International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(1): 2780-2784

Received: 19-11-2019
Accepted: 23-12-2019

S Chandrasoorian
Agriculture Teacher, Government Boys Higher Secondary School, Thiruppuvanam, Sivagangai, Tamil Nadu, India

NS Venkataraman
Professor and Head, Dept. of Agronomy, Agricultural College and Research Institute, TNAU, Madurai, Tamil Nadu, India

R Babu
Professor, Agricultural College and Research Institute, TNAU, Kudumiyanmalai, Tamil Nadu, India

R Amutha
Professor, Unit of Crop physiology, Dept. of Seed Science and Technology, Agricultural College and Research Institute, TNAU, Madurai, Tamil Nadu, India

Corresponding Author:
S Chandrasoorian
Agriculture Teacher, Government Boys Higher Secondary School, Thiruppuvanam, Sivagangai, Tamil Nadu, India

Influence of organic and inorganic nutrients on yield, physicochemical properties and cooking quality of seeragasamba rice

S Chandrasoorian, NS Venkataraman, R Babu and R Amutha

DOI: https://doi.org/10.22271/chemi.2020.v8.i1ap.8690

Abstract
Field experiments were conducted during samba seasons of 2017-2018 and 2018-2019 to study the effect of organic manures and inorganic nutrients on yield, physicochemical and cooking quality of Seeragasamba rice. The experiments were conducted in sandy clay loam with pH around 7.5. Fourteen treatments comprising different sources of organic manures and inorganic nutrients were replicated thrice under RBD. The treatments are as follows: T_1- 100%N through Green Manure, T_2-75%N through Green Manure+25%N through RDF, T_3-50%N through Green Manure+50% N through RDF, T_4 -100%N through FYM, T_5-75% N through FYM+25% N through RDF, T_6-50% N through FYM+50% N through RDF, T_7-100% N through Composted Poultry Manure, T_8-75%N through Composted Poultry Manure+25%N through RDF, T_9-50% N through Composted Poultry Manure+50%N through RDF, T_{10}-100%N through Vermicomposted Pressmud, T_{11}- 75% N through Vermicomposted Pressmud+25% N through RDF, T_{12}-50% N through Vermicomposted Pressmud + 50% N, T_{13}-RDF @ 56:37:37 NPK Kg/ha through in organic and T_{14} - Control (No Nitrogen). The results revealed that in both samba seasons, the highest grain yield was obtained in (T_3) application of 50% N through green manure + 50% N through RDF and it was followed by the (T_{12}) application of 50% N through vermicomposted pressmud + 50% N through RDF. However, both treatments were found to be on par with each other. The milling recovery, head rice recovery, protein and starch amylose content were also found to be higher in these treatments as compared to others. The cooking quality evaluated interms of increased length and breadth of cooked rice were also enhanced in these treatments. The sensory evaluation attributes *viz*., colour, taste, texture and overall acceptability were also increased in T_3 and T_{12}.

Keywords: Grain yield, milling recovery head rice recovery, protein starch, amylose and sensory

Introduction
Rice can be classified as aromatic and non-aromatic rice by aroma. Aromatic rice emits a unique aroma with cooking. Indian sub-continence is habitat for aromatic rice diversity (Bisne and Sarawgi, 2008) [5]. In aromatic rice, the flavor is expressed as one of the most significant factors in market business, which distinguishes aromatic rice from ordinary rice (Laohakunjit and Kerdchoechuen, 2007 [14]; Fitzgerald *et al.*, 2009) [9]. This flavour compound is stemming primarily from its 2-Acetyl-1-pyrroline content (Bhattacharjee *et al.*, 2002) [3], which generally plays a role in consumer acceptability of rice (Bergman *et al.*, 2000) [2]. Aromatic rice such as 'Seeragasamba', 'Rascadam' and 'Basmathi' are known for their characteristics fragrance when cooked. They also fetch a premium price in the local and regional markets (often 3 to 4 times more than the ordinary rice varieties), besides attracting good exports. Although a promising foreign exchange earns the cultivation of aromatic rice has been largely confined to the states of Uttar Pradesh, Punjab and Haryana (Saha *et al.*, 2007) [20].
Rice growers have traditionally used organic materials particularly farmyard manure and green manures in the preindustrial age. Green manuring can improve soil physical, chemical, and biological properties and consequently crop yields (Fageria, 2007) [8]. Importance of this soil ameliorating practice is increasing in recent years because of increasing prices and low efficiency of chemical N fertilizer and low organic matter content of soils, inclusion of green manuring crops in the rice- based cropping systems, deserves priority consideration (Bhuiyan and Zaman, 1996) [4].

But with the present day high yielding cultivars, which have higher nutrient requirements, the use of inorganic fertilizers has increased considerably leading to declining in the use of organic materials (Hossain and Singh, 2000) [12]. It is well known that sustainable production of crops cannot be maintained by using only chemical fertilizers and similarly it is not possible to obtain higher crop yield by using organic manure alone (Bair, 1990) [1]. For sustainable agriculture and to ensure the food production with high quality, it is necessary to combined use of organic and inorganic sources of nutrients (Mahmud *et al.*, 2016) [16]. Keeping in view of the above, the present investigation was carried out to find out the effects of organic and inorganic nutrients on yield, physical, chemical grain quality and cooking quality of Seeragasamba rice.

Materials and Methods

Field experiments were conducted during samba seasons of 2017-2018 and 2018-2019 at Madurai. It is located at Southern agro-climatic zones of Tamil Nadu at 9.54ºN Latitude and 78.80ºE longitude at an altitude of 147 m above MSL. In the first year experiment, a total of 278.1 mm of rainfall was received in 12 days. The maximum temperature ranged from 29.7 ºC to 40.8 ºC and minimum temperature ranges from 18.6 ºC to 26.1 ºC. In the second year experiment, a total rainfall of 377.8 mm was received in 11 days. The maximum and minimum temperature ranged from 29.7 ºC to 38.4 ºC and from 18.9 ºC to 34.4 ºC respectively. The soil of the experimental fields was sandy clay loam with pH around 7.5 and EC of 0.37 (dSm^{-1}). The experiment was conducted with fourteen treatments replicated thrice. The treatment details are as follows:

T_1- 100%N through Green Manure, T_2-75%N through Green Manure+25%N through RDF, T_3 - 50%N through Green Manure+50% N through RDF, T_4 -100%N through FYM, T_5-75% N through FYM+25% N through RDF, T_6-50% N through FYM+50% N through RDF, T_7-100% N through Composted Poultry Manure, T_8-75%N through Composted Poultry Manure+25%N through RDF, T_9-50% N through Composted Poultry Manure+50%N through RDF, T_{10}-100%N through Vermicomposted Pressmud, T_{11}- 75% N through Vermicomposted Pressmud+25% N through RDF, T_{12}-50% N through Vermicomposted Pressmud+50% N, T_{13}-RDF @ 56:37:37 NPK Kg/ha through In organic and T_{14}- Control (No Nitrogen). All the treatments except T14 received recommended dose of P_2O_5 and K_2O recommended dose of N, P_2O_5 and K_2O for two samba seasons are : 56.37:36 kg/ha.

The observation on grain yield was made at harvest stage. After milling, milling recovery and head rice recovery were assessed as per the method suggested by Saha *et al.* (2007) [21]. The protein (Lowry's *et al.* (1957) [15], starch and protein (Sadasviam and Manickam, 1996) [20] were estimated from the hulled rice sample. After cooking, the colour, texture, taste and overall acceptability were assessed by using Hedonic scale (Peryam and Pilgram, 1957) [19]. Data collected were analyzed as per the method suggested by Gomez and Gomez (1984) [10].

Results and Discussion

Grain yield

The grain yield of rice was significantly influenced by the application of different sources of organic manures and inorganic nutrients in samba in both 2017-2018 and 2018-2019 (Table 1). Among the treatments, the application of (T_3) 50% N through green manure + 50% N through RDF recorded the highest grain yield of 4577 kg/ha in 2017-2018 and 4619 kg/ha in 2018-2019. It was followed by (T_{12}) the application of 50% N through vermicomposted pressmud + 50% N through RDF which recorded the grain yield of 4436 kg/ha during 2017-2018 and 4481 during 2018-2019. The higher grain yield due to the (T_3) application of 50% N through green manure + 50% N through RDF and (T_{12}) application of 50% N through vermicomposted pressmud + 50% N through RDF might be due to the favourable soil condition and synchronized release of nutrients throughout the growth period (Murali and Setty, 2004) [17]. Similar results were also reported by Pandey *et al.* 1999 [18].

Table 1: Effect of different organic manures and inorganic nutrients on grain yield and physical grain quality of Seeragasamba rice

Treatments		Grain yield (kg/ha)		Milling recovery (%)		Head rice recovery (%)	
		2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
T_1	100% N through green manure	2701	2754	57.1	58.4	65.8	65.9
T_2	75% N through green manure+25% N through RDF	3497	3567	61.6	62.8	69.1	68.6
T_3	50% N through green manure+50% N through RDF	4573	4619	69.3	70.4	75.6	76.4
T_4	100% N through FYM	2265	2288	55.2	56.5	62.5	64.1
T_5	75% N through FYM+25% N through RDF	2934	2963	58.7	59.1	67.2	66.7
T_6	50% N through FYM+50% N through RDF	3836	3875	65.1	66.5	73.8	72.3
T_7	100% N through composted poultry manure	2562	2488	56.2	57.4	63.7	64.8
T_8	75% N through composted poultry manure+25% N through RDF	3189	3222	59.4	60.2	67.9	67.4
T_9	50% N through composted poultry manure+50% N through RDF	4070	4212	66.4	67.3	74.3	73.7
T_{10}	100% N through vermin composted pressmud	2620	2673	56.5	58	64.4	65.3
T_{11}	75% N through vermin composted pressmud+25% N through RDF	3392	3426	60.4	61.3	68.2	68.2
T_{12}	50% N through vermin composted pressmud+50% N through RDF	4436	4481	67.1	68.1	73.6	74.5
T_{13}	RDF @ 56:37:37 NPK kg/ha through inorganic	3760	3800	63.6	64.7	71.5	70.8
T_{14}	Control (No nitrogen)	2084	2105	54.1	55.6	61.3	62.1
SEd		201.2	181.0	4.63	3.66	3.15	3.60
CD (P=0.05)		413.5	372.0	9.52	7.51	6.46	7.41

Physical grain quality

The milling recovery (per cent) and head rice recovery (per cent) are the most important characters which decides the physical grain quality of rice. With respect to milling recovery, the highest milling recovery (69.3 per cent in 2017-2018 and 70.4 in 2018-2019) were recorded due to the application of 50% N through green manure + 50% N through RDF (T_3) and it was followed by T_{12} (67% in 2017-2018 and 68.14 in 2018-2019), T_9 (66.4 in 2017-2018 and 67.3 in 2018-2019). The treatments were found to be significantly higher than the other treatments.

The head rice recovery was significantly improved by the application of organic manures and inorganic nutrients. Significantly, the highest head rice recovery (75.6 in 2017-2018 and 76.4 per cent in 2018-2-19) was recorded in T_3, followed by T_9 (74.3 per cent 2017-2018) and T_{12} (67.3 per cent in 2018-2019). These treatments *viz*, T_3 and T_9 were found to be significantly higher than the other treatments during 2017-2018 and T_3 and T_{12} were found to be significantly higher than the other treatments in 2018-2019.

The superior performances of these treatments might also be owing to improvement in physical, chemical and microbiological environment of soil favouring increased availability of nutrients to the rice crop. On the other hand, chemical fertilizers reduces the physical and microbiological properties of soil. Similar results was reported by Hemalatha *et al.* (2004) [11].

Biochemical constituents

In the case of protein content, it was significantly increased by the application of different organic manures and inorganic nutrients (Table 2). Among the treatments, T_3 recorded the highest protein content of 8.40 per cent in 2017-18 and 8.91 per cent in 2018-19 followed by T_2 - 8.21 per cent in 2017-18 and 8.39 per cent in 2018-19, T_9 - 8.13 per cent in 2017-2018 and 8.29 per cent in 2018-19. All treatments were significantly superior to the rest of the treatments. The treatments T_{14} recorded the lowest protein content (6.57).

The data related to starch content revealed that it was significantly enhanced due to the application of different organic manures and inorganic nutrients. The highest starch content was registered in T_3 - 68.72 per cent in 2017-18 and 70.09 per cent in 2018-10, followed by T_{12} - 66.32 per cent in 2017-18 and T_2 - 67.4 per cent in 2018-19. These treatments were found to be significantly higher than the other treatments. The lowest starch content (58.57 per cent) was recorded in T_{14}.

Different treatments significantly influenced the amylose content of rice. Among the treatments, T_3 recorded the highest amylose content of 24.10 per cent in 2017-18 and 24.24 per cent in 2018-19 followed by recorded T_{12} - 23.51 per cent in 2017-18 and 25.75 per cent in 2018-2019 and which reigster T_9 - 23.52 per cent in 2017-18 and 23.55 per cent in 2018-2019. All these treatments were found to be significantly higher than the other treatments and control. The control (T_{14}) recorded the lowest amylose content (19.00 per cent).

The higher protein, starch and amylose content in these treatments might be due to the more availability of both macro and micronutrients from green manure and vermicomposted and farmyard manures. Improvement in quality parameters of rice due to the combined application of organic sources of nutrients along with inorganic fertilizer was also reported by Dixit and Gupta (2000) [7].

Table 2: Effect of different organic manures and inorganic nutrients on biochemical constituents of Seeragasamba rice

Treatments		Protein (%)		Starch (%)		Amylose (%)	
		2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
T_1	100% N through green manure	7.49	7.64	61.35	62.58	21.40	21.61
T_2	75% N through green manure+25% N through RDF	7.88	8.04	63.50	64.77	22.45	22.67
T_3	50% N through green manure+50% N through RDF	8.40	8.91	68.72	70.09	24.10	24.34
T_4	100% N through FYM	7.26	7.41	60.23	61.43	20.38	20.58
T_5	75% N through FYM+25% N through RDF	7.57	7.72	62.12	63.36	21.96	22.18
T_6	50% N through FYM+50% N through RDF	8.09	8.25	65.68	67	23.27	23.5
T_7	100% N through composted poultry manure	7.37	7.52	60.82	62.04	20.84	21.05
T_8	75% N through composted poultry manure+25% N through RDF	7.60	7.75	62.44	63.7	22.14	22.36
T_9	50% N through composted poultry manure+50% N through RDF	8.13	8.29	66.01	67.33	23.32	23.55
T_{10}	100% N through vermin composted pressmud	7.44	7.51	61.00	62.22	21.02	21.22
T_{11}	75% N through vermin composted pressmud+25% N through RDF	7.63	7.78	63.16	64.42	22.20	22.42
T_{12}	50% N through vermin composted pressmud+50% N through RDF	8.21	8.37	66.33	67.64	23.51	23.75
T_{13}	RDF @ 56:37:37 NPK kg/ha through inorganic	8.00	8.16	64.12	65.4	22.73	23.00
T_{14}	Control (No nitrogen)	6.57	6.83	58.57	59.74	19.00	19.20
SEd		0.298	0.547	3.343	3.654	0.937	1.370
CD (P=0.05)		0.613	1.124	6.872	7.510	1.926	2.817

Cooking quality

The cooking quality characteristics *viz*. kernel length, kernel breath, length breath ratio after cooking of milled rice were estimated in samba seasons of both experiments 2017-2018 and 2018-2019 and the data are presented in Table 3.

In the case of kernel length after cooking, the data revealed that the length of cooked rice was significantly increased by the application of different organic manures and inorganic nutrients in both experiments. Among the treatments, T_3 recorded the (6.27mm in 2017-18 and 6.40 mm in 2018-19) highest kernel length after cooking, followed by T_{12} (6.20 mm in 2017-18 and 6.30 mm in 2018-2019). All these two treatments found to be significantly superior to the rest of the treatments. The control recorded the lowest kernel length (5.42 mm) after cooking.

With regard to kernel breadth, T_3 recorded the maximum breadth of kernel (2.25 in 2017-18 and 2.28 mm in 2018-19) followed by T_{12} (2.23 mm in 2017-2018 and 2.24 mm in 2018-2019). These two treatments *viz*. T_3 and T_{12} were found to be significantly higher than the other treatments. The lowest kernel breadth after cooking was (1.82 mm) obtained in T_{14} (control).

Similar increase in kernel length and breadth due to the application of organic sources of plant nutrients was also reported by Saha *et al*. (2007) [20].

The observation on length-breadth ratio after cooking revealed that the highest ratio was 3.0 and 3.5 was recorded in T_{14} during 2017-18 and 2018-2019 repectively. However, the data were not significantly influenced by the different nutrients treatments.

Table 3: Effect of different organic manures and inorganic nutrients on cooking quality characteristics of Seeragasamba rice

Treatments		KLAC (mm)		KBAC (mm)		LBRAC	
		2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
T_1	100% N through green manure	5.73	5.86	1.93	1.95	2.97	3.00
T_2	75% N through green manure+25% N through RDF	5.88	6.00	2.04	2.06	2.88	2.91
T_3	50% N through green manure+50% N through RDF	6.27	6.40	2.25	2.28	2.79	2.81
T_4	100% N through FYM	5.57	5.68	1.87	1.88	2.98	3.02
T_5	75% N through FYM+25% N through RDF	5.78	5.90	2.00	2.02	2.89	2.92
T_6	50% N through FYM+50% N through RDF	6.11	6.23	2.20	2.22	2.78	2.80
T_7	100% N through composted poultry manure	5.63	5.74	1.89	1.90	2.99	3.02
T_8	75% N through composted poultry manure+25% N through RDF	5.81	5.86	2.01	2.02	2.89	2.90
T_9	50% N through composted poultry manure+50% N through RDF	6.15	6.27	2.21	2.23	2.78	2.80
T_{10}	100% N through vermicomposted pressmud	5.69	5.80	1.90	1.92	3.00	3.02
T_{11}	75% N through vermicomposted pressmud+25% N through RDF	5.84	5.97	2.02	2.04	2.90	2.93
T_{12}	50% N through vermicomposted pressmud+50% N through RDF	6.20	6.30	2.23	2.24	2.78	2.81
T_{13}	RDF @ 56:37:37 NPK kg/ha through inorganic	5.90	6.02	2.11	2.13	2.80	2.83
T_{14}	Control (No nitrogen)	5.42	5.52	1.82	1.85	2.98	3.05
SEd		0.284	0.341	0.098	0.119	0.162	0.144
CD (P=0.05)		0.585	NS	0.202	0.245	NS	NS

KLAC-Kernal Length after cooking; KBAC- Kernal Breath after cooking; LBRAC-Length Breath, Ratio After Cooking

Sensory evaluation

The sensory evaluation parameters *viz*, colour, texture, taste and overall acceptability were evaluated by using hedonic scale in samba seasons of both 2017-18 and 2018-19 experiments (Table 4). The highest colour score of 8.5 in 2017-18 and 8.7 in 2018-19 were recorded in T_3. It was followed by T_{12} which recorded 8.3 in 2017-18 and 8.5 in 2018-19.

Data pertaining to the texture of cooked rice, the highest score (8.8 in 2017-18 and 8.9 in 2018-19) were recorded in T_3 and was followed by T_{12} (8.50 in 2017-18 and 8.6 in 2018-19). However, T_3 and T_{12} were found to be on par with each other.

Similar to the texture, the highest taste score (8.90 in 2017-18 and 9.0 in 2018-19) was recorded in T_3, T_3 was followed by T_{12} which registered the taste score of 8.70 in 2017-18 and 8.8 in 2018-19. The lowest score of 7.60 during 2017-18 and 7.9 in 2018-19 were recorded in T_{14}.

The overall acceptability was observed in both experiments and the data revealed that the highest overall acceptability (8.8 in 2017-18 and 8.9 in 2018-19) was recorded in T_3 and it was followed by T_{12} (8.7 in 2017-18 and 8.8 in 2018-19). These two treatments *viz*, T_3 and T_{12} were found to be significantly higher than the other treatments. However, these treatments were found to be on par with each other. The lowest score of 7.6 was recorded in both experiments.

The highest overall acceptability in these treatments might be due to the better texture, colour, taste observed. Similarly the highest starch and amylose content was also contributed to the better texture and taste. The higher accumulation of 2-acetyl-1- pyrroline, aromatic biochemical in rice may be also been an added reason for overall acceptability of rice due to the application of organic manure was also reported by Champagne *et al.* 2007 [6].

Table 4: Effect of different organic manures and inorganic nutrients on sensory evaluation of cooked of Seeragasamba rice

Treatments		Colour		Texture		Taste		Overall acceptability	
		2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
T_1	100% N through green manure	7.8	7.9	7.9	8.0	8.10	8.2	7.9	8.3
T_2	75% N through green manure+25% N through RDF	8.1	8.0	8.1	8.2	8.30	8.4	8.3	8.5
T_3	50% N through green manure+50% N through RDF	8.5	8.7	8.8	8.9	8.90	9.0	8.8	8.9
T_4	100% N through FYM	7.8	7.9	7.9	8.0	8.10	8.2	7.9	8.3
T_5	75% N through FYM+25% N through RDF	8.1	8.0	8.1	8.2	8.30	8.4	8.3	8.5
T_6	50% N through FYM+50% N through RDF	8.3	8.5	8.5	8.6	8.70	8.8	8.7	8.8
T_7	100% N through composted poultry manure	7.8	7.9	7.9	8.0	8.10	8.2	7.9	8.3
T_8	75% N through composted poultry manure+25% N through RDF	8.1	8.0	8.1	8.2	8.30	8.4	8.3	8.5
T_9	50% N through composted poultry manure+50% N through RDF	8.3	8.5	8.5	8.6	8.70	8.8	8.7	8.8
T_{10}	100% N through vermin composted pressmud	7.8	7.9	7.0	8.0	8.10	8.2	7.9	8.3
T_{11}	75% N through vermin composted pressmud+25% N through RDF	8.1	8.0	8.1	8.2	8.30	8.4	8.3	8.5
T_{12}	50% N through vermin composted pressmud+50% N through RDF	8.3	8.5	8.5	8.6	8.70	8.8	8.7	8.8
T_{13}	RDF @ 56:37:37 NPK kg/ha through inorganic	8.1	8.2	8.3	8.4	8.60	8.6	8.6	8.7
T_{14}	Control (No nitrogen)	7.5	7.6	7.7	7.8	7.60	7.9	7.6	7.6
SEd		0.45	0.56	0.55	0.51	0.50	0.43	0.34	0.51
CD (P=0.05)		NS	1.15	1.11	1.06	1.03	0.85	0.70	1.05

Hedonic 9 point scale: 1 - Dislike extremely, 2 - Dislike very much, 3 - Dislike moderately, 4 - Dislike slightly, 5 - Neither like nor dislike, 6 - Like slightly, 7 - Like moderately, 8 - Like very much, 9 - Like extremely3

Conclusion

From the present investigation, it can be concluded that application of 50% N through green manure + 50% N through RDF as well as 50% N through vermicomposted pressmud + 50% N through RDF significantly increased the yield of Seeragasamba. These treatments not only increased the yield but also enhanced protein, starch and amylose content. The milling recovery, head rice recovery, kernel length and breadth of cooked rice were also found to be increased by the combination of green manure or vermicomposted pressmud along with inorganic nutrients. The cooked rice from these treatments were found to be have higher taste, texture, colour

and overall acceptability than the other treatments.

References

1. Bair W. Characterization of the environment for sustainable agriculture in Semi-arid Tropics. In: Proc. Sustainable Agriculture Issue, Prospective and Prospects in Semi-arid Tropics (ed. Singh, RP), Hyderabad, India, India Society of Agronomy, 1990, 90-128.
2. Bengman CJ, Delgado JT, Bryant R, Grimm C, Cadwallader KR, Webb BD. Rapid gas chromatographic technique for quantifying 2-acetyl-l-pyrroline and hexanal in rice (*Oryza sativa* L.) Cereal Chem. 2000; 77(4):454-458.
3. Bhattacharjee P, Singhal RS, Kulkarni PR. Basmati rice: A review. International Journal of Food Science and Technology. 2002; 37:1-12.
4. Bhuiyan NI, Zaman SK. Use of green manure crops in rice fields for sustainable production in Bangladesh agriculture. In: Rahman M, Podder A. K, Van Hove C, Begum ZNT, Heulin T, Hartmann. A (Eds.). Biological nitrogen fixation associated with rice production. Developmnets in Plant and Soil Sciences. 1996; 70:51-64.
5. Bisne R, Sarawgi AK. Agro-morphological and quality characterization of Badshah bhog group from aromatic rice germplasm of Chhattisgarh, Bangladesh Journal of Agricultural Research. 2008; 33(3):479-492.
6. Champagne ET, Garber KLB, Grimm CC, Mcdung AM. Effect of organic fertility management on physiochemical properties and sensory quality of diverse rice cultivars. Cereal Chem. 2007; 84:320-327.
7. Dixit KG, Gupta BR. Effect of FYM, chemical and biofertilizer on yield and quality of rice and soil prosperities. J Indian Soc. Soil Sci. 2000; 48(4):773-780.
8. Fageria NK. Green manuring in crop production. J Plant Nutr. 2007; 30(5):691-719.
9. Fitzgerald MA, McCouch SR, Hall RD. Not just a grain of rice: The quest from quality. Trends in Plant science. 2009; 14: 133-139.
10. Gomez KA, Gomez AA. Statistical procedure for agricultural research, II edn. John Wiley and York, 1994, 680.
11. Hemalatha M, Thirumurugan V, Balasubramanian R. Effect of organic sources of nitrogen on productivity, quality of rice (*Oryza sativa*) and soil fertility in single crop wetlands. Indian J Agron. 2000; 45:564-567.
12. Hossain M, Singh VP. Fertilizer use in Asian Agriculture: Implications for sustaining food security and the environment. Nutrient Cycling in Agroeconsystems. 2000; 57(2):155-169.
13. Houssain MF, Bhuiya MSU, Ahmed M, Mian MH. Effect of organic and inorganic fertilizer on the milling and physio-chemical properties of aromatic rice. J Agri. Sci. 2009; 42:213-218.
14. Laohakunjit N, Kerdchoechuen O. Aroma enrichment and the change during storage of nonaromatic milled rice coated with extracted natural flavor. Food Chemistry. 2007; 101(1):339-344.
15. Lowry OH, Roseberg NJ, Farr AI, Randal RJ. Protein measurement with folin phenol reagent. J Biol. Chem. 1951; 193:367-388.
16. Mahmud AJ, Shamsuddoha ATM, Haque MN. Effect of organic and inorganic fertilizer on the growth and yield of rice (*Oryza satvia* L.) Nature Science. 2016; 14(2):45-54.
17. Murali MK, Setty RA. Effect of fertilizer, vermicompost and triacontanol on growth and yield of scented rice. Oryza. 2004; 41(1 & 2):57-59.
18. Pandey N, Sarawgi AK, Rastogi NK, Tripathi RS. Effect of farmyard manure and chemical N fertilizer on grain yield and quality of scented rice (*Oryza sativa*) varieties. Indian J Agric. Sci. 1999; 69:621-623.
19. Peryam DR, Pilgrim FI. Hedonic scale method of measuring food preference. Food. Tech. 1957; 11:9-14.
20. Sadasivam S, Manickam A. Biochemical method for Agricultural Sciences, New Age International Pvt. New Delhi, 1996.
21. Saha M, Mondal SS, Acharya D, Saha S. Effect of integrated nutrient management on productivity and quality of basumathi rice. Oryza. 2007; 44:125-129.