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Manures and Zinc Supplementation Effects in Rice (*Oryza sativa L.,*) – Blackgram (*Vigna mungo L.*) Sequence 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 influence of manures and zinc supplementation effects at different nitrogen levels on productivity and nutrient uptake of rice-blackgram sequence. The experiment was laid out in a split plot design replicated thrice. The study revealed that the highest grain yield of 5130 kg ha^{-1} and 5062 kg ha^{-1} during 2010 and 2011, respectively, was recorded with Greenmanuring *in situ* + $ZnSO_4$ @ 50 kg ha^{-1} as basal which was comparable with FYM 10 t ha^{-1} + $ZnSO_4$ @ 50 kg ha^{-1} as basal in enhancing the productivity of rice during both the years of study. Straw yield was not significantly influenced by organic manures during both the years of study. Significantly higher grain yield, straw yield and harvest index were recorded with the highest level of nitrogen 180 kg N ha^{-1} irrespective of the manure and zinc supplementation. Straw yield and harvest index values were comparable with 120 kg N ha^{-1} during both the years of study. Nutrient uptake (N, P, K and Zn) was significantly influenced by manures and zinc supplementation and nitrogen levels. The highest nutrient uptake was recorded with the greenmanuring *in situ* + $ZnSO_4$ @ 50 kg ha^{-1} as basal at the highest level of nitrogen (180 kg N ha^{-1}) application.

The productivity of blackgram that followed rice in the sequence also increased significantly with manures and zinc supplementation to rice at every level of nitrogen application upto 180 kg N ha^{-1} showing residual benefit of the practice in the system.

Key words : Blackgram, Rice, Manures, Nitrogen levels, Nutrient uptake, 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. There is an urgent need to produce 50% more rice by 2025 to feed ever growing population with the existing limited resources. Plateauing/ decline in rice productivity might be due to low organic matter as well as micronutrient content of soils. Organic manures alone cannot meet the nutrient requirement of crops. 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 the best cropping sequence followed in the 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 the most important in Rice-Blackgram sequence for increasing overall productivity of the sequence.

MATERIAL AND METHODS

The present investigation was conducted during two consecutive years 2010 – 11 and 2011 – 12 on a sandy clay loam soil at Agricultural College Farm, Bapatla. The experiment was laid out in different sites during two consecutive years. 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% during 2010 – 11 and 2011 – 12, respectively. 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

Table 1. Grain yield, straw yield and harvest index of rice as influenced by organic manures and nitrogen levels.

Treatments	Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})		Harvest index (%)	
	2010	2011	2010	2011	2010	2011
Organic manures and Zinc (M)						
M_1	4708	4441	5907	5521	44.0	44.2
M_2	4495	4194	5775	5373	43.5	43.4
M_3	5130	5062	6188	5889	45.0	46.0
M_4	4894	4736	6029	5617	44.4	45.5
SEm±	104.3	96.3	122.6	156.7	0.73	0.80
CD (P=0.05)	361.0	333.1	NS	NS	NS	NS
CV (%)	7.5	7.2	7.1	9.7	5.7	6.2
Nitrogen levels						
S_1	3596	3272	5270	466	40.5	41.2
S_2	4331	4237	5587	5147	43.7	45.2
S_3	5404	5131	6417	5982	45.7	46.1
S_4	5895	5793	6625	6603	47.1	46.7
SEm±	77.7	84.6	96.4	102.7	0.67	0.70
CD (P=0.05)	206.9	246.9	281.5	299.7	1.94	2.03
CV (%)	5.6	6.4	5.6	6.4	5.2	5.4
Interaction						
M X S	NS	NS	NS	NS	NS	NS

replicated three times. The treatments comprised of four organic nutrition treatments 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 and blackgram were BPT 5204, LBG 752 during 2010 and BPT 5204, PU – 31 during 2011 – 12.

RESULTS AND DISCUSSION

Rice yield

Grain yield of rice was significantly influenced by manures and nitrogen levels but not by interaction (Table 1). The highest grain yield of 5130 kg ha^{-1} during 2010 and 5062 kg ha^{-1} during 2011 was recorded with greenmanuring *in situ* + $ZnSO_4$ @ 50 kg ha^{-1} (M_3) as basal. Irrespective of the manures, the highest grain yield was recorded with the highest level of nitrogen i.e., 180 kg N ha^{-1} during both the years of study. Straw yield and harvest index were significantly influenced by nitrogen level but not by manures and interaction (Table 1). The maximum straw yield of 6625 kg ha^{-1} and 6603 kg ha^{-1} and harvest index 47.1 and 46.7 during 2010 and 2011 respectively, were recorded with 180 kg N ha^{-1}. The harvest index values recorded at 180 kg N ha^{-1} were comparable with 120 kg N ha^{-1} during both the years of study (Table 1). The increase in harvest index with increasing levels of nitrogen might be due to better translocation of assimilates from source to sink. Similar results were also reported by Zayed *et al.* (2011), Ombir Singh *et al.* (2012).

Nutrient uptake

Nutrient uptake (N,P,K and Zn) of rice crop at maturity was significantly influenced by manures and nitrogen levels but not by their interaction during

Table 2. Total nitrogen, phosphorus, potassium and zinc uptake of rice at maturity as influenced by organic manures and nitrogen levels.

Treatments	Total Nitrogen uptake (kg ha^{-1})		Total Phosphorus uptake (kg ha^{-1})		Total Potassium uptake (kg ha^{-1})		Total Zinc uptake (kg ha^{-1})	
	2010	2011	2010	2011	2010	2011	2010	2011
Organic manures and Zinc (M)								
M_1	98.7	87.2	14.26	13.17	95.9	87.7	0.265	0.261
M_2	91.0	79.3	12.40	11.25	88.9	82.0	0.227	0.230
M_3	112.5	108.6	19.12	17.62	109.7	104.2	0.366	0.326
M_4	105.0	96.7	15.98	14.64	102.3	95.7	0.320	0.294
SEm±	2.7	1.8	0.45	0.42	2.6	2.9	0.0055	0.0061
CD (P=0.05)	9.3	6.2	1.54	1.46	9.1	10.1	0.019	0.021
CV (%)	9.2	6.6	9.99	10.32	9.2	10.9	6.4	7.6
Nitrogen levels								
S_1	70.4	59.1	12.95	10.64	86.2	76.0	0.179	0.175
S_2	88.7	77.8	13.51	13.15	91.4	84.5	0.244	0.234
S_3	115.4	105.7	16.93	15.05	108.5	100.3	0.341	0.311
S_4	132.6	129.2	18.37	17.83	110.8	108.9	0.413	0.389
SEm±	1.8	1.5	0.36	0.27	1.8	2.0	0.0054	0.0048
CD (P=0.05)	5.2	4.5	1.04	0.78	5.2	5.8	0.016	0.014
CV (%)	6.1	5.8	8.02	6.51	6.2	7.4	6.3	6.03
Interaction								
M X S	NS	NS	NS	NS	NS	NS	NS	NS

both the years of study (Table 2). Irrespective of the nitrogen levels, the highest total nitrogen uptake of 112.5 kg ha^{-1} and 108.6 kg ha^{-1}, phosphorus uptake at 19.12 kg ha^{-1} and 17.62 kg ha^{-1}, potassium uptake of 109.7 kg ha^{-1} and 104.2 kg ha^{-1} and zinc uptake at 0.366 kg ha^{-1} and 0.326 kg ha^{-1} were recorded during the first and second years of study, respectively, with greenmanuring *in situ* + $ZnSO_4$ @ 50 kg ha^{-1} as basal (M_3) which was significantly superior to other treatments (Table 2).

Irrespective of the manures, significantly highest total nitrogen uptake 132.6 kg ha^{-1} and 129.2 kg ha^{-1}, total phosphorus uptake 18.37 kg ha^{-1} and 17.83 kg ha^{-1}, total potassium uptake 110.8 kg ha^{-1} and 108.9 kg ha^{-1}, total zinc uptake 0.413 kg ha^{-1} and 0.389 kg ha^{-1} were recorded during 2010 and 2011, respectively, with highest level of nitrogen 180 kg N ha^{-1}(Table 2). This increase in nutrient uptake might be due to profuse plant growth and other growth characters such as number of tillers, drymatter production and nutrient concentration in grain and straw of rice. Similar results were also reported by Dwivedi and Thakur (2000), Behera and Nandram (2004) and Zayed *et al.* (2011).

Available nutrient status of soil

The available nitrogen status of the soil was significantly influenced by manures and nitrogen levels but not by their interaction (Table 3). Significantly higher available nitrogen (162.3 kg ha^{-1} and 177. 3 kg ha^{-1} respectively) was recorded with greenmanuring *in situ* + $ZnSO_4$ @ 50 kg ha^{-1} as basal (M_3) during 2010 and 2011, respectively. Irrespective of the manures, highest level of nitrogen 180 kg N ha^{-1} recorded the highest available nitrogen in soil which was significantly superior to other levels of nitrogen during both the years of study.

Table 3. Available nutrient status after harvest of rice as influenced by manures and nitrogen levels.

Treatments	Avilable Nitrogen (kg ha^{-1})		Avilable Phosphorus (kg ha^{-1})		Avilable Potassium (kg ha^{-1})		Avilable Zinc (kg ha^{-1})	
	2010	2011	2010	2011	2010	2011	2010	2011
Organic manures and Zinc (M)								
M_1	126.4	150.5	25.0	27.7	220.3	226.3	0.63	0.81
M_2	107.4	125.8	20.9	26.3	205.9	223.4	0.66	0.85
M_3	162.3	177.3	28.8	31.4	245.6	244.4	1.05	1.10
M_4	135.1	157.7	26.8	30.0	235.2	237.1	1.08	1.14
SEm±	5.1	5.0	0.8	1.0	3.5	4.1	0.030	0.033
CD (P=0.05)	17.6	17.4	2.9	3.6	12.2	14.3	0.10	0.11
CV (%)	13.3	11.4	11.5	12.4	5.4	6.2	12.8	11.7
Nitrogen levels								
S_1	101.6	118.7	26.1	27.9	219.8	231.1	0.82	0.96
S_2	122.0	143.3	25.1	27.6	232.2	233.3	0.85	1.01
S_3	144.0	163.6	25.0	29.9	225.3	234.0	0.89	0.96
S_4	164.7	185.8	25.3	29.9	229.8	232.8	0.86	0.96
SEm±	3.7	3.7	0.7	0.8	3.4	3.6	0.027	0.030
CD (P=0.05)	10.9	10.8	NS	NS	NS	NS	NS	NS
CV (%)	9.7	8.4	9.6	10.1	5.2	5.3	10.8	10.7
Interaction								
M X S	NS	NS	NS	NS	NS	NS	NS	NS

The available phosphorus, available potassium and available zinc in the soil was significantly influenced by manures but not by the nitrogen levels (Table 3). The higher available phosphorus (25.3 kg ha^{-1} and 29.9 kg ha^{-1}), potassium (229.8 kg ha^{-1} and 232.8 kg ha^{-1}) and zinc (0.86 ppm and 0.96 ppm) were recorded with greenmanuring *in situ* + $ZnSO_4$ @ 50 kg ha^{-1} as basal during 2010 and 2011, respectively.

Increase in available P with greenmanure might be due to P solubilising capacity of greenmanure. Organic acids and CO_2 liberated during the decomposition of green matter might have formed complex substances with metal ions and increased the concentration of P in the soil. The green manure registered significantly higher K availability in soil due to their easy decomposition of mineral constituents and their effect on dislodging the exchangeable K in the solution. Increase in available Zn in soil after harvest of rice might be due to increased supply of nutrients through the application of $ZnSO_4$ @ 50 kg ha^{-1} as basal resulted in higher availability of zinc from soil reservoir and also from added sources of organic manures. These results were in conformity with Vinay Singh (2006) Thakur *et al.* (2009) and Upadhyaya *et al.* (2011).

Blackgram yield

Seed yield of black gram was significantly influenced by manures and nitrogen levels but not by their interaction (Table 4). The highest seed yield of 807 kg ha^{-1} and 767 kg ha^{-1} during 2010 – 11 and 2011 -12, respectively were recorded with greenmanuring *in situ* + $ZnSO_4$ @ 50 kg ha^{-1} as basal (M_3) which was significantly superior over the other treatments. Irrespective of the manures, the highest seed yield of 810 kg ha^{-1} and 835 kg ha^{-1} during 2010 -11 and 2011 – 12, respectively was recorded with the highest level of nitrogen i.e., 180 kg N ha^{-1}.

Table 4. Residual effect of organic manures and nitrogen levels on the yield of blackgram crop in rice-blackgram sequence.

Treatments	Seed yield (kg ha^{-1})		Haulm yield (kg ha^{-1})		Harvest index (%)	
	2010 - 11	2011 - 12	2010 - 11	2011 - 12	2010 - 11	2011 - 12
Organic manures and Zinc (M)						
M_1	725	644	1293	1272	35.8	33.6
M_2	656	592	1247	1234	34.4	32.4
M_3	807	767	135	1381	36.9	35.5
M_4	753	706	1326	1316	36.2	34.7
SEm±	20.7	13.1	38.6	48.6	0.8	1.0
CD (P=0.05)	71.5	38.3	NS	NS	NS	NS
CV (%)	7.7	6.7	10.2	12.9	7.9	10.2
Nitrogen levels						
S_1	663	538	1257	1162	34.5	31.7
S_2	714	602	1290	1228	35.5	33.1
S_3	754	734	1333	1364	36.1	35.0
S_4	810	835	1362	1448	37.3	36.5
SEm±	16.3	13.1	19.8	41.0	0.5	0.8
CD (P=0.05)	47.6	38.3	57.7	119.6	1.5	2.3
CV (%)	7.7	6.7	5.2	10.9	5.1	8.0
Interaction						
M X S	NS	NS	NS	NS	NS	NS

Haulm yield and harvest index values were significantly influenced by nitrogen levels but not by manures and their interaction (Table 4). The highest haulm yield of 1362 kg ha^{-1} and 1448 kg ha^{-1} and harvest index 37.3% and 36.5% were recorded with highest level of nitrogen i.e., 180 kg N ha^{-1} which was significantly superior to the rest of the nitrogen levels.

This increase in blackgram yield might be due to higher content of soil available N, P, K and Zn in those treatments which received the highest levels of these nutrients. These results were in conformity with those of Dekamedhi and Medhi (2000), Raju *et al.* (2003), Babou (2005), Senthivelu *et al. (*2009) and Ombir Singh *et al.* (2012).

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