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Growth and Yield of Medicinal Rice Njavara as Influenced by Nutrient Sources Under Different Management Systems

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Experimants were conducted in 2007 and 2008 to find out the effect of nutrient sources under different management systems at Cropping Systems Research Centre, Karamana, Thiruvananthapuram, Kerala. The experiment was laid out in split plot design with four replications. The treatments consisted of four management systems *viz*., SRI (M_1), ICM (M_2), PoP (M_3) of KAU and Farmers' practice (M_4) in main plot. Nutrient sources *viz*., organic sources (S_1), integrated nutrient sources (S_2) and inorganic sources (S_3) were the sub plot treatments. Farmers' practice (M_4) recorded higher values of growth (height of plants, number of leaves hill^{-1}, leaf area index (LAI) and number of tillers per unit area) and yield attributes (No of productive tillers m^{-2}, grain and straw yield). Sources of nutrients did not influence growth characters in Njavara. Among the nutrient sources, higher number of grains panicle^{-1}, filled grains panicle^{-1} and crop yield (grain and straw) were recorded under integrated nutrient source than organic and inorganic sources.

Key words: Njavara rice, management systems, nutrient sources, growth and yield

Rice continues to be the staple food in India and Kerala, and its demand is ever increasing. Cultivation of specialty rices like medicinal rice which fetches substantially higher prices is more profitable. Njavara (shashtika in Sanskrit), a rice (*Oryza sativa* L.) landrace described in ancient Sanskrit treatises of Ayurveda for its nutritive and medicinal properties, is traditionally used in Kerala for Ayurveda treatments (Kumar *et al.,* 2010). At present Njavara cultivation is confined to some pockets mainly in the Northern part of Kerala. No other medicinal rice is used in the world as widely as Njavara is used in Ayurveda (Thomas *et al*., 2006). Production is not sufficient even to meet the indigenous demand. At present, Njavara is exported in a very small extend. Its importance as a health food offers opportunity to establish niche global market (Balachandran *et al*., 2006). Keeping this in view, the present study was undertaken to study the response of medicinal rice Njavara to nutrient sources under management systems like System of Rice Intensification (SRI), Integrated Crop establishment Method (ICM), Package of Practices (PoP) of KAU and Farmers' practice.

Materials and Methods

Field experiments were conducted for two consecutive years *i.e.*, summer/third crop/*puncha* season of 2007 and 2008 at Cropping Systems Research Centre, Karamana, Thiruvananthapuram, Kerala. The soil was acidic in reaction (5.5 pH), high in organic carbon content (1.23%), medium in available nitrogen (261.93 kg ha^{-1}), available phosphorus (22.07 kg ha^{-1}) and available potassium (140.20 kg ha^{-1}) status. The experiments were laid out in a split plot design replicated thrice by fitting the management systems in main plot *viz*. SRI (System of Rice Intensification) (M_1), ICM (Integrated Crop Establishment Method) (M_2), PoP (Package of Practices) (M_3) (Recommendation of Kerala Agricultural University) as well as the Crop Management Practices of Farmers (M_4). Nutrient sources *viz*., organic sources (S1), integrated nutrient sources (S2) and inorganic sources (S3) were allotted to sub plot.

Black glumed type of Njavara was selected as the test crop. Eight, twelve and eighteen days old seedlings as per treatments were transplanted at the rate of 1, 2 and 3 seedlings per hill at 20x20 cm, 20x20 cm and 15x10 cm spacings in SRI, ICM and PoP treatments respectively. In Farmers' practice treatment pre germinated seeds were broadcasted on the same day. Nutrient management as per recommended practice FYM + 40:20:20 kg NPK ha^{-1}. Full FYM + 2/3 N + Full P + ½ K were applied as basal. 1/3 N + ½ K were applied at panicle initiation. In the organic treatments 40:20:20 kg NPK ha^{-1}were supplied through FYM, rock phosphate and wood ash. In integrated nutrient management treatments
40: 20: 20 kg NPK ha^{-1} were supplied through urea, rock phosphate and muriate of potash along with 5t FYM. In the inorganic treatments NPK contribution by 5t FYM was calculated and they were supplied through urea, rock phosphate and muriate of potash.

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NPK was also applied at the rate of 40:20:20 kg ha-1, respectively.

Results and Discussion

Effect of management systems on growth

Growth parameters like plant height, number of leaves hill-1, leaf area index (LAI) and number of tillers per unit area were significantly influenced by management systems.Tallest plants were produced in Farmers' practice which was 18/14% higher in 2007/2008 than ICM. Earlier reports were also available on the tendency of broadcast crop to grow taller and accumulate more dry matter compared to transplanted rice (Rathore *et al.*, 1995). Maximum number of leaves hill-1 were produced in Farmers' practice and it was 14/13 per cent higher in 2007/2008 than the number of leaves produced in SRI (22.05/22.02 in 2007/2008). Increase in plant height and tiller number in Farmers' practice might have contributed to a corresponding increase in the number of leaves (Table 1). Similar result was reported by Thomas (2000). Farmers' practice had significantly higher LAI than all other management systems.

Table 1. Effect of management systems and nutrient sources on growth and growth attributes of Njavara rice

Treatment	Plant height (cm)		Number of leaves hill-1		Leaf area index		Number of tillers m-2	
	2007	2008	2007	2008	2007	2008	2007	2008
Management systems								
M_1 (SRI)	98.53	103.13	22.05	22.02	0.83	0.82	96.0	95.5
M_2(ICM)	92.10	98.92	23.15	22.81	0.77	0.78	146.7	146.7
M_3 (PoP)	101.92	105.82	24.60	23.70	1.08	1.09	591.1	587.8
M_4 (F.P)	108.74	112.60	25.24	24.88	1.46	1.48	981.4	976.4
SEd	1.00	2.90	0.24	0.59	0.02	0.59	4.02	2.16
CD (0.05)	2.49	6.55	0.55	1.34	0.04	1.34	9.10	4.88
Nutrient sources								
S_1 (Organic)	101.26	104.79	23.86	23.62	1.06	1.09	454.7	450.7
S_2(Integrated)	100.09	106.66	24.01	23.57	1.06	1.04	452.0	451.5
S_3 (Inorganic)	99.62	103.90	23.41	22.88	0.99	1.00	453.9	452.7
SEd	1.14	2.02	0.26	0.48	0.01	0.48	3.96	2.16
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Effect of management systems and nutrient source on yield

Higher number of grains and filled grains per panicle were recorded in SRI (M_1) which was followed by ICM, PoP and Farmers' practice respectively. Among the nutrient sources, integrated nutrient source (S_2) recorded the maximum grains per panicle and filled grains per panicle. It was significantly higher than organic source and inorganic source having the least value. SRI with organic source (M_1S_1) registered the maximum grains per panicle which was on par with SRI with integrated nutrient source (M_1S_2) and SRI with inorganic source (M_1S_3) (Table 2). Bozorgi *et al.* (2011) also reported that high plant density resulted in higher percentage of unfilled grains. Wang *et al.*, (2002) observed lower sterility percentage with single seedling per hill than with two seedlings hill-1.

Maximum grain yield recorded in Farmers' practice (M_4) was 16/15% higher in 2007/2008 than PoP, 24/26% higher in 2007/2008 than in SRI and 36/37% higher in 2007/2008 than ICM. The highest grain yield (928.7/920.5 kg ha-1 in 2007/2008) was obtained in integrated nutrient source (S_2) which was followed by organic source (872.1/857.9 kg ha-1 in 2007/2008) and inorganic source (857.3/857.5 kg ha-1 in 2007/2008), respectively. Among the interactions, Farmers' practice with integrated

Table 2. Effect of management systems and nutrient sources on yield and yield parameters of Njavara rice

Treatment	Grains panicle-1		Filled grains panicle-1		Grain yield (kg ha-1)		Straw yield (kg ha-1)	
	2007	2008	2007	2008	2007	2008	2007	2008
ManagementSystems								
M_1 (SRI)	57.73	60.13	53.49	55.67	840.8	821.6	1235	1210
M_2(ICM)	52.05	54.20	47.93	49.63	764.7	756.2	1126	1115
M_3 (PoP)	47.76	49.58	43.75	45.45	897.3	899.7	1338	1324
M_4 (F.P)	45.63	47.15	41.58	42.74	1041.4	1038.4	1685	1697
SEd	0.57	0.56	0.53	0.55	9. 41	9.28	15.68	15.43
CD (0.05)	1.29	1.26	1.19	1.24	21. 29	20. 99	35.47	34.89
Nutrient sources								
S_1 (Organic)	50.76	52.42	46.62	48.04	872.1	857.9	1285	1266
S_2 (Integrated)	51.77	54.39	47.59	50.02	928.7	920.5	1494	1496
S_3 (Inorganic)	49.85	51.49	45.86	47.14	857.3	857.5	1258	1246
SEd	0.43	0.56	0.38	0.52	9.25	9.06	14.26	34.89
CD (0.05)	0.89	1.26	0.79	1.07	19.10	18.71	29.42	28.59

nutrient source (M_4S_2) recorded the highest grain yield (1206.2 kg ha^{-1} in 2007 and 1189.7 kg ha^{-1} in 2008) which was superior to all other interactions (Table 3). Significantly higher grain yield realized in Farmers' practice may be attributed to better growth and yield parameters realized in this treatment compared to other management systems. Significantly higher growth characters like leaf number per plant, leaf area index, flag leaf area, tiller number per unit area and leaf area duration might have resulted in increased photosynthesis and production of photosynthates which finally transformed into significantly higher number of panicles per unit area and higher relative accumulation of dry matter in the panicles.

Table 3. Interaction effect of management systems and nutrient sources on yield and Yield attributes of Njavara rice

Interaction effects	Grains panicle^{-1}		Filled grains panicle^{-1}		Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})	
	2007	2008	2007	2008	2007	2008	2007	2008
M_1S_1	58.76	61.34	54.47	56.64	860.2	825.6	1270	1218
M_1S_2	57.51	59.85	53.10	55.36	835.5	832.2	1224	1224
M_1S_3	56.92	59.19	52.90	55.01	826.6	806.9	1210	1187
M_2S_1	51.11	52.66	47.04	48.44	784.5	791.6	1161	1174
M_2S_2	55.55	58.95	51.25	54.50	780.2	741.0	1143	1089
M_2S_3	49.48	50.99	45.51	45.96	729.2	736.0	1073	1083
M_3S_1	47.78	49.18	43.75	45.05	863.5	845.0	1270	1245
M_3S_2	47.50	49.65	43.50	45.83	892.7	919.0	1370	1411
M_3S_3	48.00	49.92	44.00	45.76	935.5	935.0	1375	1315
M_4S_1	45.39	46.49	41.20	42.03	980.0	969.6	1439	1424
M_4S_2	46.51	49.10	42.50	44.37	1206.2	1189.7	2240	2262
M_4S_3	44.98	45.85	41.04	41.82	938.0	956.0	1375	1402
SEd	1.09	1.11	1.00	1.04	18.51	18.13	28.51	27.71
CD (0.05)	2.25	2.27	2.08	2.14	38.20	50.99	58.85	57.18

Straw yield also showed the same trend like grain yield in management system, nutrient sources and its interactions. Even though Njavara did not respond to SRI and ICM to the same extent in tillering like other varieties, all the tillers produced in SRI were productive tillers and 91% of the tillers produced in ICM bore panicles. It is observed that in transplanted crops (SRI, ICM and PoP) number of productive tillers per hill increased with increase in number of seedlings per hill. Similar results were reported earlier by Obulamma and Reddy (2002).

Conclusion

Farmer's management practices coupled with integrated nutrient source can be considered as the ideal crop production package for Njavara rice in lowlands.

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