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Baijayanti Nayak
1. Department of Agronomy, College of Agriculture, Odisha University of Agriculture & Technology, Bhubaneswar, Odisha, India
2. ICAR - National Rice Research Institute, Cuttack, Odisha, India

BS Rath
Department of Agronomy, College of Agriculture, Odisha University of Agriculture & Technology, Bhubaneswar, Odisha, India

M Shahid
ICAR - National Rice Research Institute, Cuttack, Odisha, India

SN Jena
Department of Agronomy, College of Agriculture, Odisha University of Agriculture & Technology, Bhubaneswar, Odisha, India

Ashirbachan Mahapatra
1. ICAR - National Rice Research Institute, Cuttack, Odisha, India
2. Department of Agronomy, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Sanjoy Saha
ICAR - National Rice Research Institute, Cuttack, Odisha, India

Corresponding Author:
Sanjoy Saha
ICAR - National Rice Research Institute, Cuttack, Odisha, India

Effect of organic nutrient management on plant growth, productivity and economics of aromatic rice

Baijayanti Nayak, BS Rath, M Shahid, SN Jena, Ashirbachan Mahapatra and Sanjoy Saha

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Abstract
A field experiment was carried out during *kharif* seasons of 2015 and 2016 at Agronomy Research Farm, Central Research Station, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, to study the effect of organic nutrient management on plant growth, productivity and economics of aromatic rice. Application of recommended dose of fertilizer to aromatic rice (Geetanjali) produced improved plant growth with higher grain and straw yield having higher net return with B:C ratio. Among organic treatments, similar plant growth, yield and profit also obtained with application of 100% recommended dose of nitrogen through poultry manure along with top dressing with liquid manure twice at 25 and 50 days after transplanting.

Keywords: Aromatic rice, poultry manure, growth, yield, economics

Introduction
The area under aromatic rice varieties is increasing day by day with the opening of the world market as well as increased domestic consumption due to their superior cooking and eating quality [1]. Simultaneously, organic rice is also gaining importance in world market. At present, the farmers cultivate such premium aromatic rice in native areas following chemical-based agricultural practices, which has led to increased productivity but has adversely affected the grain quality, soil health and environment. However, organic nutrient management in rice is getting much attention in present-day agricultural system due to increased demand for organic foods. Moreover, Murali and Setty [2] reported that organic manures improved the quality of aromatic rice. Geetanjali is a long slender aromatic rice variety mainly cultivated in Mahanadi river belts of Odisha. It is very popular in market for preparation of polao, biryani as well as for making, payash (dessert) etc. To promote organic cultivation of Geetanjali rice in Odisha, the present investigation aims to identify the best suitable organic nutrient management practice for higher productivity and economic return in aromatic rice.

Materials and Methods
The experiment was carried out at the Agronomy Research Farm, Central Research Station, Odisha University of Agriculture and Technology, Bhubaneswar during *kharif* seasons of 2015 and 2016. The soil property of the experimental site was sandy loam (72.3% sand, 11.5% silt and 16.2% clay) with slightly acidic in reaction (pH 5.92), medium in organic carbon (0.52%), low in available N (247.21kg/ha), high in available P_2O_5 (44.38 kg/ha) and medium in K_2O content (168.84 kg/ha). Sixteen treatments consisting of fourteen organic from three different sources either alone or its combination as well as one inorganic and one control without organic or inorganic, *viz*. T_1: 100% Recommended Dose of Nitrogen (RDN) through Farm Yard Manure (FYM), T_2: 100% RDN through Concentrated manure (CM), T_3: 100% RDN through Poultry manure (PM), T_4:50% RDN through FYM + 50% RDN through CM, T_5:50% RDN through FYM + 50% RDN through PM, T_6:50% RDN through CM + 50% RDN through PM, T_7:1/3rd RDN through FYM + 1/3rd RDN through CM + 1/3rd RDN through PM, T_8: T_1 + TD{Top dressing with Liquid manure twice at 25 and 50 Days after transplanting (DAT)}, T_9: T_2 + TD, T_{10}: T_3 + TD, T_{11}: T_4 + TD, T_{12}: T_5 + TD, T_{13}: T_6 + TD, T_{14}: T_7 + TD, T_{15}:

Recommended Dose of Fertilizer (RDF) (80:40:40 kg N:P:K/ha), T_{16}: Control without organic or inorganic were laid out in randomized block design in three replicates.

Of the three different sources of organic manure i. e. FYM, PM and CM, the first two were collected from different sources and the third one was self-prepared. The liquid manure (LM) "Sanjivak" was also self-prepared following the procedure given by Yadav [3]. The nutrient composition of these organic manures (FYM, CM, PM and LM) are 0.58-0.31-0.58, 2.1-1.32-1.71, 2.24-2.3-2.1, 0.57-0.06-0.37% N-P-K, respectively. From these organic manures FYM, PM and CM were incorporated as per the standard treatments i.e. one day before transplanting in the puddled field. The recommended dose of fertilizers (RDF) i.e. 80-40-40 kg NPK/ha were applied through urea, single super phosphate and murate of patash. Half of the N and full of P and K were applied at the time of puddling while remaining N was applied in three equal splits i.e. at early tillering, late tillering and panicle initiation stage. Twenty-five days old seedlings of "Geetanjali" aromatic rice were transplanted in the main experimental field on 14th and 19th August in *kharif* during 2015 and 2016, respectively, at a spacing of 20 cm x 10 cm. Under growth parameters, plant height, leaf area index and dry matter production were recorded at 90 DAT. After harvest of the crop, grain yield and yield attributing characters *viz.* panicles/m^2, panicle length, grains/panicle, sterility percentage, 1000 grain weights were determined and economics was calculated as per the prevailing market values. The data were subjected to the Analysis of Variance using the Statistical Analysis System (SAS) and significant differences among the treatment means tested Fisher's protected Least Significant Difference (LSD) test at $p \leq 0.05$.

Results and Discussion

Growth

The data presented in the Table 1 clearly pointed out that the rice plants supplied with inorganic source produced tallest plants (118.3 cm), highest leaf area index (4.36) and the highest dry matter per plant 60.9g/hill at 90days after transplanting. The rate of increase in dry matter accumulation was almost 1g/day. Among organic treatments, maximum height of the plant (115.3cm) and dry matter accumulation (60.7g) were obtained by the crop supplied with poultry manure with liquid manure top dressed twice at 25 and 50 DAT (T_{10}), which was found at par with height and dry matter obtained from crop supplied with sole poultry manure (T_3) and concentrated manure alone (T_2) or in combination with liquid manure top dressed twice at 25 and 50 DAT (T_9) during both the year. The increase in plant height as a result of chemical fertilizer application might be primarily due to the improved vegetative growth and additional subscription of nitrogen [4]. Besides, Hasanuzzaman *et al.* [5] opined that the variation in plant height due to application of different nutrient sources was a result of differential availability of major nutrients. The leaf area index increased progressively with advancement of the age of the crop up to 75 DAT and declined thereafter. From the data it was evident that highest leaf area index (4.36) was recorded from the crop supplied with chemical fertilizer which is significantly different from the LAI (4.14) recorded from the best organic practices during the study period. The superiority of chemical fertilizer in manifesting higher LAI was mostly due to higher availability of major nutrients while among the organic sources, the superiority of poultry manure (PM) was justified because of higher decomposition rate of PM as compared to FYM.

Table 1: Plant height (cm), Leaf Area Index and Dry matter production (g/hill) at 90 days after transplanting in aromatic rice as influenced by organic nutrient management (Mean of 2 years)

Treatments	Plant height (cm)	Leaf Area Index	Dry matter production (g/hill)
T_1: FYM 100%RDN	108.5	3.83	50.6
T_2: CM 100%RDN	112.7	4.00	56.9
T_3: PM 100%RDN	113.3	4.10	60.6
T_4: FYM 50%RDN+CM 50%RDN	106.4	3.72	47.2
T_5: FYM 50% RDN+PM 50% RDN	109.5	3.88	51.9
T_6: PM 50% RDN+CM 50% RDN	111.2	3.94	53.3
T_7: FYM1/3rd RDN+CM1/3rd RDN+PM1/3rd RDN	106.9	3.75	47.5
T_8: T1+Top dressing with liquid manure	109.3	3.86	52.0
T_9: T2+Top dressing with liquid manure	112.7	4.03	57.4
T_{10}: T3+Top dressing with liquid manure	115.3	4.14	60.7
T_{11}: T4+Top dressing with liquid manure	107.7	3.78	47.7
T_{12}: T5+Top dressing with liquid manure	110.6	3.91	52.5
T_{13}: T6+Top dressing with liquid manure	111.9	3.97	54.0
T_{14}: T7+Top dressing with liquid manure	108.2	3.80	49.2
T_{15}: 80:40:40 RDF	118.2	4.36	60.9
T_{16}: Control	103.6	3.45	44.2
S.Em±	2.13	0.03	1.41
CD(P=0.05)	6.14	0.08	4.08

Yield and yield attributes

Data on yield and yield attributing characters are presented in Table 2 which revealed that organic nutrient management also had a positive effect on yield attributes over control. Again application of recommended dose of fertilizer (T_{15}), resulted highest yield attributing characters like tiller/m^2 (459.01), panicle length (26.55 cm), grains/panicle (122.52) and 1000 grain weight (22.95 g) with lowest sterility percentage (6.84) which was superior to all other treatments. Among various organic sources, application of poultry manure in combination with liquid manure twice at 25 and 50 DAT (T_{10}), resulted maximum tiller/m^2 (395.97), panicle length (26.31 cm), grains/panicle (106.45) and 1000 grain weight (22.88 g). The crop received neither inorganic nor organic sources of nutrients (Control, T_{16}) produced lowest yield and yield attributing characters. Increased production of tillers/m^2 and filled grains in rice obtained through the application of enriched poultry manure or composted poultry manure was also reported earlier by Sangeetha *et al.* [6].

Yield is the better manifestation of growth and yield attributing characters (Table 2). During both the years of study, yield outcomes from the organic treatments were

higher than the control (T_{16}), but lower than the inorganic sources of fertilizer application (T_{15}). Application of liquid manure twice at 25 and 50 DAT marginally improved the growth and yield of rice. Application of such liquid manure extended the leaf area duration that sufficed the nutrient requirement during the latter part of crop growth and ensured better partitioning of photosynthates from the source to the sink [7]. But interestingly the yield obtained from Gitanjali rice when supplemented with organic sources like PM and CM either in sole or in combination were almost at par with the yield recorded from the rice crop grown inorganically during the period of study. The advantage of PM than other sources of organic manures was also registered earlier in a clay loam soil of Bapatla, Andhra Pradesh [8] and the advantage of inorganic sources over the organic sources of fertilizer was reported by Kumari *et al*. [9].

Table 2: Yield attributes, Grain yield (t/ha) and Harvest index of aromatic rice as influenced by organic nutrient management (Mean of 2 years)

Treatments	No. of Panicles /m^2	Panicle length (cm)	Sterility percentage (%)	No. of Grains/ Panicle	1000 grain weight (g)	Grain Yield (t/ha)	Straw yield (t/ha)	Harvest Index
T_1: FYM 100%RDN	335.06	24.72	18.50	88.36	22.49	3.50	5.42	39.24
T_2: CM 100%RDN	354.76	25.32	13.69	100.27	22.68	3.72	6.08	37.92
T_3: PM 100%RDN	377.58	26.24	11.80	104.52	22.86	3.98	6.23	38.98
T_4: FYM 50%RDN+CM 50%RDN	298.78	24.32	23.57	79.24	22.25	3.27	4.97	39.67
T_5: FYM 50% RDN+PM 50% RDN	341.47	24.98	15.70	94.28	22.55	3.57	5.73	38.42
T_6: PM 50% RDN+CM 50% RDN	348.03	25.25	14.90	95.81	22.64	3.67	6.00	37.93
T_7: FYM1/3rd RDN+CM1/3rdRDN+PM1/3rd RDN	318.48	24.35	22.17	79.24	22.35	3.32	4.99	39.96
T_8: T_1+Top dressing with liquid manure	338.51	24.75	16.87	88.42	22.51	3.54	5.66	38.46
T_9: T_2+Top dressing with liquid manure	374.30	25.55	12.51	102.06	22.83	3.75	6.10	38.03
T_{10}: T_3+Top dressing with liquid manure	395.97	26.31	10.96	106.45	22.88	4.17	6.44	39.30
T_{11}: T_4+Top dressing with liquid manure	325.21	24.55	21.12	81.04	22.43	3.42	5.34	39.06
T_{12}: T_5+Top dressing with liquid manure	344.09	25.25	15.13	95.54	22.62	3.59	5.83	38.11
T_{13}: T_6+Top dressing with liquid manure	351.32	25.28	13.83	96.27	22.67	3.70	6.03	38.01
T_{14}: T_7+Top dressing with liquid manure	328.33	24.62	18.85	83.30	22.46	3.44	5.36	39.10
T_{15}: 80:40:40 RDF	459.01	26.55	6.84	122.52	22.95	4.19	6.51	39.17
T_{16}: Control	275.80	23.82	25.22	72.65	22.09	2.48	4.83	33.89
S.Em±	16.33	0.47	3.01	10.11	0.23	0.19	0.31	1.71
CD (P=0.05)	47.15	1.36	8.70	29.19	0.65	0.55	0.91	4.94

Among the organic treatment crop receiving PM along with top dressing twice with liquid manure (T_{10}) 17.9% higher yield over FYM 100% RDN + TD with liquid manure and at par with the yield recorded from PM 100% RDN, CM 100% RDN, CM 100% RDN + TD with liquid manure. Higher nutrient content and steady nutrient release pattern of poultry manure and concentrated manure enhanced the yield of aromatic rice compared to FYM.

Devegowda [10] reported that the superiority of poultry manure was mostly because it contains both urinary and fecal excretions which lead to three times more nutrient value than FYM. Harvest Index (HI) is the indication of the quantum of partitioning of photosynthates from vegetative towards the reproductive part of the plant. The influence of nutrient management on HI of rice was found at par in all the treatments except control (T_{16}) where the lowest value was obtained.

Economics

Highest cost of cultivation (₹ 36458/-) was registered in plots received 100% RDN through FYM along with liquid manure top dressing twice at 25 and 50 DAT (T_8) and lowest cost of cultivation (₹ 24758/-) was in control plots (T_{16}) during the period of investigation.

Table 3: Economics of aromatic rice as influenced by organic nutrient management (Mean of 2 years)

Treatments	Cost of cultivation (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	B:C ratio
T_1: FYM 100% RDN	35438	57897	22459	0.63
T_2: CM 100% RDN	32638	61846	29208	0.89
T_3: PM 100% RDN	30238	65910	35672	1.18
T_4: FYM 50%RDN+CM 50% RDN	34038	53968	19930	0.59
T_5: FYM 50% RDN+PM 50% RDN	32838	59333	26495	0.81
T_6: PM 50% RDN+CM 50% RDN	31438	61048	29610	0.94
T_7: FYM1/3rdRDN+CM1/3rdRDN+ PM1/3rdRDN	32771	54824	22053	0.67
T_8: T_1+Top dressing with liquid manure	36458	58709	22251	0.61
T_9: T_2+Top dressing with liquid manure	33658	62307	28649	0.85
T_{10}: T_3+Top dressing with liquid manure	31258	68960	37702	1.21
T_{11}: T_4+Top dressing with liquid manure	35058	56709	21651	0.62
T_{12}: T_5+Top dressing with liquid manure	33858	59734	25876	0.76
T_{13}: T_6+Top dressing with liquid manure	32458	61498	29040	0.89
T_{14}: T_7+Top dressing with liquid manure	33791	56953	23161	0.69
T_{15}: 80:40:40 RDF	30758	69374	38616	1.26
T_{16}: Control	24758	42019	17261	0.70

Maximum gross return of ₹ 69374/ha and net return of ₹ 38616/ha with B:C ratio 1.26 was realized from rice grown with 100% RDF chemical fertilizer (T_{15}) followed by the best organic practice i.e poultry manure + liquid manure top

dressing twice at 25DAT and 50DAT (T_{10}) with values ₹ 68960/ha, ₹ 37702/ha and 1.21 respectively. Further application of chemical fertilizer (T_{15}) gave 2.42% higher net return than poultry manure application (T_{10}). Similarly, application of Poultry manure with liquid manure (T_{10}) gave 31.6% and 69.4% higher net return than application of concentrated manure with liquid manure (T_9) and FYM with liquid manure (T_8) respectively. The lowest net profit was obtained from the treatments without supplementation of any fertilizer or manure (T_{16}) to rice ₹ 17261/ha. In the long run, organic cultivation might be more beneficial compared with conventional, because it has the potential to deliver a sustainable economic yield with low cost inputs over the years [11].

Conclusion

Geetanjali rice grown organically with poultry manure alone or in combination with liquid manure i.e. PM 100% RDN + Top dressing with liquid manure at 25 and 50 DAT was found to be the most suitable organic nutrient management system not only for higher growth and productivity but also for generation of higher returns. Application of recommended dose of chemical fertilizer to aromatic rice recorded the higher productivity and profit during two years of study but the adaptation of organic nutrient management practices in community approach basis can enhance the farmers' income in long run sustaining the productivity and profitability.

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