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Effect of integrated nutrient management on growth and productivity of Kodo millet (*Paspalum scrobiculatum* L.)

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Abstract

A field experiment was carried out during *kharif* season 2016 and 2017 at the farmer's field in village Gudhar, Rewa (M.P.) to study the effect of integrated nutrient management on growth and productivity of kodo millet. Sixteen treatments were evaluated in randomized block design with three replications. The results revealed that the application of 100% NPK fertilizers (40 kg N, 20 kg P₂O₅ and 10 kg K₂O)/ha proved the most beneficial for growing kodo millet var. JK-13 under rainfed condition of Kymore plateau. Accordingly 100% NPK fertilizers dose. resulted in maximum plant height (36.95 cm), tillers (95.0/m length), leaves (35.35/plant), LAI (3.84), roots (58.45/plant), root length (15.0 cm), grain yield (27.55 q/ha) and net income of Rs.60098/ha with 5.46 B: C ratio. Amongst the INM packages, application of 100% N by 80 q/ha vermicompost along with 66.6 kg/ha rock phosphate performed the best giving higher growth attributes and yield of 25.35 q/ha with net income up to Rs. 51950/ha and 4.47 B:C ratio. The second best INM package (50% N by FYM + green manuring +33.3 kg rock phosphate/ha) gave 23.74 q/ha yield and Rs. 46706/ha net income. Both these INM packages may be recommended to achieve sustainable productivity of kodo millet in Kymore plateau of Madhya Pradesh.

Keywords: Integrated nutrient management, kodo-millet, growth, productivity

Introduction

Kodo Millet (*Paspalum scrobiculatum* L.) is one of the important small millet crops of Madhya Pradesh particularly in Kymore plateau. It provides staple food with cheap protein, minerals and vitamins to poor, marginal, tribal and backward people of Madhya Pradesh. Dindori district ranks second after Bastar among the small millets growing district of the state Madhya Pradesh. It is mostly taken by small and marginal farmers in tribal areas under rainfed conditions with low productivity. Kodo millet grown in the soils of lower nutrient contents results in lower quality and quantity of produce. Therefore, manures are the only option for improving the quality and sustain the yield of kodo millet as well as soil health.

The continuous use of chemical fertilizers has degraded physico-chemical and biological properties of soil, its environment and soil health. The nutrient requirement of crops can not, however, be met through fertilizers alone. Besides the escalating prices of fertilizers and their inadequacy calls for integration of organic – cum – inorganic nutrient sources for meeting the nutrient demand of crops. The estimated nutrient potential of organic wastes in the country is about 19.11 million tonnes. Organic wastes can be transformed into usable manures with high nutritive value (Sharanappa, 2002) [7]. In fact, the balanced fertilization from different sources is referred as the integrated nutrient management. Organic manures such as vermicompost, poultry manure, FYM (cattle manure), composts etc. are the important components of integrated nutrient management. Organic manures also supply the micronutrients, which are generally not applied by the farmers to their crops. *Azospirillum* and *Aspergillus* are the potential biofertilizers and are capable to contribute nitrogen and phosphorus to a number of non-legumes. In the light of these facts as well as for securing sustainable production of kodo-millet under the agro-climatic conditions of Kymore plateau, the present investigation was conducted.

Materials and Methods

The field experiment was carried out during rainy season 2016 and 2017 at the farmer's field in

village Gudhar, Rewa (M.P.). The soil of the experimental field was silty clay-loam having pH 7.3-7.4, electrical conductivity 0.30-0.35 dS m⁻¹, organic carbon 6.75-6.82 g kg⁻¹, available-N 226-231 kg ha⁻¹, available-P₂O₅ 23.0-24.9 kg ha⁻¹, available-K₂O 374-389 kg ha⁻¹ and available-S 12.8-13.4 kg ha⁻¹. The experiment was laid out in randomized-block design with three replications. The treatments comprised sixteen INM packages (Table 1). The kodo-millet variety JK-13 was sown on 12 and 14 July 2016 and 2017, respectively keeping a seed rate of 10 kg ha⁻¹ and row spacing 25 cm and plant spacing 7.5 cm. The organic and inorganic sources of nutrients were applied as basal according to the specified treatments. The crop was grown under rainfed condition. The rainfall received during the crop season 2016 and 2017 was 681.0 and 704.6 mm with 33 and 37 rainy days, respectively. The crop was harvested on 17-19 October in both the years. The growth attributes and yield of kodo millet were recorded under each of the INM treatments.

Results and Discussion

Growth parameters: The data (Table 1) revealed that among the applied packages, 100% inorganic sources of nutrients (N₄₀P₂₀K₁₀) i.e. T₁₅ performed the best in augmenting all these growth parameters upto significant extent. At 75 days stage, the maximum plant height was 36.95 cm, tillers 95.04/m row length, leaves 35.35/plant, LAI 3.84, roots 58.45/plant and root length 15.06 cm. This may be owing to the immediate availability of the major plant nutrients in the requisite amount from the 100% NPK fertilizers.

Amongst the (INM) packages, T₂ (100% N by vermicompost + 66.6 kg rock phosphate/ha) and T₆ (T₂ + dual biofertilizers) performed the best, although other packages viz. T₈, T₁₁, T₁₃ and T₁₄ also performed equally well in encouraging all the growth parameters. The better growth parameters owing to sustained supply of FYM, vermicompost along with dual biofertilizers have provided all the important growth nutrients along with micronutrients during the peak demand period in the early growth stage coupled with more photosynthesis and translocation of more photosynthetic might have been the reason for superior growth parameters. These results are in accordance with the findings of

Kaushik *et al.* (2012), Singh and Chauhan (2014)^[9], Dwivedi *et al.* (2016)^[2] and Ram Bharose *et al.* (2018)^[6] and Pandey *et al.*, (2018)^[5].

Productivity parameters: Application of 100% NPK fertilizers (T₁₅) recorded the significantly higher grain (27.55 q ha⁻¹) and straw yield (46.83 q ha⁻¹) over most of the other treatments. (Table 2) This might be owing to the fact that NPK fertilizers provided immediate availability of major nutrients to the actively growing plants. The superiority of 100% NPK (T₁₅) over other treatments with respect to growth and yield attributes have mutually accompanied to give rise maximum out put in the form of grain and straw yields. All these parameters were found beneficial in increasing production and transmission of photosynthates towards the sink.

Amongst the integrated supply of nutrients, T₆ having 100% N by vermicompost + rock phosphate + biofertilizers and then T₂ having 100% N by vermicompost + rock phosphate resulted in the second and third best in productivity (26.55 and 25.35 q ha⁻¹, respectively). This might be attributed to higher availability of primary, secondary and micro-nutrients, higher occurrence of different beneficial microorganisms, production of growth-promoting hormones, antibiotics, enzymes in vermicompost (Kaushik *et al.*, 2012; Dwivedi *et al.*, 2016 and Pandey, 2018)^[1, 2, 5]. The beneficial effect of vermicompost on rice has been reported by Barick *et al.* (2008)^[1] who found that substitution of chemical fertilizers through vermicompost by 40-60% of nitrogen would be better to reduce chemical fertilizers without affecting the crop yield and soil quality.

Economics: Application of 100% NPK fertilizers (T₁₅) resulted in the maximum net income of Rs.60098 ha⁻¹ with 5.46 B:C ratio. This was followed by T₂ (Rs.51950 ha⁻¹ with 4.47 B:C ratio) and then T₁₁ (50% N by FYM + GM + 33.3 kg RP/ha) giving net income of Rs.46706 ha⁻¹. The lowest net income (Rs.28451 ha⁻¹) was obtained from the absolute control (T₁₆). This was eventual as the net income is directly positively correlated with the grain and straw yields obtained from these treatments.

Table 1: Growth parameters of kodo millet as influenced by INM treatments

S. No.	Treatments	Plant height (cm) at 75 DAS	No. of tillers/m row length at 75 DAS	No. of leaves/plant at 75 DAS	Leaf area index at 75 DAS	No. of roots/plant at 75 DAS	Length of roots/plant at 75 DAS
T ₁	50% N by 40 q VC/ha + 33.3 kg RP/ha	36.70	84.84	29.42	2.63	52.33	11.05
T ₂	100% N by 80 q VC/ha + 66.6 kg RP/ha	36.25	91.65	33.56	3.55	56.44	14.25
T ₃	50% N by 50 q FYM/ha + 33.3 kg RP/ha	34.85	86.05	28.85	2.56	54.05	11.27
T ₄	100% N by 100 q FYM/ha + 66.63 kg RP/ha	35.05	88.25	30.44	3.17	53.85	13.07
T ₅	T ₁ + 8 kg Biof. (Azos. + Asper.)/ha	35.35	87.15	30.05	2.87	52.84	11.06
T ₆	T ₂ + 16 kg Biof. (Azos. + Asper.)/ha	36.35	90.56	31.35	3.76	57.34	14.74
T ₇	T ₃ + 10 kg Biof. (Azos. + Asper.)/ha	35.35	88.25	31.56	2.76	53.26	11.57
T ₈	T ₄ + 20 kg Biof. (Azos. + Asper.)/ha	35.05	92.75	31.95	3.25	54.04	13.16
T ₉	T ₁ + 50% N by 50 q FYM/ha + 33.3 kg RP/ha	35.34	87.14	29.84	2.85	53.05	12.06
T ₁₀	T ₉ + 17.9 kg Biof. (Azos. + Asper.)/ha	35.55	85.76	29.95	3.06	54.23	12.44
T ₁₁	50% N by FYM + GM +	34.85	89.18	31.56	3.34	54.56	13.64

	33.3 kg RP/ha						
T ₁₂	T ₁₁ + 10 kg Biof. (Azos. + Asper.)/ha	35.25	86.09	31.24	2.93	52.84	12.33
T ₁₃	100% N by FYM + GM + 33.3 kg RP/ha	35.44	90.56	31.44	3.45	55.56	14.07
T ₁₄	T ₁₃ + 20 kg Biof. (Azos. + Asper.)/ha	36.33	86.05	31.86	3.56	56.13	14.46
T ₁₅	100% inorganics (N ₄₀ P ₂₀ K ₁₀)	36.95	95.04	35.35	3.84	58.45	15.06
T ₁₆	Absolute control	36.70	80.21	27.58	2.34	51.81	10.66
	S.Em±	0.08	0.08	0.46	0.03	0.13	0.05
	C.D. (P=0.05)	0.21	0.23	1.32	0.10	0.37	0.12

VC = vermicompost, FYM = farmyard manure, GM = green manure, Biof. = biofertilizers, RP = rock phosphate

Asper. = *Aspergillus awamori*, Azos. = *Azospirillum brasilense*

Table 2: Effect of INM practices on yield and economics of kodo millet

	Treatments	Grain yield (q ha ⁻¹)	Straw yield (q ha ⁻¹)	Net income (Rs. ha ⁻¹)	B:C ratio
T ₁	50% N by 40 q VC/ha + 33.3 kg RP/ha	19.25	35.65	30840	2.48
T ₂	100% N by 80 q VC/ha + 66.6 kg RP/ha	25.35	35.25	51950	4.47
T ₃	50% N by 50 q FYM/ha + 33.3 kg RP/ha	19.05	37.94	35569	3.24
T ₄	100% N by 100 q FYM/ha + 66.6 kg RP/ha	23.25	37.94	42569	3.20
T ₅	T ₁ + 8 kg Biof. (Azos. + Asper.)/ha	22.65	44.75	39450	2.82
T ₆	T ₂ + 16 kg Biof. (Azos. + Asper.)/ha	26.55	42.06	39631	2.28
T ₇	T ₃ + 10 kg Biof. (Azos. + Asper.)/ha	20.74	37.93	38793	3.30
T ₈	T ₄ + 20 kg Biof. (Azos. + Asper.)/ha	23.75	42.05	42730	3.05
T ₉	T ₁ + 50% N by 50 q FYM/ha + 33.3 kg RP/ha	22.74	39.35	36435	2.50
T ₁₀	T ₉ + 17.9 kg Biof. (Azos. + Asper.)/ha	23.46	40.65	36595	2.40
T ₁₁	50% N by FYM + GM + 33.3 kg RP/ha	23.74	42.06	46706	3.77
T ₁₂	T ₁₁ + 10 kg Biof. (Azos. + Asper.)/ha	23.15	33.79	43404	3.43
T ₁₃	100% N by FYM + GM + 33.3 kg RP/ha	24.46	40.65	44865	3.20
T ₁₄	T ₁₃ + 20 kg Biof. (Azos. + Asper.)/ha	24.64	42.05	43455	2.94
T ₁₅	100% inorganics (N ₄₀ P ₂₀ K ₁₀)	27.55	46.83	60098	5.46
T ₁₆	Absolute control	15.16	29.01	28451	3.30
	S.Em±	0.09	0.10	--	--
	C.D. (P=0.05)	0.25	0.28	--	--

VC = vermicompost, FYM = farmyard manure, GM = green manure, Biof. = biofertilizers, RP = rock phosphate

Asper. = *Aspergillus awamori*, Azos. = *Azospirillum brasilense*

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