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Effect of graded levels of potassium and micronutrients on yield, quality and nutrient uptake in pigeon pea through soil and foliar application under Vertisols

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Abstract
A field experiment was conducted during *Kharif* 2017-18 at Research Farm of Department of Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani on Vertisol to evaluate the "Effect of graded levels of potassium and micronutrients on yield, quality and nutrient uptake in Pigeon pea through soil and foliar application under Vertisols". The experiment was laid out in Randomized Block Design (RBD) with ten treatments and replicated thrice, The results revealed that, the application of 100% NP + 50 kg K_20 ha^{-1} + Grade-I micronutrient recorded significantly higher grain and dry matter yield followed by 100% NP + 50 kg K_20 ha^{-1} + Grade-II (0.5%) micronutrient. The quality parameters viz. test weight and protein content were found to be higher with the application of 100% NP + 50 kg K_20 ha^{-1} + Grade-I micronutrient. Among the different treatment combinations, the highest uptake of major nutrients was noticed highest in 100% NP + 50 kg K_20 ha^{-1} + Grade-I micronutrient followed by 100% NP + 50 kg K_20 ha^{-1} + Grade II (0.5%) micronutrient.

Keywords: Pigeon pea, foliar application, grain yield, quality, nutrient uptake

Introduction
Pigeon pea (*Cajanus cajan* L. Millsp.) is one of the most important pulse crop of India and 91 per cent of the world's pigeon pea is produced in India. It is also an important pulse crop of Maharashtra and ranked second in crop area and production.

Pigeon pea plays a great role in providing protein rich diet and also in improving native soil fertility. Being a drought resistant crop, it is suitable for dryland and predominantly sown as intercrop with cotton, sorghum and soybean in most parts of the Maharashtra. Now a days, nutrients application through soil has not benefited more, hence farmers are using different ways, out of which foliar application, is a method which improves nutrition and decreases environmental pollution. Foliar application of an element can improve root absorption of that element or other element through root growth and increasing nutrient element absorption by Tabarizi *et al.* (2009) [9]. The essential role of micronutrients in plant metabolism, as activators or co-factors in all vital processes of any plant cannot be ignored. This leads undoubtedly to an increase in the crop production, which is considered as main goal. Hanan *et al.* (2012) [3] showed that application of micronutrients significantly increased all yield components, as well as seed and straw yields of different crops. The effect of micronutrients elements on yield and crop performance has been reported that, yields were higher for the treatments with micronutrients. In this respect, they reported that, foliar spray of ferrous sulphate or chelates soil application in correcting Fe-chlorosis in wheat and micronutrient uptake was a result of improving root growth which consequently led to greater absorbing surface.

Materials and Methods
The field experiment was conducted during *Kharif* 2017-2018 at Research Farm, Department of Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani to evaluate the effect of graded levels of potassium and micronutrients on yield, quality and nutrient uptake in Pigeon pea through soil and foliar application in Vertisols. The experiment was laid out in Randomized Block Design (RBD) with ten treatments and replicated thrice. The treatment details are, T_1: Absolute control (No Fertilizers), T_2: 100% NP (25:50:00 N and P_2O_5 kg ha^{-1}), T_3: 100% NP + 25 kg K_2O ha^{-1}, T_4: 100% NP + 50 kg K_2O ha^{-1}, T_5: 100% NP + 25 kg K_2O ha^{-1} + Grade-I micronutrient (soil application), T_6: 100% NP + 50 kg K_2O ha^{-1} + Grade-I micronutrient (soil application), T_7: 100% NP + 25 kg K_2O ha^{-1} + Grade-II micronutrient (0.5% Foliar Spray), T_8: 100% NP + 50 kg K_2O ha^{-1} + Grade-II

micronutrient (0.5% Foliar Spray), T_9: 100% NP + 25 kg K_2O ha^{-1} + 2% KNO_3 (Foliar Spray), T_{10}: 100% NP + 50 kg K_2O ha^{-1} + 2% KNO_3 (Foliar Spray). Pigeon pea variety BSMR-736 was used for continuing research trial.

Results and Discussion

Grain and dry matter yield

The data furnished in Table 1 indicated that significantly higher grain and dry matter yield was received with the application of 100% NP + 50 kg K_2O ha^{-1} + Grade-I micronutrient followed by application of 100% NP + 50 kg K_2O ha^{-1} + Grade-II micronutrient (0.5% foliar spray). The treatment T_6 comprises 100% NP + 50 kg K_2O ha^{-1} and Grade-I micronutrient fertilizer application produced 16.73 q ha^{-1} grain yield which was found to be statistically at par with T_6 and T_8 treatments receiving potassium and micronutrients. The positive effect of potassium on crop yield might be also due to its requirement in carbohydrate synthesis and translocation of photosynthesis. This may be due to fact that, potassium and micronutrient are reported to enhance the absorption of native as well as added major nutrient such as N and P which might have been attributed to improvement in yield similar findings were also observed by Malla *et al.* (2007) [5] and Balpande *et al.* (2016) [1]. The highest dry matter yield (69.26) was obtained from treatment receiving T_6 100% NP + 50 kg K_2O ha^{-1} + Grade-I micronutrient (soil application), which was significantly higher than other treatments at harvesting stage. This was due to effect of potassium nutrition on cell elongation and turgor potential in leaves. These results are in compliance with findings of Sonawane *et al.* (2015) [8]. However treatment T_6 was significantly superior over absolute control and only 100% NP. Addition of potassium either 25 or 50 Kg ha^{-1} recorded significant improvement in all parameters contributing for grain yield and quality. The grain and dry matter yield of Pigeon pea was increased with soil application of Grade-I micronutrient or foliar spray of Grade-II micronutrient.

Test weight and protein content

The data furnished in Table 1 indicates that the significant increase in test weight was observed due to application of graded levels of potassium and micronutrient. The higher test weight was obtained by the application of T_6: 100% NP + 50 kg K_2O ha^{-1} + Grade-I micronutrient (soil application) followed by treatment T_8: 100% NP + 50 kg K_2O ha^{-1} + Grade-II micronutrient (0.5% foliar spray). The higher levels of potassium supplied sufficient potassium to plants which initiated maximum translocation of photosynthates to fruiting zone. Similar findings were also reported by and Malla *et al.* (2007) [5]. The protein content in seed was increased significantly with increased in K levels. The highest protein content was observed in treatment T_6 i.e 100% NP+ 50 kg K_2O ha^{-1} + Grade-I micronutrient (soil application) followed by treatment T_8: 100% NP + 50 kg K_2O ha^{-1} + Grade-II micronutrient (0.5% Foliar Spray). The protein content in seed was increased significantly with increase in potassium levels. The above results were statistically non-significant. Results are in confirmation with earlier observations reported by Tiwari *et al.* (2012) [10], Selvaraj *et al.* (2012) [7] and Balpande *et al.* (2016) [1].

NPK and micronutrient uptake

The data presented in Table 2 indicates that, the uptake of nitrogen, phosphorous and potassium by pigeon pea with respect to graded levels of potassium and micronutrient application enhanced significantly with application of potassium and micronutrient along with RDF. The data shows increased in nitrogen uptake (140.37 kg ha^{-1}) receiving 100% NP + 50 kg K_2O ha^{-1} + Grade-I micronutrient (soil application) followed by treatment T_8 (130.12 kg ha^{-1}) receiving 100% NP + 50 kg K_2O ha^{-1} + Grade-II micronutrient (0.5% foliar spray). In presence of potassium, the increase in P uptake of plant was significantly enhanced due to application of potassium in combination with micronutrient over control and only RDF treatments. The highest P uptake 26.86 kg ha^{-1} was recorded with treatment T_6: 100% NP+ 50 kg K_2O ha^{-1} + Grade-I micronutrient (soil application). Similar trends were also noticed by Kherawat *et al.* (2013) [4], Chavan *et al.* (2012) [2], and Mukundgowda *et al.* (2015) [6], like nitrogen and phosphorus, potassium uptake was also significantly influenced due to potassium and micronutrient application. This might be due to application of higher doses of mineral potassium with micronutrients favoured higher root and shoot development which might have also increased the potassium uptake. Results are in conformity with the findings of Chavan *et al.* (2012) [2] and Kherawat *et al.* (2013) [4].

The maximum uptake of zinc, iron, copper and manganese uptake was observed in T_6 receiving 100% NP + 50 kg K_2O ha^{-1} + Grade-I micronutrient (soil application) followed by treatment T_8 100% NP + 50 kg K_2O ha^{-1} + Grade-II micronutrient (0.5% foliar spray). The higher Zn, Fe, Mn and Cu uptake in pigeon pea was also reported by Balpande *et al.* (2016) [1].

Table 1: Effect of graded levels of potassium and micronutrients on yield and quality parameters of Pigeon Pea.

T. No.	Treatments	Yield (q ha^{-1})		Quality parameters	
		Grain yield	Dry matter yield	Test weight (gm)	Protein content (%)
T_1	Absolute control	7.49	30.37	8.14	19.10
T_2	100% NP (25:50 N and P_2O_5 kg ha^{-1})	10.81	52.58	8.85	19.50
T_3	100% NP + 25kg K_2O ha^{-1}	12.07	54.73	8.89	20.50
T_4	100% NP + 50kg K_2O ha^{-1}	13.37	55.78	9.19	20.75
T_5	100% NP + 25kg K_2O ha^{-1} + Grade-I micronutrient (soil application)	14.80	63.75	9.49	21.37
T_6	100% NP + 50kg K_2O ha^{-1} + Grade- I micronutrient (soil application)	16.73	69.26	9.89	21.93
T_7	100% NP + 25kg K_2O ha^{-1} + Grade-II micronutrient (0.5% Foliar Spray)	15.33	65.17	9.65	21.56
T_8	100% NP + 50 kg K_2O ha^{-1} + Grade-II micronutrient (0.5% Foliar Spray)	16.46	68.70	9.71	21.68
T_9	100% NP + 25kg K_2O ha^{-1} + 2% KNO_3 (Foliar Spray)	12.30	56.55	8.55	20.68
T_{10}	100% NP + 50 kg K_2O ha^{-1} + 2% KNO_3 (Foliar Spray)	13.31	59.34	9.32	20.93
	SE (±)	0.65	1.03	0.32	2.00
	CD at 5%	1.93	3.08	0.97	NS

Table 2: Effect of graded levels of potassium and micronutrient application on uptake in Pigeon Pea plant.

T. No.	Treatments	NPK (Kg ha^{-1})			Micronutrient (g ha^{-1})			
		N	P	K	Zn	Fe	Mn	Cu
T_1	Absolute control	50.69	6.35	23.79	99.88	471.08	129.09	46.14
T_2	100% NP (25:50 N and P_2O_5 kg ha^{-1})	81.42	13.56	44.58	171.88	836.16	223.39	54.17
T_3	100% NP + 25 kg K_2O ha^{-1}	94.87	15.08	49.02	177.72	1231.96	238.87	61.42
T_4	100% NP + 50 kg K_2O ha^{-1}	100.16	17.17	51.76	189.20	1621.65	261.69	66.16
T_5	100% NP + 25 kg K_2O ha^{-1} + Grade-I micronutrient (soil application)	127.94	21.50	69.39	251.61	2192.28	322.83	132.69
T_6	100% NP + 50 kg K_2O ha^{-1} + Grade- I micronutrient (soil application)	140.37	26.86	73.27	275.70	2388.47	349.20	138.40
T_7	100% NP + 25 kg K_2O ha^{-1} + Grade-II micronutrient (0.5% Foliar Spray)	128.19	22.55	69.85	260.91	2254.11	327.27	134.19
T_8	100% NP + 50 kg K_2O ha^{-1} + Grade-II micronutrient (0.5% Foliar Spray)	130.12	25.26	70.60	270.18	2300.27	345.40	136.12
T_9	100% NP + 25 kg K_2O ha^{-1} + 2% KNO_3 (Foliar Spray)	96.54	16.19	60.30	187.02	1756.41	272.36	63.54
T_{10}	100% NP + 50 kg K_2O ha^{-1} + 2% KNO_3 (Foliar Spray)	102.17	17.66	63.99	209.30	1818.85	284.09	69.12
	SE (±)	5.60	1.96	1.82	9.69	139.04	9.16	3.17
	CD at 5%	16.64	5.85	5.42	28.79	413.15	27.23	9.43

Conclusion

Findings based on above research trial indicates that the foliar application of graded levels of potassium and micronutrients gave a positive effect on yield, quality and nutrient uptake in Pigeon pea. It can be recommended that, the application of T_6: 100% NP + 50kg K_2O ha^{-1} + Grade- I micronutrient (soil application) recorded maximum grain yield and dry matter yield of Pigeon Pea Followed by T_8 100% NP + 50 kg K_2O ha^{-1} + Grade-II micronutrient (0.5% foliar spray).

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