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Influence of different spacing and nutrient sources on yield and economic of *Zaid* finger millet (*Eleusine coracana* (L.) Gaertn) under eastern UP condition

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Abstract
A field experiment was conducted during *Zaid* season 2020 at Crop Research Farm (CRF), Department of Agronomy, SHUATS, Prayagraj (UP) on sandy loam soil to investigate the influence of different spacing and nutrient sources on yield and economic of *Zaid* finger millet (*Eleusine coracana* (L.) Gaertn) under eastern UP condition. The treatments consisted of spacing *viz*., 20 cm x 10 cm, 30 cm x 10 cm and 40 cm x 10 cm and nutrient sources *viz*., 100% RDN, 100% N through vermicompost and 50% RDN + 50% N through vermicompost whose effect is observed on finger millet (var. Godra-OT). The experiment was laid out in randomized block design with nine treatments replicated thrice. Study revealed that spacing of 20 cm x 10 cm + 50% RDN + 50% N through vermicompost was recorded significantly higher grain yield (2.74 t/ha) and biological yield (7.41 t/ha) as compared to all the treatment combinations. The economic analysis clearly indicates that higher B:C ratio (1.90) recorded with treatment of spacing 20 cm x 10 cm + 50% RDN + 50% N through vermicompost as compared to all treatment combinations.

Keywords: finger millet, spacing, recommended dose of nitrogen, vermicompost, yield, economics

Introduction
In India, finger millet is cultivated in an area of 1.27 million ha with a production of 2.61 million tonnes and an average productivity of 1489 kg/ha. (FAI, 2018) ragi (finger millet) alone occupies 20.5% out of total area occupied by small millets. Finger millet is good for prevention of premature aging. It has been growing for time immemorial as a dual-purpose crop where crop production and animal husbandry go hand in hand. In finger millet, health benefits epidemiological studies indicated that regular consumption of whole grain and its products can protect against the risk of cardio-vascular diseases, type II diabetes, obesity, gastro-intestinal cancers and range of other disorders (Mckeown, 2002) [5]. The grain content 9.2% proteins, 1.29% fats, 76.32% carbohydrates, 2.2% mineral, 3.90% ash, 0.33% calcium. The demand of finger millet is in increasing trend due to its nutritional value besides it is also used as a staple food grains in some parts of India. Straw makes valuable fodder for both drought and milking animals. Grain may also be malted and a flour of the malted grain can be used as cakes or porridge and a nourishing food for infants and physically weak people. Finger millet is considered whole food for diabetes. Crop geometry depends on various factors such as plant type, season, soil fertility levels and age of seedlings. The ideal crop geometry has to be adopted for getting optimum plant stand in the field which results in higher yield. In finger millet the optimum plant density of plant population per unit area under appropriate spacing to obtain maximum yield. The productivity of finger millet can be increased by applying judicious combination of organic and inorganic fertilizers which helps to improve the soil health as well as the productivity of finger millet (Ramamurthy *et al*., 1993). Finger millet is normally grown on poor, marginal soils with imbalanced nutrient applications. Among various nutrients nitrogen is an inevitable nutrient for any crop. Nitrogen (N) as an element has been identified to be of critical importance to high yield of finger millet during vegetative development, flowering and seed set (Korir *et al*., 2018) [4]. Combined application of nitrogen through organic manures and fertilizers generally produces higher crop yield than sole

application. Vermicompost has been recognized as a low cost and environmentally sound process for treatment of many organic wastes. Vermicompost prepare from animal waste sources, usually contained more mineral elements than commercial plant growth media (Edwards and Burrows, 2010) [3]. In the vermicompost production, the complex organic residues are biodegraded by symbiotic association between earthworms and microbes.

Material and Methods

A field experiment was carried out to study the "Influence of Different Spacing and Nutrient Sources on Yield and Economic of *Zaid* Finger Millet (*Eleusine coracana* L. Gaertn) under Eastern UP condition" during *Zaid* season 2020 at Crop Research Farm (CRF) SHUATS, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh. The Crop Research Farm is situated at 25.75^0 N latitude, 87.19^0 E longitude and at an altitude of 98m above mean sea level. The soil of the experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.4), low in organic carbon (0.48%), medium in available N (278.93 Kg/ha), available P (19.03 Kg/ha) and available K (238.1 Kg/ha). The field trial was laid out in a randomized block design with consisted of nine treatments replicated thrice *viz*., T_1: 20 cm x 10 cm + 100% RDN, T_2: 20 cm x 10 cm + 100% N through vermicompost, T_3: 20 cm x 10 cm + 50% RDN + 50% N through vermicompost, T_4: 30 cm x 10 cm + 100% RDN, T_5: 30 cm x 10 cm + 100% N through vermicompost, T_6: 30 cm x 10 cm + 50% RDN + 50% N through vermicompost, T_7: 40 cm x 10 cm + 100% RDN, T_8: 40 cm x 10 cm + 100% N through vermicompost and T_9: 40 cm x 10 cm +50% RDN + 50% N through vermicompost. Finger millet variety "Godra-OT" (Farmer variety in Orissa) was used during *Zaid* season 2020. Vermicompost was applied on N -equivalent basis. All nutrients were applied through soil as urea, single super phosphate (SSP) and muriate of potash (MOP). Full dose of P, K and vermicompost was applied basal for respective plots, half dose of N (as urea) was applied basal and the remaining at active tillering stage. The growth parameters were recorded at periodical intervals of 20, 40, 60, 80 DAS and at harvest stage from the randomly selected five plants in each treatment. Statistically analysis was done and mean compared at 5% probability level for significant results.

Result and Discussion

Grain Yield (t/ha), Biological Yield (t/ha) and Harvest Index (%)

Data pertaining to grain yield (t/ha), biological yield (t/ha) and harvest index (HI%) is presented in Table 1. The treatment with spacing of 20 cm x 10 cm + 50% RDN + 50% N through vermicompost were recorded maximum grain yield (2.74 t/ha) and biological yield (7.41 t/ha) which was significantly superior over all the treatments. However, in case of grain yield and biological yield treatment with spacing of 20 cm x 10 cm + 100% RDN and spacing of 30 cm x 10 cm + 50% RDN + 50% N through vermicompost were statistically on par with treatment of spacing 20 cm x 10 cm + 50% RDN + 50% N through vermicompost. Harvest index (%) shows non – significant result among different treatments but it found maximum (37.03%) under more biomass producing treatment 20 cm x 10 cm + 50% RDN + 50% N through vermicompost. Lower grain yield was recorded under wider spacing because total number of plants per unit area was far lesser than with closer planting. Optimum planting pattern is the prerequisite for proper utilization of growth resources and ultimately to exploit the potential productivity of any crop. This is in agreement with the findings of Rafey and Srivastava, (1998) [7]. A wider spacing 30 cm x 10 cm and 40 cm x 10 cm is significantly lesser dry weight compared to the closer spacing 20 cm x 10 cm. Therefore, more plant material due to higher plant population. The closer spacing may have been lead to the higher plant population that resulted in higher number of heads and more grains compared to wider spacing. The closer spacing may not affect yield due to the adverse effect of competition between plants associated with closer spacing, this also agreed by Shinggu *et al*., (2009) [9] and Korir *et al*., (2018) [4]. The judicious use of inorganic and organic source has beneficial effect on physiological process of plant metabolism and growth there by leading to higher grain yield. The nitrogen is easily available due to mineralization of organics. Therefore, the shoot and root growth influenced so it absorption of other nutrient favored. Similar results were obtained by Varalakshmi *et al*., (2005) [11], Yakadri and Reddy, (2009) [12], Umesh *et al*., (2006) [10], Basavaraju and Purushotham, (2009) [2].

Economics

Economics of crop production is dependent on market price of inputs and quantity of output produced and price in the market (Aparna *et al*., 2020). Cost of cultivation varied due to variation in spacing and nutrient sources from ₹30528.35/ha to ₹31106.95/ha. As result found grain and biological yield varies from treatment to treatment. The maximum gross return and net return was observed in high yield producing treatment, i.e. 20 cm x 10 cm + 50% RDN + 50% N through vermicompost. The maximum gross return (₹90104.00/ha), net return (₹59095.25/ha) and B:C ratio (1.90) were found under treatment of spacing 20 cm x 10 cm + 50% RDN + 50% N through vermicompost which was given ₹18813.5/ha more net return on lowest yield producing treatment (Table 2).

The various return obtained from different treatments was due to prevailing prices and relative advantage by crop. The high grass return and net return under treatment 20 cm x 10 cm + 50% RDN + 50% N through vermicompost it all because crop was well established and nutrient availability in conveniently way choice increase yield. Similar results reported by Pallavi *et al*., (2016) [6].

The closer spacing and applying judicious combination of organic and inorganic sources of nitrogen progressively increased the net returns and B:C ratio of finger millet crop.

Table 1: Grain Yield, Biological Yield and Harvest Index of Finger Millet as influenced by Different Spacing and Nutrient Sources

Treatments	Grain Yield (t/ha)	Biological Yield (t/ha)	Harvest Index (%)
20 cm x 10 cm + 100% RDN	2.69	7.31	36.86
20 cm x 10 cm +100% N through vermicompost	2.37	6.66	35.58
20 cm x 10 cm + 50% RDN + 50% N through vermicompost	2.74	7.41	37.03
30 cm x 10 cm + 100% RDN	2.35	6.62	35.49
30 cm x 10 cm +100% N through vermicompost	2.42	6.66	36.37
30 cm x 10 cm + 50% RDN + 50% N through vermicompost	2.62	7.17	36.60
40 cm x 10 cm +100% RDN	2.28	6.49	35.20
40 cm x 10 cm +100% N through vermicompost	2.09	6.22	33.61
40 cm x 10 cm + 50% RDN + 50% N through vermicompost	2.15	6.22	34.52
SEm(±)	0.0462	0.2391	0.8797
CD (p=0.05)	0.1385	0.7170	NS

Table 2: Total Cost of Cultivation, Gross Return, Net Return and B:C ratio of Finger Millet as influenced by Different Spacing and Nutrient Sources

Treatments	Total Cost of Cultivation (₹/ha)	Gross Return (₹/ha)	Net Return (₹/ha)	B:C ratio
20 cm x 10 cm + 100% RDN	30928.35	88584	57655.65	1.86
20 cm x 10 cm +100% N through vermicompost	31106.95	78814	47707.05	1.53
20 cm x 10 cm + 50% RDN + 50% N through vermicompost	31008.75	90104	59095.25	1.90
30 cm x 10 cm + 100% RDN	30688.35	82517	51828.65	1.68
30 cm x 10 cm +100% N through vermicompost	30866.95	80083.3	49216.35	1.59
30 cm x 10 cm + 50% RDN + 50% N through vermicompost	30768.75	86534	55765.25	1.81
40 cm x 10 cm +100% RDN	30528.35	76344	45815.65	1.50
40 cm x 10 cm +100% N through vermicompost	30706.95	70988.7	40281.75	1.31
40 cm x 10 cm + 50% RDN + 50% N through vermicompost	30608.75	72274	41665.25	1.36

Conclusion

It is concluded that due to the higher plant population at the closer spacing of 20 cm x 10 cm the number of heads per plant was higher compared to wider spacing. This led to a significantly higher grain yield for the closer spacing as compared to wider spacing. The integrated use of 50% RDN + 50% N through vermicompost is the best nutrient management practice that can be adopted to obtain better yield with high benefit cost ratio. Therefore, it is recommended to farmers for receiving higher yield and economic benefits of finger millet.

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