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Effect of integrated nutrient management on yield and nutrient uptake of transplanted Kodo millet

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ABSTRACT
An experiment was conducted at Annamalai University Experimental Farm, Department of Agronomy, Annamalai University, Annamalai Nagar for *kharif* seasons of 2014 to study the effect of integrated nutrient management (INM) on yield and nutrient uptake of transplanted kodo millet. The treatments consisted of The treatments comprised of T_1-Control,T_2 -75 % Recommended Dose of Fertilizers (33:17.5:0 kg NPK ha^{-1}),T_3 -75 % RDF + soil application of *Azospirillum* @ 2 kg ha^{-1}, T_4 -75 % RDF + soil application of *Azospirillum* @ 2 kg ha^{-1}+ vermicompost @ 2 t ha^{-1}, T_5 -75 % RDF + soil application of *Azospirillum*@ 2 kg ha^{-1} + vermicompost @ 2 t ha^{-1} + foliar application of 1 % poly feed at tillering and flowering, T_6 -100 % RDF (44:22:0 kg NPK ha^{-1}), T_7 -100 % RDF + soil application of *Azospirillum* @ 2 kg ha^{-1}, T_8 -100 % RDF + soil application of *Azospirillum* @ 2 kg ha^{-1} + vermicompost @ 2 t ha^{-1}, T_9-100 % RDF + soil application of *Azospirillum* @ 2 kg ha^{-1} + vermicompost @ 2 t ha^{-1} + foliar application of 1 % poly feed at tillering and flowering, T_{10} -125 % RDF (55:27.5:0 kg NPK ha^{-1}), T_{11} -125 % RDF + soil application of *Azospirillum* @ 2 kg ha^{-1}, T_{12} -125 % RDF + soil application of *Azospirillum* @ 2 kg ha^{-1} + vermicompost @ 2 t ha^{-1}, T_{13} 125 % RDF + soil application of *Azospirillum* @ 2 kg ha^{-1} + vermicompost @ 2 t ha^{-1} + foliar application of 1 % poly feed at tillering and flowering. The experiment was laid out in Randomized Block Design with three replications. The higher yield (grain and straw) and nutrient uptake (NPK) of kodo millet was recorded at 125% RDF, *Azospirillum*, vermicompost and poly feed. This was on par with 125 % recommended dose of fertilizers (55:27.5:0 kg NPK ha^{-1}) + soil application of *Azospirillum* @ 2 kg ha^{-1} + vermicompost @ 2 t ha^{-1}). The lowest grain, straw yield and NPK uptake was observed under absolute control.

Keywords: INM, kodo millet, yield, NPK uptake.

Introduction

The under-utilized food grains have a vast scope for not only supporting the commercially grown crops by reducing pressure on their availability but they are cheap source of nutrients and can be raised at low management cost (Sankhala *et al*., 2004) [7]. Minor millets are a group of grassy plants with short stalk and small grains possessing remarkable ability to survive under severe drought. The nutritional significance of minor millets lies in their richness in micronutrients like calcium, iron, phosphorus, vitamins and sulphur containing amino acids. The soluble fiber content of minor millets varies from 3.4 % in foxtail and proso millet, while 6.5 % in barnyard and finger millet. Owing to its superior properties, of minor millets have been recently designated as "*Nutritious Millets*" by Prof. M.S. Swaminathan. However, six minor millets *viz*., Finger millet (*Eleusine Coracana*), Foxtail/Italian millet (*Setaria Italica*), Kodo millet (*Paspalum Scrobiculatum*), Common/Proso millet (*Panicum miliaceum*), Little millet (*Panicum sumatrense*), Barnyard/Sawa millet (*Echinochloa utilis*) are those important minor millet crops, in view of their area and production in different parts of the India.

Among the small millets crops, kodo millet (*Paspalum Scrobiculatum* L.) is one of the major food crops being cultivated in tribal areas of the country. The crop was first domesticated in southern part of Rajasthan and Maharashtra some 3,000 years ago. It is a minor grain crop in India and an important crop in the Deccan plateau. Wider adaptability, easy cultivation, ability to tolerate the biotic and abiotic stresses has made this crop as a major component of dry farming ecosystem. In India, kodo millet is grown mostly in Uttar Pradesh, Madhya Pradesh, Maharashtra, Andhra Pradesh, Kerala, Karnataka and Tamil Nadu. This minor cereal is locally known as varagu, kodo, haraka and arakalu (Kajale, 1977) [3]. The fiber content of the whole grain is very high.

Kodo millet has 11 % protein and the nutritional value of the protein has been found to be slightly better than that of foxtail millet but comparable to that of other small millets. As with other food grains, the nutritive value of kodo millet protein could be improved by supplementation with legume protein. The productivity of kodo millet is subject to wide fluctuations and the area is declining. The major constraints are (i). Kodo millet is grown on poor, shallow and marginal soils under rainfed conditions, which is still grown in the hilly areas under shifting cultivation (ii). The soils on which this crop is cultivated have low moisture retention capacity and (iii). Seeds are often broadcasted under unfertilized and un-weeded conditions. Therefore, there is a need to develop a suitable sowing or planting method, balance supply of nutrients and proper weed management practices are essential for obtaining higher yield.

Integrated Nutrient Management (INM) is an integrated approach of effective and efficient utilization of all nutrient resources, organics including microbes as well as inorganic which is locally available, economically viable, and socially acceptable and eco-friendly for sustaining and increasing crop production. Keeping the above fact in consideration, the present experiment was conducted to study the effect of Integrated Nutrient Management on yield and nutrient uptake of kodo millet.

Materials and Methods

Field experiment was conducted at Annamalai University Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University during *kharif* season of 2014. The soil of the experimental field is clay loam in texture with low in available nitrogen, medium in available phosphorus and high in available potassium. The treatments comprised of T_1-Control,T_2 -75 % Recommended Dose of Fertilizers (33:17.5:0 kg NPK ha^{-1}),T_3 -75 % RDF + soil application of *Azospirillum* @ 2 kg ha^{-1}, T_4 -75 % RDF + soil application of *Azospirillum* @ 2 kg ha^{-1}+ vermicompost @ 2 t ha^{-1}, T_5 -75 % RDF + soil application of *Azospirillum*@ 2 kg ha^{-1} + vermicompost @ 2 t ha^{-1} + foliar application of 1 % poly feed at tillering and flowering, T_6 -100 % RDF (44:22:0 kg NPK ha^{-1}), T_7 -100 % RDF + soil application of *Azospirillum* @ 2 kg ha^{-1}, T_8 -100 % RDF + soil application of *Azospirillum* @ 2 kg ha^{-1} + vermicompost @ 2 t ha^{-1}, T_9-100 % RDF + soil application of *Azospirillum* @ 2 kg ha^{-1} + vermicompost @ 2 t ha^{-1} + foliar application of 1 % poly feed at tillering and flowering, T_{10} -125 % RDF (55:27.5:0 kg NPK ha^{-1}), T_{11} -125 % RDF + soil application of *Azospirillum* @ 2 kg ha^{-1}, T_{12} -125 % RDF + soil application of *Azospirillum* @ 2 kg ha^{-1} + vermicompost @ 2 t ha^{-1}, T_{13} 125 % RDF + soil application of *Azospirillum* @ 2 kg ha^{-1} + vermicompost @ 2 t ha^{-1} + foliar application of 1 % poly feed at tillering and flowering. The experiment was laid out in Randomized Block Design with three replications. Twenty days old seedlings were transplanted @ 2 seedlings hill^{-1} by adopting the spacing of 15 x 10 cm. The grain yield was recorded from the net plot area and expressed in kg ha^{-1} at 14 per cent moisture level. The straw yield of kodo millet was recorded from the net plot area after enough sun drying and expressed in kg ha^{-1}.The NPK uptake was recorded at harvesting stage. The data on various characters studied during the investigation were statistically analyzed as suggested by Gomez and Gomez (1984) [2] and wherever the treatment differences were found significant (F test); critical differences were worked out at five per cent probability level.

Results and Discussion

Integrated nutrient management practices significantly enhanced the yield and nutrient uptake of transplanted kodo millet.

Yield

Among the various treatments imposed, application of 125% recommended dose of fertilizers (55:27.5:0 kg NPK ha^{-1}) + soil application of *Azospirillum* @ 2 kg ha^{-1} + vermicompost @ 2 t ha^{-1} + foliar application of 1 % poly feed at tillering and flowering significantly increased the grain and straw yield of transplanted kodo millet (Table 1). The increased yield could be due to yield attributing characters. Obviously, the yield attributes have contributed to increased yield potential of the crop as reflected by the higher grain yield. These findings are in consonance with the Saravanane *et al*. (2012) [8]. The improved plant growth, translocation, assimilation and storage of photosynthates from source to sink might have resulted in higher grain and straw yield. The highest level of N and P resulted in the significant increase in yield. These results are in conformity with the findings of Saleem *et al*. (2011) [6]. Vermicompost contains macro and micronutrients which might have influenced the grain yield. These findings are in agreement with the Tolanur and Badnur (2003) [10]. In respect of *Azospirillum* inoculated treatments, a well-developed root system coupled with increased availability of nutrients could have promoted greater uptake of nutrients resulting in higher grain yield (Rana, 1985) [5]. Poly feed contains micronutrients which might have influenced the grain yield. This was on par with application of 125 % recommended dose of fertilizers (55:27.5:0 kg NPK ha^{-1}) + soil application of *Azospirillum* @ 2 kg ha^{-1} + vermicompost @ 2 t ha^{-1}. The treatment absolute control recorded the lowest grain and straw yield of transplanted kodo millet.

Nutrient uptake

The NPK uptake of transplanted kodo millet was significantly influenced by various INM practices (Table1). Among them, application of 125 % recommended dose of fertilizers (55:27.5:0 kg NPK ha^{-1}) + soil application of *Azospirillum* @ 2 kg ha^{-1} + vermicompost @ 2 t ha^{-1} + foliar application of 1 % poly feed at tillering and flowering recorded highest NPK uptake of transplanted kodo millet. The higher level of nitrogen application resulted in maximum N uptake by the crop and also due to close inter-relationship between N and P metabolism in the plant cell. Similar inferences were reported by Machado *et al*. (1985) [4]. The highest NPK uptake might be due to better nutritional environment, which influenced the crop growth rate and dry matter production. The combination of vermicompost and biofertilizers resulted in the better NPK uptake by kodo millet. Integrating inorganics with organics and biofertilizer helps in maintaining soil fertility besides enhancing the uptake of nutrients by crop through their complementary effects. Similar results were reported by Singh and Kundan Wasnik (2014) [9]. *Azospirillum* plays an important role in fixing atmospheric nitrogen that paves the way for more and easy availability of nutrients to plants and resulted in higher uptake of NPK. These results are in accordance with the findings of Bhande *et al.* (2002) [1]. From the present study, it can concluded that application of 125% recommended dose of fertilizers (55:27.5:0 kg NPK ha^{-1}) + soil application of *Azospirillum* @ 2 kg ha^{-1} + vermicompost @ 2 t ha^{-1} + foliar application of 1 % poly feed at tillering and flowering holds immense potentiality to boost the overall productivity of transplanted kodo millet.

Table 1: Effect of integrated nutrient management on yield and nutrient uptake of transplanted kodo millet

Treatments	Yield (kg/ha)		Nutrient uptake (kg/ha)		
	Grain	Straw	N	P	K
T_1- Control	1340.94	3909.54	31.74	7.73	49.88
T_2- 75 % Recommended Dose of Fertilizers (RDF) (33:17.5:0 kg NPK ha^{-1})	2295.15	5033.65	39.61	11.70	57.01
T_3- T_2 + soil application of *Azospirillum* @ 2 kg ha^{-1}	2396.22	5251.56	41.40	12.77	59.20
T_4- T_3 + vermicompost @ 2 t ha^{-1}	2893.35	6547.52	49.04	17.99	68.25
T_5- T_4 + foliar application of 1 % poly feed at tillering and flowering	2975.12	6869.06	50.51	18.82	69.39
T_6- 100 % Recommended Dose of Fertilizers (RDF) (44:22:0 kg NPK ha^{-1})	2583.56	5749.43	46.64	14.75	62.87
T_7- T_6 + soil application of *Azospirillum* @ 2 kg ha^{-1}	2695.77	6054.00	46.17	15.98	65.08
T_8- T_7 + vermicompost @ 2 t ha^{-1}	3487.37	8154.22	58.32	23.61	78.86
T_9- T_8 + foliar application of 1 % poly feed at tillering and flowering	3570.48	8365.76	59.43	24.62	79.97
T_{10}- 125 % Recommended Dose of Fertilizers (RDF) (55:27.5:0 kg NPK ha^{-1})	3291.09	7377.03	53.52	20.81	73.30
T_{11}- T_{10} + soil application of *Azospirillum* @ 2 kg ha^{-1}	3176.59	7656.90	55.35	21.93	75.33
T_{12}- T_{11} + vermicompost @ 2 t ha^{-1}	3767.71	8798.32	62.22	26.55	82.89
T_{13}- T_{12} + foliar application of 1 % poly feed at tillering and flowering	3863.96	8848.43	63.73	27.46	84.02
S.Ed	61.24	200.6	1.08	0.70	1.27
CD(p=0.05)	122.49	401.21	2.17	1.41	2.54

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