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The effect of liquid biofertilizer practices on the growth and yield of finger millet

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Abstract
Biofertilizers are products that contain living microorganisms that are used in agriculture for N_2 fixation, P absorption and nutrient mobilisation to improve soil quality and agricultural production. The randomized block design with three replications involving 11 treatments to determine the effect of liquid biofertilizer on the growth and yield of finger millet. The factors under study comprised different liquid biofertilizer practices. The variety of finger millet (RAU-8) was sown on 28th July 2020. A common recommended dose of fertilizer of 40N:20 P_2O_5:20 K_2OKg ha^{-1} was applied. The maximum significant grain yield (23.58 qha^{-1}) was recorded with T_1 - 100%RDF+seed treatment with liquid biofertilizer (5 ml kg^{-1} seed) followed by soil application of liquid biofertilizer (2.5 lit., mix with 500kgha^{-1} FYM and apply in-furrow which was statistically at par with treatment T_3-100%RDF + Soil application with liquid biofertilizer and (21.47 qha^{-1}) T_4-85%RDF+Seed treatment with liquid biofertilizer (5 ml kg^{-1} seed) followed by Soil application of liquid biofertilizer (2.5 lit., mix with 500kgha^{-1} FYM and apply in-furrow, (20.92 qha^{-1}) T_6 -85%RDF + Soil application of liquid biofertilizer. All the growth parameters like plant height (92.45 cm), the number of tillers per plant (4.39), dry matter accumulation (20.57g $plant^{-1}$), days to 50% flowering (81.25), crop growth rate (2.73 g $day^{-1}m^{-2}$), and relative growth rate were significantly influenced the treatments and maximum recorded at T_1 - 100% RDF + seed treatment with liquid biofertilizer (5 ml kg^{-1} seed) followed by soil application of liquid biofertilizer (2.5-liter mix with 500kgha^{-1}FYM applied in furrows.

Keywords: Finger millet, growth, liquid biofertilizer, growth

Introduction
Finger millet is a herbaceous annual plant extensively grown in the semiarid and arid areas of Asian and African countries. It is a self-pollinating tetraploid species under the Poaceae family and is one of the essential food cereals in Sub- Saharan Africa. Finger millet, native to Uganda and Ethiopia's highlands, is commonly grown by small-scale farmers and consumed locally (Adugna *et al*., 2011) [1]. In Africa, finger millet is usually consumed as a porridge, but it is also used to create bread, soup, roti (flatbread), and beer in South Asia. New finger millet-based food products, including pasta, noodles, vermicelli, snacks, sweets, and various bakery products, are becoming increasingly popular among younger people. Finger millet outperforms other major cereal crops, particularly polished rice, when it comes to several nutritious components. Finger millet is known for its high nutritional content with protein-7 g, carbohydrate-72 g, fat-3.6 g, and calories-328 kilocalories in each 100 g of seed. Finger millet contains a huge amount of fiber (18%), calcium (0.38%), phenolic compounds (0.3-3%), and sulfur-containing amino acids. Finger millet contains a huge amount of cysteine, tryptophan, methionine, and total amino acids compared to other cereals. It is an important crop in underdeveloped countries to combat starvation. Millets are one of the oldest foods known to humans, but they were forsaken in favor of wheat and rice with urbanization and industrialization. Ragi (*Eleusine coracana* L.), also known as finger millet, is a staple food crop in Karanataka, particularly in the southern region, and a portion of excellent food for diabetic patients. Among the minor millets, it has the most area under cultivation. In addition to being high in carbohydrates and protein, the grains are high in calcium and iron.

It is grown on 11.94 million hectares in India with a production of 19.85 million tonnes and productivity of 1662 kg ha^{-1}. Finger millet was planted on 4.21 lakh ha in Bihar, with an annual yield of 4.19 lakh tonnes and productivity of 944 kg ha^{-1}. Millets are important food and fodder crops in semiarid locations, and they're gaining popularity around the world. They are primarily planted in marginal areas or agricultural settings where major cereals fail to produce sufficient yields (Global Facilitation Unit for Underutilized Species, 2014). Both natural (Van Der 2 Heijden *et al.* 2008) and agricultural (Artursson *et al*. 2006) [2] ecosystems rely heavily on soil microbes for plant productivity and health. They may improve interpersonal systems and mutually beneficial interactions with plant roots that serve as hosts influencing plant growth, nutrient intake, and stress tolerance in the process (Bender *et al*. 2016) [3].

Materials and Methods

Experimental site

A field experiment was carried out during Kharif 2020 at Research Farm of Tirhut College of Agriculture, Dholi, RPCAU, Pusa, Bihar, located on the BurhiGandak's southern bank, at an elevation on 58 metres above sea level, it is located at 25.59^0 North latitude & 85.35^0 East longitudes. The monsoon has a tremendous impact on the humid sub-tropical climate zone. He soil was alluvial and calcareous in nature, having evolved over time from BudhiGandak river debris. During the crop development season, 598.6 mm of precipitation was reported. The wettest month was September 2020, with 125.4 mm of rain. During the agricultural season, the highest and lowest weekly average temperatures range from 15.8^{o}c to 32.7^{o}c and 6.7^{o}c to 27.5^{o}c respectively. The highest temperature of 36.52^{o}c was noted in April, whereas; the minimum temperature of 6.7^{o}c was recorded in January. The RH was measured twice a day, at 7 A.M and 2 P.M., along with the weekly average was considered. During the experiment, the highest weekly RH range starting 94.2 percent to 100.0 percent, while the lowest relative humidity goes from 73.7 percent to 96.0 percent. Finger millets variety RAU-8 was chosen for the experiment. This variety was released in the year 1994 by Rajendra Agricultural University, Pusa Samastipur. It has protein content (7.3%) and carbohydrates content (72%) and matures in 110-120 days. Maximum seed yield (35-37 q ha^{-1}). Certified RAU-8 seeds were used for seeding on 28th July 2020, the crop was planted using the recommended seed rate of 10-12 kg ha^{-1}.

Biometric and yield observation

Mostly from base of the parent plant to that same apex including its plant, average height on 5 randomly chosen plants from every plot were evaluated by cm during 30, 60DAS, and harvesting. Total no. of tillers plant^{-1} were observed from one m $^{-2}$ area. Three hills were chosen by each block then dried overnight in a hot air oven between 65 to 70^{o}c to determine the dry mass for plant^{-1}. Its CGR and RGR indicates the dry weight growth over time in proportion towards the starting weight. After sun drying, the ripe plant has been collected as from net plot area, as well as the bundles mass was measured. Throughout the thrashing, winnowing, washing, then dry operations, grain yield were measured (kg plot^{-1}). After that, it was multiplied by the conversion factor to get kg ha^{-1}. The (HI) was computed to use the preceding method based on the resultant force from economical (grain) seed yield and biological (grain + straw) yield.

Results and Discussion

Plant height, tillers per unit area, dry matter accumulation by plant, days to 50% flowering, crop growth rate and relative growth rate are all growth parameters that were directly or indirectly responsible for the grain and straw yields of finger millet at produce. Higher growth and yield attributing *viz*. it was significantly affected at different phases of its growth plant height (92.45 cm). The maximum number of tillers per plant was registered under T_1- (4.39) (Table1).Those very same finding is consistent of Rathore et.al. (2006) The dry weight of plants was significantly affected by several liquid biofertilizers on maximum dry matter accumulation was registered under dry matter accumulation per plant (20.57g plant^{-1}). It was explained by (Table 2). Similar findings have been confirmed by Singh *et al.* (2008) [9] days to 50% flowering (81.25) (Table 3), crop growth rate per unit area (2.73 g day^{-1} m $^{-2}$) (Table 4), Comparable findings was found from Meena *et al*. (2015). and relative growth rate per unit area (0.0054 gg^{-1} day^{-1}) (Table 5), These finding correlate the work of Swapna and Brahmaprakash (2013) [10], test weight (3.42 g), seed yield (23.58q ha^{-1}) Similar results were found by Shah and Kumar (2014), straw yield (48.51q ha^{-1}) where as observed an increase in grain and straw yields. These results were found to be related to the work of Nath *et al*. (2011) [6], biological yield (72.16 q ha^{-1}) (Table 6). These findings correlate the work of Khan *et al* (2012) [4] and harvest index (33.52%) were recorded with the liquid biofertilizer treatment T_1 -100%RDF+seed treatment with liquid biofertilizer (5 ml kg^{-1} seed) followed by soil application of liquid biofertilizer (2.5 lit., mix with 500 kgha^{-1} FYM and apply in-furrow. Which was statistically at par with T_3-100%RDF + soil application with liquid biofertilizer and T_4-85%RDF+Seed treatment with liquid biofertilizer (5 ml kg^{-1} seed) followed by soil application of liquid biofertilizer (2.5 lit., mix with 500 kgha^{-1} FYM and apply in furrow, T_6 - 85%RDF + soil application of liquid biofertilizer. the most economically effective treatment and also recorded the highest economics parametric values i.e., maximum cost of cultivation of ₹ 26965, gross return of ₹ 89824, net return of ₹62859 and benefit to cost ratios were 2.33 followed by the treatment T_3.

Table 1: Response of liquid biofertilizer and their mode of application on plant height and number of tillers of Finger millet

Treatment No.	Treatment	Plant hight (cm)			No of tiller plant^{-1}
		30 DAS	60 DAS	At Harvest	
T_1	100%RDF+seed treatment with liquid biofertilizer followed by soil application of liquid biofertilizer	30.65	60.49	92.45	4.39
T_2	100%RDF +seed treatment with liquid biofertilizer	27.62	54.52	82.78	3.48
T_3	100%RDF+ soil application with liquid biofertilizer	30.24	59.68	91.11	4.31
T_4	85%RDF+ seed treatment with liquid biofertilizer followed by soil application of liquid biofertilizer	29.99	59.20	90.05	4.16
T_5	85%RDF + seed treatment with liquid biofertilizer	26.16	51.63	78.45	3.15
T_6	85%RDF + soil application with liquid biofertilizer	29.81	58.84	89.55	3.95

T_7	70%RDF+ seed treatment with liquid biofertilizer followed by soil application of liquid biofertilizer	24.57	48.49	73.49	2.98
T_8	70%RDF + seed treatment with liquid biofertilizer	23.56	46.51	70.43	2.75
T_9	70%RDF + soil application with liquid biofertilizer	24.06	47.49	72.36	2.87
T_{10}	RDF (40:20:20,N:P_2O_5:K_2O Kg ha $^{-1}$)	27.00	53.30	81.02	3.36
T_{11}	Control	17.18	33.91	51.58	2.15
	S.Em.±	1.02	2.02	3.12	0.094
	CD (P=0.05)	3.07	6.077	9.28	0.27
Seed treatment = (Bio- NPK liquid biofertilizer @ 5ml/kg seed) Soil application = liquid biofertilizer(bio-NPK @ 2.5 lit.) mixed with 500 Kg ha^{-1} FYM applied in furrow					

Table 2: Response of liquid biofertilizer and their mode of application on Dry matter accumulation of Finger millet

Treatment No.	Treatment detail	Dry Matter Accumulation (g hill^{-1})			
		30 DAS	60 DAS	90 DAS	At Harvest
T_1	100%RDF+seed treatment with liquid biofertilizer followed by soil application of liquid biofertilizer	3.80	12.91	17.48	20.57
T_2	100%RDF +seed treatment with liquid biofertilizer	3.24	10.95	13.58	15.55
T_3	100%RDF+ soil application with liquid biofertilizer	3.72	12.62	16.13	18.82
T_4	85%RDF+ seed treatment with liquid biofertilizer followed by soil application of liquid biofertilizer	3.67	12.64	16.49	18.69
T_5	85%RDF + seed treatment with liquid biofertilizer	3.06	10.25	13.30	14.89
T_6	85%RDF + soil application with liquid biofertilizer	3.59	12.30	16.17	18.43
T_7	70%RDF+ seed treatment with liquid biofertilizer followed by soil application of liquid biofertilizer	2.67	8.98	11.97	13.24
T_8	70%RDF + seed treatment with liquid biofertilizer	2.40	7.62	11.73	13.02
T_9	70%RDF + soil application with liquid biofertilizer	2.57	8.56	12.94	13.96
T_{10}	RDF (40:20:20, N:P_2O_5:K_2O Kgha $^{-1}$)	3.19	10.72	13.48	14.56
T_{11}	Control	1.42	4.59	7.13	7.58
	S.Em.±	0.14	0.57	0.63	0.61
	CD (P=0.05)	0.42	1.73	1.89	1.84
Seed treatment - (Bio- NPK liquid biofertilizer @ 5ml/kg seed) Soil application - liquid biofertilizer(bio-NPK @ 2.5 lit.) mixed with 500 Kg ha^{-1} FYM applied in furrow					

Table 3: Response of liquid biofertilizer and their mode of application on days on flowering and test weight of finger millet

Treatment No.	Treatment detail	Days to flowering	1000 seed Weight (g)
T_1	100%RDF+seed treatment with liquid biofertilizer followed by soil application of liquid biofertilizer	81.25	3.42
T_2	100%RDF +seed treatment with liquid biofertilizer	81.13	3.29
T_3	100%RDF+ soil application with liquid biofertilizer	81.02	3.39
T_4	85%RDF+ seed treatment with liquid biofertilizer followed by soil application of liquid biofertilizer	80.86	3.34
T_5	85%RDF + seed treatment with liquid biofertilizer	80.16	3.26
T_6	85%RDF + soil application with liquid biofertilizer	80.44	3.31
T_7	70%RDF+ seed treatment with liquid biofertilizer followed by soil application of liquid biofertilizer	80.06	3.22
T_8	70%RDF + seed treatment with liquid biofertilizer	79.67	3.19
T_9	70%RDF + soil application with liquid biofertilizer	79.82	3.21
T_{10}	RDF (40:20:20,N:P_2O_5:K_2O Kg ha $^{-1}$)	80.98	3.27
T_{11}	Control	78.48	3.16
	S.Em.±	1.15	0.07
	CD (P=0.05)	NS	NS
Seed treatment = (Bio- NPK liquid biofertilizer @ 5ml/kg seed) Soil application = liquid biofertilizer(bio-NPK @ 2.5 lit.) mixed with 500 Kg ha^{-1} FYM applied in furrow			

Table 4: Response of liquid biofertilizer and their mode of application on crop growth rate of Finger millet

Treatment No.	Treatment	Crop growth rate (g day^{-1} m^{-2})			
		0-30 DAS	30-60 DAS	60-90 DAS	90-Harvest
T_1	100%RDF+seed treatment with liquid biofertilizer followed by soil application of liquid biofertilizer	3.38	8.25	4.31	2.73
T_2	100%RDF +seed treatment with liquid biofertilizer	2.88	6.85	2.33	1.74
T_3	100%RDF+ soil application with liquid biofertilizer	3.30	7.97	3.85	2.39
T_4	85%RDF+ seed treatment with liquid biofertilizer followed by soil application of liquid biofertilizer	3.26	7.96	3.72	1.95
T_5	85%RDF + seed treatment with liquid biofertilizer	2.72	6.38	2.71	1.41
T_6	85%RDF + soil application with liquid biofertilizer	3.19	7.73	3.43	2.00
T_7	70%RDF+ seed treatment with liquid biofertilizer followed by soil application of liquid biofertilizer	2.37	5.60	2.65	1.12

T_8	70%RDF + seed treatment with liquid biofertilizer	2.13	4.64	3.65	1.14
T_9	70%RDF + soil application with liquid biofertilizer	2.28	5.32	2.89	0.90
T_{10}	RDF (40:20:20,N:P_2O_5:K_2O Kg ha $^{-1}$)	2.84	6.68	2.45	0.95
T_{11}	Control	1.26	2.82	2.25	0.40
	S.Em.±	0.12	0.51	0.22	0.076
	CD (P=0.05)	0.37	1.55	0.65	0.22
Seed treatment = (Bio- NPK liquid biofertilizer @ 5ml/kg seed) Soil application = liquid biofertilizer(bio-NPK @ 2.5 lit.) mixed with 500 Kg ha^{-1} FYM applied in furrow					

Table 5: Response of liquid biofertilizer and their mode of application on Relative growth rate of Finger millet

Treatment No.	Treatment	Relative growth rate (g g^{-1} day^{-1})			
		0-30 DAS	30-60 DAS	60-90 DAS	90-Harvest
T_1	100%RDF+seed treatment with liquid biofertilizer followed by soil application of liquid biofertilizer	0.15	0.05	0.014	0.0054
T_2	100%RDF +seed treatment with liquid biofertilizer	0.14	0.04	0.007	0.0045
T_3	100%RDF+soil application with liquid biofertilizer	0.15	0.04	0.013	0.0052
T_4	85%RDF+ seed treatment with liquid biofertilizer followed by soil application of liquid biofertilizer	0.15	0.04	0.012	0.0042
T_5	85%RDF + seed treatment with liquid biofertilizer	0.14	0.04	0.008	0.0037
T_6	85%RDF +soil application with liquid biofertilizer	0.15	0.04	0.009	0.0043
T_7	70%RDF+ seed treatment with liquid biofertilizer followed by soil application of liquid biofertilizer	0.14	0.04	0.009	0.0034
T_8	70%RDF + seed treatment with liquid biofertilizer	0.13	0.04	0.010	0.0035
T_9	70%RDF + soil application with liquid biofertilizer	0.14	0.04	0.007	0.0025
T_{10}	RDF (40:20:20,N:P_2O_5:K_2O Kg ha $^{-1}$)	0.14	0.04	0.007	0.0025
T_{11}	Control	0.12	0.03	0.014	0.0020
	S.Em.±	0.0015	0.002	0.0009	0.0003
	CD (P=0.05)	0.0044	0.0067	0.0026	0.0008
Seed treatment = (Bio- NPK liquid biofertilizer @ 5ml/kg seed) Soil application = liquid biofertilizer(bio-NPK @ 2.5 lit.) mixed with 500 Kg ha^{-1} FYM applied in furrow					

Table 6: Response of liquid biofertilizer and their mode of application on yield and harvesting index of Finger millet

Treatment No.	Treatment detail	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})	HI (%)
T_1	100%RDF+seed treatment with liquid biofertilizer followed by soil application of liquid biofertilizer	23.58	48.51	72.16	33.54
T_2	100%RDF +seed treatment with liquid biofertilizer	19.40	38.45	57.88	33.41
T_3	100%RDF+ soil application with liquid biofertilizer	23.05	47.04	70.78	33.47
T_4	85%RDF+ seed treatment with liquid biofertilizer followed by soil application of liquid biofertilizer	21.47	44.18	65.71	33.42
T_5	85%RDF + seed treatment with liquid biofertilizer	18.24	36.48	54.79	33.38
T_6	85%RDF + soil application with liquid biofertilizer	20.92	42.57	63.42	33.41
T_7	70%RDF+ seed treatment with liquid biofertilizer followed by soil application of liquid biofertilizer	16.86	35.25	52.17	33.29
T_8	70%RDF + seed treatment with liquid biofertilizer	14.28	30.45	44.76	33.37
T_9	70%RDF + soil application with liquid biofertilizer	15.28	32.14	47.49	33.18
T_{10}	RDF (40:20:20,N:P_2O_5:K_2O Kg ha $^{-1}$)	19.02	38.07	57.13	33.40
T_{11}	Control	9.40	20.92	30.35	32.24
	S.Em.±	1.00	1.64	1.53	0.004
	CD (P=0.05)	2.99	4.87	4.60	NS
Seed treatment = (Bio- NPK liquid biofertilizer @ 5ml/kg seed) Soil application = liquid biofertilizer(bio-NPK @ 2.5 lit.) mixed with 500 Kg ha^{-1} FYM applied in furrow					

Table 7: Response of liquid biofertilizer and their mode of application on cost of cultivation and benefit cost ratio of Finger millet

Treatment No.	Treatment detail	Cost of Cultivation (₹ ha^{-1})	Gross Return (₹ ha^{-1})	Net Return (₹ ha^{-1})	B:C ratio
T_1	100%RDF+seed treatment with liquid biofertilizer followed by soil application of liquid biofertilizer	26965	89824	62859	2.33
T_2	100%RDF +seed treatment with liquid biofertilizer	24098	73536	49438	2.05
T_3	100%RDF+ soil application with liquid biofertilizer	26593	87710	61117	2.30
T_4	85%RDF+ seed treatment with liquid biofertilizer followed by soil application of liquid biofertilizer	26685	81789	55104	2.07
T_5	85%RDF + seed treatment with liquid biofertilizer	23808	69221	45413	1.91
T_6	85%RDF + soil application with liquid biofertilizer	26313	79574	53261	2.02
T_7	70%RDF+ seed treatment with liquid biofertilizer followed by soil application of liquid biofertilizer	26402	64366	37964	1.44

T_8	70%RDF + seed treatment with liquid biofertilizer	24025	54665	30640	1.28
T_9	70%RDF + soil application with liquid biofertilizer	26030	58383	32353	1.24
T_{10}	RDF (40:20:20,N:P_2O_5:K_2O Kg ha $^{-1}$)	23726	72188	48462	2.04
T_{11}	Control	21500	36203	14703	0.68
	S.Em.±		3188	3188	0.093
	CD (P=0.05)		9470	9470	0.277

Seed treatment = (Bio- NPK liquid biofertilizer @ 5ml/kg seed)
Soil application = liquid biofertilizer(bio-NPK @ 2.5 lit.) mixed with 500 Kg ha^{-1} FYM applied in furrow

Conclusion

On the basis of above finding the broad conclusion can be drawn for adoption of farmer's level. Application of 40N:20 P_2O_5:20 K_2O kg ha-^{1} + seed treatment with liquid biofertilizer (bio-NPK @5 ml kg^{-1}seed) + soil application of liquid biofertilizer (bio-NPK @ 2.5 lit.) mixed with 500 Kg ha^{-1} FYM applied in furrow may be recommended for obtaining profitable grain yield as well as improves soil nutrient status in finger millet we had investment on ₹ 1 in our research trail and profit in ₹ 2.33.

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