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Effect of Agro-techniques on Yield, Yield Attributes and Phosphorus Uptake of Maize (*Zea mays* L.) in Mining Soil Reserve Phosphorus

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ABSTRACT

A field experiment was conducted during the *rabi* 2009-10 to study the effect of certain agro-techniques to mine soil reserve phosphorus by cultivation of maize (*Zea mays* L.). The results of the experiment revealed that yield attributes, yield and phosphorus uptake were significantly influenced by organic/inorganic treatments, inoculation treatment and their interactions. Among different treatment combinations studied, application of FYM and PSB together showed significantly the highest yield attributes, yield and phosphorus uptake of maize over other treatment combinations studied.

Key words : Agro-techniques, FYM, Maize, P uptake, PSB, VAM,Yield

Continued use of straight phosphatic fertilizers in yester years and excessive use of complex fertilizers in recent years, especially DAP, coupled with usual low phosphorus use efficiency of crops made the cultivated soil high in phosphorus status. Escalating costs of phosphatic fertilizers and environmental concerns of excessive use of phosphatic fertilizers have been prompting the researchers to develop alternative strategies to meet crop phosphorus needs through agro-techniques that enhance solubilization of fixed soil phosphorus. A few of the practices, which have shown some promise in this context include addition of organic manures (Misra and Das, 2000), or inoculating with micro-organisms (Mukherjee and Rai, 2000), which solubilize soil fixed phosphorus.

MATERIAL AND METHODS

A field experiment was conducted during *rabi* 2009-2010 at Agricultural College Farm, Bapatla. The experiment comprised of fifteen treatments, five organic/inorganic treatments (1. No application of organic manure or no fertilizer P; 2. Application of FYM @ 5 t ha^{-1}; 3. Green manuring *in situ* with sunnhemp; 4. Application of phosphorus fertilizer @ 50% of recommended dose i.e 30 kg P_2O_5 ha^{-1} and 5. Application of recommended dose of phosphorus fertilizer i.e 60 kg P_2O_5 ha^{-1}) and three inoculation treatments (1. No inoculation or no phosphorus fertilization; 2. Soil inoculation of Phosphate Solubulizing Bacteria @ 2.5 kg ha^{-1} and 3. Soil inoculation of Vesicular Arbusicular Mycorrhizae @ 5 kg ha^{-1}) arranged in a randomized block design with factorial concept and replicated thrice. The soil was clay loam in texture, slightly alkaline in reaction (pH 7.9), low in organic carbon (0.32%) and available nitrogen (234 kg ha^{-1}), medium in available phosphorus (35 kg P_2O_5 ha^{-1}) and high in available potassium (583 kg K_2O ha^{-1}). Bold and healthy seeds of maize hybrid 30 V 92 were hand dibbled into the soil on 6 -12- 2009 at a spacing of 60 cm x 30 cm. A common dose of 120 kg N ha^{-1} through urea was applied in three splits (1/3 as basal, 1/3 at knee high stage and 1/3 at tasseling stage). As per treatments, phosphorus was applied in two different levels 100 % recommended dose (60 kg P_2O_5 ha^{-1}) and 50 % recommended dose (30 kg P_2O_5 ha^{-1}) through single super phosphate. Irrespective of the treatments, a common dose of 40 kg K_2O ha^{-1} murate of potash was applied at the time of planting. Recommended package of practices were followed. Pre and post-harvest observations in respect of both growth and yield parameters were recorded following standard procedures.

RESULTS AND DISCUSSION

The results indicated that the growth yield attributes such as cob length, cob weight, 100-kernel weight, shelling percentage and kernel yield, stover yield, phosphorus uptake were significantly influenced by organic/inorganic inoculation treatments and their interactions.

Table 1. Yield attributes of maize as affected by different agro-techniques

Organic/ inorganic fertilizer treatments (o)	Cob length (cm)				Cob weight (g)				100-kernel weight (g)				Shelling (%)			
	Inoculation (I)				Inoculation (I)				Inoculation (I)				Inoculation (I)			
	No inoculation	PSB	VAM	Mean	No Inoculation	PSB	VAM	Mean	No inoculation	PSB	VAM	Mean	No inoculation	PSB	VAM	Mean
Control	14.3	19.8	19.2	17.8	145.3	164.4	163.3	157.7	21.7	27.4	26.3	25.2	72.0	76.0	74.0	74.0
FYM	20.4	24.5	20.7	21.9	178.0	220.7	200.7	199.8	29.3	34.5	32.9	32.2	79.0	87.7	85.3	84.0
GM	18.1	21.2	20.5	19.9	173.2	192.7	186.0	184.0	28.7	30.5	30.2	29.8	77.2	81.3	81.0	79.8
50 % RDP	17.4	20.6	18.9	19.0	160.7	165.9	164.4	163.7	24.4	29.7	28.4	27.5	76.0	80.3	78.0	78.1
100 % RDP	17.6	21.5	19.5	19.5	161.3	184.9	167.4	171.2	27.9	30.2	29.1	29.1	78.0	82.7	80.3	80.3
Mean	17.6	21.5	19.8		163.7	185.7	176.4		26.4	30.5	29.4		76.4	81.6	79.7	
	O	I	O x I		O	I	O x I		O	I	O x I		O	I	O x I	
SEm±	0.36	0.40	0.80		1.3	1.4	2.8		0.31	0.34	0.69		0.73	0.82	1.64	
CD (0.05)	1.6	1.6	2.5		5.7	5.5	8.7		1.4	1.3	2.1		3.3	3.2	5.1	
CV (%)	9.4				3.7				5.5				4.8			

Table 3. Phosphorus uptake (kg ha^{-1}) of maize at different growth stages as affected by agro-techniques

Organic/ inorganic fertilizer treatments (o)	30 DAS				60 DAS				90 DAS				Maturity			
	Inoculation (I)				Inoculation (I)				Inoculation (I)				Inoculation (I)			
	No inoculation	PSB	VAM	Mean	No Inoculation	PSB	VAM	Mean	No inoculation	PSB	VAM	Mean	No inoculation	PSB	VAM	Mean
Control	1.1	3.2	3.0	3.0	4.1	8.3	7.4	6.6	10.8	24.9	23.1	19.6	15.8	26.7	26.2	22.9
FYM	2.4	7.6	6.9	6.9	6.4	17.2	15.8	13.1	24.0	33.9	28.4	28.8	28.6	36.2	31.6	32.1
GM	1.8	5.2	5.0	5.0	5.7	12.0	11.3	9.5	23.3	27.2	23.9	24.8	25.0	30.8	29.6	28.5
50 % RDP	2.6	5.1	4.6	4.6	6.8	11.4	11.0	9.9	21.5	25.0	22.2	22.9	22.7	28.6	25.6	25.6
100 % RDP	2.9	5.6	5.4	5.4	7.2	15.0	12.7	12.0	22.2	27.8	23.3	24.4	23.5	31.5	26.5	27.2
Mean	2.2	5.3	5.0	5.0	6.04	12.8	11.6		20.8	27.6	24.2		23.1	30.8	27.9	
	O	I	O x I	O x I	O	I	O x I		O	I	O x I		O	I	O x I	
SEm±	0.1	0.1	0.2	0.2	0.2	0.2	0.3		0.57	0.64	1.29		0.50	0.56	1.13	
CD (0.05)	0.4	0.3	0.6	0.6	0.7	0.6	1.0		2.6	2.5	4.0		2.3	2.2	3.5	
CV (%)	10				7.4				12.3				9.5			

Table 2. Kernel yield, stover yield and harvest index of maize as affected by agro-techniques

Organic/ inorganic fertilizer treatments (o)	Kernel yield (kg ha^{-1})				Stover yield (kg ha^{-1})			
	Inoculation (I)				Inoculation (I)			
	No inoculation	VAM	PSB	Mean	No Inoculation	PSB	VAM	Mean
Control	4568	5809	6218	5809	5337	6844	6469	6469
FYM	6563	7112	7812	7112	7250	8533	8233	8233
GM	6187	6773	6776	6773	7061	7734	7690	7690
50 % RDP	6121	6778	6552	6778	6950	7586	7360	7360
100 % RDP	6166	6567	6773	6567	6978	7673	7482	7482
Mean	5921	6608	6826	6608	6715	7674	7447	7447
	O	O x I	I	O x I	O	I	O x I	O x I
SEm±	124	278	139	278	109	122	244	244
CD (0.05)	559	856	546	856	491	479	752	752
CV (%)	10				8.0			

Effect of organic/inorganic treatments

The maximum cob length (21.9 cm), cob weight (199.8 g), 100-kernel weight (32.2 g), shelling percentage (84.0), kernel yield (7162 kg ha^{-1}), stover yield (8006 kg ha^{-1}) and phosphorus uptake (32.1 kg ha^{-1}) at maturity were recorded with application of FYM @ 5 t ha^{-1} over control and other organic/ inorganic treatments (Table 1, 2, & 3). The increased in yield attributes, yield and phosphorus uptake due to application of FYM might be due to increased solubilization of soil fixed phosphorus by releasing organic acids during decomposition and other nutrients present in FYM, which inturn, might have enabled increase in yield contributing character, yield and phosphorus uptake by maize crops. Similar result with the application of FYM were noticed earlier by Mehta *et al*. (2005) and Rajput *et al.* (2007).

Effect of inoculation treatments

The yield attributes *viz.*, cob length, cob weight, 100-kernel weight, shelling percentage, kernel yield, stover yield and uptake of phosphorus (Table 1, 2 & 3) were the maximum with PSB which was significantly superior to inoculation with VAM and no inoculation treatments. The increased in yield attributing characters, yield and nutrient uptake might be due to bacterial secretion of organic acids, to solubilize phosphorus and by production of amino acids, vitamins and growth promoting substances. These results were in accordance with the findings of Rachewad *et al.* (1991) and Sutaliya and Singh (2005).

Interaction effect of different treatment combination

Maize yield attributes, yield and phosphorus uptake was significantly influenced by different treatment combinations studied. As was noticed with all yield attributing parameters, kernel yield (7812 kg ha^{-1}), stover yield and phosphorus uptake recorded with the combined application of FYM and PSB was the highest of all the treatment combinations studied in the experiment (Table1, 2 & 3) followed by FYM along with VAM. Application of FYM along with PSB proved even better in increasing yield attributes, which might be due to bacterial secretion of organic acids, to solubilize phosphorus and by production of amino acids, vitamins and growth promoting substances, that helped in promoting yield attributes, kernel yield, stover yield and phosphorus uptake. When the PSB was added with FYM, the solubilization of phosphorus enhanced in addition to the quantity of plant nutrients contained by FYM. Also, the FYM might have acted as food stuff for PSB. Similar result were obtained by Surendra and Sharanappa (2000) and Sutaliya and Singh (2005).

Overall, from this study, it can be concluded that there is equal need for P fertilization and agro-techniques when maize crop is grown on soil of medium to high soil phosphorus status. Instead of using higher doses of phosphoric fertilizers, it is better to use lower doses of phosphatic fertilizer and adopt various agro-techniques that solubilize soil fixed phosphorus. Application of phosphate

solubilizing micro-organisms along with organic manures significantly increased the solubility of native phosphorus in cultivation of maize. Among different agro-techniques, application of FYM along with the phosphate solubilizing micro-organisms i.e. PSB or VAM increased the phosphorus solubility on clay loam soil of medium to high soil test value for P.

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