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# Impact of Row Spacing and Nitrogen Levels on Growth, Yield and Economics of Fodder Sorghum (*Sorghum bicolour* L. Moench)

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**ABSTRACT**

The field experiment entitled "Impact of Row Spacing and Nitrogen Levels on Growth, Yield and Economics of Fodder Sorghum (*Sorghum bicolour* L. Moench)" was conducted during the Kharif season of 2022 in the sandy loam soil at Crop Research Centre, ITM University, Gwalior (M.P.). The experiment was laid out in the RBD with three replications. The experiments included twelve treatments, consisting of three-row spacing i.e., 20cm, 30cm and 40 cm and four nitrogen levels viz., 0, 60, 90 and 120 kg ha$^{-1}$. The results revealed that the growth attributes such as plant height, number of leaves per plant, number of tillers per plant and leaf-stem ratio were found significantly higher in the wider row spacing of 40 cm over 20 and 30 cm. while the green fodder yield, dry fodder yield and total green and dry fodder yield was found higher at the row spacing of 30 cm as compared to 20 and 40 cm of row spacing. Results indicated that the application of various nitrogen levels had significant effects on plant growth such as plant height, number of leaves per plant, number of tillers per plant, leaf-stem ratio and dry matter percentage was found significantly higher with the application of nitrogen up to 120 kg ha$^{-1}$. Increased nitrogen levels considerably influenced the yield characters and maximum when nitrogen was applied 120 kg ha$^{-1}$; The highest green (35.12 t ha$^{-1}$) and dry fodder yield (7.52 t ha$^{-1}$) was recorded at the tune of 35.12 t ha$^{-1}$ and 7.52 t ha$^{-1}$, respectively with the application of 120 kg N ha-1 which was significantly higher over lower doses of nitrogen. Appreciably higher net return ( 49646.1) and B: Cratioof ( 2.0 re$^{-1}$ invested) with a combination of 30 cm row apart.

***Key words:*** *Dry fodder yield, Fodder Sorghum, Green fodder yield Nitrogen Levels and Row spacing.*

## Introduction

Sorghum [*Sorghum bicolor* (L.) Moench] is indigenous to Africa, belongs to the family Poaceae, and the sub-family Panicoideae. Sorghum is considered as the king of millets and provides food, feed, stover and fuel to millions of poor farm families and their livestock in the arid and semi-arid tropical regions of the world. Presently in India,having a livestock population of 536.76 million (DAHD and F, 2021). Which demanded a green fodder is about 1134 million tonnes and dry fodder is about 630 million tonnes. The supply of green fodder is about 405.9 million tonnes and dry fodder is about 473 million tonnes (IDC. ICRISAT, 2019). The amount of green forage must increase by 1.69% year to make up for the insufficient, while only 4% of the land area of the nation is devoted to raising fodder with total cultivated land (8.4 million hectares), and it hasn't been changed in past few decades. (Dagar, 2017; Halli *et al.*, 2018; Meena *et al.*, 2018). In India, fodder crops are cultivated on an area of 4.89% with an annual fodder production of 866.6 m t (400.6 m t green and 466 m t dry fodder). While, the yearly fodder requirement is about 1666 million tons (1097 m t green and 466 m t dry fodder) to support the present domesticated animal population. So, there is a great need to maintain a regular and balanced supply of more nutritious feed and fodder for stall-feeding animals. The productive milch herds can be maintained, which would accelerate the growth of milk production. The production of fodder sorghum can be increased by adopting an improved package of practices. Among the different agronomic factors, row spacing and nitrogen are of prime importance for getting higher forage yields of better quality (Midha *et al*., 2014). Row spacing is one of the most important factors that determine the efficient use of water, land, light and nutrients. Among growth factors, adequate inorganic nitrogenous fertilizers are considered to be of prime importance due to their profound impact on various aspects of the growth and development of the crop. Nitrogen is an essential element for both fodder quality and quantity as it is a component of protein and chlorophyll. It is thus, essential for photosynthesis, vegetative and reproductive growth and it often determines the yield of sorghum. Sorghum fodder contains a relatively high concentration of soluble carbohydrates and high-quality biomass within a short period, making it attractive as hay and silage crops for tropical regions. The application of nitrogen not only affects the forage yield of sorghum but also improves its quality, especially its protein content. Keeping this in view, the present investigation was conducted to find out the effect of nitrogen levelsand row spacing on the growth, yield and economics of fodder sorghum (*Sorghum bicolor* L. Moench).

## Materials and Methods

A field experiment was conducted during the Kharif season of 2022 at the Crop Research Centre, School of Agriculture, ITM University, Gwalior (M.P.). During the cropping season, the highest rainfall was recorded 135 mm of the total rainfall. The experiment was laid out in RBD consisting of three replication and twelve treatments. The different row spacing (i.e., 20 cm, 30 cm and 40 cm as S1, S2 and S3) is one factor and four different nitrogen levels (0, 60, 90 and 120 kg ha$^{-1}$as N1, N2, N3 and N4) as another factor. Nitrogen was applied in splits as at the time of sowing, 30 DAS and after the first cut of the sorghum crop. The entire dose of Phosphorus and potassium were applied at the time of sowing (40:40 kg ha$^{-1}$). The Plant height, number of leaves per plant, number of tillers per plant, leaf-stem ratio and dry matter per cent was recorded from the four tagged plants in each plot at all the crop growth stages. The leaf- stem ratio,was determined by separating the leaves from stem and then weighted both of them and mean values were worked out for analysis. Data on yield attributes such as green and dry fodder yield was taken at 60 days after sowing and subsequent cut was done at 40 days after the first cut. The plants were cut at 10 cm above the ground level at 1$^{st}$ cutting. The weight of green fodder yield per plot was recorded after the harvest and yield was measured in terms of tonnes per hectare.

## Results and Discussion

### Growth parameters

The plant height, number of leaves plant$^{-1}$, number of tillers plant$^{-1}$ and leaf-stem ratio were influenced due to the row spacings (Table 1). The plant height, number of leaves plant$^{-1}$, number of tillers plant$^{-1}$ and leaf-stem ratio at 60 DAS (1$^{st}$ cut) and 100 DAS (2$^{nd}$ cut) were recorded significantly higher when crop sown in the wider row spacing of 40 cm as compared to 20 and 30 cm row spacings. This might be due towider row spacing which resulted in less competition between the plants as compared to closer row spacing of 20 cm and 30 cm. However, 40 cm row spacing, utilized all the resources like moisture, sunlight and nutrients efficiently required for plant growth and development. The results were in conformity with the findings of Manjunatha (2011), Afzal *et al*. (2013), Akhtar *et al*. (2013), Zand and Shakiba (2013) and Chavan *et al*. (2017). The row spacing did not influence on the dry matter content of fodder sorghum significantly but higher values were observed in the row spacing of 40 cm at the crop growth stages of at 1$^{st}$ cut and 2$^{nd}$ cut. The interaction effect on growth attributes of fodder sorghum was not influenced by the row spacing.

Among the nitrogen levels, the growth parameters such as plant height, number of leaves plant$^{-1}$, number of tillers plant$^{-1}$, leaf-stem ratio and dry matter per cent were recorded significantly higher with the application of nitrogen 120 kg ha$^{-1}$ as compared to 0, 60 and 90 kg ha$^{-1}$ at 60 DAS (1$^{st}$ cut) and 100 DAS (2$^{nd}$ cut). Increases in the growth parameters with increases in the nitrogen levels from 0 to 120 kg ha$^{-1}$ might be due tothe rapid synthesis of car-

**Table 1.** Effect of row spacing and Nitrogen levels on growth attributes of fodder sorghum.

| Treatments | Plant height at (cm) | | No of Leaves plant$^{-1}$ | | No of Tillers plant$^{-1}$ | | L:S ratio | | DMC (%) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | At 1st cut (60 DAS) | At 2nd cut (100 DAS) | At 1st cut (60 DAS) | At 2nd cut (100 DAS) | At 1st cut (60 DAS) | At 2nd cut (100 DAS) | At 1st cut (60 DAS) | At 2nd cut (100 DAS) | At 1st cut (60 DAS) | At 2nd cut (100 DAS) |
| Row Spacing | | | | | | | | | | |
| $S_1$- 20 cm | 176.25 | 119.39 | 10.17 | 6.67 | 5.71 | 3.54 | 0.37 | 0.33 | 19.95 | 15.01 |
| $S_2$- 30 cm | 180.93 | 126.33 | 11.10 | 7.21 | 6.18 | 3.81 | 0.39 | 0.35 | 20.97 | 15.29 |
| $S_3$- 40 cm | 199.81 | 134.76 | 12.11 | 8.28 | 7.25 | 4.28 | 0.42 | 0.37 | 21.59 | 15.96 |
| SEm± | 4.53 | 3.04 | 0.285 | 0.17 | 0.20 | 0.12 | 0.009 | 0.008 | 0.48 | 0.35 |
| C.D. (P= 0.05) | 13.29 | 8.91 | 0.836 | 0.52 | 0.59 | 0.36 | 0.028 | 0.029 | NS | NS |
| N levels (Kg ha$^{-1}$) | | | | | | | | | | |
| $N_1$- 0 kg ha$^{-1}$ | 142.17 | 108.25 | 9.24 | 6.01 | 4.23 | 2.46 | 0.30 | 0.27 | 16.57 | 12.13 |
| $N_2$- 60 kg ha$^{-1}$ | 186.43 | 117.36 | 11.00 | 7.09 | 5.36 | 3.22 | 0.39 | 0.35 | 20.13 | 14.95 |
| $N_3$- 90 kg ha$^{-1}$ | 196.19 | 130.44 | 11.67 | 7.84 | 7.05 | 4.41 | 0.42 | 0.37 | 22.49 | 16.55 |
| $N_4$- 120 kg ha$^{-1}$ | 217.85 | 151.28 | 12.60 | 8.60 | 8.88 | 5.44 | 0.46 | 0.41 | 24.16 | 18.04 |
| SEm± | 5.23 | 3.51 | 0.32 | 0.20 | 0.23 | 0.14 | 0.011 | 0.010 | 0.55 | 0.41 |
| C.D. (P= 0.05) | 15.35 | 10.29 | 0.96 | 0.60 | 0.68 | 0.42 | 0.032 | 0.028 | 1.63 | 1.20 |
| Interaction S X N | | | | | | | | | | |
| SEm± | 9.06 | 6.08 | 0.57 | 0.35 | 0.40 | 0.25 | 0.019 | 0.017 | 0.96 | 0.71 |
| C.D. (P= 0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

*L:S – Leaf to stem ratio, DMC(%) – Dry matter content

bohydrates converted into protoplasm, which resulted in increased size of the cell. It contributes to cell division and cell elongation and enhances the metabolic activity of the plant leads to increases in the vegetative growth of the plant and rapid development of dark green foliage, which could intercept and utilize the incident solar radiation in the production of photosynthates. These results are in accordance with the findings of Meena and Meena (2012), Bhoya *et al*. (2014), Midha *et al.* (2014) and Chaudhary *et al*. (2018), Crawford *et al.* (2018) and Palanjiya *et al.* (2019). The interaction effect on yield attributes of fodder sorghum was not influenced by the various nitrogen levels.

**Green and Dry fodder yield**

The green and dry fodder yield were influenced due to row spacing and nitrogen levels (Table 2). The significantly higher green and dry fodder yield was observed in 30 cm row spacing as compared to 40 and 20 cm row spacing during the 1st and 2nd cut. This is mainly due to the plant population per sq. metre are a being higher as compared to the wider row spacing of 40 cm. While, the 20 cm row spacing, accommodates a higher plant population per sq. meter area but more competition between plant populations leads to grassy shoot appearances resulting in less improvement in vegetative growth as compared to 30 cm and 40 cm row spacing. Therefore, ultimately increased dry fodder yield. These similar results were observed by Manjunatha *et al*. (2013), and Sanmugapriya and Kalpana (2017).

Among the various nitrogen levels, significantly higher green and dry fodder yield was recorded with the application of nitrogen 120 kg ha$^{-1}$ as compared to 0, 60 and 90 kg ha$^{-1}$ nitrogen during the 1st and 2nd cuts. The maximum green fodder yield was obtained due to the overall improvement of vegetative growth parameters like plant height, number of leaves per plant, number of tillers per plant, leaf-stem ratio and dry matter content with an increase in nitrogen levels. The positive effect of nitrogen on increasing cell wall material, which resulted in an increase in cell size, supports to cell elongation and cell division. So, this resulted in an increase in the green yield of the fodder sorghum. In case of dry fodder yield, significant

**Table 2.** Effect of row spacing and Nitrogen levels on yield attributes of fodder sorghum

| Treatments | Yield (t ha$^{-1}$) | | | | | |
|---|---|---|---|---|---|---|
| | Green Fodder yield | | | Dry Fodder yield | | |
| | 1$^{st}$ Cut | 2$^{nd}$ Cut | Total | 1$^{st}$ Cut | 2$^{nd}$ Cut | Total |
| Row Spacing | | | | | | |
| $S_1$- 20 cm | 15.68 | 9.79 | 25.30 | 3.14 | 1.74 | 4.86 |
| $S_2$- 30 cm | 18.19 | 11.57 | 29.42 | 3.50 | 1.98 | 5.48 |
| $S_3$- 40 cm | 13.98 | 8.62 | 22.61 | 2.78 | 1.54 | 4.44 |
| SEm± | 0.51 | 0.36 | 0.68 | 0.10 | 0.06 | 0.12 |
| C.D. (P= 0.05) | 1.50 | 1.06 | 1.99 | 0.31 | 0.18 | 0.36 |
| N levels (Kg ha$^{-1}$) | | | | | | |
| $N_1$- 0 kg ha$^{-1}$ | 9.23 | 6.72 | 15.84 | 1.38 | 0.78 | 2.21 |
| $N_2$- 60 kg ha$^{-1}$ | 13.86 | 8.67 | 22.53 | 2.61 | 1.40 | 4.07 |
| $N_3$- 90 kg ha$^{-1}$ | 18.41 | 11.53 | 29.61 | 3.81 | 2.07 | 5.91 |
| $N_4$- 120 kg ha$^{-1}$ | 22.30 | 13.06 | 35.12 | 4.75 | 2.75 | 7.52 |
| SEm± | 0.59 | 0.42 | 0.78 | 0.12 | 0.07 | 0.14 |
| C.D. (P= 0.05) | 1.74 | 1.23 | 2.30 | 0.36 | 0.21 | 0.42 |
| Interaction S X N | | | | | | |
| SEm± | 1.02 | 0.72 | 1.36 | 0.21 | 0.12 | 0.25 |
| C.D. (P= 0.05) | NS | NS | NS | NS | NS | NS |

impact of N on enhancing green and dry fodder yields of sorghum could be responsible for this increase in yields. The characteristics of plant growth, providea favourable nutritional environment by N and alsoa beneficial effect on crop growth, which ultimately resulted in higher fodder yields. These similar results confirm the findings of Singh and Sumeriya (2012), Meena *et al.* (2018), Meena and Meena (2012), Adam and Taleim (2018), Chaudhary *et al*. (2018) and Palanjiya *et al.* (2019). The interaction effect on yield attributes of fodder sorghum was not influenced by the row spacing and nitrogen levels.

**Economics**

The combination of row spacing and nitrogen levels affects the economics of fodder sorghum. The combination of row spacing 30 cm with 120 kg ha$^{-1}$ of nitrogen application was recorded as the highest net return (Rs. 49646.1) and B: C ratio (2.0) followed by the row spacing 30 cm with 90 kg ha$^{-1}$ of nitrogen application with the net return (Rs.37855.6) and B: C ratio (1.55) (Table 3).

## Conclusion

On the basis of findings of the investigation entitled "Impact of Row Spacing and Nitrogen Levels on Growth, Yield and Economics of Fodder Sorghum (*Sorghum bicolour* L. Moench)" was conducted during the Kharif season of 2022. It is concluded that the 30 cm row spacing and 120 kg ha$^{-1}$ nitrogen levels resulted in the highest green fodder and dry fodder yield along with the highest net return and B:C ratio.

**Table 3.** Effect of row spacing and Nitrogen levels on economics of fodder sorghum

| Treatments | Net return ( ha$^{-1}$) | B-C Ratio ( Re$^{-1}$ invested) |
|---|---|---|
| 0 kg N ha$^{-1}$ + 20 cm | 4387.8 | 0.18 |
| 0 kg N ha$^{-1}$ +30 cm | 7007.0 | 0.30 |
| 0 kg N ha$^{-1}$ +40 cm | 3492.9 | 0.15 |
| 60 kg N ha$^{-1}$+20 cm | 16188.8 | 0.66 |
| 60 kg N ha$^{-1}$+30 cm | 20400.9 | 0.85 |
| 60 kg N ha$^{-1}$+40 cm | 12638.4 | 0.53 |
| 90 kg N ha$^{-1}$+20 cm | 26780.5 | 1.07 |
| 90 kg N ha$^{-1}$+30 cm | 37855.6 | 1.55 |
| 90 kg N ha$^{-1}$+40 cm | 21838.1 | 0.91 |
| 120 kg N ha$^{-1}$+20 cm | 35962.7 | 1.42 |
| 120 kg N ha$^{-1}$+30 cm | 49646.1 | 2.00 |
| 120 kg N ha$^{-1}$+40 cm | 29607.1 | 1.21 |

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