EFFECT OF ROW SPACING AND NITROGEN LEVELS ON THE GROWTH AND YIELD ATTRIBUTES OF MULTICUT FODDER SORGHUM (*SORGHUM BICOLOR X SORGHUM SUDANENSE*)

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SUMMARY

A field experiment was conducted at Instructional Farm, College of Agriculture, Vellayani, Thiruvananthapuram, Kerala from November 2022 to August 2023 to study the influence of row spacing and nitrogen levels on growth and yield attributes of multicut fodder sorghum. The field experiment was laid out in randomized block design with (3 x 3) + 1 treatment, replicated thrice. The treatment combinations included three levels of row spacing (R) (r_1- 20 cm, r_2- 30 cm, r_3- 40 cm) and three levels of nitrogen application (N) (n_1- 315 kg/ha, n_2-245 kg/ha, n_3-175 kg/ha), compared against the control treatment (30 cm row spacing, nitrogen application-315 kg/ha in seven equal splits, and $MgSO_4$-80 kg/ha). Nitrogen was applied in seven equal splits- as basal, 20, and 40 days after sowing and after each cut. The variety used for the study was COFS-31, released from Tamil Nadu Agricultural University. The results revealed that control treatment with row spacing (30 cm) and nitrogen dose of 315 kg/ha/y (seven equal splits) along with $MgSO_4$- 80 kg/ha/y proved its superiority by registering higher growth and yield attributes such as plant height, stem girth, leaf stem ratio, green and dry fodder yield. This was at par with row spacing (30 cm) and nitrogen dose of 315 kg/ha/y.

Key words: Multicut fodder sorghum, row spacing, nitrogen application, and magnesium application

Livestock is a key part of Indian agriculture, comprising 29 per cent of total output. Achieving 4 per cent annual agricultural growth relies on boosting livestock productivity (GOI, 2019). However, declining livestock productivity is mainly due to insufficient and poor-quality fodder. Sorghum cultivars derived from sorghum [*Sorghum bicolor* (L.) Moench] and sudan grass (*Sorghum sudanense* Piper) are considered superior in terms of fodder yields because of their multicut nature and longer duration of fodder availability over single cut forage sorghum (Kumari *et al.,* 2020). Multi-cut sorghum varieties have gained prominence under irrigated conditions all over the world (Satpal *et. al*., 2023). A multi-cut fodder sorghum variety named COFS-29 was developed by TNAU, Coimbatore, and released for general cultivation in Tamil Nadu in 2001. This variety possesses all desirable characteristics except for one issue related to seed-shattering behaviour. After reaching physiological maturity, the seeds of COFS-29 tend to shatter completely from the panicle's rachis, to overcome this, the Department of Forage Crops at Tamil Nadu Agricultural University, Coimbatore used mutation breeding with gamma rays to develop COFS-31, a non-seed-shattering, high-yielding multicut fodder sorghum. This variety was released at the state level in 2014 for fodder production in Tamil Nadu.

Row spacing is a key agronomic factor that impacts fodder production. It affects plant fertility and resource competition, influencing overall growth and yield (Irfan *et al.*, 2016). Nitrogen is crucial for the growth and development of fodder crops, impacting various aspects such as plant height, tillering capacity, leaf growth, and chlorophyll production. It is essential for cell elongation, division, and the expansion of internodes. Additionally, nitrogen plays a key role in the early establishment of fodder crops and is a major component of proteins and chlorophyll, contributing to the green coloration of plants and promoting early vegetative growth.

In Kerala, magnesium (Mg) deficiency is common due to soil leaching under heavy rainfall. About 80 per cent of soils lack sufficient Mg reserves (GOK, 2018). To combat this, applying $MgSO_4$ at 80 kg/ha is recommended (KAU, 2016). The study objective was to determine the impact of different crop geometries and nitrogen levels on multicut fodder sorghum growth, yield, and quality parameters.

MATERIALS AND METHODS

The experiment was laid out in the upland area of the Instructional Farm attached to the College of Agriculture, Vellayani, Thiruvananthapuram, Kerala, geographically located at 8º28′41.2″ North latitude and 76º59'16.7" E longitude, at an altitude of 29 m above the mean sea level. The field experiment was laid out in randomized block design with (3 x 3) + 1 treatment, replicated thrice. The treatment combinations included three levels of row spacing (R) (r_1- 20 cm, r_2- 30 cm, r_3- 40 cm) and three levels of nitrogen application (N) (n_1- 315 kg/ha, n_2- 245 kg/ha, n_3- 175 kg/ha), compared against the control treatment (30 cm row spacing, nitrogen application- 315 kg/ha in seven equal splits, and $MgSO_4$- 80 kg/ha). Nitrogen was applied in seven equal splits- as basal, 20, and 40 days after sowing and after each cut. The variety used for the study was COFS-31, released from Tamil Nadu Agricultural University. The soil in the experimental site was identified as sandy clay loam in texture, moderately acidic (pH 5.7) in reaction, medium in organic carbon (0.80%), available nitrogen (352.52 kg/ha) and available potassium (240.32 kg/ha), high in available phosphorus (92.44 kg/ha) and deficient in available magnesium (108.22 mg/kg) status. The crop was planted during November 2022 and was maintained for ten months for the study. Multicut fodder sorghum variety, COFS-31, released from Tamil Nadu Agricultural University was used for the study. The entire dose of phosphorus, potassium, and magnesium was applied as basal. Nitrogen was applied in equal split doses after every harvest. Other agronomic and plant protection measures were adopted as and when needed. For green forage harvesting was done at 70 days after sowing and subsequent cuts were harvested at an interval of 60 days. Green fodder was recorded in the field itself after each cut. The crop samples collected from each net plot were sun-dried and then oven dried to a constant weight at 65 ± 5°C. The dry matter content was computed and dry fodder yield was worked out and expressed in t/ha.

RESULTS AND DISCUSSION

Growth characters

Data on plant height revealed that spacing had a significant influence. The optimum row spacing of 30 cm resulted in taller plants compared to 20 cm and 40 cm row spacing. When compared to the 20 cm line sowing, the decreased intra-row spacing competition resulted in a taller plant height in the 30 cm line sowing. Effective use of growth resources like sunlight, moisture, and nutrients may cause the observed higher plant height. According to Afzal *et al.* (2013), and Palanjiya *et al.* (2019), these results are comparable.

Data showed that plant height was significantly influenced by different levels of nitrogen application. Plants with 315 kg N/ha produced taller plants compared to lower levels of nitrogen application *i.e.,* 245 and 175 kg N ha^{-1}. The primary cause of the higher plant height at higher nitrogen levels was thought to be the crop's increased ability to access and absorb nitrogen, which increased the amount of vegetative growth and protoplasmic constituents and sped up the processes of cell division, expansion, and differentiation, leading to luxuriant growth. These findings are in agreement with Agarwal *et al.* (2005).

The application of $MgSO_4$ had a significant effect on plant height. The control treatment (30 cm row spacing with an application of 315 kg N/ha, and 80 kg $MgSO_4$) recorded higher plant height over other treatment combinations. However, treatment r_2n_1 was on par with the control treatment. Plant height is mostly a genetic trait. However, it is also influenced by environmental conditions and available nutrient levels in the soil. The application of $MgSO_4$ might have influenced nitrogen uptake, cell division, proliferation of cells, and metabolism of carbohydrates, altogether promoting higher plant height.

Data on stem girth showed that spacing had a significant influence. The wider row spacing of 40 cm showed wider stem girth compared to row spacing of 30 cm and 20 cm line sowing. These outcomes are in line with Afzal *et al.* (2013) and Zand and Shakiba (2013). Increased leaf size and lower stem girth were the causes of the greater leaf-stem ratio at a 30 cm spacing. Since there are more plant populations per unit space, the spacing of 20 cm results in the formation of grassy shoots. With 40 cm between plants, there was greater room for crop growth, which raised the stem girth and decreased the leaf-stem ratio, which in turn led to higher and lower seed rates. Verma *et al.* (2005) obtained similar results.

Data revealed that the application of different nitrogen levels had a significant influence on leaf stem ratio. It was found to be highest at 315 kg N/ha over lower levels of nitrogen application *i.e.,* 245 and 175 kg N/ha. Higher levels of nitrogen application might have enhanced the production of leafy material relative to the stem. Similar results were observed by Kothari and Saraf (1987) in fodder sorghum.

TABLE 1
Effect of row spacing and nitrogen levels on growth and yield attributes

Treatments	Plant height (cm)	Stem girth (cm)	Leaf stem ratio	Total green fodder yield (t/ha)	Total dry fodder yield (t/ha)
Row spacing (R)-3					
r_1 (20 cm)	181.88	2.30	0.42	127.21	29.48
r_2 (30 cm)	206.15	2.47	0.51	148.09	34.56
r_3 (40 cm)	189.03	2.52	0.45	140.89	32.65
S Em±	2.24	0.05	0.01	1.45	0.41
C. D. (P=0.05)	6.73	0.13	0.02	4.33	1.23
Nitrogen levels (N)-3					
n_1 (315 kg/ha)	215.04	2.75	0.51	159.87	37.36
n_2 (245 kg/ha)	191.18	2.47	0.46	137.72	31.91
n_3 (175 kg/ha)	170.85	2.07	0.41	118.60	27.41
S. Em±	2.24	0.05	0.01	1.45	0.41
C. D. (P=0.05)	6.73	0.13	0.02	4.33	1.23
R x N interaction					
r_1n_1	189.99	2.43	0.45	143.96	33.36
r_1n_2	188.13	2.56	0.43	124.25	28.67
r_1n_3	167.53	1.90	0.39	113.42	26.40
r_2n_1	235.78	2.91	0.55	172.58	40.60
r_2n_2	207.60	2.37	0.52	147.72	34.51
r_2n_3	175.08	2.12	0.46	123.97	28.56
r_3n_1	219.34	2.90	0.53	163.07	38.13
r_3n_2	177.81	2.47	0.44	141.20	32.54
r_3n_3	169.94	2.20	0.39	118.40	27.28
S. Em±	3.89	0.08	0.01	2.50	0.71
C. D. (P=0.05)	11.65	0.23	0.03	7.50	2.13
Control	237.99	3.04	0.57	175.80	41.52
Treatment vs Control	S	S	S	S	S

The application of magnesium fertilizer to control treatment has shown a significant impact on stem girth and leaf stem ratio. Control treatment showed a higher stem girth and leaf stem ratio over other treatment combinations. The application of magnesium fertilizer enhanced the production of net assimilates and also improved light interception by plants which resulted in a higher leaf stem ratio in rice plants by Kartika e*t al.* (2018).

Yield attributes

The results showed that yield attributes like GFY and DFY were significantly influenced by spacing. The optimum row spacing of 30 cm resulted in higher GFY and DFY compared to 20 cm and 40 cm row spacing were attributed mainly to better aeration, increased moisture, and nutrient availability, and improved solar radiation absorption could all be contributing factors for an increase in GFY and DFY at the 30 cm row spacing. Comparable results were seen in studies done by Shivaprasad and Singh (2017) and Manjunath *et al.* (2013) in fodder sorghum.

The results showed that yield attributes like GFY and DFY were significantly influenced by different levels of nitrogen application. GFY and DFY increased significantly with an increase in nitrogen application. Higher GFY and DFY were observed at nitrogen levels of 315 kg N/ha over lower levels of nitrogen application *i.e.,* 245 and 175 kg N/ha. The increase in total GFY and DFY was mainly due to the effect of nitrogen application on plant height, tillers, leaf length, leaf breadth, stem girth, leaf to stem ratio. A higher amount of nitrogen application might also resulted in a higher uptake of nutrients from the soil and nitrogen's positive effects on cell elongation and cell division, nucleotide and coenzyme synthesis, meristematic activity and photosynthetic area led to greater production and accumulation of photosynthates, which in turn produced larger levels of dry matter and green fodder yield. Similar results were reported by Shivaprasad and Singh (2017).

The application of magnesium fertilizer to control treatment has shown a significant impact on total green fodder yield. Control treatment recorded a higher total green fodder yield (175.8 t/ha) and it was statistically on par with the treatment combination r_2n_1 (172.5 t/ha). The application of magnesium fertilizer improved green fodder yield because magnesium plays a key role in terms of sugar synthesis in plants, nutrient absorption, and its mobilization, enhanced light interception, and improved photosynthesis. Moreover, magnesium is the central element present in chlorophyll. Hence, it is actively involved in cell division, cell differentiation, cell growth, and development in plants and other metabolic processes, all of which increased the production of total green fodder yield in the Bajra Napier hybrid (Thampi and Thomas, 2018).

The application of magnesium fertilizer to control treatment has shown a significant impact on total dry fodder yield. Control treatment recorded a higher total dry fodder yield (41.52 t ha^{-1}) over other treatment combinations and was statistically on par with the treatment combination r_2n_1 (40.60 t ha^{-1}). The application of magnesium fertilizer improved carbohydrate metabolism in plants, total green fodder yield, and dry fodder yield Lekshmi *et al.* (2007).

CONCLUSION

Based on the study, it could be inferred that multicut fodder sorghum is best suitable for cultivation when grown at a row spacing (30 cm) and nitrogen dose of 315 kg/ha/year (seven equal splits) along with FYM @ 10 t/ha, P_2O_5 @ 40 kg/ha/year, K_2O @ 40 kg/ha/year, and $MgSO_4$ @ 80 kg/ha/year for getting higher productivity and profitability.

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