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Effect of potassium and zinc application on macro nutrient uptake of red gram under Vertisols

SS Thamake[1*], MA Ajabe[2], SP Kale[3]
[1-3] Department of Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India
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Abstract
A field experiment was conducted during *Kharif* season 2016-17 to studies on effect of graded levels of potassium and zinc on growth, yield, nutrient uptake and quality of pigeon pea at experimental farm, Department of Soil Science and Agricultural Chemistry, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The experiment was laid out on Vertisols with eight treatments replicated three times in randomized block design. The initial soil fertility status showed that soils were slightly alkaline in soil reaction, safe in soluble salt, low in organic carbon content and calcareous in nature. The available N and P status was low. The experimental soil was high in available K content. The soil is deficient in Fe and Zn while sufficient in Mn and Cu. The nutrient uptake of pigeon pea was significantly enhanced with the application of potassium and zinc along with RDF. Application of RDF + 30 kg K_2O ha^{-1} + 15 kg Zn ha^{-1} (T_7) showed maximum uptake of N, P and K in pigeon pea plant and grain, followed by RDF + 15 kg K_2O ha^{-1} + 15 kg Zn ha^{-1} (T_6) and RDF + 45 kg K_2O ha^{-1} + 15 kg Zn ha^{-1} (T_8)

Keywords: potassium, zinc, nutrient uptake, red gram

1. Introduction

Pigeon pea is one of the important pulse crops of India and 91 per cent of the world's pigeon pea is produced in India. The productivity of pigeon pea in India (799 kg ha-1) is far below the average productivity (848 kg ha-1) of world. In India, it occupies an area of about 4.09 million hectares producing 3.27 million tonnes with an average productivity of 799 kg per hectare (Anon, 2010). Pigeon pea is normally cultivated during kharif season. It is the second most important pulse crop next to chickpea, covering an area of around 4.42 m ha (occupying about 14.5% of area under pulses) and production of 2.86 MT contributing to 16% of total pulse production. (Sameer et al., 2014) [7].

Potassium is an essential element for plant growth and is an extremely dynamic ion in plant and soil system. As an ion, potassium is highly mobile in the plant system but only moderately mobile in the soil system. Just like humans require a balanced diet with appropriate amounts of carbohydrates, proteins, vitamins, minerals, fats and water, plants to require conditions of balanced nutrition.

Potassium is a key nutrient in the plants tolerance to stresses such as high / low temperatures, drought, and disease and pest occurrences. It has a critical role to play in osmo-regulation-regulation of water use in plants. Osmo-regulation maintains high cell turgor pressure which affects cell elongation for growth and most importantly regulates the opening and closing of the stomata which affect transpirational cooling and carbon dioxide uptake for photosynthesis. Zinc is a major metal component and activator of several enzymes involved in metabolic activities and biochemical pathways. It is a functional, structural or regulatory co-factor of a large number of enzymes. It is required in a large number of enzymes and plays an essential role in DNA transcription.

2. Material and methods

A field experiment was conducted during kharif season 2016-2017 to study effect of graded levels of potassium and zinc on growth, yield, nutrient uptake and quality of pigeon pea at Research Farm of Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani.

2.1 Details of field experiment

The representative soil samples were collected plot wise to assess the initial soil fertility status of experimental plot. The experiment was laid out in a randomized block design with 8 treatments and 3 replications. The plot size was 5.4 m. x 4.2 m. and the recommended spacing of 90 cm x 20 cm was adopted.

The recommended dose of fertilizer was 25:50 kg N and P2O5 ha-1. The RDF, K2O and zinc fertilizers were applied through soil application at the time of sowing of pigeon pea. Fertilizers were applied as per the treatment, through Urea, Diammonium phosphate, Muriate of potash and zinc sulphate prior to sowing of pigeon pea. The treatment comprised of

Table 1

Treatments	Treatments details
T_1	Absolute control
T_2	Only RDF (25:50 N and P_2O_5 kg ha^{-1})
T_3	RDF + 15 kg K_2O ha^{-1}
T_4	RDF + 30 kg K_2O ha^{-1}
T_5	RDF + 45 kg K_2O ha^{-1}
T_6	RDF + 15 kg K_2O ha^{-1} + 15 Kg Zn ha^{-1}
T_7	RDF + 30 kg K_2O ha^{-1} + 15 Kg Zn ha^{-1}
T_8	RDF + 45 kg K_2O ha^{-1} + 15 Kg Zn ha^{-1}

Recommended Dose of Fertilizer (RDF) = 25: 50:00 kg ha^{-1} N: P_2O_5:K_2O.
Dose of $ZnSO_4$ @ 15 kg ha^{-1} applied in treatment of T_6 to T_8

2.2 Uptake of nutrients

Nutrient uptake i.e. uptake of N, P and K was calculated by considering grain and dry matter yield at harvest in particular treatment plot in relation to concentration of the particular nutrient in respective treatment plot using the formula.

$$\text{Uptake (kg ha-1)} = \frac{\text{Nutrient concentration (\%) X Dry matter yield (kg ha-1)}}{100}$$

3. Results and Discussion

Effect of potassium and zinc on nutrient uptake of N, P and K at critical growth stages of pigeon pea.

3.1 N uptake

The data pertaining to nitrogen uptake by pigeon pea with respect to graded levels of potassium and zinc are presented in table 1.

The effect of different treatments on N uptake of pigeon pea was found to be enhanced significantly with application of potassium and zinc along with RDF. The data presented in table. 1 revealed that, the plant N uptake was ranged from 81.92 to 125.99 kg ha-1, 86.97 to 195.42 kg ha-1 and 52.81 to 135.16 kg ha-1 at flowering, pod development and harvesting stage and grain N uptake was in the range from 15.21 to 135.16 kg ha-1 respectively. The treatment T7 (RDF+ 30 kg K2O ha-1+ 15 kg Zn ha-1) had maximum value (125.99 kg ha-1) at flowering, (195.42 kg ha-1) pod development and (135.16) at harvesting stage and it was at par with treatment T6 (RDF+ 15 kg K2O ha-1 + 15 kg Zn ha-1) and T8 (RDF +45 kg K2O ha-1+ 15 kg Zn ha-1) over absolute control and in only RDF treatment (T2). In grain, treatment T7 (RDF+ 30 kg K2O ha-1+ 15 kg Zn ha-1) (35.36 kg ha-1) recorded maximum uptake of N and found to be at par with treatment T6 (RDF+ 15 kg K2O ha-1 + 15 kg Zn ha-1) and T8 (RDF +45 kg K2O ha-1+ 15 kg Zn ha-1) and it was significantly superior over control and only RDF. Kherawat et al. (2013), Singh and Singh (1994) [8], Chavan et al. (2012) [2] and Keram and Singh (2014) [7] supported these findings.

Table 1: Effect of levels of potassium and zinc on N uptake at various growth stages

Treatments		N uptake (kg ha^{-1})			
		Flowering	Pod development	Harvesting	Seed
T_1	Absolute control	81.92	86.97	52.81	15.21
T_2	Only RDF (25:50 N and P_2O_5 kg ha^{-1})	90.49	99.71	93.58	23.99
T_3	RDF + 15 kg K_2O ha^{-1}	103.09	119.81	82.27	20.33
T_4	RDF + 30 kg K_2O ha^{-1}	106.80	129.54	99.46	22.94
T_5	RDF + 45 kg K_2O ha^{-1}	100.48	111.15	108.14	23.06
T_6	RDF + 15 kg K_2O ha^{-1} + 15 kg Zn ha^{-1}	121.72	187.29	119.22	33.51
T_7	RDF + 30 kg K_2O ha^{-1} + 15 kg Zn ha^{-1}	125.99	195.42	135.16	35.36
T_8	RDF + 45 kg K_2O ha^{-1} + 15 kg Zn ha^{-1}	116.82	190.70	122.18	29.03
Grand Mean		105.92	140.07	101.60	25.43
SEm (±)		2.65	5.40	7.22	1.29
CD at 5%		6.60	13.45	17.97	8.77

3.2 Puptake

The data presented in table 2 revealed that, the significant increase in P uptake by pigeon pea with application of potassium and combination with zinc over control and only RDF.

The P uptake was in the range from 13.10 to 24.48 kg ha-1, 12.74 to 32.67 kg ha-1 and 10.45 to 19.02 kg ha-1 at flowering, pod development and harvesting stage and grain P uptake was in the range from 10.45 to 19.02 kg ha-1 respectively. The highest P uptake in plant was noticed in treatment T7 (RDF+ 30 kg K2O ha-1 + 15 kg Zn ha-1) and at par with treatment T6 (RDF +15kg K2O ha-1+15 kg Zn ha-1) and T8 (RDF+ 30 kg K2O ha-1 + 15 kg Zn ha-1), at flowering, Pod development and harvest stage. The highest P uptake in grain recorded with treatment T7 (RDF+ 30 kg K2O ha-1 + 15 kg Zn ha-1) and at par with treatment T6 (RDF+ 15 kg K2O ha-1 + 15 kg Zn ha-1) which was significantly superior over control and only RDF. Similar trend was noticed by Kherawat et al. (2013), Joshi et al. (1974) [4], Chavan et al. (2012) [2] and Keram et al. (2014) [5].

Table 2: Effect of graded levels of potassium and zinc on P uptake at various growth stages

Treatments		P uptake (kg ha^{-1})			
		Flowering	Pod development	Harvesting	Seed
T_1	Absolute control	13.10	12.74	10.45	3.86
T_2	Only RDF (25:50 N and P_2O_5 kg ha^{-1})	15.99	14.79	13.32	4.14
T_3	RDF + 15 kg K_2O ha^{-1}	19.99	15.17	13.64	4.53
T_4	RDF + 30 kg K_2O ha^{-1}	18.54	24.45	12.97	4.47
T_5	RDF + 45 kg K_2O ha^{-1}	18.42	16.88	12.47	5.31
T_6	RDF + 15 kg K_2O ha^{-1} + 15 kg Zn ha^{-1}	23.64	32.55	17.64	6.21
T_7	RDF + 30 kg K_2O ha^{-1} + 15 kg Zn ha^{-1}	24.48	32.67	19.02	6.48
T_8	RDF + 45 kg K_2O ha^{-1} + 15 kg Zn ha^{-1}	22.63	30.39	17.55	5.50
Grand Mean		19.60	22.45	14.63	5.06
SEm (±)		0.51	0.49	0.61	0.26
CD at 5%		1.28	1.23	1.52	0.65

3.3 Kuptake

The data presented in Fig. 1 revealed that, the K uptake was influenced due to K and Zn application. The K uptake in plant was ranged between 48.08 to 105.41 kg ha-1, 54.90 to 143.82 kg ha-1 and 45.61 to 88.14 kg ha-1 at flowering, pod development and at harvest stage of crop. The K uptake in grain ranged from 14.55 to 25.56 kg ha-1. At flowering pod development and harvest stage the maximum uptake of K (105.42, 143.82 and 88.14 kg ha-1) was in treatment T7 (RDF + 30 kg K2O ha-1+ 15 kg Zn ha-1) and it was at par with treatment T6 (RDF+ 15 kg K2O ha-1+15 kg Zn ha-1) and T8 (RDF +45 kg K2O ha-1+15 kg Zn ha-1). In grain, the maximum K uptake was observed (25.56 kg ha-1) in treatment T7 (RDF + 30 kg K2O ha-1+ 15 kg Zn ha-1) which showed its significancy over rest of the treatments excluding over control treatment. Results are inconformity with the findings of Kherawat et al. (2013), Brar et al. (2010) [1], Jat et al. (2013) [1], Chavan et al. (2012) [3] and Keram and Singh (2014) [5].

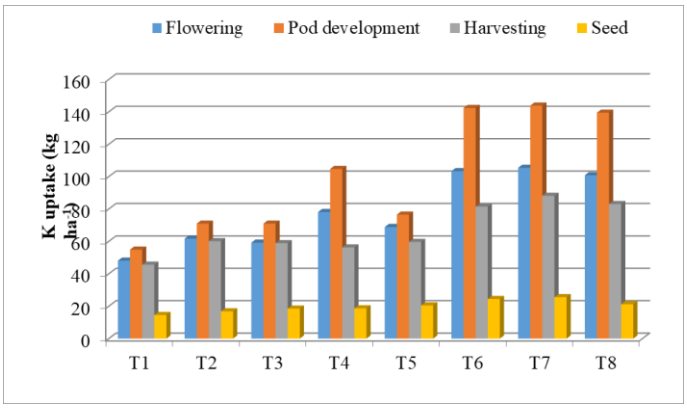

Fig 1: Effect of graded levels of potassium and zinc on K uptake (kg ha-1)

4. Conclusion

Application of 30 kg potassium with 15 kg zinc in recommended dose of pigeon pea (25:50 kg N and P2O5 ha-1) significantly enhanced nutrient uptake N, P and K of pigeon pea.

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