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Influence of residual phosphorous and zinc fertilization on total nutrient content and uptake of succeeding pearl millet

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Abstract
Two year field experiment was conducted at Rajasthan Agriculture Research Institute, Durgapura, during rainy seasons of 2016 and 2017 in split plot design with three replications to study the growth, productivity and economics of fenugreek - pearl millet cropping system by using four levels of phosphorus (0, 20, 40 and 60 kg P_2O_5/ha /ha) and six treatments of zinc and zinc solubilizer [0, 2.5 and 5.0 kg Zn/ha, zinc solubilizer (*Bacillus endophyticus*), 2.5 kg Zn/ha + zinc solubilizer & 5 kg Zn/ha + zinc solubilizer) applied to fenugreek. Results revealed that total nitrogen and phosphorus contents of pearl millet were increased significantly up to residual effect of 40 kg P_2O_5/ha while, potassium and zinc contents were not influenced significantelly. However, the significant increase in uptake of nutrients nitrogen, phosphorous, potassium and zinc were obtained up to 60 kg P_2O_5/ha by the tune of 90.5 and 99.5 per cent over control, during the years 2016 and 2017 except 20 kg P_2O_5/ha.
The highest nitrogen and zinc contents and uptake values were obtained with 5 kg Zn/ha + zinc solubilizer. The residual effect of 2.5 kg Zn/ha + zinc solubilizer was at par with 5 kg Zn/ha. The increase in total uptake of zinc were 40.6 and 67.0 per cent, during respective years over control.

Keywords: Nutrient content, nutrient uptake, pearl millet, phosphorus, yield, zinc and zinc solubilizer

Introduction
In India, pearl millet is one of the important millet crops which flourishes well even under adverse conditions. It is nutritious and palatable and adapted to drought and poor soil fertility, but responds well to good management and higher fertility levels. Phosphorus (P) is an essential nutrient for growth and development of plant by playing its role in seed germination and root formation (Hrinathan *et al*., 2016). Phosphorous is immobile in the soil system and very small amount of it is used by the crops and a substantial part of applied phosphorous remains in soil that can be used by succeeding crops for producing higher yields (Raju *et al.* 2005) [10].
Since zinc is growth promoting substance which plays indispensable role in various plant physiological processes (Khinchi *et al*., 2017) [6]. A greater part of soil phosphorus and zinc are in the form of insoluble phosphates that can be utlized by using zinc solublizer which solubilize the fixed unavailable zinc into available form and that residue fertilizer can be utilize by succeeding crop. Barman *et al.* (1998) [1] were of the opinion that residual effect of different levels of zinc applied to soybean crop significantly increased dry matter of succeeding wheat crop.

Materials and Methods
Two year field experiment was conducted, during rainy seasons of the years 2015-16 and 2016-2017 at research farm of Rajasthan Agricultural Research Institute-Durgapura (SKNAU, Jobner). The soil of the field was loamy sand, low in available nitrogen and phosphorous, medium in potassium and low in zinc content (139.2, 26.6, 182 kg/ha and 0.37 ppm) during 2015-16 and (134.2, 24.5, 180 kg/ha and 0.35 ppm) during 2016-17, respectively in 0-30 cm soil depth. The soil pH was 8.3 and 8.1 and per cent organic carbon content was 0.17 and 0.14 per cent with respective years. Treatments comprised of twenty four treatment combinations consisting of four phosphorous levels (0, 20, 40 and 60 kg P_2O_5/ha) as main plot treatments and six zinc treatments (0, 2.5, 5.0 kg Zn/ha, zinc solubilizer (*Bacillus endophyticus*), 2.5 kg Zn/ha + zinc solubilizer and 5 kgZn/ha + zinc solubilizer) as sub plot treatments were tested in split plot design with three replications.

A uniform dose of 20 kg N/ha along with phosphorous and zinc as per treatment were drilled through diammonium phosphate and zinc sulphate (21%), respectively. To compensate the sulphur obtained from different levels of zinc compensatory dose of sulphur applied through elemental sulphur. To assess the residual effect of phosphorous and zinc treatments applied to preceding crop fenugreek, succeeding crop of pearl millet (var. RHB 177) was raised, during *kharif* seasons of 2016 and 2017 in same lay out and was sown on 18 July 2016 and 20 July 2017, respectively. Recommended dose of nitrogen (90 kg/ ha) was applied to pearl millet in two splits, half as basal and remaining as top dress at 30 days after sowing and no other nutrient was applied. Not a major insect/disease was observed during the life cycle of fenugreek in the experiment, but weeds were manually controlled twice (30 and 58 days after sowing). Economics of treatments were worked out using market price of inputs and minimum support price of outputs.

The plant samples were analysed for estimation of N with methods of Snell and Snell, 1949 [12]; P and K with Jackson, 1973 [5] and Zn contents through the method Lindsay and Norvell, 1978 [9]. The total uptake of nitrogen, phosphorous, potassium and zinc by the crop at harvest of each treatment was computed by multiplying seed and straw yields with their respective contents and adding the same as per formula given below.

$$\text{Nutrient uptake (for NPK) (kg/ha)} = \frac{\text{Nutrient content in seed (\%)} \times \text{Seed yield (kg/ha)} + \text{Nutrient content in straw (\%)} \times \text{Straw yield (kg/ha)}}{100}$$

$$\text{Nutrient uptake (for Zn) (g/ha)} \; \frac{\text{Nutrient content in seed (ppm)} \times \text{Seed yield (kg/ha)} + \text{Nutrient content in straw (ppm)} \times \text{Straw yield (kg/ha)}}{1000}$$

Result and Discussion

Total nutrient content

The total nitrogen and phosphorous contents of pearl millet, were significantly increased with different levels of residual phosphorous over control up to 60 kg P_2O_5/ha during 2016 and 2017, respectivelly that was significantly better over 20 kg P_2O_5/ha and non significantlly differed with 40 kg P_2O_5/ha during 2017 and 2016, respectivelly. However, total potassium and zinc contents were not singnificantlly influenced with residual phosphorous fertilization on pearlmillet crop. The increase in yields of pearl millet owing to residual effects of phosphorous levels might be due to the fact that phosphorus application increased symbiotic root nodulation of fenugreek that promoted microbial activities promoting mineralization in soil that resulted in relatively higher availability and better absorption of these nutrients by the plant. Experimental evidences from different agro-ecological regions have clearly demonstrated that phosphorous application to legumes not only benefited that such crop but also favourably affected the nitrogen content of soil for succeeding non-legume crop of soil (Ganeshamurthy *et al.*, 2003) [3].

The residual effect of zinc fertilization were significant in increasing total nitrogen and zinc contents except zinc solubilizer over control in nitrogen content, however, the effect of 2.5 kg Zn/ha and zinc solublizer were not significantlly differed to each other and also effect of 5 kg Zn/ha and 2.5 kg Zn/ha + zinc solublizer, during both the years. During 2016, treatment effect of 5 kg Zn/ha and 2.5 kg Zn/ha + zinc solublizer were statistically simillar to each other in increasing total zinc content. However, The residual effect of zinc treatments were failled to excert significant effect on total phosphorous and total potassium contents.

Nourishment with zinc helps in improving nitrogen content of plant through biological nitrogen fixation (BNF) though, nitrogen appears to be synergistic with zinc, which may leads to increase in many physiological and molecular activities which in turn improve yield attributing characters (Cakmak *et al.*, 2010) [2]. In dry land areas zinc application increases absorption of minerals by roots (Singh *et al.*, 2017) [11].

Total nutrient uptake

Perusal of data contained in Table 2, reveal that residual effect of phosphorous significantly increased total uptake of nitrogen, phosphorous, potassium and zinc by pearlmillet crop with every successive level of phosphorous applied to fenugreek except that effect of 20 kg P_2O_5/ha, total potassium uptake, during 2017 and total zinc uptake during 2016 however, the highest uptake values were recorded with the residual effect of 60 kg P_2O_5/ha, during both the years. During 2016 and 2017, positive effect of residue of phosphorous fertilization, on total phosphorous uptake was to the extent of 90.5 and 99.5 per cent with the application of 60 kg P_2O_5/ha, respectively, over control. The higher volume of fine roots of pearl millet having greater efficiency of nutrient absorption from soil and increasing quantum of yield with every increase in phosphorous level significantly increased the uptake of these nutrients irrespective of their contents in grain and stover.

A perusal of data embodied in Table 2, shows that residual effect of different zinc treatments significantly enhanced total nitrogen, phosphorous, potassium and zinc uptake by succeeding pearlmillet crop, over control. The highest total nutrients uptake were recorded under the residual effect of 5 kg Zn/ha + zinc solublizer that was significantly superior over rest of the treatments followed by 2.5 kg Zn/ha + zinc solublizer, during both the years. However, later treatment effect was at par with 5 kg Zn/ha, for all such responses. However, total uptake of nitrogen, during 2016, significantly enhanced with zinc solublizer, over control but statistically at par with 2.5 kg Zn/ha. The significant rsponse to total potassium uptake was not observed with residual zinc solubilizer and 2.5 kg Zn/ha, during both the years and in increasing zinc uptake with the application of zinc solublizer, during 2016. The increased values of total uptake of zinc were 33.3 and 40.6, during 2016 and 57.9 and 67.0 per cent, during 2017 higher over control with the respective application of 2.5 kg Zn/ha + zinc solublizer and 5 kg Zn/ha + zinc solublizer. Solubilizers solubilize fixed zinc through their acid production action and increased microbial activity in the soil led to higher uptake of these nutrients which had a favorable effect on succeeding crop. Further, zinc availability is also increased, during rainy season due to increased temperature and intermittent wetting and drying of soil due to rains and dry spells owing to temporal variations in rains in monsoon season (Raju *et al.*, 2005) [10].

Biological yield

The residual effect of 60 kg P_2O_5/ha was significantely superior over rest of phosphorous levels during both the years and also fetch the highest biological yield of pearlmillet. The increase was to the tune of 44 and 48 per cent over control with 60 kg P_2O_5/ha. Cereals respond nitrogen and phosphorus to a great extent and increased availability of these nutrients in soil led to increased growth which had a favourable effect on the yield of pearl millet (kumawat and sammauria, 2018) [8].

Residual effect of 5.0 kg Zn/ha + zinc solubilizer produced the highest biological yield of succeeding pearl millet and it was significantly superior over rest of the zinc treatments followed by 5 kg Zn/ha and 2.5 kg Zn/ha + zinc solubilizer, during both the years. During 2016, residual effect of 2.5 kg Zn/ha + zinc solubilizer statistically simillar to 2.5 kg Zn/ha and 5 kg Zn/ha. During 2017, only residual effect of 5 kg Zn/ha was non-significantly differed with 2.5 kg Zn/ha + zinc solubilizer, however, zinc solubilizer did not affect significantly the biological yield, during both the years. The magnitude of increase in biological yield of succeeding pearl millet, over control, during 2016 and 2017, were 16, 31 per cent and 20, 35 per cent higher over control with the residual effect of 2.5 kg Zn/ha + zinc solublizer and 5.0 kg Zn/ha + zinc solublizer, respectively. Significant improvement in yield due to fertilization with zinc that was augmented by coupling with zinc solubilizer had a contributory effect in improving yield attributes. Photosynthetic reactions depend on an adequate supply of zinc because of the presence of this metal in key photosynthetic enzymes, such as RuBisCO (ribulose-1,5-bisphosphate carboxylase / oxygenase) and carbonic anhydrase (in C_4 plants) Kryvoruchko (2017) [7].

Table 1: Residual effect of phosphorous and zinc fertilization on total nutrient contents of succeeding Pearl millet during both the years.

Treatments	Nitrogen content (%)		Phosphorous content (%)		Potassium content (%)		Zinc content (ppm)	
	2016	2017	2016	2017	2016	2017	2016	2017
Phosphorus (P_2O_5 kg ha^{-1})								
0.0	1.96	1.96	0.442	0.411	0.811	0.817	25.92	25.30
20	2.14	2.13	0.498	0.469	0.820	0.826	25.35	24.74
40	2.27	2.24	0.530	0.511	0.825	0.833	25.05	24.46
60	2.35	2.30	0.549	0.538	0.827	0.835	24.95	24.30
S.Em±	0.02	0.02	0.005	0.005	0.014	0.013	0.37	0.48
CD (P=0.05)	0.07	0.08	0.019	0.019	NS	NS	NS	NS
Zinc(kg ha^{-1})								
0.0	2.01	2.00	0.520	0.496	0.811	0.819	23.34	22.90
2.5	2.13	2.12	0.495	0.473	0.818	0.827	24.71	24.15
5.0	2.24	2.22	0.492	0.470	0.822	0.830	26.44	25.68
Zinc solubilizer	2.08	2.06	0.512	0.489	0.811	0.819	24.07	23.61
2.5 + zinc solubilizer	2.26	2.23	0.507	0.484	0.829	0.835	26.13	25.45
5.0 + zinc solubilizer	2.35	2.31	0.504	0.482	0.833	0.836	27.20	26.42
S.Em±	0.03	0.03	0.008	0.008	0.013	0.011	0.34	0.24
CD (P=0.05)	0.09	0.07	NS	NS	NS	NS	0.96	0.70

Table 2: Residual effect of phosphorous and zinc fertilization on total nutrient uptake by succeeding Pearl millet during both the years.

Treatments	Nitrogen uptake (kg/ha)		Phosphorous uptake (P_2O_5 kg/ha)		Potassium uptake (K_2O kg/ha)		Zinc uptake (g/ha)	
	2016	2017	2016	2017	2016	2017	2016	2017
Phosphorus (P_2O_5 kg ha^{-1})								
0.0	47.53	39.96	23.50	18.89	25.55	21.45	69.34	57.03
20	57.49	48.75	29.61	24.12	28.32	24.08	74.13	62.03
40	72.43	61.64	38.03	31.80	33.53	28.97	86.09	73.18
60	84.87	71.29	44.76	37.68	37.96	32.59	96.33	81.27
S.Em±	0.86	1.24	0.41	0.50	0.72	0.81	1.43	1.35
CD (P=0.05)	2.96	4.28	1.40	1.73	2.49	2.80	4.94	4.68
Zinc(kg ha^{-1})								
0.0	52.51	42.89	30.57	24.36	26.99	22.38	64.61	52.85
2.5	60.93	50.60	31.70	25.81	29.81	25.04	75.47	62.13
5.0	71.64	60.64	35.20	29.36	33.39	28.58	90.42	75.58
Zinc solubilizer	57.24	46.82	31.82	25.43	28.46	23.59	70.14	57.13
2.5 + zinc solubilizer	69.24	59.96	35.00	29.72	32.47	28.50	86.15	74.31
5.0 + zinc solubilizer	81.93	71.53	39.57	34.04	36.91	32.56	102.03	88.27
S.Em±	1.53	1.07	0.79	0.64	0.81	0.60	1.97	1.42
CD (P=0.05)	4.37	3.06	2.25	1.84	2.32	1.73	5.63	4.07

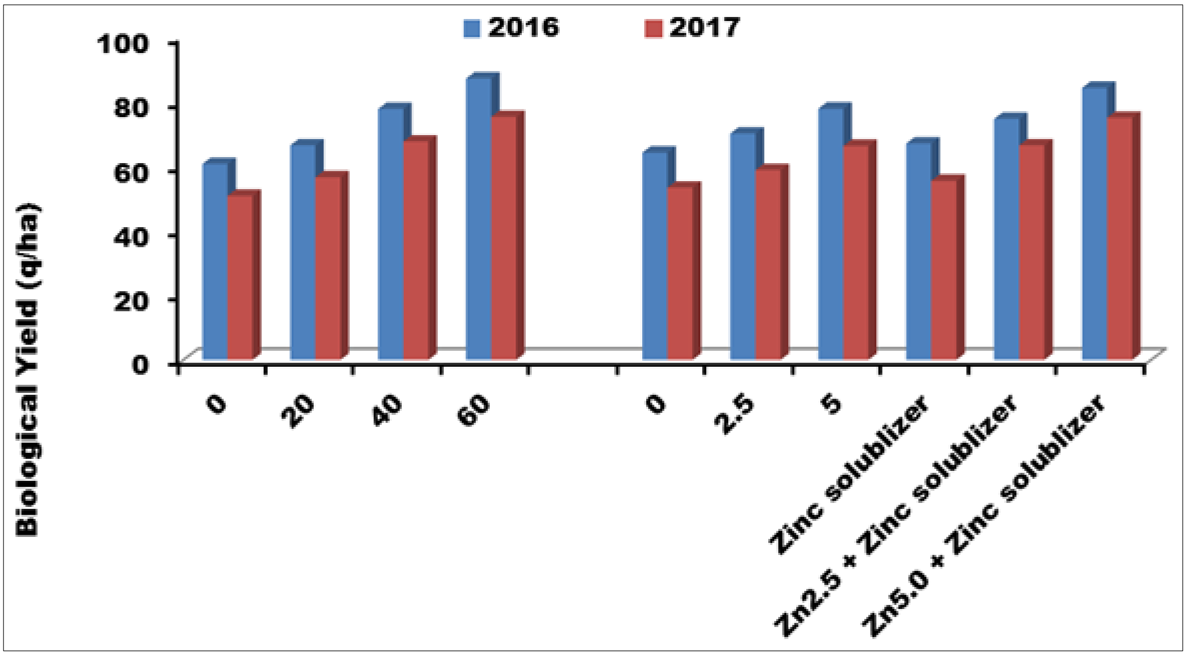

Fig 1: Biological yield of succeeding pearl millet crop obtained with residual effect of phosphorous and zinc fertilization.

Conclusion

On the basis of this study it is concluded that the significant improvement was observerd in increasing plant nutrient content and uptake of pearl millet crop through residual phosphorous and zinc fertilization of 40 kg P_2O_5/ha and 5 kg Zn/ha + zinc solublizer.

References

1. Barman KK, Ganeshamurthy AN, Takkar PN. Zinc requirement of soybean-wheat cropping sequence in some swell-shrink soils. Indian journal of Agricultural science. 1998;68(12):759-61.
2. Cakmak I, Pfeiffer WH, Mc Clafferty B. Bio fortification of durum wheat with zinc and iron. Cereal Chem 2010;87:10-20.
3. Ganeshamurthy AN, Sriniwasrao CH, Singh KK, Ali M. Management of phosphorous for higher pulse productivity in different agro-climatic regions of India. Fertilizer News. 2003;48(5):23-27, 27-34, 37-41
4. Harinathan B, Sankaralingam S, Palpperumal S, Kathiresan D, Shankar T, Prabhu D. Effect of Phosphate Solubilizing Bacteria on Growth and Development of Pearl Millet and Ragi. Journal of Advances in Biology & Biotechnology. 2016;7(3):1-7.
5. Jackson ML. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi, 1973.
6. Khinchi V, Kumawat SM, Dotaniya CK. Effect of Nitrogen and Zinc Levels on Yield and Economics of Fodder Pearl Millet (*Pennisetum americanum* L.). International Journal of Pure and Applied Bioscience. 2017;5(3):426-430.
7. Kryvoruchko IS. Zn-use efficiency for optimization of symbiotic nitrogen fixation in chickpea (*Cicer arietinum* L.). Turkish Journal of Botany. 2017;41:423-441.
8. Kumawat S, Sammauria R, Kumawat P. Growth and productivity of succeeding pearl millet (*Pennisetum glaucum*) influenced by residual phosphorus, zinc and zinc solubilizer International Journal of Chemical Studies. 2018;6(5):272-275.
9. Lindsay WL, Norwell WA. Development of DTPA soil test for zinc, iron, manganese and copper. Soil Science Society of America Journal. 1978;42:421-428.
10. Raju RA, Subba Rao A, Rupa TR. Strategies for integrated phosphorous management for sustainable crop production. Indian Journal of Fertilizer 2005;1:25-28 & 31-36.
11. Singh L, Sharma PK, Jajoria M, Deewan P, Vermam R. Effect of Phosphorus and Zinc Application on Growth and Yield Attributes of Pearl millet (*Pennisetum glaucum* L.) under Rainfed Condition. Journal of Pharmacognosy and Phytochemistry 2017;6(1):388-391
12. Snell FD, Snell CT. Colorimetric Methods of Analysis. 3rd Edn. D. Van Nostrand Co. Inc., New York, 1949, Vol. 2.