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Research article

STUDIES ON PERFORMANCE OF ORGANIC FARMING AND CHEMICAL FARMING IN RAINY SEASON RICE

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ABSTRACT: Field experiments conducted consecutively for four years during *kharif* 2007 to 2010 on Godavari alluvial soils with five exclusive organic farming practices, one integrated nutrient management practice (INM) and 100percent recommended dose of fertilizer (RDF) with an objective to study the performance of organic farming practices in comparison with INM and RDF. The four years pooled results revealed that, application of 100% recommended NPK along with Zn so_4 @50 $kgha^{-1}$ resulted the higher tillers, yield attributes, root growth ,grain yield, returns, and more sustainability in yields over exclusive organic farming practices and found at par to integrated nutrient management practice . Milling parameters and grain quality parameters were significantly influenced by source of nutrition. Incidence of blast, infestation of stemborer and brown plant hopper were markedly higher in application of 100% recommended NPK along with Zn so_4 @50 $kgha^{-1}$ followed by integrated use of 50% NPK + 50% N as FYM compared to exclusive organic practices. The Organic carbon content was conspicuously increased with all the exclusive organic nutrient management practices as well as integrated use of nutrients. The status of available soil potassium was remarkably decreased in all the nutrient management practices regardless of source of nutrition.
Key words: Rice, Organic farming, yield, sustainability, economics

INTRODUCTION

Rice is one of the major contributor to the success by contributing approximately 43% of total food grain production of India, now witnessed the yield stagnation and declining productivity due to Continuous use of high level of chemical fertilizers had led to soil degradation problems . Use of chemical inputs has increased the crop yield but caused many environmental problems including soil, air and water pollution and finally human health hazards and making the crop productivity unsustainable [1].At the same time organic farming is gaining momentum throughout the world including India due to the farmers movement, growing awareness among the consumers and promotion from the policy makers. Organic rice posses better nutritional quality [2] and fetches higher market price. Organic farming also permits the recycling of organic wastes, disposal of which could be difficult and expensive [3].Promotion of organic farming is being viewed as farming practice with distinct advantages of sustainability of crop production, offers protection against deteriorating soil, water and environment and also as an economic venture. Documental evidences are necessary to understand the role of organic farming on soil health, production and profitability of rice, which is a key holder of India's food security. Keeping the above aspects in view, the present study was undertaken to compare the performance of organic farming, chemical farming and integrated nutrient management in rice.

MATERIAL AND METHODS

Field experiments were conducted on rice (*Oryza sativa* L.) consecutively for four *kharif* seasons of 2007, 2008 ,2009 and 2010 on Godavari alluvials (Vertic chromusters) at Andhra Pradesh Rice Research Institute- Maruteru, A.P. India (26.38^0 N, 84. 44^0 E and 5 m above mean sea level). The soil was clay loam having pH 7.2, organic carbon 0.80%, available P_2O_5 34 $kgha^{-1}$ and K_2O 379 $kgha^{-1}$. The trial consists of ten treatments. T1: 50% rec.

NPK + 50% N as FYM;T2 : 100% Rec. N) 1/3 each through FYM + Vermicompost + neam cake); T3: T2 + intercropping with sesbania.T4: T2 + organic practices for weed and pest control; T5: 50% N as FYM + rock phosphate to substitute the P requirement of crops + PS B +Azospirillum;T6: T2 + biofertiliser containing N & P carriers (Azo + PSB);T7: 100% NPK + 50 kg Zn so4/haT8: T2+ organic pest control. BPT 5204 (145 days duration) was the test variety planted 25to 30 days old seedlings at a spacing of 20X15 cm with 2-3 seedlings per hill. Weeds were controlled by application of pre emergence herbicide Pretilachlore @ 0.75 kg a.i per hectare followed by one hand weeding at 40 days after transplanting except in T4 where weeds were controlled manually. Water was maintained at a depth of 2 cm up to panicle initiation and 5 cm thereafter up to one week before harvest. The field was drained before application of fertilizers and one week before harvest. Manures and fertilizers were applied as per the treatmental requirement through Urea, SSP, MOP. Entire P & K and 1/3 recommended N was applied as basal, remaining N was applied in two splits at active tillering and panicle initiation .Organic manures were applied based on their nutrient content and incorporated two weeks before planting. The experiments were received uniform plant protection and cultural management practices throughout the period of crop growth except in T4 and T8 where neem oil and pseudomonas was utilized for pest and disease management. Data on yield attributes and yield, pest & diseases were collected following standard procedures from 10 randomly marked hills. Root volume at flowering was calculated using water displacement method. Root biomass & weed biomass was estimated at flowering duly following standard procedure.NPK uptake was calculated by multiplying nutrient content with dry matter production at harvest. The quality parameters were assessed as per the procedure given by [4]. Sustainability Index was calculated using formula given by [5].Data were analyzed using ANOVA and the significance was tested by Fisher's least significance difference (p= 0.05) by pooling four years data.

Table 1. Nutrient content of different organic manures

Organic manure	% N	% P	% K
FYM	0.86	0.39	0.51
Vermi compost	1.68	2.21	0.67
Neem cake	3.70	0.94	1.19

RESULTS AND DISCUSSION

Yield parameters, yield and sustainability

Four years pooled data revealed that, application of 100% recommended NPK along with Zn so_4 @50 kg/ha resulted the highest no of tillers m^{-2}, panicles m^{-2}, 1000 grain weight and grain yield. which was significantly superior over all the organic farming practices irrespective of the combinations however it was at par to integrated use of 50% NPK + 50% N as FYM (Table 2). More number of tiller m^{-2} , yield attributes and grain yield with application of 100% recommended NPK along with Zn so_4 @50 kg/ha might be due to sufficient nutrient supply as per the crop needs resulted in favourable growth and yield structure compared to exclusive organic nutrient management practices. [6] reported adequate availability and translocation of nitrogen and other nutrients to sink manifests marked yield improvement in rice.

Table 2.Effect of different nutrient management practices on yield parameters, root parameters, weed biomass and SYI of rice (Pooled data of four years)

Treatment	Tillers/ m^2	Panicles/ m^2	Filled grains / panicle	Test weight (g)	Grain yield (kg/ha)	Sustainability Index	Root volume ml/plant	Root Biomass g/hill	Weed Biomass (g)
T1- 50% rec. NPK + 50% N as FYM	491	354	158	18.04	5486	0.85	22.70	10.13	31.36
T2- 100% Rec. N (1/3 each through FYM + Vermicompost + neam cake)	446	319	142	18.16	4492	0.75	23.84	11.05	28.87
T3- T2 + intercropping with sesbania	469	301	136	18.07	4506	0.84	23.96	11.17	24.95
T4- T2 + organic practices for weed and pest control	421	305	133	18.00	4309	0.82	22.47	9.59	28.55
T5- 50% N as FYM + Rec.P thro.RP + PS B +Azospirillum	407	295	134	17.92	4351	0.73	21.02	9.55	26.96
T6- T2 + biofertiliser containing N & P carriers (Azo + PSB)	459	331	146	17.99	4783	0.83	23.92	11.11	21.65
T7- 100% NPK + 50 kg Zn so4/ha	522	356	154	18.10	5412	0.87	21.27	9.61	32.85
T8- T2+ organic pest control	440	320	141	18.06	4496	0.76	21.39	10.70	29.40
SEm ±	7.56	6.62	5.53	0.08	78	-	0.36	0.17	0.92
CD (P=0.05)	23	20	16	0.24	230	-	1.06	0.50	2.70

Similar results of higher yields of rice with 100% RDF over organic farming was reported by [7]. However, the yield reduction of 16.07% was recorded with the best exclusive organic treatment compared to application of 100% recommended NPK along with Zn so_4 @50 kg/ha. After four years of experimentation 25.4 % yield reduction was recorded with organic farming treatments over 100% RDF in *Kharif* rice [8].Yield obtained under organic farming was 14-51 % lower than inorganic and integrated nutrient management in rice after seven years across the country [9].Sustainability Index reveals that Integrated nutrient management showed more sustainability among all the treatment followed by100% RDF. Higher sustainability with integrated nutrient use compared to chemical fertilization in rice-rice system was reported by [10]. Among different organic practices application of 100% Rec. N (1/3 each through FYM +Vermicompost+ neam cake)+ intercropping with sesbania followed by 100% Rec. N (1/3 each through FYM +Vermicompost + neam cake)+ biofertiliser containing N & P carriers l showed more stability compared to other practices

Table 3.Effect of different nutrient management practices on pert and disease incidence and quality parameters of rice (Pooled data of four years)

Treatment	% Sheath blight incidence	% Blast incidence	White ears/m^2	BPH/ hill	Hulling (%)	Milling (%)	% HRR	L/B Ratio	Amylase Content (%)	Protein Content (%)
T1- 50% rec. NPK + 50% N as FYM	34.28	33.60	19.50	12.50	77.35	72.52	62.03	2.99	25.76	7.81
T2- 100% Rec. N (1/3 each through FYM + Vermicompost + neam cake)	24.33	25.99	11.50	13.25	78.38	73.26	63.13	2.87	26.14	7.88
T3- T2 + intercropping with sesbania	26.91	27.56	13.25	13.00	78.42	73.19	62.83	2.91	26.23	7.99
T4- T2 + organic practices for weed and pest control	17.68	25.99	10.75	14.00	78.96	73.07	63.36	2.93	26.55	7.90
T5- 50% N as FYM + Rec.P thro.RP + PS B +Azospirillum	19.83	23.89	10.00	12.75	78.09	72.38	62.26	2.82	25.81	7.85
T6- T2 + biofertiliser containing N & P carriers (Azo + PSB)	25.74	28.09	12.50	14.25	78.15	73.52	64.06	2.89	26.28	7.94
T7- 100% NPK + 50 kg Zn so4/ha	31.59	37.54	19.75	16.00	76.17	70.04	61.8	3.02	24.92	7.75
T8- T2+ organic pest control	22.86	27.04	13.00	12.75	77.46	72.33	62.2	3.00	25.17	7.80
SEm ±	0.70	0.63	0.50	0.20	0.48	0.41	0.36	0.09	0.24	0.04
CD (P=0.05)	2.10	1.85	1.48	0.58	1.42	1.21	1.07	NS	0.71	0.12

Table 4. Effect of different nutrient management practices on post soil nutrient status and economics of rice (Pooled data of four years)

Treatment	pH	EC	Organic carbon (%)	Available P_2O_5 kg/ha	Available K_2O (kg/ha)	Gross Returns (Rs/ha)	Cost of cultivation (Rs/ha)	Net Returns (Rs/ha)	Rupee per rupee invested (Rs/Rs)
T1- 50% rec. NPK + 50% N as FYM	7.2	0.49	0.80	34	379	-	-	-	-
T2- 100% Rec. N (1/3 each through FYM + Vermicompost + neam cake)	6.8	0.56	0.76	32.3	243.6	51720	33206	18514	0.64
T3- T2 + intercropping with sesbania	5.8	0.45	0.90	34.2	261.6	42425	42134	291	0.03
T4- T2 + organic practices for weed and pest control	5.9	0.43	0.89	36.5	230.4	42349	44009	-1660	0.00
T5- 50% N as FYM + Rec.P thro.RP + PS B +Azospirillum	6.1	0.48	0.88	33.8	223.2	40537	44040	-3503	-0.06
T6- T2 + biofertiliser containing N & P carriers (Azo + PSB)	6.3	0.46	0.82	34.6	244.8	41137	35209	5928	0.22
T7- 100% NPK + 50 kg Zn so4/ha	6.3	0.47	0.91	36.1	213.6	44978	43396	1581	0.07
T8- T2+ organic pest control	7.0	0.59	0.75	31.8	192	50868	32831	18037	0.65
SEm ±	6.1	0.44	0.85	35.6	291.6	42457	41896	560	0.04
CD (P=0.05)	0.19	0.031	0.026	1.060	6.037	742	1108	198	0.008

Root parameters and weed bio mass

Application of 100% Rec. N (1/3 each through FYM + Vermicompost + neam cake)+ intercropping with sesbania and 100% Rec. N (1/3 each through FYM + Vermicompost + neam cake)+ biofertiliser containing N & P carriers recorded higher root volume as well as root biomass per plant at flowering, which were significantly higher over application of 100% recommended NPK along with Zn so_4 @50 kg/ha and integrated use of 50% NPK + 50% N as FYM.

The higher root volume as well as root biomass with organic farming practices might be due to prevailing of improved physical properties. Weed bio mass 30 DAT also higher in application of 100% recommended NPK along with Zn so_4 @50 kg/ha followed by integrated use of 50% NPK + 50% N as FYM compared to most of the exclusive organic nutrient supply treatments , however the treatment involves organic weed control also recorded higher weed biomass.

Pest and disease incidence

Percent sheath blight incidence was significantly higher with integrated use of 50% NPK + 50% N as FYM followed by application of 100% recommended NPK along with Zn so_4 @50 kg/ha over all the organic farming practices irrespective of the combinations. Where as incidence of blast, infestation of stem borer and brown plant hopper were markedly higher in application of 100% recommended NPK along with Zn SO_4 @50 kg/ha followed by integrated use of 50% NPK + 50% N as FYM. Markedly lesser population of WBPH per hill in organically manured plots compared to plots received chemical fertilizers was reported by [11].Asparagine content of plant phloem sap was significantly low under organic cultivation there by adcersely affecting the feeding activities of BPH [12].Among exclusive organic farming treatments , application of 100% Rec. N (1/3 each through FYM + Vermicompost + neam cake)+ intercropping with sesbania and 100% Rec. N (1/3 each through FYM + Vermicompost + neam cake)+ biofertiliser containing N & P carriers recorded higher incidence of pests and diseases over other . Soils with a high functional diversity of microorganisms, which occur very often under organic agriculture practice, develop disease and insect suppressive properties and can help to induce resistance in plants [13]. This supports the findings of [14] who noted low densities of BPH & WBPH in organically cultivated fields and those with low N content.

Grain Quality

Milling parameters and grain quality parameters were significantly influenced by source of nutrition. Percent hulling, milling and head rice recovery were noticeably superior in all the organic farming practices irrespective of the combinations over chemical farming i.e. application of 100% recommended NPK along with Zn so_4 @50 kg/ha. L:B ratio was unaffected by various N sources. Whereas amylase content and protein content were markedly higher with excusive organic nutrition treatments compared to application of 100% recommended NPK along with Zn so_4 @50 kg/ha. Conspicuous improvement in quality aspects of rice under organic farming was also reported by [15].

Post soil nutrient status

The fertility status of the soil after four years of the study showed remarkable variations due to effect of different sources nutrients. There was significant decrease in soil $_P$H over initial values with exclusive organic nutrient management practices and though there was decrease in $_P$H with 100% chemical fertilization and integrated use of nutrients the change was not statistically measurable. There was significant increase in EC was noticed with100% chemical fertilization and it was maintained with different organic nutrient supply treatments. The Organic carbon content was conspicuously increased with most of the exclusive organic nutrient management practices over application of 100% recommended NPK along with Zn so_4 @50 kg/ha, integrated use of nutrients and application of 50% N as FYM + rock phosphate to substitute the P requirement of crops + PS B +Azospirillum. Incorporation of organic amendments resulted in increased organic carbon status might be due to improvement of physical and biological properties of soil [16].The available phosphorus status was maintained or slightly improved with most of the organic farming treatments. Whereas there was slight decline in available phosphorus status with 100% chemical fertilization and integrated use of nutrients though the differences were not statistically measurable. The status of available soil potassium was decreased in all the treatments over initial values , however the decrease was significant in all exclusive organic nutrient management practices , integrated use of nutrients and application of 100% recommended NPK along with Zn so_4 @50 kg/ha showed that the nutrient replenishment was not in tune of the crop needs.

Economics

Economic analysis of the four years showed that the highest gross returns were recorded with application of 100% recommended NPK along with Zn so_4 @50 kg/ha followed by Integrated use of 50% NPK + 50% N as FYM and were significantly superior over all the exclusive organic nutrient management practices (Table 4). Among exclusive organic nutrient management practices the gross returns were higher with 100% Rec. N (1/3 each through FYM + Vermicompost + neam cake)+ biofertiliser containing N & P carriers and at par in other exclusive organic nutrient management practices. The net returns and Rupee per rupee invested were also significantly higher with integrated use of 50% NPK + 50% N as FYM and application of 100% recommended NPK along with Zn so_4 @50 kg/ha compared to exclusive organic nutrient management practices .Higher cost of production besides reduced yields lead to decreased returns from different exclusive organic farming treatments. Similar findings were also reported by [17].

Among different exclusive organic nutrient management practices application of 50% N as FYM + rock phosphate to substitute the P requirement + PS B +Azospirillum recorded significantly higher net returns and application of 100% Rec. N (1/3 each through FYM + Vermicompost + neam cake)+ biofertiliser containing N & P carriers recorded higher rupee returned per rupee invested .The treatment involved organic practices for weed and pest control and sesbania intercropping d recorded net loss in income due to higher cost of cultivation in these treatments.

CONCLUSIONS

The results indicated that Organic farming has an edge over inorganic farming to sustain the soil health ,point of grain quality and incidence of pests and diseases ,but this practice is highly expensive, less productive and not profitable as per the existing market. Integrated nutrient management found to be good option to stabilise the production and profits besides maintaining soil health.

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