PRODUCTIVITY ENHANCEMENT OF RICE IN LOW LAND RANGES OF CAUVERY DELTA REGIONS THROUGH SUSTAINABLE NUTRIENT MANAGEMENT STRATEGIES

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Abstract

Field studies were undertaken to study the influence of seed soaking with nutrients, bio-chemicals and bio-fertilizers in combination with three levels of fertilizers on the growth and yield of paddy cv. CO 43 and ADT 36 raised in 'samba' (August - January) 1997-98 and 'kuruvai' 1998 (May to September) respectively at the Experimental Farm, Department of Agronomy, Annamalai University. In both the seasons, the growth and yield attributes of rice were greatly increased by the application of 120: 38: 38 N, P_2O_5 and K_2O kg ha^{-1} in conjunction with seed soaking with KH_2PO_4 (2%) + Penshibao (0.01%) + *Azospirillum* (600g/ha) + phosphobacteria (600g/ha). In 'samba' season of 1997-98, this treatment combination resulted in maximum grain yield (5790 kg ha^{-1}) and straw yield (8058 kg ha^{-1}), which was 33.25 and 28.18 per cent higher than the control (unsoaked at M_1 level). In 'kuruvai' season of 1998, the corresponding increase in grain and straw yield over the control was 28.64 and 21.80 per cent. Besides, the uptake of NPK by rice in both the seasons was significantly increased by the above treatment combination. Net return ha^{-1} and return per rupee invested were also considerably increased.

Key words: Agricultural productivity, paddy cultivation, cropping pattern, sustainable nutrient management strategies, etc.

1. Introduction

Rice is the most important and extensively grown food crop in India and it is the staple food for more than half of the world's population. The average annual production of rice in India is only 2.8 t ha-1 which is far lower than the yield of rice obtained in countries like Japan, China and Korea. The yield gap could be attributed to various reasons viz. inadequate plant population, non-judicious application of fertilizers and pesticides and poor water management practices. Producing vigorous seedlings by proper manorial management at nursery and sustaining good vigor and stand of the crop at main field by rational integrated nutrient management will greatly help in increasing the rice production. As regards crop vigor, better manuring practices that supplement the crop nourishment commencing rice from nursery up to main field attain prime importance. Seedling of

crop has been shown to improve due to seed coating with bio-fertilizers, growth regulators and chemical nutrients.

Use of biofertilizers such as Azospirillium and Phosphobacteria is gaining momentum, in the context of prohibitive cost of N and P fertilizers. Fixing nitrogen by Azospirillum was well documented. Besides, it has been shown to produce growth promoting substances which may increase seed germination and improve the initial vigor of plants, which ultimately contribute to increased yield. Phosphobacteria mobilize the unavailable form of phosphorus into available form. Seed hardening with two per cent KH_2PO_4 has been reported to increase the germination percentage, seedling vigur, grain yield and also benefit: cost ratio. Bio-chemicals have contributed a great deal, to the progress of agricultural sciences. The growth and yield of many crop plants could be influenced by applying small amount of these chemicals to crops, as either seed treatment or soil application. Taking these aspects into consideration, a field investigation was taken up.

2. Materials and methods

Investigations were undertaken to study the effect of seed soaking with nutrients, bio-chemicals and bio-fertilizers in conjunction with three levels of fertilizers on the growth and yield of paddy cv. CO 43 and ADT 36 raised in 'samba' (August-January) 1997-98 and 'kuruvai' 1998 (May to September) respectively at the Experimental Farm, Department of Agronomy, Annamalai University. There were eight seed treatments viz., (S_1) seed soaking with KH_2PO_4 (2%), (S_2) seed soaking with KH_2PO_4(2%) + Penshibao (0.01%) , (S_3) seed soaking with KH_2PO_4 (2%) + Penshibao (0.01%) + *Azospirillum* (600g/ha), (S_4) seed soaking with KH_2PO_4(2%) + Penshibao (0.01%) + phosphobacteria (600g/ha), (S_5) seed soaking with KH_2PO_4 (2%) + Penshibao (0.01%) + *Azospirillum* (600g/ha) + phosphobacteria (600g/ha), (S_6) seed soaking with KH_2PO_4 (2%) + *Azospirillum* (600g/ha). (S_7) seed soaking with KH_2PO_4 (2%) + *Azospirillum* (600g/ha) + Phosphobacteria (600g/ha) and, (S_8) control (no soaking). The treatments were replicated thrice adopting Randomized block design. In the main field, three levels of NPK fertilizers viz., M_1 (120: 38: 38 N, P_2O_5 and K_2O kg ha^{-1} -recommended schedule), M_2 (75% N: 100% P_2O_5: 100% K_2O of recommended schedule) and M_3 (75% N: 75% P_2O_5: 100% K_2O of recommended schedule) were tested as main plot treatments and nursery treatments numbering eight were superimposed as sub-plot treatments, all replicated thrice adopting split plot-design.

3. Results and discussions

Nursery studies (Table 1): In seasons, the treatment (S_5) seed soaking with potassium dihydrogen phosphate (2%) + Penshibao (0.01%) + *Azospirillum* (600g/ha) + phosphobacteria (600g/ha) markedly influenced the germination percentage, shoot and root lengths, root volume, biomass and vigour index. Synergistic and cumulative action of KH2PO4, biofertilizers *viz.*, Azospirillum and Phosphobacteria and micronutrient rich Penshibao might have constituted to

favourable seedling characteristics including vigour index. Similar result with organics and inorganics and biofertilizers were reported by Jayabal and Kuppuswamy (1998).

Main field studies (Table 2): All the treatments significantly influenced the grain yield. Among the three levels of NPK tested as main treatments, M_1 (recommended fertilizer level - 120: 38: 38 N, P_2O_5 and K_2O kg ha^{-1}) produced the highest grain yield. The least was observed with 75 per cent each of N and P_2O_5 and 100 per cent K_2O of recommended manurial schedule along with no seed soaking (M_3S_8). The higher manurial dose probably gave better nourishment to rice resulting in higher panicle number and filled grain percentage. In addition to that, enhanced availability of Nitrogen due to fixation of N by Azospirillum, increased availability of phosphorus due to the effect of KH2PO4, solubilization of soil P by phosphobacteria and increased availability of micronutrients such zinc, boron, etc. due to inclusion of Penshibao, could have been responsible for the production of vigorous seedlings at nursery. Proper nutritional environment given to nursery could be expected to have its positive effect on the nutrophysiological process of the transplanted rice seedlings leading to the production of favourable yield components.

Economics (Table 3): The recommended manurial schedule along with seed soaking in KH_2PO_4 + Penshibao + *Azospirillum* + Phosphobacteria (M_1S_5) registered the highest net return of Rs. 17,682 and Rs. 16,374 ha^{-1} and highest return per rupee invested of Rs. 2.43 and Rs. 2.32 in 'samba' and 'kuruvai' season respectively. Treatment M_2S_5 (75% N, 100% P_2O_5 and 100% K_2O of recommended schedule along with seed soaking of KH_2PO_4 + Penshibao + *Azospirillum* + Phosphobacteria) was found to be the next best in terms of net return and return per rupee invested. From the results, it is evident that though M_1S_5 gave the highest net return ha^{-1} and return per rupee invested, treatment combination of M_2S_5 was found cost effective in view of saving of 25 per cent of N-fertilizer.

4. Reference

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TABLE 1

SEEDLING CHARACTERS OF RICE

Treatment	Germination percentage		Shoot length (cm) on 21 DAS		Root length (cm) on 21 DAS		Root volume (cc) on 21 DAS		Biomass (g) on 21 DAS		Vigour index on 21 DAS (Biomass)	
	Samba	Kuruvai	Samba	Kuruvai	Samba	Kuruvai	Samba	Kuruvai	Samba	Kuruvai	Samba	Kuruvai
S1 (KH_2PO_4)	87.64 (69.41)	85.32 (67.47)	30.10	30.45	15.10	14.21	1.12	1.12	6.90	7.20	605	614
S2 (KH_2PO_4 + Penshibao)	88.92 (70.55)	86.72 (68.62)	31.12	32.45	15.84	15.12	1.25	1.29	7.16	7.46	637	647
S3 (KH_2PO_4 + Penshibao + Azos)	91.84 (73.40)	90.12 (71.67)	33.62	34.79	17.86	17.12	1.64	1.76	8.00	8.21	735	739
S4 (KH_2PO_4 + Penshibao + Phospho)	90.86 (72.40)	88.96 (70.59)	32.70	33.90	17.11	16.41	1.53	1.60	7.72	7.96	701	708
S5 (KH_2PO_4 + Penshibao + Azos + Phospho	92.77 (74.40)	91.36 (72.90)	34.65	35.68	18.64	17.98	1.80	1.92	8.25	8.52	765	778
S6 (KH_2PO_4 + Azos)	89.21 (70.82)	87.21 (69.04)	31.48	32.84	16.03	15.43	1.34	1.39	7.28	7.59	649	662
S7 (KH_2PO_4 + Azos + Phospho)	90.43 (71.97)	88.44 (70.12)	32.40	33.72	16.84	16.22	1.48	1.54	7.54	7.84	682	693
S8 (No soaking)	85.21 (67.38)	84.16 (66.90)	28.40	29.12	14.21	13.54	1.00	0.96	6.61	6.96	563	586
Mean	89.61 (71.19)	87.78 (69.54)	31.80	32.86	16.45	15.75	1.39	1.44	7.43	7.71	667.13	678.38
S. Ed.	0.36	0.37	0.36	0.35	0.32	0.30	0.05	0.07	0.11	0.09	14.33	11.01
C.D. (p = 0.05)	0.71	0.74	0.72	0.69	0.64	0.59	0.11	0.13	0.22	0.19	28.65	22.01

Figures in parentheses are angular transformed

TABLE 2
GRAIN YIELD (Kg ha^{-1})

Sub-treatment	Main Treatment (Samba)				Main Treatment (Kuruvai)			
	M_1	**M_2**	**M_3**	**Mean**	**M_1**	**M_2**	**M_3**	**Mean**
S_1	4573	4471	4344	4462.67	4515	4406	4263	4394.67
S_2	4796	4692	4563	4683.67	4728	4585	4443	4585.33
S_3	5530	5417	5301	5416.00	5330	5219	5106	5218.33
S_4	5324	5200	5046	5190.00	5159	5044	4909	5037.33
S_5	5790	5624	5501	5638.33	5560	5388	5251	5399.67
S_6	4925	4823	4698	4815.33	4837	4723	4587	4715.67
S_7	5138	5036	4900	5024.66	5098	4897	4761	4918.67
S_8	4345	4244	4118	4235.66	4322	4208	4073	4201.00
Mean	5055.50	4938.38	4808.88		4943.63	4808.75	4674.13	
	Main	**Sub**	**MxS**	**SxM**	**Main**	**Sub**	**MxS**	**SxM**
S. Ed.	54.53	99.98	197.25	185.35	60.19	75.25	146.44	144.64
CD (p=0.05)	109.06	199.95	392.50	370.71	120.13	150.50	292.88	289.27

TABLE 3
ECONOMIC ANALYSIS

Sub-treatment	Samba		Kuruvai	
	Net Return (Rs ha^{-1})	Return per rupee invested	Net return Rs ha^{-1}	Return per rupee invested
M_1S_1	11876	1.99	11483	1.95
M_1S_2	12866	2.06	12399	2.02
M_1S_3	16360	2.32	15266	2.23
M_1S_4	15310	2.24	14416	2.17
M_1S_5	17682	2.43	16374	2.32
M_1S_6	13392	2.09	12865	2.05
M_1S_7	14486	2.18	14137	2.15
M_1S_8	10677	1.89	16526	1.88
M_2S_1	11584	1.99	11226	1.96
M_2S_2	12601	2.06	11995	2.01
M_2S_3	16051	2.33	14994	2.24
M_2S_4	14942	2.24	14131	2.17
M_2S_5	17106	2.41	15833	2.31
M_2S_6	13105	2.09	12588	2.05
M_2S_7	14197	2.19	13466	2.12
M_2S_8	10374	1.89	10245	1.87
M_3S_1	11384	2.01	11003	1.98
M_3S_2	12347	2.08	11776	2.04
M_3S_3	15643	2.32	14607	2.23
M_3S_4	14341	2.21	13646	2.15
M_3S_5	16652	2.40	15338	2.30
M_3S_6	12920	2.13	12396	2.08
M_3S_7	13954	2.22	13275	2.16
M_3S_8	10159	1.91	10057	1.99

Cost of Grain = Rs 4.50 kg^{-1}, cost of straw = Rs. 0.50 kg^{-1}.