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Effect of Integrated Use of Organic and Inorganic Sources of Nutrients and Biofertilizers on Drymatter Production, N, P, K , S and Micronutrient Uptake 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 yield and quality 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 the highest drymatter, N, P, K, S and micro nutrient uptake in maize grain during *kharif* season whereas experimental data on *rabi* onion grown in two different situations like fertilized and unfertilized to know the cumulative and residual effect of *kharif* maize treatments revealed that the fertilized onion produced highest drymatter, N, P, K, S and micronutrient uptake when compared to unfertilized one. With in fertilized and unfertilized onion INM treatments showed highest drymatter, N, P, K, S and micronutrient uptake compared to other treatments.

Key words : Drymatter, Maize, Nutrient uptake, Onion.

Maize (*Zea mays* L.) is one of the important food crops of India next to wheat and rice. In India, it is grown in an area of 8.17 M ha with a production of 19.7 M t and an average productivity of 1793 kg ha^{-1}(CMIE, 2010). In Andhra Pradesh, it covers an area of 0.85 M ha with a production of 3.09 M t and an average productivity of 4066 kg ha^{-1}. (CMIE, 2010)

Onion (*Allium cepa* L.) is one of the major bulbous crops of the world and one of the most important commercial vegetable crops grown in India. It occupies an area of 0.83 million hectares with a total production of 13.56 million tones with an average yield of 126.5 q ha^{-1}. In Andhra Pradesh it is grown in an area of 0.039 million hectares with a production of 0.66 million tones with an average yield 160.0 q ha^{-1} (CMIE, 2010).

Organic manures are used for substituting the inorganic fertilizer to some extent. According to principles of INM, at least 30 percent of the nutrient requirement of crop should be in organic form. Unlike N, the P has marked residual effect on the succeeding crops due to its low recovery by the first crop and its rapid conversion in to various inorganic P fractions. This indicates the possibility to economize the expenditure on phosphate fertilizers by scheduling fertilizer on crop sequence basis rather than on individual crop basis. Though much work has been reported on the use of organic manures along with inorganic fertilizers on production of maize and onion crops individually, no systemic investigation has been carried out on the use of organic manures along with inorganic fertilizers and biofertilizers on drymatter production and nutrient uptake 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 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

Table 1. Effect of different fertility management treatments on total (grain + stover) yield and nutrient uptake (kg ha^{-1}) of maize at harvest.

Treatments	Total yield (q ha^{-1})	Nitrogen	Phos-phorus	Potas-sium	Sulphur
T_1: Control (No fertilizers)	52.26	47.92	7.12	43.73	12.17
T_2: 50% N, P through RDF	70.63	66.57	11.70	62.14	16.89
T_3: 75% N, P through RDF	83.36	83.24	15.00	77.57	19.97
T_4:100% N, P through RDF(120-60 kg N, P_2O_5 ha^{-1})	93.60	97.99	18.03	88.87	23.25
T_5: 75% N through RDF + 25% N through Poultry manure	104.33	116.36	23.23	99.47	26.93
T_6: 75% N through RDF + 25% N through Poultry manure + Azotobacter	105.66	119.41	24.63	101.61	27.36
T_7: 75% N through RDF + 25% N through Vermi compost	107.56	122.28	24.60	104.96	28.45
T_8: 75% N through RDF + 25% N through V.C. + AZB	109.63	127.85	26.63	108.02	29.42
T_9: 75% P through RDF + 25% P through P.M.	105.36	118.02	24.65	101.24	27.24
T_{10}: 75% P through RDF + 25% P through P.M. + Phosphorus solubilising bacteria	108.50	123.61	26.87	105.87	28.21
T_{11}: 75% P through RDF + 25% P through V.C	106.73	120.22	24.91	104.77	27.67
T_{12}: 75% P through RDF + 25% P through V.C + P.S.B.	109.30	125.63	27.65	107.76	29.38
SEm±	2.03	3.65	1.81	3.44	2.24
CD(P=0.05)	5.99	10.78	5.35	10.16	6.62

and P through RDF(T_4) and integrated nutrient management treatments namely 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 crop is 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 of 60×20 cm (maize) and 20×10 cm (onion) and all the recommended cultural practices were followed. The maize crop was harvested at maturity i.e. at 100 days after sowing (DAS). The onion bulbs were harvested one week after 50% neck fall. The drymatter production was recorded and nutrient uptake was computed.

Table 2. Effect of different fertility management treatments on total (grain + stover) uptake of micro nutrients by maize at harvest.

Treatments	Total uptake (g ha^{-1})			
	Fe	Mn	Zn	Cu
T_1: Control (No fertilizers)	150.10	120.40	83.20	71.10
T_2: 50% N, P through RDF	213.40	173.20	113.20	97.50
T_3: 75% N, P through RDF	252.60	210.50	133.80	115.70
T_4:100% N, P through RDF(120-60 kg N, P_2O_5 ha^{-1})	293.20	239.18	153.20	131.50
T_5: 75% N through RDF + 25% N through Poultry manure	330.60	266.60	176.20	156.20
T_6: 75% N through RDF + 25% N through Poultry manure + Azotobacter	335.50	271.70	179.30	158.80
T_7: 75% N through RDF + 25% N through Vermi compost	340.10	277.76	183.30	162.90
T_8: 75% N through RDF + 25% N through V.C. + AZB	350.10	284.60	187.60	166.60
T_9: 75% P through RDF + 25% P through P.M.	335.60	272.80	177.40	158.40
T_{10}: 75% P through RDF + 25% P through P.M. + Phosphorus solubilising bacteria	345.30	280.90	183.20	163.80
T_{11}: 75% P through RDF + 25% P through V.C	339.70	276.20	181.40	160.20
T_{12}: 75% P through RDF + 25% P through V.C + P.S.B.	348.6	283.20	186.80	165.33
SEm±	8.40	7.56	6.50	5.56
CD(P=0.05)	24.79	22.34	19.21	16.43

RESULTS AND DISCUSSION

Drymatter production and nutrient uptake by maize

Dry matter content of maize and the uptake of N and K reduced significantly with successive reduction in the level of N and P fertilizers to 75%, 50% and to control, The total uptake of P and S were significantly low in unfertilized maize. The total dry matter of maize increased significantly by the integrated nutrient management treatments as compared to fertilizer application. Similarly, the substitution of 25% N or P with poultry manure or vermicompost with or without the addition of biofertilizers were more effective to increase the total uptake of N, P and K by maize as compared to its inorganic fertilization. But, the effect of these integrated nutrient management treatments did not differ significantly from the inorganic source of fertilization for the total uptake of S (Table 1.).

The unfertilized crop possessed 150.10 g ha^{-1} Fe. The total uptake of this element increased significantly (Table 2) by the application of 50% N and P while it raised further to 250.60 g ha^{-1} by the application of 75% N and P fertilizers. The uptake increased to 293.20 g ha^{-1} by the application of recommended level of 120, 60 kg ha^{-1} N and P_2O_5 respectively. The integrated nutrient management treatments were more effective to increase the uptake of these micronutrients than inorganic fertilizers. The total uptake of Mn and Zn also recorded similar trend. The uptake of Mn by unfertilized maize was 120.40 g ha^{-1} and it increased to 239.18 g ha^{-1} by the application of recommended level of fertilizers, The integrated nutrient management treatments enabled the crop to remove further larger quantities of 266.60 to 284.60 g Mn ha^{-1}. The uptake of Zn was 83.20 g ha^{-1} by the unfertilized maize, It increased to 153.20 g ha^{-1} by the application if recommended level of N and P fertilizers, The crop raised with integrated nutrient management treatments recorded significant increase in the uptake of this micro nutrient compared to the crop fertilized with recommended level of N and P. The uptake of Cu increased to 131.50 g ha^{-1} due to the application of recommended level of fertilizers compared to the uptake of 71.10 g ha^{-1} by the unfertilized maize. The uptake of this micronutrient recorded a significant increase due to the integrated nutrient management treatments than the inorganic source

Table 3. Influence of fertility management treatments in maize onion cropping system on total (leaf + bulb) dry matter, N, P, K , S and Fe, Mn, Zn and Cu uptake of onion at harvest.

Fertilized (cumulative)	Total drymatter (q ha^{-1})	Total uptake (kg ha^{-1})				Total uptake (gha^{-1})			
		N	P	K	S	Fe	Mn	Zn	Cu
T_1: Control (No fertilizers)	47.88	108.15	7.23	113.43	32.02	71.33	69.68	79.10	16.54
T_2:50% N, P (RDF)	49.65	118.32	7.67	117.66	34.08	73.09	72.25	82.02	17.32
T_3:75% N, P (RDF)	49.88	119.07	8.14	118.48	34.91	73.77	72.63	82.41	17.26
T_4:100% N, P through RDF(120-60 kg N, P_2O_5 ha^{-1})	50.36	125.67	8.45	120.33	35.51	75.43	73.39	83.25	18.28
T_5:75% N (RDF) + 25% N Poultry manure	53.51	135.71	11.94	133.26	41.50	81.00	81.46	91.89	18.63
T_6: 75% N (RDF) + 25% N Poultry manure + azotobacter	54.58	137.70	12.72	136.16	42.55	84.44	83.09	93.72	20.16
T_7: 75% N (RDF) + 25% N Vermicompost	55.90	141.12	14.29	140.68	44.15	87.16	85.11	95.81	20.62
T_8: 75% N (RDF) + 25% N V.C. + AZB	57.30	145.17	14.47	145.32	45.82	90.70	87.29	98.47	21.43
T_9: 75% P (RDF)+ 25% P P.M.	54.03	136.53	12.82	134.65	41.53	82.54	82.27	92.77	19.97
T_{10}: 75% P (RDF) + 25% P P.M. + Phosphorus solubilising	55.18	139.40	13.81	138.08	43.26	85.36	84.01	94.78	20.66
bacteria	55.20	138.20	13.75	138.93	43.33	86.31	84.05	94.78	20.88
T_{11}: 75% P (RDF) + 25% P V.C	56.46	142.68	15.77	142.81	44.63	88.21	86.94	97.14	20.68
T_{12}: 75% P RDF + 25% P V.C + P.S.B.	29.24	54.33	5.07	58.80	15.06	34.73	41.30	46.14	9.68
Unfertlized(Residual)	32.96	63.35	5.73	66.16	19.52	38.53	46.64	50.59	10.68
T_1: Control (No fertilizers)	33.20	64.11	5.77	66.93	20.00	38.81	46.98	50.90	10.78
T_2:50% N, P (RDF)	34.10	66.25	5.92	68.85	20.86	40.17	48.26	52.21	11.07
T_3:75% N, P (RDF)	35.55	70.42	6.99	73.09	23.18	42.10	50.97	56.88	11.92
T_4:100% N, P through RDF(120-60 kg N, P_2O_5 ha^{-1})	35.85	71.78	7.23	73.93	23.63	42.34	51.42	56.80	12.02
T_5:75% N (RDF) + 25% N Poultry manure	35.72	71.36	7.01	74.18	23.79	42.58	51.27	57.40	11.98
T_6: 75% N (RDF) + 25% N Poultry manure + azotobacter	36.37	73.26	7.67	75.76	24.90	43.10	52.20	58.71	12.24
T_7: 75% N (RDF) + 25% N Vermicompost	35.68	70.88	7.27	73.79	23.79	42.29	51.21	57.45	12.00
T_8: 75% N (RDF) + 25% N V.C. + AZB	36.02	71.58	7.19	74.91	24.15	42.58	51.69	57.93	12.08
T_9: 75% P (RDF)+ 25% P P.M.	35.45	70.14	6.97	73.34	23.61	42.09	50.88	56.85	11.88
T_{10}: 75% P (RDF) + 25% P P.M. + Phosphorus solubilising	36.10	71.86	7.74	75.13	24.40	42.86	51.91	62.47	12.18
bacteria	0.36	1.18	0.43	1.27	0.70	1.00	0.64	0.79	0.35
T_{11}: 75% P (RDF) + 25% P V.C	1.03	3.45	1.25	3.72	2.05	2.93	1.87	2.31	1.02
T_{12}: 75% P RDF + 25% P V.C + P.S.B.	2.55	6.22	2.44	6.72	4.39	7.56	4.00	4.56	1.11
Effect of kharif treatments at same levels of rabi treatments	NS	NS	NS	NS	NS	NS	NS	NS	NS
SEm±									
CD(P=0.05)									
Effect of rabi treatments at same or different levels of kharif treatments SEm±									
CD(P=0.05)									

of nutrient supply. The increase in uptake of nutrients was due to increase in dry matter and nutrient concentrations. Similar results were made by Parmar and Vinod Sharma(2001), Jat and Balyan (2004) and Chandrapala *et al*.(2010).

Drymatter Production and nutrient uptake by Onion

The total dry matter content (Table 3) of onion was 47.88 q ha^{-1} due to the direct influence of fertilizer application. It increased significantly due to the cumulative influence of different levels of fertilizer application to maize and fertilizers applied at 75% of the recommended level of NPK to onion. The crop produced 50.36 q ha^{-1} dry matter due to the cumulative effect of recommended level of N and P fertilizer application to maize and 75% recommended level of NPK to onion.

The cumulative effects of integrated nutrient management treatments to maize and fertilizer application to onion were significantly superior to fertilizer application to both the crops. The unfertilized onion produced low dry matter content in all the treatments. It produced total dry matter of 29.24 q ha^{-1} in the unfertilized cropping system. The residual fertility through the application of recommended level of N and P fertilizers to maize significantly increased the total dry matter to 34.10 q ha^{-1}.

The residual fertility through different integrated nutrient management treatments was significantly superior to the inorganic fertilizer application to maize. It increased the total dry matter of onion. The uptake of nutrients by the onion crop increased by the application of fertilizers both to maize and onion in the cropping system. The crop removed 108.15 kg N, 7.23 kg P, 113.43 kg K and 32.02 kg S per hectare in response to the direct effect of fertilizer application only to this crop. The nutrient uptake increased significantly to 125.67 kg N, 8.45 kg P, 120.33 kg K and 35.51 kg S per hectare due to the cumulative effect of fertilizer application to both the crops. The uptake of micro nutrients also exhibited a similar response to the cumulative over the direct influence of fertilizer application. The uptake was 71.33 g Fe, 69.68 g Mn, 79.10g Zn and 16.54 g Cu per hectare in the fertilized onion without any fertilizer application to the preceding maize. The uptake of the corresponding micronutrients increased significantly to 75.43, 73.39, 83.25 and 18.28 g ha^{-1} due to the cumulative influence of fertilizer application to both the crops.

The uptake of N, P, K and S and micronutrients Fe, Mn, Zn and Cu increased significantly over the uptake due to the cumulative influence of fertilizers applied to maize and onion. The residual effect of fertilizer application to maize significantly increased the N, K, S, Fe, Mn, Zn and Cu uptake by the onion crop.

The residual fertility due to integrated nutrient management treatments was significantly superior to the effect of fertilizers, in increasing the total uptake of N, P, K, S, Mn and Zn. The response pattern due to the cumulative and residual effect of integrated nutrient management treatments was on par with the residual effect compared to the inorganic fertilizer application on the dry matter and nutrient uptake. Similar results were also reported by (Reddy and Reddy, 1998) in maize-soybean cropping system.

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