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RESEARCH PAPER

Effect of integrated nutrient management and planting geometry on growth and yield of aerobic rice

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Abstract : A field experiment was conducted with three integrated nutrient management practices and three spacings were laid out in Factorial Randomized Complete Block Design with three replications during *Kharif* 2009 at College of Agriculture, Shimoga. The integrated nutrient management practices including 50% RDN through chemical fertilizers and 50% RDN through organic sources like farm yard manure, poultry manure and vermicompost with three spacing *viz.*, 30 x 30 cm, 20 x 20 cm and 20 x 10 cm. Among integrated nutrient management practices (M_3) 50% RDN through chemical fertilizers + 50% RDN through vermicompost recorded significantly higher plant height (80.54 cm), leaf area (1537.69 cm^2), number of tillers $hill^{-1}$(30.04), total dry matter accumulation $hill^{-1}$ (84.78 g) grain yield (39.48 q ha^{-1}) and straw yield (52.9 q ha^{-1}). Wider spacing of 30 x 30 cm (S_3) had registered significantly higher plant height (84.26 cm), leaf area (1538.12 cm^2) number of tillers $hill^{-1}$ (33.32), total dry matter accumulation $hill^{-1}$ (87.18 g), grain yield (40.61 q ha^{-1}) and straw yield (53.63 q ha^{-1}).

Key Words : Aerobic rice, Organic manures, INM, Spacing

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INTRODUCTION

Rice is grown under four major ecosystems *viz.*, Irrigated (21.0 m ha), rainfed lowland (14 m ha), rainfed upland (6 m ha) and flood prone (3 m ha). More than half of rice area (55%) is rainfed and distribution wise 80 per cent of the rainfed rice areas are in eastern India, making its cultivation vulnerable to vagaries of monsoon. In Karnataka, it is grown in an area of 1.42 million ha with an annual production of 3.6 million tonnes (Anonymous, 2005). Food security in Asia is challenged by increasing food demand and is threatened by declining water availability. In Asia the per capita availability of water has declined by 40 to 60 per cent between 1955 and 1990. Projections indicated that most of the Asian countries will have severe water problems by 2025 (Anonymous, 2008). So, Aerobic rice is a new method of growing rice characterized by direct seeding of high yielding varieties in non puddled condition without standing water. The total water requirement from sowing to harvest is estimated about 650 to 830 mm under aerobic condition and about 1350 mm under flooded condition and water productivity will be increased from 20 to 40 per cent (Castaneda *et al.*, 2005). Further, water use in aerobic rice is about 60 per cent less than that of low land rice and, the total water productivity being 1.6 to 1.9 times higher.

Use of fertilizers in conventional rice cultivation has been reported to have poor nutrient use efficiency due to excessive use of water and readily available nature of nutrients in fertilizers and their ready loss by leaching and volatalization. But total replacement of fertilizer by manures to avoid such losses may not be an easy alternative as manures contain lower nutrient concentration. Hence, it is desirable to adopt integrated approach in meeting the nutrient demand of the crop. This approach involves application of chemical

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fertilizers, organic manures or crop residues to bridge the gap between nutrient demand and supply to improve the grain yield. Integrated Nutrient Management (INM) is the adoption of technically appropriate and managerially efficient in achieving the objectives of judiciously utilizing all the major sources of plant nutrients in an integrated manner so as to attain optimum economic yield from a specific cropping system (Sarkar, 2000).Using organic sources such as FYM, vermicompost, poultry manure deserves priority for sustained production and better resource utilization in integrated nutrient management *i.e.*, use of organic manures with inorganic fertilizers. INM technology is sustainable as compared to modern chemical farming as it relies more on organic inputs (Singh *et al.*, 2001).

Plant geometry in rice has a direct bearing on the grain yield, since it is an important yield parameter maintaining inadequate or excess plant population often leads to reduction in yield. So finding out the optimum plant population per unit area under different levels of integrated nutrients is of major importance. With this background an experiment on effect of integrated nutrient management and planting geometry on growth and yield of aerobic rice was conducted during *Kharif* 2009 at college of Agriculture, Shimoga.

MATERIAL AND METHODS

The field experiment was conducted at Zonal Agricultural Research Station Navile, Shimoga of region IV and agro climatic zone VII (Southern Transitional Zone) of Karnataka which is situated at $14^0 0'$ to $14^0 01'$ North latitude and $75^0 45'$ to $77^0 42'$ East longitude with an altitude of 650 meters above the mean sea level. The soil of experimental site was red sandy loam with slightly acidic reaction (pH 5.6), and low in nitrogen (245.96 kg ha^{-1}), medium in phosphorus (33.90 kg ha^{-1}) and medium in potassium (184.50 kg ha^{-1}). The crop experienced favorable weather conditions during the crop growth period.

Recommended dose of fertilizer (100: 50: 50 kg N, P_2O_5 and K_2O kg ha^{-1}) was applied through chemical fertilizers. Nitrogen was applied in three split doses *viz.*, 50 per cent as basal, 25 per cent at 30 days after sowing and remaining 25 per cent at 60 days after sowing. Among the different sources of organic manures used, FYM and poultry manure was incorporated into the soil 20 days before sowing, and vermicompost was applied at the time of sowing. The nutrient composition of different organic manures is given in Table A.

Table A : Nutrient composition of different organic manures

Organic manure	Nutrient composition (%)		
	Nitrogen	P_2O_5	K_2O
Farm yard manure	0.58	0.31	0.46
Poultry manure	2.12	1.60	1.32
Vermicompost	1.15	0.79	0.62

RESULTS AND DISCUSSION

Supplying 50 per cent N through vermicompost and remaining 50 per cent N through chemical fertilizers has recorded significantly higher grain yield (39.48 q ha^{-1}) compare to 50 % RDN through chemical fertilizers + 50 % RDN through poultry manure (35.38 q ha^{-1}) and which was at par with 50% RDN through chemical fertilizers + 50% RDN through farm yard manure (35.73 q ha^{-1}) (Table 2). This significant increase in grain yield may be due to the higher yield parameters like panicles $hill^{-1}$(25.15), number of filled grains $panicle^{-1}$(149.26), panicle length (21.11 cm), higher panicle weight (3.63 g), 1000 grain weight (22.70 g) and

Table 1 : Growth parameters at harvest as influenced by integrated nutrient management practices and planting geometry in aerobic rice

Treatments	Plant height (cm)	Leaf area (cm^2)	Number of tillers $hill^{-1}$	Total dry matter accumulation (g $hill^{-1}$)
Nutrient sources (M)				
M_1	72.37	1335.36	26.48	78.04
M_2	72.76	1255.65	25.95	77.75
M_3	80.54	1537.69	30.04	84.78
S.E. ±	1.21	44.43	1.01	1.36
C.D. (P=0.05)	3.74	136.92	3.10	4.20
Spacing (S)				
S_1	68.64	1235.36	20.73	75.04
S_2	72.77	1355.21	28.42	78.35
S_3	84.26	1538.12	33.32	87.18
S.E. ±	1.21	44.43	1.01	1.36
C.D. (P=0.05)	3.74	136.92	3.10	4.20
Interaction (M x S)				
M_1S_1	66.79	1156.89	21.50	72.69
M_1S_2	70.81	1392.55	25.22	78.06
M_1S_3	79.51	1456.65	32.71	83.36
M_2S_1	67.09	1166.92	20.35	74.60
M_2S_2	71.97	1283.15	27.16	76.65
M_2S_3	79.22	1316.88	30.34	81.99
M_3S_1	72.03	1382.28	20.34	77.81
M_3S_2	75.53	1389.95	32.88	80.34
M_3S_3	94.06	1840.83	36.91	96.19
S.E. ±	2.10	76.96	1.74	2.36
C.D. (P=0.05)	NS	NS	NS	NS

Note:
M_1: 50 % RDN through chemical fertilizers + 50% RDN through farm yard manure.
M_2: 50 % RDN through chemical fertilizers + 50% RDN through poultry manure.
M_3: 50 % RDN through chemical fertilizers + 50% RDN through vermicompost.
S_1: 20 x 10 cm S_2: 20 x 20 cm S_3: 30 x 30 cm
NS: Non- significant

significant reduction in chaffiness (6.44%) (Table 2). The increase in yield was due to the promotion of no. of panicles and panicle length and weight with the supply of vermicompost. Nitrogen application results in increased amount of interception of photo synthetically active radiation and greater photosynthesis by crop and the supply of secondary nutrient like magnesium as well as micronutrients through vermicompost improved the chlorophyll content and caused reduction of chaffy percentage. (Sudha and Chandini, 2003). Application of 50 % RDN through chemical fertilizer + 50 % RDN through vermicompost (52.90 q ha^{-1}) recorded significantly higher straw yield. (Table 2).

Significantly higher total dry matter (84.78 g) was recorded with application of 50 % RDN through chemical fertilizer + 50 % RDN through vermicompost. Application of vermicompost helped in balanced availability of nutrients at all stages (Vasanthi and Kumaraswamy, 2008). Improved soil aggregation, higher quantity of nutrient availability and enhanced soil microbial activity, resulting in congenial soil condition which improved uptake of nutrients resulted in higher dry matter. Application of 50 % RDN through chemical fertilizer + 50 % RDN through vermicompost (30.04) has recorded significantly higher tillers per hill at harvest (Table 1). Tiller number increased with nitrogen supply and is in accordance with the findings of Krishna kumar (1986). Significantly higher leaf area per hill (2220.77 cm^2 hill^{-1}) at 90 DAS was recorded with 50% RDN through chemical fertilizer + 50% RDN through vermicompost as compared to 50% RDN through chemical fertilizers + 50% RDN through FYM (1985.11 cm^2 hill^{-1}).

Wider spacing of 30 x 30 cm has recorded significantly higher grain yield (40.61 q ha^{-1}) as compared to 20 x 20 cm (36.27 q ha^{-1}) and 20 x 10 cm (33.71 q ha^{-1}) (Table 2). The higher grain yield with wider spacing might be due to higher yield parameters such as number of panicles per hill (25.40), panicle weight (4.02 g), panicle length (21.19 cm) and test weight (23.11 g) (Table 3). These results are in accordance with the findings of Rao *et al*. (2005) and Satyavarma *et al.* (2009).

Significantly higher tillers were recorded in wider spacing of 30 x 30 cm (33.32) at harvest as compared to

Table 2 : Yield and yield parameters as influenced by integrated nutrient management practices and planting geometry in aerobic rice

Treatments	Number of panicles hill^{-1}	Panicle length (cm)	Panicle weight (g)	Test weight (g)	Chaffiness (%)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
Nutrient sources (M)							
M_1	20.23	19.26	3.07	20.12	11.96	35.73	46.45
M_2	19.35	18.59	2.83	19.79	11.21	35.38	46.70
M_3	25.15	21.11	3.63	22.70	6.44	39.48	52.90
S.E. ±	0.91	0.37	0.12	0.43	0.58	0.93	1.24
C.D. (P=0.05)	2.80	1.16	0.37	1.34	1.80	2.88	3.81
Spacing (S)							
S_1	17.49	18.24	2.38	19.50	14.99	33.71	44.51
S_2	21.85	19.53	3.13	20.00	8.70	36.27	47.90
S_3	25.40	21.19	4.02	23.11	5.91	40.61	53.63
S.E. ±	0.91	0.37	0.12	0.43	0.58	0.93	1.24
C.D. (P=0.05)	2.80	1.16	0.37	1.34	1.80	2.88	3.81
Interaction (M x S)							
M_1S_1	17.84	18.47	2.42	19.04	17.10	32.94	42.82
M_1S_2	19.21	19.13	3.09	19.00	12.57	35.01	45.52
M_1S_3	23.65	20.18	3.71	22.31	6.20	39.23	51.00
M_2S_1	14.60	17.03	2.14	18.89	17.64	32.68	43.13
M_2S_2	19.76	19.16	2.69	19.39	8.91	35.20	46.46
M_2S_3	23.69	19.58	3.64	21.09	7.09	38.26	50.50
M_3S_1	20.02	19.22	2.59	20.58	10.24	35.50	47.57
M_3S_2	26.57	20.29	3.61	21.60	4.63	38.60	51.72
M_3S_3	28.85	23.82	4.70	25.91	4.45	44.33	59.40
d	1.58	0.65	0.21	0.75	1.01	1.62	2.14
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS

M_1: 50 % RDN through chemical fertilizers + 50% RDN through farm yard manure. S_1: 20 x 10 cm NS: Non- significant
M_2: 50 % RDN through chemical fertilizers + 50% RDN through poultry manure. S_2: 20 x 20 cm
M_3: 50 % RDN through chemical fertilizers + 50% RDN through vermicompost. S_3: 30 x 30 cm

rest of two spacings *i.e.* 20 cm x 20 cm (28.42) and 20 cm x 10 cm (20.73). This might be due to more plant density, which might have resulted in more competition among the plants for nutrients, moisture and light (Cruciol *et al.*,2000). Significantly higher leaf area per hill (2271.21 cm^2 $hill^{-1}$) at 90 DAS was recorded with wider spacing of 30 x 30 cm. Higher production and translocation of photosynthates towards sink might be due to higher leaf area $hill^{-1}$ at wider spacing of 30 x 30 cm which influenced higher grain yield.

Conclusion:

More supply of nutrients through chemical fertilizers as results in environmental problems and reduction in total factor productivity or only supply of organic manures cannot meet the nutrient requirement and causes sudden yield loss. So, an integrated approach that recognizes soil as the storehouse of most of the plant nutrients essential for plant growth and that the way in which nutrients are managed will have a major impact on plant growth, soil fertility, and agricultural sustainability. From this experiment it is concluded that 50 % RDN through chemical fertilizers + 50 % RDN through vermicompost + 30 x 30 cm performed well under aerobic rice.

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