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# Influence of graded levels of nitrogen application on growth and yield of multicut fodder sorghum genotypes

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## Abstract
A field experiment was conducted to study the "Response of multicut fodder sorghum genotypes to nitrogen levels under irrigated condition in Northern Dry Zone (Zone 3) of Karnataka" in medium deep black soils at ICAR- Krishi Vigyan Kendra, Vijayapur, during *Kharif* 2019-20. The experiment was laid out under split plot design with three replications, the treatment consisted of two genotypes *viz*. (CoFS-29 and CoFS-31) and five nitrogen levels *viz*. (100, 125, 150, 175 and 200 kg ha$^{-1}$). Nitrogen at all levels is divided into six equal parts and applied at sowing, 30 days after sowing and after each cutting four times. Entire doze of Phosphorus and potassium were applied at the time of sowing (40:40 kg ha$^{-1}$). The crop was harvested for green forage at 50 percent flowering in each treatment at all the five cuttings. Forage quality parameters were analysed on whole plant dry matter basis.
The genotype CoFS-31 recorded significantly higher total green fodder (130.49 t ha$^{-1}$) and total dry matter yield (29.67 t ha$^{-1}$) compared to CoFS-29 (114.59 and 26.14 t ha$^{-1}$). Application of 200 kg N ha$^{-1}$ recorded significantly higher total green fodder yield (154.32 t ha$^{-1}$) and total dry matter yield (34.97 t ha$^{-1}$) compared to other levels of nitrogen. Higher level of nitrogen improved the quality of fodder sorghum.
Higher total green fodder yield (167.05 and 156.28 t ha$^{-1}$), total dry matter yield (37.52 and 35.78 t ha$^{-1}$), gross returns (₹ 250575 and 234430 ha$^{-1}$), net returns (₹ 176270 and 160447 ha$^{-1}$), benefit cost ratio (3.37 and 3.17) and better quality parameters were observed under CoFS-31 genotype with supply of 200 and 175 kg N ha$^{-1}$, respectively.

**Keywords:** CoFS-29, CoFS-31 (multicut sorghum), genotypes, green fodder yield, nitrogen levels

## Introduction
India is one of the country which has biggest livestock population about 536 million heads, which covers 15 percent of the world's domesticated animals population. India supports 55, 16, 20 and 4 percent of world's buffaloes, goats, cattle and sheep population, respectively. However, the nation has just 4.89 percent of fodder crop cultivated area with a yearly fodder production of 866.6 m t (400.6 m t green and 466 m t dry fodder). While, the yearly fodder requirement is 1666 million tons (1097 m t green and 466 m t dry fodder) to support the current domesticated animals population (Anon., 2019) [1]. The current fodder and feed assets of the nation can meet just 48 percent of the prerequisite, with an immense lack of 61 percent of dry and 22 percent of green forage, respectively (Anon., 2014) [2].
The inaccessibility of fodder is being one of the limiting components for the livestock industry in India. The efficiency and accessibility of good quality fodder and feed has a prime significance for the advancement of livestock. However, the current fodder and feed resources cannot meet the necessity of current livestock population. Nitrogen fertilization assumes a fundamental role in improving the yield and quality. It improves crude protein, dry matter content, decline the fibre content among different characters. The availability of green fodder from single cut is short period while multicut sorghum helps to provide green fodder spread over a long period which mitigates the trouble of repeating field preparation and reseeding, which also increase the cost of pre-cultivation. Cutting management plan assumes a significant role in the quality and yield of forage. Therefore, to increase the yield and quality of fodder sorghum it is relevant to decide its nitrogen necessity and harvesting time.
Dry fodder of the sorghum crop after harvesting of grain which is typically fed to the livestock. Such straw provide low quality fodder to milch breeds because of lower content of crude protein with higher content of crude fibre.
To meet this demand, TNAU, Coimbatore released a multicut fodder sorghum CoFS-29 during 2001 for general cultivation in Tamil Nadu. This variety was introduced in Karnataka especially at University of Agricultural Sciences, Dharwad during 2007-08.

Again attempts have been made at Department of Forage Crops, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore through Mutation breeding using gamma rays to arrest the seed shattering behaviour and as a high fodder yielding and non-seed shattering multicut fodder sorghum CoFS-31 has been identified and released at state level during 2014.

Amongst the different variables, appropriate crop nutrition and varietal factors are of major significance in receiving higher green fodder yield with better quality. Among the significant supplement components, nitrogen has been accounted for to improve the green fodder yield and also the crude protein content of multicut fodder sorghum. Application of nitrogen fertilizer has been reported to increase the fodder yield and also improve its quality components like, crude protein and crude fibre content of the multicut fodder sorghum.

## Materials and Methods

A field experiment was conducted to study the "Influence of graded levels of nitrogen application on growth and yield of multicut fodder sorghum genotypes" during *Kharif* 2019-20 at instructional farm, Krishi Vigyana Kendra, Vijayapur. The soil at KVK Vijayapur is medium deep black soil. The soil was texturally clay, alkaline in reaction (pH 8.14), with salinity (0.54 $dSm^{-1}$), medium in available Nitrogen (289 kg N $ha^{-1}$) medium in available Phosphorus (35.6 kg $P_2O_5$ $ha^{-1}$), and medium in available Potassium (460.5 kg $K_2O$ $ha^{-1}$). The annual rainfall received during 2019-20 was 634.5 mm as against average rainfall at 622 mm. A well distributed rainfall of 542.3 mm was received during cropping period (June fourth week to May fourth week).

The experiment was laid out in split plot design with 10 treatment combinations of two genotypes (CoFS-29, CoFS-31 as $V_1$ and $V_2$ respectively) and five levels of nitrogen (100, 125, 150, 175 and 200 kg $ha^{-1}$ as $N_1$, $N_2$, $N_3$, $N_4$ and $N_5$ respectively).

Nitrogen at all levels is divided into six equal parts and applied at sowing, 30 days after sowing and after each cutting four times. Entire dose of Phosphorus and potassium were applied at the time of sowing (40:40 kg $ha^{-1}$). Since the crop was sown in *kharif* season, no irrigation was provided till November, five months after sowing because of sufficient rain. Later on, 10 irrigations were given at an interval of 15 – 20 days. The crop was harvested for green forage at 50 percent flowering in each treatment at all the five cuttings. The first cutting was made 90 DAS and subsequent cuttings were made at an interval of 60 days. The plant were cut 5 cm above the ground level at the time of each cutting. The green fodder weight per plot was recorded in the field immediately after harvest. Totally, five cuts were taken from June 2019 to May 2020. The treatment wise green forage yield was multiplied by respective dry matter percentage to get the dry matter yield. Economics parameters were calculated on the basis of prevailing market prices.

The data collected from the experiment at different growth stages and from laboratory analysis was subjected to statistical analysis as described by Gomez and Gomez (1984). The level of significance used in 'F' test was 0.05. A critical difference value was calculated wherever the 'F' test found to be significant.

## Results and Discussion

### Effect of genotypes on growth and yield attributes of multicut fodder sorghum

The genotype CoFS-31 recorded significantly higher plant height (230 cm) and higher number of tillers per meter row (73) compared to CoFS-29, The genotype CoFS-31 recorded significantly higher total green fodder and total dry matter yield compared to genotype

CoFS-29. Since the crop has potential to tillering it could produce more number of tillers per m row and per unit area which was responsible for getting higher green and dry matter yield. Meena *et al*., 2012 [12], Rana *et al*., (2013) [14], Singh *et al*., 2014 [16]. Grewal *et al*., (2005) [8] also observed that higher number of tillers per plant helped to increase the fodder yield of forage sorghum. The genotype CoFS-31 produced statistically higher total phytomass yield (130.49 t $ha^{-1}$) and total biomass yield (29.67 t $ha^{-1}$) compared to CoFS-29 (114.59 and 26.14 t $ha^{-1}$, respectively). Similar trend followed in all successive cuttings for phytomass yield and biomass yield. The genotype CoFS-31 produced 12.18 percent and 11.89 percent higher total phytomass and total biomass yield respectively compared to CoFS-29. The results are in close conformity with the findings of Sumeriya (2010) [17] and Mahesh *et al.* (2020) [9].

The variation in plant height of the genotypes might be related to inherent difference and their high vigour. The differential behaviour of these genotypes could also be explained solely by the variation in their genetic constituent (Meena *et al*., 2012) [11]. The genotype CoFS-31 has potential to produce higher number of tillers compared to CoFS-29 which in turn increases green and dry matter yield. Similar findings were also revealed by Grewal *et al.* (2005) [8] and Rana *et al.* (2013) [14], found that higher tillers per plant helps to increase forage sorghum's fodder yield.

### Effect of nitrogen level on growth and yield attributes of multicut fodder sorghum

The green fodder and dry matter yield was increased significantly with successive increase in nitrogen levels up to 200 kg N $ha^{-1}$ in all the cuts. The total green fodder yield (154.32 t $ha^{-1}$) was significantly higher at 200 kg N $ha^{-1}$ and was 43.1, 31.3, 18.9 and 7.9 percent higher over 100, 125, 150 and 175 kg N $ha^{-1}$, respectively. The total dry matter yield (34.97 t $ha^{-1}$) was also significantly increased with increase in nitrogen levels and was 42.9, 31.0, 19.8 and 7.1 percent higher over 100, 125, 150 and 175 kg N $ha^{-1}$, respectively. The improvement in both Phytomass and biomass yield at higher N levels was attributed to improved growth and yield parameters, such as plant height, number of tillers per meter row and dry matter yield per meter row.

The increased nitrogen application significantly increased the plant height and number of tillers per meter row. Application of 200 kg N $ha^{-1}$ significantly increased plant height than remaining nitrogen levels. This might be due to the increased protoplasmic constituents and acceleration in the process of cell division and thereby resulting in luxuriant growth. Similar results were reported by and Verma *et al*. (2005) [18], Manjunatha *et al*. (2013) [10], Afzal *et al.* (2013) [1], Chaudhary *et al.* (2018) [5], Yadav *et al.* (2019) [19]. Singh *et al.* (1988) [15] opined that the beneficial effects of nitrogen on cell division and elongation, formation of Co-enzymes and nucleotides resulted in increased photosynthetic area and meristematic activity and hence more production and accumulation of photosynthates, which reflected in luxuriant growth.

### Effect of genotypes and nitrogen level on growth and yield attributes of multicut fodder sorghum

There was significant interaction between genotypes and nitrogen levels with respect to growth parameters, green forage and dry matter yield. The combination of genotype CoFS-31 with 175 and 200 kg N ha$^{-1}$ recorded the highest plant height (245 and 257 cm), number of tillers per meter row (82 and 89), total green fodder yield (156.28 and 167.05 t ha$^{-1}$) and total dry matter yield (35.78 and 37.52 t ha$^{-1}$), respectively. The higher total green forage with treatment combinations of CoFS-31 genotype with 200 kg N ha$^{-1}$ was due to higher plant height and number of tillers per meter row compared to other treatment combinations. This was mainly due to application of higher rate of nitrogen met requirement of plants at different growth stages, resulted in higher uptake of nitrogen by plants. This might have accelerated the meristematic activity, vegetative growth and photosynthetic activity, consequently resulting in to increased plant height, number of leaves per plant, green and dry leaf weight per plant, green and dry stem weight per plant which had eventually increased green fodder and dry fodder yields (Chaudhary *et al.*, 2018) [5]. Similar trend were also observed by Ayub *et al.* (2002) [4], Verma *et al.* (2005) [18], Devi *et al.* (2007) [6], Meena *et al.* (2012) [12] and Rana *et al.* (2012) [13].

### Effect of genotypes and nitrogen level on economics of multicut fodder sorghum

The genotype CoFS-31 with nitrogen @ 200 kg ha$^{-1}$ produced significantly higher gross, net returns and B:C (₹ 250575, ₹ 176270 and 3.37, respectively). However, it was on par with application of nitrogen @ 175 kg ha$^{-1}$ (₹ 234430, ₹ 160447 and 3.17 respectively). This might be due to higher production of green fodder yield. The significantly lowest gross, net returns and B:C was observed on CoFS-29 with N @ 100 kg N ha$^{-1}$.

**Table 1:** Growth and yield of multicut fodder sorghum genotypes as influenced by varied levels of nitrogen

| Treatment | Plant height at harvest (cm)* | Number of tillers per meter row* | Total green fodder yield (t ha$^{-1}$) | Total dry fodder yield (t ha$^{-1}$) |
|---|---|---|---|---|
| **Varieties (V)** | | | | |
| CoFS-29 ($V_1$) | 206 | 61 | 114.59 | 26.14 |
| CoFS-31 ($V_2$) | 230 | 73 | 130.49 | 29.67 |
| S.Em. ± | 3.02 | 1.58 | 2.47 | 0.47 |
| C.D. at 5 % | 18.39 | 9.34 | 15.02 | 2.86 |
| **Nitrogen levels (N) (kg ha$^{-1}$)** | | | | |
| 100 ($N_1$) | 192 | 58 | 87.76 | 19.94 |
| 125 ($N_2$) | 207 | 62 | 106.00 | 24.12 |
| 150 ($N_3$) | 218 | 65 | 122.62 | 28.02 |
| 175 ($N_4$) | 232 | 73 | 142.00 | 32.46 |
| 200 ($N_5$) | 244 | 78 | 154.32 | 34.97 |
| S.Em. ± | 4.04 | 1.69 | 3.27 | 0.70 |
| C.D. at 5 % | 12.10 | 5.05 | 9.80 | 2.10 |
| **Treatment combinations (V × N)** | | | | |
| $V_1 N_1$ | 177 | 54 | 87.23 | 19.82 |
| $V_1 N_2$ | 198 | 59 | 102.40 | 23.28 |
| $V_1 N_3$ | 210 | 63 | 114.03 | 26.04 |
| $V_1 N_4$ | 220 | 64 | 127.71 | 29.15 |
| $V_1 N_5$ | 230 | 67 | 141.60 | 32.42 |
| $V_2 N_1$ | 207 | 61 | 88.29 | 20.06 |
| $V_2 N_2$ | 215 | 65 | 109.60 | 24.96 |
| $V_2 N_3$ | 226 | 67 | 131.21 | 30.01 |
| $V_2 N_4$ | 245 | 82 | 156.28 | 35.78 |
| $V_2 N_5$ | 257 | 89 | 167.05 | 37.52 |
| S.Em. ± | 5.71 | 2.38 | 4.62 | 0.99 |
| C.D. at 5 % | 17.13 | 7.15 | 13.86 | 2.97 |

* mean of five cuts

**Table 2:** Gross, net returns and benefit cost ratio (B:C) of multicut fodder sorghum genotypes as influenced by varied levels of nitrogen

| Treatment | Cost of cultivation (₹ ha$^{-1}$) | Gross returns (₹ ha$^{-1}$) | Net returns (₹ ha$^{-1}$) | B:C |
|---|---|---|---|---|
| **Varieties (V)** | | | | |
| CoFS-29 ($V_1$) | 73662 | 171858 | 98196 | 2.33 |
| CoFS-31 ($V_2$) | 73662 | 195729 | 122067 | 2.65 |
| S.Em. ± | - | 3685 | 3685 | 0.05 |
| C.D. at 5 % | - | 22420 | 22420 | 0.30 |
| **Nitrogen levels (N) (kg ha$^{-1}$)** | | | | |
| 100 ($N_1$) | 73020 | 131643 | 58623 | 1.80 |
| 125 ($N_2$) | 73341 | 158913 | 85571 | 2.17 |
| 150 ($N_3$) | 73662 | 183928 | 110265 | 2.50 |
| 175 ($N_4$) | 73983 | 213000 | 139017 | 2.88 |
| 200 ($N_5$) | 74305 | 231485 | 157180 | 3.12 |
| S.Em. ± | - | 4903 | 4903 | 0.07 |

| | | | | |
|---|---|---|---|---|
| C.D. at 5 % | - | 14698 | 14698 | 0.20 |
| **Treatment combination (V × N)** | | | | |
| $V_1 N_1$ | 73020 | 130845 | 57825 | 1.79 |
| $V_1 N_2$ | 73341 | 153435 | 80094 | 2.09 |
| $V_1 N_3$ | 73662 | 171045 | 97383 | 2.32 |
| $V_1 N_4$ | 73983 | 191570 | 117587 | 2.59 |
| $V_1 N_5$ | 74305 | 212395 | 138090 | 2.86 |
| $V_2 N_1$ | 73020 | 132440 | 59420 | 1.81 |
| $V_2 N_2$ | 73341 | 164390 | 91049 | 2.24 |
| $V_2 N_3$ | 73662 | 196810 | 123148 | 2.67 |
| $V_2 N_4$ | 73983 | 234430 | 160447 | 3.17 |
| $V_2 N_5$ | 74305 | 250575 | 176270 | 3.37 |
| S.Em. ± | - | 7344 | 7344 | 0.11 |
| C.D. at 5 % | - | 22158 | 22158 | 0.32 |

## Conclusion

Based on the results it can be concluded that genotype CoFS-31 with supply of 175 and 200 kg N ha$^{-1}$ recorded higher plant height, number of tillers per meter row, green and dry fodder yield. Which was found to be optimum and profitable produced higher green fodder yield in multicut fodder sorghum under irrigated condition.

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