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Effect of nutrient management on growth and yield of finger millet in hilly area

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Abstract
A field study was carried out for two consecutive years (2020 and 2021) at the Rajendrapur Farm, NAU, Waghai (Dangs), Gujarat to assess the impact of nutrient management practices on finger millet. A randomized block design was used to set up the experiment. Nine treatments, *viz*., T_1 :100% RDF + *Azospirillum* + PSB (2 lit/ha root deeping at TP), T_2 :100% RDF + NPK bio-consortium (2 lit/ha root deeping at TP), T_3:100% RDF + Banana pseudo stem sap 1% at tillering and panicle initiation stage, T_4 :75% RDF + *Azospirillum* + PSB (2 lit/ha root deeping at TP), T_5 :75% RDF + NPK bio-consortium (2 lit/ha root deeping at TP), T_6 :75% RDF + Banana pseudo stem sap 1% at tillering and panicle initiation stage, T_7 :50% RDF + *Azospirillum* + PSB (2 lit/ha root deeping at TP), T_8 :50% RDF + NPK bio-consortium (2 lit/ha root deeping at TP) and T_9 :50% RDF + Banana pseudo stem sap 1% at tillering and panicle initiation stage were applied to finger millet. The results revealed that application of 100% RDF + Banana pseudo stem sap 1% at tillering and panicle initiation stage (T_3) recorded significantly higher growth, yield attributes and yields of finger millet, but it remained statistically at par with treatments T_1, T_2 and T_6. Gross realizations, net returns and BCR were also obtained higher under the treatment of 100% RDF + Banana pseudo stem sap 1% at tillering and panicle initiation stage followed by treatments T_1, T_2 and T_6.

Keywords: Finger millet, banana pseudo stem sap, bio-fertilizer, NPK bio-consortium

Introduction
Finger millet [*Eleusine coracana* (L.) Gaertn.] is the third most important millet, next to sorghum and pearl millet in India. Among the major food grains, finger millet is one of the most nutrition's crop for protein, minerals (Ca and Fe) and provides 8-10 times more calcium than wheat or rice (Anon., 2014) [1]. Finger millet having the unique property of slower digestibility, thereby it is very good food crop for pregnant women and person who suffering from diabetes. Watt and Breyer-Brandwijk (1962) [16] reported that finger millet has been used to remedy for several diseases. Finger millet is an important small millet crop grown in India and has the pride place in having the highest productivity among small millets. It is also known as *Ragi*, African millet, Bird's foot millet and important staple food crop in part of Eastern and Central Africa and India. Among the several factors, nutrient management is one of the most important factors responsible for low productivity. Application of chemical fertilizer can boost up crop yields, but it impairs soil properties. Therefore, an integrated use of different sources of plant nutrients is required to check nutrient depletion, maintain soil fertility and crop productivity (Rao, 1994) [9]. The basic concept of integrated nutrient management is the maintenance or adjustment of soil fertility and plant nutrients supply to an optimum level for sustaining the desired crop productivity through optimization of benefits from all possible sources of plant nutrients in an integrated manner (Tondon, 1992) [14]. The appropriate combination of mineral fertilizers, organic manures, crop residues and N fixing crop varies according to the system, land use, ecological, social and economic conditions. Experience from long term fertilizers experiments revealed that integration of organic manure with graded level of chemical fertilizers and bio-fertilizer is promising, not only harvest higher yield, but also maintain soil fertility for longer period for stability in crop production.

Materials and Methods
The current investigation was under taken by conducting a field trial at Rajendrapur Farm, NAU, Waghai on finger millet crop with various doses of fertilizers combined with organic manures (Banana pseudo stem sap, Bio-fertilizers and NPK Bio-consortium) for two years (2020 and 2021).

The soil of the experimental site had a clayey texture, medium medium in organic carbon (0.60%), available nitrogen (272.80 kg/ha) and available phosphorus (29.84 kg/ha), whereas high in available potassium (367.50 kg/ha). This region has a warm, humid monsoon with heavy rainfall, a moderately hot summer and a fairly cool winter. The seeds of cultivar GNN 6 were used in the present investigation. A randomized block design with three replications was used to set up the experiment. The experiment comprising nine nutrient management treatments *viz*., T_1 :100% RDF + *Azospirillum* + PSB (2 lit/ha root deeping at TP), T_2 :100% RDF+ NPK bio-consortium (2 lit/ha root deeping at TP), T_3:100% RDF + Banana pseudo stem sap 1% at tillering and panicle initiation stage, T_4 :75% RDF + *Azospirillum* + PSB (2 lit/ha root deeping at TP), T_5 :75% RDF + NPK bioconsortium (2 lit/ha root deeping at TP), T_6 :75% RDF + Banana pseudo stem sap 1% at tillering and panicle initiation stage, T_7 :50% RDF + *Azospirillum* + PSB (2 lit/ha root deeping at TP), T_8 :50% RDF + NPK bio-consortium (2 lit/ha root deeping at TP) and T_9 :50% RDF + Banana pseudo stem sap 1% at tillering and panicle initiation stage. The required quantities of organics, Bio-fertilizers and NPK Bio-consortium were calculated and applied to the finger millet at the transplanting of seedling in accordance with the treatments. Banana pseudo stem sap was sprayed at the time of tillering and panicle initiation stages. FYM @ 5 t/ha was applied as common at the time of field preparation. The fertilizers were applied to finger millet as per treatments. Nitrogen was applied in the form of urea, while phosphorus applied in the form of SSP. Finger millet nursery was raised using 5 kg/ha seed rate and one month old seedlings were transplanted at 22.5 cm × 7.5 cm spacing.

3. Results and Discussion

The results summarized in Table 1 revealed that 100% RDF + Banana pseudo stem sap 1% at tillering and panicle initiation stage (T_3) applied treatment recorded significantly higher plant height at harvest,but it was statistically at par with treatments T_1, T_2 and T_6 during individual years and in pooled results. Significantly higher dry matter accumulation/plant was recorded under the treatment T_3, but it remained at par with treatments T_1, T_2 and T_6 during both the years and in pooled results, respectively. Significantly higher number of panicles/m^2 produced with the treatment 100% RDF + Banana pseudo stem sap 1% at tillering and panicle initiation stage (T_3), but it remained at par with treatments T_1, T_2 and T_6 during both the years and in pooled results. Here, the treatment with integration of inorganic and organic sources provided enough amounts of nutrients and organic matter which ultimately influenced the soil environment in positive way for development of more plant growth. Nitrogen being a constituent of the plant cell influenced different physiological processes such as a cell division, cell elongation and chlorophyll production which ultimately resulted in better growth. Similar results have been reported by Vijaymahanthesh *et al*. (2013) [15], Goudar *et al*. (2016) [3] and Thimmaiah *et al*. (2016) [13].

Table 1: Growth and yield attributes of finger millet as influenced by different treatments of nutrient management

Treatments	Plant height (cm) at harvest			Dry matter accumulation at harvest (g/plant)			Number of panicles/m^2		
	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled
T_1	119.1	120.9	120.0	25.45	26.05	25.75	94.30	96.80	95.55
T_2	118.3	119.3	118.8	25.00	25.65	25.33	94.20	96.50	95.35
T_3	119.7	122.1	120.9	25.60	26.90	26.25	96.75	98.70	97.73
T_4	106.2	108.8	107.5	22.45	23.10	22.78	85.90	87.80	86.85
T_5	104.9	104.9	104.9	21.45	21.90	21.68	82.20	84.05	83.13
T_6	115.6	115.9	115.7	24.20	25.00	24.60	91.55	93.30	92.43
T_7	101.4	100.8	101.1	19.65	20.10	19.88	78.95	81.05	80.00
T_8	98.6	97.9	98.2	20.50	20.80	20.65	76.50	78.55	77.53
T_9	102.2	101.8	102.0	20.70	21.10	20.90	79.80	81.75	80.78
S.Em. ±	4.42	4.41	3.37	0.85	0.94	0.65	3.49	3.66	2.60
CD (P=0.05)	12.91	12.88	9.59	2.49	2.74	1.84	10.19	10.67	7.40

Results furnished in Table 2 showed that 100% RDF + Banana pseudo stem sap 1% at tillering and panicle initiation stage (T_3) produced significantly higher grain yield and it remained at par with treatments T_1, T_2 and T_6. Higher grain yield due to combined application of inorganic fertilizers and organic manures might have attributed to sustained nutrient supply and also as a result of better utilization of applied nutrients through improved micro-environmental conditions, especially the activities of soil micro-organisms involved in nutrient transformation and fixation. These findings are in agreement with those obtained by, Saraswathi *et al*. (2018) [10], Chowdary and Patra (2019) [2] and Shilpa *et al*. (2021) [12]. In case of straw yield, the treatment T_3 produced significantly higher straw yield which was statistically at par with the treatments T_1, T_2 *and* T_6 *during both the years* as well as on *pooled* basis. Straw yield of a crop is closely related to the vegetative growth *viz.*, plant height, tiller numbers and final plant stand of a crop. The beneficial effect of any treatment on one or more of these characters without a corresponding decrease in one or more of them will result in increased straw yield. These findings are in agreement with those obtained by, Savita *et al*. (2013) [11], Pallavi *et al*. (2016) [7] and Raman and Krishnamoorty (2016) [8].

The data of economics, consisting of the cost of cultivation, gross realizations and net returns as well as B: C ratio influenced by different treatments is furnished in Table 2. The results showed that gross realizations, net returns and BCR were obtain higher under treatment of 100% RDF + Banana pseudo stem sap 1% at tillering and panicle initiation stage (T_3) followed by treatments 100% RDF + *Azospirillum* + PSB (T_1) and 100% RDF+ NPK bio-consortium (T_2). However, the lowest values of gross realizations, net returns and B: C ratio were recorded under the treatment of 50% RDF + NPK bio-consortium (T8). The same outcomes were also reported by Hebbal *et al*. (2018) [5], Harika *et al*. (2019) [4] and Mane *et al*. (2019) [6].

Table 2: Yield and economics of finger millet crop as influenced by different treatments of nutrient management (Average of two years)

Treatment	Yield (kg/ha)		Cost of cultivation (₹/ha)			Gross realizations (Rs./ha)	Net returns (Rs./ha)	B:C ratio
	Grain	Straw	Fixed	Variable	Total			
T_1	1919	5296	43287	2012	45299	83052	37753	1.83
T_2	1901	5273	43287	1872	45159	82353	37194	1.82
T_3	1960	5392	43287	1782	45069	84760	39691	1.88
T_4	1728	4698	43287	1629	44916	74561	29645	1.66
T_5	1657	4691	43287	1489	44776	72056	27280	1.61
T_6	1851	5131	43287	1399	44686	80176	35490	1.79
T_7	1557	4495	43287	1248	44535	67989	23454	1.53
T_8	1534	4487	43287	1108	44395	67166	22771	1.51
T_9	1609	4583	43287	1018	44305	70056	25752	1.58

Conclusion

Two years of research have led to the conclusion that finger millet crop should be fertilized with 100% RDF (40-20-00 N-P_2O_5-K_2O kg/ha) along with two spray of 1% Banana pseudo stem sap at tillering and panicle initiation stage in order to obtain higher growth, yields and net returns in hilly area.

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