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ield and economics of maize-sunflower-fodder cowpea cropping system as influenced by phosphorus management practices.

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Abstract: **Field experiments were carried out during 1997-98 and 1998-99 at Tamil Nadu Agricultural University, Coimbatore, to study the effect of phosphorus sources and levels in a maize - sunflower- fodder cowpea croppmg system. The maize grain equivalent yield MGE increased when SSP was applied with microbial inoculants with 75 % recommended level of P_2O_5 when applied to all the three crops in the system. The economics of the system revealed that SSP with microbial inoculants, P_2O_5 at 75% recommended level, P_2O_5 for maize and sunflower and skipping P_2O_5 for fodder cowpea was found to be economical.**

Key words: Phosphorus, Maize Grain Equivalent, Cropping system, Economics.

itroduction

Phosphorus is a major nutrient which is aving wide response in major soils of India. hosphorus as single super phosphate (SSP) is ostlier whereas Mussoorie rock phosphate (MRP) s a cheaper source of P. gained momentum in ecent years. In India about 145 million tonnes of rock phosphate deposits one available. (Jaggi, 1986). Phosphorus through MRP is not quickly compared released as SSP but M.R.P is effective in a cropping system. Ratnamurthy and Velayudham (1976) reported that the magnitude of the residual effect depends on the rate and kind of P fertilizer used, the crop management systems followed and to a greater extent on the type of the soil.

Materials and Methods

Field experiments were conducted during 1997-98 and 1998-99 at Tamil Nadu Agricultural University, Coimbatore. The soil was clay loam with a pH of 8.3. The first crop maize was raised in a split plot design and the treatments consisted of phosphorus sources as 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). The phosphorus levels in the sub plots were 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). The second crop sunflower and the third crop of fodder cowpea 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 skipping 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 ie. P_2O_5 application for all the three crops in the system (S_3). The design adopted for second and third crop was split split plot. The N and K were applied at recommended levels for all the three crops in the system. The microbial inoculants consisted of Phosphobacteria at 1.75 kg ha^{-1}, *Trichoderma viride* 880 g ha^{-1} and *Pseudomonas florescens* 880 g ha^{-1}. This mixture was applied after the crop was sown. The varieties of maize, sunflower and fodder cowpea used were Co1, Co4, and Co5 respectively. Maize crop was raised during the month of September: sunflower during January and fodder cowpea during April. The recommended P_2O_5 for maize, sunflower and fodder cowpea were 62.5, 20 and 40 kg ha^{-1} respectively. The root stubbles of the crops in the system were allowed as such in the field. The *Trichoderma viride* was used to decompose the stubbles left by the preceding crops.

Results and Discussion

The net return and B:C ratio for the individual crop *viz.* maize, sunflower and fodder cowpea were higher at SSP with microbial inoculants and P_2O_5 at recommended level. The reason might be due to the increased yield attributes and yield. The P_2O_5 applied for all the three crops in the system increased the net return and B:C ratio of the individual crop in the system. (Table. 1)

Table 1. Net return and B:C ratio of maize, sunflower and fodder cowpea

Treatments	Maize				Sunflower				Fodder Cowpea			
	1997-98		1998-99		1997-98		1998-99		1997-98		1998-99	
	Net return Rs. ha^{-1}	B:C ratio	Net return Rs. ha^{-1}	B:C ratio	Net return Rs. ha^{-1}	B:C ratio	Net return Rs. ha^{-1}	B:C ratio	Net return Rs. ha^{-1}	B:C ratio	Net return Rs. ha^{-1}	B:C ratio
Phosphorus sources												
M_1	16099	2.30	14272	2.13	4099	1.50	4307	1.51	353	1.07	1526	1.26
M_2	13607	2.10	11674	1.93	3551	1.43	3916	1.47	361	1.07	1217	1.21
M_3	20993	2.66	16374	2.28	5061	1.61	5429	1.65	2138	1.37	3488	1.59
M_4	18901	2.50	16122	2.26	4891	1.59	4939	1.59	1809	1.32	2719	1.47
Phosphorus levels												
P_1	16174	2.32	13221	2.06	3942	1.48	4114	1.49	499	0.91	946	1.16
P_2	17683	2.41	15015	2.18	4570	1.51	4855	1.58	1833	1.33	2746	1.47
P_3	18344	2.44	15597	2.21	4689	1.56	4975	1.59	2159	1.38	3021	1.52
Skipping Phosphorus												
S_1	-	-	-	-	3941	1.48	4204	1.51	-94	0.98	1077	0.79
S_2					4860	1.58	5091	1.60	1728	1.32	2918	1.01
S_3					-	-	-	-	1863	1.32	2718	0.96

Table 2. Maize grain equivalent yield and Economics of maize- sunflower - fodder cowpea cropping system.

Treatments	Maize Grain Equivalent yield (t ha^{-1})			Net return (' 000 Rs ha-')	B:C ratio
	1997-98	1998-99	Mean		
Phosphorus sources					
M_1	12.84	13.89	13.37	20.48	0.77
M_2	12.10	12.94	12.52	17.21	1.65
M_3	15.61	16.51	16.06	26:95	2.00
M_4	14.74	15.46	15.10	24.92	1.93
CD (P=0.05)	1.20	0.84	-	1.023	0.08
Phosphorus levels					
P_1	11.77	13.02	12.40	19.08	1.72
P_2	14.63	15.30	14.97	23.53	1.88
P_3	15.07	15.77	15.42	24:57	1.91
CD (PO.05)	0.55	0.70	-	0.945	0.06
Skipping Phosphorus					
S_1	12.51	13.33	12.92	20.58	1.78
S_2	14.14	15.17	14.66	23.32	1.88
S_3	14.82	15.60	15.21	23.28	1.86
CD (P=0.05)	0.64	0.49	-	0.787	0.07

M_1 : MRP + Microbial inoculants
M_2 : MRP alone
M_3 : SSP + Microbial inoculants
M_4 : SSP alone

P_1 : 50% recommended P_2O_5
P_2 : 75% recommended P_2O_5
P_3 : 100% recommended P_2O_5

S_1 : Skipping P_2O_5 for sunflower & cowpea
S_2 : Skipping of P_2O_5 to cowpea alone
S_3 : Application of P_2O_5 to all the crops.

Phosphorus sources had significant influence on maize grain equivalent yield (MGEY). During 1997-98, SSP with microbial inoculants recorded higher MGEY which was comparable to SSP applied alone, whereas in 1998-99, SSP with microbial inoculants was significantly superior over the SSP applied treatment. SSP with microbial inoculants might have increased the soil available P and the crop residues of the preceding crops also decomposed, resulting in increased uptake of P and the yield of the individal crops in the system, thereby increased the MGEY. Increased P uptake increased the maize grain yield (Sankhyan and Sharma,1997), sunflower seed yield (Jagadev singh and Singh, 1997), green fodder yield of cowpea (Jene *et al.* 1995). Crop residues increased the available soil P by several folds. (Walters *et al.*1992). The phosphorus levels also significantly influenced the MGEY The MGEY increased upto 75% recommended level of P_2O_5. This trend was noticed in both the years.(Table 2). Phosphorus application to all the crops in the system increased the MGEY (14.82 t ha^{-1}) during 1997-98, and in 1998-99, (15.60 t ha^{-1}) of P_2O_5 and was on par with P_2O_5 application for the first two crops in the uptem during the year 1998-99.

In the maize -sunflower -fodder cowpea Cowpea cropping system, SSP with microbial inoculants recorded a higher net return and B:C ratio and was significantly superior over the SSP applied alone. Increased yield of the individual crops might be the reason for increased net return and B:C ratio. The net return and B:C ratio increased up to 75 % recommended level of P_2O_5. (Table 2). The P_2O_5 application for maize, sunflower and skipping P_2O_5 for fodder cowpea recorded a higher net return and B:C ratio. Similar finding of skipping P in the cropping system was reported by Duraisamy (1997).

Thus from the study, it can be concluded that, SSP with recommended level of P_2O_5 increased the net return and B:C ratio of maize. Skipping P for fodder cowpea increased the net return and B:C ratio of the sunflower and fodder cowpea. Increased MGEY was observed when SSP was applied with or with out microbial inoculants, P_2O_5 at 75% recommended level applied to all the three crops in the system. Considering the overall economics of the system, SSP with microbial inoculants, P_2O_5 at 75% recommended level and skipping P_2O_5 for fodder cowpea in the cropping system was found to be economical.

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