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Effect of integrated nitrogen management on nutrient uptake, quality, economics and soil fertility of pearlmillet under rainfed conditions

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ABSTRACT

Field experiments were conducted during *kharif* seasons of 2006 and 2007 to evaluate the effect of integrated nitrogen management nutrient uptake, quality, economics and soil fertility of pearlmillet under rainfed conditions. Applications of 50% RDN through FYM + 50% through urea, 80% RDN through vermicompost + 20% through urea and 25% RDN through FYM + 75% through urea were found the most superior and equally effective treatments in terms of total uptake of nitrogen, phosphorus and potassium, protein content in grain, grain yield, net returns and B:C ratio. Significantly, higher total uptake of nitrogen (66.73 kg/ha), phosphorus (14.48 kg/ha) and potassium (97.16 kg/ha), protein content in grain (11.83%), grain yield (2.22 t/ha) net returns (₹ 11169/ha) and B:C ratio (1.95) were recorded where 50% RDN through FYM + 50% through urea was applied. Whereas, application of 100% RDN through FYM was proved most superior treatment for improvement in post experiment soil fertility by increased soil organic carbon, N, P and K content

Introduction

In India, pearlmillet (*Pennisetum glaucum* L.) is the fifth most important cereal grain crop next to rice, wheat, maize and sorghum. Today, it is getting more attention due to increasing evidence of less seasonal rainfall, terminal heat, frequent occurrence of extreme weather events coupled with scanty water resources (Singh *et al*. 2010). Pearlmillet traditionally is an indispensable component of dry-farming system and it is considering more efficient in utilization of soil moisture, and has a higher level of heat tolerance than even sorghum and maize. It is the food for millions of people in the poor soils of semi-arid tropics. India is the largest producer of pearlmillet in world occupying about 9.4 million hectare with annual production of 10.1 million tonnes with average productivity of 1069 kg/ha (Economic Survey of India, 2011). The crop is mostly confined to low fertile water deficit soils. Because of its remarkable ability to withstand and grow in harsh environment, reasonable and nearly assured harvests are obtained.

Adoption of pearlmillet-wheat or pearlmillet-mustard sequence over a long period without a provision for adequate replenishment of nutrients results in declining of soil fertility. Withdrawal of nutrients from the soils of rainfed areas has remained much higher than their application (Gupta, 2001). The gap between nutrient removal and supply under rainfed situation, calls for integrated nutrient management strategy involving use of fertilizer, organic manure and bio-fertilizers. Nitrogenous fertilizer has played a key role in increasing food grains production in India and will continue to do so in future (Prasad, 2011). Bio-fertilizers play an important role in increasing availability of nutrients and enhancing productivity in a sustainable manner. *Azotobactor* and *Azospirillum* are free living bacteria. On an average the former is known to fix 20-40 kg N/ha, whereas, *Azospirillum* can fix 20 kg N/ha/year besides producing growth promoting substances. The present investigation was, therefore, conducted to find out the effect of integrated nitrogen management on nutrient uptake, quality, economics and soil fertility of pearlmillet under rainfed conditions.

Materials and Methods

A field experiment was conducted during *kharif* season of 2006 and 2007 at Research farm of S.K.N. College of Agriculture, Jobner (Rajasthan) for two consecutive years to know the effect of integrated nitrogen management on nutrient uptake, quality, economics and soil fertility of pearlmillet under rainfed conditions. The soil was loamy sand in texture, alkaline in reaction (pH 8.2), low in organic carbon (0.24 %), available nitrogen (139.13 kg/ha), available phosphorus (16.78 kg P_2O_5/ha) and medium in potassium (231.13 kg K_2O/ha) content. The experiment consisted of seven treatments of fertilizers and manure and their combinations (control, 100% RDN through urea, 100% RDN through FYM, 75% RDN through FYM + 25% through urea, 50% RDN through FYM + 50% through urea, 25% RDN through FYM + 75% through urea and 80% RDN through vermicompost + 20% through urea) in main plots and three bio-fertilizer inoculation (control, *Azotobactor* and *Azospirillum*) in sub plots thereby making twenty one treatment combinations were replicated thrice in a split plot design.

Twenty four days old seedlings of pearlmillet cv. Raj 171 were transplanted at 40 x 10 cm spacing during both the years. A basal dose of phosphorus (30 kg P_2O_5/ha) through single super phosphate was drilled in all plots. The weighed quantity of FYM and vermicompost were applied two weeks before transplanting as per treatment. The half of nitrogen through urea as per treatment was applied as basal to crop before transplanting. The

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remaining half of nitrogen was top dressed at knee height stage when an adequate rain occurs. Bio-fertilizers were applied as per treatment by dipping the roots of seedlings just before transplanting. Total rainfall received during crop season was 143.6 and 237.7 mm, during 2006 and 2007, respectively. The experimental data were statistically analysed by Fisher's 'Analysis of Variance' technique (Fisher, 1950).

Results and Discussion

Effect of nitrogen management

Total uptake of nutrients

Results indicated that all the treatments of integrated nitrogen management significantly increased the total uptake of nutrients in comparison to control (Table 1). Application of 50% RDN through FYM + 50% through urea remained at par with 80% RDN through vermicompost + 20% through urea and 25% RDN through FYM + 75% through urea and resulted significantly higher total uptake of nitrogen and phosphorus over remaining treatments of integrated nitrogen management. The magnitude of increase with application of 50% RDN through FYM + 50% through urea was 69.9, 19.0, 27.1 and 20.0 per cent in nitrogen uptake and 76.4, 33.0, 31.6 and 27.5 per cent in phosphorus uptake, respectively over control, 100% RDN through urea, 100% RDN through FYM and 75% RDN through FYM + 25% through urea. However, in total uptake of potassium application of 50% RDN through FYM + 50% through urea remained at par only with 80% RDN through vermicompost + 20% through urea. This treatment was significantly enhanced the total uptake of potassium by 46.7, 23.7, 23.3, 21.6 and 17.0 per cent, respectively over control 100% RDN through urea, 100% RDN through FYM and 75% RDN through FYM + 25% through urea. This might be due to improved nutritional environment in the rhizosphere as well as its utilization in the plant system leading to enhanced translocation of nutrients towards reproductive structures *viz.*, ear heads, seeds and other plant parts. These results gain support from Meena and Gautam (2005).

Table 1. Effect of integrated nitrogen management on nutrient uptake, protein content, grain yield and economics of pearlmillet (Pooled mean of two years)

Treatment	Total nutrient uptake (kg/ha)			Protein content (%)	Grain yield (t/ha)	Net returns (₹/ha)	B:C ratio
	N	P	K				
Integrated nitrogen management							
Control	39.27	8.21	66.23	10.49	1.42	5713	1.56
100% RDN through urea	56.08	10.89	78.81	11.63	1.80	8700	1.80
100% RDN through FYM	52.50	11.00	79.87	11.44	1.81	6860	1.56
75% RDN through FYM + 25% through urea	55.59	11.36	83.02	11.51	1.90	7821	1.65
50% RDN through FYM + 50% through urea	66.73	14.48	97.16	11.83	2.22	11169	1.95
25% RDN through FYM + 75% through urea	61.47	13.29	87.83	11.47	2.10	10399	1.92
80% RDN through VC + 20% through urea	64.25	13.67	95.10	11.66	2.17	10382	1.86
SEm±	1.82	0.42	2.87	0.17	0.03	356	0.03
CD (P=0.05)	5.30	1.24	8.36	0.50	0.10	1037	0.09
Inoculation							
Control	54.90	11.41	81.87	11.26	1.88	8402	1.73
Azotobactor	57.88	12.21	85.58	11.57	1.94	8967	1.78
Azospirillum	56.88	11.91	84.56	11.46	1.92	8792	1.76
SEm±	0.62	0.09	0.81	0.08	0.02	138	0.01
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS

Table 2. Effect of integrated nitrogen management on soil fertility after experimentation

Treatment	Organic carbon (%)	Available nutrient content (kg/ha)		
		Nitrogen	Phosphorus	Potassium
Integrated nitrogen management				
Control	0.18	90.5	13.3	215.6
100% RDN through urea	0.19	140.8	16.2	222.8
100% RDN through FYM	0.30	146.1	18.9	237.8
75% RDN through FYM + 25% through urea	0.26	139.3	17.8	232.5
50% RDN through FYM + 50% through urea	0.26	137.2	17.3	233.4
25% RDN through FYM + 75% through urea	0.23	137.4	16.8	237.4
80% RDN through VC + 20% through urea	0.27	141.4	18.8	237.3
SEm±	0.004	2.6	0.3	4.0
CD (P=0.05)	0.012	7.6	0.8	11.7
Inoculation				
Control	0.23	132.7	16.7	230.3
Azotobactor	0.25	134.8	17.2	231.4
Azospirillum	0.24	132.2	17.0	231. 2
SEm±	0.003	1.4	0.1	1. 3
CD (P=0.05)	NS	NS	NS	NS

Initial values: OC (0.24%); Avail N (139.13 kg/ha); Avail P (16.78 kg/ha); Avail. K (231.13 kg/ha)

Protein content in grain

Protein content of pearlmillet grain was influenced significantly due to adoption of integrated nitrogen management practices (Table 1). All the treatments of integrated nitrogen management were remained at par with each other and proved significantly superior over control. Application of 50% RDN through FYM + 50% through urea resulted in the highest grain protein content (11.83%). It may be because of increased N content in seed which might be the result of increased availability of nitrogen to plants. Another reason for higher nitrogen content might be due to increased activity of nitrate reductase enzyme. Higher nitrogen in seed is directly responsible for higher protein because it is a primary component of amino acids which constitute the basis of protein. The findings of present investigation are in agreement with those of Mundra *et al*. (2002) and Meena and Gautam (2005).

Grain yield

Results showed that different combination of fertilizers and manures caused a remarkable effect on grain yield of pearlmillet over control wherein, application of 50% RDN through FYM + 50% through urea being at par with 80% RDN through vermicompost + 20% through urea produced significantly higher grain yield over rest of the treatments and represented an increase of 56.6, 22.9, 22.2, 16.7 and 5.6 per cent respectively, over control, 100% RDN through urea, 100% RDN through FYM, 75% RDN through FYM + 25% through urea and 25% RDN through FYM + 75% through urea (Table 1). This could be attributed to the continuous availability of nutrients throughout the growing season. The efficacy of organic fertilizer is much pronounced when it is combined with organic manures (FYM and vermicompost). The increased vegetative growth and the balanced C:N ratio might have increased the synthesis of carbohydrates, which ultimately promoted yield. The present trend of increase in yield is in close conformity with the findings of Satyajeet and Nanwal (2007) and Parihar *et al*. (2010).

Economics

Results of two year experimentation showed that the different treatments of integrated nitrogen management were significantly influenced the economics of pearlmillet (Table 1). Application of 50% RDN through FYM + 50% through urea recorded significantly higher net returns of ₹ 11169 along with B:C ratio of 1.95 followed by 25% RDN through FYM + 75% through urea (net returns of ₹ 10399 with B:C ratio of 1.92) and 80% RDN through vermicompost + 20% through urea (net returns of ₹ 10382 with B : C ratio of 1.86). The increase in net returns might be due to higher grain yield obtained under these treatments as compared to cost involved under these treatments. Choudhary and Gautam (2007) and Ramesh *et al*. (2009) also obtained similar findings.

Soil fertility status

Results of post experimentation analysis (Table 2) at the end of two years of cropping season showed that a significant improvement in soil organic carbon status was observed due integrated nitrogen management treatments. Application of 100% RDN through FYM recorded significantly highest value of soil organic carbon (0.30%) as compared to all other treatments of integrated nitrogen management. Available N, P and K content were also influenced significantly with different treatments of integrated nitrogen management as compared to control. The plots receiving 100% RDN through FYM showed the highest residual nitrogen (146.1 kg/ha), phosphorus (18.9 kg/ha) and potassium (237.8 kg/ha) followed by those receiving 80% RDN through vermicompost + 20% through urea. It could be understood in the light of differential solubility and rate of decomposition of fertilizers and manures. It is quite established that only a part of FYM is mineralized in one season and the rest has carry over effect. The residual status of nutrient is thus, a function of nutrients supplied and their loss/removal. These results are in agreement with those obtained by Jamwal (2005) and Ramesh *et al*. (2009).

Effect of seedling inoculation

Seedling inoculation with bio-fertilizers (*Azotobactor* and *Azospirillum*) could not bring any significant improvement on nutrient uptake, quality, grain yield, net returns, B:C ratio of pearlmillet and after experimentation soil fertility status (Table 1 and 2).

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