The Andhra Agric. J 59(4): 574-579, 2012

Effect of Integrated Use of Organic and Inorganic Sources of Nutrients and Biofertilizers on Soil Physical and Physico-Chemical Properties 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 physical and physico-chemical properties 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 improved the water holding capacity but did not effect significantly on bulk density, hydraulic conductivity, pH, EC and organic carbon content of the soil. 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 there were no remarkable changes in soil bulk density, pH and EC but slight improvement in water holding capacity and hydraulic conductivity were observed with cumulative effect of integrated nutrient management treatments to maize and fertilizer application to onion. The organic carbon content reduced sharp.

Key words : Biofertilizers, Maize, Onion, Physical and physico-chemical properties.

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).

In recent years chemical fertilizers have played significant role in providing nutrients for intensive crop production. Continuous and indiscriminate use of high analysis fertilizers has resulted in several physical and physico- chemical problems such as acidity, alkalinity etc,(Chhonkar,1995). To maintain better soil quality it is compulsory to go integrating all the resources of nutrients in a proper manner to get good yields without affecting the quality of soil.

Though much work has been reported on the use of organic manures along with inorganic fertilizers on production of maize and onion individually, but no systemic investigation has been carried out on the use of organic manures along with inorganic fertilizers and biofertilizers on soil physical and physico-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. The experimental soil was sandy loam with bulk density 1.56 Mg m^{-3}, hydraulic conductivity 2.17 cm h^{-1}, water holding capacity 22.8%, 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}). 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 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* (onion) 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 of nutrients and biofertilizers were applied at the time of field preparation. The soil samples were collected after harvest of each crop and analyzed for physical and physico-chemical properties by following standard methods.

RESULTS AND DISCUSSION :

The results showed that the bulk density was 1.56 Mg m^{-3} before sowing the crop. After the harvest of maize it ranged from 1.50 to 1.54 Mg m^{-3} and there were no significant differences due to the treatments.

The hydraulic conductivity was 2.17 cm h^{-1} before sowing the crop. After the harvest it ranged from 2.16 to 2.23 cm h^{-1} in field plots treated with different inorganic and integrated nutrient supply systems. The differences were not significant.

The water holding capacity of soil was 22.8% before the commencement of the experiment. The unfertilized soil and that receiving 50, 75 or 100% recommended level of N and P through the fertilizers had a similar water holding capacity of 22 to 22.06%.The soil held relatively more moisture content ranging from 24.03 to 26.16% due to the integrated nutrient management treatments. This improvement was significant.

The soil had 7.28 pH before sowing the crop. After the harvest, it ranged from 7.24 to 7.26. Therefore this property was not influenced by any of the fertilized treatments or their substitution by 25% N or P through the poultry manure or vermicompost. The EC was 0.22 dS m^{-1} before sowing the crop. After the harvest, it ranged from 0.23 to 0.26 dS m^{-1}. None of the treatments had a remarkable influence on this property. The organic carbon content of the soil was 0.49% before the commencement of the experiment, None of the treatments exhibited a remarkable change in this property. After the harvest of the crop, the organic carbon ranged from 0.48 to 0.52% due to different treatments.

The substitution of 25% N and P with poultry manure or vermicompost, while supplementing nitrogen with azotobacter and phosphorus with phosphorus solubilising bacteria showed a spectacular response over the use of inorganic fertilizers. The tendency to reduce the bulk density and hydraulic conductivity due to the addition of organic manures was not significant only after one season in the present investigation. The influence on pH, electrical conductivity and organic carbon were also not significantly different from the soil treated with the inorganic fertilizers or unfertilized control. However, the water holding capacity increased significantly due to the addition of organic materials. The changes in the physical properties are a slow process and are mainly dependent on the quality of organic manure added and time of its decomposition. Yet, the overall influence of slight reduction in bulk density and hydraulic conductivity and improvement in organic carbon content of the soil might have created a congenial substrata in the rhizosphere for increased availability of the nutrients. The practice of applying poultry manure and vermicompost is blended with several advantages. The organic manures improve the soil aggregation, reduce the bulk density, improve the porosity and aeration, hydraulic conductivity and water holding capacity (Bellaki *et al.,*1992., Sheeba and Chellamuthu, 1996., Santhy *et al.,*1999., Mathan, 2000 and Selvi *et al.,*2005). They are also documented to be good substrata for the rapid microbial activity to feed on the nitrogen (Tumbare and Pawar, 2003) and thereby reduce the C:N ratio (Babhulkar *et al*., 2000). These characteristics help in better root growth which in turn utilize the moisture and nutrients from relatively larger surface area and more efficiently.

After harvest of onion crop the bulk density of soil was more due to the cumulative influence than the residual effect of treatments, while the reverse was true for hydraulic conductivity and water holding

Table 1. Effect of different fertility management treatments on physical properties of soil after harvest of maize (Field experiment during *kharif*,2009)

Treatments	BD (Mg m^{-3})	HC (cm h^{-1})	WHC (%)
T_1: Control (No fertilizers)	1.54	2.16	22.00
T_2: 50% N, P through RDF	1.54	2.17	22.00
T_3: 75% N, P through RDF	1.53	2.17	22.03
T_4:100% N, P through RDF(120-60 Kg N, P_2O_5 ha^{-1})	1.53	2.18	22.06
T_5: 75% N through RDF + 25% N through Poultry manure	1.51	2.20	24.03
T_6: 75% N through RDF + 25% N through Poultry manure + Azotobacter	1.51	2.21	24.10
T_7: 75% N through RDF + 25% N through Vermi compost	1.50	2.21	25.06
T_8: 75% N through RDF + 25% N through V.C. + AZB	1.50	2.22	26.16
T_9: 75% P through RDF + 25% P through P.M.	1.51	2.21	25.00
T_{10}: 75% P through RDF + 25% P through P.M. + Phosphorus solubilising bacteria	1.51	2.22	26.00
T_{11}: 75% P through RDF + 25% P through V.C	1.50	2.21	26.00
T_{12}: 75% P through RDF + 25% P through V.C + P.S.B.	1.50	2.22	26.10
SEm±	0.02	0.03	0.59
CD(P=0.05)	N.S.	N.S.	1.74

Table 2. Effect of different fertility management treatments on soil physico-chemical properties in soil after harvest of maize (Field experiment during *kharif*,2009)

Treatments	pH	EC(d Sm^{-1})	OC (%)
T_1: Control (No fertilizers)	7.26	0.23	0.48
T_2: 50% N, P through RDF	7.26	0.25	0.49
T_3: 75% N, P through RDF	7.26	0.25	0.50
T_4:100% N, P through RDF(120-60 Kg N, P_2O_5 ha^{-1})	7.25	0.25	0.51
T_5: 75% N through RDF + 25% N through Poultry manure	7.25	0.25	0.51
T_6: 75% N through RDF + 25% N through Poultry manure + Azotobacter	7.25	0.26	0.51
T_7: 75% N through RDF + 25% N through Vermi compost	7.24	0.26	0.51
T_8: 75% N through RDF + 25% N through V.C. + AZB	7.24	0.26	0.52
T_9: 75% P through RDF + 25% P through P.M.	7.25	0.25	0.51
T_{10}: 75% P through RDF + 25% P through P.M. + Phosphorus solubilising bacteria	7.25	0.26	0.51
T_{11}: 75% P through RDF + 25% P through V.C	7.25	0.26	0.50
T_{12}: 75% P through RDF + 25% P through V.C + P.S.B.	7.25	0.26	0.51
SEm±	0.01	0.01	0.01
CD(P=0.05)	N.S.	N.S.	N.S.

Table 3. Influence of fertility management treatments in maize onion cropping system on physical properties of soil after harvest of onion .

Fertilized(cumulative)	Bulk density (Mg m^{-3})	Hydraulic conductivity (cm h^{-1})	Water holding capacity (%)
T_1: Control (No fertilizers)	1.56	2.14	21.20
T_2:50% N, P (RDF)	1.54	2.17	21.30
T_3:75% N, P (RDF)	1.55	2.14	22.07
T_4:100% N, P through RDF(120-60 Kg N, P_2O_5 ha^{-1})	1.55	2.15	23.17
T_5:75% N (RDF) + 25% N Poultry manure	1.52	2.19	23.20
T_6: 75% N (RDF) + 25% N Poultry manure + azotobacter	1.52	2.15	23.20
T_7: 75% N (RDF) + 25% N Vermicompost	1.52	2.18	23.21
T_8: 75% N (RDF) + 25% N V.C. + AZB	1.52	2.26	23.21
T_9: 75% P (RDF)+ 25% P P.M.	1.52	2.20	23.30
T_{10}: 75% P (RDF) + 25% P P.M. + Phosphorus solubilising bacteria	1.53	2.20	23.21
T_{11}: 75% P (RDF) + 25% P V.C	1.53	2.21	23.21
T_{12}: 75% P RDF + 25% P V.C + P.S.B.	1.53	2.24	23.20
Unfertlized(Residual)			
T_1: Control (No fertilizers)	1.59	2.12	20.30
T_2:50% N, P (RDF)	1.58	2.12	20.30
T_3:75% N, P (RDF)	1.58	2.09	21.10
T_4:100% N, P through RDF(120-60 Kg N, P_2O_5 ha^{-1})	1.58	2.12	21.10
T_5:75% N (RDF) + 25% N Poultry manure	1.57	2.10	21.30
T_6: 75% N (RDF) + 25% N Poultry manure + azotobacter	1.57	2.10	21.30
T_7: 75% N (RDF) + 25% N Vermicompost	1.56	2.15	22.10
T_8: 75% N (RDF) + 25% N V.C. + AZB	1.56	2.11	22.20
T_9: 75% P (RDF)+ 25% P P.M.	1.57	2.14	22.07
T_{10}: 75% P (RDF) + 25% P P.M. + Phosphorus solubilising bacteria	1.56	2.14	21.30
T_{11}: 75% P (RDF) + 25% P V.C	1.56	2.15	22.10
T_{12}: 75% P RDF + 25% P V.C + P.S.B.	1.56	2.15	22.13
Effect of kharif treatments at same levels of rabi treatments SEm±	0.01	0.01	0.46
CD(P=0.05)	NS	0.03	1.29
Effect of rabi treatments at same or different levels of kharif treatments SEm±	0.12	0.09	2.53
CD(P=0.05)	NS	NS	NS

capacity. Initially the soil had bulk density of 1.56 Mg m^{-3}, hydraulic conductivity of 2.17 cm h^{-1} and water holding capacity of 22.8%. There were no substantial changes in the bulk density of soil due to the direct, cumulative or residual effect of fertilizer and integrated nutrient management treatments.

The hydraulic conductivity tended to improve due to the cumulative effect of integrated nutrient management treatments by the substitution of 25% P with poultry manure or vermicompost for maize and fertilizer application to onion. The residual fertility effect was not substantial.

The water holding capacity of soil 21.2% due to the direct effect of fertilizer application to onion, it raised to 23.17% due to the cumulative influence of fertilizer application to both the crops. The integrated nutrient management treatments to maize were similar in effect. There were no substantial differences in the water holding capacity to the residual effect of different treatments to maize.

Table 4.Influence of fertility management treatments in maize onion cropping system on physico chemical properties of soil after harvest of onion .(Field experiment *rabi*,2009-10)

Fertilized(cumulative)	pH	EC (dSm^{-1})	OC(%)
T_1: Control (No fertilizers)	7.33	0.22	0.37
T_2:50% N, P (RDF)	7.32	0.21	0.37
T_3:75% N, P (RDF)	7.33	0.22	0.38
T_4:100% N, P through RDF(120-60 Kg N, P_2O_5 ha^{-1})	7.32	0.21	0.38
T_5:75% N (RDF) + 25% N Poultry manure	7.29	0.23	0.40
T_6: 75% N (RDF) + 25% N Poultry manure + azotobacter	7.29	0.23	0.41
T_7: 75% N (RDF) + 25% N Vermicompost	7.26	0.23	0.41
T_8: 75% N (RDF) + 25% N V.C. + AZB	7.26	0.23	0.41
T_9: 75% P (RDF)+ 25% P P.M.	7.25	0.25	0.40
T_{10}: 75% P (RDF) + 25% P P.M. + Phosphorus solubilising bacteria	7.26	0.21	0.41
T_{11}: 75% P (RDF) + 25% P V.C	7.26	0.24	0.41
T_{12}: 75% P RDF + 25% P V.C + P.S.B.	7.26	0.23	0.41
Unfertlized(Residual)			
T_1: Control (No fertilizers)	7.40	0.20	0.32
T_2:50% N, P (RDF)	7.42	0.22	0.33
T_3:75% N, P (RDF)	7.38	0.24	0.33
T_4:100% N, P through RDF(120-60 Kg N, P_2O_5 ha^{-1})	7.44	0.25	0.34
T_5:75% N (RDF) + 25% N Poultry manure	7.30	0.23	0.35
T_6: 75% N (RDF) + 25% N Poultry manure + azotobacter	7.32	0.24	0.36
T_7: 75% N (RDF) + 25% N Vermicompost	7.30	0.23	0.36
T_8: 75% N (RDF) + 25% N V.C. + AZB	7.29	0.23	0.36
T_9: 75% P (RDF)+ 25% P P.M.	7.28	0.22	0.35
T_{10}: 75% P (RDF) + 25% P P.M. + Phosphorus solubilising bacteria	7.30	0.23	0.35
T_{11}: 75% P (RDF) + 25% P V.C	7.29	0.22	0.36
T_{12}: 75% P RDF + 25% P V.C + P.S.B.	7.29	0.22	0.36
Effect of kharif treatments at same levels of rabi treatments SEm±	0.03	0.01	0.02
CD(P=0.05)	0.09	NS	NS
Effect of rabi treatments at same or different levels of kharif treatments SEm±	0.20	0.04	0.06
CD(P=0.05)	NS	NS	NS

Initially the soil was neutral with 7.28 pH, normal salt content with EC of 0.22 dS m^{-1} and low in the fertility status with 0.49% organic carbon. There was no remarkable change in the pH or EC of the soil due to different treatments. The organic carbon content reduced sharp, due to the cumulative effect of both the fertilizers and integrated nutrient management treatments to maize after the harvest of fertilized onion. The organic carbon content reduced further in the soil grown with unfertilized onion.

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(Received on 19.09.2011 and revised on 25.10.2011)