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Growth, Yield Attributes, Yield and Nutrient Uptake of Rice (*Oryza sativa L.*) as Influenced by Organic Manures and Zinc Supplementation at Different Nitrogen Levels

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ABSTRACT

A field experiment was conducted at the Agricultural College Farm, Bapatla on a sandy clay loam soil during 2010 – 11 and 2011 -12 to study the integrated use of higher levels of nitrogen in conjunction with organic manures and zinc supplementation. The experiment was laid out in a split plot design replicated three times. The study revealed that the highest growth parameters of rice such as plant height, number of tillers m^{-2}, drymatter production, yield attributing parameters such as number of productive tillers m^{-2}, number of filled grains $panicle^{-1}$, 1000 grain weight, grain yield, straw yield and harvest index of rice and nutrient uptake were realised with M_3 (Greenmanuring *in situ* + $ZnSO_4$ @ 50 kg ha^{-1} as basal) along with the application of 180 kg N ha^{-1} during both the years of study. The highest blackgram productivity was also recorded with same treatment during both the years of study.

Key words : Blackgram, Growth, Manures, Nitrogen, Rice,Yield attributes, Zinc.

Rice (*Oryza Sativa L.,*) is the dominant cereal crop in many developing countries and is a staple food for more than half of the world's population. In India rice is grown in an area of 43.97 million hectares with a production of 104.3 million tonnes and productivity of 2.37 t ha^{-1}. In Andhra Pradesh, it is grown in an area of 4.01 million hectares with a production of 12.89 million tonnes and productivity of 3.13 t ha^{-1}. The average productivity of rice in India (2.37 t ha^{-1}) is quite lower than the world's average productivity of 4.31 t ha^{-1}. Hence, conjunctive use of organic manures with inorganic chemical fertilizers for producing higher and sustainable crop yield without nutrient mining from the soil is the need of time.

Rice – Blackgram is an age old and best cropping sequence followed in Krishna Agro-climatic Zone of Andhra Pradesh. The potential of increasing the productivity of both the crops i.e., rice and blackgram in sequence is tremendous with sustainable nutrient management practices. Farmers in this region grow blackgram crop only on residual soil fertility. Hence, maintaining higher residual fertility through the credible use of chemical fertilizers and organic manures in rice crop is most important in Rice-Blackgram sequence.

MATERIAL AND METHODS

A field experiment was conducted during two consecutive years, 2010 – 11 and 2011 – 12 at Agricultural College Farm, Bapatla on sandy clay loam soil. The experiment was laid out in different sites during the two consecutive years, where the soil pH was 8.0 and 8.1, electrical conductivity 0.34 and 0.31 dsm^{-1}, organic carbon 0.42% and 0.40%, respectively in 2010 - 11 and 2011 – 12. The initial soil available nitrogen content was low (226 and 220 kg ha^{-1}), medium in available phosphorus (24 and 17 kg P_2O_5 ha^{-1}), high in available potassium (350 and 305 kg ha^{-1}) and low in available zinc (0.56 ppm and 0.68 ppm) respectively, during 2010 – 11 and 2011 – 12. The experiment was laid out in a split plot design replicated three times. The treatments comprised of four organic nutrition treatments viz., M_1(Greenmanuring *in situ*), M_2(FYM @ 10 t ha^{-1}), M_3(Greenmanuring *in situ* + $ZnSO_4$ @ 50 kg ha^{-1} as basal), M_4(FYM @ 10 t ha^{-1} + $ZnSO_4$ @ 50 kg ha^{-1} as basal) assigned to main plots and four nitrogen levels S_1(No nitrogen), S_2(60 kg N ha^{-1}), S_3(120 kg N ha^{-1}), S_4(180 kg N ha^{-1}) assigned to subplots. At the end of the crop during the two consecutive years, blackgram was sown as a relay crop in the same plots with the

same design to assess the residual effect of treatments given to rice in rice-blackgram sequence. The cultivars used in the study for rice, blackgram were BPT 5204, LBG 752 during 2010 – 11 and BPT 5204, PU – 31 during 2011 – 12.

RESULTS AND DISCUSSION

Growth Parameters

Plant height at maturity was significantly influenced by nitrogen levels but not by organic manures and interaction (Table 1). Irrespective of the organic manures maximum plant height of 107.2 cm and 106.4 cm during 2010 – 11 and 2011 – 12, respectively was recorded with 180 kg N ha^{-1} which was comparable with 120 kg N ha^{-1} during both the years of study. The mean percent increase in plant height at maturity due to nitrogen levels i.e., 60, 120 and 180 kg N ha^{-1} over no nitrogen treatment was 8.2, 16.4 and 18.6 during 2010 – 11 and 8.6, 13.3 and 18.0 during 2011 – 12, respectively.

Number of tillers m^{-2} at maturity was significantly influenced by both organic manures and nitrogen levels but not by their interaction (Table 1). Irrespective of the nitrogen levels maximum number of tillers m^{-2} were recorded with M_3 (Greenmanuring *in situ* + $ZnSO_4$ @ 50 kg ha^{-1} as basal) which was comparable with M_4 (FYM @ 10 t ha^{-1} + $ZnSO_4$ @ 50 kg ha^{-1} as basal) during both the years of study. Irrespective of the organic manures highest number of tillers m^{-2} were recorded with the highest level of nitrogen i.e., S_4 (180 kg N ha^{-1}) which was comparable with S_3 (120 kg N ha^{-1}) during both the years of study.

Drymatter production at maturity was significantly influenced by organic manures and nitrogen levels but not by their interaction (Table 1). Among the organic manures maximum drymatter production was recorded with M_3 treatment (Greenmanuring *in situ* + $ZnSO_4$ @ 50 kg ha^{-1} as basal) which was significantly superior over M_2 (FYM @ 10 t ha^{-1}) but comparable with all other organic manures during both the years of study. Among the nitrogen levels, maximum drymatter production (13335 ka ha^{-1} during 2010 – 11 and 13272 kg ha^{-1} during 2011 – 12) was recorded with highest level of nitrogen i.e., 180 kg N ha^{-1} which was significantly superior over the rest of the nitrogen levels during both the years of study.

Increased nutrient availability at higher levels of nitrogen and lower nutrient loss maintained by Greenmanuring *in situ* + $ZnSO_4$ @ 50 kg ha^{-1} as basal supported for higher growth parameters such as plant height, number of tillers m^{-2} and drymatter production. Similar results were reported by Hemalatha *et al.* (2000), Aruna and Shaik Mohammad (2005), Yadav *et al.* (2009), Anitha and Jose Mathew (2010), Zayed *et al.* (2011).

Days to 50% flowering

Number of days taken by rice to reach 50% flowering was significantly influenced by nitrogen levels but not by organic manures and interaction (Table 1). Irrespective of the year of study, the number of days taken by the rice crop to reach 50% flowering was decreased with increasing rate of N application from 0 to 180 kg N ha^{-1} which might be due to more availability of nitrogen leading to faster growth and development and hence early flowering. These results are in accordance with the findings of Hemalatha *et al.* (2000)

Yield attributes

The number of productive tillers m^{-2} was significantly influenced by organic nutrition and nitrogen levels but not by their interaction during 2010 – 11 and significantly influenced by nitrogen levels only during 2011 – 12 (Table 2).

Irrespective of the nitrogen levels significantly higher number of productive tillers m^{-2} was produced by M_3(Greenmanuring *in situ* + $ZnSO_4$ @ 50 kg ha^{-1} as basal) which was significantly superior over M_2 (FYM @ 10 t ha^{-1}) but was comparable with all other organic manures during 2010 – 11. Irrespective of the organic manures significantly higher number of productive tillers m^{-2} were recorded with higher level of nitrogen i.e., 180 kg N ha^{-1} which was significantly superior over all the other levels of nitrogen during both the years of study. The mean percent increase in number of tillers m^{-2} with the application of 60, 120, 180 kg N ha^{-1} over control was 16.1, 20.4, 24.4 and 8.0, 10.3, 15.4 during 2010 – 11 and 2011 -12, respectively. This increase in productive tillers m^{-2} might be due to maximum utilization of nutrients and other natural resources that enabled rice plant to assimilate sufficient photosynthates resulting in

Table 1: Plant height (cm), number of tillers m^{-2} at maturity and dry matter production (kg ha^{-1}) at maturity and days to 50% flowering as influenced by manures and nitrogen levels.

Treatments	Plant height (cm)		Number of tiller m^{-2} at maturity		Dry matter production at maturity (kg ha^{-1})		Days to 50% flowering	
	2010	2011	2010	2011	2010	2011	2010	2011
Organic manures and Zinc (M)								
M_1	99.1	97.7	427	454	11100	10746	110.8	111.8
M_2	97.5	95.7	412	442	10500	9931	112.1	112.3
M_3	103.6	103.5	451	478	11656	11387	109.7	110.3
M_4	100.6	99.9	436	467	11249	10991	110.6	111.2
SEm±	1.79	3.00	6.9	6.9	195.5	271.8	0.50	0.54
CD (P=0.05)	NS	NS	23.8	24.0	676.5	940.7	NS	NS
CV (%)	6.19	10.49	5.5	5.2	6.1	8.7	1.56	1.67
Nitrogen levels								
S_1	90.4	90.2	404	435	8884	8272	113.9	114.3
S_2	97.4	98.0	424	454	10211	9584	112.0	112.7
S_3	105.2	102.2	444	472	12074	11927	109.8	110.0
S_4	107.2	106.4	454	480	13335	13272	107.4	108.6
SEm±	1.59	1.86	6.3	6.8	175.3	232.3	0.45	0.49
CD (P=0.05)	4.64	5.42	18.4	20.0	511.6	678.1	1.33	1.43
CV (%)	5.50	6.49	5.0	5.1	5.5	7.5	1.42	1.52
Interaction								
M X S	NS	NS	NS	NS	NS	NS	NS	NS

increased drymatter production and these together produced more productive tillers. These results were in conformity with the findings of Hemalatha *et al.* (2000), Sudhakar *et al.* (2006), Kavitha *et al.* (2008), Zayed *et al.* (2011) and Ombir Singh *et al.* (2012).

The number of filled grains per panicle was significantly influenced by organic manures and nitrogen levels but not by their interaction during both the years of study (Table 2). Significantly higher number of filled grains per panicle (175 during 2010 – 11 and 174 during 2011 -12) were recorded with M_3 (Greenmanuring *in situ* + $ZnSO_4$ @ 50 kg ha^{-1} as basal) which was comparable with M_4 (FYM + $ZnSO_4$ @ 50 kg ha^{-1} as basal) during both the years of study. Irrespective of the organic manures highest level of nitrogen (180 kg N ha^{-1}) recorded higher number of filled grains per panicle (189 during 2010 – 11 and 186 during 2011 – 12) which was comparable with 120 kg N ha^{-1} and significantly superior over other levels of nitrogen during both the years of study.

1000 grain weight was significantly influenced by the organic manures and nitrogen levels (Table 2). Irrespective of the nitrogen levels M_3 treatment (Greenmanuring *in situ* + $ZnSO_4$ @ 50 kg ha^{-1} as basal) recorded higher 1000 grain weight which was comparable with M_4 (FYM + $ZnSO_4$ @ 50 kg ha^{-1} as basal) and significantly superior over the rest of the treatments. Among the nitrogen levels, the highest 1000 grain weight was recorded with 180 kg N ha^{-1} and was comparable with 120 kg N ha^{-1} and significantly superior over the rest of the treatments during both the years of study. This might be due to increased transportation of photosynthates from source to sink, which resulted in more filled grains per panicle and 1000 grain weight. These results were in conformity with Kavitha *et al.* (2008) and Zayed *et al.* (2011).

Table 2. Productive tillers m^{-2}, number of filled grains $panicle^{-1}$ and 1000 grain weight (g) of rice as influenced by manures and nitrogen levels.

Treatments	Productive tillers m^{-2}		Number of filled grains $panicle^{-1}$		1000 grain weight (g)	
	2010	2011	2010	2011	2010	2011
Organic manures and Zinc (M)						
M_1	400	407	155	153	16.4	15.4
M_2	383	387	148	145	16.4	15.2
M_3	430	425	175	174	17.2	15.9
M_4	413	415	165	165	16.8	15.8
SEm±	8.47	8.30	5.21	5.08	0.18	0.15
CD (P=0.05)	29.30	NS	18.02	17.57	0.61	0.51
CV (%)	7.21	7.1	11.23	11.05	3.65	3.25
Nitrogen levels						
S_1	353	377	124	123	15.7	15.1
S_2	410	407	150	150	17.0	15.3
S_3	425	416	180	178	16.9	15.7
S_4	439	435	189	186	17.2	16.1
SEm±	5.99	6.2	3.75	3.06	0.17	0.11
CD (P=0.05)	17.49	18.0	10.95	8.92	0.50	0.31
CV (%)	5.10	5.2	8.09	6.66	3.58	2.34
Interaction						
M X S	NS	NS	NS	NS	NS	NS

Rice yield

Grain yield of rice was significantly affected by organic manures and nitrogen levels but not by their interaction during both the years of study (Table 3). Among the organic manures, M_3 (Greenmanuring *in situ* + $ZnSO_4$ @ 50 kg ha^{-1} as basal) recorded the highest grain yield of 5130 kg ha^{-1} and 5062 kg ha^{-1} during the first and second year of study which was comparable with M_4 (FYM @ 10 t ha^{-1} + $ZnSO_4$ @ 50 kg ha^{-1} as basal) and significantly superior over the other organic manures during both the years of study. Irrespective of the organic manures highest grain yield (5895 kg ha^{-1} during 2010 – 11and 5793 kg ha^{-1} during 2011 -12) was recorded with the highest level of nitrogen i.e., 180 kg N ha^{-1} which was significantly superior over the rest of the treatments. Increase in grain yield with increasing levels of nitrogen might be due to better translocation of photosynthates from manures to sink which resulted in production of more yield attributes that reflected in increased grain yields during both the years of study.

Straw yield of rice was significantly influenced by nitrogen levels but not by the organic manures and interaction (Table 3). The highest straw yield (6625 kg ha^{-1} during 2010–11 and 6603 kg ha^{-1} during 2011–12) was recorded with 180 kg N ha^{-1} which was comparable with 120 kg N ha^{-1} during 2010–11 but significantly superior over the rest of the nitrogen levels during 2011 -12. This might be due to continuous and higher supply of N to rice crop resulting in increased growth parameters such as plant height, number of tillers m^{-2} and drymatter production. These results were in confirmation with the findings of Hemalatha *et al.,* (2000), Sudhakar *et al.* (2006) and Zayed *et al.,* (2011).

Blackgram yield

Seed yield of blackgram was significantly influenced by both organic manures and nitrogen levels but not by their interaction during both the years of study (Table 3). The highest seed yield 807 kg ha^{-1} during 2010 -11 and 767 kg ha^{-1} during 2011–12 were recorded with M_3 treatment (Greenmanuring *in situ* + $ZnSO_4$ @ 50 kg ha^{-1} as

Table 3. Yield of rice and blackgram as influenced by manures and nitrogen levels in rice-blackgram sequence.

Treatments	Rice				Blackgram			
	Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})		Seed yield (kg ha^{-1})		Haulm yield (kg ha^{-1})	
	2010	2011	2010	2011	2010	2011	2010	2011
Organic manures and Zinc (M)								
M_1	4708	4441	5907	5521	725	644	1293	1272
M_2	4495	4194	5775	5373	656	592	1247	1234
M_3	5130	5062	6188	589	807	767	1375	1381
M_4	4894	4736	6029	5617	753	706	1326	1316
SEm±	104.3	96.3	122.6	156.7	20.7	14.8	38.6	48.6
CD (P=0.05)	361.0	333.1	NS	NS	71.5	51.1	NS	NS
CV (%)	7.5	7.2	7.1	9.7	9.7	7.6	10.2	12.9
Nitrogen levels								
S_1	3596	3272	5270	4669	663	538	1257	1162
S_2	4331	4237	5587	5147	714	602	1290	1228
S_3	5404	5131	6417	5982	754	734	1333	1364
S_4	5895	5793	6625	6603	810	835	1362	1448
SEm±	77.7	84.6	96.4	102.7	16.3	13.1	19.8	41.0
CD (P=0.05)	226.9	246.9	281.5	299.7	47.6	38.3	57.7	119.6
CV (%)	5.6	6.4	5.6	6.4	7.7	6.7	5.2	10.9
Interaction								
M X S	NS	NS	NS	NS	NS	NS	NS	NS

basal). During 2010 – 11 the yield recorded in M_3 treatment was comparable with M_4. Among the nitrogen levels, highest level of nitrogen 180 kg N ha^{-1} recorded maximum yield of blackgram 810 kg ha^{-1} during 2010 - 11 and 835 kg ha^{-1} during 2011 – 12, respectively. This increase in yield might be due to higher residual effect in those treatments which received highest level of nutrients. Haulm yield of blackgram was significantly influenced by nitrogen levels but not by their organic manures and interaction (Table 3). Among the nitrogen levels tested, highest haulm yield 1362 kg ha^{-1} during 2010–11 and 1448 kg ha^{-1} during 2011–12 were recorded with 180 kg N ha^{-1} which was on a par with 120 kg N ha^{-1} during both the years of study. This increase in blackgram yields might be due to the higher residual fertility in those treatments which received highest level of nutrients. These results were in conformity with Dekamedhi and Medhi (2000), Raju *et al.* (2003). Babou (2005), Senthivelu *et al.* (2009) and Ombir Singh *et al.* (2012).

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