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Influence of crop geometry and nutrient management practices on productivity of finger millet: A review

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Abstract
Millets are small-grained group of cereals grown around the world both for food and fodder. Millets are well adapted and cultivated under harsh environment of arid and semi-arid region and known as "crops of the future". They are excellent sources of carbohydrates, proteins, fatty acids, minerals, vitamins, dietary fiber and polyphenols. Finger millet is one of the important millet crops of the country, having the highest productivity among millets and provides staple food in relatively short period mostly in countries of Africa and India. Despite, of the afore mentioned importance of finger millet, its productivity is reduced. Major constraints determining its yield level are low soil fertility, faulty methods of cultivation and inadequate nutrient management. Among the various agro-techniques, crop geometry and nutrient management are the supreme important agronomic practices for exploring the higher yield of crops. The objective of this paper is to comprehensively review the literature concerning response of finger millet to various crop geometries and nutrient management options.

Keywords: Crop geometry, nutrient management, productivity and finger millet

Introduction
Millets are one of the promising foods for fighting hunger and malnutrition and potential for ensuring food and nutritional security. In spite of their admirable qualities and importance in food and nutrition security these crops are neglected. India is the largest producer of various kinds of millets and out of the total minor millets produced, the production of finger millet accounts for about 85% in India (Divya, 2011) [6]. Finger millet grains are known as "famine reserves" due to their long storability. Although finger millet plays a very important role in the diet of rural people, it has become a less important cereal crop due to high demand for the major cereals like rice and maize. Finger millet is highly valued by traditional farmers as a low fertilizer input crop, however, it suffers from lower yields as they are mostly cultivated in resource poor soils deficient in macro and micronutrients, mainly due to continuous cropping, low use of mineral fertilizer and low rates of organic matter application and faulty methods of cultivation *etc*,. The modern agronomic approaches like suitable planting and fertilizer application were imperative in boosting the yields. Crop geometry is a very important factor to achieve higher production by better utilization of moisture and nutrients from the soil and above ground by harvesting maximum possible solar radiation and in turn better photosynthesis (Uphoff *et al*. 2011) [28]. The unbalanced use of chemical fertilizers in intensive cropping system causes deterioration of soil health, multi-nutrient deficiencies, low productivity and environmental hazards. In order to explore better yields optimizing crop geometry and nutrient management practices were important.

Influence of crop geometry on growth and yield of finger millet
Shinggu and Gani (2012) [25] in their experiment at the experimental farm of the Institute for Agricultural Research (IAR), Ahmadu Bello University, Zaria observed that planting finger millet at row spacing of 10 and 15 cm gave heavier panicle weight (2643 and 2184 g) and grain yield (1346 and 1218 kg ha^{-1}) than when planted at 20 cm.
Yayeh and Fekremariam (2014) [30] noted that the highest grain yield of finger millet was recorded at 30 cm row spacing (3235.98 kg ha^{-1}) while the lowest was recorded at 20 cm row spacing (2862.63 kg ha^{-1}).
Yoseph (2014) [31] found that the maximum (2.25 t ha^{-1}) and the minimum (1.45 t ha^{-1}) grain yield were recorded from the inter row spacing of 45 cm and 75 cm, respectively and the yield obtained from the inter row spacing of 45 cm was higher by 35.4% compared to the inter row spacing of 75 cm.

Anitha (2015) [2] carried out an experiment during *rabi* on sandy clay loam soil of S.V. Agricultural college, Tirupati and reported that among different crop geometry practices tried in the experiment, transplanting at 15×10 cm resulted in the highest plant population, tallest plants, maximum LAI, highest dry matter production and total number of tillers m^{-2} and it was at par with transplanting at 20×20 cm spacing, while, the plant population and LAI were at their lowest with transplanting at 30× 30 cm.

Hebbal *et al*. (2018) [15] reported that significantly higher grain and straw yield of finger millet (2737 and 4849 kg ha^{-1}, respectively) was found with the recommended (30×10 cm) spacing due to higher plant population (3,33,333 ha^{-1}) per unit area followed by 30×30 cm spacing (2607 and 4667 kg ha^{-1}, respectively) and significantly lower grain and straw yield was found with 45×30 cm spacing (2419 and 4477 kg ha^{-1}, respectively).

Results from the experiment conducted by Kumar (2018) [12] revealed that transplanting at 22.5 cm x 22.5 cm spacing recorded significantly maximum value of growth parameters *viz*., no. of tillers m^{-2} (115.23), leaf area index (3.50), CGR (15.63 g m^{-2} day^{-1}) at 90 DAS and plant height (110.2 cm.) and dry matter accumulation (1018.45 g m^{-2}) at maturity and yield attributes namely, maximum effective tillers m^{-2} (110.72), weight of ear (9.36 g), ear length (6.35 cm), no. of grain per ear (2623) and significantly the highest grain (3205 kg ha^{-1}) and straw (6458 kg ha^{-1}) yield.

Kumar *et al*. (2019) [13] reported that yield attributing traits were significantly influenced by the crop geometry. Yield attributing characters *viz*., effective tillers m^{-2}, number of grain ear $head^{-1}$, number of fingers ear $head^{-1}$, test weight and length of the fingers were recorded the best with transplanting of seedlings at 25×25 cm and it significantly enhanced the values of above characters.

Influence of nutrient management practices on growth traits of finger millet

Giribabu (2006) [8] reported that the nutrient management system that received 100 per cent of the recommended NPK through fertilizers and 3 t ha^{-1} of FYM, significantly increased plant height, tiller number and dry matter production over the rest of nutrient management systems on sandy soils of Agricultural College Farm, Bapatla.

Goud (2012) [12] carried out an experiment during *kharif* at Gandhi Krishi Vignana Kendra (GKVK), Bengaluru on sandy clay loam soils and recorded higher growth parameters *viz*., plant height (88.19 cm), number of tillers $hill^{-1}$ (6.47), leaf area (1430.06 cm^2), total dry matter accumulation $hill^{-1}$ (83.45 g) and chlorophyll content (15.05) with application of 150 per cent customized fertilizer dose compared to other treatments.

Saunshi (2012) [24] reported that application of FYM 10 t + BDLM enriched with poultry manure & rock phosphate equivalent to 60 kg N ha^{-1} produced significantly superior growth parameters *viz*., tall plants (141.1 cm), leaf area per plant (1886.3 cm^2), leaf area index (6.29) and total dry matter accumulation (43.08 g) and the lowest plants height, leaf area per plant, leaf area index, total dry matter accumulation (109.1 cm, 1294.8 cm^2, 4.32 & 25.74 g, respectively) were found in recommended practice (FYM 7.5 t + 50:40:25 $N:P_2O_5:K_2O$ kg ha^{-1}).

Nevse *et al*. (2013) [18] in their experiment at College of Agriculture, Dapoli recorded higher growth parameters of finger millet *viz*., plant height, number of functional leaves $hill^{-1}$, number of tillers $hill^{-1}$ and dry matter accumulation $hill^{-1}$ with application of 150% FYM and RDF.

Ashoka (2016) [4] recorded higher growth parameters *viz*., plant height (78.9 cm) and no. of productive tillers (20.3) with combined application of organic matter + 100 % RDF than the absolute control during *kharif* season of 2015 at the Dryland Agriculture Project, GKVK, Bangalore on sandy clay loam soils.

Gani *et al*. (2016) [7] recorded higher plant height, leaf area index and relative growth rate with incorporation of poultry manure at 5 t ha^{-1} and NPK fertilizer than the unfertilized plot.

Raman and Krishnamoorthy (2016) [20] recorded the highest growth attributes *i.e*., plant height, DMP and LAI with vermicompost to substitute 50% N + 50% fertilizer N + P and K + bio fertilizer (Azospirillum + Phosphobacteria as soil application) and the minimum growth attributes observed under vermicompost to substitute 100% N + P and K.

The experiment conducted by Goudar *et al*. (2017) [10] resulted in significantly higher plant height (81.11 cm), LAI (2.61), higher number of tillers $hill^{-1}$ (4.96) and SPAD (27.93) with application of organic matter + 100% recommended dose of fertilizer, due to supply of the required quantity of nutrients as well as improvement in the soil properties. Significantly lower growth parameters were recorded in absolute control (43.86 cm, 0.58, 2.63 and 21.67 respectively).

Mahapatra (2017) [17] recorded the tallest plants, highest leaf area index, drymatter production and total no. of tillers m^{-2} at all stages of observation with 100 % recommended dose of nutrients through fertilizers, which was significantly superior to the different organic sources tried.

Significantly higher growth parameters *viz.* plant height (68.7 cm), number of tillers $hill^{-1}$ (10.8), leaf area (1934 cm^2) and total dry matter production (39.74 g $hill^{-1}$) were recorded due to the application of FYM 7.5 t ha^{-1} + RDF (50:40:37.5 kg N, P_2O_5 and K_2O ha^{-1}) and significantly lower plant height (66.2 cm), number of tillers $hill^{-1}$ (9.7), leaf area (1811.76 cm^2) and total dry matter production (37.96 g $hill^{-1}$) were observed with FYM on N equivalent basis due to lower availability of nutrients (Hebbal *et al*., 2018) [15].

A field trial conducted at Centurion University, Paralakhemundi during summer on sandy loam soils revealed that the plant height of finger millet was highest at 90 kg N ha^{-1} and was comparable with that of 60 kg N ha^{-1} and significantly superior over 30 kg N ha^{-1} (Vamshi krishna *et al*., 2019) [29].

Influence of nutrient management practices on yield and yield attributing traits of finger millet

Basavaraju and Rao (1997) [5] observed increased efficiency of chemical fertilizers in combination with FYM and obtained higher grain and straw yield with application of 50% N through FYM + 50 % NPK through fertilizers.

Jagathjothi *et al*. (2008) [16] in their experiment conducted on clay loam soils of Coimbatore reported higher yield attributes *viz*., productive tillers m^{-2} and finger length with integration of organics and inorganics compared to control.

Govindappa *et al*. (2009) [11] conducted a field trail under rainfed condition on red sandy loam soils of Regional Research Station, GKVK Campus, Bangalore and noted that application of 100% RDF+ FYM @ 7.5 t ha^{-1} produced significantly higher grain yield (3660 kg ha^{-1}) and straw yield (6610 kg ha^{-1}) over rest of the treatments.

Ahiwale *et al*. (2011) [1] observed that FYM @ 5 t ha^{-1} plus 75 per cent RDF plus biofertilizers (integration of all sources of nutrients) was effective in improving the growth and ultimately yield parameters of finger millet at Dapoli.

Arulmozhiselvan *et al*. (2015) [3] reported superiority of integrated application of 100% NPK + FYM in increasing the grain (3125 kg ha^{-1}) and straw yield (5123 kg ha^{-1}) over control due to effective utilization of applied nutrients which increased sink capacity and nutrient uptake by the crop.

Tsado *et al*. (2016) [26] reported that the application of recommended dose of inorganic fertilizer (100 kg N, 50 kg P_2O_5 and 50 kg K_2O ha^{-1}) produced the longest fingers (15.3 cm), the highest number of fingers (12.0), seeds per head (4855) and grain yield (4530.7 kg ha^{-1}) and the control treatment recorded the lowest yield attributes and yield of finger millet.

Sandhya rani *et al*. (2017) [22] registered significantly higher grain and straw yields with application of 200% RDN + 100% RDP + 100% RDK + 25% RDZn + 25% RDS + 25% RDB integrated with FYM @ 5t ha^{-1} (37.35 q ha^{-1} and 88.5 q ha^{-1}).

Ullasa *et al*. (2017) [27] reported that among the different organic manure treatments recommended FYM @ 7.5 tonnes ha^{-1} + 100% N equivalent vermicompost and recommended FYM @ 7.5 tonnes ha^{-1} treatments proved statistically at par and recorded significantly higher productive tillers (4.48 and 4.31 $hill^{-1}$), higher number of fingers per head (7.06 and 6.96), lengthier fingers (9.38 and 9.11 cm) and finally higher yield per plant (14.12 and 12.73 g $plant^{-1}$) as compared to rest of the treatments.

Hatti *et al*. (2018) [14] conducted an experiment at AICRP on Dry Land Agriculture Project, University of Agricultural Sciences, GKVK, Bengaluru and observed that application of 100% recommended NPK + 7.5 t FYM ha^{-1} produced significantly higher grain and straw yield of finger millet (3.03 and 4.69 t ha^{-1}, respectively) which attributed to better release of nutrients.

Roy *et al*. (2018) [21] noted maximum grain yield (3773 kg ha^{-1}) with combination of organic, inorganic and biofertilizers *i.e*., application of FYM (10 t ha^{-1}) + Biofertilizer + $ZnSO_4$ (12.5 kg ha^{-1}) + Borax (5 kg ha^{-1}) + 75% RDF.

Saraswathi *et al*. (2018) [23] reported that the grain and straw yield of ragi crop varied significantly due to application of nutrient based on different approach and the highest grain and straw yield (3238 kg ha^{-1} and 8926 kg ha^{-1}) were recorded with the application of STCR based NPK and compost @ 10 t ha^{-1} which differed significantly over control (2385.70 kg ha^{-1} and 6616.00 kg ha^{-1}, respectively).

Prashantha *et al*. (2019) [19] registered significantly highest number of ear heads (5.14), ear head length (8.17 cm), 1000 grain weight (3.39 g), grain yield (43.67 q ha^{-1}) and straw yield of finger millet (58.88 q ha^{-1}) with application of RDF + FYM + $ZnSO_4$ @ 15 kg ha^{-1} + Borax @ 12.5 kg ha^{-1} as compared to absolute control (2.18, 5.95 cm, 2.24 g, 17.96 q ha-1 and 27.23 q ha^{-1}, respectively).

From the results of various experiments on effect of crop geometry and nutrient management practices on growth and yield of finger millet has been shown that crop geometry and nutrient management has significant impact and transplanting at an optimum spacing without compromising the population and integrated management of nutrients improves the growth and yield of the crop due to higher availability of nutrients, besides improving soil properties.

References

1. Ahiwale PH, Chavan LS, Jagtap DN. Effect of establishment methods and nutrient management on yield attributes and yield of finger millet (*Eleusine coracana* G.). Advance Research Journal of Crop Improvement. 2011; 2(2):247-250.
2. Anitha D. Finger millet [*Eleusine coracana* (L.) Gaertn] productivity as influenced by crop geometry and age of seedlings. *M*.Sc. (Agri.) Thesis. Acharya N.G. Ranga Agricultural University, Hyderabad, 2015.
3. Arulmozhiselvan K, Sathya S, Elayarajan M, Malarkodi M. Soil fertility changes and crop productivity of finger millet under continuous fertilization and manuring in finger millet-maize cropping sequence. Research in Environment and Life Sciences. 2015; 8(4):751-756.
4. Ashoka HK. Soil carbon and nitrogen dynamics as influenced by long term use of different sources of nutrients in finger millet based cropping system under *rainfed* condition of eastern dry zone of Karnataka. *M. Sc. (Agri.) Thesis*. University of Agricultural Sciences, Bangalore, 2016.
5. Basavaraju TB, Rao MRG. Integrated nutrient management in finger millet under rainfed conditions. Karnataka Journal of Agricultural Sciences. 1997; 10(3):855-856.
6. Divya GM. Growth and instability analysis of finger millet crop in Karnataka. M. Sc. (Agri.) thesis. University of Agricultural Sciences, Bengaluru, India, 2011.
7. Gani M, Mahadi MA, Dadari SA, Babaji BA, Shinggu CP. Effect of seed rate, sowing method and poultry manure on the performance of finger millet (*Eleusine coracana* L. Gaertn.) in Samaru northern Guinea Savanna, Nigeria. Equity Journal of Science and Technology. 2016; 4(1):51-56.
8. Giri Babu B. Productivity and quality of finger millet [*Eleusine coracana* (L.) Gaertn.] Cultivars as affected by nutrient management system. *M.Sc (Agri) Thesis*. Acharya N.G. Ranga Agric. Univ., Hyderabad, (India), 2006.
9. Goud BR. Effect of customized fertilizers on the productivity of finger millet (*Eleusine coracana* (L.) Gaertn.). M. Sc. (Agri.) thesis. University of Agricultural Sciences, GKVK, Bangalore, 2012.
10. Goudar PK, Ramachandrappa BK, Thimmegowda MN, Sahoo S. Influence of rotation, use of organic and inorganic sources of nutrients on growth, yield and quality of *Eleusine coracana* (L.) Gaertn. Environment & Ecology. 2017; 35(3):2306-2311.
11. Govindappa M, Vishwanath AP, Harsha KN, Thimmegowda P, Jnanesh AC. Response of finger millet (*Eluesine coracana*. L.) to organic and inorganic sources of nutrients under rainfed condition. Journal of Crop and Weed. 2009; 5(1):291-293.
12. Kumar C. Performance of finger millet (*Eleusine coracana* L. Gaertn.) under different crop establishment methods. M. Sc. (Ag.) thesis. Birsa Agricultural University Ranchi, Jharkhand, 2018.
13. Kumar PD, Sagar Maitra, Tanmoy Shankar, Pushpalatha Ganesh. Effect of crop geometry and age of seedlings on productivity and nutrient uptake of finger millet (*Eleusine coracana* L. Gaertn). International Journal of Agriculture, Environment and Biotechnology. 2019; 12(3):267-272.
14. Hatti V, Ramachandrappa BK, Mudalagiriyappa, Sathish A, Thimmegowda MN. Soil properties and productivity of *rainfed* finger millet under conservation tillage and nutrient management in Eastern dry zone of Karnataka. Journal of Environmental Biology. 2018; 39(5):612-624.
15. Hebbal N, Ramachandrappa BK, Mudalairiyappa, Thimmegouda MN. Yield and economics of finger millet with establishment methods under different planting geometry and nutrient source. Indian Journal of Dryland

Agriculture and Research & Development. 2018; 33(1):54-58.
16. Jagathjothi N, Ramamoorthy K, Kokilavani S. Effect of FYM with and without enrichment on soil microbial population, soil fertility, yield and economics. Research Journal of Agriculture & Biological Sciences. 2008; 4(6):647-650.
17. Mahapatra SS. Nutrient management through organics for sustained productivity of finger millet. M. Sc. Ag. thesis, submitted to ANGRAU, Guntur, 2017.
18. Nevse GP, Chavan LS, Jagtap DN. Performance of finger millet (*Eleusine coracana* [L.] Gaertn) to age of Seedlings, FYM and fertilizer levels. Journal of Indian Society of Coastal agricultural Research. 2013; 31(2):64-70.
19. Prashantha GM, Prakash SS, Umesha S, Chikkaramappa T, Subbarayappa CT, Ramamurthy V. Direct and residual effect of zinc and boron on yield and yield attributes of finger millet – groundnut cropping system. International Journal of Pure and Applied Biosciences. 2019; 7(1):124-134.
20. Raman R, Krishnamoorthy R. Response of INM on finger millet (*Eleusine coracana* (L.) Gaertn). International Journal of Agronomy and Crop Science. 2016; 1(2):9-12.
21. Roy AK, Ali N, Lakra RK, Alam P, Mahapatra P, Narayan R. Effect of integrated nutrient management practices on nutrient uptake, yield of finger millet (*Eleusine coracana* L. Gaertn.) and post-harvest nutrient availability under rainfed condition of Jharkhand. International Journal of Current Microbiology and Applied Sciences. 2018; 7(8):339-347.
22. Sandhya Rani Y, Triveni U, Patro TSSK, Divya M, Anuradha N. Revisiting of fertilizer doses in finger millet [*Eleusine coracana* (L.) Garten.] through targeted yield and soil test crop response (STCR) approach. International Journal of Current Microbiology and Applied Sciences. 2017; 6(7):2211-2221.
23. Saraswathi Y, Vishawanath Shetty, Dinesh Kumar M. Effect of NPK application through different approaches on yield and major nutrient uptake by finger millet (*Eleusine coracana* L.) under rainfed conditions. Journal of Pharmacognosy and Phytochemistry. 2018; 7(3):3661-3665.
24. Saunshi S. Effect of enriched bio-digester liquid manure on growth and yield of organic finger millet [*Eleusine coracana* (L.) Gaertn.] M. Sc. (Agri.) thesis. University of Agricultural Sciences, Bangalore, 2012.
25. Shinggu CP, Gani M. Effects of planting methods, sowing dates and spacing on weed and the productivity of finger millet (*Eleusine corocana* L. Gaertn) in the Northern Guinea Savanna of Nigeria. Global Journal of Bioscience and Biotechnology. 2012; 1(2):160-162.
26. Tsado EK, Jatau DB, Daniya E. Performance of finger millet (*Eleusine corocana* L. Gaertn) as influenced by nutrient sources in the Southern and Northern Guinea Savanna, Nigeria. Direct Research Journal of Agriculture and Food Science. 2016; 4(7):182-192.
27. Ullasa MY, Pradeep S, Shrikantha CD, Sridhara S, Ganapathi. Effect of different organic nutrient management practices on growth, yield and economics of finger millet, *Eleusine coracana* (L) Gaertn. International Journal of Farm Sciences. 2017; 7(2):10-14.
28. Uphoff N, Marguerite T, Devi J, Behera D, Verma AK, Pandian BJ. National Colloquium on System of Crop Intensification (SCI), 2011. In: http://sri.ciifad.cornell.edu/aboutsri/othercrops/index.html.
29. Vamshi Krishna K, Deepthi CH, Devender Reddy M, Raju PS, Arunabha Pal. Effect of nitrogen and phosphorus levels on growth and yield of finger millet *[Eleusine coracana* (L.)] during summer. Indian Journal of Agricultural Research. 2019, 1-5.
30. Yayeh B, Fekremariam A. Determination of Seed Rate and Inter Row Spacing for Finger Millet Production (*Eleusine Coracana* Gaertn.) in North Western Ethiopia. International Journal of Research & Review. 2014; 1(4):1-7.
31. Yoseph T. Determination of inter row spacing and seed rate on productivity of finger millet [*Eleusine Coracana* (L.) Gaertn.], at Jinka, Southern Ethiopia. International Journal of Research in Agricultural Sciences. 2014; 1(3):172-176.