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Effect of Nitrogen and Phosphoruslevels on growth, yield and nutrient uptake of pearl millet (*Pennisetum glaucum.L*)

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ABSTRACT
A field experiment was conducted during kharif 2012 with 12 treatments combination of 4 nitrogen levels (0, 40, 80 and 120 kg N/ha) and 3 phosphorus levels (0, 30 and 60 kg P/ha) applied through urea and SSP, respectively in RBDwith three replication. The results shows that growth parameters of pearl millet crop increased with increasing N levels up to 120 kg N/ha but increase beyond 80 kg/ha was not found significant in general. Effect of P levels also increased growth parameters up to 60 kg P/ha but, in general, it was found significant up to 30 kg P/ha. Yield attributing characters also followed the same pattern. Grain and stover yield of pearl millet increased in a linear fashion with increasing levels of N and P up to 120 kg N and 60 kg P/ha. The combined application of 120 kg N + 60 kg P/ha produced highest of 26.45 q/ha grain yield and 87.60 q/ha stover yield. The total uptake of NPK by crop was maximized at highest level of 120 kg N and 60 kg P/ha. The combined use of both, 120 kg N and 60 kg P/ha recorded highest values of 94.29 kg N, 65.01 kg P.
***Key word**:Pearl millet, Nitrogen and Phosphorus, growth and yield, nutrient uptake.*

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INTRODUCTION

The millets are a group of highly variable small grained grasses, widely grown around the world as cereal crops. It is a dual purpose crop grown as grain for food and fodder for animals. Millets are important crop in the semi-arid tropics of Asia and Africa. In Asia, it is especially grown in the country like India and in African continent is grown in countries like Nigeria and Niger. Millets are favoured due to its productivity and short growing season under dry and high temperature conditions. Millets are indigenous to many parts of the world and had an evolutionary origin in tropical western Africa where the great number of both wild and cultivated form exists. Millets have been important food staples in human history, particularly in Asia and Africa and they have been in cultivation in East Asia for the last 10,000 years. India is the world's largest producer of millet. In the 1970's, all of the millet crops harvested in India were used as food staple. By 2000s, the annual millets production had increased in India, yet per capita consumption of millets had dropped by between 50%-75% in different regions of the country. As of 2005, the majority of millets produced in India are being used for alternative applications such as livestock fodder and alcohol production. Indian organizations are discussing ways to increase millet used as food

to encourage more production; however, they found that some consumers prefer the taste of other grain over millet. Since, pearl millet is a major cereal crop in the arid and semi-arid region of India is gaining more attention today due to increasing avoidance of rainfall, increase in temperature, frequent occurrence extreme weather events coupled with exactly water resources, poor fertilizer managements. Though it is also adopted in resource poor situation this crop also suffers badly due to low soil fertility. Among the plant nutrients, N and P are important nutrients which can affect plant growth and there by yield in cereal crops particularly in millet crops. N plays an important role in the synthesis of chlorophyll as well as amino acids, which is the building unit of protein as the N is mobile elements. The N splitting with different quantity is most important for efficient utilization of nitrogen as well as maximization of the crop yield.

Phosphorus is another major plant nutrient present in most plant in concentration between 0.1 and 0.5 percent absorbed either in H_2PO_4 or HPO_4^{--} forms. Adequate supply of P early in the life of plant is important in the developing of its reproductive parts. It is associated with increased root growth and greater straw strength in cereals. Indian soils are poor in this element so the crops show good response to addition of P. Phosphorus is second important major plant nutrient for crop production. It has been called as the "Bottlneck of world hunger". Phosphorus is a structural component of cell membranes, chloroplast and mitochondria. It is necessary for such life process of plant as photosynthesis, development of plant cell as well as fat and albumin's, the synthesis and breakdown of carbohydrates and transfer of energy within the plant. It is stimulant for the plant which is evident as accumulation of soluble organic nitrogenous compounds, free amino acid and amides, and decrease in protein content. Plants have poorly developed root developments as well as plant tillers. Its absence results in distributing the 'nitrogen' metabolism root system. Leaves of phosphorus deficient plants are small and greenish, reddish brown and purple to bronze colour, flowering and ripening is retarded and grain remains small. The quantity and quality of produce is also poor. On the other hand, excess of phosphorus accelerates ripening. It also strengthens stem of cereal plants, reducing their tendency to lodge.

MATERIAL AND METHODS

The experiment was conducted at Nawabganj Farm field of the Department of Seed Science and Technology, C.S. Azad University of Agriculture & Technology, Kanpur during kharif season 2012 at latitude of 250 28' to 260 58' North and 790 31' to 800 34' East with an elevation of 125.9 m MSL with annual rainfall 816.0 mm. The treatments comprised 12 combinations of four (0, 40, 80 and 120 kg/ha) nitrogen and three (0, 30 and 60 kg/ha) phosphorus. Initial physico-chemical properties of experimental soil were bulk density 1.36 g/cm3, particle density 2.65 g/cm3, pH 7.90, EC 0.15 dS/m, organic carbon 0.35 g/kg, water holding capacity 41%, available NPK 209.70, 13.60 and 188.20 kg/ha, respectively.

RESULTS AND DISCUSSION

Effect of N&P levels on growth parameter

Effect of plant height of pearl millet was noticed that increased up to the increasing dose of NP and maximum plant height was recorded withhighest dose of nitrogen, but significant increase was noticed only up to the 40 kg nitrogen per hectare. It might be due to increase availability of N to the crop and N affects plant growth up to certain level. The similar findings have also been observed [1, 2 and 3] in pearl millet and [4] in maize crop. Similarly, plant height of pearl millet was influenced significantly by phosphorus application up to 30 kg P/ha. [5, 6] also observed same results.

Number of tillers/m row length increased significantly with increasing N levels up to 80 kg/ha and also with P application up to 30 kg/ha (Table 1). In a similar way N and P affects significantly 50 per cent flowering of pearl millet at 80 kg N and 30 kg P/ha. Ear length and dry matter also enhanced significantly up to 80 kg N and 30 kg P/ha. Increase in all growth characters due to N has been observed [7].

Effect of NP levels on yield attributes

Grain and stover yields:

Grain and stover yield of pearl millet (Table 1) increased with each successive doses of N and P. Significant response was noticed up to the levels of 80 kg N/ha. The increase in yield due to N application could be ascribed to better plant growth and dry matter production

due to higher photosynthetic area. This is further supported by the fact that soil of experimental field was low in N. Thus, an increase in nitrogen supply might have increased all growth parameters, yield attributing characters which ultimately contributed to increase in grain and stover yield. The results confirm the finding of [8,9,10, 11]. Grain and stover yield of pearl millet also increased with phosphorus doses. Significant effect was observed only up-to 30 kg P/ha. This might attributed to more P fixing capacity of experimental plots. Effect of phosphorus may also be due to that available phosphorus of soil was in medium range and application of phosphorus improved the nutrient availability status, resulting into greater uptake which might have increased the photosynthesis and then trans located to different plant parts and hence increased the growth parameters which contributed to yield. These results are in close conformity to those of [12, 13 and 14].

Effect of NP levels on nutrient contents and uptake

Nitrogen content in grain and stover of pearl millet increased with every incremental dose of nitrogen and phosphorus (Table 2). It seems to be due to increased nitrogen level in the soil solution from added nitrogen and phosphorus which is utilized by the plant and in later stage it translocate to grain. These results are in agreement to the findings of [15]) in late shown niger, [16] in pulse crop and [17, 18]in pearl millet crop.

Phosphorus content in pearl millet grain and stover also increased with nitrogen and phosphorus levels (Table 2). 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. These results confirm the findings of [19,20] in pulses and [21,22] in pearl millet. Potassium content in grain and stover of pearl millet showed significant increase up to 80 kg nitrogen and 30 kg phosphorus per hectare. It might be due to increased absorption of K by crop plants along with N and P, particularly the nitrogen. Almost similar findings have also been suggested [23].

Nutrient uptake

Nitrogen uptake in grain, stover and total uptake in pearl millet increased up to highest levels of N and P applied. However, significant effect was noticed up to 80 kg N/ha and 30 kg P/ha (Table 2). It might be due to N content in crop and crop yields. As both these nutrient increases contents also increased. These results are in close conformity to the finding of [24,25] in pulse crop and 26,27,28] in pearl millet. Phosphorus uptake in pearl millet enhanced with each levels of nitrogen and phosphorus by both grain and straw. Increase in P uptake due to N and P application seems to be due to increase in P content and crop yield with increasing levels of N and P. Combined effect of both increased the P uptake in grain, stover and total uptake in pearl millet crop. These results corroborate with the findings of [29] in pulse cropand [30] in oat. Potassium uptake in pearl millet crop increased significantly up to 80 kg N/ha and with phosphorus up to 30 kg P/ha. These trend in K uptake are attributed to more concentration of K in grain and stover, and higher crop yield at increased rates of N and P fertilization. Combined effect of both might has increased the K-uptake in grain, stover and whole crop. The results are also supported by the finding of [31] in pulse crop [32, 33] in rice crop

Table 1: Effect of NP levels on growth and yield attributes of pearl millet under rainfed condition

Treatment	Plant height (cm)	No. of effective tiller/m	50% flowering	Ear length (cm)	Dry matter production (g/plant)	Test weight (g)	Yield (q/ha)	
							Grain	Stover
N_0P_0	161.20	13.30	43.20	20.00	41.13	5.90	15.10	61.30
N_0P_{30}	174.00	14.60	45.75	22.20	44.20	6.79	17.85	68.60
N_0P_{60}	177.50	14.80	46.23	22.40	44.75	6.94	19.20	69.80
$N_{40}P_0$	176.70	15.60	46.25	24.10	46.83	6.73	18.75	70.40
$N_{40}P_{30}$	188.30	16.80	48.10	26.30	49.42	7.61	21.30	76.30
$N_{40}P_{60}$	191.00	16.90	48.35	26.50	49.86	7.80	22.00	77.00
$N_{80}P_0$	187.40	16.70	48.50	26.60	50.75	7.34	21.40	77.40
$N_{80}P_{30}$	195.10	17.50	49.90	28.40	52.96	7.87	24.25	83.50
$N_{80}P_{60}$	196.80	17.80	50.15	28.60	53.10	8.00	25.10	84.70
$N_{120}P_0$	190.00	16.90	48.75	27.00	51.80	7.42	22.30	79.20
$N_{120}P_{30}$	196.00	17.60	50.80	28.60	53.25	7.76	25.60	86.30
$N_{120}P_{60}$	198.30	18.50	51.20	28.90	53.66	7.90	26.45	87.60
SEm ±	5.15	1.40	3.08	2.86	3.04	1.19	2.80	4.87
CD (p=0.5)	14.25	4.11	9.16	8.47	8.97	3.14	8.57	16.21

Table 2:Effect of NP levels on nutrient content and uptake by grain and stover of pearl millet under rainfed condition

Treatment	Nutrient content by Grain (%)			Nutrient content by Stover (%)			Nutrient uptake by Grain (kg/ha)			Nutrient uptake by Stover (kg/ha)			Total nutrient uptake (kg/ha)		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
N_0P_0	1.40	0.81	0.36	0.48	0.46	0.81	21.14	6.95	5.45	29.42	28.20	49.59	50.56	35.15	55.04
N_0P_{30}	1.45	0.83	0.37	0.52	0.49	0.82	25.88	8.75	6.57	35.67	33.62	56.05	61.55	42.37	62.62
N_0P_{60}	1.48	0.84	0.37	0.53	0.50	0.82	28.42	9.60	7.10	36.99	34.90	57.10	65.41	44.50	64.20
$N_{40}P_0$	1.46	0.85	0.37	0.53	0.49	0.82	27.37	9.18	6.99	37.31	34.50	57.45	64.68	43.68	64.44
$N_{40}P_{30}$	1.49	0.87	0.38	0.57	0.52	0.83	31.74	11.08	8.05	43.49	39.68	62.95	75.23	50.76	71.00
$N_{40}P_{60}$	1.50	0.88	0.38	0.58	0.54	0.83	33.00	11.88	8.34	44.66	41.58	63.68	77.66	53.46	72.02
$N_{80}P_0$	1.50	0.88	0.38	0.55	0.51	0.82	32.10	10.92	8.17	42.57	39.47	63.54	74.67	50.39	71.71
$N_{80}P_{30}$	1.53	0.91	0.39	0.60	0.55	0.83	37.10	13.34	9.38	50.10	35.93	69.14	87.20	59.27	78.52
$N_{80}P_{60}$	1.54	0.92	0.39	0.62	0.56	0.83	38.65	14.06	9.76	52.51	37.43	70.22	91.16	61.49	79.98
$N_{120}P_0$	1.52	0.89	0.39	0.57	0.52	0.82	33.89	11.60	8.58	45.14	41.18	65.18	79.03	52.78	73.76
$N_{120}P_{30}$	1.54	0.92	0.39	0.60	0.56	0.83	39.42	14.34	9.96	50.58	48.33	71.45	90.00	62.67	81.41
$N_{120}P_{60}$	1.55	0.94	0.39	0.63	0.57	0.83	40.99	15.08	10.34	53.30	49.93	72.71	94.29	65.01	83.05
SEm ±	0.39	0.42	0.22	0.31	0.19	0.71	3.24	2.54	3.58	4.21	4.25	5.24	3.54	5.97	4.15
CD (p=0.5)	1.05	1.24	0.94	0.94	0.84	1.24	9.24	6.87	10.28	12.25	13.25	14.58	10.27	13.58	12.87

CONCLUSION

The status of organic carbon, available nitrogen, available phosphorus and available potassium improve from their initial values under all treatments and increasing levels of nitrogen and phosphorus further increased their values in post-harvest soil. It might be due to more available nitrogen and phosphorus in soil solution resulting increase in residual P and K and more litter fall because of better crop growth due to N and P fertilizers.

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