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Efficient Nutrient Management can Improve Growth and Yield of Finger Millet (*Eleusine coracana* L. Gaertn) in Calcareous Soils of Bihar

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ABSTRACT

Finger millet is considered a neglected crop in Bihar in spite of having huge potentiality to boost the farmer's income. The growth and yield under calcareous soil are very low for this crop. Therefore, suitable nutrient management practice is required to boost the growth and yield of the crop. Considering this, a field experiment was conducted during the *Kharif* season of 2020 at Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar, to determine the effective nutrient management for optimum growth and yield. The experiment has consisted of seven different nutrient management *viz.* T_1 – Control, T_2 – N omission, T_3 – P omission, T_4 – K omission, T_5 – 75% recommended dose of fertilizer (RDF), T_6 – 100% RDF, and T_7 – 125% RDF. These treatments were evaluated under a randomized complete block design with three replications. Application of 125% RDF exhibited the highest plant height, dry matter accumulation, and crop growth rate during different stages of the crop. Similarly, the highest value of grain yield was also recorded under the application of 125% RDF. Further, N, P, and K omission treatments significantly reduced the growth and yield of the crop. Hence, it may be concluded that the optimum growth and yield potentiality of the crop can be achieved with 25% additional chemical fertilizers than the present recommended doses in calcareous soils of Bihar.

HIGHLIGHTS

- Finger millet is an important crop in Bihar under changing climatic scenario.
- Suitable nutrient management for this crop in calcareous soils is yet to develop.
- Such situation results in poor yield of this crop in calcareous soils.
- Application of 25% additional RDF in calcareous soils can ensure growth and yield of the crop.

Keywords: Finger millet, Nutrient management, Growth, and Yield

India is the biggest producer of different types of millet crops. Finger millet [*Eleusine coracana* (L.) Gaertn.] accounts for approximately 85% of all minor millets produced in India (Sakamma *et al.* 2018). The production acreage of finger millet stands sixth after wheat, rice, maize, sorghum, and bajra in India (Chandra *et al*. 2016). Significant finger millet cultivating states in India are Karnataka, Andhra Pradesh, Tamil Nadu, Orrisa, Jharkhand, Maharashtra, and Uttarakhand. In India, finger millet is grown on 1.19 million hectares (Mha) with annual production and productivity of 1.98 million tons (Mt) and 1661 kg/ha, sequentially. In Bihar, the total acreage, production, and productivity of

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this crop were 4211 ha, 4184 Mt, and 994 kg/ha, respectively, during 2018–19 (DES, Bihar Govt., 2019). Finger millet is a nutrient-rich crop and is also known as nutri-cereals (Gupta *et al*. 2011).

Despite being such an important crop, this crop remains neglected (Harika *et al.* 2020). Nutrient management is essential to get the proper yield of any crop (Kumar *et al.* 2021). In this context, it has been found that a nutrient management approach is a plausible option and to be tested in different agroecosystems for its possible adoption for larger areas in the future (Kumar *et al.* 2019). The optimal doses of major nutrients, *viz.* nitrogen, potassium, and phosphorus, ensure attaining the desired yield goal as well as maintaining soil productivity for the long-run (Pramanick *et al.* 2020). Unfortunately, most of the areas allowed for reclamation in Bihar are calcareous soils containing relatively high amounts of calcium carbonate ($CaCO_3$), low organic matter, high EC, and alkaline pH have a significant impact on nitrogen (N) loss and or fixation, as well as reducing solubility and availability of both potassium (K) and phosphorus (P) (Laik *et al.* 2021). The volume of nutrients required for crop growth and productivity is frequently limited under such conditions (Nath *et al.* 2021). Farmers can attain higher yields and greater sustainability both in the short and medium-term by adopting good crop management and nutrient management practices (Singh *et al.* 2017).

Considering above all, an experiment was conducted in calcareous soils of Bihar to find out the effective nutrient management for finger millet in terms of optimum growth and yield.

MATERIALS AND METHODS

The experiment was implemented at the Crop Research Centre of Dr. RPCAU, Pusa (Samastipur), Bihar, in the *Kharif* season of 2020. Geographically, Pusa is located at 25⁰59′N and 85⁰40′E with an altitude of 52.9 m above mean sea level (MSL) on the sub-tropical area on the western side of river *Burhi Gandak.* The field topography was even with deep and well-drained soil. The soil of the location results from sediment deposition from the river *Burhi Gandak*. The experimental soil was sandy loam in texture, alkaline in soil reaction (pH 8.2), low in organic carbon (0.47%), medium in available nitrogen (241 kg/ha), medium in available phosphorus (13.8 kg/ha) medium in available potassium (128 kg/ha) and calcareous. This region has the climate of sub-tropical-humid. The rainfall in a year for the location is estimated to be on an average of 1276 mm. About 1035 mm occurred in the rainy months (July– September) and the hottest month through the experiment was august with a maximum temperature of 33.1°C. Rainfall was the maximum in July. The RH in the cropping season ranged from 92% in July to 86 % in November. During the experimental period, there was 1035 mm of rainfall. It was highest (646.8 mm) during July. The mean maximum monthly temperature under the cropping period varied at 33.1°C in August and 28.7°C in November. The investigation was performed during *Kharif* season 2020 in Randomized Complete Block Design (RCBD) with 7 treatments replicated thrice. The spacing row to row and plant to plant distance 25 cm × 10 cm, and the net plot size was 4 m x 3.6 m. The treatments were: T_1- Control, T_2- N omission, T_3- P omission, T_4- K omission, T_5- 75% RDF, T_6- 100% RDF, and T_7- 125% RDF. RDF for finger millet was 60:30:30 :: N:P:K (kg/ha), respectively. Plant heights were monitored on ten erratically selected plants from each plot. The height of plants was taken up to the tallest leaf. The average height of the plants was computed. For dry matter production, ten plants were randomly selected. We first cleaned and sun-dried the samples and then dried them in an oven at 70 °C ± 5 °C until we obtained a consistent weight. The CGR was calculated based on the periodical observation about dry matter accumulation/m², by applying the given formula *i.e.*

$$\text{CGR (g/m}^2\text{/day)} = \frac{W_2 - W_1}{t_2 - t_1}$$

Where W_2, and W_1 are dry weight (g/m²) of a plant at t_1 and t_2 days, correspondingly.

The net-plot harvested yield data were considered, and the grain yield was measured in kg/ha at 12% moisture.

All the data were subjected to ANOVA. Data analysis was done using software SPSS v.23.0. LSD at 5% probability was used to differentiate the treatment means.

RESULTS AND DISCUSSION

Crop growth

The effect of various nutrient management treatments on plant height (cm) of finger millet during distinct growth stages is depicted in Table 1. At 30 DAS, the variation of plant height due to different treatment was the minimum. However, the maximum attainment of plant height (18.5 cm) was recorded with T_7 (125% RDF) being statistically at par with T_6 (100% RDF) and T_5 (75% RDF). The lowest value of plant height (15.7 cm) was recorded with T_1 (control plot), and this treatment was found at par with T_2, T_3, T_4 and T_5. At 60 DAS, the maximum height of the finger millet (71.7 cm) was again recorded, with T_7 being at par with T_6 (70.3 cm). The minimum value of plant height was recorded with T_1 (45. 5 cm), and this treatment was statistically inferior to other nutrient management practices. At 90 DAS, similar kinds of results were observed the maximum plant height at 90 DAS were observed with T_7 (98.9 cm) being at par with T_6 (97.0 cm), and the least values of plant height were again documented with T_1 during 90 DAS. The higher nitrogen availability could be the reason for increased plant height. The plant needed nitrogen for its metabolism, which aided in greater cell division, cell elongation, and dry matter production, increasingthe plant height. A similar finding was recorded previously by Maitra *et al.* (2020), Pramanick *et al.* (2018).

Table 1: Effect of different nutrient management practices on plant height (cm) of finger millet

Treatments	Plant height (cm)		
	30 DAS	60 DAS	90 DAS
T_1: Control	15.7	45.5	55.7
T_2: N omission	16.0	48.9	58.2
T_3: P omission	16.2	50.1	60.3
T_4: K omission	16.5	51.5	61.3
T_5: 75% Recommended dose of fertilizer (RDF)	17.5	65.7	90.4
T_6: 100% RDF	18.3	70.3	97.0
T_7: 125% RDF	18.5	71.7	98.9
SEm (±)	0.6	0.9	0.7
LSD (P=0.05)	1.8	2.8	2.1

Dry matter accumulation (g/m^2) of finger millet was also varied with the different nutrient managements during different growth stages, as depicted in Table 2. At 30 DAS, the highest dry matter accumulation (110 g/m^2) of finger millet was recorded, with T_7 (125% RDF) being statistically at par with T_6 (100% RDF). The minimum value of dry matter accumulation (69 g/m^2) was recorded with T_1 (control plot), and this treatment was found at the statistically same level with nitrogen omission (T_2), phosphorus omission (T_3), and potassium omission (T_4). At 60 DAS, the highest DMA of the finger millet (321 g/m^2) was again recorded, with T_7 being at par with T_6 (312 g/m^2). The minimum dry matter accumulation of finger millet was recorded with T_1 (199 g/m^2), and this treatment was found at par with T_2, T_3 and T_4. At 90 DAS, similar kinds of results were recorded. The highest accumulation of dry matter (g/m^2) at 90 DAS were observed under T_7 (745 g/m^2) being at par with T_6 (733 g/m^2), while the minimum values of dry matter accumulation were again recorded with T_1 (477 g/m^2 and 490 g/m^2, respectively). This treatment was at par with T_2 during both growth stages. Higher dry matter accumulation with increased RDF may be attributed to better nutrition to the crop. Lakshmi *et al.* (2021) also reported similarly.

Table 2: Effect of different nutrient management practices on dry matter accumulation (g/m^2) of finger millet

Treatments	Dry matter accumulation (g/m^2)		
	30 DAS	60 DAS	90 DAS
T_1: Control	69	199	477
T_2: N omission	73	205	500
T_3: P omission	74	211	533
T_4: K omission	77	222	567
T_5: 75% Recommended dose of fertilizer (RDF)	88	277	651
T_6: 100% RDF	105	312	733
T_7: 125% RDF	110	321	745
SEm (±)	3.4	8.8	13.9
LSD (P=0.05)	10	26	41

The effect of different nutrient management practices on crop growth rate (g/m^2/d) of finger millet during distinct growth stages is depicted in Table 3. The table shows the significant consequence of different nutrient management on the crop growth rate (CGR) of finger millet. In 0 – 30 days after sowing (DAS), the maximum crop growth rate (3.67 g/m^2/d) of finger millet was recorded with T_7 (125% RDF) being statistically at par with

T_6 (100% RDF). The minimum value of CGR (2.30 g/m²/d,) was recorded with T_1 (control plot), and this treatment was at par with nitrogen omission (T_2) and phosphorus omission (T_3). During 30 – 60 DAS, the maximum CGR (7.03 g/m²/d) of finger millet was recorded with T_7 and this treatment was found at par with T_6. The minimum CGR of finger millet was recorded with T_1 (4.33 g/m²/d), and this treatment was at par with T_2 and T_3. During 60 – 90 DAS, the maximum crop growth rate (14.13 g/m²/d) of finger millet was recorded, with T_7 being at par with T_6 (14.03 g/m²/d). The minimum crop growth rate of finger millet was recorded with T_1 (9.27 g/m²/d), and during 90 DAS – harvest, the maximum crop growth rate (1.25 g/m²/d) of finger millet was recorded with T_7 being at par with T_6. Perhaps, due to more dry matter accumulation owing to greater light interception and greater LAI.

Table 3: Effect of different nutrient management practices on crop growth rate (g/m²/d) of finger millet

Treatments	Crop growth rate (g/m²/d)			
	0 – 30 DAS	30 – 60 DAS	60 – 90 DAS	90 DAS – harvest
T_1: Control	2.30	4.33	9.27	0.46
T_2: N omission	2.43	4.40	9.83	0.75
T_3:P omission	2.47	4.57	10.73	0.61
T_4: K omission	2.57	4.83	11.50	0.46
T_5: 75% Recommended dose of fertilizer (RDF)	2.93	6.30	12.47	0.68
T_6: 100% RDF	3.50	6.90	14.03	1.21
T_7: 125% RDF	3.67	7.03	14.13	1.25
SEm (±)	0.15	0.14	0.07	0.05
LSD (P=0.05)	0.44	0.41	0.22	0.14

Yield

Variations in grain yield (kg/ha) due to various nutrient management are depicted in Fig. 1. The data revealed that the crop yield was influenced considerably by different nutrient levels. The maximum accomplishment of grain yield (2612 kg/ha) of finger millet was recorded, with T_7 being at par with T_6 (2511 kg/ha). The treatment T_1 (control) recorded the least grain yield (777 kg/ha). Another critical observation recorded in this study is that the N-omission resulted in significantly lower grain yield than the P or K-omission. This may be due to the greater availability of nutrients, which resulted in accelerated growth, increased values of yield attributing characters, enhanced photosynthetic activity, and higher photosynthate translocation efficiency (Dey *et al.* 2022).

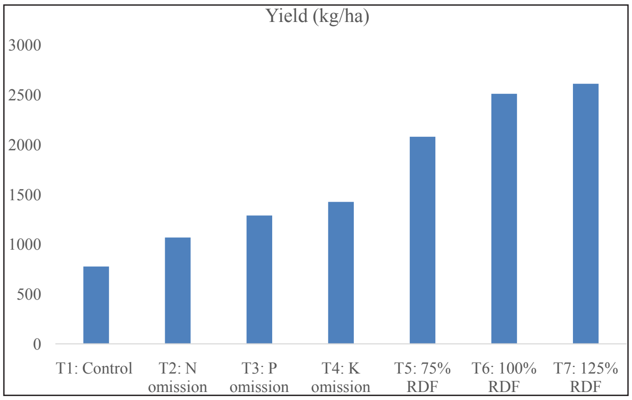

Fig. 1: Effect of different nutrient management practices on yield of finger millet

CONCLUSION

Based on the study of nutrient management in finger millet, it may be concluded that finger millet may be grown efficiently in Bihar conditions during *Kharif* season with 125% recommended dose of fertilizers.

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