EVALUATIONOF SILAGEQUALITYOF FORAGEMAIZE *(Zea mays*L.) ANDSWEET SORGHUM(*Sorghum bicolor* L.Moench)VARIETIES ATDIFFERENTPHENOPHASES

ABSTRACT

Aim: Toevaluatethegreenfodderproductionpotentialofforagemaizeandsweetsorghum varietiesat different phenophases.

Experiment design: Factorial Randomized Block Design (FRBD)

Place and duration of study: AICRP on Forage Crops and Utilization, Agricultural Research Institute. Duration from July 2022 to Nov 2022

Methodology: Field experiment was conducted at AICRP on Forage Crops and Utilization, Agricultural Research Institute (ARI), Rajendranagar, Hyderabad during *kharif* 2022. The treatments consisted of four maize varieties (Africantall, J–1006,TSFM15-5andDHM-117) and two sweet sorghum varieties (CSH-22SSandCSV-49SS) and three harvest stages (S_1: Milky stage, S_2: Soft dough stage and S_3:Dentstage) laid out in randomized block design with factorial conceptwith two factors. Factor (A) as six varieties and factor (B) as three harvest stages (phenophases) with three replications. Texture of the soil was sandy loam with the pH of 7.0, low in available nitrogen (199.3 kg ha^{-1}), medium in available phosphorous (39.12 kg ha^{-1}) and potassium (195.30 kg ha^{-1}).

Results: Fodder maize varietyAfrican tall recorded significantly higher plant height (265.8cm) at dent stage, leaf-stem ratio (0.36) at milky stage, green fodder yield (438 qha^{-1}) at soft dough stage and dry fodder yield (122.7 qha^{-1}) at dent stage of harvest. while J-1006 recorded significantly highest dry matter content (29.8 %) at the dent stage of harvest. CSH 22SS recorded significantly higher crude protein content(10 %) in the milky stage.

Conclusion: African tall variety has recorded significantly higher green fodder yield (438 qha^{-1}) at soft dough stage and dry fodder yield at the dent stage (122.7 qha^{-1}).

Keywords: Forage maize, fodder yield, Factorial Randomized Block Design, greenfodder

1. INTRODUCTION

Maize (*Zea mays* L.*)* holds prime position as a cereal crop. In India, maize is used as a feed crop due to its expanding demand, especially with the growth of dairy, poultry, and maize-related industries(Ahmed *et al*.2010).This versatile crop is being used more extensively as animal feed and fodder, suitable for both green forage and silage. It has considerable production potential, broad adaptabilityand diverse applications(Gour *et al.* 2006). Itserves as a dual-purpose crop, yielding both grain and fodder in India (Mahdi *et al*.2010).Forage maize exhibits rapid growth,succulent and sweet in nature, high yielding, nutrientrichand has no harmful chemical substances,thus making it a safe option for animal feed at any growth stage (Devi, 2002). Green fodder from maize offers ample energy and protein for animal growth and milk production (Takawale *et al*. 2009). The significance of corn as a feed for animals and poultry lies in its highernet energy content and lowerfiber content.

Sweet sorghum (*Sorghum bicolor L. Moench*), C_4 crop has adaptability to a wide range of climatic conditions. Sweet sorghum accumulates high amount of sugar in the stem and has vast use as a bio-energy crop (Mullet *et al.* 2014) It has high amount of water-soluble carbohydrates. Due to the high protein and high fiber content sweet sorghum is widely used as forage and also as a silage for ruminants [18,19]. This characteristic holds the potential to enhance the quality of ensiled forage by expediting the production of lactic acid. Consequently, the cultivation of sweet sorghum as a silage crop offers promising advantages, positioning it as a viable contender to corn cultivationespecially in regions characterized by abundant rainfall.

2. MATERIALS AND METHODS

Thefield experiment was conducted during *kharif* season 2022 at AICRP onForage Crops and Utilization, Agricultural Research Institute,Rajendranagar, Hyderabad, Telangana, India. Experiment is designed with the objective of evaluatingthegreenfodderproductionpotentialofforagemaize (*Zea mays*) andsweetsorghum (*Sorghum bicolor L. Moench*) varieties at different phenophases. The experiment was laid out in Factorial randomized block design (FRBD) with two factors. The soil was sandy loam with low nitrogen content, medium phosphorous and potassium contents. The pH of soil was neutral (7.0). The experiment consisted of two factors and 18 treatments (Factor A: six varieties:V_1: Africantall, V_2: J–1006, V_3:TSFM15-5and V_4: DHM-117, V_5: CSH 22SS, V_6:CSV 49SS)and (Factor B: 3 Stages: S_1: Milky stage, S_2: Soft dough stage and S_3:Dentstage) with three replications. Nitrogen was applied in three splits in the form of urea (60N kgha^{-1}basal;30kgNha^{-1}30DAS;30kg Nha^{-1}60DAS), Phosphorous(40 kg P_2O_5ha^{-1}) and potassium (30 kgK_2Oha^{-1})as basal application.The crop was sown on25thJuly,2022at inter row spacing of 30cm and harvested at three stages (Milky, Soft dough and Dentstage). Five plants were randomly selectedand labelled in each net plot for recording the experimental observations(growth and yield parameters). The samples were shade dried for two to three days before oven drying(60^{0}C)to attain constant weight. On weight basis green fodder yield was converted into dry fodder yield (qha^{-1}) and dry matter content (%) is calculated.The soil analysis and fodder quality parameters were analyzed following standard procedures. Data obtained was statistically analyzed as mentioned by Gomez and Gomez. (1984).

3. RESULTS AND DISCUSSION

Yield attributes

3.1 Varieties

Among six fodder varieties tested (Four fodder maize varieties: Africantall, J–1006, TSFM15-5, DHM-117 and two sweet sorghum varieties: CSH 22SS, CSV 49SS), yield attributes and green fodder yield of all the varieties variedsignificantly across the treatments (Table.1). The fodder maize variety African tall has recorded significantly higher plant height (228.8 cm), Leaf-stem ratio (0.36), green fodder yield (417.7 q ha^{-1}) and dry fodder yield (103.1 qha^{-1}).The variety J-1006 recorded significantly higher dry matter content (25.6 %) followed by Africantall (24.6 %) while, CSH 22SS (24.4 %)was on par with African tall (24.6%) in terms of dry matter content (Table 2).With respect to the crude protein content CSH 22SS (8.4%) recorded significantly higher crude protein content followed by CSV 49SS(8.0%).On the other hand,no significance differences were observed between African tall (6.7%) and J-1006 (6.7%) in terms of crude protein.

With respect toAcid Detergent Fiber (ADF%) CSH 22SS has recorded significantly higher contentADF(38.1%) whereas,African tall (37.9 %) and CSV 49SS (37.8 %) were on par with CSH 22SS. The varietyCSH 22SS (66.5%) had significantly higher Neutral Detergent Fiber NDF% and CSV 49SS (64.7%)was on par with CSH 22SS(Table. 1)Thesesignificant differencesamong varieties were due to genetical variations.

3.2 Phenophases (Stages)

Among three stages of harvest, dent stage recorded significantly higher plant height (235.2 cm), dry matter content (27.6 %),dry fodder yield (109.3%) and ADF (35.6 %).There weresignificantdifferencesamong phenophases (milky stage, soft doughstage and dent stage)in terms of plant height, dry matter, dry fodder yield and ADF % but with respect to leaf: stem ratio significantly higher ratio was found atmilky stage (0.33) followed by soft dough stage (0.28)and dent stage (0.21) respectively. Similarly, crude protein also followed the sametrend (milky stage (8.0%), soft dough stage (7.0%) and dent stage (6.3%).

In terms of greenfodder yield, soft dough stage recordedsignificantly higher green fodder yield (409.3 q ha^{-1}) followed by dent stage (397 q ha^{-1}) and milky stage (373 q ha^{-1}) respectively. (Table. 2) These differences were due to physiological and morphological changes occurring with crop maturityas the crop advances towards maturity, moisture content reduces and dry portion of the plant increases reflecting in higher dry matter content, ADF%,and dry fodder yield.Decrease in the leaf portion was due to foliage dryingand increase in the stem portion withcrop advancement reflects the lower Leaf: stem ratio towards maturity. There was a non-significant result in terms of NDF%.

3.3 Interaction effect

The interaction among the varieties and stages was found to be significant in terms of plant height, leaf-stem ratio, drymatter %, green fodder yield, dry matter yield and crude protein %.While the interaction was found to be non-significant with respect to ADF % and NDF % (Table.1).

3.3.1 Plant height

At all the three harvest stages of harvest (S_1: Milky stage, S_2: Soft dough stage and S_3:Dentstage) variety African tallrecorded the significantly higher plant height (S_1: 194.6 cm, S_2:225.9cm, S_3: 265.8 cm)and J-1006 (262.2 cm)was on par with African tallatdent stage (S_3). While, the lowest plant height was recorded by TSFM 15-5 (136.3) at the milky stage.These results corroborate with the findings of Digvijay Singh *et al.* (2020).

3.3.2 Leaf-stem ratio

The Leaf-stem ratio of African tall was significantly higher at all the three stages (S_1: 0.40, S_2: 0.38, S_3: 0.29). L:S ratio of J-1006 was on par with African tall at themilky and soft dough harvest stages(S_1: 0.40, S_2: 0.32 respectively). While,at the dent stage DHM-117 (0.26) was on par with African tall (Table. 1)Superiority of African tall variety wasdue to wide and thick and heavier foliage a specific genetical character as compared to other varieties. As the crop advanced leaf portion gets decreased and increases the stem potion reflected in lower Leaf-stem ratio at dent stage of harvest as compared to the milky and soft dough stage. These results are in line with the findings of Ginwal *et al.* (2019) and Rathod *et al.* (2021).

3.3.3 Dry matter content (%)

At the milky stage (S_1) variety CSH 22SS (22.9%) recorded significantly higher dry matter contentand J-1006 (22.1%), TSFM15-5 (22.0%), CSV 49SS (22.4 %) were on par with CSH 22SS. Variety DHM-117 was significantly inferior to rest of the varieties (Table.1)

At the soft dough stage (S_2) and dent stages (S_3)J-1006had recordedsignificantly higher dry matter (24.9% and 29.8% respectively) and rest of the varieties were on par with J-1006.Significantly lower dry matter was observed withCSV 49SS (22.4%).

At the dent stage of harvest J-1006 (29.8%) recorded significantly higher dry matter % and African tall (28.8 %) was on par with J-1006.With the crop advancement towards maturity dry matter content of the plant increased due to decreased moisture content in plant reflects increases dry matter with maturity. Similar findings were reported by Ayub *et al*. (2002), Ayub *et al*. (2009), Filho *et al*. (2011) and Chattha *et al.* (2017).

3.3.4 Green fodder yield (q ha^{-1})

At the milky stage (S_1), CSH 22SS (396 qha^{-1}) recorded significantly higher green fodder yield and African tall (389 qha^{-1}) was on par with CSH 22SS.On the other hand, significantly lowest green fodder yield was recorded by J-1006 (334 qha^{-1})(Table.2).

At the soft dough stage, African tall (438 qha^{-1}) recorded significantly higher green fodder yield and TSFM 15-5 (431 qha^{-1}) was on par with African tall and J-1006 (379 qha^{-1}) recorded significantly lower green fodder yield.

At the dent stage (S_3), African tall (426 qha^{-1}) recorded significantly higher green fodder yield and CSV 49SS (410 qha^{-1}) and was on par with African tall.TSFM 15-5 (395 qha^{-1}) and CSH 22SS (399 qha^{-1})were on par with each other. Variety J-1006 (371 qha^{-1}) recorded significantly lowgreen fodder yield. African tall recorded significantly higher green fodderyielddue to significantly higher plant height, stemgirth, number of leaves plant^{-1} (Singh *et al.* 2020).

3.3.5 Dry fodder yield (q ha^{-1})

At the milky stage,CSH22SS (90.7 qha^{-1}) recorded significantly higher dry fodder yield andCSV 49SS (84.6 qha^{-1}) was on par withCSH 22SS. J-1006 (73.8 qha^{-1}) recorded significantly lower dry fodder yield (Table. 3)

At the soft dough stage, African tall (104.7 qha^{-1}) recorded significantly higher dry fodder yield. Varieties TSFM 15-5 (103.4 qha^{-1}),CSH 22SS (99.5 qha^{-1}), CSV 49SS (99.7 qha^{-1}) were on par with African tall. DHM-117 (92.9 qha^{-1}) recorded significantly lower dry fodder yield.

At the dent stage, African tall (122.7 qha^{-1}) recorded significantly higher dry fodder yield and variety CSH 22SSrecorded significantly lower dry fodder yield.(101.7 q ha^{-1}). As the maturity advances dry matter content of the plant increases due to decreasing trend of moisture content in plant increasing trend of dry matter yield with maturity. Similar findings were reported by Ayub *et al*. (2002).

3.3.6 Crude protein content (%)

At the milky stage,CSH 22SSrecorded significantly higher crude protein content (10%) while,J-1006(7.3%) and DHM-117 (7.3%) were statistically comparable with each other while the lowest crude protein content was recorded by TSFM 15-5 (7.0%) (Table. 1)

At the soft dough stage, CSH 22SS (8.2%) recorded significantly higher crude proteincontent.Variety CSV 49SS (7.9%) was on par with CSH 22SS.Significantly lower crude protein content was recorded by TSFM 15-5 (6.2%) and DHM-117 (6.2%).

At the Dent stage,CSH 22SSand CSV 49SSrecorded significantly higher and statistically comparable crude protein content (6.2%). Significantly lower crude protein content was recorded by J-1006 (5.8%). During the initial reproductive phase, there will be accumulation of crude protein in various plant plants due to active photosynthetic rate to supply nutrients to the reproductive structures andgradually with the ontogeny of the crop protein content will be reduced due to its translocation to grains (Amodu *et al*.2014, Chattha *et al*.2017 andHorst *et al*. 2021).

3.3.7 Acid Detergent Fiber (%) and Neutral Detergent Fiber (%)

There were no significant differences among varieties and phenophases in terms of ADF% and NDF%.

Table 1. Effect of different varieties and harvest stages on growth parameters

fodder yield and quality parameters of fodder maize and sweet sorghum.

Treatments	Plant height (cm)	Leaf-stem ratio	DM%	GFY (qha^{1})	DFY (qha^{1})	CP%	ADF%	NDF%
Varieties (V)								
African tall	228.8	0.36	24.6	417.7	103.1	6.7	37.9	61.3
J-1006	220.8	0.32	25.6	361.3	92.78	6.7	31.7	58.8
TSFM 15-5	183.1	0.30	24.9	399.6	99.48	6.4	30.6	56.8
DHM-117	184.1	0.30	23.8	383.0	91.10	6.5	31.3	56.7
CSH 22SS	186.5	0.18	24.4	398.7	97.29	8.4	38.1	66.5
CSV 49SS	204.6	0.16	23.9	400.0	95.77	8.0	37.8	64.7
S Em±	1.9	0.003	0.2	3.3	1.2	0.06	0.2	0.7
CD(P=0.05)	5.5	0.008	0.6	9.6	3.5	0.19	0.8	2.1
Phenophases (P)								
Milky stage	165.9	0.33	21.8	373.8	81.41	8.0	33.6	60.0
Softdoughstage	202.8	0.28	24.2	409.3	99.03	7.0	34.6	60.8
Dent stage	235.2	0.21	27.6	397.0	109.3	6.3	35.6	61.6
S Em±	1.4	0.002	0.1	2.3	0.8	0.04	0.2	0.5
CD(P=0.05)	3.9	0.005	0.4	6.8	2.5	0.13	0.5	NS
Interaction (V×P)								
S Em±	3.3	0.005	0.4	5.7	2.1	0.11	0.4	1.2
CD(P=0.05)	9.6	0.013	1.1	16.7	6.1	0.33	NS	NS

DM: Dry matter

GFY: Green fodder yield

DFY: Dry fodder yield

CP: Crude protein

ADF: Acid detergent fiber

NDF: Neutral detergent fiber

Table 2.Interaction effect of different varieties and harvest stages on green fodder yieldof fodder maize and sweet sorghum.

Varieties (V)	Green fodder yield (qha^{-1})			
	Phenophases (P)			
	Milky stage	Soft dough stage	Dent stage	Mean
African Tall	389.0	438.0	426.0	417.7
J-1006	334.0	379.0	371.0	361.3
TSFM 15-5	373.0	431.0	395.0	399.6
DHM-117	373.0	395.0	381.0	383.0
CSH 22SS	396.0	401.0	399.0	398.7
CSV49SS	378.0	412.0	410.0	400.0
Mean	373.8	409.3	397.0	
(V ×P)	S Em±			5.7
	CD (P=0.05)			16.7

Table 3.Interaction effect of different varieties and harvest stages on dry fodder yield of fodder maize and sweet sorghum.

Varieties (V)	Dry fodder yield (qha^{-1})			
	Phenophases (P)			
	Milky stage	Soft dough stage	Dent stage	Mean
African Tall	82.0	104.7	122.7	103.1
J-1006	73.8	94.0	110.5	92.8
TSFM 15-5	82.0	103.4	113.0	99.5
DHM-117	75.3	92.9	105.2	91.1
CSH 22SS	90.7	99.5	101.7	97.3
CSV49SS	84.6	99.7	103.0	95.8
Mean	81.4	99.0	109.3	
(V ×P)	S Em±			2.1
	CD (P=0.05)			6.1

4. CONCLUSION

Based on the research results of the present study it can be concluded that forage maize variety African tall has recorded significantlyhigher growth, quality parameters, green fodder yield (438 q ha^{-1}) at soft dough stage and dry fodder yield (122.7 q ha^{-1}) at dent stages respectively.

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