International Journal of Bioresource Science
Citation: IJBS: **11**(01): 15-19, June 2024
DOI: 10.30954/2347-9655.01.2024.2

ASSOCIATION FOR AGRICULTURE ENVIRONMENT AND BIOTECHNOLOGY

RESEARCH PAPER

Effect of Nitrogen Management and Spacing on the Growth, Yield Attributes and Yield of Finger Millet in Coastal Part of West Bengal

Ranit Ghosh, Tanuj Kumar Mandal*, Ayan Sarkar and Arup Manna Das

Department of Agronomy and Agroforestry, School of Agriculture and Allied Sciences, The Neotia University, Sarisha, West Bengal, India

*Corresponding author: tanujkumar.mandal@tnu.in (**ORCID ID:** 0000-0003-4599-7548)

Received: 10-03-2024 **Revised:** 15-05-2024 **Accepted:** 02-06-2024

ABSTRACT

Finger millet (*Eleusine coracana* L.) is one of the vital millets which responds well to added nitrogenous fertilizers and agronomic management practices. Based on the facts, a field experiment was carried out at Instructional Farm, The Neotia University, West Bengal to study the effect of nitrogen management and spacing on the growth, yield attributes and yield of finger millet during *kharif* season of 2023. The soil of the experimental field contains 58.29% sand, 21.78% silt and 19.93% clay and having 356 kg ha^{-1} available N, 26.75 kg ha^{-1} available P_2O_5, 360 kg ha^{-1} K_2O and 0.46 % organic carbon. The experiment was laid out in split plot design, replicated thrice, having four levels of nitrogen viz., N_0, Control, N_1, 20 kg N ha^{-1}, N_2, 40 kg N ha^{-1}, N_3, 60 kg N ha^{-1} and three spacings: S_1, 15 cm × 10 cm, S_2, 20 cm × 10 cm, S_3 25 cm × 10 cm. The variety of finger millet was CFMV 1 (Indravathi). Results showed that application of 60 kg N ha^{-1}, *i.e.*, N_3 recorded significantly higher values ofall the growth attributes, yield attributes, seed yield (18.59 q ha^{-1}) and straw yield (26.04 q ha^{-1}) of finger millet. Among various spacings studied, S_3, *i.e.*, 25 cm×10 cm spacing recorded highest seed yield (15.75 q ha^{-1}) and straw yield (23.44 q ha^{-1}) of finger millet. The results concluded that cultivation of finger millet can be done with 60 kg N ha^{-1} and 25 cm × 10 cm to obtain higher growth and productivity of finger millet in the coastal part of West Bengal.

HIGHLIGHTS

- Application of 60 kg N ha^{-1} recorded higher values of all the growth attributes, yield attributes and seed yield of finger millet.
- A Spacing of 25 cm ×10 cm was beneficial for finger millet cultivation in coastal West Bengal.

Keywords: *Ragi*, nutrient management, plant stand, growth parameters, Yield attributes, Seed yield

In the current climate change context, adopting a climate-resilient cropping system and choosing ecologically hardy crops are of prime concern (Tomar *et al*. 2021; Maitra *et al*. 2023a,b; Sagar *et al*. 2023). In the present context of temperature rise and the ill effect of climate change, the low input demanding and ecologically sound finger millet (*Eleusine coracana* L.), which is commonly known as *ragi*, can automatically be chosen for agricultural sustainability in drylands (Maitra *et al*. 2000, 2022). Finger millet is a drought-tolerant crop grown in drylands under rainfed and harsh climatic conditions with higher CO_2 abatement opportunities. Finger millet is nutritionally superior to other cereals (Maitra *et al*. 2001; Brahmachari *et al*. 2019; Banerjee and Maitra, 2020; Panda *et*

How to cite this article: Ghosh, R., Mandal, T.K., Sarkar, A. and Das, A.M. (2024). Effect of Nitrogen Management and Spacing on the Growth, Yield Attributes and Yield of Finger Millet in Coastal Part of West Bengal. *Int. J. Bioresource Sci.*, **11**(01): 15-19.

Source of Support: IUCEA; **Conflict of Interest:** None

al. 2020; Mukesh Kumar *et al*. 2024). Recently developed finger millet varieties respond well to added nutrients and proper nutrient management is essential for production sustainability.

Finger millet is widely cultivated in India, Africa, Ceylon, Malaysia, China and Japan. In India, it is cultivated over an area of 2.65 million hectares with a total production of about 2.9 million tonnes. In India, Karnataka (61.8%), Andhra Pradesh (2.3%), Tamil Nadu (16.2%), Maharashtra (5.4%), Himachal Pradesh (3.4%) and Uttar Pradesh 7.1% are leading finger millet growing states. India is the largest producer of millet in the world as of 2021, with a total share of 41%, followed by Niger (12%) and China (8%). India also ranks 12th among those countries that produce high yields of millet. Millets have been an integral part of our diet for centuries. They offer many health benefits and are also good for the environment, as they have low water and input requirements for production. To create awareness and increase production and consumption of millets, the United Nations declared 2023 as the 'International Year of the Millet' at the behest of the Government of India.

Several improved finger millet varieties have been developed in the country, which are fertilizer-responsive and yield satisfactorily under good agricultural practices (Panda *et al*. 2021; Maitra *et al*. 2020). Among primary nutrients, nitrogen (N) plays a vital role in plant growth and development (Panda *et al*. 2022; Sairam *et al*. 2020; 2023). N promotes vegetative growth, improves the leaf area index, increases chlorophyll synthesis, and so on (Di Mola *et al*. 2019); thus increasing photosynthesis and plant assimilate production. N profoundly influences the plant's physiological processes, directly affecting yield and nutritional quality. N is deficient in most of the farmlands in India, which requires a proper focus on N nutrition (Fageria and Baligar, 2013; Sairam *et al*. 2024). In finger millet, nitrogen application has been found to increase the growth, dry matter production and yield under dryland and rainfed conditions (Hari Prasanna, 2016). Spacing is another vital crop management practice in finger millet cultivation, exerting multifaceted effects on its growth, development, and overall agronomic performance (Prasanna Kumar, 2019a,b).

The studies on N fertilization indicate that higher grain yields were recorded with the application of N ranging from 0 to 90 kg ha^{-1} (Bekele *et al*. 2016). Spacing is a critical factor in the cultivation of finger millet, influencing various aspects of plant growth, development and yield. The distance between plants and rows significantly affects resource utilization, sunlight exposure, and overall crop performance (Prasanna Kumar, 2019a). Variation in the plant population causes changes due to light intensity, humidity and temperature within canopy. Under wider spacing, plants tend to put forth a vigorous vegetative growth, while closer spacing tend to restrict the same (Charate *et al*. 2018, Gabatshele *et al*. 2014 and Jadhav *et al*. 2015) Optimum population level is the one, which provides the plant with the best environment to express its full capacity under the given conditions (Nagappa *et al*. 2021). Earlier research suggests that optimal spacing is essential for achieving maximum productivity in finger millet cultivation.

As there is insufficiency in research on finger millet in the coastal areas of West Bengal and the crop has nutritional and ecological importance, the present study has been considered for optimization of nitrogen dose and spacing for finger millet cultivation.

MATERIALS AND METHODS

The field experiment was carried out at the Instructional Farm, School of Agriculture and Allied Sciences, The Neotia University Sarisha, Jhinga, South 24 Parganas, West Bengal, during the *Kharif* (rainy) season from July to November 2023. The experimental site is situated at 22.261297° N latitude and 88.198288° E longitude, with an elevation above 7.10 m mean sea level. The soil of the experimental field is a medium-textured new alluvial inceptisol with a loam texture and moderate water holding capacity. The key soil characteristics include sand (58.29%), silt (21.78%), and clay (19.93%). The chemical composition of the soil includes a pH of 7.34 and nutrient levels such as 356 kg ha^{-1} of available N, 26.75 kg ha^{-1} of available P_2O_5, and 360 kg ha^{-1} of available K_2O. The experiment was focused on studying the effect of nitrogen management and spacing on the growth and yield of finger millet. The experiment was designed in a split plot design having four levels of nitrogen, viz., N_0, Control, N_1, 20 kg N ha^{-1}, N_2, 40 kg N ha^{-1} and N_3 60 kg N ha^{-1}as main plot treatments and three spacings: S_1, 15 cm

Table 1: Effect of nitrogen management and spacing on the growth and yield of finger millet

Treatments	Plant height at harvest (cm)	Dry matter accumulation at harvest (g m^{-2})	Ear length (cm)	Number of grain ear^{-1}	Grain weight ear^{-1} (g)	1000 grain weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
				Levels of Nitrogen				
N_0	86.80	1265.24	5.16	1403.89	4.59	3.40	11.11	18.69
N_1	91.37	1325.59	5.51	2228.55	5.84	3.58	13.37	21.29
N_2	92.89	1486.44	6.01	2537.44	6.25	3.69	15.68	22.98
N_3	94.29	1685.11	6.26	2987.00	6.94	3.75	18.59	26.04
S. Em. (±)	0.254	4.704	0.073	49.824	0.053	0.023	0.068	0.088
C.D. (*p=0.05*)	0.880	16.28	0.254	172.41	0.185	0.080	0.235	0.306
C.V.	2.50	2.94	11.51	19.58	8.14	5.78	4.17	3.57
				Spacing				
S_1	89.60	1365.70	5.48	1914.33	5.64	3.55	13.74	21.01
S_2	91.81	1429.16	5.76	2303.08	5.94	3.62	14.58	22.29
S_3	92.60	1526.92	5.96	2650.25	6.13	3.65	15.75	23.44
S. Em. (±)	0.195	2.976	0.058	27.013	0.113	0.016	0.041	0.097
C.D. (*p=0.05*)	0.584	8.922	**NS**	80.984	**NS**	**NS**	0.123	0.290
C.V.	2.56	2.48	—	14.16	—	—	3.37	5.22

N_0: Control; N_1: 20kg Nha^{-1}; N_2: 40kg Nha^{-1}; N_3: 60kg Nha^{-1}; S_1: 15 cm × 10 cm; S_2: 20 × 10 cm; S_3: 25 × 10 cm; NS: Non-significant.

× 10 cm, S_2, 20 cm × 10 cm, S_3 25 cm × 10 cm as sub plot treatments. The variety of finger millet was CFMV 1 (Indravathi). A common basal fertilizer dose of 40 kg P_2O_5, 40 kg K_2Oha^{-1} and varying dose of N were applied during final land preparation. The observations were recorded form 10 randomly selected plants. The data were subjected to statistical analysis using analysis of variance method (Gomez and Gomez, 1984) and the significance of different sources of variations were tested by error mean square using Fisher and Snedecor's F-test at a probability level of 0.05.

RESULTS AND DISCUSSION

Nitrogen levels and spacing significantly influenced the plant height (cm) and dry matter accumulation (g m^{-2}) of finger millet. The highest plant height (94.29 cm) and dry matter accumulation (1685.11 g m^{-2}) were recorded with the application of 60 kg N ha^{-1} (*i.e.* N_3). Among the spacings, 25 cm × 10 cm spacing (S_3) recorded significantly higher plant height (92.60 cm) and dry matter accumulation (1526.92 g m^{-2}) as compared to other treatments. A higher plant height and dry matter accumulation with the application of 60 kg N ha^{-1} and 25 cm × 10 cm spacing was mainly due to efficient nutrient utilization through well-established root system because of sufficient N supply and optimum plant stand. The results confirmed the findings of Sial *et al*. (2024) and Manasa and Umesha (2022).

Different nitrogen levels and spacing influenced most of the yield attributes, namely, ear length, number of grains ear^{-1}, grain weight ear^{-1} and 1000 grain weight significantly. The application of 60 kg N ha^{-1}*i.e.*, N_3 recorded the highest ear length (6.26 cm), number of grains per ear (2987.00) and 1000 grain weight (3.75 g). The results are in conformity with findings of Prasanna Kumar *et al*. (2019b) and Panda *et al*. (2021).

The application of 60 kg N ha^{-1} *i.e.* N_3 also recorded highest grain yield (18.59 q ha^{-1}) and straw yield (26.04 q ha^{-1}) of finger millet. The increase in grain yield per hectare in finger millet with nitrogen application at 60 kg ha^{-1}can be attributed to several factors. Firstly, nitrogen is essential for promoting vigorous vegetative growth, leading to larger and more robust plants capable of producing more grains. Additionally, nitrogen enhances photosynthetic activity, increasing the synthesis of carbohydrates and other essential compounds necessary for grain formation. Moreover, nitrogen plays a crucial role in reproductive processes such as flower initiation, pollen viability, and fertilization, resulting in improved grain set and yield. The results confirmed the findings of Roy *et al.* (2001), Yadav *et al.* (2010) and Maitra *et al*. (2020).

A spacing of 25 cm × 10 cm recorded maximum ear length (5.96 cm), number of grains per ear (2650.25), 1000 grain weight (3.65), grain yield (15.75 q ha^{-1}) and straw yield (23.44 q ha^{-1}) of finger millet as compared to all other treatments. Wider spacing is responsible for higher plant growth and yield by achieving better plant height, increased leaf length, maximum utilization of nutrients and less competition among the plants. A similar type of results were recorded by Prasanna Kumar (2019a,b) and Maitra *et al*. (2001).

CONCLUSION

Results of the study recorded that growth parameters, namely plant height and dry matter accumulation, and the most of the yield attributes recorded their highest values with 60 kg N $ha^{-1}$and a spacing of 25 cm × 10 cm. The reflection of growth parameters and yield attributes were prominently observed in seed and straw yields. Hence, the study concluded that finger millet could be grown in the coastal areas of West Bengal with 60 kg N $ha^{-1}$and a spacing of 25 cm × 10 cm for achieving higher yields.

ACKNOWLEDGEMENTS

The authors are thankful to the staff members of university farm and departmental laboratory for providing incessant facilities for conducting field trial as well as for laboratory analysis.

REFERENCES

Banerjee, P. and Maitra, S. 2020. The role of small millets as functional food to combat malnutrition in developing countries. *Indian J. Nat. Sci.*, **10**(60): 20412-20417.

Bekele, H., Assen, Y. and Tsegaye, A. 2016. Effect of nitrogen fertilization on growth, yield, and yield components of finger millet (*Eleusine coracana* L.) at Assosa Zone, Benishangul Gumuz Regional State, Western Ethiopia. *J. Agric. Crop*, **2(4)**: 40-45.

Brahmachari, K., Sarkar, S., Santra, D.K. and Maitra, S. 2019. Millet for food and nutritional security in drought prone and red laterite region of Eastern India, *Int. J. Plant Soil Sci.*, **26**(6): 1-7.

Charate, R., Manjrekar, M. and Rajurkar, N. 2018. Effect of plant spacing and fertilizer levels on growth, yield and quality of finger millet. *Int. J. of Chemical Studies*, **6**(5): 360-363.

Di Mola, I., Ottaiano, L., Cozzolino, E., Senatore, M., Giordano, M., El-Nakhel, C. and Mori, M. 2019. Plant-based biostimulants influence the agronomical, physiological and qualitative responses of baby rocket leaves under diverse nitrogen conditions. *Plants*, **8**.

Fageria, N.K. and Baligar, V.C. 2003. Methodology for evaluation of lowland rice genotypes for nitrogen use efficiency. *J. Plant Nutr.*, **26**: 1315-33.

Gabatshele, K., Makgoga, R.M. and Seletse, T. 2014. Effects of planting density on the growth and yield of finger millet (*Eleusine coracana* L.) in Botswana. *J. of Appl. Biosci.*, **76**: 6395-6402.

Gomez, K.A. and Gomez, A.A. 1984. Statistical procedures for Agricultural Research (2nd Ed.), An International Rice Research Institute Book. A Willey Inter-Science Publication (John Willey and Sons), New York, pp. 258-259.

Hari Prasanna, M. 2016. Nitrogen and phosphorus management in finger millet under rainfed conditions. *Int. J. Agric. Sci.*, **8**(49): 2106-2109.

Jadhav, S.B., Choudhary, R.P. and Patil, D.R. 2015. Effect of nitrogen levels and spacing on yield and economics of finger millet (*Eleusine coracana* L.). *Agril. Sci. Digest*, **35**(2): 151-153.

Maitra, S., Ghosh D.C., Sounda G., Jana P.K. and Roy D.K. 2020. Productivity, competition and economics of intercropping legumes in finger millet (*Eleusine coracana*) at different fertility levels. *Indian J. Agric. Sci.*, **70**(12): 824-828.

Maitra, S., Ghosh, D.C., Sounda, G. and Jana, P.K. 2001. Performance of intercropping legumes in fingermillet (*Eleusine coracana*) at varying fertility levels. *Indian J. Agron*., **46**(1): 38-44.

Maitra, S., Patro, T.S.S.K., Reddy, A., Hossain, A., Pramanick, B., Brahmachari, K., Krishna Prasad, K., Santosh, D.T., Mandal, M., Shankar, T., Sagar, L., Banerjee, M., Palai, J.B., Praharaj, S. and Sairam, M. 2023b. Brown top millet (*Brachiaria ramosa* L. Stapf; *Panicum ramosum* L.) - The neglected and smart crop in fighting against hunger and malnutrition. *In:* Neglected and Underutilized Crops, Farooq, M. and Siddique, K.H.M., pp. 221 - 245, https://doi.org/10.1016/B978-0-323-90537-4.00012-0.

Maitra, S., Pramanick, B. and Sounda, G. 2020. Performance of finger millet (*Eleusine coracana*) as influenced by different nutrient management practices. *J. Crop Weed*, **16**(3): 207-211.

Maitra, S., Reddy, M. D. and Nanda, S.P. 2020. Nutrient management in finger millet (*Eleusine coracana* L. Gaertn) in India. *Int. J. Agric. Environ. Biotechnol.*, **13**(1): 13-21.

Maitra, S., Sahoo, U., Sairam, M., Gitari, H.I., Rezaei-Chiyaneh, E., Battaglia, M.L. and Hossain, A. 2023. Cultivating sustainability: A comprehensive review on intercropping in a changing climate. *Res. Crop*., **24**(4): 702-715.

Manasa, A. N., and Umesha, C. 2022. Performance of finger millet (*Eleusine coracana* L.) genotypes under different levels of nitrogen. *Int. J. Agric. Sci.*, **14**(1): 45-48.

Mukesh, G., Sairam, M., Sagar Maitra, Dinkar Jagannath Gaikwad, Narasupalli Anuradha, Upasana Sahoo and Subhajit Pal (2024). Performance Evaluation of Different Finger Millet (*Eleusine coracana* L. Gaertn.) Cultivars for Growth, Productivity and Nutrient Quality of Grains Under Hot and Subhumid Region of Odisha. *Int. J. Experim. Res. Rev.*, **39**(spl.): 01-14.

Nagappa, M., Pal, M. and Kaur, J. 2021. Role of planting density and nitrogen in the performance of finger millet (*Eleusine coracana* L.). *Indian J. Agron.*, **66**(2): 205-210.

Panda, P., Maitra, S., Panda, S. K., Shankar, T. and Adhikary, R., Sairam, M. and Gaikwad, Dinkar J. 2021. Influence of nutrient levels on productivity and nutrient uptake by finger millet (*Eleusine coracana* L. Gaertn) varieties. *Crop Res.*, **56**(3-4): 128-134.

Panda, S.K., Panda, P., Pramanick, B., Shankar, T., Praharaj, S., Saren, B.K., Gitari, H.I., Brahmachari, K., Hossain, A. and Maitra, S. 2020. Advantages of cotton based intercropping system: A review. *Int. J. Biores. Sci.*, **7**(2): 51-57.

Panda, S.K., Sairam, M., Sahoo, U., Shankar, T. and Maitra, S. 2022. Growth, productivity and economics of maize as influenced by maize-legume intercropping system. *Farming and Management,* **7**(2): 61-66.

Prasanna Kumar, D., Maitra, S., Shankar, T., 2019b. Growth, yield and quality of finger millet (*Eleusine coracana* L. gaertn) as influenced by crop geometry and age of seedlings. *Int. J. Biores. Sci.*, **6**(2): 75-79

Prasanna Kumar, D., Maitra, S., Shankar, T. and Pushpalatha, G. 2019a. Effect of Crop Geometry and Age of Seedlings on Productivity and Nutrient Uptake of Finger Millet (*Eleusine coracana* L. Gaertn). *Int.J. Agric. Environ. Biotechnol.*, **12**(3): 267-272.

Roy, S., Jha, G.K. and Rao, D.N. 2001. Studies on growth and yield of finger millet under different nitrogen levels. *Indian J. Agron.*, **46**(2): 356-360.

Sagar, L., Singh, S., Sharma, A., Maitra, S., Attri, M., Sahoo, R.K., Ghasil, B.P., Tanmoy Shankar, T., Gaikwad, D.J., Sairam, M., Sahoo, U., Hossain, A. and Roy, S. 2023. Role of soil microbes against abiotic stresses induced oxidative stresses in plants. In: Microbial Symbionts and Plant Health: Trends and Applications for Changing Climate, Rhizosphere Biology, Mathur, P., Kapur, R., Roy, S. (Eds.), pp. 149-177.

Sairam, M., Maitra, S., Sahoo, U., Sagar, L. and Gopala Krishna, T. 2023. Evaluation of precision nutrient tools and nutrient optimization in maize (*Zea mays* L.) for enhancement of growth, productivity and nutrient use efficiency. *Res. Crop.*, **24**(4): 666-677.

Sairam, M., Shankar, T., Maitra, S. and Duvvada, S.K. 2020. Effect of integrated nutrient management on growth, yield, nutrient content and economics of summer rice (*Oryza sativa* L.), *Indian J. Pure Appl. Biosci.*, **8**(3): 421-427.

Sairam, M., Maitra, S., Sain, S., Gaikwad, D.J. and Sagar, L. 2024. Dry Matter Accumulation and Physiological Growth Parameters of Maize as Influenced by Different Nutrient Management Practices. *Agric. Sci. Digest*, **44**(2): 219-225.

Sial, M.A., Talpur, N.A. and Qureshi, M.A. 2024. Influence of nitrogen application on growth and yield of finger millet. *Pakistan J. Agric. Res.*, **27**(1): 12-19.

Tomar, S., Manepalli S. B., Gaikwad, D.J. and Maitra, S. 2021. A review on molecular mechanisms of Wheat (*Triticum aestivum* L.) and rice (*Oryza sativa* L.) against abiotic stresses with special reference to drought and heat. *Int. J. Agric. Environ. Biotechnol.*, **14**(2): 215-222.

Yadav, D.S., Singh, S.S. and Tripathi, S. 2010. Response of finger millet (*Eleusine coracana* L.) to nitrogen and phosphorus fertilization in an eastern Uttar Pradesh condition. *Indian J. Agric. Res.*, **44**(3): 199-203.