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The Effects of Varying Forms of Sickle Senna (*Cassia Tora)* on the Growth and Performance of Sorghum in Northern Sahel Savannah of Nigeria

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Abstract: *The research was carried out at the screen house of the Ramat's Research and Teaching farm, Ramat Polytechnic Maiduguri to evaluate the different varieties of sorghum grown under two soil type as a way of reducing overreliance on inorganic fertilizer. Hence, estimating a better form of soil towards bumper farming practice grown on top and subsoils of Northern Sahel Savanna. The specified 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 specified 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, Green Manure, Sorghum, ICSVIII, Fara Fara, Northern Sahel Savanna*

Introduction

The needs to use renewable forms of energy and reduce the cost of fertilizing crop have revived the use of organic fertilizer worldwide. *Cassia tora* (sub-family: Caesalpinioideae; Family: Leguminosae/Fabaceae) is a small shrub which grows up in warm moist soil throughout the tropical parts of Asian and African countries. It is known by different names in different places like wise Foetid *Cassia tora*, Sickle Senna, Wild Senna, Sickle Pod, Coffee Pod, Tovara, Chakvad, Ring-worm Plant. *Cassia tora* as one of the freely available weed biomasses can be utilized for manuring purpose which helps the poor farmers in weed control, soil and crop improvement. Incorporating of *Cassia tora* into the soil adds nutrients to the soil thereby improving water retention, aeration, structure, texture, permeability and fertility of the soil as these factors that influence crop growth and development.

The cost of in-organic fertilizer is hazardous to the farmer and the general public whose sources food is from those in-organically produced crops. The general problem of the synthetic materials to the ecosystem also needs to be addressed in-order to safeguard the globe from the harmful effect of these chemicals. Organic farming is one of the important management practices that can tackle these problems.

In developing countries like Nigeria, the population growth rate is so high that improved technologies including rational use of fertilisers must be employed to meet the food requirement of the people (Beyenesh and Nigussie., 2018). Improved soil fertility through the application of fertilisers is an essential factor enabling the world to feed the billions of people that are added to its population (Brady and Weil, 1999).

Apart from the high cost of in-organic fertilizer, its health hazard on the farmer and the general public, when only inorganic fertilisers are used in highly weathered soils of the tropics like the one we have here in Maiduguri, poor physical structure and nutrient retention characteristics would adversely affect crop growth. Declining soil fertility is a major production constraint in Africa, especially in Nigeria, and it is becoming increasingly critical to secure sustainable soil productivity. The negative effects of the synthetic materials to the ecosystem need to be addressed effectively in-order to safeguard the environment from the harmful effect of these chemicals. Organic farming is one of the important management practices that can tackle these problems. At the end of this research *Cassia tora* which has been a weed all over the study area can be use alternatively as a source of nutrients to the soil, and of course this weed plant can be a major control to soil acidity which occurs by frequent use of in-organic nitrogenous fertilizers.

The research targets the evaluation of different varieties of sorghum grown under two soil type as a way of reducing overreliance on inorganic fertilizer. Hence, estimating a better form of soil towards bumper farming practice.

Methodology

Experimental site:

The experiment will be conducted at the Teaching and Research Farm of Ramat Polytechnic, Maiduguri latitude 11º 50" 35.40 N and longitude 13º 07" 45.05 E using sorghum variety popularly known as fara-fara.

Experimental Design and Treatments:

The experiment will be laid out in a Completely Randomized Block Design (CRBD) with three replications and 5 treatments. The treatments will consist of 4 forms of *Cassia tora* namely: chopped, dried and ground (CDG); Chopped, dried and burnt (CDB); freshly crushed and dried (FCD), freshly crushed (FC) and sorghum variety as second factor (T1= ICSVIII; and T2= fara fara) soil type as the third factor (S1= topsoil; and S2= subsoil). Which gives a total of 4x2x2+16 treatments replicated 3 x to have a total of 48 experimental units.

Sorghum seeds was planted when the rain is fully established as being practiced by the farmers in the area. Five to 10 seeds were planted per hole of 3cm to 5cm depth dug using a hoe. The seedlings were later thinned to two plants per stand one week after germination as recommended (Usman et al., 2017) number of days to germination, while growth parameters assesement of plant height, leaf area index, stem girth, leaf width, leaf length and leaf number. All data collected will be subjected to Analysis of Varience (ANOVA) using PROC GLM of the Statistical Analysis System (SAS, 2003). Duncan's multiple range test at $P<0.05$ will be use to separate the means.

Table 1. Physicochemical properties of the soil and green manure under study area

Parameters	Value		Cassia tora	
	Top Soil	Sub Soil	Parameters (%)	Value
pH (H_2O)	6.2	5.7	N	2.07
Organic Matter (%)	0.56	0.46	C	3.46
Total N (%)	0.06	0.03	C:N	1.64
Available P (ppm)	26	16	K	1.31
Exchangeable Bases (cmol/kg)			P	0.44
K	0.10	0.04	Ca	3.13
Na	0.06	0.04	Na	0.02
Mg	0.3	0.04	Crude Protein	16.6
Ca	1.6	1.3	Crude Fibre	16.6
Particle Size (%)			Ash	15.3
Sand	68.01	78.01	Dry Matter	93
Silt	22.00	12.00		
Clay	10.00	10.00		
Textural Class (USDA)	Sandy Loam	Sandy		

RESULTS AND DISCUSSION

Table 1 displays the soil properties with pre-planting analysis of the top and subsoil used indicated that the topsoil is more fertile than the subsoil which was collected from 30-46 cm below the soil surface,

A. Effects of different forms of Cassia tora, variation 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. Effect of Cassia tora forms on the growth of sorghum plant

Freshly crushed form of Cassia tora (FC) 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 correspondingly, however 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

The control treatment with 28.99, 52.30 and 78.66 at 4, 6 and 8 WAP was recorded as the means as presented in Table 3.

The same procedure was experienced 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.

Comparable 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. 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 analyzed 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.

Similar 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. Effect of Soil Type on Growth of Sorghum Plant

Topsoil (T1) perform significantly better statistically ($p<0.05$) than subsoil (T2) across all the parameters measured and analyzed 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 similar 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	**	**	**	ss	tt	ss	ss	ss	ss	ss	ss	ss	ss	ss	ss	as	ss	ss
V	ns	s*	ns	*	s	ss	s	ss	s	ss	ss	s	s	s	ns	ns	ns	ns
S	ss	ss	ss	**	**	s*	s*	s	s	ss	ss	ss	ss	ss	ss	ss	ss	ss
Interactions																		
Cx V	ns	ns	ns	ns	ns	ns	Ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
CxS	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
CxVxS	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= Cass/a *tow* 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. Mam 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	3	4	6	8	4	6	3	4	6	3
Cassia t orq 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
Ci (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)	47.73 c	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	6.33a	8.75bc	10.94a
C,(FC)	67.71a	99.91a	121.44a	6.10a	9.76a	11.31a	42.63 a	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
ViOCSVlll)	53.15a	90.34a	113.16a	5.30a	3.84a	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	83.32b	104.93b	4.52b	8.32b	9.29b	31.82b	54.85b	63.17b	3.03 b	5.46b	5.99b	78.26b	237.93b	298.12a	6.65a	8.80a	10.73 a
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
Si (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	7.13 a	9.23 a	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	8.43 b	10.50b

NB: Means with the same letter with in 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 Sign ificantDjffe rent

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 gap 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).

CONCLUSION

Green form of Cassia tora (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).

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