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Performance of sorghum hybrids under different nitrogen levels in Coastal Andhra Pradesh and their effects on yield, yield attributes, and NPK content

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Abstract

The present investigation was carried out in Agricultural College Farm Bapatla during *rabi* 2023-24 to study the performance of sorghum hybrids under different nitrogen levels. The field experiment was laid out in Split plot design and replicated thrice. Three sorghum hybrids were allocated to main plots (M₁: CSH 30, M₂: CSH 41, M₃: MLSH 296) while five nitrogen levels (N₁: control, N₂- 120 kg N ha⁻¹, N₃ - 160 kg N ha⁻¹, N₄ - 200 kg N ha⁻¹, N₅ - 240 kg N ha⁻¹) were allocated to sub plots. Among the different hybrids tested MLSH 296 recorded superior growth, yield attributes and grain yield. Application of 240 kg N ha⁻¹ resulted in higher yield attributes and yield (Kg ha⁻¹) and it was statistically on a par with 200 kg N ha⁻¹ and 160 kg N ha⁻¹. Nutrient uptake of Nitrogen, Phosphorus and potassium by both grain and stover were influenced by both hybrids and graded levels of nitrogen. Higher nutrient uptake by both grain and stover was recorded with the hybrid MLSH 296 and with the application of 240 kg N ha⁻¹.

Keywords: Sorghum hybrids, Nitrogen levels, Rice fallows

Introduction

Sorghum is an important crop that is widely grown in India. Sorghum is believed to have originated in Africa and later spread to Asia, the Americas, and other parts of the world due to its remarkable adaptability to diverse climatic conditions. It is the fifth most important cereal crop followed by rice, wheat, maize and barley. Grain sorghum is also called "milo". It is popularly known as "jowar" in India. It is emerging as a potential alternative food, feed, fodder and bio energy crop. It is regarded as "king of millets". Its grains have about 9.35% protein, 3.35% fat, 72.41% carbohydrate and 10.66% moisture content. (Adebiyi *et al.*, 2005) ^[1]. Sorghum is considered a climate-resilient crop because of its strong tolerance to high temperatures and moisture stress. Its natural ability to withstand drought makes it a preferred crop in tropical, warm and semi-arid regions that frequently face heat and water scarcity. In Krishna-Godavari zone of Andhra Pradesh, sorghum is emerging as a strong alternative to pulses. As the area under pulses is declining due to late planting of rice and severe attack of viral diseases and parasitic weed *Cuscuta* spp. Additionally, its capacity to grow with limited water makes it a suitable option for marginal farmers, particularly as a follow-up crop after rice harvest. Farmers are cultivating local sorghum varieties that are tall and prone to lodging, largely due to the excessive use of nitrogen fertilizers. To address this issue, it's crucial to develop and promote improved sorghum hybrids that are well-suited to rice fallows and resistant to lodging. In this context nitrogen management has become increasingly important in evaluating the potential yields of the sorghum crop and viability in the rice fallows because it is well known fact that amongst the plant nutrients nitrogen plays a vital role in the growth and development of crops. Nitrogen is an essential nutrient for enhancing crop productivity, as it forms a key component of protoplasm and in vital compounds such as chlorophyll, and is involved in nearly all physiological activities of plant cells. Adequate nitrogen supply enhances vegetative growth, leaf area development, photosynthetic activity and ultimately grain yield. However, nitrogen is highly susceptible to losses through volatilization and leaching. Crops require nitrogen in relatively large quantities, while most Indian soils are deficient in this

nutrient. Therefore, proper optimization of nitrogen application is crucial to achieve higher yields and improve nutrient use efficiency.

Materials and Methods

The present investigation was carried out at Agricultural College Farm, Bapatla during *rabi* 2023-24. The experimental site is situated at 80° 25' E longitude, 15° 54' N latitude and at an altitude of 5.49 m above MSL and 7 km away from the Bay of Bengal. The experiment was carried out in split plot design and replicated thrice. Different sorghum hybrids (M₁: CSH 30, M₂: CSH 41, M₃: MLSH 296) were taken as main plots and varied nitrogen levels (0 kg N ha⁻¹, 120 kg N ha⁻¹, 160 kg N ha⁻¹, 200 kg N ha⁻¹, 240 kg N ha⁻¹) were allocated to sub plots. After the harvest of the rice crop the sorghum crop was sown by dibbling method without performing any tillage operations at the spacing of 45 cm × 15 cm. For effective weed control spraying of paraquat @ 2.5 ml l⁻¹ and atrazine @ 1.0 kg a.i. ha⁻¹ was done immediately after sowing of the crop. Nitrogen (120, 160, 200, 240 kg ha⁻¹) was applied in the form of urea (46% N) at varied doses in 3 equal splits i.e., 1/3 each as basal dose, 30 DAS and the remaining at 60 DAS as per the treatments. Entire recommended dose of phosphorus 60 kg P₂O₅ ha⁻¹ and 40 kg K₂O ha⁻¹ were applied as basal in the form of single super phosphate and muriate of potash respectively at the time of sowing. Carbofuran 3G granules @ 10 kg ha⁻¹ were applied in the leaf whorls of individual plant to control shoot borer in sorghum. The data regarding the Number of ear heads m⁻², length of ear head (cm), number of grains per earhead, Grain yield and straw yield were taken from five tagged plants from every experimental net plot.

Statistical Analysis

Statistical analysis of the data recorded was carried out following the Fisher's method of analysis of variance (ANOVA) as outlined by Panse and Sukhatme (1978) [24] for the design adopted in the study. The significance of treatment effects was tested using the F-test at the 0.05 level of probability. Whenever the treatment effects were found to be significant, critical difference (CD) values were calculated at the 5 per cent probability level to compare the treatment means. Treatment differences that were not significant were expressed as non-significant (NS).

Results and Discussion

Results demonstrated that among the different sorghum hybrids taken for the trial, MLSH 296 (32.3 cm) recorded longer earheads followed by CSH 41 (30.2 cm) and CSH 30 (28.4 cm). Higher number of grains per earhead were recorded in the hybrid MLSH 296 (2552) and the lowest was recorded with CSH 30 (2066). However, the test weight of sorghum was not influenced by the different sorghum hybrids. The higher grain yield was recorded with MLSH 296 (5359 kg ha⁻¹) and lowest grain yield was recorded in the hybrid CSH 30 (4064 kg ha⁻¹) and it was on par with CSH 41 (4487 kg ha⁻¹). MLSH 296

recorded higher stover yield (10048 kg ha⁻¹) when compared to the other two hybrids. However, the interaction was found to be nonsignificant. The higher yield of the hybrid MLSH 296 might be due to better adaptability and vigour to obtain maximum amount of nutrients from the soil in zero till conditions. These results are in accordance with the results reported by Ashvathamma *et al.*, Mishra *et al.* (2011) [19], Patil *et al.* (2012) [25] and Chapke *et al.* (2014) [6]. Nutrient uptake (nitrogen, phosphorus and potassium) by grain and stover was significantly higher in the hybrid MLSH 296, whereas the lowest uptake was recorded in CSH 30, which was statistically on par with CSH 41. Application of nitrogen @ 240 kg ha⁻¹ recorded higher dry matter accumulation (16828 kg ha⁻¹) and was on a par with 200 kg N ha⁻¹ (16332 kg ha⁻¹) and 160 kg N ha⁻¹ (15837 kg ha⁻¹) and significantly superior over 120 kg N ha⁻¹ (14403 kg ha⁻¹) and the lowest dry matter accumulation (8531 kg ha⁻¹) was recorded with no application of nitrogen. Higher SPAD meter readings were recorded with the application of 240 kg N ha⁻¹ (59.7) and was on a par with 200 kg N ha⁻¹ (58.5) and the lowest was recorded with no application of nitrogen. Maximum earhead length was recorded with the application of 240 kg N ha⁻¹ (33.6 cm) and significantly superior over the 120 kg N ha⁻¹ (30.5 cm) and the lowest was recorded with control. The maximum number of grains per earhead was recorded with the application of 240 kg N ha⁻¹ (2729) and was on a par with the both 200 kg N ha⁻¹ and 160 kg N ha⁻¹ and significantly superior over application of 120 kg N ha⁻¹ (2325). However minimum grains per earhead was recorded with the application of 0 kg N ha⁻¹ (1122). As the test weight of the sorghum was genetically controlled character it was not influenced by different nitrogen regimes. These results are in agreement with the findings of the researchers such as Sujathamma *et al.* (2015) [27] and Kishor *et al.* (2017) [12]. The higher grain yield and stover yield was recorded with 240 kg N ha⁻¹ (5486 kg ha⁻¹, 10810 kg ha⁻¹) which was significantly superior over the application of nitrogen @ 120 kg ha⁻¹ (4638 kg ha⁻¹, 9265 kg ha⁻¹) and the lowest (2350 kg ha⁻¹, 5672 kg ha⁻¹) was recorded with no application of nitrogen. Increasing levels of nitrogen might have enhanced the functional activity of the plants, thereby facilitating greater extraction and uptake of nutrients from the soil, which are essential for plant growth and development. The significant improvement in yield attributes with increasing nitrogen levels might have resulted in a cumulative effect, leading to higher yield. These results are completely in accordance with findings of Miko and Manga (2008) [18], Mishra *et al.* (2013) [21], Narges *et al.* (2014) [23] and Kumari *et al.* (2022) [15]. Among the different levels of nitrogen application higher nutrient uptake (Nitrogen, Phosphorus and Potassium) uptake was recorded with the application of 240 Kg N ha⁻¹ and it was on a par with 200 kg N ha⁻¹ and 160 kg N ha⁻¹ and statistically superior over the application of 120 kg N ha⁻¹. Lowest nutrient uptake was recorded with control. The higher uptake of nitrogen by both grain and stover resulting from the increased levels of nitrogen application might be due to the more availability of nutrients in the soil solution. These results are in close proximity with Buah and Mwinkaara (2009) [4], Mishra *et al.* (2013) [21].

Table 1: Earhead length (cm) Number of grains per earhead, Test weight(g), Grain yield (kg ha⁻¹) Stover yield (kg ha⁻¹) as influenced by sorghum hybrids and nitrogen levels

Treatments	Earhead length (cm)	Number of grains per earhead	Test weight(g)	Grain yield (kg ha ⁻¹)	Stover yield (kg ha ⁻¹)
Sorghum Hybrids					
M1 - CSH 30	28.4	2066	24.1	4064	8706
M2 - CSH 41	30.2	2291	25.3	4487	8964
M ₃ - MLSH 296	32.3	2552	26.5	5359	10048
SEm (±)	0.55	59.03	0.6	121	253
CD (p=0.05)	2.2	232	NS	474	993
CV (%)	7.1	9.9	8.5	10.1	10.6
Nitrogen levels (kg ha⁻¹)					
N 1 - 0	23.4	1122	23.4	2350	5672
N 2 - 120	30.5	2325	25.2	4638	9265
N 3 - 160	31.8	2638	25.8	5294	10028
N 4 - 200	32.2	2702	26.1	5414	10423
N ₅ - 240	33.6	2729	26.3	5486	10810
SEm (±)	0.78	70	0.7	135	297
CD (p=0.05)	2.29	203	NS	426	867
CV (%)	7.7	9.1	8.4	8.7	9.6
Interaction					
SEm (±)	1.36	120.66	1.22	232.2	525
CD (P=0.05)	NS	NS	NS	NS	NS

Table 2: NPK uptake (kg ha⁻¹) of sorghum as influenced by Sorghum hybrids and nitrogen levels

Treatments	NPK uptake (kg ha ⁻¹)					
	Nitrogen		Phosphorous		Potassium	
	Grain	Stover	Grain	Stover	Grain	Stover
Sorghum hybrids						
M1 - CSH 30	59.43	40.66	21.26	18.42	13.27	115.69
M2 - CSH 41	66.85	43.82	23.95	20.32	14.75	122.58
M ₃ - MLSH 296	81.57	51.48	29.31	26.03	18.19	140.54
SEm (±)	1.94	1.34	0.71	0.55	0.39	3.00
CD (p=0.05)	7.62	5.26	2.79	2.15	1.51	11.77
CV (%)	10.8	11.4	11.2	9.8	9.7	9.2
Nitrogen levels (kg ha⁻¹)						
N 1 - 0	28.15	15.31	11.50	9.06	6.89	72.91
N 2 - 120	67.82	41.11	24.54	19.13	14.59	124.72
N 3 - 160	80.47	52.89	28.47	24.21	17.56	136.42
N 4 - 200	83.37	57.17	29.13	26.74	18.84	144.81
N ₅ - 240	86.62	60.11	30.56	28.80	19.13	152.48
SEm (±)	2.20	1.59	0.76	0.76	0.57	3.21
CD (p=0.05)	6.42	4.65	2.21	2.23	1.68	9.63
CV (%)	9.5	10.5	9.2	10.6	11.2	7.6
Interaction						
SEm (±)	3.81	2.64	1.31	1.32	0.99	5.56
CD (P=0.05)	NS	NS	NS	NS	NS	NS

Conclusion

Three sorghum hybrids (MLSH 296, CSH 30 and CSH 41) were evaluated for their relative response to five levels of nitrogen application (0,120,160,200,240 kg ha⁻¹) in rice fallow conditions in Agricultural College Fram Bapatla. Significantly higher grain yield was recorded with MLSH- 296 hybrid and the lowest was recorded with CSH-30. Among the graded levels of nitrogen application of 240 kg N ha⁻¹ recorded higher yield attributes and yield and the lowest was recorded with no application of nitrogen. Higher nutrient uptake by both the grain and straw was recorded with MLSH 296 and lowest was recorded with CSH 30. Among the different nitrogen levels taken for trial 240 kg N ha⁻¹ recorded higher nutrient uptake and was significantly higher over 120 kg N ha⁻¹. Lowest nutrient uptake was recorded with 0 kg N ha⁻¹.

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