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Effects of Cutting Time and Varieties on Fodder Grain Yields and Yield Components of Sorghum under Semi Arid Environments of Makueni County in Kenya

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Abstract

Field trials were conducted at the Kenya Agricultural and Livestock Research Organization (KALRO), Kiboko, Kenya during season 1 (October –December 2013) and season 2 (March - May, 2014). The objectives of the experiment were to determine the fodder and grain yield in sorghum varieties cut at different times and the effect of cutting time on sorghum yield components. The experimental was laid out in a 4 x 4 factorial split plot design, replicated thrice. The main plots were allocated the four cutting times, *viz.*, No cut (C_0), Cutting 40 days after sowing (C_{40}), Cutting 75 days after sowing (C_{75}) and Cutting at 40 and then 75 days after sowing (C_{40-75}), respectively. The sub-plot treatments were four varieties, namely Gadam El Hamam (Vg), Mexico R Line 5 (Vm), KAT 369 X F6 YQ 212 (VK3) and KAT 487 (VK4), respectively. The results indicated that cutting time and varieties significantly affected sorghum plant height, number of tillers per plant, 1000 grain weight, grain and fodder yields. The effects of cutting time and varieties did not significantly affect seedling emergence and vigor. Variety Mexico R Line 5 produced the highest mean fodder yield of over 16 t/ha under C_{75} in season 1.

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KAT487 produced the largest amount of grain yield of 2.66 t/ha and under C_{40} in season 2. Cutting sorghum at 40 DAS resulted in re-growth that eventually produced both fodder and grain. Sorghum variety KAT 487 was the best dual purpose sorghum while Mexico R Line 5 was most suited for fodder production.

Keywords**:** sorghum grain; sorghum fodder; varieties; cutting time; yield components**.**

1. Introduction

Sorghum yields are generally low, averaging 500–800 kg/ha in small scale farms of semi-arid regions This is attributed to the growing of low yielding cultivars, the use of poor production techniques and the unfavorable water limited growing environmental conditions of Semi Arid lands. Sorghum productivity and thus production can be enhanced by identifying and growing improved high yielding varieties [1] and the use of ideal management practices within the resource poor farmers' circumstances in semi arid Kenya. Studies on sorghum cultivation indicate significant differences among varieties with respect to physiological growth traits, grain yield and fodder yield. References [2] and [3] reported significant differences in head length, head weight, fodder yield and grain yield per hectare among cultivars. Therefore, the identification, development and production of high yielding dual purpose sorghum cultivars for both grain and fodder production, could mitigate the demand for grain and fodder [4].

In Kenya sorghum is a traditional crop grown mainly for subsistence use in many parts of the country and in particular in the arid and semi-arid regions [5] Due to increasing incidents of drought and the desire to stabilize food security in the country, promotion of drought-tolerant crops such as sorghum have generated renewed interest [6] Stable, high-yielding sorghum varieties have been developed [7] The advantage with sorghum production is that it has low input requirements compared with most other cereals that include maize. In Kenya, the initiatives to promote sorghum production are mostly concentrated in the arid and semi-arid lands [5] which is mainly a government strategy to meet household food security needs and increase rural income [6] The initiatives have great potential for growth and expansion of the crop and are expected to impact the livelihoods of many farmers through food security and income generation [5].

Makueni County in Eastern province of Kenya is characterized by increasingly frequent drought occurrences, sometimes extending for two to three years. Over the last two decades, there has been repeated crop failure of maize which is a staple food in many parts of Kenya due to drought [8]. Improved sorghum varieties if grown in semi-arid areas like Makueni, can survive and yield well in such unreliable rainfall conditions [9]. [7] noted that increase in production depend mainly on efficient use of available technologies. Selection of high yielding sorghum varieties can therefore guarantee higher fodder and grain yields in semi arid areas when coupled with improved management efficiency in production by the farmers [11]. Sorghum has quick growth, high grain yielding ability, high fodder dry matter content and high nutritional quality [12].

The scarcity of green forages and grazing resources in Africa has kept the livestock production potential at sub-optimum levels as compared to many developed nations [13].

Therefore, the potential alternate use of sorghum, i.e., as either a dual purpose or for either fodder or grain – as dictated by the weather and cultivar grown and cutting management - will be of significant importance for the economic activities in the ASALS; where livestock productivity depends on the availability of quality and abundance of fodder.

2. Materials and Methods

This field study was conducted at Kenya Agricultural and Livestock Research Organization (KALRO), Kiboko Field Station (1^{o} 31'S, 37^{o}16'E) which lies at an altitude of 1260m above sea level and is classified as Agro ecological zone Lower Midland IV [14]. The area receives an average annual rainfall of 500-1300 mm. which is bi-modal with long rains (March-May) and short rains (October-December). The total rainfall received at the experimental site for season 1 (October – December 2013) ranged between 2.0 mm to 228.2 mm and season 2 (April – May 2014) was 4.0 mm 186.50 mm, respectively. The average relative humidity was 87.18. ^{o}C, respectively. The Mean minimum temperatures for season 1 and season 2 were 17.3 ^{o}C and 17.7 ^{o}C, respectively. The mean minimum and maximum annual temperatures were between 11.9^{o}C and 25.5^{o}C, respectively. The soils are characterized as Pellic Vertisols that are imperfectly drained, moderately deep, friable, dark grayish brown to black, very firm, gravelly cracking clay on gentle slopes [14]. The average minimum and maximum temperatures in the field during the trial were 14^{o}C and 32.9^{o}C respectively.

The experimental design was a split-plot factorial in a Completely Randomized Block Design with cutting time treatments place in the main plots and varieties as the sub-plots. Each treatment was replicated thrice. Plot size was 4.0 m x 3.0 m. Spacing was 60 cm between rows and 20 cm within rows. The main plot treatments consisted of no cutting (Co), cutting at 40 DAS (C_{40}), cutting at 40 then 75 DAS (C_{40-75}) and cutting at 75 DAS (C_{75}) respectively. The varieties evaluated were Mexico R Line 5 (Vm), KAT 487 (VK4), KAT 369 X F6 YQ 212 (VK3) and Gadam el Hamam (Vg). Phosphorus (P) was applied as DAP at the recommended rate of 30 kg P/ha [15]. in the furrows and mixed with the soil. Sorghum seeds were sown at a spacing of 60 cm between rows and 20 cm between the plants. Plots were irrigated twice a week at approximately 27 mm of water per irrigation during the first 30 DAS and once per week afterwards until 90 DAS. N was applied as top dressing with CAN six weeks after sowing at the rate of 40 kg N per hectare [1].

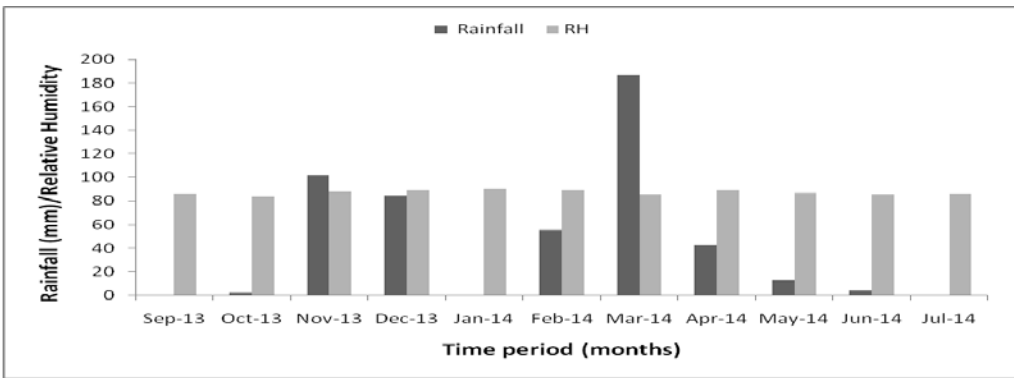

Figure 1: Rainfall and Relative Humidity data for KALRO, Kiboko during the study period (Source- ICRISAT Kiboko field weather station 2013/2014)

Seedling vigor and seedling emergence were scored at 20 DAS. Plant height was measured at 20; 40 and 75 DAS. Dry fodder weight was determined 40 DAS, 40 and then 75 DAS, 75 DAS and 118 DAS, depending on the cutting time treatment allocation. Number of tillers was taken at 40, 75 and 118 DAS. Plot grain weight and 1000-grain weight were determined using an electronic weighing balance. The data collected was subjected to ANOVA using GENSTAT 14th Edition [16]. Means were separated using LSD at 5% level.

3. Results

3.1 Morphological growth parameters and yield components

Plant Stand

Seedling vigor did not differ significantly with cutting time or variety. An average plant stand of 66,333 plants ha^{1} (approx. 80%) was obtained for all treatments by 20 days after sowing.

Plant Height

Cutting time had significant effect on plant height only under C_{75} and at 118 days after sowing for all cutting time treatments in both seasons. Plant height increased progressively with the growing periods of sorghum varieties from a range of 45.69 cm at 20 days after sowing to a maximum height of 177.7 cm for C_0 treatment followed by 124.0 cm, 90.9 cm and 87.7 cm for crops under C_{40}, C_{40-75} and C_{75}, respectively in season 1. The corresponding sorghum heights for season 2 were 44.82 cm at 20 days after sowing to a maximum of 167.9 cm for C_0 treatment followed by 115.2 cm, 115.2 and 79.1 cm for plants under C_{40}, C_{40-75} and C_{75}, respectively for season 1. The trend was similar in season 2 for all cutting time treatments.

Variety differences in height were significant at all stages of growth. Sorghum height increased progressively for all varieties with increase in maturity. The varieties were tallest at 75 days after sowing with Mexico R Line 5 being significantly the tallest (158.59 cm) followed by KAT 487 (144.57 cm), KAT 369 (140.93 cm) and last was Gadam (114.32 cm). At maturity (118 days after sowing), the varieties were shorter compared to height at 75 days after sowing due to the imposed cutting treatments. Cutting time severely affected sorghum height for C_{40-75} and C_{75} respectively which declined from an average of 125.68 cm and 129.07 cm to 82.4 cm and 74.1 cm for both cutting time treatments in season 1. The same trend was observed in season 2.

Interactions between cutting time treatments and variety on sorghum height were observed for C_{75} and 118 days after sowing only for both seasons. Under no cut (Co), Mexico R Line 5 was the tallest ($P \leq 0.05$) at 211 cm by 118 days after sowing. This was followed by KAT 369 and KAT 487. Under C_{40} treatment, Mexico R Line 5 and KAT 487 had significantly taller crops compared to KAT 369 and Gadam. Sorghum under C_{40-75} treatment showed marked decline in height of between 77cm and 96 cm in season1. Similar trends were observed in season 2.

Mathematical functions developed to depict increase in sorghum height with maturity had high coefficients of determination where $R^2 > 98.4\%$ (Fig. 2).

In treatment $C_{0,}$ the sorghum height was greatest at about 100 days after sowing of about 180 cm, followed by treatment C_{40} at 130 cm. This was followed by C_{40} with 130 cm by 95 days after sowing, then C_{75} and $C_{40\text{-}75}$ at 117 cm at 85 days after sowing. Beyond 100 days after sowing, the height declined as defined by the developed function. This was true for all cutting treatments except for Co where the height remained constant after 105 days after sowing until harvest.

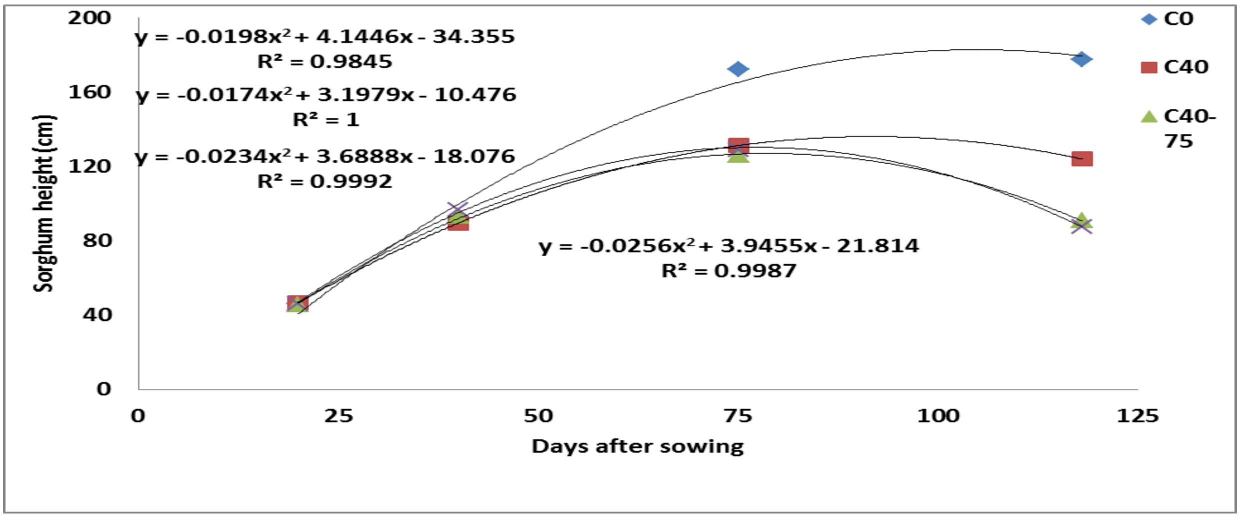

Figure 2: Relationship between sorghum heights with maturity of sorghum varieties as affected by cutting time at Kiboko, Kenya

Tillering

Significant differences in tiller production in sorghum due to varieties were observed in all varieties at 75 and 118 days after sowing in season 1 and season 2. Differences in tillering at 40 days after sowing for all sorghum varieties were only significant in season 2. Tillering increased with maturity of sorghum. All sorghum varieties had the highest tiller numbers at 118 days after sowing. Gadam produced the highest average number of tillers at 40, 75 and 118 days after sowing in season 1 and season 2. Irrespective of cutting time treatments, tillers per plant increased with maturity of crops. There were no effects due to interaction of cutting time and variety on sorghum tillering. The number of tillers per plant increased with increase in maturity for all varieties as given by the linear and quadratic functions in Figures 3a and 3b.

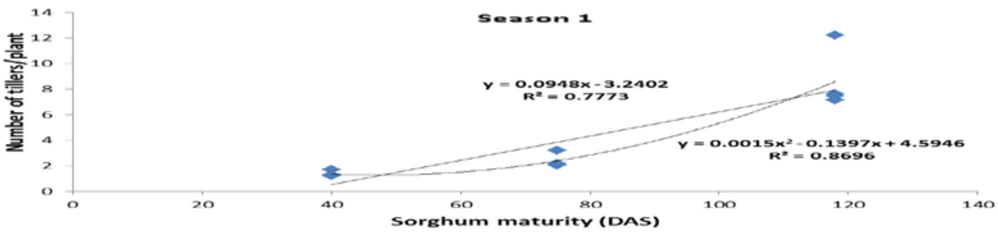

Figure 3a: Relationship of number of tillers per plant with time to maturity of sorghum varieties in S1 at Kiboko, Kenya

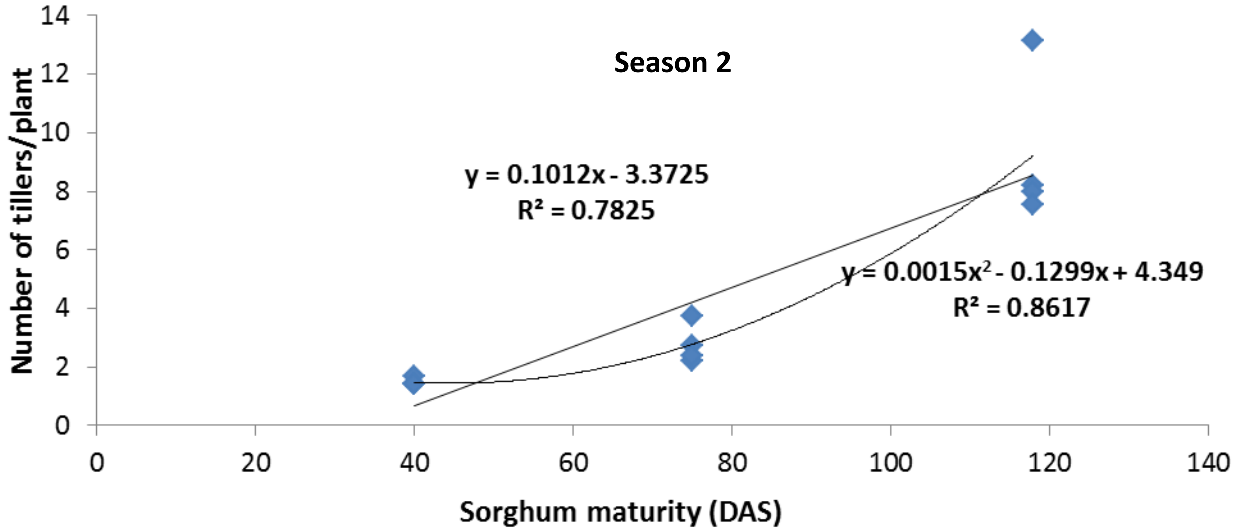

Figure 3b: Relationship of number of tillers per plant with time to maturity of sorghum varieties in S2 at Kiboko, Kenya

Sorghum Fodder yield

Sorghum fodder yield at 40 days after sowing differed significantly across all cutting times. Cutting at 40 then 75 days after sowing ($C_{40\text{-}75}$) produced the highest mean yield of 0.65 t/ha in season 1. Cutting once at 40 days after sowing (C_{40}) had the highest mean fodder yield (0.69 t/ha) in season 2. At harvest, C_0 produced the highest fodder yield of 11.87 t/ha and 9.54 t/ha in season 1 and season 2, respectively. Cutting once at 75 days after sowing (C_{75}) produced the lowest amount of fodder of 3.19 t/ha and 2.45 t/ha at harvest in season 1 and 2, respectively. Sorghum varieties had significant effect on dry matter yield at 40, 75 and 118 days after sowing in both seasons except during season 2 under C_{75}. Mexico R Line 5 produced the highest fodder yield in both seasons at all harvest intervals with a minimum yield of 0.11 t/ha under $C_{40\text{-}75}$ and a maximum of 7.15 t/ha under C_{75}. Gadam had the lowest average fodder yield across all cutting time treatments.

Interaction effects of cutting time and variety on fodder yield were significant for all cutting times in seasons 1and 2. Crops under C_0 produced the highest fodder yield among all varieties. Mexico R Line 5 out yielded the other varieties with a fodder yield of 15.0 t/ha and 12.57 t/ha in season 1 and 2, respectively. Gadam under C_0 produced the lowest fodder DM yield of 9.2 t/ha and 7.0 t/ha in season 1 and 2, respectively. Under C_{75}, sorghum produced the second highest quantity of fodder DM across all varieties and seasons while C_{40} produced the lowest fodder yield among all varieties. Fodder yield among the sorghum varieties increased with increase in maturity. Fodder yield for Season 2 for all cutting treatments were slightly lower compared to season 1, due to poorer rainfall conditions in season 2. Growth rate with respect to fodder yield was highest for Mexico R Line 5 at 0.0868 t/ha/day. Gadam had the lowest fodder DM accumulation rate of 0.0558 t/ha/day (Fig. 4). Production functions developed had high predictive value for determining fodder productivity for the four varieties with coefficient of determination R^2 of over 0.98.

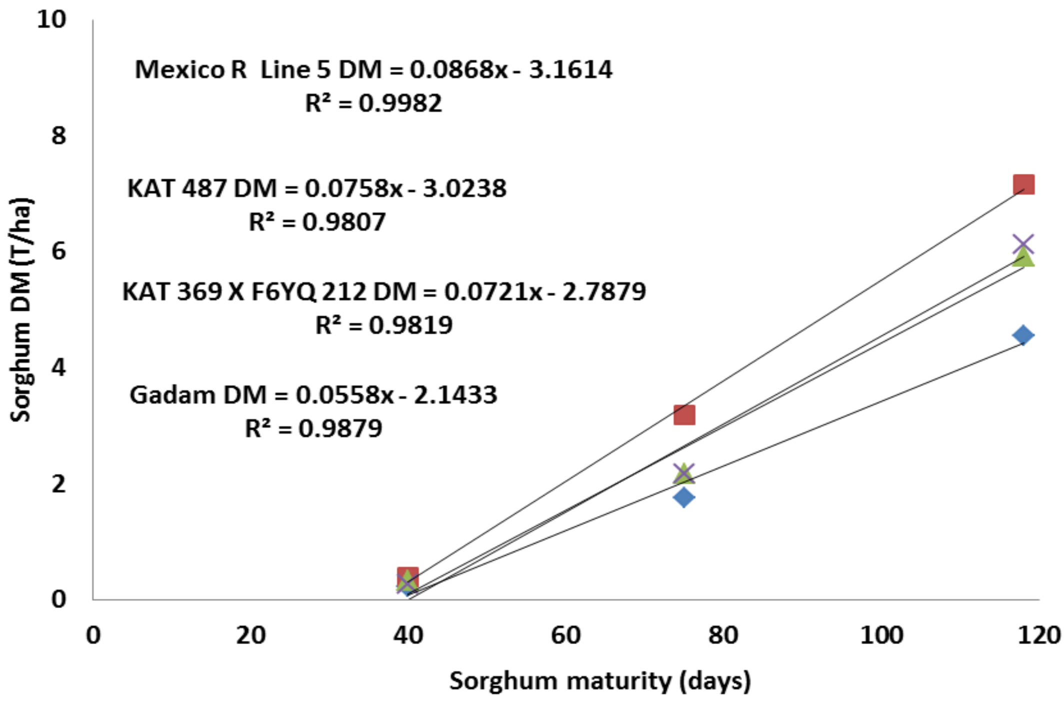

Figure 4: Relationship of sorghum varieties to fodder yield under varying cutting time treatments

Relationship between sorghum height and dry matter yield

Linear curves with R^2 = 0.874 and 0.892 were fitted for season 1 and season 2 crops respectively to relate sorghum height at 75 days after sowing with above ground dry matter yield at 118 days after sowing, when subjected to varying cutting time treatments. The fitted linear functions revealed that DM increased at the rate of 0.085 t/ha and 0.071 t/ha for every unit increase in height (cm) in seasons 1 and 2, respectively (Fig. 5).

It is therefore possible to predict sorghum fodder yield at 75 days after sowing from known crop height at harvest (118 days after sowing) using these functions with over 87.4 % and 89.2 % confidence respectively. Relationship of sorghum height at 118 days after sowing with fodder yield at 118 days after sowing had predictive confidence of 77.29% and 68.5%, in season 1 and season 2, respectively (Figures 6a and 6b).

It is therefore, possible to predict fodder harvest at 118 days after sowing by use of crop height at 118 days after sowing with up to 77.2% and 68.5% confidence in season 1 and 2, respectively, which is acceptable for field grown crops.

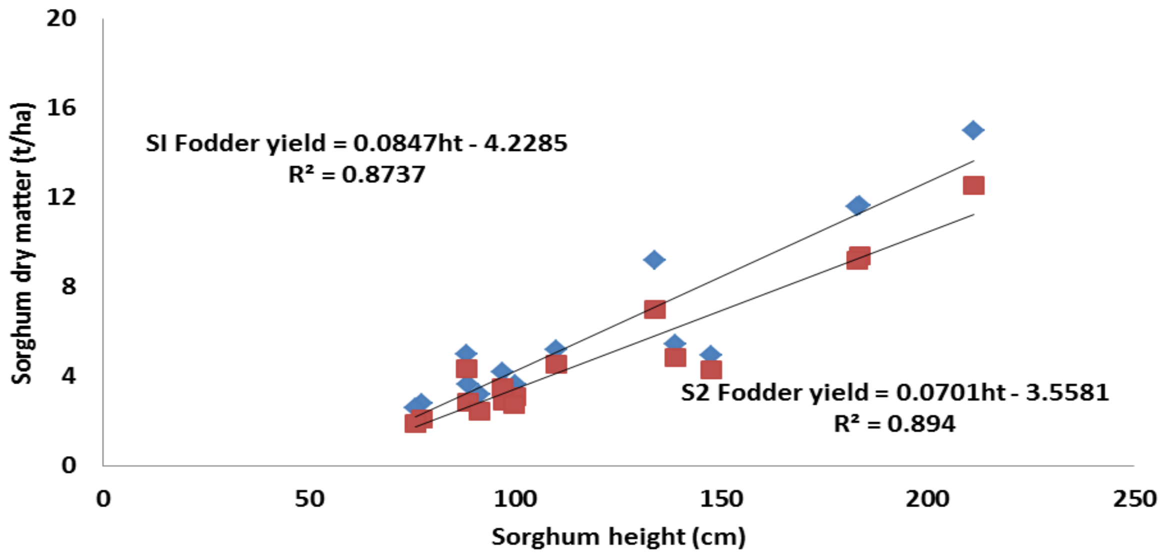

Figure 5: Relationship of sorghum height at 75 DAS to fodder yield at 118 DAS at Kiboko, Kenya

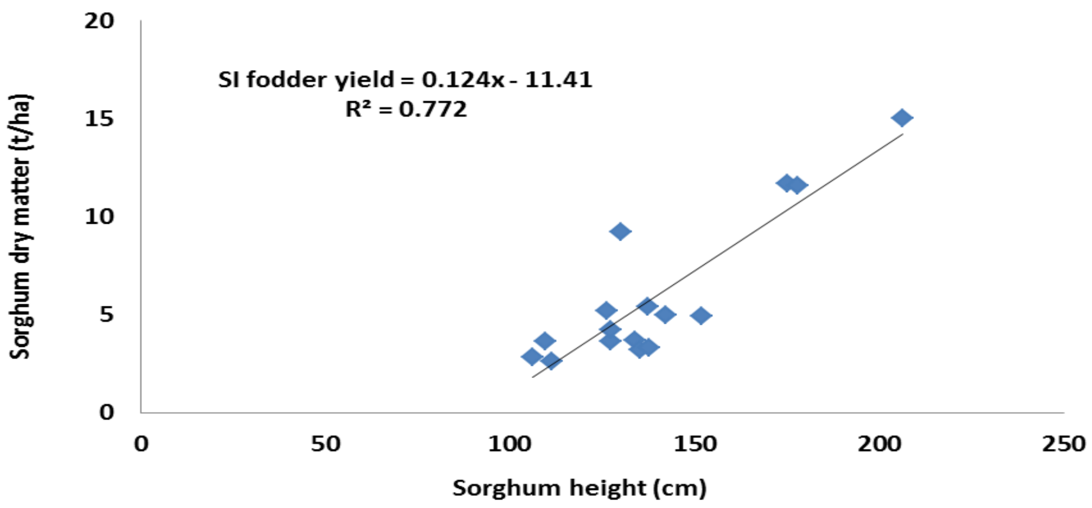

Figure 6a: Relationship of sorghum height to fodder yield at 118 days after sowing in season 1 at Kiboko, Kenya

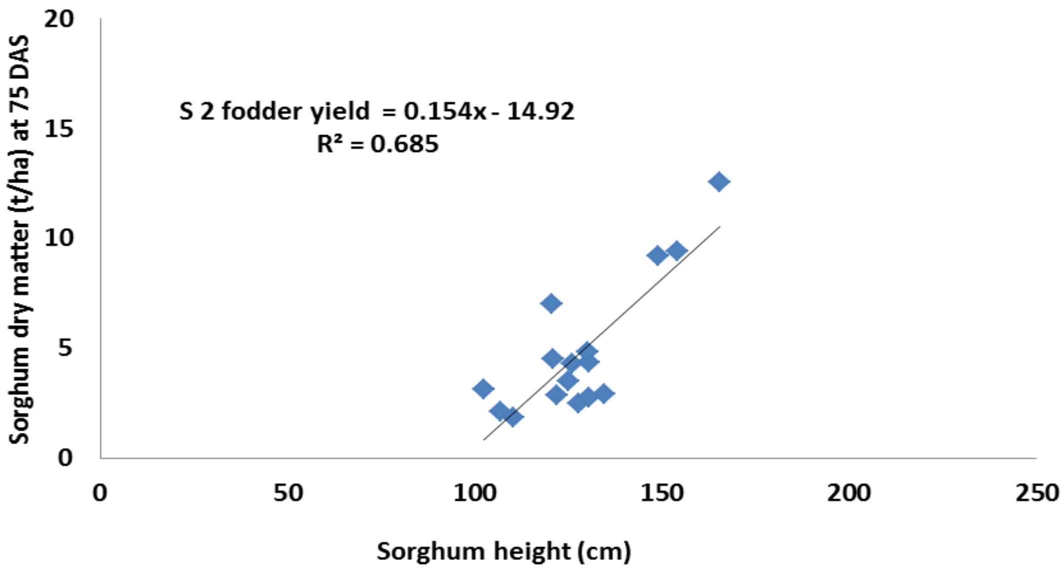

Figure 6b: Relationship of sorghum height to fodder yield at 118 DAS in season 2 at Kiboko, Kenya

Linear curves fitted for each variety in season 1 and 2 to relate sorghum height at 118 days after sowing with above ground DM yield at 118 days after sowing had R2 = 0.924 and 0.961for Gadam and for season 1 and season 2, respectively (Fig. 7). KAT 487 had R2 values of 0.909 and 0.940; Mexico R Line 5 had R2 values of 0.807 and 0.812 while KAT 369 had R2 values of 0.995 and 0.990 for season 1 and season 2 respectively. Fodder yield of sorghum for each respective variety can therefore be estimated from known plant height at harvest using these functions with over 81 % reliability.

From regression analysis to evaluate the relationship of height at 75 DAS with fodder yield for each variety at harvest, sorghum height at 75 days after sowing positively influences fodder production at harvest. The rate of fodder production (t/ha) per unit increase in height (cm) was 0.284 and 0.246 for Gadam, 0.160 and 0.234 for Mexico R Line 5, 0.158 and 0.183 for KAT 369 and 0.159 and 0.258 for KAT 487 in season 1 and 2, respectively. The regression functions accounted for more than 81% of the variations for all the varieties.

Sorghum grain yield

Sorghum grain yield varied significantly with imposed cutting. C_0 and produced grains at harvest. Average grain yield under C_0 was 2.01 t/ha and 1.92 t/ha while, C_{40} yield was 1.82 t/ha and 1.64 t/ha in season 1 and season 2, respectively. Plants subjected to C_{40-75} and C_{75} did not produce grain. KAT 487 was the highest yielding variety with an average grain yield of 1.27 t/ha and 1.22 t/ha while KAT 369 had the lowest average yield of 0.69 t/ha and 0.65 t/ha in season 1 and 2, respectively. Effect of interactions between sorghum variety and cutting time were significant in both seasons. Variety KAT 487 produced the highest quantity of grain (2.66 t/ha and 2.59 t/ha) under C_0. Variety KAT 487 produced the largest quantity of grain under C_{40} of 2.42 t/ha and 2.27 t/ha.

1000 Grain Weight

Cutting time had 1000 grain weight in both seasons. Sorghum plants subjected to no cut DAS treatments produced grain with an average weight of 29.83g and 28.67 g per 1000 grains in season 1 and 2 respectively. Plants cut 40 days after sowing produced grains with an average weight of 30.33 g and 28.33 g per 10000 grains in season 1 and 2 respectively. Sorghum subjected to cutting at 40 then 75 days after sowing and 75 days after sowing did not produce grain at harvest. There were no differences in 1000 grain weight of sorghum among the four varieties.

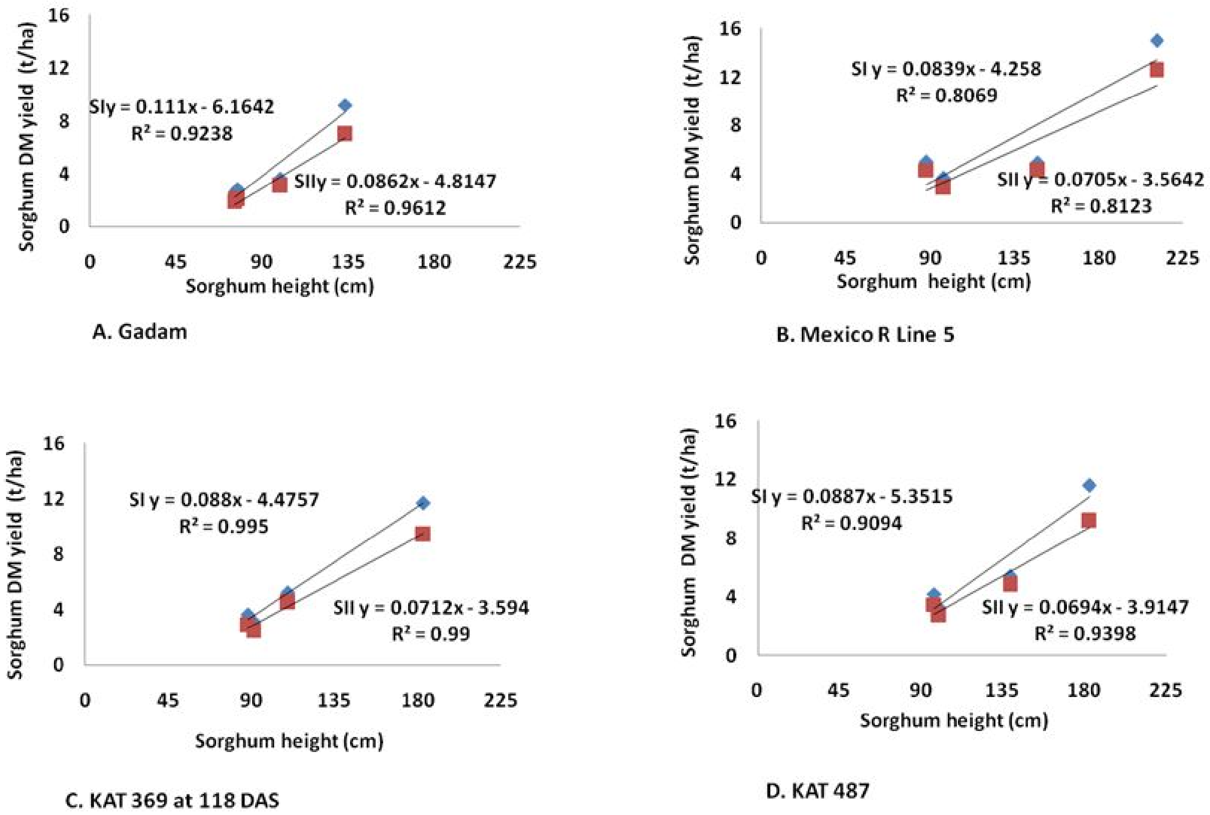

Figure 7: Relationship of sorghum height to fodder yield per variety at 118 DAS at Kiboko, Kenya

4. Discusion

Effect of cutting time on morphology, yield and yield components of sorghum varieties

Cutting reduced sorghum height and consequently fodder DM productivity. Sorghum cut more than once (C_{40-75}) and that cut close to maturity (C_{75}) i.e., at post -anthesis produced shorter crops and lower fodder DM yield due to interference in composition of biomass during grain filling [17]. [18] and [19] also reported a reduction in plant height and fodder DM yield in sorghum during subsequent cuts. Height was found to strongly correlate with fodder DM yield. Taller crops yielded significantly higher fodder DM irrespective of cutting time treatment.

Cutting slowed down the rate of vegetative growth by between 24 % and 50.6 % for sorghum cut once at 40 days after sowing and twice at 40 then 75 days after sowing respectively.

Regression analysis to evaluate relationship of sorghum height at 75 days after sowing to fodder DM yield at final harvest (118 days after sowing), indicated a positive relationship between height and DM yield with a confidence of more than 81 %. [20] reported that taller sorghum varieties produced higher fodder yields compared to shorter varieties. The rate of increase in fodder DM per unit increase in height (cm) ranged between 0.16 t/ ha / cm and 0.284 t /ha / cm across all the sorghum varieties. Extrapolation of the linear regression for Gadam variety to a height of 150 cm revealed that fodder production of up to 15 t/ha can be obtained; if it can be improved genetically to grow to a height of 150 cm. Therefore breeders should look into the possibility of increasing sorghum heights for increased fodder productivity and production. From regression analysis developed to evaluate relationship between sorghum height and fodder DM yield potential, it can be concluded that selection of sorghums for fodder production should preferably be of taller genetic stature at over 175 cm height by the 75^{th} days after sowing. This will guarantee the farmer over 9-11 tons $ha^{-1}$of fodder depending on rainfall, other environmental and management factors such as cutting. Breeding for taller sorghum crop varieties that have a fast growth rate of over 240kg DM/ha/cm height for increased DM production is recommended. Based on relationships developed for sorghum height and DM yield, it was observed that sorghum height at 75 days after sowing is positively related to fodder yield at final harvest (118 days after sowing). Such relationships can be used to predict sorghum fodder yield potential at final harvest to enable the farmers to plan for effective fodder utilization such as storage, feeding management, preservation or sale.

Sorghum fodder yield differed significantly among cutting times in both seasons. The quantity of fodder increased with increase in age to maturity of sorghum. As the crop matures there is increase in size and number of yield components such as leaves and stems. Subsequent increase in lignin, cellulose and hemicellulose coupled with decreasing amounts of plant water content leads to increase in dry matter [21]. Crops cut early in the growing season (C_{40}) produced low amounts of fodder compared to those that were cut later in the season (C_0 and C_{75}). The slower growth due to cutting in sorghum and subsequent reduction in fodder and grain yields could be attributed to interference in the crop physiological processes [22]. Sorghum fodder DM yield differed significantly ($P \leq 0.05$) among varieties. This is in agreement with [23] who reported significantly differences in forage yield traits among sorghum cultivars.

Variety Mexico R Line 5 produced the highest fodder yields followed by KAT 369X F6 YQ 212. These varieties also produced taller crops compared to KAT 487 and Gadam. Gadam which is a short variety produced the lowest quantities of fodder. [24], [25] and [23] reported fodder yield advantage among varieties that produced bigger, taller plants with more leaves and thicker stems. [26], [27] and [28] observed significant differences in fodder yield among sorghum varieties. It is therefore preferable to grow taller sorghum varieties such as Mexico R Line 5 and KAT 369 in order to maximize fodder production. Significant differences in 1000 grain weight were observed among cutting time treatments. This was attributed to the fact that sorghum cut at 40 followed by a second cut at 75 days after sowing (C_{40-75}), and the one cut treatment at 75 days after sowing (C_{75}), respectively did not produce grain. Sorghum cut at 40 days after sowing (C_{40}) and the crop that was not cut produced grain that did not significantly differ in the test weight ($P \leq 0.05$).

However, sorghum that was subjected to no cut produced slightly heavier grain compared to that cut at 40 days after sowing. This would indicate that cutting sorghum slightly reduces the test weight and consequently the grain weight of cut crops. This is in agreement with [29] who reported significant differences in 1000 seed weight due to the effect of cutting. This finding informs that cutting early in the growth period of sorghum does not significantly affect the physiological process of grain formation. This is because the flowering period for sorghum occurs after 55 days after sowing. Cutting at 40 days after sowing would therefore not affect grain formation thus there were no significant differences among cutting times. Grain filling is dependent on photosynthetic assimilates produced and stored in the leaves and stem biomass. Therefore, crops with higher biomass (and height) have higher assimilates (sources) for use in grain filling (sink) than shorter crops.

KAT 487 produced significantly higher grain yields while Mexico R Line 5 produced the highest quantity of fodder DM under all cutting time treatments. Therefore these two varieties differ with respect to grain and fodder productivity. These findings concur with those of [30] who reported a highly significant effect of varieties on fodder and grain yield in a study of four different varieties. For this reason, KAT 487 should be recommended for grain production, while Mexico R Line 5 should be recommended for fodder production.

Though the differences in 1000 grain weight were not significant among varieties ($P \leq 0.05$), variety Mexico R produced slightly larger grains followed by Gadam in season 1. KAT 369 and KAT 487 however had slightly larger grains in season 2. This concurred with the findings of [2] and [3] who opined that grain weight significantly, differed among sorghum varieties. This implies that the varieties KAT 369 and KAT 487 may be more drought tolerant compared to Mexico R and Gadam as the rainfall distribution in season 2 (188.5 mm) was poorer than season 1 (245.4 mm)

Sorghum grain yields varied significantly with imposed cutting time treatments ($P \leq 0.05$). This was attributed to the fact that crops cut at 40 then 75 days after sowing (C_{40-75}) and 75 days after sowing (C_{75}) did not produce grain at final harvest (118 days after sowing). This is because sorghum flowers after an average of 55 days after sowing. The findings of [29] reported a negative effect of cutting on growth and yield of sorghum. Cutting after 55 days after sowing interferes with the reproductive cycle of sorghum thus no further grain can be produced by the plants within the remaining period of the growing season (43 days). Sorghum that was left to grow to maturity without cutting (C_0) produced higher grain yield compared to C_{40}. Grain yield in season 2 was lower than season 2 due to poorer distribution of rainfall during the season

There were significant differences in grain yield among sorghum varieties ($P \leq 0.05$). Variety KAT 487 out-yielded the other varieties followed by Gadam. The average yields for each variety were slightly higher in season 1 compared to season 2 due to a better distribution of rainfall in season 1. Selection of KAT 487 and Gadam varieties is advisable to maximize grain yield. Both varieties produced significantly shorter crops. This may suggest that shorter sorghum crops are suitable for grain. The findings were in agreement with those of [31], [32], [3] and [33], who reported significant differences in grain yield among sorghum varieties. Though the crop under C_{75} yielded only fodder, Mexico R Line 5 produced a large quantity of fodder from cutting at 75 days after sowing and re-growth cut at final harvest (118 days after sowing). By 75 days after sowing, the crop has completed grain formation and therefore produces high quantities of fodder. KAT 487.

However produced relatively high quantities of fodder cut at 40 days after sowing and grain at final harvest. This implies that for farmers interested in producing fodder for livestock feed and grain for human food, KAT 487 is preferable as a dual purpose variety. Allowing sorghum to grow to maturity without cutting produces a large quantity of fodder. The fodder is however of low nutritional quality and is composed of woody stems and low leaf: stem ratio. Such fodder is unlikely to attract good returns compared to fodder cut earlier in the growing season. Protein content, digestibility and the energy content decrease as the crop matures [21].

5. Conclusions

Plant height is a useful trait in selecting for fodder yield potential as taller plants with or without cutting produced higher quantity of fodder compared to shorter varieties.

Variety Mexico R Line 5 is best suited for fodder production if harvested at 75th day after sowing, while variety KAT 487 best suited for production of both fodder and grain when harvested for fodder at 40 days after sowing and grain at about 120 days after sowing.

Farmers can harvest KAT 487 sorghum for livestock feed early in the season at 40 days after sowing to obtain large quantity of grain from the same crop at the end of the growing season. This can be used to produce livestock feed and human food from the same crop.

6. Recommendations

Farmers should select and grow taller sorghum varieties such as Mexico R Line 5 and KAT 487 that have the potential to produce large quantities of fodder.

Farmers should grow Mexico R Line 5 cut preferably after 75 days to maximize fodder production. KAT 487 should be selected as the most suitable dual purpose sorghum among the four varieties.

Sorghum Breeders should focus on breeding for taller varieties for potential attaining higher fodder yield.

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