Optimizing Nutrient Management for Finger Millet (*Eleusine coracana*) in Lateritic Soils of Odisha: Effects on Growth, Yield, and Economics

Abstract

Finger Millet is a nutritional powerhouse as it contains many essential nutrients including iron, protein, calcium, dietary fibre, and carbohydrates. Since it's a gluten-free cereal, it has received attention for its impressive value in nutrition thus serving as a potential tool in battling malnutrition. It is resistant to extreme weather conditions. Despite its rich nutrient content, recent studies show lesser intake of millets as a whole. Therefore, a field experiment has been conducted at the farmers' field of Bargarh district of Odisha in kharif, 2023 in Lateritic soil under the demonstration programme of Krishi Vigyan Kendra, Bargarh to assess the impact of nutrient management practices on the growth, yield, and economics of finger millet crop at Bargarh district of Odisha. The recommended dose (40:20:20) was applied through Farmer's practice (FP). Recommended practice (RP), application of lime @0.25 LR; lime is applied 15 days before flowering followed by N-P2O5-K2O (30:20:20 kg ha-1). Each treatment was replicated 10 times on randomized block design. Nutrient management practices at applied dose resulted in the increased yield along with the entire yield attributes of the crop. Also, the maximum net return and B:C was noted in RP when compared with FP. Finger millet thresher was proved to be effective as it increased the working capacity than the traditional practices. The cost of threshing was found to be low than the conventional practices for threshing of one quintal of finger millet.

Keywords : *Plant height, yield, economics, nutrient management, finger millet*

Introduction

Finger millet, is an important food crop of the Asia and Africa semi-arid tropics and an integral part of dry-land farming systems. It is named from the form of the seed head, resembling human fingers (Kerr et al., 2014; Pokharia et al., 2014 and Goron et al., 2015). Locally, the crop is referred to as finger millet or marua (India); koddo (Nepal); bulo (Uganda) and kurakkan (Sri Lanka) (National Research Council, 1996). It was domesticated 5000 years ago in the highlands of Ethiopia and Uganda, but reached India some 3000 years ago (National Research Council, 1996 and Dida et al., 2008). Currently, the

crop ranks fourth worldwide in importance among millets after sorghum, pearl millet, and foxtail millet (Gupta et al., 2012). An important characteristic of finger millet is its adaptability to diverse agro-climatic conditions. It is well adapted to high altitudes and grows in the Himalayas at an elevation of up to 2400 m (NRC, 1996). Its adaptability to drought has been proven: it is drought-tolerant (Dass et al., 2013 and Hegde et al., 1986), resistant to diseases, especially many fungal and viral diseases (Kerr et al., 2014), effective in suppressing weed growth (Samarajeewa et al., 2006), and can grow on marginal lands with poor soil fertility. It can be established either by broadcasting the seeds or transplanting the seedlings in rows, where the yield is higher when transplanted in rows as compared to broadcasting (Hegde et al.,1986 and Tenywa et al., 1999). Though finger millet is valued by traditional farmers as a low fertilizer input crop (NRC, 1996) under these conditions, it suffers from low yields (Rurinda et al., 2014; Sial et al., 2024). Most of the soils where finger millet is grown are deficient in macro and micronutrients primarily owing to continuous cropping, bad recycling of crop residues, and low rates of organic matter application which can limit yield potential (Rao et al., 2012). For improvement in productivity, integrated nutrient management is one of the important practices. This calls for balanced use of fertilizers and adoption of INM practices (Hema et al., 2022). INM aims at efficient and judicious use of the major sources of plant nutrients in an integrated approach so as to get maximum economic yield without any deleterious effect on physico-chemical and biological properties of the soil (Arbad et al.,2008). These are the major benefits that yield increased INM: water use efficiency, grain quality, economic return, and sustainability (Wu et al., 2015). Thus, the present study attempts to increase the yield of the finger millet crop by optimum nutrient management practice.

Materials & Methods:

The experiment was conducted in farmers field during *kharif*, 2023 by taking the finger millet crop of variety KMR-630 at village Sodha, Saplahar & Sarkanda of Bargarh district of Odisha under the field demonstration programme of KVK, Bargarh to study the influence of nutrient management practices on yield, growth and economics of Finger millet. The treatments were taken as Farmers' practice (FP) on application of recommended dose (40 :20 :20) only and recommended practice (RP) on application of lime @ 0.25 LR (applied 15 days before flowering) along with N-P_2O_5-K_2O (30-20-20 kg ha^{-1}). Each treatment replicated for 10 times with randomized block design. The soil is sandy loam in texture having pH 6.1. The fertility status of the soil was less in organic carbon (0.41 %), low status of available nitrogen (239 kg ha-

^{1}), less of available phosphorous (11 kg ha^{-1}) and medium in potassium (143 kg ha^{-1}). Crop was fertilized as per respective treatments with lime application. Optimum plant protection measures were adopted and applied insecticide as per need of crops. The observations were taken up on growth (plant height), yield parameters and economics. Harvesting was done on the harvest stage. The yield of both grain and straw was recorded. To carry out this each respondent was tied of the digital heart rate monitor for taking of heart rate during the post-harvest operation. Energy expenditure during work was also calculated from average heart rate (AHR) by using regression equation by Varghese et al., 1994. The Energy Expenditure = 0.159 X HR (beats min^{-1}) – 8.72. The working capacity of this machine over traditional practices was also measured in terms kg/hr.

Results & Discussion

The effect of nutrient management practices significantly increased the plant height at various stages (60 DAS, 90 DAS & at harvest stage) of finger millet. At 60 DAS, the plant height of 36.81 cm and 35.28 cm was recorded in RP and FP respectively, (4.3 per cent increase over FP). Similar trend was observed in plant height particularly 90 DAS and during the harvest. The RP increased the plant height @ 4.3, 3.6 and 4.8 % respectively, at 60 DAS, 90 DAS and at harvest stage over FP. (Table 1).

Table-1 : Influence of nutrient management practices particularly on plant height (cm) at various stages of Finger millet

Treatments	60 DAS	90 DAS	At harvest
FP	35.28	53.19	70.86
RP	36.81	55.12	74.28
SE(d)±	1.08	0.85	0. 48
C.D. at 5 %	1.53	0.24	1.06

More no. of fingers/head, no. of productive tillers and no. of ear head/ plant was observed in RP as compared to FP. The increase was 35, 6.5 and 42 %, respectively (Table 2).

Table-2 : Nutrient management practices effects on yield attributing parameters of Finger millet

Treatments	No. of fingers /head	No. of productive tillers /plant	Ear head/ plant no	1000 of grain weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
FP	6.48	110.21	4.68	3.26	20.9	50.18

RP	10.12	117.83	8.10	3.68	24.7	55.36
SE(d)±	0.16	0.85	0. 09	0.07	0.45	0. 69
C.D. @ 5 %	0.47	1.19	0.62	0.13	0.64	0.83

The 1000 grain weight (g) was 3.68 g and 3.26 g in RP and FP, respectively, which was 11.4 % increase over FP. The grain yield of 24.7 q ha^{-1} and 20.9 q ha^{-1} was (15.4 per cent increase over FP) observed in RP and FP respectively. The increased straw yield of 9.4 percent was observed over FP. The lowest yield was recorded the FP whereas highest was seen in the RP (Table 2).

The economic analysis showed the significant increase in gross cost and gross return in RP as compared to FP. The RP significantly increased the net return and B:C ratio over the FP. The highest net return was seen in RP and lowest was seen in FP.

Table-3 : Nutrient management practices influence on economics of Finger millet

Treatments	Gross Cost (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio
FP	25600	80381	54781	3.13
RP	28800	94996	66196	3.29

The performance of Finger millet thresher with its impact on ergonomical parameters has been represented in the Table-4

The threshing & cleaning of finger millet after harvesting is considered as a tedious work. So KVK, Bargarh has promoted the use of OUAT developed finger millet thresher for processing of finger millet seeds to overcome the problem. This thresher was operated with 1 hp motor with threshing efficiency of 93.5% & cleaning efficiency of 92.4%. The performance of Finger millet thresher over manual method along with its impact on agronomical parameter was studied for its wider acceptability.

Table-4: Performance of Finger millet thresher with its impact on agronomical parameters

	Working capacity (kg hr^{-1})	Rate of Working Heart (beats min^{-1})	Rate on Energy Expenditure (KJ min^{-1})	Cost of threshing (Rs. Q^{-1})
Threshing by manual beating	**7.1**	**123**	10.83	660
Power operated manual thresher	46.4	94	6.22	240

SE(d)+	0.25	0.96	0.15	
C. D at 5%	0.81	3.09	0..49	

It was clearly depicted that finger millet thresher had proved efficient as it increased the working capacity (46.4 kg hr^{-1}) than to the traditional practices (**7.1** kg hr^{-1}). The percentage change in average working heart rate was decreased to 23.5% with the use of finger millet thresher while the average energy expenditure was reduced to 42.5 %. The variation in heart rate and energy expenditure for the thresher may be attributed to the design &configurations of the thresher. Similar agronomical observations were also made by Mohanty *et al*., 2009 & Khadatkar et al., 2018 for thresher. The cost of threshing was found to be Rs. 420/- less than traditional practices for threshing of one quintal of finger millet. Hence this finger millet thresher can be effectively used for increasing the working capacity along with reducing the time & degree of drudgery to a great extent than traditional practices.

Conclusion

The nutrient management practices application increased all the yield attributing parameters of finger millet i.e. the plant height at different growth stages, no of fingers/head, no of productive tillers/head, no. of ear head/plant as compared to the farmers' practice. The 1000 of grain weight and highest showing of yield both grain and straw was recorded in RP. The highest showing of net return and ratio of B:C was observed in RP. Finger millet thresher had proved efficient as it increases the working capacity than the traditional practices. The cost of threshing was found to be Rs. 420/- less than traditional practices for threshing of one quintal of finger millet.

References

Arbad, B.K., Ismail, S., Shinde, D.N. and Pardeshi, R.G. 2008. Effect of integrated nutrient management practices on soil properties and yield in sweet sorghum in Vertisols. Annals of Asian Journal of Soil Science 3: 329-332.

- Bibliography....?viMillets Workshop, Bangalore, India, 29 October–2 November pp. 209-236.
- Dass, A., Sudhishri, S. and Lenka, N.K. 2013.Integrated nutrient management to improve finger millet productivity and soil conditions in hilly region of Eastern India. Journal of Crop Improvement 27: 528-546.

- Dida, M.M., Wanyera, N., Dunn, M.L.H., Bennetzen, J.L. and Devos, K.M.2008. Population structure and diversity in finger millet (Eleusine coracana) germplasm. Tropical Plant Biology 1: 131-141.
- Goron, T.L. and Raizada, M.N. 2015. Genetic diversity and genomic resources available for the small millet crops to accelerate a new green revolution. Frontier Plant Science 6: 157.
- Gupta, N., Gupta, A.K., Gaur, V.S. and Kumar, A. 2012. Relationship of nitrogen useefficiency with the activities of enzymes involved in nitrogen uptake and assimilation of finger millet genotypes grown under different nitrogen inputs. Science World Journal 1: 10.
- Hegde, B.R. and Gowda, L. 1986. Cropping systems and production technology for smallmillets in India. In Proceedings of the First International Small
- Kerr, R.B. 2014. Lost and found crops: Agro biodiversity, indigenous knowledge, and a feminist political ecology of sorghum and finger millet in Northern Malawi. Annals of the Association of American Geographers104: 577-593.
- Khadatkar, A., Potdar. R. , Narwariya, B., Wakudkar, H. & Dubey, U (2018).An ergonomic evaluation of pedal operated paddy threshers for farm women. Indian journal of Agricultural sciences 88 (2):280-283.
- Mohanty,S. K., Behera B. K. & Satapathy,G.C. (2009). Ergonomical Assesment of pedal paddy threshers with farm women. Journal of Agricultural Engineering 46 (3): 1-8.
- NRC (National Research Council).1996. Lost Crops of Africa, 1st ed.; National Academy Press: Washington DC, USA.
- Pokharia, A.K., Kharakwal, J.S. and Srivastava, A. 2014. Archaeo-botanical evidence of millets in the Indian sub-continent with some observations on their role in the Indus civilization. Journal of Archaeological Sciences 42: 442-455.
- Rao, B.K.R.; Krishnappa, K.; Srinivasarao, C.; Wani, S.P.; Sahrawat, K.L.; Pardhasaradhi, G.2012. Alleviation of multinutrient deficiency for productivity enhancement of rain-fed soybean and finger millet in the semi-arid region of India. Communications in Soil Science and PlantAnalysis43: 1427–1435.
- Rurinda, J., Mapfumo, P., van Wijk, M.T., Mtambanengwe, F., Rufino, M.C., Chikowo, R.and Giller, K.E.2014. Comparative assessment of maize, finger millet and sorghum for household food security in the face of increasing climatic risk. European Journal of Agronomy 55: 29-41.
- Samarajeewa, K.B.D., Horiuchi, T. and Oba, S.2006. Finger millet (Eleucine corocana L.Gaertn.) as a cover crop on weed control, growth and yield of soybean under different tillage systems. SoilTillage Research 90: 93-99.
- Tenywa, J.S., Nyende, P., Kidoido, M., Kasenge, V., Oryokot, J. and Mbowa, S. 1999.Prospects and constraints of finger millet production in Eastern Uganda. African Crop Science Journal7: 569-583.
- Wu, W. and Ma, B. 2015. Integrated nutrient management (INM) for sustaining crop productivity and reducing environmental impact: A review. Science Total Environmentpp.512-513.

- Sial , Parshuram, Himangshu Das, Lalatendu Nayak, Biman Ranjan Behera, and Debabrata Panigrahi. 2024. “Effect of Nitrogen on the Performance of Finger Millet in Eastern Ghat High Land Zone of Odisha, India”. Journal of Experimental Agriculture International 46 (3):79-85. https://doi.org/10.9734/jeai/2024/v46i32327.
- Hema, Parsha, . Elangovan, Sushil Pandey, and Burri Naveen Yadav. 2022. “Study of Genetic Variability and Character Association in Elite Lines of Finger Millet [Eleusine Coracana (L.)] Suitable for Eastern Plain Zone of Uttar Pradesh”. International Journal of Environment and Climate Change 12 (12):438-47. https://doi.org/10.9734/ijecc/2022/v12i121480.