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Effect of Integrated use of Organic and Inorganic Sources of Nutrients and Biofertilizers on Yield and Quality 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% Recomended Dose of Fertilizers along with 25% N or P substituted through vermicompost or poultry manure with addition of azotobacter or phosphorus solubilising bacteria recorded highest grain yield, protein percent, protein yield, oil content and oil yield in maize grain during kharif season 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 produced highest bulb yield when compared to unfertilized one. With in fertilized and unfertilized onion INM treatments showed highest bulb yield compared to other treatments. Quality parameters like total soluble solids and total sugars did not exhibit an appreciable change in the present investigation.

Key words : Maize, Oil, Onion, Protein, Total sugars, Yield.

Maize 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 with 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 into various inorganic P fractions. This indicates the possibility to economize the expenditure on phosphate fertilizers on 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, but no systemic investigation has been carried out on the use of organic manures along with inorganic fertilizers and biofertilizers on yield and quality parameters in maize – onion cropping system.

MATERIAL AND METHODS

A field experiment was conducted during *kharif* (maize) and *rabi* (onion) on Alfisols at college farm, college of agriculture, Rajendranagar, Hyderabad. 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 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

Table 1. Effect of different fertility management treatments on grain yield, protein and oil content(%) in maize.

Treatments	Grain Yield (q ha^{-1})	Protein content(%)	Oil content(%)
T_1: Control (No fertilizers)	27.26	7.5	7.4
T_2: 50% N, P through RDF	34.23	7.8	7.4
T_3: 75% N, P through RDF	39.16	8.3	7.5
T_4:100% N, P through RDF(120-60 Kg N, P_2O_5 ha^{-1})	43.10	8.3	7.0
T_5: 75% N through RDF + 25% N through Poultry manure	50.23	8.6	7.4
T_6: 75% N through RDF + 25% N through Poultry manure + Azotobacter	51.26	8.8	7.3
T_7: 75% N through RDF + 25% N through Vermi compost	52.26	8.8	7.3
T_8: 75% N through RDF + 25% N through V.C. + AZB	53.23	9.0	7.0
T_9: 75% P through RDF + 25% P through P.M.	50.26	8.8	7.1
T_{10}: 75% P through RDF + 25% P through P.M. + Phosphorus solubilising bacteria	52.20	8.8	7.4
T_{11}: 75% P through RDF + 25% P through V.C	51.53	8.8	7.0
T_{12}: 75% P through RDF + 25% P through V.C + P.S.B.	53.10	8.8	7.1
SEm±	1.41	0.14	0.49
CD(P=0.05)	4.18	0.42	N.S.

vermicompost (T_{11}), 75% P through RDF + 25% P through vermicompost + phosphorus solubulising bacteria (T_{12}).In *rabi* (onion) 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 fallowed. The crop was harvested at maturity i.e. at 100 days after sowing (DAS). The seed samples were analysed for nitrogen content by micro kjeldhal method and the nitrogen content was multiplied with the factor 6.25 to get crude protein content in the seed (Walinga *et al*., 1989). Oil content in the seed was estimated by Nuclear Magnetic Resonance Spectroscopy Technique (Tiwari *et al*., 1974).

Fresh onion bulbs were analysed for quality parameters following standard procedures.Total soluble solids present in bulbs were determined with the help of "Erma" hand refractometer (range: 0-32%) and expressed in per cent. Total sugars were estimated by Lane and Eynon method given by Ranganna (1994) and expressed in per cent.

RESULTS AND DISCUSSION

Grain yield:

The results showed that the crop was highly sensitive to the reduction in level of N and P fertilizers by 50% of their recommended level. The crop fertilized with the recommended level of 120 kg N and 60 kg P_2O_5 per hectare produced 43.10 q ha^{-1}grain. It reduced to 34.23 q ha^{-1} by the application of 50% of these nutrients through the fertilizers(Table 1.). The crop grown without the application of these nutrients produced extremely low yield of 27.26 q ha^{-1}. The substitution of 25% N through poultry manure or vermicompost with or without the addition of azotobacter increased the grain yield significantly. Such an yield advantage was also recorded by the substitution of 25% P fertilizer through the poultry manure or vermicompost with or without the addition of phosphorus solubilising bacteria. Grain yield

Table 2. Influence of fertility management treatments in maize onion cropping system on bulb yield and quality parameters of onion at harvest .

Treatments	Bulb yield (t ha^{-1})	TSS(%)	Total sugars(%)
Fertilized (cumulative)			
T_1: Control (No fertilizers)	10.84	8.84	8.34
T_2:50% N, P (RDF)	11.56	8.85	8.35
T_3:75% N, P (RDF)	12.45	8.85	8.34
T_4:100% N, P through RDF(120-60 Kg N, P_2O_5 ha^{-1})	12.65	8.91	8.40
T_5:75% N (RDF) + 25% N Poultry manure	12.69	9.21	9.12
T_6: 75% N (RDF) + 25% N Poultry manure + azotobacter	12.71	9.24	9.13
T_7: 75% N (RDF) + 25% N Vermicompost	12.74	9.24	9.15
T_8: 75% N (RDF) + 25% N V.C. + AZB	12.79	9.28	9.16
T_9: 75% P (RDF)+ 25% P P.M.	12.72	9.26	9.14
T_{10}: 75% P (RDF) + 25% P P.M. + Phosphorus solubilising bacteria	12.74	9.26	9.14
T_{11}: 75% P (RDF) + 25% P V.C	12.73	9.26	9.14
T_{12}: 75% P RDF + 25% P V.C + P.S.B.	12.74	9.27	9.15
Unfertlized (Residual)			
T_1: Control (No fertilizers)	8.56	6.30	6.62
T_2:50% N, P (RDF)	8.65	7.30	7.40
T_3:75% N, P (RDF)	8.87	7.32	7.35
T_4:100% N, P through RDF(120-60 Kg N, P_2O_5 ha^{-1})	8.94	7.40	7.39
T_5:75% N (RDF) + 25% N Poultry manure	9.01	7.92	7.52
T_6: 75% N (RDF) + 25% N Poultry manure + azotobacter	9.24	8.02	7.53
T_7: 75% N (RDF) + 25% N Vermicompost	9.28	9.02	7.65
T_8: 75% N (RDF) + 25% N V.C. + AZB	9.31	9.10	8.00
T_9: 75% P (RDF)+ 25% P P.M.	9.26	8.11	7.61
T_{10}: 75% P (RDF) + 25% P P.M. + Phosphorus solubilising bacteria	9.28	8.16	7.65
T_{11}: 75% P (RDF) + 25% P V.C	9.28	9.00	7.59
T_{12}: 75% P RDF + 25% P V.C + P.S.B.	9.25	9.02	7.62
Effect of kharif treatments at same levels of rabi treatments			
SEm±	0.08	0.36	0.28
CD(P=0.05)	0.24	1.05	NS
Effect of rabi treatments at same or different levels of rabi treatments			
SEm±	0.49	2.07	1.85
CD(P=0.05)	NS	NS	NS

exceeded 50 q ha^{-1} in response to these integrated nutrient management treatments, recording about 7 q ha^{-1} additional production compared to the yield obtained by feeding the crop through inorganic N and P.

The productivity of the grain increased significantly. The enhanced availability of major and minor nutrients due to the combined supply of organic or inorganic nutrient sources significantly increased the grain yield compared to the inorganic fertilization. Therefore it is logical to infer that the substitution of 25% N or P with poultry manure or vermicompost is desirable to ensure both the food grain and nutritional security. The usefulness of integrated nutrient supply over chemical fertilizers alone was also reported by Karki *et al*., (2005).

Protein content (%)

Maize seed had 8.3% protein by fertilizing the crop with the recommended level of 120 kg N and 60 kg P_2O_5 per hectare. The application of 75% of these nutrients did not reduce the protein percent. Significant reduction in protein percent was recorded by growing the crop without the application of N and

P fertilizers or their application at 50% of the recommended level (Table 1).

Improvement in the protein content is the most desirable feature to reduce the malnutrition in man and animal. The results confirmed that the application of recommended level of 120 kg N, 60 kg P_2O_5 ha^{-1} increased the concentration of proteins in the maize grain significantly from 7.5% in the unfertilized crop to 8.3%.The integrated nutrient management treatments were beneficial than the inorganic fertilizers. They enriched the maize grain with protein.

Oil content(%)

The maize kernel had 7.0 to 7.5% oil content. This was not influenced by the application of fertilizers or the integrated nutrient management treatments (Table 1).The exploitation of edible oil from endosperm of maize grain is gaining popularity amongst several research workers to meet the domestic requirement and bridge the gap of import (Sorte *et al*., 2005).

Cumulative and residual fertility of maize crop on onion bulb yield

In rabi (onion), the influence of cumulative and residual fertility due to different nutrient management treatments in maize on the production of bulbs and quality of fertilized and unfertilized onion is presented in Table 2. Mean bulb yield of 10.84 t ha^{-1} onion was realized due to the direct influence of 75% recommended level of N PK applied to onion in the maize - onion cropping system. The cumulative effect due to different levels of N and P fertilizer application to maize and 75% NPK to onion increased the bulb yield significantly. The recommended level of N and P fertilizers to maize significantly increased the bulb yield of fertilized onion to 12.65 t ha^{-1}. The difference in bulb yield was not significant due to variation in the source of nutrients applied to maize. The yield was on par both due to inorganic as well as integrated nutrient management treatments to maize and fertilizer application to onion.

The unfertilized onion produced mean bulb yield of 8.56 t ha^{-1}. The residual effect of 75 or 100% N and P fertilizers to the preceding maize crop had a significant influence on the bulb yield of onion. The yield increased to 8.87 and 8.94 t ha^{-1} through these residual effects. The integrated nutrient management treatments were superior to inorganic fertilizer application to maize. The bulb yield increased significantly due to these integrated nutrient management treatments over fertilizer application to maize.

Cumulative and residual fertility of maize crop on onion quality parameters

The quality of onion measured in terms of total soluble solids and total sugars did not differ significantly due to the cumulative influence of fertilizer application both to maize and onion compared to the direct effect of fertilizer application only to onion. The cumulative influence of integrated nutrient management verses inorganic fertilizer application to maize also did not change the total soluble solids or total sugars of the fertilized onion (Table 2).

The residual effects of fertilizer application or integrated nutrient management treatments were more pronounced on the total soluble solids compared to total sugars than unfertilized onion. The total soluble solids of the bulbs in the unfertilized crop was 6.30%. The residual fertility due to the application of recommended level of N and P fertilizers to maize significantly improved the total soluble solids to 7.40%. But, the total sugars were not influenced by the residual fertility. The substitution of 25% fertilizer N or P with vermicompost significantly increased the total soluble solids percent compared to the residual fertility through N and P fertilizers applied to maize. But, the total sugars did not change. The response pattern due to the cumulative or residual influence of integrated nutrient management and fertilizer treatments to maize were similar on the fertilizer and unfertilized onion for bulb yield, total soluble solids as well as total sugars.

Among the quality parameters, total soluble solids and total sugars are important to improve the keeping quality of onion (Patel and Patel, 1990). But quality of bulbs in terms of total soluble solids and total sugars did not exhibit an appreciable change in the present investigation. The bulb yield, total soluble solids and total sugars did not show further improvement due to the integrated nutrient management treatments than the inorganic fertilization to maize. The residual effect of N and P fertilizers applied to maize significantly increased the bulb yield and TSS percent of the unfertilized onion. Unlike the cumulative effect the influence of integrated nutrient management treatments was markedly noticed. The bulb yield of unfertilized onion recorded a significant increase due to the residual effect of integrated nutrient management treatments than the fertilizer application alone to maize in the

preceding season. The TSS percent increased significantly due to the substitution of either 25% N or P with vermicompost but not poultry manure. Therefore, the substitution of 25% N or P with this organic manure is likely to preserve onion for a relatively longer time ensuring a better keeping quality than those harvested from the residual fertility of fertilizers applied to maize.

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