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YIELD, NUTRIENT UPTAKE AND POST-HARVEST SOIL AVAILABLE NUTRIENT STATUS OF BARNYARD MILLET AS INFLUENCED BY VARIETIES AND NITROGEN LEVELS

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ABSTRACT

A field experiment was conducted during *kharif,* 2022 on sandy loam soils of S.V. Agricultural College Farm, Tirupati. The experiment was laid out in a split-plot design and replicated thrice. The treatments consisted of four varieties of barnyard milled *viz.,* VL-172 (V_1), VL-207 (V_2), CO-2 (V_3) and VL-182 (V_4) assigned to main plots and three nitrogen levels *viz.,* 20 kg N ha^{-1} (N_1), 40 kg N ha^{-1} (N_2) and 60 kg N ha^{-1} (N_3) allotted to sub plots. The results of the experiment indicated that among the varieties tested significantly higher grain yield, straw yield and nutrient uptake were obtained with the variety CO-2 (V_3), while the higher post-harvest soil nutrient status was with VL-182 (V_4). Among the nitrogen levels tried, application of 60 kg N ha^{-1} (N_3) resulted in significantly higher grain yield, straw yield, nutrient uptake and post-harvest soil available nitrogen status, while the highest post-harvest soil available phosphorus and potassium were with 20 kg N ha^{-1}.

KEYWORDS: Barnyard millet, Nutrient uptake, Varieties, Yield.

INTRODUCTION

Barnyard millet (*Echinochola esculenta*) is an ancient millet grown under natural precipitation in warm temperate regions of the world and widely cultivated in Asia, particularly in India, China, Japan and Korea. It has enough potential to sustain under the changing climatic scenario as well as to produce nutritional gains under resource poor soils. Among many cultivated and wild species of barnyard millet, two of the most popular species are *Echinochloa frumentacea* (Indian barnyard millet) and *Echinochloa esculenta* (Japanese bardyard millet) (Sood *et al*., 2015). It is the fourth most produced minor millet, providing food security to many poor people across the world. Globally, India is the biggest producer of barnyard millet, both in terms of area (0.146 M ha) and production (0.147 M t) with average productivity of 1034 kg ha^{-1} (IIMR, 2018).

Higher productivity deserves cultivation of improved varieties with other agronomic management practices. The choice of an appropriate genotype is crucial because the genetic potential of cultivars affects their ability to respond to nutrients. Furthermore, production and nutrient uptake are different amongst cultivars. In India, the yield potential of barnyard millet is not as high as the yield that would be possible. Growing a suitable variety for a certain region and using the right management techniques might maximize production potential. In majority of Indian soils, nitrogen is the first limiting nutrient out of the three primary nutrients. Nitrogen fertilization encourages strong, healthy plants with green pigments and increases the number and spread of roots. There is a necessity to fix the optimum dose in accordance with the demand of crop because different crop species have different nitrogen requirements. Therefore, the present investigation was carried out to find the suitable variety and correct dose of nitrogen for maximizing barnyard millet yield.

MATERIAL AND METHODS

The present investigation was carried out at S.V. Agricultural College Farm, Tirupati campus of Acharya N.G. Ranga Agricultural university which is in the Southern Agro-climatic Zone of Andhra Pradesh. The experiment was laid out in a split-plot design with four main plots and three sub plots and replicated thrice. The treatments consisted of four varieties of barnyard millet *viz.,* VL-172 (V_1), VL-207 (V_2), CO-2 (V_3) and VL-182 (V_4) assigned to main plots and three nitrogen levels *viz.,* 20 kg N ha^{-1} (N_1), 40 kg N ha^{-1} (N_2) and 60 kg N ha^{-1} (N_3) allotted to sub plots. The experimental field was sandy loam in texture which is low in organic carbon (0.27 %). The soil is neutral in reaction (pH 6.82), low in available nitrogen (153.4 kg ha^{-1}), medium in available phosphorus (23.0 kg ha^{-1}) and potassium (178.9 kg ha^{-1}). Total rainfall of 450.2 mm was received in 38 rainy days during the crop growing period. Nitrogen was applied according to the treatments at three levels *viz.,* 20 kg N ha^{-1} (N_1), 40 kg N ha^{-1} (N_2) and 60 kg N ha^{-1} (N_3) through urea. Phosphorus was applied to all the plots in common

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as basal in the form of single super phosphate. Available soil nitrogen (N) was estimated by the method as described by Subbiah and Asija (1956) and soil available phosphorus was determined as described by Olsen *et al.* (1954) using a spectrophotometer and was expressed in kg ha^{-1}. Plant samples collected for estimation of dry matter production were used to estimate the nutrient uptake by the crop at harvest. The oven dried samples of plant material were ground in a willey mill and analyzed for N, P and K contents. The nitrogen, phosphorus and potassium uptake were calculated by multiplying the nutrient content of the plant sample with the corresponding total dry matter and expressed in kg ha^{-1}. The data collected on yield, nutrient uptake at harvest and post harvest soil available nutrients were analyzed statistically following the procedure given by Panse and Sukhatme (1978) wherever the treatment differences were significant, critical differences were worked out at 5 per cent probability level. Treatment differences that were not significant are denoted as NS.

RESULTS AND DISCUSSION

Yield

Among the varieties evaluated, the variety CO-2 (V_3) registered higher grain and straw yield, which was however comparable with VL-172 (V_1). The latter was inturn significantly superior to that of VL-207 (V_2). Significantly lower gain yield was realized with the variety VL-182 (V_4). The superiority of the variety CO-2 (V_3) with respect to leaf area, number of tillers m^{-2} and dry matter production might have contributed to higher stature of yield attributes which was finally reflected as higher grain yield of barnyard millet. The results of the present investigation are in agreement with the findings of Triveni *et al*. (2018), Thirumala (2020) and Mahesh (2021).

Application of 60 kg N ha^{-1} (N_3) resulted in higher grain and straw yield compared to lower levels of nitrogen. The next best nitrogen level in realizing higher grain yield was 40 kg N ha^{-1} (N_2) which was significantly superior to that of 20 kg N ha^{-1} (N_1). Better availability of nitrogen with application of 60 kg N ha^{-1} (N_3) might have enhanced the total biomass accumulation and its efficient translocation from source to sink which resulted in elevated growth parameters (dry matter production, leaf area index and number of tiller m^{-2}) and yield attributes (number of panicles m^{-2}, panicle length, grain weight panicle^{-1} and test weight) and have the grain yield . The linear increase in grain yield with increase in supply of nitrogen was reported by several workers *viz.,* Hasan *et al*. (2013), Mubeena *et al*. (2019) and Himasree (2021).

Table 1. Grain and straw yield of barnyard millet as influenced by varieties and nitrogen levels

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Varieties (V)		
V_1 : VL-172	1426	2837
V_2 : VL- 207	1224	2458
V_3 : CO-2	1554	2974
V_4 : VL-182	1088	2289
SEm±	37.6	47.1
CD (P=0.05)	130	163
Nitrogen levels(N)		
N_1 : 20 kg ha^{-1}	1098	2431
N_2 : 40 kg ha^{-1}	1358	2652
N_3 : 60 kg ha^{-1}	1513	2836
SEm±	37.9	52.4
CD (P=0.05)	114	157
Varieties (V) × Nitrogen levels (N)		
V at N		
SEm±	75.7	104.8
CD (P=0.05)	NS	NS
N at V		
SEm±	72.4	132.8
CD (P=0.05)	NS	NS

Nutrient Uptake

The higher nutrient (nitrogen, phosphorus and potassium) uptake at harvest was observed with the variety CO-2 (V_3) which was however comparable with that of VL-172 (V_1). The next best variety was VL-207 (V_2) which was significantly higher than VL-182 (V_4), which recorded the lower nutrient uptake. This might be due to difference in rooting pattern of the varieties. The variety CO-2 (V_3) might be efficient in exploring the nutrients exhaustively from the soil resulting in higher nutrient uptake by the crop at harvest. The present investigation confirms the documented evidence of Mahesh (2021) and Leela (2022).

With regards to nitrogen levels tried, application of 60 kg N ha^{-1} (N_3) resulted in higher nutrient uptake

Table 2. Post-harvest soil available N, P_2O_5 and K_2O as influenced by varieties and nitrogen levels in barnyard millet

Treatments	Available N (kg ha^{-1})	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})
Varieties(V)			
V_1 : VL-172	110.7	28.6	162.1
V_2 : VL- 207	124.3	32.4	175.6
V_3 : CO-2	109.6	27.6	150.7
V_4 : VL-182	137.0	35.5	188.2
SEm±	3.64	0.53	3.60
CD (P=0.05)	12.6	1.8	12.4
Nitrogen levels(N)			
N_1 : 20 kg ha^{-1}	106.1	34.2	181.8
N_2 : 40 kg ha^{-1}	120.5	31.5	168.6
N_3 : 60 kg ha^{-1}	134.6	27.3	157.1
SEm±	3.60	0.84	3.54
CD (P=0.05)	10.8	2.5	10.6
Varieties (V) x Nitrogen levels (N)			
V at N			
SEm±	7.20	1.68	7.08
CD (P=0.05)	NS	NS	NS
N at V			
SEm±	9.57	1.91	9.44
CD (P=0.05)	NS	NS	NS

followed by 40 kg N ha^{-1} (N_2) and 20 kg N ha^{-1} (N_1) in the order of descent with significant difference between any two of them. Application of 60 kg N ha^{-1} (N_3) may improved the microbial activity through enhanced root exudates and increased translocation of nutrients might inturn contributed to higher nitrogen, phosphorus and potassium contents respectively in the plant tissue which were further being complemented with their higher dry matter production. These results are in accordance with the findings of Mubeena (2019).

POST-HARVEST SOIL AVAILABLE NUTRIENT STATUS

Post harvest soil nutrient was varied significantly due to varieties and nitrogen levels, while the interaction between varieties and nitrogen levels was found to be non-significant.

Among the different varieties tried, VL-182 (V_4) recorded higher post harvest soil available nitrogen, phosphorus and potassium which was significantly superior over VL-207 (V_2). Lower post harvest soil available nitrogen, phosphorus and potassium were recorded with CO-2 (V_3) which was on par with that of VL-172 (V_1). Better development of` tillers and higher dry matter accumulation might required more nutrients in CO-2 (V_3) to be absorbed from the soil as in lead to a reduction in post harvest soil available nutients. The similar results were reported by Bhavani (2020) and Mahesh (2021).

Post harvest soil available nitrogen increased significantly with successive increment in nitrogen level from 20 to 60 kg N ha^{-1}. Higher post harvest soil available nitrogen with 60 kg N ha^{-1} (N_3) was due to higher microbial activity which mineralized the organic

Table 3. Nutrient uptake of barnyard millet at harvest as influenced by varieties and nitrogen levels

Treatments	Nitrogen uptake (kg ha^{-1})	Phosphorus uptake (kg ha^{-1})	Potassium uptake (kg ha^{-1})
Varieties			
V_1 : VL-172	30.8	15.2	49.9
V_2 : VL- 207	27.2	12.0	43.5
V_3 : CO-2	32.8	15.3	51.3
V_4 : VL-182	24.0	10.1	37.9
SEm±	0.86	0.48	1.37
CD (P=0.05)	2.9	1.6	4.7
Nitrogen levels			
N_1 : 20 kg ha^{-1}	21.8	10.2	38.4
N_2 : 40 kg ha^{-1}	29.1	12.6	45.4
N_3 : 60 kg ha^{-1}	35.2	16.7	53.1
SEm±	1.09	0.34	1.11
CD (P=0.05)	3.3	1.0	3.3
Varieties (V) × Nitrogen levels (N)			
V at N			
SEm±	2.18	0.68	2.21
CD (P=0.05)	NS	NS	NS
N at V			
SEm±	2.64	1.08	3.24
CD (P=0.05)	NS	NS	NS

nitrogen coupled with nitrogen added to the soil through urea. Higher post harvest soil available phosphorus and potassium were with 20 kg ha^{-1} (N_1) which was significantly higher than that of 40 kg N ha^{-1} (N_2) and 60 kg N ha^{-1} (N_3), while the latter two treaments maintained significant disparity. Application of 60 kg N ha^{-1} (N_3) have led to better uptake of phosphorus and potassium from the soil, resulting in their lower availability in the soil at harvest. These results corroborates with the findings of Dimple (2020) and Leela (2022).

Among the four varieties of barnyard millet tested, CO-2 or VL-172 performed better which were at par with each other in recording higher grain yield, straw yield with higher nutrient uptake and lower post-harvest soil avaliable nutrient status. Barnyard millet responded significantly upto 60 kg N ha^{-1} (N_3) and resulted in higher grain yield, straw yield, nutrient uptake and higher post-harvest soil available nitrogen.

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