Influence of Integrated Nutrient Management Practices on Yield and Uptake of Nutrientsin Rice (Oryza sativa L.)

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ABSTRACT

The present investigation entitled "Influence of integrated nutrient management practices on yield and nutrient uptake of rice (Oryza sativa L.)"was conducted at farmer's field, Devaryamjal village, near Hakimpet, Rangareddy district, Telangana during Kharif season 2014 to evaluate the use of inorganic fertilizers and organic manures on growth & yield.The experiment was laid out in randomized block design (RBD) with 11 treatments, each replicated 3 times. The treatments consisted of control (T_1), 100% RDFN (T_2), 75% RDFN + 25% N through VC, PM and FYM (T_3, T_6, T_9), 50% RDFN + 50% N through VC, PM and FYM (T_4, T_7, T_{10}), 100% RDN through VC, PM and FYM (T_5, T_8, T_{11}). Among the different INM treatments maximum grain yield of (54.9 q ha^{-1}) and straw yield (68.3 q ha^{-1})was recorded with treatment T_3 (75% RDFN + 25% N through VC) which was closely followed by treatmentT_6 (75% RDFN + 25% N through PM) with grain and straw yield of (52.9 q ha^{-1}) and (66.3 q ha^{-1}) respectively. Highest uptake of nitrogen (90.2 Kg ha^{-1}), phosphorus (26.8 Kg ha^{-1}) and potassium (100.4 Kg ha^{-1}) was recorded with Treatment T_3. Treatment T_1 – Control (No RDFN) recorded lowest grain yield,straw yield and nutrient uptake.

Keywords: Rice, INM, Yield, Nutrient uptake

INTRODUCTION

Rice (Oryza sativa L.) is an important and extensively cultivated food crop which feeds more than of half of the world's population. In Asia alone, more than 2 billion people obtain 60 to 70 percent of their energy intake from rice and it's derivatives. India has the largest area among rice growing countries and it stands second in production next to China (Udhyakumar and Ramasamy, 2016). It is estimated that rice requirement of India by 2020 will be 118.93 MT (Sahane et al., 2013). Fertilizers are continuing to play an important role on the productivity of crops but at the same time use of chemical fertilizers alone is not sufficient to sustain the productivity due to deficiency of certain elements resulting in decline in productivity as well as soil health. Further in recent years long term sustainability of agricultural productivity and safety of the environment are being questioned due to the facts such as deterioration of soil organic matter, low fertilizer use efficiency, yield stagnation and wide N, P, K ratio. Around 2/3rd of nutrient requirement of crops in India are met through fertilizers and gap is expected to be met through organic manures. Organic manures not only increase the nutrient status of the soil but also improve various physical, chemical and biological properties leading to better soil quality and increased fertilizer use efficiency (Dick and Gregorich 2004). Further energy crisis has resulted in higher prices of chemical fertilizers coupled with limited production. The escalating costs of fertilizers on one hand and undesirable effects on soil properties on the other hand have led to inclusion of organic manures in cultivation of crops. Thus integrated nutrient management (INM) system envisages use of inorganic fertilizers, organic manures, crop residues, green manures, bio fertilizers taking into account the fertility status of soils. Organic manures such as farm yard manure, poultry manure and vermicompost are some of the important manures used as components of INM.

Thereforethe main purpose of this research is to study the effect of INM on yield and nutrient uptake of rice.

MATERIALS & METHODS

The present investigation entitled "Effect of integrated nutrient management on growth and yield of rice (Oryza sativa L.) was conducted at farmer's field, Devaryamjal village, near Hakimpet, Rangareddy district, Telangana during Kharif season 2014 to evaluate the use of inorganic fertilizers and organic manures on growth & yield.It is situated at an altitude of 536 m above mean sea level, $17^0 23'$ N latitude and $78^0 28'$ E longitude. It is classified as Southern Telangana agro-climatic zone of Telangana State. The experiment was laid out in randomized block design (RBD) with 11 treatments, each replicated 3 times. The treatments consisted of control (T_1), 100% RDFN (T_2), 75% RDFN + 25% N through VC, PM and FYM (T_3, T_6, T_9), 50% RDFN + 50% N through VC, PM and FYM (T_4, T_7, T_{10}), 100% RDN through VC, PM and FYM (T_5, T_8, T_{11}). Soil of the experimental field is a sandy clay loam (ultisol), slightly alkaline in reaction (pH : 7.60), non saline (EC : 0.39 dS m^{-1}), medium in organic carbon (0.51%), low in available N (235 kg ha^{-1}), medium in available P_2O_5 (23 kg ha^{-1}) and high in available K_2O (304 kg ha^{-1}). Rice (BPT 5204) was test crop grown during Kharif season with RDF applied as N : P_2O_5: K_2O @ 120 : 60 : 40 kg ha^{-1}. A uniform dose of 60 kg ha^{-1} P_2O_5 and 40 kg ha^{-1} K_2O was applied as basal to all the plots. The plant samples of rice were collected at 30, 60, 90 DAT and at harvest. After recording dry weights the samples were ground in a willey mill and analyzed for the concentrations of N, P and K by adopting standard procedures. The nitrogen content in the dried plant samples was determined by micro kjeldahl digestion and distillation method after destroying the organic matter using H_2SO_4 and H_2O_2 and expressed as % (Piper 1966). The phosphorus content in the tri acid digest was determined by developing vanadomolybdo phosphoric yellow colour method with Barton's reagent.The intensity of yellow colour was determined by using UV visible spectrophotometer at 420 nm, GBC-(906) and expressed as % (Piper 1966).Thepotassium content in the tri acid digest was determined by using ELICO flame photometer and expressed as % (Piper, 1966).

The uptake of N,P and K were computed using the following formula:

$$\text{Uptake of nutrient (kg ha}^{-1}) = \frac{\text{Nutrient concentration (\%) x dry matter Production (kg ha}^{-1})}{100}$$

RESULTS AND DISCUSSION

Influence of Integrated Nutrient Management Practices on Yield

Grain yield(Table 1)

From the results presented in Table 1, it was observed that all the treatments showed significant variation in grain yield of rice. The grain yield varied from 27.5 q ha^{-1} (T_1-0% RDFN) to 54.9 q ha^{-1} (T_3-75% RDFN + 25% N-VC) with a mean value of 43.0q ha^{-1}. The treatment T_6 (75% RDFN + 25% N-PM) followed T_3(75% RDFN + 25% N-VC) with grain yield of 52.9 q ha^{-1}. Rice fertilized with 100% recommended dose of fertilizer recorded 50.4 q ha^{-1} which was significantly high compared to rest of all the treatments except T_3 and T_6. Among the treatments having combinations of organic manures with fertilizer N, treatments T_4 (50% RDFN + 50% N-VC) &T_7 (50% RDFN + 50% N-PM) were on par with each other while these treatments recorded significantly high grain yield compared with treatment T_{10} (50% RDFN + 50% N-FYM). Application of entire dose of N through VC i.e., T_5 (100% RDN-VC) resulted in grain yield of 40.3 q ha^{-1}which was significantly high compared to treatments T_8 (100% RDN-PM) and T_{11} (100% RDN-FYM). The grain yield recorded in these three treatments were significantly inferior to grain yield recorded with treatment T_2 (100% RDFN).

Straw yield (Table 1)

The data presented in Table 1 indicated that the straw yield of rice varied from 34.4 to 68.3 q $ha^{-1}$with a mean of 52.7 q ha^{-1}. Highest straw yield was recorded with treatment T_3(75% RDFN + 25% N-VC) which was closely followed by treatment T_6 (75% RDFN + 25% N-PM) which recorded 66.3 q ha^{-1}. Treatment T_2 (100% RDFN) recorded straw yield of 61.8 q ha^{-1} and it differed significantly from the organic manure alone applied treatments i.e., T_5, T_8 and T_{11}. Among the combined treatments T_4 and T_7 were on par with each other and both the treatments were superior compared with the treatment T_{10} (50% RDFN + 50% N-FYM).

The higher yield of rice with integrated use of chemical fertilizers (urea) and vermicompost with 75% and 25% of recommended dose of nitrogen may be attributed to higher availability of NPK and other nutrients, higher occurrence of different beneficial micro organisms, presence of growth promoting hormones, antibiotics, enzymes etc., in vermicompost. Similar results were reported by(Barik et al., 2008, Arun Kumar Barik et al., 2006, Edwards and Arancon 2004, Dick and Gregorich 2004). Rice responded favourably to the addition of vermicompost as a substitute for a part of chemical N fertilizer compared to application of FYM separately and in combination with fertilizers (Banik and Ranjita Bejbaruah 2004). In rice crop, 25% of recommended fertilizer NPK can be substituted by any of the organic manures (Sing et al., 2009). Treatment T_2(100% RDFN) recorded significantly high grain and straw yields compared to organic manure alone applied treatments i.e., T_5, T_8&T_{11} through VC, PM and FYM respectively. This could be due to high availability and utilization of nitrogen by the crop from inorganic source (fertilizer) whereas release of nitrogen from organic source may not be full during the crop growth period [Singh et al., 2005].

Influence of Integrated Nutrient Management on uptake of Nutrients

Uptake of Nitrogen (Table 2)

The data on uptake of nitrogen by rice as influenced by integrated nutrient management treatments at 30, 60, 90 DAT and at harvest are presented in Table 2. At 30 DAT, the uptake of nitrogen by rice ranged from 11 to 36.8 Kg ha^{-1} with a mean value of 24.5 Kg ha^{-1}. The nitrogen uptake increased at a rapid rate to as high as 50.9 Kg ha^{-1} by 60 DAT to 68.4 Kg ha^{-1} by 90 DAT. The rate of increase was found to be rapid upto 60 DAT followed by marginal increase from 60 to 90 DAT. At harvest the total uptake was 77.3 Kg ha^{-1} out of which grains accumulated 50.3 Kg ha^{-1}. When rice was grown on native soil fertility conditions, uptake of nitrogen was 11 Kg ha^{-1}. Highest uptake of nitrogen was observed with treatment T_3(75% RDFN + 25% N-VC) which is closely followed by treatment T_6 (75% RDFN + 25% N-PM).

Rice grown with T_2 (100%RDFN) recorded 31.2 Kg N ha^{-1} which was inferior to treatments T_3(75% RDFN + 25% N-VC) and T_6 (75% RDFN + 25% N-PM), but significantly superior to rest of other treatments. Similar trend persisted in the subsequent stages of sampling until harvest.

Uptake of Phosphorus (Table 3)

The data on uptake of phosphorus by rice as influenced by integrated nutrient management treatments at 30, 60, 90 DAT and at harvest are presented in Table 3. Uptake of phosphorus by rice increased steadily with the age until harvest.

The mean uptake of phosphorus by rice was 4.5 Kg P ha^{-1}at 30 DAT. When the crop reached 60 DAT, it accumulated around 12.4 Kg P ha^{-1}, the uptake continued at a slow rate in the later stages accumulating around 18.7 Kg P ha^{-1} at 90 DAT. A maximum of 22.5 Kg P ha^{-1} was accumulated by crop at harvest out of which 14.9 Kg P ha^{-1} was accumulated in grain and 7.6 kg P ha^{-1} in straw. The highest uptake of phosphorus of 7.6 Kg P ha^{-1} was recorded with treatment T_3(75% RDFN + 25% N-VC) which was on par with treatment T_6 (75% RDFN + 25% N-PM) (7.3kg P ha^{-1}), while lowest uptake of 2.1 kg P ha^{-1} was observed with treatment T_1 (0% RDN). Treatment T_2 (100% RDFN) resulted in P uptake of 6.1 kg P ha^{-1} which was significantly superior to organic manure alone applied treatments T_5, T_8 and T_{11}, values being 3.5, 3.4 and 2.8 kg P ha^{-1} respectively. Among the combined treatments T_4 (50% RDFN + 50% N-VC) was on par with T_7 (50% RDFN + 50% N-PM) and both the treatments were significantly superior to T_{10} (50% RDFN + 50% N-FYM). This trend persisted in subsequent stages of sampling until harvest.

Uptake of Potassium (Table 4)

The data on uptake of potassium by rice as influenced by integrated nutrient management treatments at 30, 60, 90 DAT and at harvest are presented in Table 4. Uptake of potassium by rice was 26.5, 57.7, 73.7 Kg ha^{-1} at 30, 60, 90 DAT respectively. At harvest grain and straw accumulated 15.2 and 84.3 Kg ha^{-1} of K. At 30 DAT treatment T_3(75% RDFN + 25% N-VC) recorded significantly high uptake of potassium closely followed by treatment T_6 (75% RDFN + 25% N-PM). These two treatments were significantly high when compared to T_2 (100% RDFN). Though treatment T_2 (100% RDFN) recorded lower uptake of potassium when compared to treatments T_3 and T_6, it was found superior to combined (T_4, T_7, T_9, T_{10}) and organic manure alone applied treatments (T_5, T_8 and T_{11}). Lowest uptake of potassium was recorded with treatment T_1 (0% RDN). This trend persisted in subsequent stages of sampling until harvest. At harvest percent increase in uptake of N, P and K by grain and straw in T_3 was 11.57, 14.88 and 14.67 in grain and 14.98, 17.61 and 13.93 in straw respectively over treatment T_2 (100% RDFN).

The increase in uptake of N, P and K may be attributed to the increase in dry matter production as the major nutrients were supplied in required quantities. Since the applied nitrogen increases vegetative growth, uptake of P and K was also enhanced. In the presence ofnitrogen the increase in uptake of P shows synergistic effect.

Increase in uptake of K may be due to increase in mobilization of K in the presence of N and P, better root growth and activity and also due to better K status of soil.

Moreover the beneficial effect of vermicompost and fertilizers N, P, K on N uptake might be attributed to their faster release of nitrogen during mineralization, there by resulting in higher N uptake by rice owing to higher grain yield. The increased uptake of P and K might be ascribed to better availability of these nutrients from fertilizers and native source. In addition vermicompost also contained different growth promoting substances which induced high dry matter yield leading to higher uptake of nutrients. Similar results were reported by (Banik and Ranjita Bejbaruah 2004, Powar, 2004, Prakash and Bhadoria, 2003).

CONCLUSION

Integrated Nutrient Management (INM) practices showed positive effect on grain, straw yield and uptake of nutrients. From the study it may be concluded that application of 75% RDFN + 25% N – VC recorded significantly higher grain, straw yield and uptake of nutrients in rice over 100% RDFN and other treatments.

Table 1	Effect of integrated nutrient management treatments on yield attributes and yield of Kharif rice			
Treatments			Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
T_1	-	Control (No RDFN)	27.5	34.4
T_2	-	100% RDFN	50.4	61.8
T_3	-	75% RDFN + 25% N-VC	54.9	68.3
T_4	-	50% RDFN + 50% N-VC	46.4	55.8
T_5	-	100% RDN-VC	40.3	47.3
T_6	-	75% RDFN + 25% N-PM	52.9	66.3
T_7	-	50% RDFN + 50% N-PM	43.6	54.4
T_8	-	100% RDN-PM	36.0	46.0
T_9	-	75% RDFN + 25% N-FYM	47.9	56.2
T_{10}	-	50% RDFN + 50% N-FYM	40.5	49.3
T_{11}	-	100% RDN-FYM	32.9	39.9
SEm±			1.00	1.15
CD (P=0.05)			**2.97**	**3.38**
CV (%)			4.05	3.77
Mean			**43.0**	**52.7**

Table 2	Influence of integrated nutrient management treatments on uptake of nitrogen (kg ha^{-1}) at various growth stages of rice						
Treatments			Days after transplanting			Harvest	
			30	60	90	Grain	Straw
T_1	-	Control (No RDFN)	11.0	32.5	47.5	28.3	15.1
T_2	-	100% RDFN	31.2	61.6	78.4	60.5	32.7
T_3	-	75% RDFN + 25% N-VC	36.8	71.5	90.2	67.5	37.6
T_4	-	50% RDFN + 50% N-VC	26.3	52.6	70.5	54.8	29.0
T_5	-	100% RDN-VC	20.2	43.0	61.6	45.9	23.7
T_6	-	75% RDFN + 25% N-PM	35.4	69.9	88.0	64.6	35.8
T_7	-	50% RDFN + 50% N-PM	25.3	51.0	69.3	51.0	27.7
T_8	-	100% RDN-PM	19.3	42.2	59.8	40.9	22.5
T_9	-	75% RDFN + 25% N-FYM	27.1	53.8	71.4	57.0	29.2
T_{10}	-	50% RDFN + 50% N-FYM	21.0	44.2	62.2	46.6	24.6
T_{11}	-	100% RDN-FYM	15.4	37.4	53.7	36.2	19.2
SEm±			0.67	1.28	1.74	1.41	0.68
CD (P=0.05)			**1.99**	**3.77**	**5.13**	**4.16**	**2.00**
CV (%)			4.78	4.35	4.40	4.86	4.34
Mean			**24.5**	**50.9**	**68.4**	**50.3**	**27.0**

Table 3	Influence of integrated nutrient management treatments on uptake of phosphorus (kg ha^{-1}) at various growth stages of rice						
Treatments			Days after transplanting			Harvest	
			30	60	90	Grain	Straw
T_1	-	Control (No RDFN)	2.1	6.1	9.7	8.0	3.1
T_2	-	100% RDFN	6.1	15.7	23.4	18.2	9.9
T_3	-	75% RDFN + 25% N-VC	7.6	18.7	26.8	20.9	11.6
T_4	-	50% RDFN + 50% N-VC	4.5	13.0	19.9	16.2	8.4
T_5	-	100% RDN-VC	3.5	10.3	15.9	13.3	6.2
T_6	-	75% RDFN + 25% N-PM	7.3	18.2	26.1	20.1	11.3
T_7	-	50% RDFN + 50% N-PM	4.3	12.6	19.3	14.8	8.2
T_8	-	100% RDN-PM	3.4	10.1	15.3	12.0	6.0
T_9	-	75% RDFN + 25% N-FYM	4.7	13.3	20.6	16.8	8.4
T_{10}	-	50% RDFN + 50% N-FYM	3.7	10.5	16.4	13.4	6.4
T_{11}	-	100% RDN-FYM	2.8	8.0	12.5	10.2	4.4
SEm±			0.14	0.56	0.74	0.53	0.41
CD (P=0.05)			**0.41**	**1.65**	**2.18**	**1.57**	**1.20**
CV (%)			5.35	7.82	6.85	6.18	9.27
Mean			**4.5**	**12.4**	**18.7**	**14.9**	**7.6**

Table 4	Influene of integrated nutrient management treatments on uptake of potassium (kg ha^{-1}) at various growth stages of rice						
Treatments			Days after transplanting			Harvest	
			30	60	90	Grain	Straw
T_1	-	Control (No RDFN)	13.4	32.1	48.2	8.0	46.5
T_2	-	100% RDFN	33.4	71.9	86.2	19.2	105.0
T_3	-	75% RDFN + 25% N-VC	39.0	83.2	100.4	21.9	119.6
T_4	-	50% RDFN + 50% N-VC	28.0	60.3	75.6	16.2	89.2
T_5	-	100% RDN-VC	21.9	47.9	64.4	12.9	71.0
T_6	-	75% RDFN + 25% N-PM	37.5	81.3	99.4	21.2	115.9
T_7	-	50% RDFN + 50% N-PM	26.9	58.5	74.3	15.3	87.0
T_8	-	100% RDN-PM	21.0	47.0	62.5	11.6	69.0
T_9	-	75% RDFN + 25% N-FYM	29.5	62.3	77.7	17.2	92.8
T_{10}	-	50% RDFN + 50% N-FYM	23.0	50.2	66.2	13.4	73.9
T_{11}	-	100% RDN-FYM	17.6	39.7	55.5	9.9	57.9

SEm±	1.02	1.92	2.31	0.53	2.55
CD (P=0.05)	**3.03**	**5.68**	**6.82**	**1.58**	**7.52**
CV (%)	6.71	5.78	5.44	6.11	5.24
Mean	**26.5**	**57.7**	**73.7**	**15.2**	**84.3**

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