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Research Article

NUTRIENT CONTENT AND UPTAKE IN FINGER MILLET AS INFLUENCED BY FYM AND BIOFERTILIZERS ALONG WITH DIFFERENT LEVELS OF PHOSPHORUS AND POTASSIUM

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Abstract: A field experiment was carried out at Doddabelavangala village of Doddaballapura (T) under alfisols of Bangalore Rural district, Karnataka to study the effect of organic manure (FYM) and biofertilizers along with different levels of phosphorus and potassium on nutrient content and uptake of finger millet. On the basis of experimental data significant improvements were recorded in nutrient content and uptake of finger millet. The N, P and K content in finger millet (grain and straw) were significantly increased due to super optimal dose of NPK with FYM and bio-fertilizers. The maximum N, P and K content in grain (108, 0.38 and 0.90 percent) and straw (0.71, 0.19 and 1.07 percent) was recorded with application of 100 % NPK through POP + FYM + P and K solubilizer. The similar results were found in uptake of N, P and K by grain and straw in finger millet.

Keywords: Content and Uptake, P and K solubilizers, Finger millet, Grain and Straw, Levels of P and K

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Introduction

Alfisols form a major order of soils of Karnataka and finger millet is a staple food crop grown on these soils. These soils are low in organic matter content and their ability to retain moisture is also low. The structural instability of these soils leads to reduction in surface roughness and enhance surface sealing. These properties induce excessive runoff under high intensity rain and affects the seedling emergence particularly the small seeded crops like finger millet, pearl millet and sorghum. The occurrence, quantity and nature of soil organic matter which has been influenced by climatic conditions, determines the soil productivity. The organic matter content in the soil can be improved by the application of FYM and also use of biofertilisers [1]. It is estimated that by 2025, India will use about 45 million tonnes of plant nutrients, out of which 10 million tonnes is expected to come from organic manures. It is therefore, imperative to devise way to sustain and improve the overall productivity (crop, soil and livestock) for better livelihood. Approaches involving chemical fertilizers, organic manures, crop residues and bio-fertilizers to bridge the gap between nutrient demand and supply for giving a boost to agricultural production keeping the socio-economic aspects of the farmers are the only viable alternative. Nutrient management can provide the right answer for a better livelihood for the resource-poor farmers in rainfed areas [2]. As the inorganic fertilizers alone cannot meet the nutrient requirement of crops, because of high cost and environmental related risks involved in its application and usage, complementary use of organics with inorganic fertilizers is desired. Application of mineral fertilizers alone might supply only a few nutrients but conjoint use of nutrients and organic manures along with bio-fertilizer is required to provide all the essential nutrients leading to balanced nutrition. Phosphorus (P) and potassium (K) are costly nutrients and being used in India, where few million tones are being imported annually to India. Fertilizer application by farmers in India is skewed towards nitrogen and very less of phosphorus and potassium are added. P on addition undergoes transformation leading to build up; whereas K is either fixed or leached. Thus, successful use of an elite microbial strain capable of solubilizing insoluble phosphorus and potassium from minerals quickly in large quantity can conserve our existing resources and helps to avoid environmental pollution hazards caused by heavy application of chemical fertilizers. In order to sustain the yield and reduce the dependency on inorganic fertilizers, conjunctive use of organic manures, bio fertilizers and reduced doses of chemical fertilizers are very much essential [3]. In view of the above facts, the present investigation was carried out to evaluate the effect of organic manure (FYM) and biofertilizers along with different levels of phosphorus and potassium on nutrient content and uptake of finger millet.

Materials and methods

The experiment was conducted in the farmer's field in Doddabelavangala village of Doddaballapura (T), Bangalore Rural district, Karnataka. The experiment was conducted in Alfisol. Composite soil sample was collected from the experimental site and was analyzed for physical and chemical properties. According to USDA soil textural classification, the soil is categorized as red loamy. The pH of the soil was 7.39 and low in available nitrogen content (180.12 kg N ha^{-1}), high in available phosphorous (67.39 kg P_2O_5 ha^{-1}) and high in available potassium (345.36 kg K_2O ha^{-1}) content.

Bio-fertilizer cultures were obtained from Department of Agricultural Microbiology, University of Agricultural Sciences, GKVK, Bangalore. After the preparation of land, plots were laid out as shown in the [Fig-1]. Farmyard manure was incorporated into the soil two weeks before sowing date as per the treatment. Fertilizers were added to the soil on the day of sowing of seeds as per the treatment. N was applied as urea, P as single super phosphate and K as muriate of potash and fertilizers were mixed with soil. Top dressing with 50% N was followed one month after sowing of finger millet. After 30 DAP weeding was carried out. The crop was grown under protective irrigation. Grain and straw samples of finger millet crop were collected (randomly selected five plants) from all the thirty-three plots at the harvest of the crop. The samples were cleaned and cut in to pieces, oven dried at 60^{0}C for 10 hours and later grounded using Willey stainless steel mill and stored in paper bags.

Table -1

SN	Particulars	Value obtained	Method	References
I	Physical properties of soil			
1	Sand (%)	45.5	International Pipette method [4]	Piper (1966)
2	Silt (%)	28.0		
3	Clay (%)	26.3		
4	Texture	loamy		
II	Chemical properties of soil			
1	pH (1:2.5)	7.39	Potentiometry [5]	Jackson (1973)
2	Electrical conductivity (d Sm^{-1})	0.30	Conductometry [5]	Jackson (1973)
3	OC (%)	0.47	Wet oxidation method [6]	Walkley and Black (1934)
4	Avail N (kg ha^{-1})	180.12	Soil was extracted with 2 *M* KCl and estimated with continuous auto analyser [7]	Subbaiah and Asija (1956)
5	Avail P_2O_5 (kg ha^{-1})	67.39	Bray's No. 1 extractant method, Spectrophotometry [5]	Jackson (1973)
6	Avail K_2O (kg ha^{-1})	345.36	NH_4OAC extractant method, Flame photometry [5]	Jackson (1973)

Table-2 Effect of levels of phosphorus and potassium on major nutrient content (%) in grain and straw of finger millet

	Nitrogen		Phosphorus		Potassium	
Treatments	Grain	Straw	Grain	Straw	Grain	Straw
T_1: 100 % NPK POP (+FYM)	0.78	0.46	0.25	0.11	0.64	0.78
T_2: 100 % NPK POP (-FYM)	0.71	0.43	0.23	0.09	0.59	0.71
T_3: T_1 + P and K solubilizer	1.08	0.71	0.38	0.19	0.9	1.07
T_4: T_2 + P and K solubilizer	0.97	0.69	0.34	0.17	0.71	0.91
T_5: 100 % NP + 50% K + FYM + K solubilizer	0.91	0.66	0.27	0.15	0.75	0.85
T_6: 100 % NP + 50% K - FYM + No K solubilizer	0.74	0.46	0.16	0.13	0.57	0.7
T_7: 100 % N + 50% P + 100% K + FYM + P solubilizer	0.87	0.6	0.29	0.17	0.71	0.84
T_8: 100 % N + 50% P + 100% K - FYM + No P solubilizer	0.79	0.53	0.23	0.14	0.61	0.73
T_9: 100 % N + 50% P + 50% K + FYM + P and K solubilizer	1.01	0.7	0.35	0.18	0.81	1.04
T_{10}: 100% N + 50 % P + 50% K – FYM + No P and K solubilizer	0.69	0.43	0.21	0.14	0.43	0.6
T_{11}: Absolute control	0.52	0.4	0.19	0.08	0.34	0.48
S.Em±	0.03	0.04	0.03	0.01	0.05	0.04
CD @ 5%	0.1	0.13	0.1	0.04	0.14	0.11

Table-3 Effect of levels of phosphorus and potassium on uptake (kg ha^{-1}) of major nutrients in grain and straw of finger millet

Treatments	Nitrogen		Phosphorus		Potassium	
	Grain	Straw	Grain	Straw	Grain	Straw
T_1: 100% NPK POP (+FYM)	26.85	18.47	8.45	4.42	22.96	28.04
T_2: 100% NPK POP (-FYM)	21.83	16.16	7.15	3.42	20.21	22.83
T_3: T_1 + P and K solubilizer	41.92	31.7	14.86	8.4	34.71	48.14
T_4: T_2 + P and K solubilizer	36.77	28.57	12.92	7.18	27.11	37.67
T_5: 100% NP + 50% K + FYM + K solubilizer	32.19	26.3	9.54	5.83	26.88	33.58
T_6: 100% NP + 50% K - FYM +no K solubilizer	23.8	16.94	5.1	4.96	19.86	17.96
T_7: 100% N + 50% P + 100% K + FYM + P solubilizer	31.38	23.76	10.58	6.73	25.41	33.4
T_8: 100% N + 50% P + 100% K - FYM + No P solubilizer	27.56	20.57	8.13	5.48	21.31	17.67
T_9: 100% N + 50% P + 50% K + FYM + P and K solubilizer	37.56	29.51	12.86	7.76	29.98	35.67
T_{10}: 100% N + 50% P + 50% K – FYM + No P and K solubilizer	22.54	16.21	6.97	5.47	13.95	13.56
T_{11}: Absolute control	14.02	13.77	5.19	2.75	9.17	10.45
S.Em±	1.64	1.77	1.29	0.49	1.78	1.84
CD @ 5%	4.86	5.21	3.8	1.44	5.26	5.42

The collected grain and straw samples of the crop were powdered and analyzed for N, P and K content as described by [8]. The N, P, and K content was expressed as percent and its uptake in kg ha-1 was calculated by using following formula. Protein content in grain was calculated by multiplying percent nitrogen in grain with a constant factor 6.25 [9].

Treatments	
T_1	100% NPK POP (+FYM)
T_2	100% NPK POP (-FYM)
T_3	T_1 + P and K solubilizer
T_4	T_2 + P and K solubilizer
T_5	100% NP + 50% K + FYM + K solubilizer
T_6	100% NP + 50% K - FYM + No K solubilizer
T_7	100% N + 50% P + 100% K + FYM + P solubilizer
T_8	100% N + 50% P + 100% K - FYM + No P solubilizer
T_9	100% N + 50% P + 50% K + FYM + P and K solubilizer
T_{10}	100% N + 50% P + 50% K – FYM + No P and K solubilizer
T_{11}	Absolute control

Note: FYM: Applied at the rate of 15 t ha^{-1}, P solubilizer (*Bacillus megaterium*): Applied at the rate of 5 kg ha^{-1}, K solubilizer (*Frateuria aurantia*): Applied at the rate of 5 kg ha^{-1}

The methods outlined by [10] were made used for statistical analysis of the data for drawing conclusion on the effect of various treatments on different parameters studied. The experiment was laid out in randomized complete block design having eleven treatment combinations and replicated thrice.

Results

The data pertaining to nutrient content in finger millet grain and straw are presented in [Table-2]. The nitrogen content in finger millet grain was significantly highest (1.08 percent) in T_3 (T_1 + P and K solubilizer) followed by T_9 (100 % N + 50 % P + 50 % K +FYM + P and K solubilizer) and T_4 (T_2 + P and K solubilizer) of 1.01 percent and 0.97 percent respectively. With respect to straw nitrogen content, all the treatments increased significantly compared to control. The higher N content was recorded in (0.71 percent) the treatment T_3 which received T_1 + P and K solubilizer and recorded lowest in the treatment T_{11} (0.40 percent) where no fertilizers were added. Phosphorus content in finger millet grain was significantly highest in the treatment T_3 (0.38 percent) followed by T_9 (0.35 percent) and T_4 (0.34 percent), whereas lowest phosphorus content was recorded in treatment T_{11} (absolute control: 0.19 percent). The treatment T_7 recorded high (0.29 percent)

phosphorus content than the T_5 (0.27 percent) due to application of chemical fertilizer and FYM along with inoculation of P solubilizer. With respect to phosphorus content in straw of finger millet, significantly higher content of phosphorus was recorded in the treatment T_3 (0.19 percent) followed by T_9 (0.18 percent) and T_4 (0.17 percent) respectively. The lower phosphorus content of 0.08 percent was recorded in T_{11} which received no fertilizers (absolute control). The potassium content in finger millet grain was significantly higher (0.90 percent) in treatment T_3 (T_1 + P and K solubilizer) followed by T_9 (100 % N + 50 % P +50 % K + FYM + P and K solubilizer) and T_4 (T_2 + P and K solubilizer) which recorded 0.81 and 0.71 percent respectively. The treatment T_5 (100 % NP + 50 % K +FYM + K solubilizer) recorded higher of 0.75 percent potassium content in grain than T_7 (100 % NK + 50 % P + FYM + P solubilizer). The lower potassium content was recorded in the treatment T_{11} (0.34 percent) where no fertilizers were added. Significant increase in nitrogen uptake [Table-3] by both grain and straw of finger millet crop was observed in all treatments except T_{11} (absolute control). Significantly higher content of 41.92 kg ha^{-1} and 31.70 kg ha^{-1} nitrogen uptake by grain and straw was recorded in the treatment T3 which received chemical fertilizer and FYM along with dual inoculation of both P and K solubilizer (T_1 + P and K solubilizer). The phosphorus uptake in finger millet grain showed significantly highest 14.86 kg ha^{-1} in the treatment T_3 (T_1 + P and K solubilizer) followed by the treatments T_4 (12.92 kg ha^{-1}) and T_9 (12.86 kg ha^{-1}) respectively. The treatments T11 (5.19 kg ha-1) recorded lowest phosphorus uptake. Similar trend were also observed in uptake of phosphorus by finger millet straw. The potassium uptake by finger millet grain and straw increased significantly in most of the treatments. The treatment T_3 recorded highest (34.71 kg ha^{-1}) and lowest in T_{11} (9.17 kg ha^{-1}). The treatment T_5 (100 % NP + 50 % K + FYM + K solubilizer) recorded highest of 26.88 mg kg^{-1} potassium content as compare to T_7 (25.41 kg ha-1) which received 100 % NK + 50 % P + FYM + P solubilizer. With respect to straw the T_3 (48.14 kg ha^{-1}) treatment recorded highest potassium uptake whereas lowest potassium uptake by T_{11} (10.45 kg ha^{-1}) treatment where no fertilizer was added.

Discussion

The N, P and K content in finger millet (grain and straw) were significantly increased and high due to super optimal dose of NPK with FYM and bio-fertilizers. The uptake of NPK were also high in treatment which received T_1 + P and K solubilizer due to maximum yield followed by treatment in which organic source of nutrient was applied along with varied levels of inorganic sources and bio-fertilizers. Low uptake was observed in treatment with imbalanced application of NPK (T_6, T_8, and T_{10}) and absolute control (T_{11}), which recorded low yield due to low availability of nutrients in soil. Nutrient concentration and higher uptake observed with integrated nutrient supply treatment might be due to application of nutrients as per the plant requirement in the form of both organic and inorganic sources plus bio-fertilizers which might have added nutrients to the available pool besides improving the root environment, the availability of nutrients and less loss of nutrients in soil, which intern increased the uptake of nutrients by crop. The uptake and concentration of N, P and K content in grain and straw was higher in finger millet due to the application of fertilizers and FYM along with the dual inoculation of bio-fertilizers. Similar results were reported by [11] and [12] reported that the application of co- inoculation of KSB and PSB recorded higher uptake of N, P and K than with the application of single combination and the control.

Conclusion

From the study, it was inferred that combined use of organic (FYM) and inorganic fertilizers along with biofertilizers (P and K solubiliser) was better for improving nutrient content and uptake of finger millet compared to sole application of inorganic fertilizers.

Application of research: Study of application of inorganic fertilizers

Research Category: Inorganic fertilizers

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