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Sustaining Soil Fertility and Yields of Finger Millet (*Eleusine coracana L.*) through Balanced Fertilization in Entisols

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Abstract **– A Field experiment was carried out at the Zonal Agricultural Research Station, Shenda Park, Kolhapur (Maharashtra) during *kharif* 2012-2014. The nutrient management practices comprised of four levels of nitrogen as main plot treatments, three levels of phosphorus and two levels of potassium as sub plot treatments. The treatments were replicated thrice using split plot design. The present investigation revealed that, the balanced use of nutrients along with organic supplements proves beneficial for achieving higher grain yield and sustaining soil fertility as well. After three years of experimentation, 60 kg N, 30 kg P_2O_5 and 30 kg K_2O is found to be optimum dose of fertilizers integrated with 5 t FYM ha^{-1} and seed treatment with *Azospirillum brasilens + Aspergillus awamori* each @ 25 gm kg^{-1}seed for sustaining higher grain yield of finger millet and soil fertility in Entisol of Sub-montane Zone of Maharashtra.**

Keywords **– Balanced Fertilization, Grain Yield, Potassium, Soil Fertility, Straw Yield.**

I. INTRODUCTION

Finger millet ***(Eleusine coracana L.)*** locally called as Nagli / Nachni / Ragi is the most important crop grown in Maharashtra State. In recent years, there has been increasing recognition of the importance of small millets in general and finger millet in particular. In Maharashtra finger millet is grown on an area of 1.25 lakh ha with a production of 1.42 lakh tones and a productivity of 1144 kg ha^{-1}. The yield of finger millet is very low in the state as the crop is mostly grown along the hill sides on sloppy land on light textured soils. It is also coupled with negligence in adoption of improved package of practices viz. variety and use of balance fertilizer. Application of the major macronutrients such nitrogen and phosphorus alone to finger millet does not necessarily provide better yields, rather the application of balanced nutrients is important [13]. The balanced use of fertilizers not only increases finger millet yields but also help to sustain soil fertility status [5]-[11]. The finger millet growing farmers often use fertilizers in rather indiscriminate manner with limited or no attention paid to K management in finger millet. Lack of K fertilizer application and removal of crop residues by farmers has resulted in decreased soil K levels [14]. Potassium deficiency is becoming one of the major constraints in crop production, in most of the soils. One of the reason for wide spread K deficiency in soils and crops in recent times could be less use of K fertilizer than N and P fertilizers, leading to mining of soil K. Scrutiny of the past and recent information on K status over four decades showed that there is a gradual decline in K status in Indian soils from high to medium and medium to low status [6]. Potassium besides playing important role in activating various enzymes, maintaining cell turgor, transport of sugar and starches etc., it along with N fertilizer can also improve N use efficiency [12]. The current fertilizer recommendation for finger millet for Sub-montane Zone of Maharashtra is 60:30 N: P_2O_5 kg ha^{-1} which is very much generalized without taking into consideration of the varied soil type of the Zone. Generally, more than one soil types occur in each agro-climatic zone with dissimilar behavior and response to management and needs separate K recommendation. Keeping in view these facts, an experiment was conducted to study the response of finger millet to different N, P and K levels with conjoint use of manures and bio-fertilizers to find out the most economical K recommendation ensuring balanced fertilization and for achieving higher grain yield of finger millet crop, monetary returns and maintenance of soil fertility.

II. MATERIALS AND METHODS

A field experiments were conducted during *kharif* 2012, 2013 and 2014 under rainfed condition at the Zonal Agricultural Research Station, Shenda Park, Kolhapur (Maharashtra). The experimental site was neutral in soil reaction with pH 7.0 and low in available K status (139 kg ha^{-1}). The finger millet crop was sown at spacing 30 cm x 10 cm and two healthy plants per hill were maintained by thinning after 15 days of sowing. Twenty four treatments combinations were tested in split plot design with three replications. The nutrient management treatments comprised of four nitrogen levels viz. N_1 – 30, N_2 – 45, N_3 – 60 and N_4 – 75 kg N ha^{-1} as main plot treatments and three levels of phosphorus viz. P_1 – 15, P_2 – 30, P_3 – 45 kg P_2O_5 ha^{-1} and two levels of potash viz. K_1 – 15, K_2 – 30 kg K_2O ha^{-1}as sub plot treatments. Application of well decomposed FYM @ 5 t ha^{-1} and seed treatment with bio-fertilizers (*Azospirillum brasilance* + *Aspergillus awamoori*) was common to all treatments except control. Each year the crop was sown in the first week of July and it was fertilized through urea, single super phosphate and muriate of potash at the time of sowing. The grain yield, straw yield and ancillary observations were recorded at appropriate crop growth stage and economics of the various treatments were worked out considering the prevailing market prices of inputs and outputs. The tissue analyses and soil analyses were done by following Standard analytical methods.

III. Results and Discussion

A. Grain and Straw Yield

The yields of finger millet crop, in general has shown proportionate response to higher application of nutrients (table 1). The significant higher grain yield (20.30 q ha^{-1}) was recorded with the application of 75 kg N ha^{-1} which was significantly superior over 30 and 45 kg N ha^{-1} whereas, it was found to be at par with application of 60 kg N ha^{-1}(19.95 q ha^{-1}). Similarly, amongst the different levels of phosphorus 45 kg P_2O_5 ha^{-1} recorded significant highest grain yield (18.09 q ha^{-1}). However, it was at par with the application of 30 kg P_2O_5 ha^{-1} (17.03 q ha^{-1}). In case of potassium, the higher level of potassium i.e. application of 30 kg K_2O ha^{-1} recorded significant highest grain yield (17.39 q ha^{-1}). The straw yields of finger millet crop followed similar trend to that of grain yields. The significant highest straw yield was recorded with application of 75 kg N ha^{-1} (26.0 q ha^{-1}) over 30 and 45 kg N ha^{-1}. However, it was at par with 60 kg N ha^{-1}(25.7 q ha^{-1}). Amongst different phosphorus levels, application 45 kg P_2O_5 ha^{-1} recorded highest significant straw yield (22.26 q ha^{-1}) over 15 kg P_2O_5 ha^{-1}. However it was at par with 30 kg P_2O_5 ha^{-1} (21.76 q ha^{-1}). In respect of potassium levels, application of 30 kg K_2O ha^{-1} recorded significant highest straw yield (22.3 q ha^{-1}) The present results are in consonance with those in [1]-[2]-[3]-[5]-[7]-[13]. The interaction effect between different nutrient management practices was found to be non significant.

B. Nutrient Uptake

The data on nutrient uptake by finger millet crop is presented in table 1. The data revealed that the application of 75 kg N ha^{-1} recorded significantly higher uptake of nitrogen, phosphorus and potassium (44.9, 18.7 and 53.8 kg ha^{-1}) respectively, which was at par to that of 60 kg N ha^{-1}. Amongst the different P levels, application of 45 kg P_2O_5 ha^{-1} recorded significant highest nitrogen, phosphorus and potassium uptake (37.9, 15.7 and 45.6 kg ha^{-1}) respectively. In case of potassium levels, application of 30 kg K_2O ha^{-1} showed significantly highest potassium uptake (43.4 kg ha^{-1}) over 15 kg K_2O ha^{-1} (40.1 kg ha^{-1}). Similar results were reported in [4]

C. Soil Properties and Available Nutrient Status

The data on soil properties is presented in table 2. The data revealed that the soil properties such as pH, EC and organic carbon content did not differ after three years of finger millet cropping. However, the available major nutrient recorded increase in their status with increasing level of nutrients. The highest significant value of available nitrogen was recorded by application of 75 kg N ha^{-1} (266.4 kg ha^{-1}) over rest three N levels while significant highest value of available phosphorus was recorded by application of 45 kg P_2O_5 ha^{-1} (17.1 kg ha^{-1}) over rest two P_2O_5 levels. However, the significant highest available potassium status was recorded by 30 kg K_2O ha^{-1} (170 kg ha^{-1}) over 15 kg K_2O ha^{-1}. The interaction effect of different levels of fertilizer management treatments was found to be non significant, nevertheless, the available nutrient status after three years of cropping increased substantially over the initial soil test values (Fig.2). The soil fertility was found to be improved by conjoint use of balanced inorganic fertilizer, manure and bio-fertilizer. Similar results are reported in [5]-[9]-[10]-[11].

IV. Economics

The economics calculated after three years of finger millet cropping as influenced by different levels of nutrients divulged that application of 75 kg N ha^{-1} recorded highest B:C ratio (1.55) and significantly highest gross returns (Rs.33924 ha^{-1}) and net monetary returns (Rs. 11627 ha^{-1}) over application of 30 and 45 kg N ha^{-1} however, it was at par with 60 kg N ha^{-1}. Amongst different P_2O_5 levels, application of 45 kg P_2O_5 ha^{-1} recorded highest B:C ratio (1.33) and significantly highest gross returns (Rs. 30270 ha^{-1}) and net monetary returns (Rs.7678 ha^{-1}) over application of 15 kg P_2O_5 ha^{-1} and was at par with 30 kg P_2O_5 ha^{-1}. The K_2O levels also differed in economic with highest B:C ratio (1.30) recorded by application of 30 kg K_2O ha^{-1} and significantly highest gross (Rs.28993 ha^{-1}) and net monetary returns (Rs. 6763 ha^{-1}) over application of 15 kg K_2O ha^{-1}. The interaction effects due to fertilizer levels were found to be non significant.

V. Conclusion

The present investigation envisaged that inclusion of 30 kg K_2O ha^{-1} along with existing recommended dose of fertilizer (60:30 N: P_2O_5 kg ha^{-1}) for finger millet crop to prevents further K mining. Moreover, the balanced use of fertilizer along with manures and bio-fertilizers sustains productivity and soil fertility.

Reference

[1] Ahiwale P.H. Chavan, L.S., Jagtap D.N., Mahadkar U.V., Gawade M.B. (2013). Effect of establishment methods and nutrient management on yield attributes and yield of finger millet (Eleusine coracana L.). Crop Research. 45 (1,2&3): 141-145

[2] Basavarajapp, R., Prabhakar, A.S. and Halikatti, S.I. 2003. Effect of tillage practices, organics and nitrogen levels on growth components, dry matter accumulation and physiological parameters in foxtail millet (Sataria italica). Indian Journal of Agronomy 48 (2): 111-113.

[3] Bhoite, S.V.; Nimbalkar, V.S. 1996 Response of finger millet cultivars to nitrogen and phosphorus under rain-fed condition. J. Maharashtra Agric. Univ., 20, 189–190.

[4] Chakraborty T., Roy D.K. and Sounda G.(2002). Effect of fertilizers, rock phosphate and Azospirillum on growth and yield of finger millet (Eleusine coracana L Gaertn) Indian J Agdc. Res., 36 (3) : 192 - 195, 2002

[5] Hemalatha, S.; Chellamuthu, S. 2013 Impacts of long term fertilization on soil nutritional quality under finger millet: Maize cropping sequence. J. Environ. Res. Dev., 7, 1571–1576.

[6] Naidu L. G. K., Ramamurthy V., Sindu G. S. and Dipak Sarkar 2011 Emerging deficiency of potassium in soils and crops of India. Karnataka J. Agric. Sci.,24 (1) : (12-19)

[7] Nigade R.D. Gajbhiye P. N. More S.M. 2014: Integrated nutrient management studies in finger millet (Eleusine coracana L.). Crop Research. 48 (1,2&3) : 27-31

[8] Nigade R.D. Jadhav B.S., Bhosale A.S. 2011: Response of long duration finger millet (Eleusine coracana L.). variety to different

levels of nitrogen under rainfed conditions. Internat. J. agric Sci., 7(1):152-155

[9] Raman, R and Kuppaswamy G (2004). Effect of integrated nutrient management on the growth and yield of finger millet (Eleusine coracana L.) 6th IFOAM Asia Scietific conference, Yangpyung, 7-11 September, 2004 Benigan envioronment and safe food pp. 504-509

[10] Roy, D.K.Chakraborty, T., Sound, G. and Maitra, S. 2001 Effect of fertility levels and plant population on yield & uptake of nitrogen, phosphorus and potassium in finger millet of West Bengal. Indian Journal of Agronomy 46(4): 707-711.

[11] Sankar, G.R.M.; Sharma, K.L.; Dhanapal, G.N.; Shankar, M.A.; Mishra, P.K.; Venkateswarlu, B.; Grace, J.K. 2011 Influence of soil and fertilizer nutrients on sustainability of rainfed finger millet yield and soil fertility in semi-arid Alfisols. Commun. Soil Sci. Plant Anal., 42, 1462–1483.

[12] Sangakkara, R.; Amarasekera, P.; Stamp, P. 2011. Growth, yields, and nitrogen-use efficiency of maize (Zea mays L.) and mungbean (Vigna radiata L. Wilczek) as affected by potassium fertilizer in tropical South Asia. Commun. Soil Sci. Plant Anal., 42, 832–843.

[13] Tenywa, J.S.; Nyende, P.; Kidoido, M.; Kasenge, V.; Oryokot, J.; Mbowa, S. 1999 Prospects and constraints of finger millet production in Eastern Uganda. Afr. Crop Sci. J., 7, 569–583.

[14] Timsina, J.; Singh, V.K.; Majumdar, K. 2013 Potassium management in rice-maize systems in South Asia. J. Plant Nutr. Soil Sci., 176, 317–330.

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Dr. P.N. Gajbhiye was born in Nagpur (MS) on 22nd May, 1976. He completed his masters in Soil Science and Agricultural Chemistry from College of Agriculture, Nagpur, Dr. PDKV, Akola in the year 2001 and doctorate from Raja Balwant Singh College of Agriculture, Bichpuri, Dr. B.R Ambedkar University, Agra (UP) in the year 2015.

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He is having 24 research articles published in journal of international and national repute. The area of his interest is soil health management and soil fertility.

Table 1: Yields, economics and nutrient uptake by finger millet (Pooled mean values)

Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Gross monetary returns (Rs ha^{-1})	Net monetary returns (Rs ha^{-1})	B:C Ratio	Plant Nutrient Uptake (kg ha^{-1})		
						N	P	K
A. N levels kg ha^{-1}								
N_1 – 30	11.69	14.83	19328	-2308	0.89	23.1	8.76	25.4
N_2 – 45	15.45	19.62	25661	3730	1.17	30.3	13.1	34.4
N_3 - 60	19.95	25.70	33602	11490	1.51	43.9	18.1	53.3
N_4 – 75	20.30	26.00	33924	11627	1.55	44.9	18.7	53.8
S.E. ±	0.18	0.25	556	544	-	1.19	0.56	1.55
C.D. 0.05	0.53	0.71	1583	1550	-	3.39	1.60	4.41
B. P_2O_5 levels kg ha^{-1}								
P_1 – 15	15.42	19.67	25708	4334	1.20	33.5	13.8	38.6
P_2 – 30	17.03	21.76	28410	6393	1.28	35.3	14.5	41.0
P_3 – 45	18.09	22.26	30270	7678	1.33	37.9	15.7	45.6
S.E. ±	0.38	0.21	624	472	-	1.03	0.49	1.34
C.D. 0.05	1.13	0.61	1871	1343	-	2.93	1.39	3.82
C. K_2O Levels kg ha^{-1}								
K_1 – 15	16.30	20.80	27264	5507	1.24	35.3	14.5	40.1
K_2 – 30	17.39	22.30	28993	6763	1.30	35.9	14.9	43.4
S.E. ±	0.13	0.17	393	385	-	0.84	0.40	0.93
C.D. 0.05	0.36	0.50	1120	1097	-	NS	NS	2.80
Interactions	NS	NS	NS	NS	-	NS	NS	NS

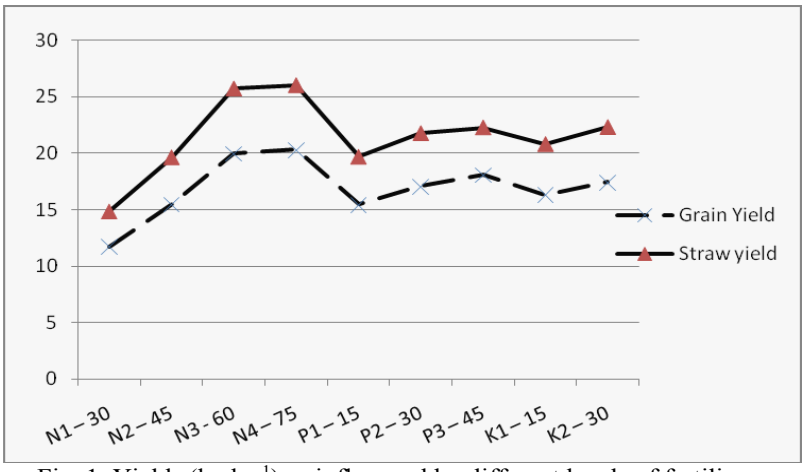

Fig. 1. Yields (kg ha^{-1}) as influenced by different levels of fertilizers

Table 2: Soil properties and available nutrient status after three years of finger millet cropping.

Treatments	pH (1:2.5)	E.C. (dSm^{-1})	O.C. %	Available Nutrients (kg ha^{-1})		
				N	P	K
A. N levels kg ha^{-1}						
N_1 – 30	7.1	0.06	0.61	225.3	15.3	166.1
N_2 – 45	7.1	0.07	0.61	240.8	16.5	164.7
N_3 - 60	7.0	0.07	0.61	258.1	16.5	167.1
N_4 – 75	7.0	0.07	0.61	266.4	16.8	167.5
S.E. ±	0.02	0.004	0.003	2.50	0.34	1.02
C.D. 0.05	NS	NS	NS	7.11	NS	NS
B. P_2O_5 levels kg ha^{-1}						
P_1 – 15	7.1	0.07	0.61	242.7	15.5	167.5
P_2 – 30	7.1	0.07	0.61	249.4	16.1	166.8
P_3 – 45	7.1	0.07	0.61	250.7	17.1	167.0
S.E. ±	0.02	0.004	0.003	2.16	0.29	0.88
C.D. 0.05	NS	NS	NS	6.16	0.83	NS
C. K_2O Levels kg ha^{-1}						
K_1 – 15	7.0	0.07	0.61	244.6	16.2	166.7
K_2 – 30	7.1	0.07	0.61	250.6	16.3	170.4
S.E. ±	0.01	0.001	0.002	1.77	0.24	0.72
C.D. 0.05	NS	NS	NS	5.03	NS	2.18
Interactions	NS	NS	NS	NS	NS	NS
Initial soil test	7.0	0.06	0.59	198	10.3	139

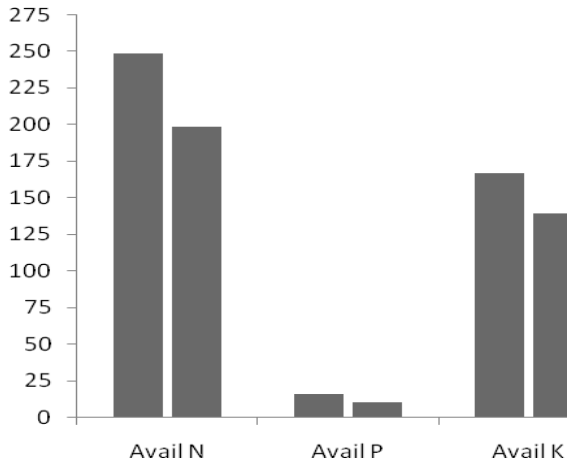

Fig. 2. Average increase in available nutrient status over initial values