

Studies on Yield Maximization in Rice Based Cropping Sequence of Northern Coastal Cauvery Delta

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Abstract

A field investigation was carried out at the Experimental farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar during 2008 - 2010 to evaluate the yield maximization in Rice based cropping sequence of Northern coastal Cauvery delta. The result revealed that the yield was maximum with the application 100 per cent Recommended dose of fertilizer + Vermicompost @ 5 t ha⁻¹ + Azospirillum @ 2 kg ha⁻¹ in rice and where as in black gram the yield was higher with the application of 2 per cent DAP + Bio-fertilizers (*Rhizobium* + *Phosphobacteria*). This was followed by the application of 100 per cent Recommended dose of fertilizer + Enriched FYM @ 12.5 t ha⁻¹ + Azospirillum @ 2 kg ha⁻¹ in rice and application of 40 ppm NAA + Bio-fertilizers (*Rhizobium* + *Phosphobacteria*) in black gram.

Rice - black gram cropping sequence plays a significant role in food security of India. Growing of two crops in a year involves heavy removal of plant nutrients, which diminishes the soil fertility. It is therefore necessary to judiciously manage the inflow of organic sources of nutrients, and their integration with fertilizers, bio-fertilizers and organic manures and recycling of crop residues, besides the adoption of package of practices by the Indian farmers. Application of organic materials along with inorganic fertilizers leads to increased productivity of the system and sustained soil health for a longer period (Gawai and Pawar. 2006). Use of organic materials not only increases the nutrient status of the soils, but also improves various physical, chemical and biological properties of soils and leads to increased fertilizer use efficiency.

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Supplementary Tables only on online edition

Due to escalation of fertilizer prices and associated environment problem the crisis has necessitated in search for alternative sources of manure for integrated nutrient management, which includes organic manure, crop residues, bio-fertilizers and inclusion of a pulse to sustain the rice based cropping system. Keeping this in view, a field investigation was carried out to study the yield maximization in rice based cropping sequence (rice-blackgram) using integrated nutrient management (INM) practices.

Materials and Methods

A field experiment was carried out at the Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar during 2008 - 2010 to study the yield maximization in Rice based cropping sequence of Northern coastal Cauvery delta. The experiment was conducted in split - plot design replicated thrice in permanent fixed layout with three main plots viz., Control (M₁), 100 per cent Recommended dose of fertilizers (M₂), 75 per cent Recommended dose of fertilizers (M₃) and six organic manure and bio-fertilizer treatment as the sub plot viz., S₁-FYM @ 12.5 t ha⁻¹ + Azospirillum (2 Kg ha⁻¹), S₂ - Vermicompost @ 5 t ha⁻¹ + Azospirillum (2 Kg ha⁻¹), S₃ - EFYM (Enriched farm yard manure) @ 12.5 tons ha⁻¹ + Azospirillum (2 Kg ha⁻¹), S₄ - Neemcake @ 500 kg ha⁻¹ + Azospirillum (2 Kg ha⁻¹), S₅ - Pressmud @ 12.5 t ha⁻¹ + Azospirillum (2 Kg ha⁻¹), S₆ - Crop residue (Sunflower) for rice. The residue crop black gram contains three main plots viz., M₁-Control, M₂-2 per cent DAP and M₃-40 ppm NAA and six sub plots viz., S₁ to S₆ - Bio-fertilizers (*Rhizobium* and *Phosphobacteria*). The experimental soil was clayey loam in texture with low, medium and high in available nitrogen, available phosphorus and available potassium, respectively. For rice ADT-36 (short duration variety) and T9 and ADT-3 for blackgram were chosen for this study. Organics, inorganic fertilizers and bio-fertilizers were applied as per

the treatment schedule. Standard cultivation practices were followed. Enriched farm yard manure is prepared by mixing super phosphate (@ 750 kg ha⁻¹) with decomposed farmyard manure. After mixing, it was heaped and plastered with red earth slurry and incubated for 30 days.

Results and Discussion

Rice

The crop performance with respect to yield (Tables 1, 2; supplementary Tables 3, 4) was significantly improved by combined application of organic, inorganic and bio-fertilizers. In first crop rice yield parameters viz., number of panicles m⁻², number of filled grains panicle⁻¹ and thousand grain weight increased significantly by the application of 100 per cent recommended dose of fertilizers + Vermicompost @ 5 tons ha⁻¹ + *Azospirillum* (2 Kg ha⁻¹). The above treatment combination resulted in the higher yield of 7107 and 8271 kg ha⁻¹ respectively. This may be attributed to higher availability of nutrients in vermicompost, increased availability of both the native and applied nutrients and better source and sink relationship which contributed to better dry matter production at all the stages of crops growth leading to the production of favourable yield components. In addition, the presence of plant growth influencing substances such as plant growth hormones and humic acids in vermicompost has also been suggested as a possible factor contributing to increased yield (Arancon *et al.*, 2003). Organic treatments stimulated soil biological activity probably due to the synergism of soil and organic material, micro-organisms or a stimulation of microbial growth by organic compounds added with the vermicompost. These results are in conformity with the findings of Kumar and Singh (2008), Marinari *et al.*, (2000), Gawai and Pawar (2006).

Black gram

The higher residual effect was realized in black gram along with the application of 2 per cent DAP + Bio-fertilizer (*Azospirillum* + *Phosphobacteria*) (Tables 5, 6, 7 and Fig 2). The *Rhizobium* inoculation formed good nodulation and increased black gram showing effective symbiosis which might have left appreciable amount of N to increased yield. Foliar application of DAP might have been absorbed into the plant system and translocated more efficiently to the developing pods and further

aided for proper filling up of the seeds resulting in higher yield. *Phosphobacteria* application made the insoluble phosphates present in the soil into soluble forms by secreting organic acids resulting in effective solubilization and utilization of phosphorus. These findings are in agreement with Subramani and Solaimalai (2000), Ramanathan *et al.*, (2004) and Sirinivasa Perumal and Sundari (2004).

Conclusion

The results have evidently proved the advantage of combining recommended dose of fertilizers with organic manures and bio-fertilizers for rice and inclusion of 2 per cent DAP along with bio-fertilizers increases the black gram yield. Therefore, this study indicated that the yield of rice and black gram would be improved by the conjunctive nutrient management.

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Table.1: Rice - Grain yield (Kg/ha)

Navarai 2008					Kuruvai 2008			
Sub treatment	Main Treatment				Main Treatment			
	M ₁	M ₂	M ₃	Mean	M ₁	M ₂	M ₃	Mean
S ₁	3417	6568	4953	4979.33	3913	7654	5776	5781.00
S ₂	3941	7107	5510	5519.33	4530	8271	6389	6396.67
S ₃	3674	6839	5221	5244.67	4212	7953	6092	6085.67
S ₄	2894	6035	4449	4459.33	3277	7021	5170	5156.00
S ₅	3158	6284	4695	4712.33	3596	7338	5487	5473.67
S ₆	2625	5771	4220	4205.33	2978	6703	4872	4851.00
Mean	3284.83	6434.00	4841.33		3751.00	7490.00	5631.00	

	MAIN	SUB	MxS	SxM	MAIN	SUB	MxS	SxM
SED	36.94	52.47	90.82	90.88	48.06	72.56	124.38	125.67
CD(p=0.05)	102.57	107.16	196.51	185.61	133.44	148.19	267.68	256.67

M₁= Control, M₂= 100% RDF, M₃= 75%RDF, S₁= FYM+ Azospirillum, S₂= Vermicompost+ Azospirillum, S₃= EFYM+ Azospirillum, S₄= Neemcake+ Azospirillum, S₅= Pressmud + Azospirillum, S₆= Crop residue (Sunflower)

Table 2 Black gram - Grain yield (Kg/ha)

May 2008					January 2009			
Sub treatment	Main Treatment				Main Treatment			
	M ₁	M ₂	M ₃	Mean	M ₁	M ₂	M ₃	Mean
S ₁	705	1317	1254	1092.00	828	1519	1450	1265.67
S ₂	832	1564	1503	1299.67	963	1799	1728	1496.67
S ₃	771	1440	1379	1196.67	894	1656	1587	1379.00
S ₄	578	1073	1014	888.33	688	1235	1166	1029.67
S ₅	641	1193	1134	989.33	757	1378	1307	1147.33
S ₆	517	952	891	786.67	620	1094	1027	913.67
Mean	674.00	1256.50	1195.83		791.67	1446.83	1377.50	

	MAIN	SUB	MxS	SxM	MAIN	SUB	MxS	SxM
SED	11.53	12.89	23.42	22.32	11.24	16.72	28.73	28.96
CD(p=0.05)	32.03	26.32	52.00	45.60	31.23	34.15	61.91	59.15

₁-Control, M₂-2 per cent DAP, M₃-40 ppm NAA, S₁ to S₆ - Bio-fertilizers (*Rhizobium* and *Phosphobacteria*)

Supplementary Table.3A: Effect of inorganic fertilizer and integrated nutrient management on number of panicle/ m² of rice

Samba 2008					Samba 2009			
	Main Treatment				Main Treatment			
Sub treatment	M ₁	M ₂	M ₃	Mean	M ₁	M ₂	M ₃	Mean
S ₁	642	1111	878	877.00	739	1271	1007	1005.66
S ₂	723	1193	956	957.33	828	1358	1092	1092.66
S ₃	684	1152	917	917.66	785	1314	1049	1049.33
S ₄	558	1030	803	797.00	652	1179	922	917.66
S ₅	599	1070	840	836.33	695	1227	964	962.00
S ₆	516	994	762	757.33	609	1137	874	873.33
Mean	620.33	1091.66	859.33		718.00	1247.66	984.66	

	MAIN	SUB	MxS	SxM	MAIN	SUB	MxS	SxM
SED	6.01	8.78	15.13	15.21	7.19	10.41	17.96	18.03
CD(p=0.05)	16.71	17.94	32.67	31.07	19.96	21.26	38.80	36.83

M₁= Control, M₂= 100% RDF, M₃= 75%RDF, S₁= FYM @ 12.5 t ha⁻¹+ Azospirillum, S₂= Vermicompost @ 5 t ha⁻¹+ Azospirillum, S₃= EFYM @ 12.5 t ha⁻¹ + Azospirillum, S₄= Neemcake @ 500 kg ha⁻¹ + Azospirillum, S₅= Pressmud @ 500 kg ha⁻¹ + Azospirillum, S₆= Crop residue (Sunflower)

Supplementary Table 3B : Effect of inorganic fertilizer and integrated nutrient management on number of filled grains/ panicle of rice

Samba 2008					Samba 2009			
Sub treatment	Main Treatment				Main Treatment			
	M ₁	M ₂	M ₃	Mean	M ₁	M ₂	M ₃	Mean
S ₁	102.72	161.70	131.54	131.98	102.78	164.42	133.10	133.43
S ₂	111.79	171.59	141.50	141.61	112.74	174.39	142.83	143.32
S ₃	107.70	166.67	136.52	136.96	107.77	169.40	137.97	138.38
S ₄	93.07	151.66	121.83	122.18	99.44	152.80	123.19	125.14
S ₅	97.59	156.72	126.81	127.04	100.79	158.56	128.14	129.16
S ₆	90.00	146.59	116.77	117.78	98.19	147.81	117.73	121.24
Mean	100.47	159.15	129.16		103.61	161.23	130.49	

	MAIN	SUB	MxS	SxM	MAIN	SUB	MxS	SxM
SED	0.36	0.34	0.70	0.68	0.44	0.37	0.81	0.79
CD(p=0.05)	0.72	0.69	1.41	1.39	0.89	0.74	1.62	1.59

M₁= Control, M₂= 100% RDF, M₃= 75%RDF, S₁= FYM @ 12.5 t ha⁻¹+ Azospirillum, S₂= Vermicompost @ 5 t ha⁻¹+ Azospirillum, S₃= EFYM @ 12.5 t ha⁻¹+ Azospirillum, S₄= Neemcake @ 500 kg ha⁻¹+ Azospirillum, S₅= Pressmud @ 500 kg ha⁻¹+ Azospirillum, S₆= Crop residue (Sunflower)

Supplementary Table 3C: Effect of inorganic fertilizer and integrated nutrient management on thousand grain weight (gm) of rice

Samba 2008					Samba 2009			
	Main Treatment				Main Treatment			
Sub treatment	M ₁	M ₂	M ₃	Mean	M ₁	M ₂	M ₃	Mean
S ₁	20.38	20.77	20.61	20.58	22.38	22.95	22.66	22.66
S ₂	20.48	20.81	20.67	20.65	22.51	23.02	22.76	22.76
S ₃	20.41	20.79	20.65	20.61	22.45	22.99	22.72	22.72
S ₄	20.29	20.72	20.57	20.52	20.46	22.86	22.58	21.96
S ₅	20.36	20.75	20.59	20.56	21.47	22.92	22.63	22.34
S ₆	20.22	20.70	20.50	20.47	20.37	22.81	22.54	21.90
Mean	20.35	20.75	20.59		21.60	22.92	22.64	

	MAIN	SUB	MxS	SxM	MAIN	SUB	MxS	SxM
SED	NS	NS	NS	NS	NS	NS	NS	NS
CD(p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

M₁= Control, M₂= 100% RDF, M₃= 75%RDF, S₁= FYM @ 12.5 t ha⁻¹+ Azospirillum, S₂= Vermicompost @ 5 t ha⁻¹+ Azospirillum, S₃= EFYM @ 12.5 t ha⁻¹ + Azospirillum, S₄= Neemcake @ 500 kg ha⁻¹ + Azospirillum, S₅= Pressmud @ 500 kg ha⁻¹ + Azospirillum, S₆= Crop residue (Sunflower)

Supplementary Table 4A : Effect of DAP, NAA and residual effect of inorganic fertilizers and organic manures on number of pods plant⁻¹ of blackgram

January 2009					January 2010			
	Main Treatment				Main Treatment			
Sub treatment	M ₁	M ₂	M ₃	Mean	M ₁	M ₂	M ₃	Mean
S ₁	20	33	32	28.33	21	39	37	32.33
S ₂	22	39	38	33.00	24	46	44	38.00
S ₃	21	36	35	30.67	22	42	40	34.67
S ₄	17	28	27	24.00	17	31	30	26.00
S ₅	18	31	29	26.00	19	35	33	29.00
S ₆	15	25	24	21.33	15	28	26	23.00
Mean	18.83	32.00	30.83		19.67	36.83	35.00	

	MAIN	SUB	MxS	SxM	MAIN	SUB	MxS	SxM
SED	0.07	0.30	0.48	0.52	0.23	0.47	0.78	0.81
CD(p=0.05)	0.21	0.61	0.99	1.06	0.65	0.96	1.64	1.66

M₁=Control, M₂= 2% DAP spray, M₃=40 ppm NAA, S₁ to S₆ =Residual organic manure + *Rhizobium* + Phosphobacteria

Supplementary Table 4B: Effect of DAP, NAA and residual effect of inorganic fertilizers and organic manures on pod length (cm) of blackgram

January 2009					January 2010			
	Main Treatment				Main Treatment			
Sub treatment	M ₁	M ₂	M ₃	Mean	M ₁	M ₂	M ₃	Mean
S ₁	4.62	7.04	6.81	6.15	7.03	11.22	10.77	9.67
S ₂	5.11	8.04	7.78	6.97	7.85	12.96	12.53	11.11
S ₃	4.86	7.53	7.28	6.61	7.42	12.09	11.66	10.39
S ₄	4.13	6.08	5.82	5.83	6.20	9.52	9.11	8.27
S ₅	4.37	6.57	6.34	5.58	6.61	10.35	9.93	8.96
S ₆	3.87	5.58	5.35	4.93	5.77	8.69	8.26	7.57
Mean	4.49	6.80	6.74		6.81	10.80	10.37	

	MAIN	SUB	MxS	SxM	MAIN	SUB	MxS	SxM
SED	0.03	0.05	0.09	0.09	0.09	0.05	0.12	0.09
CD(p=0.05)	0.09	0.10	0.19	0.18	0.25	0.11	0.30	0.20

M₁=Control, M₂= 2% DAP spray, M₃=40 ppm NAA, S₁ to S₆ =Residual organic manure + *Rhizobium* + Phosphobacteria