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Research Communication

Effect of nutrient management on grain, straw yield and economics in transplanted proso millet

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ABSTRACT

A field experiment was conducted during rainy (*Kharif*) season of 2016 at Dapoli, Maharashtra, to study the nutrient management on grain, straw yield and economics in transplanted proso millet (*Panicum miliaceum* L.) in lateritic soils of Western Ghats. The experiment was laid out in a split-plot design, containing 4 main plot and 5 subplot treatments with 3 replications. The main plot comprised 4 ages of seedlings, viz. 20 days, 30 days, 40 days and 50 days. The subplots consisted of 100% recommended dose of fertilizer (RDF), 75% RDF + 25% N through FYM, 50% RDF + 50% N through FYM, 25% RDF + 75% N through FYM and 100% N through FYM. The crop transplanted with higher nitrogen, phosphorus and potassium content and higher uptake were recorded with seedlings transplanted at 30 days as compared to the remaining treatments. The highest net returns of ₹4647/ha with a Benefit: cost (B:C) ratio of 1.25 was obtained with 30 days old seedlings, followed by 40 days old seedlings. Higher nitrogen, phosphorus and potassium content and higher uptake were recorded owing to 100% RDF through chemical fertilizer treatment as compared to other treatments under study. The highest net returns of ₹4,685/ha with a B: C ratio of 1.27 were obtained from the treatment of 100% RDF through chemical fertilizer. The highest net returns, and B: C ratio were obtained when proso millet crop transplanted with 30 days old seedlings along with 100% RDF nutrient followed by 30 days old seedling along with 75% RDF through chemical fertilizer + 25% N through FYM than rest of the treatment combinations.

Key words : Economics, FYM, NPK, Nutrients, Proso millet, RDF, Seedling age, Soil, Yield

Proso millet is considered a self-pollinated annual crop, through natural cross-pollination may exceed 10%. It is well adapted to many soil and climatic conditions. Proso millet requires very little water, possibly the lowest water requirement of any cereal, and converts water most efficiently to dry matter/grain. Proso millet is cultivated on an area of 0.07 million ha with a total production of 0.43 million tonnes in India (Anonymous, 2013) with a two-thirds share of the total recorded millet trade. Uttar Pradesh, Madhya Pradesh, Maharashtra, Andhra Pradesh, Karnataka, and Tamil Nadu are the main states of its cultivation in India. Proso millet is known for its nutritional value and is cultivated by transplanting in the Konkan region. The productivity is low due to the use of the poor-quality seed, little or no use of fertilizers, traditional methods of cultivation, delay in nursery sowing, and late transplanting. The secret of boosting its yields lies in timely transplanting and properly fertilizing the crop. At the time of transplanting, availability of labours is the main constraint in the Konkan region. Thus to get higher yields, the optimum age of seedlings with proper nutrient combinations should be adopted and hence optimization of these parametres need to be studied.

The field experiment was conducted at the Agronomy farm, college of Agriculture, Dr Balasaheb Swant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra during the rainy (*Kharif*) season 2016, to study Nutrient management on grain, straw yield and economics in transplanted proso millet in lateritic soils of Western Ghats. The soil of the experimental plot was sandy clay loam, moderately acidic in *p*H, and very high in organic carbon content. It was low in available nitrogen, low in available phosphorus, and moderately high in available potassium. The field experiment was laid out in a split-plot design. The main plot comprised 4 ages of seedlings, i.e. A_1, 20; A_2, 30, A_3, 40

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and A_4, 50 days old seedlings, and subplot treatment consisted of 5 nutrient combinations: N_1, 100% RDF; N_2, 75% RDF + 25% N through FYM; N_3, 50% RDF + 50% N through FYM, N_4, 25% RDF + 75% N through FYM and N_5 100% N through FYM and N_5, 100% N through FYM. Proso millet nursery was manured with FYM @ 250 kg/ 100 m^2 area and it was mixed thoroughly in the soil at the time of seedbed preparation. Then a nursery bed of 3 m × 1 m size was prepared in a well-tilled plot. Fertilizers, viz. urea and single superphosphate @ 1 kg and 3 kg/ 100 m^2, respectively, were used at the time of sowing. The fungicide treated seeds were sown on the raised beds in lines, at 10 cm apart, and 2.5 cm depth on different sowing times across the length of the raised beds. The seed was sown shallow and thin. After sowing, the seed was covered with soil. A hand-weeding of the nursery was done at 15 days after sowing (DAS) and it was top-dressed with urea @ 0.5 kg/100 m^2 after hand-weeding. The gross plot size was 4.2 m × 3.0 m and net plot size 3.8 m × 2.7 m. The seedbed for the main crop of proso millet was prepared by ploughing the land with tractor-drawn plough, followed by a tractor-drawn rotavator for clod crushing. After clod crushing, planking was done to bring the field into a level and fine tilth. Transplanting of proso millet was done when the seedlings were 20, 30, 40, and 50 days old respectively. The transplanting 2 seedlings/hill was done at 20 cm × 15 cm spacing. Seedlings were transplanted by the locally used *thomba* method. In this method, a sharp pointed metal or wooden rod is used to punch holes in the soil at required spacing, later in which the seedlings together with fertilizer were placed and covered with soil. The crop was manured and fertilized as per the treatments, according to the recommended dose of proso millet. The FYM @ 5 t/ha was applied and incorporated before the last preparatory tillage operation. The RDF used for proso millet was 80: 40: 0 kg NPK/ha. Nitrogen was applied in the form of urea and phosphorus was applied through single super phosphate. Harvesting of the crop was carried out when 85% of grains in the panicles were matured, to avoid shading of grains. The net plot area was harvested after removing ring lines and observation plants. The threshed product was winnowed immediately and then the grain and straw weights were recorded. The data related to each character of the crop were analyzed statistically by using the standard method of Analysis of variance.

Seedlings of 30 days age showed significantly higher nitrogen content and uptake in proso millet grain and straw compared to the other seedling ages. However, lower nitrogen uptake recorded with 20 days old seedlings. Phosphorus content and uptake in grain and straw were also significantly influenced owing to the age of seedlings. The 30-day old seedlings were superior to the rest of the treatments. The significantly lower phosphorus uptake was recorded when 20 days old seedlings were used. Higher potassium content and uptake were recorded with 30 days old seedlings. However, the potassium content and uptake were found significantly lowest with 20-day old seedlings. This might be due to the inability of seedlings to use the

Table 1. Total nitrogen, phosphorus and potassium uptake (kg/ha) in grain and straw and available N, P_2O_5 and K_2O (kg/ha) in soilof proso millet as influenced by seedling age and nutrient combinations

Treatment	Total N uptake (kg/ha)	Total P uptake (kg/ha)	Total K uptake (kg/ha)	Available N(kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)
Age of seedlings						
A_1	16.8	5.5	65.8	234.0	12.0	211.8
A_2	32.9	12.0	145.2	202.4	10.8	187.9
A_3	24.5	10.2	117.6	213.7	11.8	197.8
A_4	19.6	7.7	94.6	217.6	12.8	204.9
SEm±	0.59	0.22	1.32	6.39	0.37	6.01
CD (P≤0.05)	2.03	0.76	4.57	NS	NS	NS
Nutrient combinations						
N_1	26.9	10.9	124.2	219.2	12.1	204.5
N_2	25.3	9.7	114.6	218.1	12.4	202.7
N_3	23.6	9.0	106.2	216.8	11.8	201.1
N_4	22.1	8.1	99.4	215.9	11.7	199.7
N_5	19.2	6.5	84.6	214.7	11.2	195.0
SEm±	0.43	0.17	2.18	7.07	0.43	8.09
CD (P≤0.05)	1.23	0.48	6.27	NS	NS	NS

A_1, 20 days old seedlings; A_2, 30 days old seedlings; A_3, 40 days old seedlings; A_4, 50 days old seedlings; N_1, 100% recommended dose of fertilizer (RDF); N_2, 75% RDF + 25% N through FYM; N_3, 50% RDF + 50% N through FYM; N_4, 25% RDF + 75% N through FYM; N_5, 100% N through FYM nutrients by overaged and underaged seedlings or the higher ability of seedlings of 30 days age to absorb more nutrients from the soil (Table 1). These findings confirm the results reported by Rajesh and Thanunathan (2003).

In case of soil-fertility status, available nitrogen, phosphorus and potassium were not significantly influenced due to different age of seedlings. The data after the harvesting of proso millet on soil-fertility status indicated that, the available nitrogen, phosphorus and potassium were maximum with 20 day-old-seedlings and the lowest with 30-day old seedlings. It might be due to more nutrient uptake by 30-day-old seedlings leaving low available nutrients in the rhizosphere as shown in Table 1.

Application at 100% RDF through chemical fertilizers resulted in significantly higher nitrogen content and uptake in proso millet grain and plants followed by 75% RDF through chemical fertilizers+ 25% N through FYM (N_2), 50% RDF through chemical fertilizers + 50% N through FYM (N_3), 25% RDF through chemical fertilizers+ 75% N through FYM (N_4) and 100% N through FYM (N_5). Phosphorus content and uptake in grain and straw were significantly higher owing to the application of 100% RDF through chemical fertilizers over the rest of the treatments. Significantly lower phosphorus uptake was recorded at 100% N through FYM. Amongst different nutrient combinations, higher potassium content and uptake were recorded with 100% RDF through chemical fertilizers. However, the potassium content and uptake were significantly lowest with 100% N through FYM. This might be due to poor development of proso millet crop due to slower availability of nutrients by FYM, whereas quicker availability of nutrients through chemical fertilizers resulted in better growth of plants and thereby better uptake of nutrients by the crop.These findings confirm the results of Nigade and More (2013) and Singh (2015), who observed that increased rates of nutrient uptake resulted in increased nitrogen, phosphorus, and potassium uptake.

In the case of soil-fertility status, available nitrogen, phosphorus and potassium were not significantly influenced due to different nutrient combinations. The data after harvesting of proso millet on soil fertility dynamics indicated that the available nitrogen, phosphorus and potassium were maximum with 100% RDF through chemical fertilizers and the minimum with 100% N through FYM. This might be due to higher nutrient availability of nitrogen, phosphorus and potassium compared to initial availability in soil through 100% RDF by checmical fertilizer. The interaction between age of seedlings and nutrient combinations in respect of was non-significant at all the stages of crop growth in proso millet.

Gross returns (₹44,710), net returns (₹9,670), and Benefit: cost ratio (1.25) were higher in the crop transplanted with 30-day-old seedlings compared to the other 3 ages of seedlings (Table 2). It was owing to higher grain and straw yields as compared to the other age of seedlings. Similar findings were also reported by Aggarwal (2015).

The impact of various treatments on economics is presented in Table 2 which revealed that, the maximum gross

Table 2. Effect of seedling age and nutrient comination on yield attributes, yield (t/ha) and economics of proso millet

Treatment	Panicles/ hill	Weight of panicle (g)	1000-grains weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Gross returns ($\times10^3$₹/ha)	Net returns ($\times10^3$₹/ha)	Benefit: cost ratio
Age of seedling (days)								
A1	3.17	8.41	1.60	0.89	2.11	28.11	-1.37	0.96
A2	3.85	8.48	1.65	1.42	3.23	44.71	9.67	1.25
A3	3.56	7.99	1.63	1.23	2.96	39.02	5.34	1.16
A4	3.27	7.89	1.58	1.07	2.54	33.84	2.40	1.08
SEm±	0.06	0.10	0.01	0.21	0.36	-	-	-
CD (P=0.05)	0.22	0.33	0.03	0.71	1.25	-	-	-
Nutrient combinations								
N1	4.05	9.01	1.65	1.25	2.98	39.67	9.45	1.27
N2	3.75	8.69	1.64	1.20	2.84	38.00	6.59	1.20
N3	3.42	8.25	1.62	1.12	2.74	36.89	4.34	1.12
N4	3.20	7.92	1.60	1.12	2.65	35.49	1.99	1.05
N5	2.90	7.09	1.56	1.02	2.32	32.04	-2.32	0.92
SEm±	0.06	0.12	0.01	0.22	0.59	-	-	-
CD (P=0.05)	0.18	0.35	0.04	0.65	1.70	-	-	-

No, Numbers; /hill: Perhill; t/ha, tonnes/ha; g, Gram; A1, 20 days old seedlings; A2, 30 days old seedlings; A3, 40 days old seedlings; A4, 50 days old seedlings; N1, 100% RDF; N2, 75% RDF + 25% N through FYM; N3, 50% RDF + 50% N through FYM; N4, 25% RDF + 75% N through FYM; N5, 100% N through FYM returns (₹39,670), net returns (₹9,451) and Benefit: cost ratio (1.27) were obtained with 100% N through RDF (N_1).

Nutrient with 100% RDF through chemical fertilizers resulted in higher yield and therefore, returns per hectare. It is because the early availability of chemical fertilizers resulted in the maximum yield and ultimately in more economic returns. Our results confirm the findings of Banerjee and Pal (2012) and Singh *et al.* (2015). The interaction between age of seedling and nutrient combinations was found non-significant in respect of the economics of proso millet.

The data about grain yield presented in Table 2 revealed a significant influence on grain yield due to the age of seedlings. As discussed earlier, variation in the age of seedlings at transplanting of the proso millet crop influenced significantly the growth, as well as yield attributes of the crop, and the grain and straw yields, were influenced significantly owing to transplanting of proso millet seedlings either at the age of 20, 30, 40 and 50 days, suggesting that it can be transplanted with influence on yield adversely. As such, it can serve as an important contingency crop against crop failure due to vagaries in monsoon. The mean value reveals that in general with successive advancement in the age of seedlings from 30 to 50 days succeeding 20 days, the grain yield decreased significantly. Among different ages of seedlings, the crop planted with A_2 treatment recorded higher grain yield. Delayed planting had a significant negative impact on the grain yield of proso millet. The higher grain yield (1.42 t/ ha) obtained with A_2 treatment was owing to higher dry-matter production, more panicles/hill as compared to the others. Better translocation of nutrients from source to sink due to planting in A_2 treatment as compared to A_1, A_3, and A_4 treatments might have contributed to better grain yield. In general, grain yield is directly related to the duration of a variety and its genetic makeup. Increase in the age of seedlings for transplanting increased the duration but a decrease in main field duration and thus, the grain yield decreased when overaged and underaged seedlings. The straw yield decreased linearly with the successive advancement in the age of seedlings from 30 to 50 days succeeding 20 days. The crop planted with A_2 treatment recorded higher straw yield than to the others. The higher straw yield (3.23 t/ha) obtained with A_2 treatment was mainly attributed to more plant height, a higher number of tillers/hill, panicles/hill, and dry-matter production at harvesting time compared to the other 3 ages of seedlings. These results confirm the findings of Barla *et al.* (2013). Harvest index was not significantly influenced by the age of seedlings. However, among different ages of seedlings, the crop planted with A_2 treatment recorded the maximum harvest index compared to the other age of seedlings. Sarker *et al.* (2012) was also reported higher harvest index with early age of seedling.

The number of panicles/hill was significantly higher in the treatment N_1. However, the number of panicles/hill was found the lowest with the application of N_5. Generally, higher nutrients influenced the number of tillers/hill and it ultimately reflected into increased panicle number in proso millet crop. These results confirm the findings of Banerjee and Pal (2011). Application of N_1 recorded significantly higher panicle length followed by N_2, N_3,N_4, and N_5 treatments in descending order. Similar findings were also reported by Chouhan *et al.* (2015). Significantly maximum weight of panicle/hill was recorded with the N_1 planting. The lowest weight of panicle/hill was recorded from N_5 treatment. It is clear from Table 2 that, due to fact the application of the recommended dose in the main field help to carry out photosynthesis and established better source and sink relationship which turns in the highest weight of panicle/hill. The increased number of rachis/panicle was recorded under N_1 treatment might be due to proper crop growth rate and maximum crop net assimilation rate followed by the attainment of physiological growth, particularly panicle initiation, flowering, and asynchronous tillering. Treatment N_1 recorded the highest 1000-grains weight. The 1000-grains weight is an important yield contributor that depends on genetic makeup and is affected by growing conditions, nutrient management as well as other managemental factors. These results confirm the findings of by Banerjee and Pal (2011) and Gour *et al.* (2015). The maximum grain yield (1.25 t/ha) in treatment N_1 was owing to the combined effect of more number of tillers, more number of panicles and more number rachis/panicle. Since the grain yield is the combined result of these 3 contributory characters, the yield in the present experiment was increased with different nutrient combinations. These findings confirm the results of Nigade and More (2013), Singh *et al.* (2015), Gour *et al.* (2015) and Pradhan *et al.* (2016). The data in respect of straw yield at harvest (Table 2) indicated that the straw yield of proso millet was significantly influenced due to nutrient combinations. Application of N_1 resulted in significantly higher straw yield (2.98 t/ha) followed by N_2, N_3, N_4 and N_5 in treatments descending order. This might be because the different combinations of nutrients influenced the physiological activity of the dry-matter accumulation also increased with the nutrient application and it was optimum at the maturity stage owing to diversion of food material from source to sink. These results confirm the findings of investigator Nigade and More (2013) and Singh *et al.* (2015).

It can be cloncuded from the study that 30 days old seedlings together with 100% RDF through chemical fertilizers had potential to obtain higher higher net returns, yield and nutrient content in grain and straw. However, in a longer term this results could vary due to more use of fertilizers and failure of proper crop rotation. Therefore, long-term further research are recommended.

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