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Effect of different levels of fertilizers on growth and yield of finger millet under zero tillage conditions in rice fallows

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Abstract
A field investigation was conducted to study the effect of graded levels of fertilizers on growth and yield of finger millet under rice fallow condition. The nutrient management in rice fallow finger millet conducted during *Rabi* 2018-19 at Agricultural Research Station, Vizianagaram. Results showed that grain yield of finger millet was found to be significantly higher (35.85 q/ha) in the treatment received with 150% RDF over 100% RDF (28.81q/ha) and was on par with 125% RDF (31.11q/ha). Spraying of 1% KNO_3 at flower initiation stage along with basal application of NPK helped in further increase in grain yield, compared to their respective treatments of NPK alone to the tune of 5.2% in 50% RDF, 11.68% at 75% RDF, 10.0% at 100% RDF, 8.58% at 125% RDF and 4.12% at 150% RDF respectively compared to their alone application of graded levels of RDF. 150% RDF+1% KNO_3 foliar spray recorded significantly higher grain yield; However, it was on par with 150% RDF and 125% RDF+ 1% KNO_3 foliar spray. The highest net returns and B:C ratio were recorded in 150% RDF+1% KNO_3 foliar spray followed by 150% RDF similarly soil available nitrogen, phosphorus and potassium were significantly high in 150% RDF+1% KNO_3 foliar spray, however, it was on par with 150% RDF and 125% RDF+1% KNO_3 foliar spray. From this study, 125% RDF+1% KNO_3 foliar spray was found to be the best nutrient management in finger millet grown under rice fallow situation.

Keywords: Finger millet, nutrient management, grain yield, rice fallow

Introduction
Millet is a group of small-grained cereal grown around the world for food and fodder. Millets is known to be "crops of the future" as it is well adapted and cultivated under harsh environment of arid and semi-arid region (Resmisa, 2012) [7]. Finger millet [*Eleusine coracana* (L.) Gaertn.] commonly known as ragi in Andhra Pradesh, is one of the important millet crops grown for grain and fodder purpose under varied agro-climatic conditions. It occupies the highest area under cultivation among the small millets.

In India, it is grown in an area of 13.07 million hectares with the production of 19.29 million tonnes and the productivity is 1641 kg ha^{-1}. The state of Karnataka is the largest producer of finger millet in India. Other major finger millet growing states in India are Andra Pradesh, Tamil Nadu, Orissa, Jharkhand, Maharashtra and Uttaranchal. In Andhra Pradesh, finger millet is grown in an area of 7.88 lakh ha, with an annual production of 12.72 lakh tonnes and productivity of 1871 kg ha^{-1}.

Nitrogen, Phosphorous and Potassium are the essential elements required for plant growth and development in relatively large amounts when compare with the other essential elements (Dhhwayo and Whhgwiri. 1984) [3]. However, deficiencies of nitrogen and phosphorus are common. Soil nutrients become depleted due to leaching of nitrogen, fixation of phosphorous, soil erosion and removal by crops Duryodhana *et al.,* 2004 [4]. To maintain high crop production level, the nutrient status of the soil has to be maintained through crop rotation, addition of manures or application of fertilizers. Inorganic fertilizers are important inputs in any agricultural production system because they supply the required nutrients in a readily available form for immediate plant use. Some of the factors contributing to low yield of finger millet are lack of high yielding cultivars, low moisture stress, pest and diseases and low fertility conditions and poor crop management practices such as optimum fertilizer rate. So far efforts regarding to the determination of optimum fertilizer level and other agronomic requirement of finger millet in the study area are minimal. Among major yield limiting plant nutrients N and P are the most determinant nutrients as they are required in large quantity by

the crop. This implies that effort has to be made to improve the production and productivity of finger millet through application of appropriate level of N, P and K fertilizers and 1% KNO_3. In view of this, this research activity was initiated with the objective of determining the optimum levels of N, P and K for optimum production of finger millet and to assess the interaction between N, P and K levels on yield and yield attributing parameters of finger millet crop on sandy loam soils.

Materials and Methods

The field experiment was conducted during *Rabi*, 2018-19 at Agricultural Research Station, Vizianagaram. The soil was sandy loam in texture, low in Organic Carbon, available Nitrogen, high in available Phosphorus and medium in available Potassium. The experiment was laid down in Randomised Block Design with ten treatments replicated thrice. Required population of finger millet crop was maintained by thinning and gap filling under zero tillage condition. The treatments include T_1: 50% RDF, T_2: 75% RDF, T_3: 100% RDF, T_4: 125% RDF, T_5: 150% RDF, T_6: T_1+ 1% Multi KNO_3 Foliar Spray, T_7: T_2+ 1% Multi KNO_3 Foliar Spray, T_8: T_3+ 1% Multi KNO_3 Foliar Spray, T_9: T_4+ 1% Multi KNO_3 Foliar Spray, T_{10}: T_5+ 1% Multi KNO_3 Foliar Spray.

The recommended dose of fertilizers (R.D.F.) was 60 kg N, 40 kg P and 30 kg K ha^{-1} which was applied in the form of urea, DAP and muriate of potash. Fertilizer nitrogen was applied as per treatments in two equal splits, half at the time of sowing and half at 45 days after sowing. Phosphorus and Potash were applied basally, at the time of sowing as per the treatments. Growth parameters *viz*., plant height, No. of productive tillers, leaf length, leaf width, ear head length, No. of fingers/ear were recorded at the time of harvest from five randomly selected plants. The Grain yield and straw yield were estimated later. The initial and post-harvest soil samples were analysed for pH, EC, OC, available N, P_2O_5, K_2O and available micronutrients *viz*., Zn, Fe, Cu and Mn as per the standard procedures. The soil reaction was neutral, low electrical conductivity, low organic carbon, available nitrogen and potassium, high available phosphorus was found and micronutrients was above the critical level.

Results and Discussions

Different levels of NPK fertilizers tested in the study significantly influenced the yield and growth parameters (Table 1). The application of 150% RDF+1% KNO_3 foliar spray resulted in higher number of tillers (7.9/plant), number of fingers/ear head (7.2/plant). However, it was on par with 150% RDF and 125% RDF+1% KNO_3. The finding is supported by the fact that higher applications of fertilizers had a positive consequence on growth pattern with betterment of physiological process such as cell division, cell elongation along with timely metabolic processes (Kushwah *et. al.,* 2014 and Sandhyarani *et al.,* 2017) [5, 8]. It is also true that the rainfall pattern in transitional tract which is assured in distribution also supports the channelization of nutrients for plants at right times. The results are in accordance with Bhomte *et al*., 2016 [2]. Application of lower levels of NPK fertilizers viz 50% RDF recorded lower growth performance and continued to get lower yield parameters. These treatments recorded lowest number of productive tillers/plant (3.6). As a result these treatments ended up with lowest grain yield of 24.89q/ha. Progressive increase in levels of NPK application helped to enhance both yield attributing parameters as well as yield levels. 100% Recommended dose of fertilizer with 60:40:30 kg NPK/ha application resulted in moderate yield components (5.8 productive tillers/plant) and yield (28.81q/ha). However further increase in the NPK levels achieved increased yield components at a slow phase. The highest dose of N:P:K (90:60:45 kg/ha) and 1% KNO_3 performed better in achieving higher number of tillers (7.9) by virtue of its better growth components but which is at par with T_9 (125% RDF and 1% KNO_3) and T_5 (150% RDF). These variations are reasoned for ability of nutrients in these sandy loam soil conditions at the above said quantity which also coincided with need of the crop. These results are in conformity with Anil Kumar *et al*., 2003 [1] and Sandhyarani, *et al.,* 2017 [8]. On the similar lines the chosen treatment also resulted to obtain higher grain and straw yields of 37.33 and 74.40q/ha respectively mainly due to even supply of nutrients coinciding with higher growth resulting in better yield components than rest of the treatments under test. These findings are in line with the reports of Nigade *et al.,* 2013 [6] and Shivakumar, 2011 [9]. The treatments T_1, T_2, T_3, T_6 and T_7 were statistically non- significant with respect to yield. Hence analysis was undertaken for calculating additional profit and benefit-cost ratio by taking recommended fertilizers as base.

Table 1: Yield attributes as influenced by nutrient management in rice fallow ragi (variety, VR 847) in rice fallows under zero tillage conditions (Rabi -2018-19)

Treatment details	Plant height (cm)	No. of productive tillers/ plant	Ear head length (cm)	Boot leaf length (cm)	No. of fingers /Ear head	Grain yield (q/ha)	Straw yield (q/ha)
T_1: 50% RDF N,P,K	80.8	3.6	5.8	29.9	6.0	24.89	59.93
T_2: 75% RDF N,P,K	81.8	4.1	6.4	30.8	6.6	25.67	64.22
T_3: 100% RDF N,P,K	82.4	5.8	6.6	31.5	6.6	28.81	67.92
T_4: 125% RDF N,P,K	82.7	7.0	6.7	32.1	6.8	31.11	69.66
T_5: 150% RDF N,P,K	85.9	7.3	7.0	30.3	6.9	35.85	71.66
T_6: T1+ 1% KNO_3 spray	81.2	3.8	6.1	30.7	5.9	26.19	63.40
T_7: T2+ 1% KNO_3 spray	83.2	4.2	6.7	31.8	6.6	28.67	65.37
T8: T3+ 1% KNO_3 spray	85.3	6.1	6.7	32.9	6.8	31.7	69.37
T_9: T4+ 1% KNO_3 spray	82.2	7.2	6.8	33.8	6.9	33.78	72.07
T_{10}: T5+ 1% KNO_3 spray	83.5	7.9	7.1	33.3	7.2	37.33	74.40
SEm±	2.91	0.22	0.31	1.11	0.22	127.7	261.7
C.D. (0.05)	NS	0.68	NS	NS	0.67	379.5	777.5
C.V. (%)	6.24	6.95	8.39	6.08	5.96	7.28	6.69

Table 2: Cost economics of nutrient management in rice fallow ragi trail (Rabi 2018-19).

Treatments	Grain Yield (q/ha)	GR (Rs/ha)	COC (Rs/ha)	NR (Rs/ha)	B:C	% yield increase over control
T_1: 50% RDF N,P,K	24.89	52774	26937	25837	1.96	0
T_2: 75% RDF N,P,K	25.67	54544	27817	26727	1.96	3.1
T_3: 100% RDF N,P,K	28.81	61026	28698	32328	2.13	15.7
T_4: 125% RDF N,P,K	31.11	65705	29578	36127	2.22	25.0
T_5: 150% RDF N,P,K	35.85	75287	30459	44828	2.47	44.0
T_6: T1+ 1% KNO_3 spray	26.19	53292	27187	26105	1.96	5.2
T_7: T2+ 1% KNO_3 spray	28.67	58522	28067	30455	2.09	15.2
T8: T3+ 1% KNO_3 spray	31.7	64937	28948	35989	2.24	27.4
T_9: T4+ 1% KNO_3 spray	33.78	69153	29828	39325	2.32	35.7
T_{10}: T5+ 1% KNO_3 spray	37.33	76675	30709	45966	2.50	50.0

Table 3: Effect of nutrient management on physico-chemical properties of rice fallow ragi

Treatment particulars	Soil pH	EC (dS m^{-1})	OC (%)	Avai. N (kg/ha)	Avai. P_2O_5 (kg/ha)	Avai. K_2O (kg/ha)
T_1: 50% RDF	7.20	0.21	0.27	185	38	189
T_2: 75% RDF	7.90	0.27	0.29	198	42	196
T_3: 100% RDF	6.99	0.28	0.33	215	48	202
T_4: 125% RDF	6.23	0.25	0.37	224	53	213
T_5: 150% RDF	6.20	0.26	0.38	238	56	219
T_6: T_1+ 1% KNO_3 Foliar Spray	6.59	0.19	0.33	191	40	192
T_7: T_2+ 1% KNO_3 Foliar Spray	6.95	0.21	0.38	206	43	201
T_8: T_3+ 1% KNO_3 Foliar Spray	6.92	0.26	0.36	222	52	205
T_9: T_4+ 1% KNO_3 Foliar Spray	6.18	0.24	0.35	236	57	217
T_{10}: T_5+ 1% KNO_3 Foliar Spray	6.26	0.28	0.40	242	59	231
SEm±	0.44	0.02	0.028	5.71	2.29	8.25
CD (0.05)	NS	NS	NS	16.97	6.80	24.52
CV %	11.63	14.33	14.38	5.82	7.89	6.92

Table 4: Effect of nutrient management on micronutrients of rice fallow ragi

Treatment particulars	Zn (ppm)	Fe (ppm)	Mn (ppm)	Cu (ppm)
T_1: 50% RDF	1.54	6.71	2.61	1.36
T_2: 75% RDF	1.69	7.87	2.99	1.42
T_3: 100% RDF	1.71	7.91	3.07	1.42
T_4: 125% RDF	1.66	7.96	2.94	1.36
T_5: 150% RDF	1.78	8.10	3.03	1.47
T_6: T_1+ 1% KNO_3 Foliar Spray	1.79	8.19	3.20	1.34
T_7: T_2+ 1% KNO_3 Foliar Spray	1.65	7.97	2.96	1.40
T_8: T_3+ 1% KNO_3 Foliar Spray	1.70	7.97	3.01	1.46
T_9: T_4+ 1% KNO_3 Foliar Spray	1.68	8.09	2.92	1.36
T_{10}: T_5+ 1% KNO_3 Foliar Spray	1.66	7.90	2.86	1.33
SEm±	0.05	0.28	0.21	0.05
CD (0.05)	NS	NS	NS	NS
CV %	5.05	6.21	12.26	6.75

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