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Effect of Integrated Use of Organic and Inorganic Sources of Nutrients and Biofertilizers on Nitrogen and Phosphorus Fractions of Soil in Maize – Onion Cropping System

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ABSTRACT

A field experiment was conducted in *kharif*, (maize) and *rabi*, (onion) during 2009-10 to study the effect of integrated use of organic and inorganic sources of nutrients and biofertilizers on soil nitrogen and phosphorus fractions in maize-onion cropping system in Alfisols of Hyderabad. The results revealed that application of 75% RDF along with 25% N or P substituted through vermicompost or poultry manure with addition of *Azotobacter* or phosphorus solubilising bacteria recorded increased nitrogen and phosphorus fractions, whereas in *rabi* fertilized onion recorded maximum nitrogen and phosphorus fractions, when compared to unfertilized one. Within fertilized and unfertilized onion INM treatments showed highest nitrogen and phosphorus fractions as compared to other treatments

Key words : Maize, Nitrogen, Onion and Phosphorus fractions.

Inspite of a phenomenal progress in food grain production, the greatest challenge still remains to produce enough food to meet the requirement of growing population. Land being the limiting factor, successful management of resources to satisfy the human needs through maintaining the quality of the environmentis essential. Among the several strategies for sustainable crop production, integrated nutrient management plays an important role through minimizing the chemical fertilizers and integrating with organic manures without affecting the quality of soil.

Integrated use of fertilizers and organic manures help in maintaining yield stability in most of the agro-ecosystems through correction of secondary and micronutrient deficiencies, enhancing the efficiency of applied nutrients and providing favourable soil physical conditions. Integrated nutrient management in cropping systems is more efficient than in individual crops because it takes care of residual effects of nutrients

Though much work has been reported on the use of organic manures along with inorganic fertilizers on production of maize and onion but no systemic investigation has been carried out on the use of organic manures along with inorganic fertilizers and biofertilizers on soil nitrogen and phosphorus fractions in maize – onion cropping system.

MATERIAL AND METHODS

A field experiment was conducted during *kharif* (maize) on Alfisols at College Farm, College of Agriculture, Rajendranagar, Hyderabad. The experimental soil was sandy loam, neutral in reaction (pH 7.28), non saline (EC 0.22 dSm^{-1}), low in organic carbon (0.49%), low in alkaline $KMNO_4$ extractable N (186 kg ha^{-1}), medium in available P (23.27 kg ha^{-1}) and high in available K (395 kg ha^{-1}). The initial nitrogen fractions were exchangeable NH_4^+-N (40.28 mg kg^{-1}) and NO_3^-N (11.56 mg kg^{-1}) and phosphorus fractions were 5.2, 54.3, 55.6 and 113.2 mg kg^{-1} saloid P, Al-P, Fe-P and Ca-P respectively. The experiment was laid out in Randomized Block Design consisting of twelve treatment combinations each replicated thrice. The treatments consisted at control (T_1); three inorganic N and P levels namely 50% N and P through RDF (T_2), 75% N and P through RDF(T_3) and 100% N and P through RDF(T_4) and integrated nutrient management treatments *viz.,* 75% N through RDF + 25% N through poultry manure(T_5), 75% N through RDF + 25% N through poultry manure + *Azotobacter* (T_6), 75% N through RDF + 25% N through vermicompost (T_7), 75% N through RDF + 25% N through vermicompost + *Azotobacter* (T_8), 75% P through RDF + 25% P through poultry manure(T_9), 75% P through RDF + 25% P through

poultry manure + phosphorus solubulising bacteria (T_{10}), 75% P through RDF + 25% P through vermicompost (T_{11}), 75% P through RDF + 25% P through vermicompost + phosphorus solubulising bacteria (T_{12}). In *rabi* season onion was grown in strip plot design and all the plots were divided into two equal halves. Fertilizers were not applied to one half to know the residual effect on onion grown during *rabi* after harvest of maize crop. In another half a common dose of 75 percent of recommended dose of N, P and K fertilizers were applied to onion crop for all the treatments to know the cumulative effect.The organic sources and biofertilizers were applied at the time of field preparation , the popular varieties *viz.,* DHM-111(Maize) and Nasik red (Onion) selected and raised in the field with a spacing 60×20 cm (Maize) and 20×10 cm (Onion) and all the recommended cultural practices were fallowed. The soil samples were collected after final harvest of each crop and analyzed for chemical properties by following standard methods (Bremner, 1965; Jackson,1973).

RESULTS AND DISCUSSION

Nitrogen and Phosphorus fractions after harvest of Maize

The fractions of N and P in the soil after harvest of maize showed substantial influence of nutrient management(Tables 1 & 2).The ammonical and nitrate nitrogen fractions were less than their initial value after harvest of unfertilized crop and that supplied with 50% recommended level of N and P. They were restored by the application of recommended level of fertilizers but increased further by the substitution of 25% N or P with poultry manure or vermicompost and added with or without *Azotobacter* and phosphorus solubilising bacteria. These integrated nutrient management treatments might have enabled better nutrient supply for the succeeding crop by the transformation of NH_4^+ - N to available form of NO_3^- - N. The influence of organic manures in increasing these fractions of nitrogen was also reported by Santhy *et al*.(1998) and Duraisami *et al*.(2001).

The phosphorus fractions depleted severely by the cultivation of maize without external source of nutrient additions. The integrated nutrient management treatments increased the Saloid-P, while the Al-P and Ca-P concentrations did not change. A significant increase in the Fe-P occurred by the substitution of 25% N or P with vermicompost and poultry manure. These treatments there by provide a reserve of P nutrient and it is utilized by the succeeding crops through the slow releasing pattern that increases the residual availability (Verma *et al*., 1991; Santhy *et al*., 1998).

Nitrogen and Phosphorus fractions after harvest of Onion

The study on fractions of soil available N recorded significant abundance of both exchangeable and nitrate nitrogen due to the cumulative influence of fertilizer application both to maize and onion than to onion alone. These fractions increased further due to the cumulative effect of integrated nutrient management treatments to maize and fertilizer application to onion to more than their initial levels.

The exchangeable NH_4^+ - N and NO_3^- - N recorded an abrupt reduction by growing maize and onion without the fertilizer application. These fractions increased further due to the residual effect of recommended level of N and P fertilizers to maize. Both the fractions increased further due to the residual effect of integrated nutrient management treatments and yet did not reach their initial values. The integrated nutrient management treatments to maize and fertilizer application to onion is therefore a wise step to enhance the fractions of ammonical nitrogen for transformation to available nitrate form in larger quantities vis - a – vis the readily available NO_3^- content for direct absorption by the crop. Such benefits of integrated nutrient management treatments sustaining the soil fertility with higher levels of N fractions in fingermillet – maize – cowpea intensive cropping system was also reported by Santhy *et al*.(1998).

The phosphorus fractions *viz.,* Saloid-P, Al-P, Fe-P and Ca-P were more after the harvest of fertilized onion preceded by the unfertilized maize as compared to their initial values. These fractions increased significantly due to the cumulative influence of fertilizer application to both the crops. The integrated nutrient management treatments to maize and fertilizer application to onion further enriched the soil with these fractions. The quantity of these P-fractions reduced drastically by the cultivation of maize and onion without the application of fertilizers. The residual effect of N and P fertilizers to maize improved these fractions after the harvest of unfertilized onion. The residual influence of integrated nutrient management treatments to maize was much better to significantly increase Al-P, Fe-P and Ca-P while the Saloid-P was similar to that of residual fertility due to the inorganic fertilization. However, even these improvements due

Table 1. Effect of different fertility management treatments on inorganic N fractions (mg kg^{-1}) in soil after harvest of maize.

Treatments	(mg kg^{-1})	
	Exchangeable-NH_4^+	Nitrate-N
T_1: Control (No fertilizers)	36.25	8.52
T_2: 50% N, P through RDF	38.77	10.92
T_3: 75% N, P through RDF	40.28	11.55
T_4:100% N, P through RDF(120-60 Kg N, P_2O_5 ha^{-1})	42.05	12.74
T_5: 75% N through RDF + 25% N through Poultry manure	44.25	12.84
T_6: 75% N through RDF + 25% N through Poultry manure + Azotobacter	45.14	12.89
T_7: 75% N through RDF + 25% N through Vermi compost	45.85	13.24
T_8: 75% N through RDF + 25% N through V.C. + AZB	45.95	13.44
T_9: 75% P through RDF + 25% P through P.M.	44.35	13.52
T_{10}: 75% P through RDF + 25% P through P.M. + Phosphorus solubilising bacteria	45.54	13.60
T_{11}: 75% P through RDF + 25% P through V.C	45.72	12.98
T_{12}: 75% P through RDF + 25% P through V.C + P.S.B.	45.82	13.24
SEm±	0.73	0.13
CD(P=0.05)	2.16	0.39

Table 2. Effect of different fertility management treatments on P-fractions of soil after harvest of maize.

Treatments	Contents (mg kg^{-1})			
	Saloid P	Al-P	Fe-P	Ca-P
T_1: Control (No fertilizers)	4.0	40.2	46.0	103.8
T_2: 50% N, P through RDF	4.2	42.1	49.0	108.7
T_3: 75% N, P through RDF	4.7	46.2	53.0	111.1
T_4:100% N, P through RDF(120-60 Kg N, P_2O_5 ha^{-1})	5.3	56.1	66.1	114.1
T_5: 75% N through RDF + 25% N through Poultry manure	6.5	58.2	68.1	114.7
T_6: 75% N through RDF + 25% N through Poultry manure + *Azotobacter*	6.7	59.0	70.0	117.0
T_7: 75% N through RDF + 25% N through Vermi compost	6.7	58.3	71.0	117.8
T_8: 75% N through RDF + 25% N through V.C. + AZB	6.8	59.1	71.1	118.6
T_9: 75% P through RDF + 25% P through P.M.	6.6	58.3	70.6	116.4
T_{10}: 75% P through RDF + 25% P through P.M. + Phosphorus solubilising bacteria	6.7	59.0	72.0	117.9
T_{11}: 75% P through RDF + 25% P through V.C	6.7	58.3	71.0	118.0
T_{12}: 75% P through RDF + 25% P through V.C + P.S.B.	6.8	59.1	72.3	120.2
SEm±	0.17	1.22	1.43	1.82
CD(P=0.05)	0.51	3.62	4.22	5.39

Table 3. Influence of fertility management treatments in maize - onion cropping system on contents of inorganic P – fractions (mg kg^{-1}) in soil after harvest of onion .

Fertilized(cumulative)	(mg kg^{-1})			
	Saloid P	Al-P	Fe-P	Ca-P
T_1: Control (No fertilizers)	6.41	58.20	67.30	135.25
T_2:50% N, P (RDF)	6.45	58.26	68.20	136.42
T_3:75% N, P (RDF)	6.49	58.30	68.90	137.46
T_4:100% N, P through RDF(120-60 Kg N, P_2O_5 ha^{-1})	7.20	66.20	69.20	138.42
T_5:75% N (RDF) + 25% N Poultry manure	7.80	73.30	73.30	139.30
T_6: 75% N (RDF) + 25% N Poultry manure + *Azotobacter*	8.02	75.14	75.40	141.76
T_7: 75% N (RDF) + 25% N Vermicompost	8.04	76.20	76.20	140.20
T_8: 75% N (RDF) + 25% N V.C. + AZB	8.10	77.30	77.30	142.23
T_9: 75% P (RDF)+ 25% P P.M.	7.90	76.08	76.20	139.40
T_{10}: 75% P (RDF) + 25% P P.M. + Phosphorus solubilising bacteria	8.02	78.25	78.21	141.20
T_{11}: 75% P (RDF) + 25% P V.C	8.00	77.13	77.32	141.12
T_{12}: 75% P RDF + 25% P V.C + P.S.B.	8.15	78.20	78.25	143.23
Unfertlized(Residual)				
T_1: Control (No fertilizers)	3.30	36.13	36.25	86.95
T_2:50% N, P (RDF)	3.36	37.20	37.36	87.54
T_3:75% N, P (RDF)	3.38	37.52	38.54	88.45
T_4:100% N, P through RDF(120-60 Kg N, P_2O_5 ha^{-1})	4.13	38.47	39.20	88.90
T_5:75% N (RDF) + 25% N Poultry manure	4.16	39.07	41.10	90.10
T_6: 75% N (RDF) + 25% N Poultry manure + *Azotobacter*	4.21	39.90	42.12	90.87
T_7: 75% N (RDF) + 25% N Vermicompost	4.25	39.56	42.23	90.98
T_8: 75% N (RDF) + 25% N V.C. + AZB	4.25	39.60	42.30	92.20
T_9: 75% P (RDF)+ 25% P P.M.	4.25	40.15	43.25	90.76
T_{10}: 75% P (RDF) + 25% P P.M. + Phosphorus solubilising bacteria	4.23	38.49	43.16	92.30
T_{11}: 75% P (RDF) + 25% P V.C	4.20	39.40	44.20	92.40
T_{12}: 75% P RDF + 25% P V.C + P.S.B.	4.30	40.50	44.20	92.38
Effect of *kharif* treatments at same levels of *rabi* treatments SEm±	0.12	0.50	0.44	0.84
CD(P=0.05)	0.34	1.49	1.23	2.46
Effect of *rabi* treatments at same or different levels of *kharif* treatments SEm±	0.67	3.39	2.54	4.02
CD(P=0.05)	NS	9.94	NS	NS

to residual effect of integrated nutrient management treatments could not sustain the initial values of any of the four fractions. Hence the availability of different fractions of P (Table 3) in soil can be increased by the nutrient schedule of integrated nutrient management treatments to maize and fertilizer application to onion in the cropping system.

Table 4. Influence of fertility management treatments in maize - onion cropping system on inorganic N fractions (mg kg^{-1}) in soil after harvest of onion.

Fertilized(cumulative)	Exchangeable-NH_4^+	Nitrate-N
T_1: Control (No fertilizers)	36.05	6.51
T_2:50% N, P (RDF)	38.75	8.92
T_3:75% N, P (RDF)	40.24	9.45
T_4:100% N, P through RDF(120-60 Kg N, P_2O_5 ha^{-1})	40.12	10.64
T_5:75% N (RDF) + 25% N Poultry manure	45.24	11.17
T_6: 75% N (RDF) + 25% N Poultry manure + azotobacter	46.36	11.89
T_7: 75% N (RDF) + 25% N Vermicompost	46.52	12.14
T_8: 75% N (RDF) + 25% N V.C. + AZB	46.85	12.23
T_9: 75% P (RDF)+ 25% P P.M.	45.35	12.12
T_{10}: 75% P (RDF) + 25% P P.M. + Phosphorus solubilising bacteria	46.54	12.14
T_{11}: 75% P (RDF) + 25% P V.C	46.71	12.14
T_{12}: 75% P RDF + 25% P V.C + P.S.B.	46.81	12.15
Unfertlized(Residual)		
T_1: Control (No fertilizers)	27.23	5.12
T_2:50% N, P (RDF)	29.72	6.25
T_3:75% N, P (RDF)	31.26	7.57
T_4:100% N, P through RDF(120-60 Kg N, P_2O_5 ha^{-1})	33.27	8.84
T_5:75% N (RDF) + 25% N Poultry manure	35.25	10.23
T_6: 75% N (RDF) + 25% N Poultry manure + azotobacter	36.14	10.29
T_7: 75% N (RDF) + 25% N Vermicompost	36.54	11.25
T_8: 75% N (RDF) + 25% N V.C. + AZB	36.82	11.45
T_9: 75% P (RDF)+ 25% P P.M.	34.24	10.45
T_{10}: 75% P (RDF) + 25% P P.M. + Phosphorus solubilising bacteria	35.54	10.47
T_{11}: 75% P (RDF) + 25% P V.C	36.24	11.24
T_{12}: 75% P RDF + 25% P V.C + P.S.B.	36.52	11.25
Effect of *kharif* treatments at same levels of *rabi* treatments SEm±	0.72	0.16
CD(P=0.05)	2.10	0.47
Effect of *rabi* treatments at same or different levels of *kharif* treatments SEm±	3.86	0.62
CD(P=0.05)	NS	NS

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