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Original Research Article

Growth, Yield and Economics of Finger millet [*Eleusine Coracana* (L.) Gaertn] as Influenced by Integrated Nutrient Management

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A B S T R A C T

An experiment was conducted at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand (Gujarat) during *kharif* season of the year 2019 to study the Integrated nutrient management on growth, yield and economics on finger millet (*Eleusine coracana* (L.) Gaertn). The soil of experimental site was loamy sand in texture (locally called as "*Goradu*" soil) having good drainage and moisture retention capacity. The experimental site was low in Organic Carbon and available N, medium in available P and K. Nine INM treatments consisted of different combinations of vermicompost, farmyard manure (FYM), poultry manure, Narayan deotao pandharipande compost (NADEP), synthetic fertilizers and bio-fertilizers were compared with farmer's practice *i.e.* (RDF). The experiment was laid out in a randomized complete block design replicated four times. Higher value of growth characters like periodical plant height was recorded under treatment T_7 (25% N through vermicompost + *Azosprillum* + 50% N through fertilizer) at grand growth stage and at the time of maturity, initially it was higher in T_6 (25% N through FYM + *Azosprillum* + 50% N through fertilizer)**.** Yield attributes, yield and net returns were recorded higher under treatment T_7 (25% N through vermicompost + *Azosprillum* + 50% N through fertilizer) which was at par with T_6 (25% N through FYM + *Azosprillum* + 50% N through fertilizer)**,** T_1 (RDN 40 kg ha^{-1}), T_2 (50% N through FYM + 50 %N through fertilizer) & T_3 (50% N through vermicompost + 50% N through fertilizer).

Keywords

Finger millet, RDN, FYM, vermicompost, NADEP compost, Poultry manure, *Azosprillum*

Introduction

Among various millets, finger millet (*Eleusine coracana* (L.) Gaertn) provides staple food in relatively short period and has a pride of place in having the highest productivity among millets. It is the third most widely cultivated millets after pearl millet (*Pennisetum glaucum* L.) and foxtail millet (*Setaria italica)* in the semi-arid tropical and subtropical regions of the world.
In India, finger millet is cultivated mainly in the states like Karnataka, Tamil Nadu, Andhra Pradesh, Odisha, Jharkhand, Uttaranchal, Maharashtra, and Gujarat in an area of 1.2 million ha with an annual production of 2.06 million tonnes with an average productivity of 1700 kg ha^{-1}. In Gujarat, it is prominently cultivated with an area of 0.2 lakh ha producing 0.16 lakh tones with average productivity of 800 kg ha^{-1} (Anonymous, 2015) [1]. In India, Finger millet is normally grown on poor, marginal soils with imbalanced nutrient applications.

But there are improved varieties of finger millet which respond to added nutrients. Nutrient management should be done targeting production sustainability and integrated nutrient management (INM) is the most suitable option in this regard.

Beside nutrients availability, integration of different organic manures, synthetic fertilizer with bio-fertilizers helps to improves soil physical characteristics such as structure, porosity and water-holding capacity through increased organic matter content of soil side by side promotes the healthy environment for the microbes' growth in soil and creates a more nutrient rich soil which enables the higher growth of finger millet. Application of bio-fertilizers was found to increase the crop yield through N-fixation and thereby reducing the crop demand for the nitrogen.
With this background a field trial was undertaken to study the "Effect of nitrogen management on growth and yield of finger millet (*Eleusine coracana* (L.) Gaertn)" at Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand during *kharif* season of the year 2019.

Materials and Methods

Experimental details

A field experiment was conducted at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand, (Gujarat) during the *kharif* season of the year 2019. The soil of the experimental plot was loamy sand in texture having good drainage with 7.21 pH. The soil was low in organic carbon (0.39 %) and available nitrogen (191.34 kg ha^{-1}), while medium in available phosphorus (36.6 kg ha^{-1}) and available potash (201.92 kg ha^{-1}). The experiment was laid out in a randomized complete design replicated four times. There were 9 treatments *viz.*, T_1 (RDN 40 kg ha^{-1}), T_2 (50% N through FYM + 50% N through fertilizer), T_3 (50% N through FYM + 50 %N through fertilizer), T_4 (50% N through NADEP compost + 50% N through fertilizer),T_5 (50% N through poultry manure + 50% N through fertilizer), T_6 (25% N through FYM + *Azosprillum* + 50% N through fertilizer), T_7 (25% N through vermicompost + *Azosprillum* + 50% N through fertilizer), T_8 (25% N through FYM + *Azosprillum* + 50% N through fertilizer), T_9 (25% N through poultry manure + *Azosprillum* + 50% N through fertilizer).

Healthy seeds with good germination percent of GN 8 variety were sown in well prepared nursery beds on 18th June with seed rate of 5 kg ha^{-1}. The *Azospirillium brasilense* (5 ml ha^{-1}) solution was prepared and 27 days old seedlings for the respective treatments were treated by root dipping for 30 minutes prior to transplanting with a spacing of 30 cm x 10 cm. The entire quantity of phosphorus 20 kg ha^{-1} in the form of diammonium phosphate, 8 kg $ZnSO_4$ ha^{-1} and 25 kg $FeSO_4$ ha^{-1} were applied uniformly in each experimental plot as a basal at the time of transplanting. Nitrogen was applied as per prescribed in treatment through urea and other organic manure. As per recommended practice the 50% nitrogen application was applied in two equal splits *viz.*, ½ as basal and remaining half at 30 days after transplanting. Crop was harvested in first week of November (Table 1).

Results and Discussions

Effect of nitrogen management on growth and yield attributes

Data presented in Table 2 indicated that application of 25% N through FYM + *Azosprillum* + 50% N through fertilizer (T_6) was recorded significantly higher plant height at 30 days after transplanting which was

remain at par with treatment T_7, T_8 and T_1 as well as T_3. At 60 days after transplanting significantly higher plant height was recorded under treatment T_7 (25% N through vermicompost + *Azosprillum* + 50% N through fertilizer) which was remained at par with all other treatments except treatment T_9. Same trend was observed at the time of harvest, application of 25% N through vermicompost + *Azosprillum* + 50% N through fertilizer (T_7) recorded taller plants and being at par with all other treatments except treatments T_4 and T_9. This might be due to the availability of nutrients from combination of organics, inorganics and bio-fertilizers produced favourable condition in terms of uptake plant nutrients by the crop. The results are in conformity with the findings of Teja (2014) [13], Pradhan *et al.,* (2018) [9], Aparna *et al.,* (2019) [2] and Chowdary *et al.,* (2019) [4].

Significantly higher effective number of tillers per meter of row length was recorded under treatment T_7 (25% N through vermicompost + *Azosprillum* + 50% N through fertilizer) and which was remain at par with treatment T_6, T_1 and T_2. Same trend was observed for number of fingers and treatment T_7 recorded higher number of fingers but failed to exhibit statistical superiority over treatment T_6, T_1 & T_3. Length of finger was recorded higher under T_7 (25% N through vermicompost + *Azosprillum* + 50% N through fertilizer) and which was remain at par with treatment T_6, T_1, T_3 and T_2. The reason behind increasing yield attributes might be due to readily available nitrogen to the crop from inorganic source of fertilizer side by side with help of *Azosprillum*, mineralization of vermicompost start which provides better nutrition of crop and better soil environment. Different nitrogen management treatments fail to exert significant influence on days to maturity in finger millet crop. This is in harmony with the published work of Sridhara *et al.,* (2003) [12], Saunshi *et al.,* (2014) [11], Teja (2014) [13], Nigade *et al.,* (2011) [8], Nevse *et al.,* (2013) [7] and Prashanth *et al,* (2019) [10].

Effect of nitrogen management on yield and economics

Significantly higher grain yield was recorded under treatment T_7 (25% N through vermicompost + *Azosprillum* + 50% N through fertilizer) but failed to exhibit statistical superiority over treatment T_6, T_1, T_2 & T_3 while significantly higher straw yield was recorded with application of 25% N through FYM + *Azosprillum* + 50% N through fertilizer (T_6) which statistically similar with all another treatments except treatment T_4, T_5 and T_9. All the growth and yield attributes were found higher with application treatment T_7 followed by treatment T_6. The combined effect of those yield attributes resulted in higher yield. This might be due to application of inorganic fertilizers and organic manures might have attributed to sustained nutrient supply throughout the growth period plus *Azospirillum* application in the treatments which are free living nitrogen fixing bacteria which shows their synergistic effect to produces growth promoting substances like IAA, gibberellins, pantothenic acid, thiamine and niacin and it promotes root proliferation and hence improves grain yield. The probable reason behind that is under this treatment synthesis of photosynthates is more owing to adequate supply of nitrogen, FYM along with bio-fertilizer which increase the photosynthetic activity and production of more biomass, which ultimately resulted in grain and straw yield. These findings are in close agreement with those reported by Chaudhari *et al.,* (2011) [3], Dhanpal and verma (2013) [5], Teja (2014) [13], Kumar *et al.,* (2018) [6] and Prashanth *et al.,* (2019) [10].

Table.1 Treatment-wise amount of different nutrients applied to finger millet crop

Treatment	Quantity of nutrients						
	Kg ha^{-1}						mL
	N	P	FYM	Vermicompost	NADEP compost	Poultry manure	Bio-fertilizer
T_1	40	20	0	0	0	0	0
T_2	20	20	4000	-	-	-	-
T_3	20	20	-	1189	-	-	-
T_4	20	20	-	-	1016.66	-	-
T_5	20	20	-	-	-	655.55	-
T_6	20	20	2000	-	-	-	1000
T_7	20	20	-	594.4	-	-	1000
T_8	20	20	-	-	508.33	-	1000
T_9	20	20	-	-	-	328.77	1000

Table.2 Effect of treatments on growth and yield attributes of finger millet

Treatments	Plant height (cm)			Effective number of tillers	Days to maturity	Number of fingers per ear head	Length of finger (cm)
	30 DATP	60 DATP	AT HARVEST				
T_1	66.61	106.70	118.67	27.00	110	7.68	6.85
T_2	61.04	104.81	116.35	26.35	111	7.30	6.68
T_3	66.08	104.25	116.66	26.05	109	7.48	6.73
T_4	58.70	103.96	112.45	25.57	110	6.88	6.18
T_5	60.15	105.15	116.71	23.90	108	6.63	6.10
T_6	71.80	108.40	120.84	27.97	110	7.95	7.23
T_7	69.35	110.95	123.61	28.82	109	8.40	7.45
T_8	67.65	106.75	119.54	24.52	109	7.05	6.20
T_9	61.25	96.01	107.87	23.22	108	6.35	5.98
SEm±	2.67	2.46	2.55	0.92	0.64	0.33	0.31
C.D. (P=0.05)	7.78	7.19	7.43	2.69	NS	0.96	0.92
C.V. %	8.24	4.68	4.35	7.11	1.17	9.00	9.50

Table.3 Effect of treatments on yield and economics of finger millet

Treat-ment	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Test weight (g)	Harvest index (%)	Cost of cultivation (₹ ha^{-1})	Gross realization (₹ ha^{-1})	Net realization (₹ ha^{-1})	B:C
T_1	2410	6984	2.58	25.69	22600	62168	39568	2.75
T_2	2390	6709	2.49	26.37	27019	61218	34199	2.27
T_3	2373	6764	2.50	26.04	30382	60988	30606	2.01
T_4	2309	6430	2.44	26.55	23817	59040	35223	2.48
T_5	2154	6382	2.41	25.20	23429	55844	32415	2.38
T_6	2570	7303	2.61	26.04	25001	66006	41005	2.64
T_7	2677	7286	2.66	26.97	26682	68112	41430	2.55
T_8	2321	6749	2.44	25.47	23400	59918	36518	2.56
T_9	1993	6224	2.38	24.24	23208	52308	29100	2.25
SEm±	120	244	0.06	-	-	-	-	-
C.D. (P=0.05)	352	714	0.16	-	-	-	-	-
C.V. %	10.24	7.24	4.44	-	-	-	-	-

No any significant difference was observed in harvest index due to different nitrogen management treatments. Significantly higher test weight of finger millet was gained through the application of 25% N through vermicompost + *Azosprillum* + 50% N through fertilizer (T_7). The possible reason for increasing in test weight might be due to availability of sufficient quantity of nitrogen through combination of inorganic, organics as well as bio-fertilizer enhanced the productive efficiency through concurrent photosynthesis and effective translocation of assimilates from source to sink during the grain filling period.

The highest net realization of ₹ 41430 ha^{-1} (Table 3) was obtained under T_7 (25% N through vermicompost + *Azosprillum* + 50% N through fertilizer) with BCR of 2.55, followed by treatment T_6 incurred net realization of ₹ 41005 ha^{-1} along with BCR of 2.64. Maximum BCR of 2.75 was witnessed under application of 40 kg recommended dose of nitrogen per hectare with net realization of ₹ 39568 ha^{-1}. Maximum BCR in treatment T_1 might be due to it has lower cost of cultivation.

Hence concluded, in view of the results obtained from the present investigation, integrated application of synthetic fertilizer, organic manure along with *Azospirilum* gave higher yield, net realization and benefit cost ratio of finger millet. Besides the treatment used for comparison, common application of phosphorus 20 kg ha^{-1}, 8 kg $ZnSO_4$ ha^{-1} and 25 kg $FeSO_4$ ha^{-1} is essential.

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