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Effect of long term integrated nutrient management practices on yield and nutrient uptake by finger millet (*Eleusine coracana L.*) in an acidic *Inceptisols*

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ABSTRACT

The present experiment was conducted to study the effect of long term integrated nutrient management practices on yield and nutrient uptake by Finger millet (Eleusine coracana) in an acidic Inceptisols. Experiment was carried out in RBD with 8 treatments and 3 replications. The test crop used was finger millet, cv Arjuna and was the 26th crop in a cereal-vegetable-pulse cropping system. The soil was initially acidic (pH 5.14) in reaction and in general poor in nutrient status. Significantly higher plant height (191 cm) was recorded with (Soil test dose + FYM +Lime + Biofertilizers) whereas the lowest value was recorded with control (115 cm) after 90 days of transplanting. The total biomass production varied significantly between 3.1 and 8.3 t ha^{-1}, lowest with control and highest with all integrated package of practices (Soil test dose + Vermicompost + Lime + Biofertilizers). It followed the trend: Soil test dose < Soil test dose + Vermicompost < Soil test dose + FYM < Soil test dose + Vermicompost + Biofertilizers < Soil test dose + FYM + Biofertilizers < Soil test dose + Vermicompost + Lime + Biofertilizers < Soil test dose + FYM + Lime + Biofertilizers. Among the treatments, total nutrient uptake by finger millet was recorded lowest in control and highest in treatment (Soil test dose + FYM + Lime + Biofertilizers). The use of FYM or vermicompost did not differ significantly in respect of yield and nutrient uptake.

Keywords: Finger millet, yield, nutrient uptake, *Inceptisols*

INTRODUCTION

Integrated nutrient management (INM) influence the economic return of the investment through optimized yield and quality produce as well as the cause for minimum level of environmental hazards. The efficient and judicious use of the major sources of plant nutrients in integrated approach so as to get maximum economic yield without any deleterious effect on physico–chemical and biological properties of the soil is the aim of the integrated nutrient management (Sarkar *et. al*., 2020). The increase in yield, crop water use efficiency, grain quality, economic return and sustainability are the major advantages of INM (Wu and Ma, 2015). Integrated nutrient management including the use of mineral fertilizers and organic manures is one of the viable options for sustaining soil health and crop productivity (Pattanayak, 2016). Finger millet (*Eleusine coracana*) is one of the major staple food crops of the semi-arid tropics of Asia and Africa and has been regarded as a compelling component of dryland farming systems. Locally it is known as Ragi in India. It is commonly known as "nutritious millet" as the grain is nutritionally superior to many cereals. Finger millet is a good source of nutrients specially protein, fibers, calcium and other minerals. It is drought tolerant and disease resistant crop. It has ability to adjust at different climatic conditions. As emphasis is on producing more grains, a technologically sound integrated nutrient management practices should be formulated on ecological basis and must be transferred to farmer's field after proper evaluation. Information regarding INM package and practices suitable for specific cropping sequence or ecological situation is scanty. Therefore, the present investigation was undertaken to study the effect of long term integrated nutrient management practices on yield and nutrient uptake by Finger millet (*Eleusine coracana*) in an acidic *Inceptisols* to produce maximum yield with a better nutrient uptake.

MATERIALS AND METHODS

Long-term field experiment was initiated in the campus of College of Agriculture, OUAT, Bhubaneswar, during kharif, 2010 with cereal – vegetable – pulse cropping sequence. The experimental site is located at 25^{0}15$^'$ N latitude

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and $80^0 52'$ E longitude and altitude of 25.9 m above mean sea level (MSL). In 11th year (2019-20), finger millet was the test crop. The present crop finger millet cv. *Arjuna* was 26th crop in the sequence. This crop had inherited residual effects of 25 crops grown in the succession. The crop was transplanted after 20 days in nursery. The soil was loamy sand in texture. It was strongly acidic in reaction, pHw (1:2.5) 5.14. The organic carbon status was low (2.7 g kg^{-1}). The available nitrogen, Bray's-1 phosphorus, ammonium acetate extractable potassium and $CaCl_2$ extractable sulphur were 207 kg ha^{-1}, 37 kg ha^{-1}, 84 kg ha^{-1} and 25 kg ha^{-1} respectively. The test crop received N-P_2O_5-K_2O-S @ 60-40-40-30 kg ha^{-1} in the form of urea, navaratna (20-20-0-13) and muriate of potash, respectively. The FYM and vermicompost were applied @ 5.0 and 2.5 t ha^{-1} respectively as per treatments. The *Azotobacter*, *Azospirillum* and PSB (1:1:1) (*consortia*) @ 4kg each ha^{-1} (12 kg consortia ha^{-1}), inoculated to limed (5 per cent) vermicompost in 1:25 ratio, incubated for 7 days at 30 per cent moisture in temperature and applied as basal. The source of lime was calcium silicate (NV 80%). It was applied @ 0.1 LR and applied as basal mixed with organics. The experiment was carried out in randomized block design with 8 treatments and 3 replications. The treatment details were as T1: Control, T2: STD(Soil test-based dose- N-P_2O_5-K_2O-S @ 75- 40-50-22.5 kg ha^{-1}), T3: STD + @ 5 t FYM ha^{-1}, T4: STD + @ 2.5 t Vermicompost ha^{-1}, T5: STD + FYM + Biofertilizers (BFs), T6: STD + VC + BFs, T7: STD + FYM +Lime + BFs and T8: STD + VC + Lime + BFs. The crop was harvested in the last week of September, 2019. Different growth and yield parameters were recorded. The grain and straw samples were analysed for their N, P, K and S content by standard procedures (Panda, 2019). Nutrient uptake was computed by multiplying yield data with nutrient concentrations. The analysis of variance (ANOVA) of different variables of different treatments was statistically calculated at p = 0.05 level of significance (Panse and Sukhatme, 1985). The test of significance was analyzed by using DSSTAT software package.

RESULTS AND DISCUSSION

Growth and productivity

At 30th day after transplanting, the plant height varied between 51 and 70 cm, lowest with control and highest at STD + Lime + FYM + Biofertilizers package (Table 1). The crop continued to grow up to 90th day after transplanting and the crop attended the height ranging from 115 to 191 cm. During initial stage of crop growth, the metabolic activity of cells and synthesis of metabolites are more that leads to better vegetative growth. Supply of proper nutrients during this growth phases through integrated nutrient management practices can sustain crop growth and productivity. Similar results were also reported by Pallavi *et al.* (2017) and Sarkar *et.al*. (2020).

Table 1 Influence of long term INM practices on growth and productivity of crop Finger millet

POPs	Plant height (cm)			Yield (t ha^{-1})	
	30 DAT	60 DAT	90 DAT	Grain	Straw
T_1: Control	51	96	115	0.93	1.95
T_2: STD	58	112	130	1.10	2.60
T_3: STD + F	66	152	167	2.31	4.06
T_4: STD + VC	66	150	156	2.29	3.94
T_5: STD+F+BFs	69	170	179	2.40	3.85
T_6: STD+VC+BFs	68	168	177	2.37	3.85
T_7: STD+F+L+BFs	70	182	191	2.91	4.87
T_8: STD+VC+L+BFs	69	175	188	2.87	5.15
LSD (P = 0.05)	4.3	4.6	9.4	0.14	0.20

DAT: Days after transplanting, STD: Soil test dose of fertilizers, F: FYM, VC: Vermicompost, BFs: Biofertilizers, and L: Lime @ 0.1LR

The grain and straw yield of finger millet under the influence of integrated POPs varied significantly between 0.93 and 2.91 t ha^{-1} and 1.78 to 5.15 t ha^{-1}, respectively (Table 1). Lowest was recorded with control (receiving no external source of nutrient) and highest with STD + FYM + Lime + Biofertilizers. The grain and straw yield increased significantly due to use of external sources of nutrients when used either alone or together compared over control. There was no significant difference due to use of FYM and/or vermicompost as the sources of organics. However, their lone integration with STD significantly influenced the yield. The unintegrated STD package yielded 52 per cent less potential yield. Integrated use of consortia biofertilizerss with STD + Organics increased the grain yield by 4 per cent. Combining lime application to INM package significantly increased (20.9 %) grain yield compared over STD + Organics + Biofertilizers and 25.7 per cent over STD + Organic package. This result corroborated the findings of Shankar *et.al*. (2011), Das *et al.,* (2013). and Shanmugasundaram *et al*, (2019).

Nutrient uptake

The uptake through grain and straw ranged from 7.4 to 28.8 kg ha^{-1} and 15.8 to 60.3 kg ha^{-1}, respectively. External supplementation of nitrogen through soil test dose (STD) practice significantly increased N uptake compared to control. Integrating organics either alone or together with biofertilizers and liming significantly increased N uptake by finger millet. There was no significant difference between the performance of FYM and vermicompost on N uptake. A similar finding was also reported by Harika (2019). Proper distribution of phosphorous (P) in the crop resulted in uptake of P ranging from 1.9 to 6.7 kg ha^{-1} through grain and 4.6 to 17.0 kg ha^{-1} through straw (Table 2). The uptake of P differed significantly depending upon the package of practices adopted. Combining organics with STD package specifically FYM source significantly (92.6%) influenced P uptake than the vermicompost source (76.5%). The P uptake was further influenced by the use of biofertilizers (18.7%) and liming (53%). This result corroborated the findings of Harika, (2019).

Table 2: Uptake of nutrients (kg ha^{-1}) by crop finger millet under the influence of long term INM practices

POPs	Nitrogen		Phosphorus		Potassium		Sulphur	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_1: Control	7.4	15.8	1.9	5.1	5.6	15.5	0.2	3.9
T_2: STD	10.5	25.8	1.9	6.2	5.9	20.8	0.4	6.2
T_3: STD + F	19.4	41.7	4.7	10.9	14.7	36.7	0.9	8.9
T_4: STD + VC	20.6	42.2	4.1	10.2	14.7	36.7	1.1	7.4
T_5: STD+F+BFs	21.6	42.4	5.0	13.1	15.9	38.4	1.4	8.7
T_6: STD+VC+BFs	22.8	44.3	5.2	12.3	15.3	38.9	1.3	10.3
T_7: STD+F+L+BFs	28.8	59.5	6.7	16.6	19.5	45.8	2.0	14.8
T_8: STD+VC+L+BFs	27.8	60.3	5.7	17.0	18.4	47.0	1.8	15.0
LSD (P = 0.05)	1.24	2.04	0.27	0.53	0.83	2.22	0.27	0.47

Differential potassium (K) distribution in crop resulted in more uptake through straw (15.5 to 47.0 kg ha^{-1}) than grain (5.6 kg to 19.5 kg ha^{-1}). The K uptake increased significantly (table 2) in different treatments and it followed the trend: STD+ Organics (92.5%) < Organics + Biofertilizers (103%) < Organics + Lime + Biofertilizers (144.6%). The use of FYM or verimcompost did not differ significantly in influencing K uptake by finger millet. Similar results were also reported by Pushpa *et al.* (2013) and Roy *et al.* (2018). Distribution of sulphur (S) in finger millet followed more S uptake in straw (3.9 to 15 kg S ha^{-1}) than grain (0.2 to 2.0 kg S ha^{-1}). Significant amount of sulphur was removed under the influence of integrated package of practices (Table 2). The treatment soil test dose (STD) significantly influenced S uptake by finger millet. Combining organics with STD or biofertilizers and liming increased S uptake significantly in grain (2.0 kg S ha^{-1}) and straw (15 kg S ha^{-1}). Similar findings were also corroborated by Pushpa *et al.* (2013) and Sarkar *et.al*. (2020).

From the present study it may be concluded that use of biofertilizers and liming material in combination with STD + organics had a significant influence on finger millet economic yield. Liming practice under acid soil could enhance economic yield over no liming practice. The use of FYM or vermicompost did not differ significantly in terms of yield and nutrient uptake.

Continuous application of soil test based dose of nutrients resulted in decreased potential yield of finger millet. Use of complete integrated package of practices had a significant influence on nutrient uptake by finger millet under long term INM practices.

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