
Varietal Performance and Weed Control Methods on Growth and Stover Yield of Sorghum (*Sorghum bicolor* L.) for the Improvement of Animals' Fattening Enterprise in the Sudan Savanna of Nigeria

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ABSTRACT

A field experiment was conducted during 2023 wet season period at Audu Bako College of Agriculture Dambatta Research Dry land Farm (12°10' N, 8°39' E) characterized with an annual precipitation of 864 (341 inches), annual temperature ranges of 90° (31° – 22°) /17°f (89° – 72°f), Sandy loamy soil of pH 6.5, Organic matter content 7.9 gkg⁻¹ and total nitrogen 0.56 along Kano -Dauramain road of about 38km away from Kano to determine the effect of variety and weed control methods on growth and stover yield of Sorghum (*Sorghum bicolor* L.). The research trial consisted of six weed control treatments: -[Atrazine (1.75 and 1.25 kg a.i ha⁻¹ at sowing date), (post-emergence 2, 4 - D (1.0 and 0.50 kga.i ha⁻¹ at 6 WAS) with or without supplementary hoe weeding, weed free check, weedy check and two varieties of sorghum (improved variety of I.C.S.V 400 and local "Yar-tsanyawa] which were planted 25cm and 75cm as intra and inter double row planting on ridges. The treatments were laid in a factorial combination of randomized complete block design (RCBD) with three replications. Important weed species observed in the experimental plots were *Cassia tora*, *Digitaria horizontolis*, *Cyperus rotundus*, *Ageratum conyzoides*, *Amaranthus siphonosis*, *Euphorbia spp.*, *Commelina benghalensis*, *Cynotis cyclata* and *Digera arvensis*. Throughout the crop growth periods, weed free check significantly recorded the highest weed control efficiency (WCE%), plant height (cm), number of leaves per plant at different growth stages and Stover yield with the lowest values of weed indexes (WI%) followed by pre-emergence application of atrazine (1.75kg a. i ha⁻¹) + 2, 4-D (1.0 kg a. i ha⁻¹) at 6 WAS whereas weedy check significantly recorded the lowest mean value. According to these findings, the results show that, pre-emergence application of atrazine (1.75kg a. i ha⁻¹) + 2, 4-D (1.0 kg a. i ha⁻¹) at 6 WAS resulted to the production of higher plant growth characters / Stover yield with variety ICSV-400 among other herbicide treatments and could be adopted for cultivation due to profitable animal fattening enterprise in the study area pending to further research findings.

Key words: Weedy check, Pre-emergence, Atrazine, Post emergence, Stover Yield.

INTRODUCTION

Sorghum (*Sorghum bicolor* (L.) Moench) is the fifth most important cereal crop in the world after wheat (Ogunlela & Okoh, 1989). Sorghum is one of the valuable crop in Africa especially in the northern part of Nigeria, its growth is for both human and livestock consumption (Sangoi, *et al.*, 2002). The food security of many developing countries relies on sorghum production due to its low input requirements and ability to endure extreme climatic stresses. Sorghum is a C4 grass species which is widely cultivated for grain, feed/fodder and bio-fuel uses in tropical and semi-arid areas of the world. A pre-requisite for growing a successful sorghum crop is to obtain an adequate plant population density (Ismail & Ali, 1996).

In 1992, 45.4 million metric ton of sorghum was cultivated with an average yield of 1,532 kg ha^{-1} and over 80% of the areas of its production lie in Africa and Asia where average yield were 766 and 1,171kg ha^{-1} (FAO, 2014). In Nigeria, yield loss in sorghum production due to uncontrolled weed growth ranges from 80-100% (Kamble *et al.*, 2005). The use of cultural weed control method in alleviating this problem of weed infestation is inadequate to cope with large scale production especially for animal feed and fattening programme (Akobundu, 1987).

Based on this, the use of appropriate herbicide or herbicide combinations at the recommended rate and time in controlling weeds enables sorghum crop to effectively utilized available moisture, nutrients and light for better growth and Stover yield towards successful fattening programme in Nigeria. The objective of this study was to determine the effectiveness of various herbicide and or herbicide combinations on varieties of sorghum for better Stover yield performance as an animal feeds.

MATERIALS AND METHODS

EXPERIMENTAL SITE

Field trial was conducted at Audu Bako College of Agriculture Dambatta along Daura road of about 38km from Kano during 2023 wet season period in the Sudan savanna ecological zone of Nigeria. The annual rainfall normally begin in June/July and last until September/October. Kano is located at 11° 58N 8° 20E with the altitude of about 469m, (1539feet), annual precipitation is 864(341inches) and annual temperature range 90° (31° – 22°) /17°f (89° – 72°f).

The area belongs to the Sudan savannah region in the northern hemisphere, the hot rainy season period normally begin in June and last until September/October. The soil of the site at Dambatta was sandy loam of the pH 6.5, Organic matter content 7.9 gkg $^{-1}$ and total nitrogen 0.56 accordingly.

EXPERIMENTAL TREATMENTS AND DESIGN

Experimental trial consisted of six treatments with improved and local sorghum varieties (ICSV 400 and “Yar-tsanyawa) which were planted as intra and inter row spacing of 25cm $\times$ 75cm on ridges between stand and replicated three times using two herbicides namely, Atrazine applied as pre-emergence herbicide at 1.75 and 1.25kg a. i ha $^{-1}$ with supplementary hoe weeding at 6 WAS or 2, 4 – D as post-emergence herbicide at 1.0 and 0.5kg a. i ha $^{-1}$ at 6 WAS, weed free check and weedy check plots that served as control. The trials were laid using randomized complete block design and pre-emergence application of atrazine was applied immediately after sowing while supplementary hoe weeding (SHW) and post-emergence herbicide application (2, 4 – D) was carried out at 6 weeks after sowing (WAS).

Each gross plot consisted of 6 ridges $\times$ 0.75cm $\times$ 3m long. Alleys of 1.0m were left between plots within a block and 1.5m between blocks. Net plot was made up of 4 ridges $\times$ 0.75cm $\times$ 3m

DATA COLLECTION

Data were collected on Plant height (cm) and number of leaves / plant at different growth stages (4, 6, 8 WAS and harvest) of sorghum, weed control efficiency (WCE%) at 4 WAS, 8 WAS and at harvest, weed index (WI%) and Stover yield (kg ha⁻¹).

DATA ANALYSIS

Data collected on Plant height (cm) and number of leaves / plant at 4 WAS, 6 WAS, 8 WAS and at harvest, weed control efficiency (%) at 4 WAS, 8 WAS and at harvest, weed index (%) and Stover yield (kg ha⁻¹) were subjected to analysis of variance with the help of Gen stat 17th edition. Duncan's Multiple Range Test was used to separate treatments means where 'F' test shows significance difference between the treatments as described by Snedecor and Cochran (1967)

RESULTS AND DISCUSSION

WEED CONTROL EFFICIENCY (%)

The interaction between weed control treatments and varieties at all stages of crop growth was not found to be significant. The effect of variety and weed control methods on weed control efficiency (%) per square meter at 4, 8 WAS and at harvest are shown in Table 1. The effect of variety on weed control efficiency per m² was not significant throughout the study periods. However, significant differences were observed among weed control methods where weed free check recorded significantly the highest weed control efficiency per m² followed by T₃ and T₄ whereas Weedy check (T₆) recorded the least significant average mean values of (10.15, 13.38, 15.83) on weed control efficiency than the rest of the treatments at all the growth stages, this is because of the available dormant seeds in the seed bank as they were not controlled (Table 1). This agreed with Sharma *et al.* (2000) who reported that hoeing at 15 days and earthing up at 30 days to cultivated crop resulted in weed free condition and also Kolage *et al.* (2004) in their findings who reported that, lower weed intensity was observed with two hand weeding at 20 and 40 DAS, accordingly weed free check was found to record significantly the highest WCE at (P < 0.05) compared to rest of the control methods since it received hand weeding at regular intervals. This agreed with the findings of Eleftherohorinos and Kotoula (1995), who reported that, sorghum plot of hand weeded treatment was significantly greater than that of the weed infested plot and similar to that of herbicide treatment. At harvest, it was significantly high than all the treatments in terms of weed control efficiency (Table 1).

Table 1: Weed control efficiency (%) per square meter (m²) as influenced by variety and weed control methods during 2023 wet- Season at Audu Bako College of Agriculture Research Dry Land Farm.

Treatments	4 WAS	8WAS	At harvest
Variety			
Acikaiacikara “Yartsanyawa	55.14	58.04	55.57
ICSV-400	45.61	52.00	60.19
SE	4.685	5.115	5.688
Weed Control Methods			
T ₁ -Atr.1.25kg ai ha ⁻¹ + SHW at 5 WAS	80.56d	66.32b	59.00b
T ₂ - Atr.1.25kg ai ha ⁻¹ + 2, 4-D 1.0 kg ai ha ⁻¹ at 6 WAS	85.00bc	69.98b	67.00b
T ₃ - Atr.1.75kg ai ha ⁻¹ + 2, 4-D 0.5 kg ai ha ⁻¹ at 6 WAS	89.97ab	82.35a	86.74a
T ₄ -Atr.1.75kg ai ha ⁻¹ + 2, 4-D 1.0 kg ai ha ⁻¹ at 6 WAS	91.04ab	84.91a	88.97a
T ₅ -Weed free check	94.93a	91.23a	93.98a
T ₆ - Weedy check	10.15e	13.38c	15.83c
SE±	0.370	3.229	3.376
Interaction			
V*WCM	NS	NS	NS

Means in a column of any set of treatment followed by same letter(s) are not significantly different at 5% level of significance $P < 0.05$ using Duncan Multiple Range Test (DMRT), SHW-Supplementary hand weeding, WAS- Weeks after sowing, NS-Not significant, Atr.- Atrazine

Plant height (cm)

Significant differences were observed on the effect of weed control methods and varieties on the mean height at 4, 6, 8 WAS and at harvest (Table 2). There were significant differences between the varieties. At 4 and 8 WAS, variety ICSV-400 produced the tallest mean height followed by “Yartsanyawa variety. However, at 6 WAS there was no significant difference between the two varieties. Weed control methods showed significant variation on plant height at all stages of crop grow. The highest mean height was observed in Weed free check whereas weedy check recorded the lowest values at 4, 6, 8 WAS and at harvest, respectively.

Table 2: Effect of variety and weed control methods on plant height (cm) at different growth stages of sorghum during 2023 wet season at Audu Bako College of Agriculture Research Dry Land Farm.

Treatments	4WAS	6 WAS	8 WAS	At harvest
Variety				
Acikaiacikara “Yartsanyawa	19.00b	87.40	167.38b	169.74b
ICSV-400	19.88a	91.83	170.87a	173.28a
SE±	0.232	2.270	1.024	1.004
Weed Control Methods				
T ₁ -Atr.1.25kg ai ha ⁻¹ + SHW at 5 WAS	16.33d	68.57c	136.03e	147.23d
T ₂ -Atr.1.25kg ai ha ⁻¹ + 2, 4-D 1.0 kg ai ha ⁻¹ at 6 WAS	19.82c	98.57b	143.10d	160.10c
T ₃ -Atr.1.75kg ai ha ⁻¹ + 2, 4-D 0.5 kg ai ha ⁻¹ at 6 WAS	21.48b	103.37b	169.07c	177.8b
T ₄ -Atr.1.75kg ai ha ⁻¹ + 2, 4-D 1.0 kg ai ha ⁻¹ at 6 WAS	22.22b	113.13ab	183.50ab	186.33a
T ₅ -Weed free check	24.30a	119.20a	189.40a	192.27a
T ₆ - Weedy check	14.76e	59.34d	118.46f	124.47e
SE±	0.465	2.541	2.049	2.008
Interaction				
V*WCM	NS	NS	NS	NS

Means in a column of any set of treatment followed by same letter(s) are not significantly different at 5% level of significance $P < 0.05$ using Duncan Multiple Range Test (DMRT), SHW-Supplementary hand weeding, WAS- Weeks after sowing, NS-Not significant, Atr.- Atrazine

Among the weed control treatments, significant difference was observed on the effect of weed control treatments on plant height at 4 WAS. T_4 - Weed free check significantly recorded the tallest plant height (cm) at 4 WAS followed by T_4 -Pre-emergence application of atrazine ($1.75\text{kg a. i ha}^{-1}$) + 2, 4-D ($1.0\text{kg a. i ha}^{-1}$) at 6 WAS which produced taller plant height (22.22cm) though being statistically at parity with T_3 treatment while the shorter plant height (14.76cm) was recorded from weedy check. At 6, 8 WAS and at harvest, pre-emergence application of atrazine ($1.75\text{kg a. i ha}^{-1}$) + 2, 4-D ($1.0\text{kg a. i ha}^{-1}$) at 6 WAS significantly recorded taller plant heights (113.13, 183.50 and 186.33cm) among the herbicide treatments even though the shorter plant heights of (59.34, 118.46 and 124.47cm) were recorded from weedy check respectively. There were no significant interaction between weed control methods and varieties.

Table 3: Effect of variety and weed control methods on number of leaves per plant at different growth stages of sorghum during 2023 wet season at Audu Bako College of Agriculture Research Dry Land Farm

Treatments	4 WAS	6 WAS	8 WAS	At harvest
Variety				
Acikaiacikara “Yartsanyawa	5.32	8.38	14.27	15.43
ICSV-400	5.42	8.48	14.40	15.50
SE $\pm$	0.054	0.065	0.063	0.057
Weed Control Methods				
T_1 -Atr.1.25kg ai ha $^{-1}$ + SHW at 5 WAS	4.97d	7.73e	13.90e	14.93e
T_2 -Atr.1.25kg ai ha $^{-1}$ + 2, 4-D 1.0 kg ai ha $^{-1}$ at 6 WAS	5.52c	8.67d	14.43d	15.70d
T_3 -Atr.1.75kg ai ha $^{-1}$ + 2, 4-D 0.5 kg ai ha $^{-1}$ at 6 WAS	5.63c	8.80c	14.80c	15.93c
T_4 -Atr.1.75kg ai ha $^{-1}$ + 2, 4-D 1.0 kg ai ha $^{-1}$ at 6 WAS	5.77b	9.00b	15.00b	16.13b
T_5 -Weed free check	5.90a	9.40a	15.17a	16.33a
T_6 -Weedy check	4.77e	7.51f	11.26f	12.27f
SE $\pm$	0.008	0.031	0.025	0.015
Interaction				
V*WCM	NS	NS	NS	NS

Means in a column of any set of treatment followed by same letter(s) are not significantly different at 5% level of significance $P < 0.05$ using Duncan Multiple Range Test (DMRT), SHW-Supplementary hand weeding, WAS- Weeks after sowing, NS-Not significant, Atr.- Atrazine

NUMBER OF LEAVES PER PLANT

The effect of weed control methods and varieties on number of leaves at 4, 6, 8 WAS and at harvest are presented in Table 3. Weed control methods treatments showed significant variations in the number of leaves at all stages of crop growth. Weed free check recorded the highest significant average mean leaf number of (5.90, 9.40, 15.17, 16.33) per plant at 4, 6, 8 WAS and at harvest respectively whereas weedy check recorded the lowest significant average mean leaf number of (4.77, 7.51, 11.26, 12.27) and these lowest values might be due to uncontrolled weeds (weed infestation) leading to poor plants' growth indexes such as reduced number of leaves per plant, reduced leaf sizes, poor crop growth etc as a result of inadequate translocation of metabolites to the plants due to severe competition of moisture, nutrients, light and space by weeds. This result is in conformity with Virender (1997) who

observed that, weeds found a serious negative factor in crop production resulted to loss in crop Stover yield by 10 to 15 percent or more.

Table 4: Influences of variety and weed control methods on weed index (%) and Stover yield (kg ha⁻¹) during 2023 wet season at Audu Bako College of Agriculture Research Dry Land Farm

Treatments	Weed index (%)	Stover Yield (kg ha ⁻¹)
Variety		
Acikaia cikara “Yartsanyawa	34.77	5891.3b
ICSV-400	35.58	6167.0a
SE±	0.779	76.280
Weed Control Methods		
T ₁ -Atr.1.25kg ai ha ⁻¹ + SHW at 5 WAS	56.21b	4672.2d
T ₂ -Atr.1.25kg ai ha ⁻¹ + 2, 4-D 1.0 kg ai ha ⁻¹ at 6 WAS	39.01c	6616.7c
T ₃ -Atr.1.75kg ai ha ⁻¹ + 2, 4-D 0.5 kg ai ha ⁻¹ at 6 WAS	17.71d	6493.1c
T ₄ -Atr.1.75kg ai ha ⁻¹ + 2, 4-D 1.0 kg ai ha ⁻¹ at 6 WAS	11.48e	7708.4b
T ₅ -Weed free check	0.00f	9177.8a
T ₆ -Weedy check	69.69a	3613.1e
SE±	1.559	152.54
Interaction		
V*WCM	NS	NS

Means in a column of any set of treatment followed by same letter(s) are not significantly different at 5% level of significance $P < 0.05$ using Duncan Multiple Range Test (DMRT), SHW-Supplementary hand weeding, WAS- Weeks after sowing, NS-Not significant, Atr.- Atrazine

WEED INDEX (WI %)

The effect of variety and weed control methods on weed index is presented in Table 4. Variety had no significant effect on weed index. Weed control methods affects weed index significantly. Among all the weed control treatments, weed free check recorded significantly least value of weed index and the highest value was recorded from weedy check. The research result revealed that T₆ has the highest weed index figure than the rest treatments simultaneously (Table 4) and there was no significant interaction between the variety and weed control methods.

STOVER YIELD KG HA⁻¹

The effect of variety and weed control methods on Stover yield (kg ha⁻¹) is presented in Table 4. The result indicates that variety had significant effect as Variety ICSV-400 had significantly higher Stover yield than “Yar-tsanyawa variety. Among all the weed control treatments, weed free check recorded significantly highest Stover yield (kg ha⁻¹) while weedy check had significantly the least. T₂ and T₃ produced statistically the same Stover yield but higher than treatments T₁, except weedy check (T₆) which has significantly lowest Stover yield (Table 4). T₅-Weed free check was found to be the highest across all the treatments and this could largely be attributed due to non-competition of edaphic and climatic variables particularly soil moisture, nutrients and weed infestation. Sorghum is known to require enough and adequate moisture during initial stages of its growth (Shekhawat and Gautan, 2002). In 2023 growing season, Dambatta received more rains compared to this season. The

result was in conformity with Sandhu and Gill (1973) who observed that, maximum crop weed competition was during the period of two to six weeks after sowing as well as during head formation and grain filling. Studies on weed control have indicated that the most significant crop-weed competition for soil moisture, nutrients, light and space may occur at a particular stage of crop growth.

Sorghum stover yields varies when weeds were controlled at different periods of growth stages according to the treatments levels but a significant yield decrease had occurred when weeds were not removed. T_2 and T_3 were significantly the same with reduced sorghum Stover yield when compared to T_4 . As weed competition increased, sorghum Stover yield decreased according to T_6 . Sorghum kept weed-free T_5 throughout its growing periods indicated highest growth and Stover yield at harvest with regards to the rest of the treatments. There was no significant interaction between the varieties and weed control treatments.

SUMMARY, CONCLUSION AND RECOMMENDATION.

Higher Stover yield kg ha^{-1} of (7708.4) was recorded in T_4 -pre-emergence application of atrazine ($1.75 \text{ kg a. i ha}^{-1}$) + 2, 4 – D ($1.0 \text{ kg a. i ha}^{-1}$) at 6 WAS followed by average Stover mean yield of (6616.7) from T_2 . pre-emergence application of atrazine ($1.25 \text{ kg a. i ha}^{-1}$) + 2, 4-D ($1.0 \text{ kg a. i ha}^{-1}$) at 6 WAS compared to the highest Stover yields of weed free check (9177.8) but the lower Stover yield was recorded in T_1 - pre-emergence application of atrazine ($1.25 \text{ kg a. i ha}^{-1}$) + (SHW) at 6 (WAS) whereas the lowest was observed from weedy check among all the weed control treatments. Differences in Stover yields among different weed control methods were largely as a result of the differences in growth components. Among the growth components, plant height and number of leaves per plant were the highest from Weed free check treatment followed by pre-emergence application of atrazine ($1.75 \text{ kg a. i ha}^{-1}$) + 2, 4 – D ($1.0 \text{ kg a. i ha}^{-1}$) at 6 WAS. On the other hand weedy check had the lowest growth component values. These lowest growth component values might be due to reduced total dry matter production and number of leaves per plant as a result of inadequate translocation of metabolites to growth components due to severe competition of moisture, nutrients, light and space by weeds. This result is in conformity with Virender (1997) who observed that, weeds found a serious negative factor in crop production which resulted to loss in crop Stover yield by 10 to 15 percent or more.

Recommendations

With references to the above research findings, it is recommended that, T_5 - weed free check treatment with an average Stover mean value of (9,177.8) was significantly the best in terms of growth characters and Stover yield at harvest followed T_4 - pre-emergence application of atrazine ($1.75 \text{ kg a. i ha}^{-1}$) + 2, 4 – D ($1.0 \text{ kg a. i ha}^{-1}$) at 6 WAS which ranked significantly second treatment on Stover yield at harvest from the entire research trials. Nevertheless, T_4 - pre-emergence application of atrazine ($1.75 \text{ kg a. i ha}^{-1}$) + 2, 4 – D ($1.0 \text{ kg a. i ha}^{-1}$) at 6 WAS became the best treatment with significant average Stover mean yield value of (7708.4) among the herbicide treatments and as well variety EV99DT-WSTR was significantly better than variety 2008SynEE-WDTSTR respectively, meanwhile T_5 - weed free check treatment with average Stover mean yield value of (9177.8) combined with variety EV99DT-WSTR could be adopted at the study area as it gave highest Stover yield for the improvement of animals' feeding and fattening enterprise pending to further research findings.

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