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EFFECTS OF IRRIGATION INTERVAL AND STAGE OF GROWTH ON MORPHOLOGICAL AND GROWTH PARAMETERS OF COLUMBUS GRASS

(Sorghum almum)

[1]Hassan, N.A, [2]Baba, M, [1]Yahaya, B, [1]Bukola, O.A,[3] Egwuma, E.E, [1]Sadiq, M.S, [4]Madu, I
[1]Department of Animal Science, Federal University, Kashere, Nigeria
[2]Department of Animal Science , Bayero University, Kano, Nigeria
[3] Department of Agri Business Management, Rome Business School, Rome , Italy
[4]Department of Animal Health and Production Technology, Federal College of Horticulture , Dadin Kowa, Nigeria
(Corresponding author : Hassan, N.A nasir3472@gmail.com)

ABSTRACT

The effects of irrigation intervals and stage of growth on morphological and growth parameters of Sorghum almum (Columbus grass) was determined at the Livestock Teaching and Research farm of Federal College of Horticulture Dadin-kowa Gombe, Gombe State, Nigeria The treatments consisted of four (4) irrigation intervals (Zero, One day, Two days and Three days) and five stages of growth (vegetative, boot, milk, soft dough and hard dough stage). The experimental design used was a 4 x 5 factorial arrangement in a completely randomized design.The results revealed that both irrigation interval and stage of growth significantly affected , leaf area and leave area index were significantly ($p<0.01$) higher at milk stage with 8.57 t/ha, 188.1cm^{2}and 37.62cm compared to other stages of growth respectively. Hard dough stage produce higher ($p<0.01$) number of tillers(24 tillers). The main effect of irrigation interval had significant influence on plant height, tillers and leaf to stem ratio. Plant height was found to be significantly higher ($P<0.01$) at every day irrigation (173.55cm). Number of tillers was also significantly higher ($P<0.01$) at every day and every other day irrigation (16.00 and 15.66) respectively. Leaf to stem ratio was significantly ($P<0.01$) higher at every day and every two days irrigation intervals (1.13 and 1.15) respectively. It was concluded that Sorghum almum could be produced using 1 to 3 days irrigation intervals and be harvested at milk and soft dough stages for better growth and , higher dry matter yield and in the semi-arid zone of Gombe state Nigeria. It was therefore recommended that famers irrigate at 1 – 3 day interval for better growth and harvest their forage at the aforementioned stages and feed to livestock for better dry matter intake and improved animal performance

Keywords : Growth Parameters, Irrigation Interval, , Morphological Parameters, Stage of Growth, *Sorghum almum* ,

1.0 INTRODUCTION

The most important contribution of improved forages is their higher yield and better nutritive value, which have direct effect on livestock production. Columbus grass (*Sorghum almum*) is one of the most valuable summer forage and fodder crops adapted to semi-arid and sub-humid areas (FAO, 2010). It provides valuable fresh forage used as pasture or in cut-and-carry systems. It should be cut down to 5 cm every 6 to 12 weeks (Ecocrop, 2010). It makes a good quality, though coarse, hay and silage, provided it is cut at the mature stage and the weather is not too wet (Cook *et al.*, 2005)). Accordingly, the determination of growth, development and physiological parameters of *Sorghum almum* under different growing conditions and biochemical analysis of the nutritional value of green mass are of great scientific and practical importance (Olanite *et al.*, 2010). In Nigeria, Columbus grass is one of the several forage species introduced in to the country for use in the intensive and extensive systems of ruminant livestock production. It has been evaluated at institutional level, for agronomic characteristics, chemical composition and for conservation as silage or hay in addition to its suitability for grazing (Muhammad *et al*., 2006). Through the various researches conducted in Nigeria, *Sorghum almum* has been shown to be a promising forage species in the northern and southern guinea savannah zones of the country (Muhammad *et al.,* 2006).

However, in the semi-arid zone, with shorter duration of rainfall, it may be necessary to increase availability of good quality pasture by adopting irrigation scheme for the production of improved pasture species. *Sorghum almum* was cultivated for its high yield and palatable herbage. It has been used for silage, hay and grazing. It is highly adapted to rotational grazing but is sensitive to trampling (Baba *et al.*, 2015). Irrigation scheduling is a means of supplying water according to crop needs. It is the process of determining when to irrigate and how much water to apply. Barragan *et al,*. (2010) proposed that to appropriate irrigation, scheduling can conserve and prevent water stress in plant. Beside irrigation, one other factor that may affect productivity and availability of pasture is the stage at which pasture is harvested.

Livestock production in Nigeria is facing problem of feed shortage most especially in the semi-arid zone of the country. Pasture grasses from native rangelands are generally inadequate to meet the year round requirement of the animals thus the need to improve its production(FAO, 2010).Improving productivity of ruminant animals in this zone require substantial increase in the pasture production both in quantity and quality. The ill effect of feed inadequacy can be seen in

reduced feed intake, growth, production of animal product (meat and milk) and reduced reproductive ability with a consequent reduction in famers income (Cook *et al.,* 2005). The above scenario may severely impact the ever increasing human population in the area of widening the already existing protein gap which may lead to nutritional deficiencies.

Drought is a worldwide problem constraining global crop production, and recent global climate change has made this situation more serious (Chandler and Bartels 2003). Water scarcity and drought are the main features of the dry areas. Water is the single most limiting resource for world agriculture and food production, highly exceeding other key limitations. Large amount of water is used in field production of food crops, leading to a deficit of fresh water resources in many arid or semi-arid areas in the world. In regions where water scarcity is the principal limiting factor for cultivation, farmers are interested in growing crops that are able to adapt to drought conditions (Bannayan *et al.,* 2008).Buttar *et al.,* (2007) reported that saving water in irrigated areas is the definition of the suppression of irrigation correctly promoting the physiological seasoning of plants without compromising yield. The timing of the first irrigation is an important management consideration that depends primarily on soil water retention properties and the prevailing climate.

In the savannah zone of Nigeria, there are a number of irrigation schemes, flood plains, inland valleys and streams. Farmers both Arable crop and pastoralist use them for vegetable crops and horticultural crop production (Muhammad and Abubakar 2004). Forage grasses and legumes can also be grown under irrigation in the inland valleys or in water drawback of the flood plain to serve as out of season fodder materials and alternative cropping rotation to break up pest cycle or enrich the soil if legume is used (Muhammad *et al.,* 2006).Therefore production of fodder through irrigation method will provide a measure against the incessant feed scarcity especially during the dry season. More so, research fellows and policy makers will use the document as a reference material for future research.

This study was therefore designed to determine the effects of irrigation intervals and stage of growth on morphological and growth parameters of *Sorghum almum*(Columbus grass) in the semi-arid zone of Gombe State, Nigeria.

3.0 MATERIALS AND METHODS

3.1 Experimental site

The study was conducted at the Livestock Unit, Teaching and Research farm of Federal College of Horticulture Dadin-kowa Gombe, Gombe State Nigeria. Dadin-kowa, Yamaltu Deba Local Government Area is located in the savannah zone of North- Eastern Nigeria, on latitude 11^0.30N and longitude 100^0 20E and on altitude of 240m above sea level (GPS 2015). The area is characterized by short rainy season (4-5 months) with annual rainfall of 760mm to 1100mm, and long dry season (6-7 months). The ambient temperature could be as low as 24^0C during the dry cold season (October-January) and as high as 44^0C during the dry hot season (February-May). (UBRBDA 2022).

3.2. Soil analysis

Soil analysis was carried out to determine soil pH, percentage nitrogen, available phosphorus and potassium. Soil pH using pH meter, Kjeldahl's procedure described by Bremner and Mulverny (1986) for total nitrogen, phosphorus by atomic absorption spectrometer as describe by AOAC (2005) and flame photometry for K as describe by Gul and Maphra (2009). Particle size analysis were also determined using Bouyoucos hydrometer reading as described by Jaiswal (2003).

3.2.1 Soil preparation and seed sowing

Loamy soil-sand mixture was prepared and mixed thoroughly at the rate of 3:1 to make a composite sample. Ten kilogram (10kg) of the mixture was put into 14 liter plastic container perforated at the bottom with dimensions length and width (L=27 cm and W=29 cm) respectively. The soil was watered for three days before sowing with three (3) litters of water every day. *Sorghum almum* seeds were mixed with NPK fertilizer during sowing at the rate of 50kg/ha, using N P K 20:10:10. The Seeds were sourced from the National Animal Production Research Institute (NAPRI), Zaria. Ten(10) seeds were sown per each container. At 3 weeks post sowing seedlings were thinned to 4 plants per each plastic container

3.3 Treatment and Experimental Design

The treatments used for this experiment were four (4) irrigation intervals(Zero, one, two, and three days irrigation interval and five stages of growth(vegetative, boot, milk, soft dough and hard dough stage)which were combined in a 4 x 5 factorial arrangement in a completely randomized design replicated three times.

3.4. Data Collection

Data were collected at every stage of growth on plant height, leaf length, leaf width, tiller number, leaf-stem ratio, fresh and dry matter weights. Plants were tagged with different colors of nylon to enable smooth collection of data.

3.4.1. Plant height (PH)

Plant height was measured using a tape from the ground level to the tip of the highest flag leaf. Plants were tagged with different colors of nylon leather for easy identification during measurement.

3.4.2. Tiller number

Tillers that emerged from each particular plant were counted at every stage of growth (vegetative, boot, milk, soft dough and hard dough).

3.4.3. Leaf area (LA)

Leaf area (LA) was calculated using (Breda 2003) formula;

LA=Leaf length x leaf width x 0.75

3.4.4. Leaf area index

Leaf area index = leaf area ÷ Ground area covered

3.4.5. Harvest

Plant materials were harvested at the designated stage of growth by determining the physical features of the plant. Vegetative stage (57 days), Boot stage (68 days), milk stage (80 days), soft dough stage (93 days) and hard dough stage (115 days). During each harvest, the grass was cut at 5cm above the ground level. Fresh materials were weighed using a digital weighing scale (See plate 6). Thereafter the herbage materials were oven dried at 65^0C for 72 hours and to constant weight to determine dry weight After oven drying leaves were separated from the stem to measure the leaf to stem ratio. There after the dried sample was ground to pass through 2mm sieve and stored for chemical analysis

3.6. Data Analysis

The data collected were subjected to Analysis of variance (ANOVA) as described by Gomez and Gomez (1984). Using the procedure of SAS (SAS, 2013) version 9.4. The treatment means were separated using Duncan Multiple Range Test (DMRT 1995).

3.7. Physico-Chemical Properties of the Soil

Table 1. Shows the physical and chemical properties of the soil prepared for the experiment. Particle size distributions (Sand, Silt and Clay) of the soil were 31.23% sand, 23.13% silt and 45.64% clay; with a textural class of sandy clay loam. Bulk density was found to be 1.26 gcm^{-3}. The pH was slightly acidic 6.89 soils with neutral to slightly acidic Organic carbon was very low (1.29 gkg^{-1}). While the total nitrogen was also low (0.08 gkg^{-1}). Available Phosphorus and Potassium were also low with values of (6.64 $Mgkg^{-1}$ and 0.49 $Cmolkg^{-1}$ respectively).Electrical conductivity was low (0.19$dSm-^{1}$).

Table 1: Physico-chemical Properties of the Soil Prepared for the Experiment

Parameters	Values
Particle Size Distribution	
Sand (%)	31.23
Silt (%)	23.13
Clay (%)	45.64
Textural Class	SCL
Bulk density	1.26 g/cm^3
Ph	6.89
Electrical Conductivity	0.19 dSm^{-1}
Organic Carbon	1.29 gkg^{-1}
Organic Matter	1.97 gkg^{-1}
Total Nitrogen (N)	0.08 gkg^{-1}
Available Phosphorus (P)	6.64 $mgkg^{-1}$
Potassium (K)	0.49 $cmolkg^{-1}$

Key: SCL= Sandy Clay Loam, pH= Soil Reaction.

4.0 RESULTS AND DISCUSSION

4.1 Physico-chemical properties of the soil prepared for the experiment

Growth, yield, and quality of a plant species differ with soil types, soil nutrient status and fertilizer management. Plant species requires suitable soil for higher yield and better quality (Hossain *et al*., 2011; Islam *et al*., 2011). It is also for this reason that routine application of a compound fertilizer is generally recommended for pasture establishment in savannah zone of Nigeria. Inherent soil fertility could also be low since most sandy soils of the tropics contain low major nutrients (NPK), soil organic matter and other essential nutrient elements (Usman, 2005).The textural class of the soil in this study showed that infiltration could be moderate with moderate water holding capacity, reactions allows availability of most nutrients except some few micro nutrients (Brady and Weill, 2003).The physiochemical characteristics of the composite soil sample used for the

experiment revealed that the pH level (6.89) and the textural class (sandy clay loam) were within the tolerance level of *S almum.* The optimal growing condition for *S almum* is well drained loamy soil or heavy clay soil with pH ranging from 5 to 8.5 (FAO, 2010; Cook *et al*., 2005). The soil use for the experiment was low in both total nitrogen ($0.08gkg^{-1}$) and available Phosphorus ($6.64mgkg^{-1}$),typical with most tropical soils. The low levels of these element in most tropical soils have been the major cause of the low dry matter yields of tropical forage and have prompted attention to fertilizer application in Nigerian soils (Olanite *et al.,* 2010).

4.2.1 Effect of irrigation interval and stage of growth on dry matter yield of Sorghum almum

The main effect of irrigation interval and stage of growth on dry matter yield of *S almum* is presented in Table 2. The result revealed that both irrigation interval and stage of growth had significant ($p<0.01$) effect on dry matter yield of *S almum.* The dry matter yield was significantly ($p<0.01$) higher at milk stage which recorded (8.57 t/ha) while the least dry matter yield was recorded at the vegetative stage having (1.7 t/ha). However the main effect of irrigation interval showed that the dry matter yields from one day (5.49 t/ha), 2 days (5.49 t/ha) and 3 days (5.46 t/ha) irrigation intervals were similar and higher ($p<0.01$)dry matter yields ($p<0.01$) than from every day irrigation (4.93 t/ha). The combined effect of stage of growth at harvesting and irrigation intervals was also significant ($p<0.01$). Plant height determines the growth of plant during the growing season. The result on plant height as influenced by irrigation interval showed that *S almum* plants attained maximum height of 173.55 (Table 4) when irrigation was done on daily basis and that height decreased with increasing irrigation interval. This result is in agreement with the findings of Pandey *et al*., (2000) and Islam *et al*. (2011), who reported that plant height significantly decreased with increasing irrigation interval. Therefore the lower plant heights recorded under delayed irrigation may be attributed to the afore stated factors. On the other hand, Plant height increased with increased level of plant maturity (Hussain *et al*., 2011)

4.1.2 Interaction effect between irrigation interval and stage of growth on dry matter yield of S almum

The results on interaction between irrigation interval and stage of growth on dry matter yield revealed that dry matter yield value was significantly higher ($P<0.01$) at milk stage when *S almum* was irrigated at 1 day ($8.75\ t/ha^{-1}$), 2 days($9.44\ t/ha^{-1}$) and 3 days intervals ($8.56tha^{-1}$) harvesting at Milk stage, thus produced constantly higher dry matter yield values irrespective of irrigation

intervals. Dry matter production is a function of the nature of competition among the various species. Baba *et al.* (2015) also reported that dry matter yield is a measure of pasture productivity. It is also said to be a measure of photosynthetic efficiency of assimilatory system in plant (Iqbal, *et al.*, 2013). Dry matter increased with increasing amount of irrigation. Mansour *et al*., (2013) who work on Effects of irrigation regimes and polymer on dry matter yield and several physiological traits of forage sorghum discovered that the DM increased with increasing rate of irrigation. Dry matter yield was significantly ($p<0.01$) influenced by stage of growth and differen t irrigation intervals. Milk stage had the highest dry matter yield (Table 4). DM was highly significant ($p<0.01$) in every 1, 2 and 3 days irrigation interval (5.49, 5.48 and 5.46) ton/ha respectively. These figures are within the range reported by several authors (Seyed *et al.*, 2001; Muhammad *et al.*, 2006; 2009). The result suggest that application of water on daily basis could hamper the growth of *Sorghum almum.* In the same connection, *Sorghum almum* could tolerate short water stress situation up to a period of 3 days based on the result of the experiment

Table 2: Effect of Irrigation Interval and Stage of Growth on Dry Matter Yield of *Sorghum almum*

Treatment	**Dry matter yield (ton/ha)**
Stages of Growth	
Vegetative	1.71^{e}
Boot	3.96^{d}
Milk	8.58^{a}
Soft dough	6.96^{b}
Hard dough	5.53^{c}
SEM	0.183
LOS	**
Irrigation interval (days)	**Dry matter yield (ton/ha)**
0 (Daily)	4.93^{b}
1 (1 day)	5.49^{a}
2 (2 days)	5.49^{a}
3 (3 days)	5.46^{a}
SEM	0.647
LOS	**
Interaction	
Stage*Irrigation	**

Means with different superscript within same column are significantly different ($p<0.01$). **: highly significant, SEM: standard error of mean, LOS= Level of significance

Table 3. Interaction Effect of Irrigation Interval and Stage of Growth on Dry Matter Yield of *S almum* (tons/ha)

	Stage of growth				
Irrigation interval	Vegetative	Boot	Milk	Soft dough	Hard dough
0 (daily)	2.29^{i}	4.04^{h}	7.54^{bcd}	6.25^{ef}	4.53^{gh}
1 (1 day)	1.31^{i}	3.75^{h}	8.75^{a}	7.49^{cd}	6.15^{ef}
2 (days)	1.67^{i}	4.51^{gh}	9.44^{a}	6.52^{de}	5.30^{fg}
3 (days)	1.57^{i}	3.55^{h}	8.56^{ab}	7.56^{bc}	6.11^{ef}
SEM			0.064		
LOS			**		

Means with different superscript are significantly different ($p<0.01$). LOS= Level of significance, ** =Highly Significant at 1% level of significance, SEM: standard error of mean.

4.2.2. Effect of irrigation interval and stage of growth on morphological parameters and their interaction

Table 4 presents results on main effect of irrigation interval and stage of growth on plant height, number of tillers, leaf area, leaf area index and leaves to stem ratio. The result showed significant effects ($p<0.01$) of irrigation intervals and stages of growth on morphological parameters of *Sorghum almum* except for leaf area (LA) and leaf area index (LAI). The plant height (PH) at soft dough (191.25) and hard dough (197.02) stages. Were statistically similar ($p<0.01$) and produced taller plants compared to other stages of growth. Number of tillers was significantly higher ($p<0.01$) at hard dough stage (24 tillers) compared to other stages. The leaf area and leaf area index were significantly greater ($P<0.01$) at milk stage (188.1cm^2) (37.62cm) respectively and were lower at the vegetative stage. However higher ($P<0.01$) leaf to stem ratio was recorded at the vegetative stage (1.4) and the least was observed at the hard dough stage (0.88). The main effect of irrigation interval showed that plant height, number of tillers and leaf to stem ratio decreases as the irrigation interval increased. Thus Plant height was found to be significantly ($P<0.01$) higher at every day irrigation (173.55cm) while shorter plant were recorded at 1,2 and 3 days irrigation intervals which were found to be similar. Number of tillers was also significantly ($P<0.01$) higher at every day and every other day irrigation (16 tillers) compared to at 2 and 3 days irrigation intervals. Leaf to stem ratio was

significantly (P<0.01) higher at every irrigation day and two days irrigation interval (1.13 and 1.15) respectively compared to at one day and 3 days irrigation intervals. The effects of the interaction between the stage of growth and the irrigation intervals were found not significant on plant height, LA and LAI. However significant effect of the interaction was observed on number of tillers and leaf to stem ratios(Table 4). Plant height determines the growth of plant during the growing season. The result on plant height as influenced by irrigation interval showed that*S almum* plants attained maximum height of 173.55 (Table 4) when irrigation was done on daily basis and that height decreased with increasing irrigation interval. This result is in agreement with the findings of Pandey *et al*., (2000) and Islam *et al*. (2011), who reported that plant height significantly decreased withincreasing irrigation interval. Therefore,the lower plant heights recorded under delayed irrigation may be attributed to afore stated factors. On the other hand, Plant height increased with increased level of plant maturity (Hussain *et al*., 2011), The result (Table 3) showed that Number of tillers per plant was significantly influenced by irrigation intervals. Ibrahim (2008) also reported that number of tillers per plant was significantly affected by different irrigation intervals in wheat. Awad *et al*., (2000) reported that greater number of tillers may be attributed to tiller survival with frequent irrigation. Adequate moisture supply, particularly the beneficial effect of frequent irrigation at tillering stage. The observed reduction in number of tillers with increased irrigation intervals can be supported by the result of Seghatoleslami *et al.*,(2008) who observed that number of tillers per plant decreased by reduction in irrigation intervals. The increase in number of tillers with advancement in stage of growth may be explain in the context of increase growth rate.

Table 4. Main Effect of Irrigation Interval and Stage of Growth on Morphological Parameters and Their Interaction

TREATMENT	MORPHOLOGICAL PARAMETERS				
	Plant height (cm)	Tiller number	Leaf area (cm^2)	Leaf area index	Leaf-stem ratio
Stage of growth					
Vegetative	107.45^{d}	6^{e}	146.09^{c}	29.64^{c}	1.4^{a}
Boot	129.21^{c}	11^{d}	165.21^{b}	33.03^{b}	0.95^{c}
Milk	175.17^{b}	16^{c}	188.10^{a}	37.62^{a}	1.09^{b}
Soft dough	191.25^{a}	18^{b}	172.19^{b}	34.44^{b}	0.99^{bc}
Hard dough	197.03^{a}	24^{a}	161.68^{b}	32.34^{bc}	0.88^{c}
SEM	4.651	0.661	5.736	1.202	0.064
LOS	**	**	**	**	*
Irrigation interval					
0 (Daily)	173.55^{a}	16^{a}	160.75	32.11	1.14^{a}
1 (1 day)	160.88^{b}	16^{a}	170.2	34.04	0.97^{b}
2 (2 days)	154.02^{b}	14^{b}	167.48	33.5	1.16^{a}
3 (3 days)	151.62^{b}	13^{b}	168.17	33.98	0.99^{b}
SEM	10.191	1.687	6.126	1.238	0.07
LOS	**	*	NS	NS	*
Interaction					
Stage*interaction	NS	**	NS	NS	**

Means with different superscript within same column are significantly different ($p<0.01$). Ns = not significant, ** = Significant at 1% level of significance, SEM: standard error of mean.

4.2.3. Interaction effect of irrigation interval and stage of growth on number of tillers of S almum

The results on interaction effect of irrigation interval and stage of growth on number of tillers of *S almum* is presented on Table 5. The result showed that significantly (P<0.01) higher number of tillers (26 tillers/plant) were recorded at hard dough stage on3 days irrigation interval (Table 5). Number of tillers increases from vegetative to hard dough stages irrespective of irrigation interval. The interaction effect also revealed that both soft and hard dough recorded significantly greater (P<0.01) number of tillers irrespective of irrigation interval.

4.2.4. Interaction effect between irrigation interval and stage of growth on leaf-stem-ratio of S almum

The results on interaction effect of irrigation interval and stage of growth on leaf-stem-ratio is shown in Table 6. Leaf-stem-ratio was found to be significantly (P<0.01) higher at vegetative stage on 3 days irrigation interval (1.5633), while the lowest ratio was recorded at the soft dough and hard dough stages at 1-day irrigation interval with 0.66 and 0.63 ratios respectively.

Table 5. Interaction Effect between Irrigation Interval and Stage of Growth on Number of Tillers of *S almum*

	Stage of growth				
Irrigation interval	Vegetative	Boot	Milk	Soft dough	Hard dough
0 (daily)	6^{jkl}	12^{ghi}	18^{cde}	20^{bcd}	23^{ab}
1 (1 day)	9^{ijk}	12^{ghi}	$16e^{fg}$	19^{cde}	22^{abc}
2 (days)	5^{lk}	10^{hij}	15^{fgh}	18^{def}	23^{abc}
3 (days)	3^{l}	9^{ijk}	13^{ghi}	15^{fgh}	26^{a}
SEM			0.845		
LOS			**		

Means with different superscript are significantly different ($p<0.01$). LOS= Level of significance, ** =Highly Significant at 1% level of significance, SEM: standard error of mean.

Table 6: Interaction Effect between Irrigation Interval and Stage of Growth on Leaf-Stem Ratio of *S almum*

	Stage of growth				
Irrigation interval	Vegetative	Boot	Milk	Soft dough	Hard dough
0 (daily)	1.39^{ab}	1.01^{bcd}	1.13^{bcd}	1.27^{abc}	0.87^{cd}
1 (1 day)	1.43^{ab}	0.92^{cd}	1.19^{abc}	0.66^{d}	0.63^{d}
2 (days)	1.21^{abc}	0.99^{cd}	1.12^{bcd}	1.19^{abc}	1.27^{abc}
3 (days)	1.56^{a}	0.87^{cd}	0.93^{cd}	0.85^{cd}	0.76^{cd}
SEM			0.036		
LOS			**		

Means with different superscript are significantly different ($p<0.01$). LOS= Level of significance, ** =Highly Significant at 1% level of significance, SEM: standard error of mean.

4.0 CONCLUSION AND RECOMMENDATION

4.1 Conclusion

Based on the result of the experiment, dry matter yield values were higher at milk and dough stages, alongside Leaf to stem ratio, which is indicative of pasture quality. it can be concluded that irrespective of irrigation interval *sorghum almum* forage could be harvest at milk or soft dough stage for higher yield and better quality

4.2 Recommendation

It is recommended that pasture producers and livestock farmers can use 1 to 3 days irrigation interval on *Sorghum almum* for better growth , higher dry matter yield and better quality and harvest the forage at milk and soft dough stages.

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