sorghum) was significantly affected by the application of different forms of Cassia tora, freshly crushed (green manure) improved the growth performance of sorghum, which is related to the assertions by Bhuma et al. (2001) who reported that green manures have some growth promoting capability apart from its nutrient content (which is low compared to inorganic fertilizes), and the results obtained were in accordance to the findings of Chamle (2007) who reported leafy green manure having the capability of improving the growth performance of Spinach, due to better uptake of nutrients from the soil. According to Mathaura (2010), green manure can lead to increase in the growth of root, stem and leaf which will result in better crop yield. Similarly, the green manure inoculated field has an improved soil structure, which can be a reason for better crop development (Rao et al., 2011).

The improved sorghum variety (ICSV111) did better than the local variety (fara fara) and that can be due attributed to the growth and yield contractions of the local varieties dated back 1970s as a result of African drought, that made researchers to develop a drought-resistant variety which has higher growth performance potentials and ICSV111 comes into existence from that efforts (Dendy, 1994) an improved variety is always expected to have better growth potentials than a local variety (Arunah et al., 2006).

Topsoil contains more nutrients than the subsoil as presented in Table 1. Though the subsoil also did

better with application of green manure, but still the disparity in nutrient content of the two soil types become a reason the topsoil did significantly better statistically ($p<0.05$) as stated by Agbede et al., 2008).

## V. CONCLUSION

Cassia tora in green form (freshly crushed) can improve the growth performance of sorghum plant in marginal soils, either with an improved variety or a local variety of the crop, they all responded well to the application of the green manure more than the control and other treatments. The improved variety (ICSV111) can be used in substitute to the local variety (fara fara).

## VI. ACKNOWLEDGMENT

The authors will like to thank the Tertiary Education Trust Fund (TETFund) Nigeria, for providing the research grant and as well Federal College of Education Katsina (FCE Katsina) Nigeria for the necessary logistics for this research work.

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