The Pharma Innovation Journal 2022; 11(1): 1506-1511

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(1): 1506-1511

www.thepharmajournal.com
Received: 19-11-2021
Accepted: 29-12-2021

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Organic nutrient management in short grain aromatic rice (*Oryza sativa* L.)

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Abstract
Treatments comprised of the eleven organic and inorganic nutrient management *viz.* 100% RDN (organic) + seed treatment with PSB and Azotobacter (T1), 100% RDN (organic) + 10% foliar spray of cow urine (T2), 100% RDN (organic) + 20% foliar spray of cow urine (T3), 75% RDN (organic) + seed treatment with PSB and Azotobacter (T4), 75% RDN (organic) + 10% foliar spray of cow urine (T5), 75% RDN (organic) + 20% foliar spray of cow urine (T6), 100% RDN (organic), (Natural farming practices) (T7), 100% RDN (inorganic) (T8), 100% RDN (inorganic) + seed treatment with PSB and Azotobacter + 10% cow urine (T9), 75% RDN (inorganic) + seed treatment with PSB and Azotobacter + 10% cow urine (T10), control (0% RDN) (T11). Cow urine 10% and 20% was sprayed at 30 and 60 DAT in standing crop. Nursery raising started on 15/7/19 with 60 kg seed rate ha^{-1} and 25 days old seedlings were transplanted in 10/08/19 in the spacing 20 X 10 cm (Row X Plant), $N:P_2O_5:K_2O$ 60:40:30 kg ha^{-1}. Half dose of N and total P, K has applied a basal dose and the remaining half of the Nitrogen was administered separately at two times i.e. 1st at tillering stage and 2nd panicle initiation stage. Azotobacter and PSB culture were applied before transplanting as a root treatment in the seedling stage and foliar application of cow urine 10% was done at 30 and 60 days after transplanting.
The result revealed that the application of 100% RDN (inorganic) + seed treatment with Azotobactor and PSB + 10% cow urine (T9) and among organic treatments 100% RDN (organic) + seed treatment with PSB and Azotobacter (600 g ha^{-1} of seed) (T1) increased growth parameters and yield and yield attributes was significantly higher over other treatments. The rice responded favorably to the 100% RDN (inorganic) + seed treatment with Azotobacter and PSB + 10% cow urine (T9) treatment for achieving higher growth and yield attributes, *viz.* number of tillers $hill^{-1}$ (8.20), dry matter accumulation (42.17 g $hill^{-1}$), CGR, RGR, LAI (4.91), HI (32.70%), number of effective tillers (370 m^{-2}), number of filled grains $panicle^{-1}$ (207), panicle length (22.80 cm), 1000-grain weight (16.78 g), lower sterility (9.57%), but in case of organic treatments, 100% RDN (organic) + seed treatment with Azotobacter and PSB (T1) gave significantly higher growth and yield attributes, *viz.* number of tillers $hill^{-1}$ (8.00), dry matter accumulation (41.12 g $hill^{-1}$), CGR, RGR, LAI (4.86), HI (32.54%), number of effective tillers (350 m^{-2}), number of filled grains $panicle^{-1}$ (204), panicle length (22.47 cm), 1000-grain weight (16.63 g), lower sterility (10.26%), followed by 100% RDN (organic) + 20% foliar spray of cow urine at 30 and 60 DAT (T3) and 100% RDN (organic) + 10% foliar spray of cow urine at 30 and 60 DAT (T2), among other organic treatments for yield and yield attributes. Nitrogen, phosphorus, and potassium content and uptake in rice grain and straw were significantly higher under 100% RDN (inorganic) + seed treatment with Azotobacter and PSB + 10% cow urine (T9) and the minimum under T11 (Control (0% RDN). In case of organic treatment, 100% RDN (organic) + seed treatment with Azotobacter and PSB (T1) was found significantly superior for higher nutrient content and uptake followed by 100% RDN (organic) + 20% foliar spray of cow urine at 30 and 60 DAT (T3) and 100% RDN (organic) + 10% foliar spray of cow urine at 30 and 60 DAT (T2). Combined application of 100% RDN (inorganic) + seed treatment with Azotobacter and PSB + 10% cow urine (T9) was found most suitable and in case of organic treatment 100% RDN (organic) + seed treatment with Azotobacter and PSB (T1) significantly higher followed by 100% RDN (organic) + 20% foliar spray of cow urine at 30 and 60 DAT (T3) and 100% RDN (organic) + 10% foliar spray of cow urine at 30 and 60 DAT (T2) for enhancing rice quality parameters like hulling, milling and protein percentage. The integration of 100% RDN through the inorganic nutrient source (RDF) along with the use of organic nutrient source (Azotobacter and PSB + 10% cow urine) proved most remunerative for achieving higher gross return (₹88,342), with the highest net return (₹62,292) and B:C ratio (3.93) In case of organic farming 100% RDN (organic) + seed treatment with Azotobacter and PSB (T1) fetched significantly higher gross return (₹68,427), net return (₹41,560) and B:C ratio (2.74) followed by 100% RDN (organic) + 20% foliar spray of cow urine at 30 and 60 DAT (T3) with gross return (₹68,028), net return (₹41,478) and B:C ratio (2.53) among all other organic treatments.

Keywords: Aromatic rice, yield, and yield attributes, organic, and inorganic nutrients

Introduction

Rice (*Oryza sativa* L.) occupies an important place among cultivated food crops and is the cause of both nutritional and food safety revolution on earth (Barker *et al.* (2015) [6]. In India, intensive farming involving high yielding rice varieties resulted in significant depletion of nutrients from the soil over the past three decades. Furthermore, the imbalanced use of fertilizers by farmers has deteriorated soil health and decreased soil organic carbon content which poses a threat to sustainability.

The use of organic manures in rice cultivation contributes not only to enhancing soil's physical, chemical, and biological properties but also in maintaining good soil health and supplying almost all necessary plant nutrients for crop growth and development. So, the time has come to look for long-term steps to promote sustainability in rice production. Organic manures such as FYM, poultry manure, and vermicompost deserve priority for sustainable development and increased use in organic rice production (Acharya and Mondal, 2010) [1]. Organically grown aromatic rice has tremendous potential at home and abroad. Unique climatic conditions for growing the best quality aromatic rice available in northwest India are unparalleled in the world. If yield, disease, and pest-resistant varieties of the same standard of grain and cooking are made available, the area under aromatic rice would increase certainly. India is the leading exporter of basmati rice in the global market. The country has exported 44,14,562.21 MT of aromatic rice to the world for the worth of Rs. 32,804.19 crores during the year 2018-19 (APEDA, 2018-19) [2]. In India traditionally, aromatic rice has been grown in Northern India, confined primarily to Punjab, Hariyana, Uttar Pradesh, Uttarakhand, and Rajasthan's neighboring region. Aromatic rice is said to grow best and produce the highest quality grain under a dry, humid valley like climate. Experience has also shown that the grains do not have the same consistency when genuine aromatic varieties are grown outside of these aromatic regions. High humidity (70 to 80%) and a temperature range of 25-35 ºC are favorable during the vegetative period. From flowering onwards bright and clear sunshine, the day with a temperature range of 25 to 32 ºC the comparatively cooler night (20 to 25 ºC) moderate humidity and gentle wind velocity are considered necessary at flowering and maturity for proper development of grain and aroma at flowering and ripening level. In India, the largest area under aromatic rice is in the state of Haryana (60%) followed by Uttar Pradesh (17.1%) and Punjab (16.1%). During 2014-15 the state of Haryana contributed nearly 55% of the total aromatic rice production in the country followed by Uttar Pradesh (23.5%) and Punjab at 12.4%. In Chhattisgarh, each district is having a special aromatic variety of rice. It was grown prominently in earlier days by the farmers and gave that region a unique identity by the name of that rice, such as Nagri Dubraj of Sihava, Dhamtari, Vishnubhog in Pendra, Jeeraphool in Ambikapur, Shyamjeera in Surajpur, Badshahbhog in Jagdalpur, etc. (Rathiya *et al.*, 2015). Aromatic rice has huge potential for increasing rice consumers for their taste and delicacy and high prices to boost the economic condition of the country's rice grower. Due to its natural chemical compounds, aromatic rice offers a price higher than non-aromatic rice which gives it a distinctive fragrance or taste when fried. Increasing demand for premium rice calls for increased yield of available scented varieties without compromising the quality of the crop. The indigenous aromatic varieties of rice are low yielders whose response to fertilizer application is poor. The aroma is considered the most significant character among various quality traits. As an essential flavor component of several aromatic varieties, an aroma component 2-acetyl-1-pyrroline has been identified. However, pleasant aroma that we smell at the time of harvesting from cooked or uncooked aromatic rice or in the field from cooked or un-cooked aromatic rice or in the field is the result of a large number of specified proportions of compounds present. Many typical varieties of aromatic rice are low yielding. Despite the high importance and demand for aromatic rice, so far less progress has been made in the production enhancement of aromatic varieties.

Material and Methods

A field experiment was conducted at the Instructional Cum Research Farm, Department of Agronomy, College of Agriculture, IGKV–Raipur (CG) during the rainy (*kharif*) season of 2019. The soil of the experimental field was sandy clay loam in texture with pH 6.96. It was medium in organic carbon (0.54%), available phosphorus (13.36 kg ha^{-1}), and potassium (236.49 kg ha^{-1}) and low in available nitrogen (228.12 kg ha^{-1}). 25 days old seedlings of rice were transplanted on the puddled field keeping 2 seedling hill^{-1} at a spacing of 20cm x 10cm (R x P). The experiment was conducted with 11 treatment and 3 replications in Randomised Block Design (RBD). Recommend dose of fertilizer applied 60 kg ha^{-1} of nitrogen, 40 kg ha^{-1} phosphorus, and 30 kg ha^{-1} potassium. Crop planting was 10th July and harvest on 27th October. Five plants were randomly taken for recording growth parameters. The grain and straw yield was taken plot-wise and converted into q ha^{-1}. Optimum effective tillers m^{-2}, panicle length, filled grains panicle$^{-1,}$ and 1000-grain weight were an important factor for obtaining high grain yields of rice. They depend upon the crop economics conditions of farmers. The present study aimed to find out higher growth, yield, quality, nutrient uptake, and optimum economics pattern for farmer economy in different organic and inorganic nutrient combinations.

Economic Analysis

Harvest index

The harvest index was determined by using the formula given by Donald.

$$\text{Harvest index (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

Where

Economic yield = Seed yield

Biological yield = Seed yield + Stover yield

Cost of cultivation

The cost of cultivation (Rs ha^{-1}) of each treatment was worked out by considering the price of inputs, charges for cultivation, labour and other charges.

Gross returns

The gross returns (Rs ha^{-1}) occurred due to different treatments in the present study were worked out by considering market prices of economic product, by product and crop residues during the experimental year.

Net returns

The net returns (Rs ha^{-1}) of each treatment were worked out by deducting the mean cost of cultivation of each treatment from the gross monetary returns gained from the respective treatments.

Net return per rupee investment

The net return per rupee investment of each treatment was calculated by dividing the net returns by the mean cost of cultivation.

Result and Discussion

Effect of organic nutrient management on growth parameters of aromatic rice at different time intervals

The data on mean values of growth parameters about different treatments, recorded at 30, 60, and 90 DAT are presented in the below table. It is evident from the data that in the general growth of plant continued with the advancement of crop age though the increase in plant height, number of tillers hill^{-1}, dry matter accumulation (g plant^{-1}), number of leaves hill^{-1}, LAI, CGR, and RGR was rapid during earlier stages of crop growth up to 60 DAT and thereafter it increased slowly and reached its maximum at harvest stage. It indicates that the growth attributes were significantly influenced by various treatments at different time intervals. The growth attributes, in general under different treatments were minimum at 30 DAT but increased identically during 60 and 90 DAT. The growth attributes of rice mostly governed by different organic and inorganic nutrient combinations as also reported by Surekha *et al.* (2009) [51].

Further, it is evident from the data that among different treatments, Maximum growth attributes was observed with a combined use of 100% RDN (inorganic) + seed treatment with Azotobacter and PSB + 10% cow urine (T9), followed by 100% RDN (organic) + seed treatment with Azotobacter and PSB (T1), 100% RDN (organic) + 20% foliar spray of cow urine at 30 and 60 DAT (T3), and 100% RDN (inorganic) (T8), and minimum in control (T11). In case of organic treatments, 100% RDN (organic) + seed treatment with Azotobacter and PSB (T1) is significantly superior for higher yield followed by 100% RDN (organic) + 10% foliar spray of cow urine at 30 and 60 DAT (T2), 100% RDN (organic) + 20% foliar spray of cow urine at 30 and 60 DAT (T3) among all the other organic treatments. The increasing growth parameters due to the application of organic nutrients because of longer availability of nitrogen have also been reported by Singh *et al.* (2002) and Kumar *et al.* (2012).

Table 1: Effect of organic nutrient management on growth parameters of aromatic rice at different time intervals

Treatments	Plant height (cm)	Tillers hill^{-1} (No.)	Dry matter hill^{-1} (g)	Leaves hill^{-1} (No.)	LAI
T1 100% RDN (O) + Azo and PSB	123.91	8.00	41.12	36.53	4.86
T2 100% RDN (O) + 10% CU	123.88	7.58	39.92	33.46	4.72
T3 100% RDN (O) + 20% CU	119.27	7.91	40.86	36.53	4.81
T4 75% RDN (O) + Azo and PSB	120.20	7.40	38.68	33.07	4.65
T5 75% RDN (O) + 10% CU	123.33	7.30	38.12	30.13	4.32
T6 75% RDN (O) + 20% CU	118.53	7.37	38.35	32.27	4.56
T7 Natural farming	122.58	5.40	31.32	29.87	4.12
T8 100% RDN (IO)	130.76	7.75	40.59	34.93	4.79
T9 100% RDN (IO) + Azo and PSB + 10% CU	134.33	8.20	42.17	38.47	4.91
T10 75% RDN (IO) + Azo and PSB + 10% CU	131.86	7.50	39.45	33.30	4.68
T11 control (0% RDN)	110.51	5.10	26.88	25.80	3.95
SEm±	2.63	0.61	0.28	1.79	0.03
CD at 5%	7.78	1.24	1.83	5.29	0.08

RDN = recommended dose of nutrient, O = organic and IO = inorganic, CU = cow urine,
Azo = Azotobacter, PSB = phosphorus solubilizing bacteria, Cow urine at 30 and 60 DAT in T2, T3, T5 and T6, Cow urine at 30 DAT in T9 and T10

Effect of organic nutrient management on yield and yield attributes of short grain aromatic rice

It is evident from the experimental data presented in the below table. The treatments brought significant variation on yield and yield attributes of aromatic rice A significant improvement on yield and yield attributes of aromatic rice was observed due to an increase in the level of 100% RDN (inorganic) + seed treatment with Azotobacter and PSB + 10% cow urine (T9) which produced on yield and yield attributes of aromatic rice significantly than 75% RDN and control treatment. The lower level of nutrients significantly decreased the yield and yield attributes of aromatic rice and the lowest number were recorded under (Control (0% RDN)) (T11). Among the treatments statistically differed with each other and combined use of 100% RDN (inorganic) + seed treatment with Azotobacter and PSB + 10% cow urine (T9) produced significantly higher yield and yield attributes of aromatic rice and magnitude of increase over other treatment combinations. Number yield and yield attributes of aromatic rice recorded higher under 100% RDN (inorganic) + seed treatment with Azotobacter and PSB + 10% cow urine (T9) than other treatments and (Control (0% RDN)) (T11) registered the lowest under control treatment. In case of organic treatments, 100% RDN (organic) + seed treatment with Azotobacter and PSB (T1) is significantly superior for higher yield followed by 100% RDN (organic) + 10% foliar spray of cow urine at 30 and 60 DAT (T2), 100% RDN (organic) + 20% foliar spray of cow urine at 30 and 60 DAT (T3) among all the other organic treatments. As the cumulative effect of both organic and inorganic manure enhance availability and uptake of nutrients and utilization of food materials at both early and later stages produced more number of effective tillers. The increased yield and yield attributes of aromatic rice have also been reported by Dwivedi and Thakur (2000) [10]. An increase in yield attributes of aromatic rice in a successive time interval helped in increasing the yield. This was mainly due to higher photosynthetic efficiency and net assimilation, which helped in increasing the overall growth of the plant.

Table 2: Effect of organic nutrient management on yield and yield attributes of short grain aromatic rice

Treatments	effective tillers m^{-2} (No.)	Panicle Length (cm)	Panicle Weight (g)	1000-grain Weight (g)	Grain yield ($q^{-1}ha$)	Straw yield ($q\ ha^{-1}$)	Grain: straw ratio	Harvest Index (%)
T1 100% RDN (O) + Azo and PSB	350.00	22.47	3.35	16.63	25.39	51.54	0.48	32.49
T2 100% RDN (O) + 10% CU	300.00	22.13	3.33	16.33	24.69	49.52	0.48	32.36
T3 100% RDN (O) + 20% CU	316.50	22.27	3.34	16.63	25.25	49.03	0.48	32.54
T4 75% RDN (O) + Azo and PSB	266.50	21.87	3.27	16.22	23.94	51.42	0.47	32.18
T5 75% RDN (O) + 10% CU	253.50	21.60	3.08	16.13	23.14	48.84	0.47	32.11
T6 75% RDN (O) + 20% CU	260.00	21.80	3.15	16.21	23.85	50.64	0.47	32.09
T7 Natural farming	190.00	21.20	2.84	15.38	22.97	49.11	0.46	31.86
T8 100% RDN (IO)	300.00	22.20	3.33	16.34	25.09	52.32	0.48	32.41
T9 100% RDN (IO) + Azo and PSB + 10% CU	370.00	22.80	3.38	16.78	25.53	52.57	0.48	32.70
T10 75% RDN (IO) + Azo and PSB + 10% CU	270.00	22.07	3.30	16.30	24.65	47.77	0.47	32.18
T11 control (0% RDN)	166.50	18.67	2.55	14.25	15.10	33.25	0.45	31.23
SEm±	2.15	0.24	0.11	0.10	0.80	1.63	0.01	0.38
CD at 5%	9.23	0.71	0.31	0.30	1.35	3.81	0.03	1.12

RDN = recommended dose of nutrient, O = organic and IO = inorganic, CU = cow urine, Azo = Azotobacter, PSB = phosphorus solubilizing bacteria, Cow urine at 30 and 60 DAT in T2, T3, T5 and T6, Cow urine at 30 DAT in T9 and T10

Conclusion

The rice responded favorably to the 100% RDN (inorganic) + seed treatment with Azotobacter and PSB + 10% cow urine (T9) treatment for achieving higher growth parameters, grains as well as straw yield but in case of organic treatments, 100% RDN (organic) + seed treatment with Azotobacter and PSB (T1) gave significantly higher yield followed by 100% RDN (organic) + 20% foliar spray of cow urine at 30 and 60 DAT (T3) and 100% RDN (organic) + 10% foliar spray of cow urine at 30 and 60 DAT (T2), among other organic treatments.

References

1. Acharya NP, Mandal BN. Effect of integrated nutrient management on the quality of aromatic rice. Annals of Agricultural Research New Series. 2010;26(2):231-234.
2. APEDA. Annual report and statistics of food grains, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India. 2018, 87.
3. Bahadur B, Singh SP. Effect of nitrogen levels on growth and grain yield of dwarf aromatic rice. Annals of Agricultural Research. 2013;18(3):388-390.
4. Balasubramaniam, BS, Johnson DE. Growth response of transplanted rice to different nutrient combinations. Journal of Weed Science. 2011;59(1):119-122.
5. Banerjee S, Ghosh M, Pal SK, Mazumdar D, Mahata D. Effect of organic nutrient management practices on yield and economics or aromatic rice (Gobindabhog). Weed Technology. 2015;50(4):365-369.
6. Barker AK, Jena SN. Study of transplanted rainfed upland rice. Indian Journal of Agronomy. 2015;31(2):211-213.
7. Bhadoriya D, Prakash BB. Effect of date of planting and spacing on grain yield and quality of aromatic rice (*Oryza sativa*) varieties in wet season in coastal Orissa. Indian Journal Agricultural Science. 2003;67(3):93-97.
8. Bhardwaj V, Tyagi VV. Impact of continuous manuring on crop yields and uptake of nitrogen, phosphorus, and potassium. Journal of Potassium Research. 1994;10(3):290-293.
9. Bhattacharya KR, Sao NK. Need for widening the scope of rice breeding in India for Table rice. Weed Biology and Management. 2002;26(2):117-122.
10. Bindra AD, Thakur RC. Influence of green manures along with fertilizers on nitrogen, phosphorus, and potassium content in rice. International Rice Research Notes. 1996;33:143-145.
11. Black CA, Evans DD. Methods of soil analysis. *American Society of Agronomy*. Madison, Wisconsin, USA. 1965.
12. Choudhary JK, Das GR. Effect of time of planting and nitrogen levels on yield and yield component of rice. Annals of Plant and Soil Research. 2011;34:178-181.
13. Dawari MR, Sharma SN. Effect of different combination of organic materials and biofertilizers on productivity, grain quality, and economics in organic farming of basmati rice (*Oryza sativa L.*). Indian Journal of Agronomy. 2010;55(4):290-294.
14. Deshpanday C, Devasenapathy V. Hulling, milling, nutritional and functional properties of selected rice varieties. Proceedings of International Symposium on "Eco–Efficiency in Agriculture & Allied Research". 2010;47(2):110-117.
15. Dick K, Gregorich B. Application of crop residues in combination with chemical fertilizers for sustainable productivity in rice–wheat system. Indian Journal of Agronomy. 2014;48(1):17-21.
16. Dixit KG, Gupta BR. Effect of FYM, chemical, and biofertilizers on yield and quality of rice. Journal of the Indian Society of Soil Science. 2000;53(2):174-177.
17. Duhan SD, Singh VP. Organic farming and chemical fertilizers analysis of aromatic rice. Bulletin of the Hiroshima Prefectural Agriculture Research Centre. 2011;76(5):53-61.
18. Ghosh GK, Singh SG. Effect of organic nutrient sources on yield, nutrient uptake and soil biological properties of rice (*Oryza sativa*). Indian Journal of Agronomy. 2004;58(3):271-276.
19. Gomez AK, Gomez AA. Statistical procedures for Agricultural. A Wiley-inter Science Publication. John Wiley and Sons, New York. 1984.
20. Hemalatha ML, Duary B. Soil and Plant Analysis. Bombay, New Delhi, Asia Publishing House. 2000, 30-38.
21. Jackson DS. Growth and sink potential of rice as influenced by the split application of potassium with FYM in inceptisols of eastern and central India. Journal of Pakistan Research. 2008;14(1&4):73-77.
22. Kumar N. Effect of organic nutrient management on

yield, nutrient uptake and nutrient balance sheet in aromatic rice (*Oryza sativa*). Indian Journal of Agronomy. 2010;55(3):561-564.
23. Kumar N, Prasad K. Soil properties, nutrients uptake and productivity of rice under an integrated nutrient management system. Annuals Plant Research. 2001;3(1):269-273.
24. Kumari N, Bhoite M. Handbook of organic farming. Organic Farming Research Unit. 2004, 30-38.
25. Leopold AC, Kridemann PE. The dynamics of growth in plant growth and development. Tata Mc. Grow–Hill Publishing Cooperative Limited New Delhi. Second edition. 1975, 9-105.
26. Mahapatra AK, Khanda CM, Mishra PJ. Response of aromatic rice varieties to nitrogen application in eastern-ghat highland zone of Orissa. Journal of Tropical Agriculture. 2004;41(3&4):135-136.
27. Mahasker D, Thorat NP. Organic farming. Journal of Sustainable Agriculture. 2005;21(4):59-128.
28. Mankotiya SB. Effect of nitrogen levels on leaf area, leaf area index and grain yield of aromatic rice varieties. Journal of Soils and Crops. 2007;15(1):218-220.
29. Mannan I, Kumar DR. Influence of nitrogen on grain yield and quality traits of aromatic rice varieties under normal and late planting. Journal of Plant Breeding and Crop Science. 2010;22(2):297-299.
30. Murali MK, Settee RA. Grain yield and nutrient uptake of aromatic rice variety Pusa basmati-1 at a different level of NPK, vermicompost, and triacontanol. International Journal of Agriculture. 2001;38(1&2):84-85.
31. Netam AK, Purohit KK. Performance of integrated nutrient management on growth, soil nutrient status and yield of traditional aromatic rice (*Oryza sativa* L.) varieties. Journals of Agricultural Issues. 2008;13(1):115-118.
32. Pandey D. Physiological parameters and productivity of aromatic rice influenced by different organic and chemical nutrient packages. International Journal of Tropical Agriculture. 2012;13(3):178-181.
33. Panday N, Sarawgi AK, Tripathi RS. Effect of FYM and chemical N fertilizer on grain yield and quality of aromatic rice (*Oryza sativa*) varieties. Indian Journal of Agricultural Sciences. 1999;69(9):621-623.
34. Pandey N, Sarawgi AK, Rastogi NK, Tripathi RS. Integrated weed management on growth and yield of transplanted rice and its residual effect on succeeding blackgram. Journal of Agronomy. 1999;12(2):99-103.
35. Panday SK, Patel RS, Yognanda P. Effect of integrated nutrient management on production potential, economics and energetics of aromatic rice (*Oryza sativa* L.) Plant Archives. 2004;4(2):503-505.
36. Prasad MP, Bansasi R, Soni VK. Effect of organic nutrient sources on productivity and profitability of aromatic rice under upland eco-system. Annals of Plant Physiology. 2010;19(2):211-213.
37. Raghuraj K, Azad M, Laheria LS, Singh N. Influence of vermicompost on the physio-chemical and biological properties in a different type of soil along with yield and quality of pulse crop black gram. Journal of Sustainable Agriculture. 2001;23(1):51-58.
38. Rao KT, Ramu PS. Effect of organic manures on the performance of aromatic varieties of rice in high altitude areas of Andhra Pradesh. International Journal of Current Microbiology and Applied Science. 2013;2(11):339-346.
39. Reddy MS, Reddy DS. Nitrogen uptake and quality of rice as influenced by different nitrogen management practices. Agricultural Research on Crops, 2003;4(3):291-294.
40. Roul V, Sarawgi D. Response of rice (*Oryza sativa*) cultivars to levels of nitrogen application. Agricultural Science Digest. 2005;22(3):197-198.
41. Saha S, Panday AK, Gupta HS. Nutritional quality of organic rice grown on organic composts. Agronomy for Sustainable Development. 2007;27(3):223-229.
42. Saitoh N, Shekhar D. Quality characteristics of non-aromatic and aromatic rice varieties of Punjab. RRRS, Punjab Agricultural University, Kapurthala, Punjab. Annual report on crop research. 2002;7(2):408-410.
43. Sangeetha SP, Balakrishna A, Bhuvaneshwari J. Influence of organic nutrient sources on the quality of rice. Madras Agricultural Journal. 2010;97(7-9):230-233.
44. Sarawgi SK, Sarawg AK. Effect of blending of N with or without FYM on semi-dwarf, medium to long slender aromatic rice varieties in the lowland of Chhattisgarh. *In:* International Symposium on Rainfed Rice Ecosystems: Perspective and Potential. IGKV, Raipur, India. 2004, 11-13th Oct. pp. 159-160.
45. Shanmugam PM, Veeraputhran R. Effect of organic manure, biofertilizers, inorganic nitrogen and zinc on growth and yield of rice (*Oryza sativa* L.) Madras Agricultural Journal. 2001;87:90-93.
46. Singh AK, Adhikari PK. Effect of graded level of nitrogen and plant spacing on grain yield and quality of aromatic rice. Annals of Agricultural Research, New Series. 2005;26(3):402-495.
47. Singh MV, Tripathi HN, Tripathi HP. Effect of nitrogen and planting date on yield and quality of aromatic rice. Indian Journal of Agronomy. 1997;42(4):602-606.
48. Singh RS, Singh D. Effect of organic nutrient management on productivity and economics of rice (*Oryza sativa*). Indian Journal of Agronomy. 2007;52(3):291-293.
49. Singh SK, Maiti S, Pal S, Banerjee H. Integrated nutrient management in rice-rice cropping system. Indian Journal of Agricultural Chemistry. 2002;48(1&2):41-45.
50. Singh YV, Agrawal B. Influence of organic nutrient management on Basmati rice (*Oryza Sativa*). Indian Journal of Agronomy. 2011;56(3):169-175.
51. Surekha VP, Singh V. Integrated weed management in direct seeded rainfed low land rice. Indian Journal of Weed Science. 2009;38(1&2):49-53.
52. Suresh K, Reddy GR. Effect of organic and inorganic sources of nutrients on growth and yield of rice. Proceedings of International Symposium on "Eco–Efficiency in Agriculture & Allied Research". 2002;39(1&2):57-59.
53. Swaminathan A. Impact of vermicompost carrier-based Bio-inoculants on the growth, yield, and quality of rice (*Oryza sativa L.*) C.V. NLR 145. The Eco Scan. 2007;4(1):83-88.
54. Tripathi S, Verma NP. Efficacy of multi-micronutrients on growth, yield and quality of aromatic rice varieties: Journal of Crop Research. 2005;10(2):153-158.
55. Yadav VR. Singh VP, Kumar A. Integrated weed management in transplanted rice. Proceedings of Biennial

Conference of Indian Society of Weed Science on Emerging Challenges in Weed Management February 15-17. Directorate of Weed Science Research, Jabalpur, Madhya Pradesh, India. 2013;178:225.

56. Yaduvanshi NPS, Sharma DR. Effect of organic farming on productivity, Soil health, and economics of rice. Indian Journal of Agronomy. 2010;54(3):267-271.
57. Yogananda AA, Tahir G. Association analysis of some yield influencing traits in aromatic and non-aromatic rice. Pakistan Journals of Botany. 2012;37(3):613-627.