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Effect of Integrated Nutrient Management on Growth and Yield of Rice (Oryza sativa L.)

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ABSTRACT

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.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 growth attributes such as plant height, no. of tillers hills^{-1}were found highest with the treatment T_3 (75% RDFN + 25% N through VC) but remained on par with treatment T_6 (75% RDFN + 25% N through PM). Treatment T_3 recorded significantly higher no. of effective tillers (9.2), total no. of grains per panicle (156.3), filled grains per panicle (143.4), grain yield (54.9 q ha^{-1}) and straw yield (68.3 q ha^{-1}) when compared to rest of treatments but remained on par with treatment T_6. Treatment T_1 – Control (No RDFN) recorded lowest growth attributes, yield attributes, grain yield and straw yield.

Keywords: Rice, INM, Growth Attributes, Yield

INTRODUCTION

Rice (Oryza sativa L.) is on of the most important staple food grain crops in the world. It is a high calories food which contains 75% starch, 6-7% Proteins, 2-2.5% fat, 0.8% cellulose and 5-9% ash. In India Rice is cultivated in an area of 43.06 million hectares with a production of 103.14 million tonnes and productivity 2391 kg ha-1. In Telangana total cultivated area is 1.415 million hectares with production of 4.544 million tonnes and productivity 3211 kg ha-1 (Agricultural Statistics at a glance, 2015-16). The introduction of high yielding varieties (HYVs) which are highly responsive to chemical fertilizers and increased area under assured irrigation facilities led to a major shift from organic based nutrition to chemical fertilizer usage.

The quick response of crops to the application of chemical fertilizers had led to their rapid increase in usage by farmers.Consequently there was reduction in use of organic manures and the excess use of chemical fertilizers in an unbalanced manner. This led to problems of soil fertility such as acidity, alkalinity, deficiency of secondary and micro nutrients particularly sulphur, zinc, iron etc., and deterioration of soil physical environment (Subba Rao and Sammi Reddy 2005). Fertilizers have played and are continuing to play an important role on the productivity of both irrigated and rain fed crops. But the 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 with time.

Organic manures though improve soil health were seldom used to meet the nutrient requirement of crops because of their low nutrient content and slow release mostly governed by microbial activity. 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).Thus it is widely recognized that neither use of organic manures alone nor chemical fertilizers can achieve the sustainability of the yield under the modern intensive farming. Therefore integrated use of both organic manures and inorganic fertilizers have been quite promising not only to maintain higher productivity, soil health but also to provide maximum stability to crop production.

In this context the main purpose of this research is to study the effect of INM on growth and yield attributes 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. Data on growth attributes i.e., plant height, no. of tillers hill-1 and dry matter production was recorded at 30, 60, 90 Days After Transplanting (DAT).

RESULTS AND DISCUSSION

Effect of Integrated Nutrient Management on growth attributes.

Plant height (Table 1)
Plant height increased with increase in age of crop upto harvest in all the treatments. Maximum plant height of 54.5 cm was obtained with treatment T_3 (75% RDFN + 25% N-VC) at 30 DAT which was on par with treatment T_6 (75% RDFN + 25% N-PM) which recorded 52.7 cm. These two treatments recorded significantly more plant height when compared to treatment T_2 (100% RDFN).Significant reduction in plant height was observed when the fertilizer dose was reduced from 75% to 50% in combination with organic manures i.e., VC, PM and FYM. Application of entire dose of nitrogen through VC, PM and FYM i.e., treatments T_5, T_8 and T_{11} recorded plant height of 36.6 cm, 35.9 cm and 34.2 cm respectively, which was significantly inferior when compared to treatment T_2 (100% RDFN) i.e., 46.2 cm. Plant height recorded with treatment T_1 (0% RDN) was significantly lower compared to rest of the treatments. Similar trend was reflected at 60 DAT, 90 DAT and at harvest.

No. of Tillers Hill-1 (Table 2)
Total number of tillers $hill^{-1}$ increased with increase in age of crop upto 60 DAT in all the treatments. Maximum number of tillers per hill were obtained with treatment T_3 which was on par with treatment T_6 and significantly superior to treatment T_2 at all the stages of crop growth. But when fertilizer dose was reduced from 75% to 50% in integration with organic manures i.e., VC, PM and FYM, significant reduction in tillers was observed at all the stages of crop growth.

Dry Matter production (Table 3)
In the treatment T_1 (0% RDFN) where no nitrogen was applied, crop accumulated lowest quantity of dry matter per hectare which was significantly inferior when compared to rest of all the treatments at all the stages of crop growth. In rice crop maximum quantity of dry matter per hectare was observed with treatment T_3(75% RDFN + 25% N-VC) at all the stages of crop growth which was on par with T_6 (75% RDFN + 25% N-PM) and significantly superior to treatment T_2 (100% RDFN). The crop produced significantly low quantity of dry matter per hectare with treatments T_4, T_7&T_{10} i.e., when 50% of recommended nitrogenous fertilizer was integrated with organic manures when compared to treatment T_2 (100% RDFN) at all stages of crop growth. Among the organic manure alone applied treatments, T_5 (100% RDN-VC) was on par with T_8 (100% RDN-PM) and significantly superior to T_{11} (100% RDN-FYM) at all the stages of crop growth. The favourable effect of vermicompost on growth could be attributed to the readily available N (NH_4-N) from the assimilable products of excretion, mucoprotein, vermicast and rapid mineralization of body tissues of earthworms which led to greater availability of nutrients in the initial stages of crop growth. This could be the reason for taller plants and production of higher number of tillers in the vermicompost applied treatments (Jeyabal and Kuppu Swamy 2001). The decrease in number of tillers per hill after 60 DAT would have resulted from death of last tillers due to their failure to compete for light and nutrients (Arun Kumar Barik etal., 2006). The effect of vermicompost on the growth of rice might be due to the presence of plant growth substances identified as indole compounds which could be secreted into the cast and inturn increased plant growth and yield (Banik and Ranjita Bejbaruah 2004).

Days to 50% flowering (Table 4)
Rice crop took 108.8 days to attain 50% flowering when cultivated on native soil fertility. The days to 50% flowering was reduced by 4.7 days with application of recommended dose of fertilizers and application of 75% RDFN along with 25% nitrogen through VC by 5.8 days.

Effect of Integrated Nutrient Management on yield attributes and yield

Yield attributes (Table 4)

Rice produced 8.4 number of effective tillers per hill with 147.6 grains per panicle and 133.2 filled grains in response to treatment T_2 (100% RDFN) i.e., application of recommended level of fertilizers. Effective tillers per hill was reduced to minimum of 5.8, with only 113.2 and 91.8 total and filled grains respectively per panicle in unfertilized crop. Treatment T_3(75% RDFN + 25% N-VC) recorded significantly higher number of effective tillers, total grains and also filled grains per panicle by substantially reducing percentage of spikelet sterility. This was on par with treatment $T_6$and both T_3&T_6 treatments recorded significantly high yield attributes when compared to rest of the treatments. However there was no significant influence on test weight of rice due to imposition of various treatments. Significant reduction in yield attributes was observed when fertilizer dose was reduced from 75% to 50% in combination with organic manures i.e., VC, PM &FYM. Application of organic manures alone i.e., VC, PM &FYM recorded significantly high yield attributes compared to unfertilized crop, but significantly lesser than where they (organic manures) share 25% or 50% of RDFN.

Grain yield(Table 4)

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 ecorded 50.4 q ha^{-1} which was significantly high compared to rest of all the treatments except T_3 and T_6.

Straw yield (Table 4)

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}. The higher yield components and 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) In rice crop, 25% of recommended fertilizer NPK can be substituted by any of the organic manures (Singh 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).

CONCLUSION

Table 1		Effect of integrated nutrient management treatments on plant height (cm) at various growth stages of rice				
Treatments			Days after transplanting			
			30	60	90	Harvest
T_1	-	Control (No RDFN)	30.1	49.2	67.5	74.3
T_2	-	100% RDFN	46.2	68.8	89.6	95.2
T_3	-	75% RDFN + 25% N-VC	54.5	74.9	95.8	101.4
T_4	-	50% RDFN + 50% N-VC	41.8	62.4	82.5	89.2
T_5	-	100% RDN-VC	36.6	55.7	75.2	82.5
T_6	-	75% RDFN + 25% N-PM	52.7	74.1	95.0	100.8
T_7	-	50% RDFN + 50% N-PM	41.0	61.2	81.3	88.5
T_8	-	100% RDN-PM	35.9	54.5	74.1	81.7
T_9	-	75% RDFN + 25% N-FYM	42.7	64.3	83.9	90.1
T_{10}	-	50% RDFN + 50% N-FYM	37.5	57.3	76.8	83.6
T_{11}	-	100% RDN-FYM	34.2	53.1	72.5	80.2
SEm±			1.09	1.21	1.36	1.54
CD (P=0.05)			**3.21**	**3.59**	**4.02**	**4.54**
CV (%)			4.58	3.43	2.91	3.03
Mean			**41.2**	**61.4**	**81.3**	**88.0**

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

Table 2		Effect of integrated nutrient management treatments on number of tillers hill^{-1} at various growth stages of rice			
Treatments			Days after transplanting		
			30	60	90
T_1	-	Control (No RDFN)	4.4	6.8	6.4
T_2	-	100% RDFN	7.7	11.2	10.1
T_3	-	75% RDFN + 25% N-VC	8.4	12.0	11.0
T_4	-	50% RDFN + 50% N-VC	7.0	10.4	9.3
T_5	-	100% RDN-VC	6.4	9.7	8.6
T_6	-	75% RDFN + 25% N-PM	8.3	11.9	10.8
T_7	-	50% RDFN + 50% N-PM	6.9	10.3	9.1
T_8	-	100% RDN-PM	6.3	9.6	8.5
T_9	-	75% RDFN + 25% N-FYM	7.1	10.5	9.4
T_{10}	-	50% RDFN + 50% N-FYM	6.5	9.8	8.7
T_{11}	-	100% RDN-FYM	5.7	8.9	7.8
SEm±			0.16	0.20	0.20
CD (P=0.05)			**0.48**	**0.60**	**0.60**
CV (%)			4.19	3.47	3.90
Mean			**6.8**	**10.1**	**9.1**

Table 3		Effect of integrated nutrient management treatments on dry matter production (kg ha^{-1}) at various growth stages of rice				
Treatments			Days after transplanting			
			30	60	90	Harvest
T_1	-	Control (No RDFN)	376	1900	4050	6700
T_2	-	100% RDFN	800	3850	6300	10725
T_3	-	75% RDFN + 25% N-VC	918	4375	7150	11675
T_4	-	50% RDFN + 50% N-VC	693	3325	5750	9825
T_5	-	100% RDN-VC	564	2750	5100	8675
T_6	-	75% RDFN + 25% N-PM	884	4275	7075	11525
T_7	-	50% RDFN + 50% N-PM	668	3225	5650	9600
T_8	-	100% RDN-PM	540	2700	4950	8375
T_9	-	75% RDFN + 25% N-FYM	715	3400	5825	9925
T_{10}	-	50% RDFN + 50% N-FYM	586	2825	5175	9000
T_{11}	-	100% RDN-FYM	457	2300	4525	7550
SEm±			20	106	137	236
CD (P=0.05)			**58**	**314**	**405**	**698**
CV (%)			5.23	5.80	4.25	4.35
Mean			**655**	**3175**	**5595**	**9416**

Table 4 Effect of integrated nutrient management treatments on yield attributes and yield of rice

Treatments	Days to 50% flowering	Effective Tillers (panicles) hill^{-1}	Total no. of grains panicle^{-1}	Filled grains panicle^{-1}	Sterillity %	Test weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
T_1 - Control (No RDFN)	108.8	5.8	113.2	91.8	18.9	22.0	27.5	34.4
T_2 - 100% RDFN	104.1	8.4	147.6	133.2	9.8	23.5	50.4	61.8
T_3 - 75% RDFN + 25% N-VC	103.0	9.2	156.3	143.4	8.3	23.6	54.9	68.3
T_4 - 50% RDFN + 50% N-VC	104.8	7.6	137.5	121.6	11.6	23.2	46.4	55.8
T_5 - 100% RDN-VC	106.2	7.3	126.8	108.5	14.4	22.9	40.3	47.3
T_6 - 75% RDFN + 25% N-PM	103.1	9.1	154.1	140.7	8.7	23.6	52.9	66.3
T_7 - 50% RDFN + 50% N-PM	105.2	7.5	134.2	117.8	12.2	23.0	43.6	54.4
T_8 - 100% RDN-PM	106.7	7.2	124.9	106.3	14.9	22.8	36.0	46.0
T_9 - 75% RDFN + 25% N-FYM	104.6	7.7	140.8	125.8	10.7	23.4	47.9	56.2
T_{10} - 50% RDFN + 50% N-FYM	105.6	7.4	128.6	110.7	13.9	23.0	40.5	49.3
T_{11} - 100% RDN-FYM	107.2	6.6	119.1	99.2	16.7	22.4	32.9	39.9
SEm±	1.40	0.17	1.76	2.30	0.24	0.58	1.00	1.15
CD (P=0.05)	**4.14**	**0.50**	**5.19**	**6.79**	**0.71**	**NS**	**2.97**	**3.38**
CV (%)	2.31	3.94	2.26	3.38	3.28	4.33	4.05	3.77
Mean	**105.4**	**7.6**	**134.8**	**118.1**	**12.7**	**23.0**	**43.0**	**52.7**

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