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Research Paper :

Effect of biofertilizers on crop yield and soil available nutrients of rice and maize in alfisols of Nagarjuna Sagar left canal command area of Andhra Pradesh, India

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ABSTRACT

On farm field experiment with the participation of farmers the effect of biofertilizers on soil fertility and crop yield of rice and maize was studied in Alfisols during *Kharif* 2006 and *Rabi* 2006-07, respectively at Pilot area Ganapavaram of Nagarjuna Sagar Project left canal command under area located in Kodad mandal of Nalgonda district, Andhra Pradesh was conducted in A.P. Water Management Project affiliated to Acharya N.G. Ranga Agricultural University, Hyderabad. In rice the high yield was observed in RDF + application of biofertilizers (6800 kg ha^{-1}) followed by Farmers practice (6600 kg ha^{-1}). Similarly in maize the high yield was recorded in RDF + biofertilizers (6500 kg ha^{-1}) followed by 6150 kg ha^{-1} in 25% low RDF + bio fertilizers. There was no difference in pH when compared to initial soil status but there is slight decrease in EC. The change in organic carbon content was more in rice treatments than maize, the OC content was decreased in all treatments when compared to initial status. Increasing the availability of N was more in RDF + Biofertilizers followed by farmers practice in *Kharif* rice and decreased in 25% low RDF + Biofertilizers and RDF. Where as in *Rabi* maize the availability of N content was decreased. The P availability was increased in all the treatments in *Kharif* rice, where as in *Rabi* maize there was no much difference. K availability was decreased more in RDF followed by 25% low RDF + application of biofertilizers both in rice and maize.

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The Nagarjuna Sagar Project (NSP) is one of the biggest multi purpose projects on Krishna river in South India irrigating nearly about 11 lakhs hectare area. The NSP Left canal command area spread in Nalgonda, Khammam and Krishna districts of Andhra Pradesh with a total command of 3.87 lakhs ha, mostly consists of red sandy loams locally known as chalka soils followed by mixed sandy loams (dubba soils) together constitutes 75% of the area. The remaining 25% area belongs to clay and clay loam soil (Black cotton soils). The soils are poor in nutrient status and farmers are using large quantities of chemical fertilizers and pesticides for the cultivation of crops (Rajeshwar and Aarif Khan, 2009). The excessive usage on long run leads to the gross reduction of beneficial micro flora of the soil ecosystem. Continuous application of harmful chemicals led to decrease in the fertility of soil and resurgence of many crop pests. Due to this ill affects the yields of the crop decreased and increased the cost of production. The use of chemical fertilizers and pesticides has caused tremendous harm to the soil environment. Biofertilizers are one which help to solve such problems. Biofertilizers have an advantage over chemical fertilizers, as they provide nutrients in addition to plant growth promoting substances like hormones, vitamins, amino acids etc. (Shivankar *et al.,* 2000). The nitrogen fixing microorganism supply in addition to nitrogen, considerable amount of organic matter enriching the structure of soil. Crops have to be provided with chemical fertilizers repeatedly to replenish the loss of nutrients utilized for crop growth. On the other hand biofertilizers supply the nutrients continuously through out the entire period of crop growth in the field under favorable conditions. Nitrogen is an essential major plant nutrient. The phosphobactor biofertilizer containing bacteria called *Bacillus Megaterium var* phosphaticum, which secrets organic acids such as formic, acetic, propionic, lactic, glycolic, humalic and succinic acids. These acids lower the pH and bring about the dissolution of bond form of phosphate (Dange *et al.,* 2008). Then plant can take this soluble form of phosphorus. Hence, introduction of biofertilizers is necessary for improving the soil fertility and productivity besides reducing the expenditure on chemical fertilizers. In order to provide a base line data on the effect of biofertilizers on soil fertility and on crop yield of rice, maize the present study was taken up in Ganapavaram pilot area of NSP left canal command area in Nalgonda district of Andhra Pradesh under A.P Water Management Project, a collaborative project between Alterra ILRI, The Netherlands and Acharya N.G Ranga Agricultural University, Hyderabad, India.

MATERIALS AND METHODS

Location and site characteristic of study area:

The Ganapavaram village extending over an area of 1197 ha is bounded between 17^0 Northern latitude and 80 ^{0} Eastern longitude. On the East side Yathirajapuram Thanda, West side Ganapavaram village, South Mangalkuntathanda and North Thogarrai village. The elevation of selected pilot area was 95 m above mean sea level. The experiment was conducted as a on-farm trial in farmers fields during *Kharif* 2006 and *Rabi* 2006-07. The initial soil analysis data showed that soils were neutral to slightly alkaline in reaction (pH 7.7 and 7.4) and non saline (E.C 0.28 and 0.35 dSm^{-1} in the rice and maize field, respectively. The organic carbon content was low and medium (0.33 and 0.71%, respectively). The soil available N was low (201 kg ha^{-1}) in the both rice and maize. The available P (9.9 and 20 kg ha^{-1}) and the available K (307 and 219 kg ha^{-1}) were medium and high, respectively. The rice variety was BPT-5204, which is super fine long duration variety. The rice seedlings of 30 days old were transplanted on 28th August in 2006 and maize (Bio seed hybrid) sown on 12th January 2007. The experiment was laid out as non-replicated large plot trials (1000 m^2) with four treatments *viz*., The treatment combinations are, conventional practice or farmers practice (T_1), 75% (N and P) recommended dose of fertilizers (RDF) + Biofertilizers (T_2), RDF + Biofertilizers (T_3) and RDF (T_4). The rice crop was grown at a spacing of 20 cm X 15 cm in conventional method of transplanting with 2-3 seedlings per hill and the maize crop was sown at a spacing of 60 cm x 20 cm.

The biofertilizers consists of *Azospirillum Lipoferum* (Nitrogen fixing organism) and *Bacillus* megatherium var *phospaticum* (PSB). The soil samples after harvest of the crop were collected and analysed by standard procedures. The pH and EC was determined in 1:2.5 soil water solution, the available N was determined by kjeldal method and available P was estimated by spectrophotometer and K by flame photometer method by Jackson (1973).

The recommended dose of fertilizer for rice was 100-60-40 NPK kg ha^{-1}. The entire dose of fertilizer P and half of the K and one third dose of N were applied as basal dose at the time of last pudding. The remaining N was applied at maximum tillering (1/3) and panicle initiation stage (1/3) equally. The remaining dose of K was applied at panicle initiation stage along with N. The biofertilizers were applied at seedling stage @ 5 kg of *Azospirillum* and PSB ha^{-1}. The crop was harvested at maturity and its yield was recorded. The recommended dose of fertilizer for maize was 120-60-50 NPK kg ha-^{1}. The entire dose of fertilizer P and K and one fourth dose of N were applied as basal dose at the time of sowing. The half dose of N was applied at 30 days after sowing and remaining one fourth dose of N at 55 days after sowing. The biofertilizers were applied after germination @ 5 kg of *Azospirillum* and PSB ha^{-1}. The crop was harvested at maturity and its yield was recorded.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been presented below:

Crop productivity:

Significant increase in yield and yield attributes of rice (Table 1) and maize (Table 2) was the responded positively with the application of biofertilizers + RDF, may be due to complementary effect of biofertilizers on chemical fertilizers (Hema *et al.,* 2004). Total number of productive tillers and highest grain yield of rice was recorded 6800 kg ha^{-1} followed by Farmer practice and RDF. The straw yield also followed the same trend as that of grain yield. In the case of *Rabi* maize the highest grain yield was recorded 6500 kg ha^{-1} followed by 75% (N and P) RDF + Biofertilizers (6150 kg ha^{-1}), farmers practice and RDF. The results are in accordance of Madhavi *et al.* (1996) in maize.

Table 1 : Effect of biofertilizers on yield and yield attributes on rice (*Kharif*, 2006)

Treatments	Length of the panicle (cm)	No. of grains panicle^{-1}	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T_1 Farmers practice	19.4	166	6600	7000
T_2 75% RDF (N P) + Biofertilizers	17.8	149	6300	6800
T_3 RDF + Biofertilizers	20.0	170	6800	7200
T_4 RDF	18.0	151	6400	6900

Soil microbial and available nutrient status:

Perusal data in Table 3 revealed that the microbial population of *Azospirillum* and PSB was more in 75% RDF (N P) + Biofertilizers (96 x 10^4 and 164 x 10^4 g dry soil^{-1} in rice and maize followed by recommended dose of fertilizers + Biofertilizers (59 x 10^4 and 105 x 10^4 g dry soil^{-1} in rice and maize, when compared to initial soil (57 x 10^3 and 87 x 10^3 and 21 x 10^4 g dry soil^{-1} in rice and maize). It might be due to chemical effect, the microbial count was reduced in farmers practice and RDF in both

Table 2: Effect of bio fertilizers on yield and yield attributes of maize (*Rabi*, 2006-07)

Treatments	Plant height (m)	Cob length (cm)	Cob diameter (cm)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T_1 Farmers practice	2.19	16.3	14.4	5650	6550
T_2 75% RDF (N P) + Biofertilizers	2.35	17.5	14.7	6150	7100
T_3 RDF + Biofertilizers	2.37	18.3	14.9	6500	7650
T_4 RDF	2.28	14.6	15.0	5575	6685

Table 3 : Aerobic free living Nitrogen fixtures and total phosphorus solubulizing bacteria influenced by different treatments in rice and maize

Treatments	Free living N_2 fixers g dry soil^{-1}		Total no. of PSB g dry soil^{-1}	
	Rice	Maize	Rice	Maize
T_1 Farmers practice	42 X 10^4	81 X 10^4	50 X 10^4	86 X 10^4
T_2 75% RDF (NP) + Bio fertilizers	96 X 10^4	164 X 10^4	89 X 10^4	183 X 10^4
T_3 RDF + Bio fertilizers	59 X 10^4	105 X 10^4	58 X 10^4	127 X 10^4
T_4 RDF	46 X 10^4	96 X 10^4	50 X 10^4	94 X 10^4
Initial soil	57 X 10^3	18 X 10^4	87 X 10^3	21 X 10^4

Table 4: Soil available nutrient status after harvesting of rice and maize

Treatments	pH (1:2.5)		EC dSm^{-1}		OC (%)		Available N (kg ha^{-1})		Available P (kg ha^{-1})		Available K (kg ha^{-1})	
	Rice	Maize	Rice	Maize	Rice	Maize	Rice	Maize	Rice	Maize	Rice	Maize
T_1 Farmers practice	7.8	7.3	0.27	0.0.26	0.33	0.55	212	178	22	26	311	180
T_2 75% RDF (N and P) + Bio- fertilizers	7.9	7.3	0.23	0.22	0.46	0.70	176	213	20	23	247	203
T_3 RDF + Bio-fertilizers	7.8	7.4	0.18	0.19	0.45	0.66	223	190	25	26	277	168
T_4 RDF	7.5	7.1	0.16	0.17	0.36	0.56	180	201	22	20	219	177
Initial soil	7.7	7.4	0.28	0.35	0.33	0.71	201	201	9.9	15	307	219

rice and maize fields. Soil microbial count was higher after harvest of crops as compared to initial soil samples indicates the influence of plant rhizosphere and root exudates on soil microbial population (Singh *et al*.,1998).

The available nutrients in the soil were influenced by the application of biofertilizers to rice and maize, there was no much change observed in pH in different treatments when compared to initial soil pH. The decrease of EC was more in recommended dose of fertilizers (RDF) followed by RDF + Biofertilizers and farmers practice when compared to initial soil EC. The increase in organic carbon content was highest in 75% RDF (N P) + Biofertilizers when compared to initial soil because of balanced ratio of nutrients were applied. The available N content was more in application of RDF + Biofertilizer when compared to initial soil N (Table 4). In all other treatments the available N was decreased (Shrivastava, 2002 and Rajamani, 2009). The available P content was increased in all the treatments due to release of soluble inorganic phosphates in to soils through decomposition by phosphorus solubulizing bacteria. It is all because of the solubulizing and mineralizing process of PSB for insoluble and organic source of P (Gaur and Sunitha, 1999 and Singh *et al*., 2004)). Available K was decreased drastically in RDF treatment followed by RDF + Bio fertilizers and 75% RDF + Bio fertilizers. In the case of maize similar results were recorded but the available N content was more in 75 % RDF + Biofertilizers treatment when compared to initial soil N. In all other treatments the available N was decreased.

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