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Effect of Integrated Use of Organic and Inorganic Sources of Nutrients and Biofertilizers on Soil Available Nutrients 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 available major nutrients 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 availability of nutrients, where as in *rabi* onion grown in two different situations like fertilized and unfertilized to know the cumulative and residual effect of *kharif* maize treatments on subsequent *rabi* onion crop, the results revealed that the fertilized onion recorded maximum availability of nutrients when compared to unfertilized one. With in fertilized and unfertilized onion, INM treatments showed highest availability of all major and micro nutrients as compared to other treatments

Key words : Available major and micro nutrients, Biofertilizers,Maize, Onion.

The available nutrients in the soil are greatly influenced by the nature and age of crops, microbial activity, enzymatic transformations and application of organic manures and inorganic fertilizers. Under the intensive system of agriculture, marked changes in the soil fertility are likely to occur due to high cropping intensity with high yielding varieties and high levels of nutrient input.

Use of chemical fertilizers alone may not keep pace with time in maintenance of soil health for sustaining the productivity. Addition of organic manures in any form helps in maintaining the organic matter and fertility levels in soils. The type of organic manures added and the soils involved influence considerably the rate of decomposition as well as consequent chemical changes brought about in the soil. The superiority of an organic material used will be determined by its decomposability and mineralization pattern of nutrient elements contained there in.

Though much work has been reported on the use of organic manures along with inorganic fertilizers on production of maize and onion crops individually, but no systemic investigation has been carried out on the use of organic manures along with inorganic fertilizers and biofertilizers on soil chemical properties 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 during *kharif* and *rabi* 2009-10. 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 cationic micronutrient status of the experimental soil was 9.74, 9.16, 1.25 and 1.23 mg kg^{-1} Fe, Mn, Zn and Cu respectively. The experiment was laid out in Randomized Block Design consisting of twelve treatment combinations each replicated thrice. The treatments consisted 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 grown in strip plot design, 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. 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 (Jackson,1973).

RESULTS AND DISCUSSION

The available nutrients such as N, P, K and S increased with increase in the level of N and P fertilizers up to the (Table 1) recommended level of 120 kg N and 60 kg P_2O_5 ha^{-1}. The availability of these nutrients due to the integrated nutrient management treatments was on par with inorganic sources of N and P applied at the recommended level.

The increased level of N and P application through the fertilizers increased the availability of Fe, Mn, Zn and Cu (Table 2) at the commencement of the experiment and after harvest of the crop. The available Fe, Mn, Zn and Cu were 9.75, 9.22, 1.27 and 1.25 mg kg^{-1} respectively and these micronutrients after the harvest of maize fertilized with the recommended level of 120 kg N and 60 kg P_2O_5. The integration of poultry manure or vermicompost to substitute 25% N or P with or without the addition of biofertilizers remarkably influenced the availability of these micronutrients.

The major nutrient status was reported by the application of 75% recommended level of 120 kg N and 60 kg P_2O_5 ha^{-1} while 50% recommended level of N and P was sufficient to restore the initial level of S, Fe, Mn, Zn and Cu. The application of recommended level of N and P fertilizers was adequate to sustain the soil available nutrients. The need for adequate fertilization to crop to save the soil from depletion of major and micronutrients was also reported by Anil *et al*., (2002). The substitution of 25% N or P through poultry manure or vermicompost enhanced the availability of Fe, Mn, Zn and Cu due to their posession of micronutrients, while the level of N, P, K and S was similar in the soil supplied with inorganic fertilizers. The enrichment of soil with the micronutrients due to the addition of organic manures was also confirmed by Karki *et al*., (2005), Jamwal (2006) and Kadtare (2006).

The results of the present investigation showed that the omission of external inputs of nutrients to maize in maize –onion cropping system(Table 3) reduced the soil available P_2O_5, K_2O, Fe, Mn, Zn and Cu after the harvest of onion. Thus, the quantity of 90-60-75 kg ha^{-1} N, P_2O_5, K_2O applied to onion was perhaps insufficient to meet the requirement of these nutrients. The application of 50% recommended level of N and P to maize and 75% N, P_2O_5, K_2O to onion was sufficient to sustain their level of P and K and increase the available N content in the soil. But the drain on soil available micronutrients was yet conspicuous. These high analysis fertilizers provided N and P to meet their requirement by maize crop. It is established that only 30 percent of N and 15 percent of P is utilized by the crop. Rest of the nitrogen is likely to be lost through leaching and volatilization. But the phosphorus transformation to available forms viz., Saloid-P, Fe-P, Al-P and Ca-P are useful for absorption by the succeeding crops. Therefore the cumulative influence of residual fertility from maize and direct influence of fertilizer application to onion probably met the NPK requirement of the two crops leaving the soil with out severe depletion of these nutrients. However, these high analysis fertilizers are devoid of micronutrients. Therefore the depletion of soil in Fe, Mn, Zn and Cu as compared to their values recorded before the commencement of the experiment were conspicuous.

An appreciable buildup in soil available N, P and K occurred by the application of 120 kg N and 60 kg P_2O_5 to maize and 90 kg N, 60 kg P_2O_5 and 75 kg K_2O ha^{-1} to onion while micronutrient deficiency prevailed in the soil. The soil fertility improved remarkably recording significant increase in the buildup of NP and K as well as Fe, Mn, Zn and Cu after the harvest of fertilized onion preceded by maize treated with integrated nutrient management treatments. This benefit owes to the slow decomposition and mineralization of major and minor nutrients and their addition to the soil nutrient pool left behind in sufficient quantities after their absorption by the crop.

Sulfur was the only nutrient which was not influenced by the nutrient management treatments.

Table 1. Effect of different fertility management treatments on available N, P , K and S after harvest of maize.

Treatments	Available nutrient contents (kg ha^{-1})			
	N	P_2O_5	K_2O	S
T_1: Control (No fertilizers)	180.00	20.20	370.20	11.56
T_2: 50% N, P through RDF	191.70	26.23	380.20	12.68
T_3: 75% N, P through RDF	200.14	29.10	391.30	12.69
T_4:100% N, P through RDF(120-60 Kg N, P_2O_5 ha^{-1})	218.10	32.16	398.10	12.70
T_5: 75% N through RDF + 25% N through Poultry manure	221.23	34.23	415.20	13.12
T_6: 75% N through RDF + 25% N through Poultry manure + Azotobacter	223.25	34.47	420.10	13.24
T_7: 75% N through RDF + 25% N through Vermi compost	226.38	34.27	418.90	13.25
T_8: 75% N through RDF + 25% N through V.C. + AZB	227.30	35.20	419.60	13.25
T_9: 75% P through RDF + 25% P through P.M.	222.47	36.06	418.11	13.25
T_{10}: 75% P through RDF + 25% P through P.M. + Phosphorus solubilising bacteria	223.15	37.26	420.10	13.25
T_{11}: 75% P through RDF + 25% P through V.C	224.30	35.13	419.11	13.25
T_{12}: 75% P through RDF + 25% P through V.C + P.S.B.	226.50	37.26	420.32	13.26
SEm±	6.46	1.32	10.70	0.25
CD(P=0.05)	19.07	3.92	31.59	0.74

Table 2. Effect of different fertility management treatments on available micro nutrient contents of soil after harvest of maize.

Treatments	Available nutrient contents (kg ha^{-1})			
	Fe	Mn	Zn	Cu
T_1: Control (No fertilizers)	8.71	8.87	0.93	0.89
T_2: 50% N, P through RDF	9.73	9.15	1.25	1.22
T_3: 75% N, P through RDF	9.74	9.14	1.26	1.23
T_4:100% N, P through RDF(120-60 Kg N, P_2O_5 ha^{-1})	9.75	9.22	1.27	1.25
T_5: 75% N through RDF + 25% N through Poultry manure	12.10	10.85	1.81	1.64
T_6: 75% N through RDF + 25% N through Poultry manure + Azotobacter	12.11	10.86	1.82	1.66
T_7: 75% N through RDF + 25% N through Vermi compost	12.15	10.88	1.83	1.70
T_8: 75% N through RDF + 25% N through V.C. + AZB	12.21	10.93	1.84	1.71
T_9: 75% P through RDF + 25% P through P.M.	12.02	10.85	1.83	1.69
T_{10}: 75% P through RDF + 25% P through P.M. + Phosphorus solubilising bacteria	12.12	10.92	1.83	1.70
T_{11}: 75% P through RDF + 25% P through V.C	12.13	10.85	1.83	1.70
T_{12}: 75% P through RDF + 25% P through V.C + P.S.B.	12.14	10.92	1.84	1.70
SEm±	0.04	0.03	0.02	0.03
CD(P=0.05)	0.11	0.08	0.07	0.09

Table 3. Influence of fertility management treatments in maize onion cropping system on availabel N, P_2O_5, K_2O,S and Fe, Mn, Zn and Cu contents of soil after harvest of onion.

Fertilized(cumulative)	Available nutrients (kg ha^{-1})				Available nutrients (mg kg^{-1})			
	N	P_2O_5	K_2O	S	Fe	Mn	Zn	Cu
T_1: Control (No fertilizers)	188.86	20.80	379.91	13.07	7.48	6.89	0.74	0.75
T_2:50% N, P (RDF)	197.20	28.23	418.27	13.30	7.50	7.22	0.94	1.03
T_3:75% N, P (RDF)	205.15	31.12	426.54	13.45	7.52	7.23	0.98	1.05
T_4:100% N, P through RDF(120-60 Kg N, P_2O_5 ha^{-1})	224.15	33.14	437.24	13.59	7.51	7.24	0.98	1.05
T_5:75% N (RDF) + 25% N Poultry manure	228.36	36.28	457.20	14.12	8.50	7.28	1.21	1.36
T_6: 75% N (RDF) + 25% N Poultry manure + azotobacter	234.36	36.61	462.33	14.13	8.51	7.31	1.24	1.39
T_7: 75% N (RDF) + 25% N Vermicompost	236.10	37.12	460.30	14.13	8.51	7.31	1.25	1.42
T_8: 75% N (RDF) + 25% N V.C. + AZB	238.06	40.21	462.20	14.15	8.53	7.34	1.26	1.43
T_9: 75% P (RDF)+ 25% P P.M.	226.30	38.23	460.36	14.12	8.52	7.31	1.24	1.41
T_{10}: 75% P (RDF) + 25% P P.M. + Phosphorus solubilising bacteria	230.20	38.65	460.56	14.13	8.52	7.32	1.25	1.42
T_{11}: 75% P (RDF) + 25% P V.C	234.20	38.13	462.24	14.13	8.52	7.31	1.25	1.42
T_{12}: 75% P RDF + 25% P V.C + P.S.B.	236.11	41.11	462.29	14.15	8.52	7.32	1.25	1.42
Unfertlized(Residual)								
T_1: Control (No fertilizers)	152.31	17.21	296.16	10.52	5.98	5.81	0.75	0.72
T_2:50% N, P (RDF)	158.25	21.81	304.25	10.52	6.00	5.82	0.91	0.91
T_3:75% N, P (RDF)	161.24	24.12	312.12	10.53	6.05	5.84	0.94	0.94
T_4:100% N, P through RDF(120-60 Kg N, P_2O_5 ha^{-1})	166.11	25.61	318.20	10.54	6.10	5.85	0.95	0.95
T_5:75% N (RDF) + 25% N Poultry manure	178.20	28.12	323.31	10.92	6.12	5.99	1.11	1.11
T_6: 75% N (RDF) + 25% N Poultry manure + azotobacter	179.30	28.14	323.33	10.93	6.13	6.08	1.12	1.12
T_7: 75% N (RDF) + 25% N Vermicompost	181.17	28.14	323.22	10.93	6.15	6.11	1.13	1.13
T_8: 75% N (RDF) + 25% N V.C. + AZB	185.20	29.21	325.41	10.94	6.18	6.12	1.14	1.14
T_9: 75% P (RDF)+ 25% P P.M.	176.17	28.84	323.22	10.94	6.16	6.08	1.13	1.13
T_{10}: 75% P (RDF) + 25% P P.M. + Phosphorus solubilising bacteria	177.28	29.21	324.27	10.94	6.17	6.10	1.14	1.14
T_{11}: 75% P (RDF) + 25% P V.C	180.28	28.25	324.36	10.94	6.17	6.10	1.13	1.13
T_{12}: 75% P RDF + 25% P V.C + P.S.B.	183.24	31.25	325.08	10.94	6.18	6.11	1.14	1.14
Effect of kharif treatments at same levels of rabi treatments								
SEm±	1.70	0.50	4.07	0.36	0.01	0.01	0.01	0.01
CD(P=0.05)	4.73	1.42	11.92	NS	0.03	0.03	0.03	0.03
Effect of rabi treatments at same or different levels of kharif treatments								
SEm±	8.90	2.72	22.7	2.46	0.04	0.12	0.07	0.07
CD(P=0.05)	NS	NS	NS	NS	0.12	NS	NS	NS

The cumulative influence of integrated nutrient management treatments to *kharif* crop and fertilizer application to the succeeding crop in *rabi* was also observed to have enhanced the soil available major and minor nutrients after meeting their requirement in cropping systems of maize – soybean (Reddy and Reddy, 1998), maize – wheat (Parmar and Sharma, 2001), maize – wheat (Jamwal, 2006) and okra – onion (Sharma *et al*., 2009). The depletion of major nutrients and S and four micronutrients in this investigation was severe by growing maize and onion without any external supply of nutrients. The depletion of NPK narrowed with increase in the level of N and P fertilizers up to their recommended level of 120 kg N and 60 kg P_2O_5 ha^{-1} to maize through their residual effect recorded after the harvest of onion. Still these levels could not compensate their initial values detected before the sowing of maize.

The residual fertility due to different integrated nutrient management treatments restored the soil available P to the initial level. The depletion in N, K and S was noticed. The magnitude of depletion in Fe, Mn, Zn and Cu still persisted despite narrowing this effect due to the integrated nutrient management treatments through their residual fertility. The availability of these nutrients was less than their initial values. Therefore the substitution of 25% N or P either with poultry manure or vermicompost and fertilizer application to onion is the appropriate technology to safeguard the soil health and prevent it from degradation. This technology of adding organic manure serve as a milestone of the millennium to the growing hunger requirement of micronutrients by the crops which is not possible through the practice of application of only the high analysis fertilizers.

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