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Soil available nutrients and uptake as influenced by sources and levels of phosphorus in maize-sunflower cropping system.

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Abstract: **Field experiments were conducted to study the effect of P sources and levels in a maize -sunflower system. The results of the study revealed that, single super phosphate with or without microbial inoculants at recommended level of P_2O_5 to maize, improved the available nutrient status of the soil. The soil nutrient status in sunflower crop and the uptake of nutrients in maize and sunflower increased with SSP with microbial inoculants.**

Key words: Phosphorus, Microbial inoculants, Nutrient uptake, Soil available nutrients.

Introduction

Maize-sunflower is one of the cropping systems that is followed in Coimbatore district of Tamil Nadu. The fertilizer responsive crop like maize removes maximum quantity of nutrients from soil. Though the P applied to the soil is not completely removed by the crop, part of it is fixed in the soil. The slow mobility of applied P and its marked fixation results in low crop recoveries of the order of 20-25%, which calls for ways and means for judicious use.(Singh, 1993). Phosphorus when applied to a crop leaves residue and this residue could meet the P needs of the succeeding crop to certain extent. Hence, a study was made to find out the effect of sources and levels of P on the soil available nutrients and uptake by the crops at harvest in a maize-sunflower cropping sequence.

Materials and Methods

The field experiment was conducted in a black soil with a pH of 8.3 during 1997-98 and 1998-99 at Tamil Nadu Agricultural University, Coimbatore. The fertility status of the soil was classified as low in available N (254.0 kg ha^{-1}) and phosphorus (9.1 kg ha^{-1}) and high in available K (276.3 kg ha^{-1}) The first crop maize was raised in a split plot design, the second crop namely sunflower was raised in a split split plot design with three replications. The treatments for maize consisted of phosphorus sources in the main plots *viz.* Mussoorie rock phosphate (MRP) + Microbial inoculants (M_1), MRP alone (M_2), Single super phosphate (SSP) + Microbial inoculants (M_3), SSP alone (M_4) and phosphorus levels in the sub plots *viz.* 50% recommended level of P_2O_5 (P_1), 75% recommended level of P_2O_5 (P_2), and 100% recommended level of P_2O_5 (P_3). For the second crop (sunflower) the treatments consisted of the same main and sub plot treatments of maize. But, for the sunflower crop, the sub sub plot treatments were skipping P_2O_5 for sunflower ie. application of P_2O_5 for maize crop alone (S_1), and No slopping ie. P_2O_5 application for both maize and sunflower (S_2). Whereas for the fodder cowpea, the sub-sub plot treatments were skipping P_2O_5 for sunflower and fodder cowpea (S_1), skipping P_2O_5 for fodder cowpea alone(S_2) and no skipping i.e. P_2O_5 application for maize and sunflower crops in the system. The N and K were applied at recommended levels (Anon 1996). The microbial inoculants consisted of Phosphobacteria 1.76 kg ha^{-1}, *Trichoderma viride* 880 g ha^{-1} and *Pseudomonas florescens* 880 g ha^{-1}. The variety of maize and sunflower used were Co 1, and Co 4 respectively The maize crop was raised during the month of September and sunflower during January. The recommended P_2O_5 for maize and sunflower were 62.5 and 20.0 kg ha^{-1} respectively.

Results and Discussion

Soil available nutrients :

Maize :

The soil available N was not significantly influenced by the phosphorous sources and levels. SSP with micobial inoculants significantly increased the available soil P over the SSP applied alone in both the years. (Table 1). The reason might be, as the SSP contained water soluble P, the availability of P was more. SSP maintained a higher level of soil available P (Patel *et al.* 1986). The recommended level of P_2O_5 increased the available soil P significantly over the 75% recommended level of P_2O_5. With regard to the available potassium in the soil, SSP applied alone

Table 1. Soil available nutrients and uptake of nutrients in maize.

Treatments	Soil available nutrients (kg ha^{-1}) at harvest						Uptake of nutrients (kg ha^{-1}) at harvest					
	N		P		K		N		P		K	
	1997-98	1998-99	1997-98	1998-99	1997-98	1998-99	1997-98	1998-99	1997-98	1998-99	1997-98	1998-99
Phosphorus sources												
M_1	246.4	272.2	11.0	12.2	303.2	332.5	149.5	127.2	19.3	16.6	117.5	110.4
M_2	246.2	267.4	10.8	11.7	299.8	319.8	143.9	124.0	18.4	15.1	117.1	107.6
M_3	247.5	276.6	13.5	14.5	324.9	344.3	153.5	134.9	22.9	19.9	121.6	116.2
M_4	246.8	275.6	12.7	13.5	318.7	337.4	151.5	132.1	21.2	19.0	120.1	114.6
CD at 5%	NS	NS	0.81	0.68	6.54	14.35	6.52	0.93	0.06	0.55	NS	0.94
Phosphorus levels												
	245.8	270.1	10.2	10.9	308.9	329.7	139.4	118.6	14.2	12.4	111.3	104.4
	247.1	273.1	12.7	13.6	310.4	334.6	153.4	133.2	23.0	19.6	120.9	115.4
	247.4	275.5	13.1	14.3	315.7	336.2	155.9	136.8	24.2	21.0	124.6	116.8
CD at 5%	NS	NS	0.44	0.51	NS	NS	4.43	0.48	0.77	0.62	3.41	0.45

Table 2. Soil available nutrients and uptake of nutrients in sunflower.

Treatments	Soil available nutrients (kg ha^{-1}) at harvest						Uptake of nutrients (kg ha^{-1}) at harvest					
	N		P		K		N		P		K	
	1997-98	1998-99	1997-98	1998-99	1997-98	1998-99	1997-98	1998-99	1997-98	1998-99	1997-98	1998-99
Phosphorus sources												
M_1	236.4	257.5	9.3	9.2	312.3	325.8	52.15	49.45	10.8	10.8	37.3	39.2
M_2	232.6	255.0	9.1	8.8	300.1	321.8	17.02	46.50	9.0	10.1	33.7	34.1
M_3	254.3	262.9	10.6	11.2	315.9	334.7	54.77	56.43	12.9	14.0	40.6	44.3
M_4	238.0	259.4	10.4	9.9	312.4	333.0	52.32	53.02	11.6	13.1	38.3	42.6
CD at 5%	7.43	NS	0.47	0.46	1.73	NS	0.58	2.68	0.37	0.72	1.03	2.04
Phosphorus levels												
P_1	234.8	256.7	9.0	9.0	300.5	326.3	49.28	49.07	10.2	11.0	34.6	36.6
P_2	240.1	259.1	10.1	9.9	312.6	329.1	52.50	51.60	11.2	12.4	37.9	41.2
P_3	245.9	260.3	10.6	10.4	317.5	331.0	52.91	53.37	11.9	12.7	39.9	42.4
CD at 5%	3.43	NS	0.35	0.41	5.63	NS	0.43	2.09	0.21	0.35	0.54	1.51
Skipping Phosphorus												
S_1	237.2	257.9	9.3	9.3	301.6	327.9	48.67	48.96	10.1	10.9	35.5	37.7
S_2	243.4	259.5	10.4	10.2	318.7	329.7	54.46	53.74	12.1	13.1	39.5	42.4
CD at 5%	5.48	NS	0.23	0.27	5.06	NS	1.09	1.32	0.21	0.39	0.65	1.19

recorded an increased available K. The phosphorus levels did not show any significant influence on the soil available K.

Sunflower :

SSP with microbial inoculants significantly increased the soil available N during 1997-98. The soil available N was 254.3 kg ha^{-1} at harvest.

(Table 2). During 1998-99, soil available N was not significantly influenced by P sources. With respect to the phosphorus levels, the recommended level of P_2O_5 significantly increased the available soil N during 1997-98 and whereas 1998-99, significant differences were not noticed. The P_2O_5 application for both the crops in the system significantly increased the soil available N during 1997-98. Appreciable differences were not exhibited during 1998-99.

The available soil P was significantly influenced by P sources and levels. During 1997-98, SSP + microbial inoculants increased the soil available P and was statistically comparable with SSP alone. Whereas in 1998-99, SSP with microbial inoculants increased the soil available P . This increase in soil available P might be due to the water soluble P in the SSP. The available soil P status improved upto the recommended level of P_2O_5 in the year 1997-98 and in 1998-99, the response was upto 75% of recommended level of P_2O_5. Phosphorus application to both the crops in the system improved the available P status of the soil. (Table 2). This is due to the addition of P for maize as well as for sunflower crop, resulting in the build up of P. The available K in the soil was significantly influenced by the P management practices during the year 1997-98 and in 1998-99. But significant variations were not observed.

Nutrient Uptake

Maize :

SSP when applied alone increased the uptake of N during 1997-98. Whereas during 1998-99, SSP with microbial inoculants was significantly superior over the SSP when applied alone. (Table 1). The N uptake increased upto 75% recommended level of P_2O_5. Singh and Ahlawat (1998) reported that, P application for preceding green gram increased the N uptake of maize.

The uptake significantly increased at SSP with microbial inoculants and at recommended level of P_2O_5. The P uptake with respect to sources were 22.9 and 19.9 kg ha^{-1} during 1997-98 and 1998-99 respectively. Since SSP was applied as basal, the root development might have improved, resulting in increased P uptake. Phosphorus uptake was significantly higher in the super phosphate treated plots as compared to rock phosphate treated plots. (Zaharah *et al.* 1989).

SSP with microbial inoculants significantly increased the K uptake during 1998-99.The recommended level of P_2O_5 increased the K uptake during both the years.

Sunflower:

The uptake of N significantly increased at 75% recommended level of P_2O_5 in both the years (Table 2). The P_2O_5 application to maize and sunflower crops increased the N uptake. SSP with microbial inoculants at recommended level of P_2O_5 applied to both the crops in the system increased the P uptake. P as SSP was more effective (Rachewad *et al.* 1991).

The SSP with microbial inoculants at recommended level of P_2O_5 applied to both the crops in the system increased the K uptake during 1997-98. Whereas in 1998-99, SSP applied alone with 75% recommended level of P_2O_5 applied to both the crops in the system increased the K uptake.

It can be concluded from the study that SSP with or without microbial inoculants and P_2O_5 at recommended level to maize improved the fertility status of the soil. SSP with microbial inoculants at recommended level of P_2O_5 applied for both maize and sunflower improved the soil fertility status in sunflower crop. The uptake of nutrients in maize and sunflower increased with SSP and microbial inoculants at recommended level of P_2O_5. When P_2O_5 was applied to both maize and sunflower, the uptake of N,P and K was increased.

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