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RESEARCH ARTICLE

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Effect of different sources and time of application of organic manures on growth parameters, growth indices, dry matter production and nutrient uptake of aerobic rice (*Oryza sativa* L.)

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ABSTRACT

A field experiment was conducted during *Kharif,* 2009 at Zonal Agricultural Research Station, V.C. Farm, Mandya, University of Agricultural Sciences, Bengaluru. The initial status of available N, P_2O_5 and K_2O of the experimental site was 248.5, 26.8 and 202.8 kg ha^{-1}, respectively. The variety used was Thanu (KMP-101). The results of the field experiment showed that application of recommended dose of fertilizer (100:50:50 kg N:P:K ha^{-1}) + 10 tonnes of FYM ha^{-1} recorded significantly higher growth indices like plant height (63.2), number of tillers per hill (35.7), leaf area (1509.8 cm^2 $hill^{-1}$), leaf area index (LAI) (2.42), leaf area duration (LAD) (56.49 days), absolute growth rate (AGR) (1.6806 g $p^{-1}day^{-1}$), relative growth rate (RGR) (0.1369 g $g^{-1}day^{-1}$) and dry matter production. Significantly higher dry matter production at harvest (95.43 g $hill^{-1}$) recorded with recommended dose of fertilizer (100:50:50 kg N:P:K ha^{-1}) + 10 tonnes of FYM ha^{-1}. Significantly higher nitrogen, phosphorus and potassium uptake (103.7, 20.8 and 77.9 kg ha^{-1}, respectively) registered with recommended dose of fertilizer (100:50:50 kg N:P:K ha^{-1}) + 10 tonnes of FYM ha^{-1}.

KEY WORDS : Aerobic rice**,** AGR, RGR, Poultry manure, Biodigester liquid, Jeevamrutha

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INTRODUCTION

Rice (*Oryza sativa* L.) is the major crop of India and occupies larger cropped area of 43.18 m ha with an annual production of 97.0 m t and a productivity of 2101 kg ha^{-1}. In Karnataka, rice is grown in an area of 1.42 m ha with an annual production of 3.60 m t and productivity is 2.53 t ha^{-1} (Anonymous, 2010). Rice production is the most water consuming system and utilizes about 60 per cent of total available irrigation water. More than half of the water used for irrigation in India is shared by rice. Although rice is water loving, increasing the area under rice faces the twin problems of water scarcity and soil salinization. Thus, there is a need to find out alternate means of rice cultivation which require less water. Aerobic rice assumes grater importance in the light of the water scarcity and increasing demand for rice. Although the use of fertilizers promises increase in productivity, the indiscriminate and imbalanced use of fertilizers affects the yield, soil health and environment. Now the focus of agriculture is to evolve ecologically sound nutrient management practices. Organic farming is one such approach. The farmers use several organic sources with varying levels of nutrients. Hence, it is necessary to evaluate the different sources of organic manures for standardizing the recommendation to farmers. In the light of the above, the choice of the problem on "Effect of different sources and time of application of organic manures on growth parameters, growth indices, dry matter production and nutrient uptake of aerobic rice (*Oryza sativa* L.)" is an effort and appropriate for achieving maximum production.

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MATERIALS AND METHODS

A field experiment was conducted at Zonal

Agricultural Research Station, Visweshwaraiah Canal Farm, Mandya, University of Agricultural Sciences, Bengaluru during *Kharif* season 2009. The soil of the experimental site was red sandy loam with neutral pH (6.53) and low in organic carbon (0.45%). The initial status of available N, P_2O_5 and K_2O of the experimental site was 248.5, 26.8 and 202.8 kg ha^{-1}, respectively. The experiment was laid out in a Randomized Complete Block Design with eleven treatments replicated thrice.

Detail of treatments and the corresponding symbols used during the study are as follows.

- T_1: Recommended package of practice (100:50:50 NPK ha^{-1} +10 tonnes of FYM)
- T_2: 10 tonnes of FYM ha^{-1} as a basal dose + 100 % N equivalent through cattle urine
- T_3: 10 tonnes of FYM ha^{-1} as a basal dose + 100 % N equivalent through Biodigester liquid
- T_4: 10 tonnes of FYM ha^{-1} as a basal dose + 100 % N equivalent through Jeevamrutha
- T_5: Vermicompost equivalent to 10 tonnes of FYM + 100 % N equivalent through cattle urine
- T_6: Vermicompost equivalent to 10 tonnes of FYM + 100 % N equivalent through Biodigester liquid
- T_7: Vermicompost equivalent to 10 tonnes of FYM + 100 % N equivalent through Jeevamrutha
- T_8: Poultry manure equivalent to 10 tonnes of FYM + 100 % N equivalent through cattle urine
- T_9: Poultry manure equivalent to 10 tonnes of FYM + 100 % N equivalent through Biodigester liquid
- T_{10}: Poultry manure equivalent to 10 tonnes of FYM + 100 % N equivalent through Jeevamrutha (Note: Application of liquid manures at two splits at 40 DAS and 75 DAS as a top dress)

The land of the experimental site was prepared by ploughing twice mechanically with mould board plough and leveled with harrow. The variety used for sowing was Thanu (KMP-101). The required quantities of different organic manures based on the nitrogen content were applied as per the treatment to different plots, 15 days before sowing and the treatments were imposed. Liquid manures like jeevamrutha and biodigested liquid were prepared and applied as a top dress; where as cattle urine was collected one day before application and used as a top dress. Different organic manures were applied based on the nitrogen content; FYM (0.51), vermicompost (1.35), poultry manure (1.96), cattle urine (0.26), biodigested liquid (0.43) and jeevamrutha (0.28).

AGR is defined as growth rate of plant at any given time. It was calculated as per the formula given by Radford (1967).

$$AGR = \frac{W_2 - W_1}{t_2 - t_1} g\ p^{-1} day^{-1}$$

where, W_1 and W_2 are dry weights of plant at time t_1 and t_2, respectively

RGR is defined as the rate of increment in dry weight per unit plant weight per unit of time. It was calculated as per the formula given by Watson *et al*. (1963).

$$RGR = \frac{\log_e W_2 - \log_e W_1}{t_2 - t_1} g\ g^{-1} day^{-1}$$

where, w_1 and w_2 are dry weights of plant at time t_1 and t_2, respectively. Log_e, natural logarithm.

RESULTS AND DISCUSSION

The results obtained from the present investigation have been discussed in the following sub heads :

Growth parameters and growth indices:

The different growth indices like plant height, number of tillers, leaf area, LAI, LAD, AGR, RGR and dry matter production of aerobic rice significantly influenced by different sources of organic manures. Significantly higher plant height (63.2 cm), number of tillers per hill (35.7), leaf area (1509.8 cm^2 $hill^{-1}$) and LAI (2.42) at 90 DAS (Table 1) and growth indices like LAD (56.49), AGR (1.6806 g $p^{-1}day^{-1}$), RGR (0.1369 g $g^{-1}day^{-1}$) at 60 to 90 days interval (Table 2) were recorded with recommended dose of fertilizer (100:50:50 kg N:P:K ha^{-1}) along with 10 tonnes of FYM ha^{-1}. Significant increase in growth parameters might be due to greater availability, steady and quick release of nutrients from the inorganic source in combination with organic source and might have resulted in better vegetative growth. The lower number of leaves per plant was observed at harvest due to death and senescence of leaves. Nitrogen increases the chlorophyll content at all growth stages as it is a constituent and might have increased the photosynthesis and resulted in increased plant height. Similar findings were documented by Siddaram (2009). The higher number of tiller might be due to greater availability of nutrients encouraged the production of more tillers. Similar findings were documented by Babu and Reddy (2000). The development of leaf area is an important factor that could affect crop response to added nitrogen. Larger leaf area development aids in more interception of light leading to higher dry matter production (Vijayalakshmi and Nagarajan, 1994).

Table 1: Growth parameters as influenced by different sources of organic manures in aerobic rice

Treatments	Plant height (cm)	Number of tillers hill^{-1}	Number of leaves hill^{-1}	Leaf area (cm^2 hill^{-1})	LAI
T_1	63.2	35.7	125.2	1509.8	2.42
T_2	48.5	24.4	100.3	1187.3	1.90
T_3	52.6	30.9	105.1	1310.4	2.10
T_4	51.6	27.9	103.2	1277.7	2.04
T_5	54.7	31.7	106.7	1326.1	2.12
T_6	60.4	34.4	119.1	1446.0	2.31
T_7	57.2	32.2	114.3	1391.2	2.23
T_8	55.3	31.7	111.5	1360.8	2.18
T_9	62.6	35.1	121.1	1462.7	2.34
T_{10}	57.7	32.9	116.3	1401.2	2.24
S.E. ±	2.21	1.2	3.69	43.10	0.07
C.D. (P=0.05)	6.64	3.7	11.08	129.21	0.21

Table 2 : Growth indices at 60 to 90 DAS as influenced by different sources of organic manures in aerobic rice

Treatments	LAD (Days)	AGR (g p^{-1}day^{-1})	RGR (g g^{-1}day^{-1})
T_1	56.49	1.6806	0.1369
T_2	44.44	1.3328	0.1277
T_3	48.27	1.3779	0.1292
T_4	47.15	1.3549	0.1285
T_5	50.31	1.4036	0.1302
T_6	54.23	1.6252	0.1353
T_7	51.94	1.5457	0.1336
T_8	51.82	1.4699	0.1317
T_9	54.92	1.6334	0.1359
T_{10}	52.95	1.5524	0.1339
S.E. ±	1.29	0.10	0.85
C.D. (P=0.05)	3.86	0.31	2.55

Table 3 : Total dry matter accumulation (g hill^{-1}) as influenced by different sources of organic manures in aerobic rice at different growth stages

Treatments	30 DAS	60 DAS	90 DAS	At harvest
T_1	2.94	13.66	64.08	95.43
T_2	2.32	8.43	48.68	83.63
T_3	2.47	9.16	50.73	85.27
T_4	2.46	8.72	49.77	84.45
T_5	2.49	10.07	52.35	86.95
T_6	2.74	12.32	61.07	91.40
T_7	2.64	11.27	57.84	89.59
T_8	2.61	10.50	54.49	88.34
T_9	2.91	12.76	62.09	94.26
T_{10}	2.65	11.82	58.43	89.47
S.E. ±	0.10	0.85	2.19	2.01
C.D. (P=0.05)	0.31	2.55	6.56	6.03

The increase in growth indices might be due to higher dry matter accumulation in the leaves and stem. Kenchaiah (1997) reported that higher growth indices recorded in paddy had a positive association with higher dry matter accumulation. The higher AGR in organic treatments might be due to high availability of nutrients from poultry manured soil which made plants vigorous enough to produce more photosynthates that had partitioned to vegetative parts were explained by Sathiyasundaram (2005).

Dry matter production:

Application of recommended dose of fertilizers (100:50:50 kg N:P:K ha^{-1}) along with 10 tonnes of FYM ha^{-1} recorded significantly higher total dry matter at 30 DAS (2.94 g hill^{-1}), 60 DAS (13.66 g hill^{-1}), 90 DAS (64.08 g hill^{-1}) and at harvest (95.43 g hill^{-1}) (Table 3). However, it was at par with poultry manure equivalent to 10 t of FYM + biodigester liquid at 100 % N equivalent basis, vermicompost equivalent to 10 t of FYM + biodigester liquid at 100 % N equivalent basis, poultry manure equivalent to 10 t of FYM + jeevamrutha at 100 % N equivalent basis and vermicompost equivalent to 10 t of FYM + jeevamrutha at 100 % N equivalent basis. Significantly higher dry matter accumulation might be due to combined application of inorganic fertilizer and organic manure could have helped in balanced availability of nutrients at all stages. Higher dry matter production was perhaps due to the higher leaf dry weight and stem dry weight recorded at different stages. This has provided more photosynthetically active leaf area resulting in higher

dry matter accumulation. Apart from that, nitrogen might have involved in various physiological activities like increased photosynthetic activity and better light interception in turn resulted in higher dry matter accumulation. Kenchaiah (1997) also reported that higher growth indices recorded in paddy had a positive association with higher dry matter accumulation. Similar results were reported by Rajeswari (1990). As nitrogen could enhance tillers production and leaf area development, naturally total dry matter production also increased with increased levels of nitrogen.

Nutrient uptake:

Significantly higher nitrogen, phosphorus and potassium uptake (103.7, 20.8 and 77.9 kg ha^{-1}, respectively) recorded with recommended dose of fertilizer (100:50:50 kg N: P: K ha^{-1}) + 10 tonnes of FYM ha^{-1} (Table 4). Significantly increase in nutrient uptake might be due to added manures to the soil complex, nitrogenous compounds break down slowly and make steady N supply throughout the growth period of the crop. This might have attributed to more availability and subsequent uptake by the crop. The present findings are in close association with Sharma and Mittra (1990) and Paikaray *et al*. (2001). They stated that use of higher dose of nitrogen might have helped for good vegetative growth and root system, which increased the higher N uptake by plants and hence increased yield and yield components of rice. Joshi and Setty (2005) inferred that application of poultry manure was superior than application FYM in improving available P_2O_5, K_2O, Ca and Mg in acid soils with low organic matter status. The poultry manure was responsible for increased uptake of Mn and Zn in sandy soils and increased N mineralization. It improves mineralization of organic carbon and improve uptake of P (Das *et al.,* 1992).

Table 4 : Total nutrient uptake (kg ha^{-1}) as influenced by different sources of organic manures in aerobic rice at harvest

Treatments	Total N uptake	Total P_2O_5 uptake	Total K_2O uptake
T_1	103.7	20.8	77.9
T_2	80.5	12.4	58.3
T_3	88.0	14.6	63.7
T_4	84.6	12.9	61.7
T_5	90.0	15.1	66.1
T_6	98.4	18.7	74.2
T_7	92.9	17.3	69.9
T_8	91.1	16.3	67.1
T_9	101.1	19.5	75.8
T_{10}	93.8	17.5	70.2
S.E. ±	3.7	1.2	2.7
C.D. (P=0.05)	11.2	3.5	8.1

Conslusion:

Application of chemical fertilizers along with organic manures helps in establishing early superiority of growth characters and helps in improving the yield and yield characters of aerobic rice. Continuous application of organic manures like FYM, vermicompost and poultry manure along with liquid organic manures like cattle urine, biodigester liquid and jeevamrutha for 3 to 4 years is essential for achieving the successful organic farming.

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