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Effect of nitrogen and phosphorus on nutrient content and uptake in pearl millet

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Abstract
A field experiment was conducted at Research farm, Vivekananda Global University, Jaipur during *Kharif* season¸ 2023-24 on loamy sand soil. The experiment comprises nine treatments of nitrogen and phosphorous *viz*., (Control, 30 kg N ha^{-1} + 15 kg P_2O_5 ha^{-1}, 30 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1}, 60 kg N ha^{-1} + 15 kg P_2O_5 ha^{-1}, 60 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1}, 90 kg N ha^{-1} + 15 kg P_2O_5 ha^{-1}, 90 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1}, 120 kg N ha^{-1} + 15 kg P_2O_5 ha^{-1}, 120 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1}) was laid out in randomized block design and replicated thrice. Results indicated that among the treatments applied as application of 120 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} recorded significantly higher nitrogen, phosphorus content and uptake in grain and straw of pearlmillet.

Keywords: Field experiment, nitrogen levels, phosphorus levels

Introduction
Among all coarse and minor millets Pearl millet, scientifically known as (*Pennisetum glaucum* L.) is an important cereal grain and a staple food crop primarily grown in arid and semi-arid regions of Africa and South Asia. Pearl millet, often referred to as bajra in India, is prized for its ability to withstand heat and drought, making it an essential crop in areas with harsh environmental conditions. It flourishes satisfactorily and can yield grain under rainfall as low as 200 to 250 mm (Bidinger and Hash, 2003) [2], which makes it one of the most reliable cereal in the rainfed regions of arid and semi-arid tropics. The nutrient content of pearl millet is very well comparable with other cereals and millets. Its grain contains about 11.6% protein, 5% fat, 67% carbohydrate, 2.7% minerals and about 12.4% moisture. It also contains higher amount of carotene, riboflavin (Vit B_2) and niacin (Vit B_4). Traditionally, Bajra chapatti known as Sogra/Hogra is the part of daily diet in the western Rajasthan. Besides it, “Khichadi” and “churma” are the delicious dishes prepared from pearl millet flour. The Crop is also valued as an important source of green and dry fodder (karbi) for cattle in this belt. A small proportion of grains is used for poultry feed. Now a day, pearl millet grain is also gaining importance as a cheap source of starch for making fine quality breweries (Khairwal, 2003) [6].
Poor soil fertility and erratic rains are the most important constraints to crop production in arid and semi-arid region. Soil fertility management i.e., nutrient management particularly nitrogen (N) and phosphorus (P) plays a major role in increasing production and productivity of pearl millet. Nitrogen is an essential major nutrient for plant growth, which is closely associated with vegetative growth and development of plants. It plays an important role in plant metabolism by virtue of being an essential constituent of structural component of the cell wall and many metabolically active compounds. It is also a constituent of chlorophyll and amino acids, which is important for harvest of solar energy. It helps in early establishment of leaf area capable of photosynthesis. It promotes leaf and stem growth rapidly which consequently increase the yield and its quality. Nitrogen to some extent enhances the utilization of phosphorus and potassium. Nitrogen is most commonly deficient nutrient in Indian soil and gives considerable response in pearl millet crop (Jadhav *et al*., 2011) [5]. Pearl millet is an exhaustive crop, nitrogen is the major nutrient required by pearl millet and has shown variable growth and yield response to N application.

Phosphorus (P) is a second leading limiting factor after nitrogen for plant growth and productivity on 40% of the world's arable soil (Vance, 2001) [9]. It plays key roles in many plant processes such as energy metabolism, the synthesis of nucleic acids and membranes, photosynthesis, respiration, nitrogen fixation and enzyme regulation (Raghothama, 1999) [8]. Adequate phosphorus nutrition enhances many aspects of plant growth development including flowering, fruiting, root growth and yield components of different crops. P uptake in plants is often constrained by the very low solubility of P in the soil. In agricultural systems, phosphorus in the harvested crops is removed from the system, resulting in P deprived soils if no P is supplemented as fertilizer.

Methodology

Nutrient content in grain and straw

Representative sample from grain and stover were taken separately from each plot for estimation of N and P content. The samples were oven dried at 65 °C for 24 hrs, powdered by mechanical grinder and analyzed for respective nutrient content using following methods:

Table 1: Methods of nutrient measurement in grain and stover

Nutrient	Method	Reference
Nitrogen (%)	Modified Kjeldahl's Method	Jackson (1967) [4]
Phosphorous (%)	Vanadomolybdo phosphoric acid Yellow colour method	Jackson (1967) [4]

Total nutrient uptake

The total uptake of nitrogen, phosphorus and potassium was computed from N and P concentration in grain and stover at harvest using following relationship:

$$\text{Nutrient uptake (kg ha}^{-1}) = \frac{\text{Nutrient content in grain (\%)} \times \text{Grain yield (kg ha}^{-1}) + \text{Nutrient cont. in straw (\%)} \times \text{Straw yield (kg ha}^{-1})}{100}$$

Statistical analysis

In order to test the significance of variation in experimental data obtained for various treatment effects, the data were statistically analyzed as described by Fisher (1950) [3]. The critical differences were calculated to assess the significance of treatment mean wherever the F' test was found significant at 5 percent level of probability. To elucidate the nature and magnitude of treatment effects, summary tables along with SEm± and CD (P=0.05) were prepared and are given in the text of the chapter. Experimental results and their analyses of variance are given in Appendices at the end.

The following formula were used for standard error, critical difference and coefficient of variance estimations.

$SEm\pm = \sqrt{EMS/r}$

$C.D. = SEm\pm \times \sqrt{2} \times t\ \%$

$$C.V.\ (\%) = \frac{\sqrt{EMS}}{\text{Grand mean}} \times 100$$

Where,

r = Number of replications

t = Number of treatments

D.F. = Degree of freedom

SEm± = Standard error of mean

EMS = Error mean squares

C.D. = Critical difference

C.V. = Coefficient of variance

Results and Discussion

Results revealed that application of (T_9) 120 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} recorded higher nitrogen content (1.70 and 0.57%), phosphorus content (0.278 and 0.141%) and higher nitrogen uptake (35.95 and 25.19 kg ha^{-1}), phosphorus uptake (5.89 and 6.23 kg ha^{-1}) over control and T_8, T_7, T_6 and T_5 being statistically at par with 120 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1}. might be due to favorable effects of nitrogen on growth parameters and This yield attributes which ultimately resulted in highest grain and stover yields and consequently more nitrogen uptake by the crop. Phosphorus content in pearl millet grain and stover also increased with nitrogen and phosphorus levels. Increase in phosphorus content with increasing levels of application of direct effect of P and N which increased its availability from plant in soil. Crop plant utilized it and increased P concentration in grain and stover both. Comparable results were also reported by Pareek *et al*. (2015) [7].

Table 1: Effect of nitrogen and phosphorus on nitrogen content in grain and stover and their uptake in pearlmillet

Treatments	N content (%)		N uptake (kg/ha)	
	Grain	Stover	Grain	Stover
T_1-Control	1.50	0.43	15.17	9.52
T_2-30 kg N ha^{-1} + 15 kg P_2O_5 ha^{-1}	1.60	0.47	25.21	14.33
T_3-30 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1}	1.61	0.48	25.93	15.23
T_4-60 kg N ha^{-1} + 15 kg P_2O_5 ha^{-1}	1.62	0.49	29.25	16.20
T_5-60 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1}	1.67	0.54	34.18	21.22
T_6-90 kg N ha^{-1} + 15 kg P_2O_5 ha^{-1}	1.68	0.55	34.89	23.96
T_7-90 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1}	1.69	0.55	35.29	24.07
T_8-120 kg N ha^{-1} + 15 kg P_2O_5 ha^{-1}	1.70	0.56	35.67	24.67
T_9-120 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1}	1.71	0.57	35.95	25.19
SEm±	0.02	0.01	1.36	0.99
CD (P=0.05)	0.07	0.03	4.09	2.97

Table 2: Effect of nitrogen and phosphorus on phosphorus content in grain and stover and their uptake in pearlmillet

Treatments	P content (%)		P uptake (kg/ha)	
	Grain	Stover	Grain	Stover
T_1-Control	0.251	0.112	2.54	2.48
T_2-30 kg N ha^{-1} + 15 kg P_2O_5 ha^{-1}	0.262	0.125	4.13	3.81
T_3-30 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1}	0.263	0.128	4.24	4.06
T_4-60 kg N ha^{-1} + 15 kg P_2O_5 ha^{-1}	0.264	0.129	4.77	4.26
T_5-60 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1}	0.272	0.135	5.57	5.30
T_6-90 kg N ha^{-1} + 15 kg P_2O_5 ha^{-1}	0.275	0.137	5.71	5.97
T_7-90 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1}	0.277	0.138	5.78	6.04
T_8-120 kg N ha^{-1} + 15 kg P_2O_5 ha^{-1}	0.278	0.140	5.83	6.17
T_9-120 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1}	0.280	0.141	5.89	6.23
SEm±	0.004	0.004	0.23	0.25
CD (P=0.05)	0.011	0.011	0.69	0.76

Conclusion

The field experiment on pearl millet showed that the combined application of 120 kg nitrogen ha^{-1} and 30 kg phosphorus ha^{-1} resulted in significantly higher nitrogen and phosphorus content in both grain and stover. This treatment also led to the highest nutrient uptake, enhancing grain and stover yields. The increased availability and absorption of nutrients due to the synergistic effects of nitrogen and phosphorus contributed to the

improved growth and productivity of pearl millet. These findings underscore the importance of balanced nitrogen and phosphorus fertilization in optimizing nutrient uptake and maximizing crop yield in loamy sand soils.

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