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Effect of phosphorus and FYM on yield and uptake of nutrients in pearl millet

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ABSTRACT

A field experiment was conducted during *kharif* 2015-16 at Panwari village, Agra, Uttar Pradesh to study the effect of four graded levels of FYM (0, 5, 10 and 15 t/ha) and phosphorus (0, 20, 40 and 60 kg P_2O_5 /ha) on yield, quality and uptake of nutrients in pearl millet (*Pennisetum glaucum* L). Results revealed that the growth and yield attributes of pearl millet increased significantly with the application of FYM up to 10 t/ha and fertilizer P up to 40 kg P_2O_5/ha. The results indicated the superiority of integrated use of FYM and fertilizer phosphorus in increasing the productivity of pearl millet compared to application of fertilizer P alone. Protein content and yield in grain increased significantly with the application of 60 kg P_2O_5 /ha and 10 t FYM /ha over their respective controls. The uptake of N, P and K by pearl millet grain and stover increased significantly with increasing levels of P over control. The amounts of organic carbon, available N and P in post harvest soil increased significantly with the increasing levels of both FYM and phosphorus.

Keywords: FYM, Nutrient uptake, Pearl millet, Phosphorus, Quality, Yield

Pearl millet (*Pennisetum glaucum* L.) is an important cereal crop in arid and semi arid regions of the world with micronutrient rich cereal especially in iron and zinc. In India it is grown for grain and fodder purpose and cultivated on marginal lands. The productivity of pearl millet is very low due to lack of manuring and imbalanced fertilization. Use of optimum fertilization is the key factor in increasing the productivity which can be realized with the judicious application of plant nutrients to pearl millet crop. Phosphorus is a major plant nutrient applied as fertilizer to sustain agricultural productivity. Phosphorus has an enhancing impact on plant growth and biological yield through its importance as energy storage. It hastens the maturity and increases the development of root system. Judicious use of farmyard manure with chemical fertilizers improves soil physical, chemical and biological properties and improves crop productivity. FYM also increases the availability of soil phosphorus. In addition to the effect of FYM on soil P content, the application of FYM in presence of fertilizer phosphorus may also affect the solubility and hence the potential availability of applied P. It is widely recognized that neither use of organic manure alone nor chemical fertilizers can achieve the yield sustainability under the modern intensive farming (Singh *et al*. 2018). Integration of chemical and organic sources and their efficient management have shown promising results not only in sustaining the production but also in maintaining soil health (Singh and Singh 2017, Senthilvalavan *et al.* 2020). Limited studies have been conducted to work out the optimum proportion of FYM and phosphorus for pearl millet crop. The present investigation was, therefore, carried out to study the effect of FYM and phosphorus on yield, quality and nutrient uptake in pearl millet.

MATERIALS AND METHODS

A field experiment was conducted (2015 and 2016) at farmers' field at Panwari village, Agra (UP). The experimental site is characterized by semi-arid climate with extreme temperature during summer (45-48^{0}C) and very low temperature during winter (as low as 2^{0}C). The average rainfall is about 650 mm, most of which is received from June to September. The soil was sandy loam in texture with *p*H (8.0), low in organic carbon (3.0 g/kg). The soil was low in available N (155 kg/ha), P (8 kg/ha), and medium in K (125 kg/ha) and was deficient in DTPA-Zn (0.54 mg/kg). Pearl millet was grown with four levels each of P (0, 30, 60 and 90 kg P_2O_5 /ha) and FYM (0, 5, 10 and 15 t FYM/ha) tested in factorial randomized block design with three replications. Basal application of 100 kg N and 40 kg K_2O/ha was made through urea and muriate of potash, respectively. Phosphorus and FYM were applied through single superphosphate and well decomposed FYM, respectively. Full quantity of P and K was applied at sowing time. Half of N was applied at sowing time and another half was applied in two splits,

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one-half at first irrigation and the other at tillering stage. Farmyard manure was applied to the soil before one week of sowing. Pearl millet (var. Pioneer 86 M 86) was grown as a test crop and sown in rows 30 cm apart in the first week of July and harvested in first week of October in both the years. Plant height and test weight of pearl millet were recorded at maturity. At harvest grain and stover yields of the crop were recorded. The grain and stover samples were digested in di acid mixture (3:1 of HNO_3:$HClO_4$) and analysed for P by molybdovanadate yellow colour method and K by Flame photometer. Nitrogen content in grain and straw was determined by modified Kjeldahl's method (Jackson 1973). The uptake of nutrients was computed from their concentrations in grain and straw and respective yields crop. Post harvest soil samples collected after two years of experiment were analysed for organic carbon, available N (Subbiah and Asija 1956) and available P (Olsen *et al.* 1954). The mean data on various parameters obtained from consecutive two years were statistically analysed as per procedure given by Gomez and Gomez (1984). Least significant difference (LSD) values as CD at P=0.05 were used to determine the significance of difference between treatment means.

RESULTS AND DISCUSSION

Yield attributes and yield: Growth and yield attributes like plant height and test weight increased significantly with FYM application over control (Table 1). The tallest plants of pearl millet (192 cm) were recorded with 15 t FYM/ha. The mean maximum test weight (10.2 g) was recorded with 15 t FYM/ha. The beneficial effect of FYM may be due to its contributions in supplying additional plant nutrients, improvement of soil physical condition and biological processes in soil (Ram Bharose *et al.* 2018). Plant height and test weight also increased significantly with P application (Table 1). The mean maximum values of plant height (193 cm) and test weight (10.3 g) were obtained with 60 kg P_2O_5 /ha. This increase in these attributes may be due to higher utilization of nutrients through their well developed root system which might have resulted in better plant development and ultimately yield attributes (test weight). Similar results were reported by Pandey *et al*. (2018).

The data indicated that grain and stover yields of pearl millet increased significantly with the application of FYM and phosphorus over control (Table 1). The significant increase in grain and stover yield was recorded with 10 t FYM/ha addition which was significantly higher by 27.6 and 28.0% over control, respectively. Similar results were reported by Singh and Singh (2017). However, the maximum grain (3.80 t/ha) and stover (8.79 t/ha) yield was recorded with 15 t FYM /ha. Application of 60 kg P_2O_5/ha produced maximum yield of grain (3.89 t/ha) and stover (9.03 t/ha). However, significant increases in grain and stover yield of pearl millet were recorded with 40 kg P_2O_5/ha, which were 37.8 and 39.0% higher over control, respectively. The increase in yield may be attributed to the effective metabolic activities coupled with increased rate of photosynthesis leading to better translocation of nutrients in sink (Singh 2019). The magnitude of increase in grain and stover yield was more due to application of P fertilizers than FYM.

Grain and stover quality: There was a significant increase in protein content with increasing levels of FYM and maximum values in grain (11.8%) and stover (3.5%) were recorded with 15 t FYM/ha. This increase in protein content with FYM may be attributed to increased availability of N in soil for the crop, resulting higher N content and an ultimate increase in protein content. Positive effect of FYM on protein content has also been reported by Singh and Singh (2017). Protein yield ranged from 330.0 kg/ha at control to 448.4 kg/ha with 15 t FYM/ha. The maximum value of protein yield in pearl millet grain was recorded with 15 t FYM/ha which may be attributed to higher yield of grain

Table 1 Effect of phosphorus and FYM and phosphorus on growth, yield and quality of pearl millet (mean of 2 years)

Treatment	Plant height (cm)	Test weight (g)	Yield (t/ha)		Protein (%)		Protein yield (kg/ha)
			Grain	Stover	Grain	Stover	
FYM (t/ha)							
0	180	9.4	2.92	6.75	11.3	3.1	330.0
5	183	9.7	3.49	8.07	11.4	3.3	397.8
10	189	10.0	3.73	8.63	11.6	3.4	432.6
15	192	10.2	3.80	8.79	11.8	3.5	448.4
CD (P=0.05)	3.5	0.19	0.30	0.83	0.24	0.09	16.5
Phosphorus (kg/ha)							
0	179	9.3	2.80	6.44	11.1	3.0	310.8
20	182	9.6	3.39	7.54	11.5	3.2	390.0
40	189	10.1	3.86	8.95	11.6	3.4	447.7
60	193	10.3	3.89	9.03	11.9	3.6	463.3
CD (P=0.05)	3.5	0.19	0.37	0.83	0.24	0.09	16.5
FYM × P_2O_5	7.0	0.38	0.74	1.66	0.48	0.18	33.0

and protein content (Singh and Singh 2017). Application of P levels increased significantly the protein content in pearl millet grain and stover and maximum values in grain (11.9%) and stover (3.6%) were recorded with 60 kg P_2O_5/ha. Protein yield ranged from 310.8 to 463.3 kg/ha and maximum and minimum values of protein yield were recorded with 60 kg P_2O_5/ha and control, respectively. Similar results were reported by Pandey *et al.* (2018).

Uptake of nutrients: The uptake of nitrogen by pearl millet crop increased significantly with FYM application over control (Table 2) and the maximum values of N uptake by grain (72.2 kg/ha) and stover (50.1 kg/ha) were recorded at 15 t FYM /ha. The improvement in N uptake was mainly due to higher production of grain and stover with FYM (Singh and Singh 2017). Application of P increased N uptake significantly over control and maximum values of N uptake by grain and stover were recorded with 60 kg P_2O_5/ ha. This increase in N uptake may be attributed to increased N content coupled with higher yield. Similar results were reported by Chattopadhyay *et al.* (2019).

Application of FYM and P at different levels significantly and subsequently increased the phosphorus uptake by pearl millet grain and stover over control. The maximum uptake of P by grain (9.8 kg/ha) and stover (15.8 kg/ha) was recorded with 15 t FYM/ha. The favourable effect of FYM on P uptake may be attributed to the greater availability of P to plants in presence of organic manure and to its solubilizing effect on fixed form of P in soil (Singh and Singh 2017). The maximum utilization of P by grain and stover was recorded with 60 kg P_2O_5 /ha. The increase in P uptake with the application of P might be due to increase in yield and P concentration in pearl millet grain and stover. Similar results were also reported by Singh (2019) in pearl millet crop. FYM application affected the utilization of potassium by pearl millet grain and stover significantly over control. The increase in potassium uptake by crop was from 16.3 kg/ ha at control to 23.5 kg/ha with 15 t FYM/ha. The corresponding increase in K uptake by stover was from 124.8 to 138.7 kg/ha. This increase in K uptake with FYM application is obvious as it is considered as a store house of plant nutrients (Singh and Singh 2017). The uptake of potassium by the crop increased significantly with 40 and 60 kg P_2O_5/ha as compared to control. However, highest values of K uptake by grain (23.7 kg/ha) and stover (174.1 kg/ha) were recorded with 60 kg P_2O_5/ha. These results are in conformity with the findings of Singh and Singh (2017).

Soil fertility: Analysis of post harvest soil revealed a significant improvement in organic carbon content under various levels of FYM over the initial content. The organic carbon content ranged between 2.85 and 4.13 g/kg (Table 2). Organic carbon content of soil with an initial value of 3.10 g/kg increased significantly and attained a maximum value of 4.13 g/kg in the treatment that has received 15 t FYM/ha. This increase in organic carbon content may be attributed to supply of organic matter to the soil with FYM (Singh *et al.* 2018). Increasing levels of phosphorus helped in increasing organic carbon content from 3.17 to 3.81 g/kg with 60 kg P_2O_5/ha. This increase in organic carbon content may be due to increased contribution from the biomass and roots. Similar results were reported by Singh and Singh (2012) and Singh (2019). A perusal of the data (Table 2) revealed that the status of available nitrogen in post harvest soil increased significantly with FYM application. Available nitrogen content in soil increased from 138 kg/ha at control to 199 kg/ha with 15 t FYM/ha. The higher values of available N with FYM addition could be attributed to increased amount of N in soil due to FYM addition. Similar results were reported by Singh (2019). Available N content in soil was significantly influenced by P levels with maximum value (182 kg/ha) at 60 kg P_2O_5/ ha (Chandel and Singh 2018). Increasing levels of FYM increased the available P content in post harvest soil. The

Table 2 Effect of phosphorus and FYM levels on uptake of nutrients (kg/ha) and soil fertility at crop harvest (mean of 2 years)

Treatment	Nitrogen		Phosphorus		Potassium		Organic carbon (g/kg)	Available N (kg/ha)	Available P (kg/ha)
	Grain	Stover	Grain	Stover	Grain	Stover			
FYM (t/ha)									
0	52.8	33.7	5.5	7.4	16.3	124.8	2.85	138	8.4
5	63.8	42.7	7.3	10.4	19.8	151.7	3.26	160	11.0
10	69.7	46.6	8.9	12.9	22.3	164.0	3.64	182	13.2
15	72.2	50.1	9.8	15.8	23.5	168.7	4.13	199	16.0
CD (P=0.05)	3.5	1.5	0.53	0.64	0.95	6.4	0.15	13.0	1.53
Phosphorus (kg/ha)									
0	50.1	31.5	4.7	5.7	15.6	120.4	3.17	156	8.8
20	62.3	40.7	7.1	10.1	19.6	147.3	3.20	166	10.1
40	69.9	49.2	9.2	14.3	22.7	170.0	3.50	175	13.0
60	74.2	52.3	10.8	17.2	23.7	174.1	3.81	182	17.3
CD (P=0.05)	3.5	1.5	0.53	0.64	0.95	6.4	0.15	13.0	1.53
FYM × P_2O_5	7.0	3.0	1.06	1.28	1.90	12.8	0.30	26.0	3.06

highest available P content was recorded with 15 t FYM/ha. This increase in available P content of soil could possibly be due to beneficial role of FYM in arresting P fixation into insoluble form and keeping it in available form for extended period in addition to its own P content. Similar type of effects of FYM on available P was also reported by Chattopadhyay *et al.* (2020). The status of available P in post harvest soil improved significantly with its addition and highest value of available P was recorded with 60 kg P_2O_5/ha. The extent of rise in available P was more when P was added at higher level as compared to its lower level. This increase in available P may be attributed to addition of P through phosphatic fertilizer (Singh 2019).

It may be concluded that application of FYM and P was beneficial for optimum production of pearl millet. Application of 40 kg P_2O_5/ha and 10 t FYM/ha were found optimum for pearl millet in Agra region. Application of FYM along with P had beneficial effect on crop yield, quality and uptake of nutrients by the pearl millet crop. Fertility status of post harvest soil also improved significantly with higher doses of FYM and phosphorus application.

REFERENCES

Chandel B S and Singh B. 2018. Effect of nutrient management on yield of wheat (*Triticum aestivum*) and soil fertility. *Annals of Plant and Soil Research* **20**(supplement): S 10-S 14.

Chattopadhyay A, Singh A, Singh A P and Patra A. 2019. Assessment of phosphorus bioavailability and yield potential of baby corn (*Zea mays*) through the combined use of biochar, phosphorus and mycorrhiza in an Inceptisol. *Annals of Plant and Soil Research* **21**(3): 245-49.

Chattopadhyay A, Singh A P and Patra A. 2020. Impact of combined use of biochar, phosphorus and mycorrhiza on baby corn (*Zea mays* L) yield and soil properties. *Annals of Plant and Soil Research* **22**(3): 254-59.

Gomez K A and Gomez A A. 1984. *Statistical Procedures for Agricultural Research*. A Wiley Inter Science Publication, John Wiley and Sons, Newyork.

Jackson M L. 1973. *Soil Chemical Analysis*. Prentice Hall of India Private Limited, New Delhi.

Pandey Mamta, Abidi A B and Singh R P. 2018. Effect of sulphur and phosphorus on yield and quality of pearl millet (*Pennisetum glaucum*). *Annals of Plant and Soil Research* **20**(3): 272-75.

Ram Bharose, Kumar S, Kumar M, Kumar R, Sarita and Kumar D. 2018. Effect of organic and inorganic sources of nutrients on productivity, nutrient uptake and economics of rice (*Oryza sativa*). *Annals of Plant and Soil Research* **20**(1): 69-72.

Santhilvalaval P M, Ravi Chandran N and Sri Ramachandrasekharan M V. 2020. Consequences of integrated nutrient management and cultivation methods on nitrogen use efficiency and sustainable yield index of lowland rice (*Oryza sativa*). *Annals of Plant and Soil Research* **22**(1): 9-13.

Singh D P and Singh D. 2017. Effect of nitrogen and FYM on yield, quality and uptake of nutrients in wheat (*Triticum aestivum*). *Annals of Plant and Soil Research* **19**(2): 232-36.

Singh R and Singh A P. 2017. Effect of phosphorus, sulphur and biofertilizer on yield, quality and uptake of nutrients in cowpea (*Vigna unguiculata*). *Annals of Plant and Soil Research* **19**(2): 175-79.

Singh S and Singh J P. 2012. Effect of organic and inorganic nutrient sources on some soil properties and wheat yield. *Journal of the Indian Society of Soil Science* **60**(3): 237-40.

Singh S, Chauhan T M and Singh V. 2020. Influence of phosphorus and zinc nutrition on yield and nutrient uptake in wheat (*Triticum aestivum*) and their residual effect on green gram (*Vigna radiata*). *Indian Journal of Agricultural Sciences* **90**(9): 1791-95.

Singh S K, Kumar M, Singh R P, Singh J S, Bohra J P, Srivastava S P and Singh Y V. 2015. Conjoint application of organic and inorganic sources of nutrients on yield, nutrient uptake and soil fertility under rice (*Oryza sativa*)- wheat (*Triticum aestivum*) system. *Journal of the Indian Society of Soil Science* **66**(3): 287-94.

Singh V and Patra A. 2017. Effect of FYM and manganese on yield and uptake of nutrients by wheat (*Triticum aestivum*). *Annals of Plant and Soil Research* **19**(4): 381-84.

Singh V. 2019. Effect of nutrient management on yield uptake of nutrients and soil fertility under pearl millet (*Pennisetum glaucum*)-wheat (*Triticum aestivum*) crop sequence. *Annals of Plant and Soil Research* **21**(2): 149-53.

Subbiah B V and Asija G L. 1956. Alkaline permanganate method of available nitrogen estimation. *Current Science* **25**: 259-60.