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EFFECT OF ENRICHED FYM AND FERTILIZER LEVELS ON GROWTH AND YIELD COMPONENTS OF AEROBIC RICE (*ORYZA SATIVA* L.)

M. Ashwini *et al.,*

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M. ASHWINI[1], C. J. SRIDHAR[2], SARASWATHI, C. M. MAMATHASHREE[1], B. NETHRAVATHI[2],
[1]Department of Agronomy, UAHS, Shimoga - 577 204
[2]Department of Soil Science and Agricultural Chemistry, UAHS, Shimoga - 577 204
e-mail: ashuhallikere@gmail.com

ABSTRACT

Field experiment to assess the effect of enriched farm yard manure (FYM) and fertilizer levels on growth and yield components of aerobic rice was done at university of agricultural and horticultural sciences, Shivamogga during kharif, 2013The experiment was laid out in factorial RCBD design with three fertilizer level *viz.*, 125:62.5:62.5 NPK kg ha^{-1}, 100: 50: 50 NPK kg ha^{-1} and 75:37.5:37.5 NPK kg ha^{-1} with four methods of application *viz.*, separate application of manure and fertilizer, spot application of manure and fertilizer, broadcasting of enriched manure and spot application of enriched manure. Application of 125:62.5:62.5 NPK kg ha^{-1} recorded higher plant height (66.07 cm), number of tillers plant^{-1} (37.94), total dry matter accumulation (103.27 g plant^{-1}) and grain yield (53.54 q ha^{-1}) Significantly higher 1000 grain weight (23.37 g) recorded in application of 100:50:50 NPK kg ha^{-1} which was on par with level 75:37.5:37.5 NPK kg ha^{-1} (22.78 g).Among the methods of application spot application of enriched manure recorded significantly higher plant height (66.12 cm), total dry matter accumulation (97.10 g plant^{-1}), number of tillers (37.06), 1000 grain weight (24.24 g) and grain yield (54.03 q ha^{-1}) due to timely available of nutrients. Interaction of spot application of enriched manure with 125:62.5:62.5 NPK kg ha^{-1} has registered higher 1000 grain weight (25.80 g) this leads to higher grain yield (60.58 q ha^{-1}) under aerobic rice

*Corresponding author

INTRODUCTION

Rice means life to us in Asia. It has been the cornerstone of our food systems, our languages, our cultures and our livelihoods for thousands of years (Rash Behari and Ilang-Ilang, 2007) In Asia, more than two billion people are getting 60-70 per cent of their energy requirement from rice and its derived products. In India, rice is grown in an area of 43.97 million hectare with a production and productivity of 104.32 million tonnes and 2372 kg ha-1, respectively (Anon., 2014). Which is half of the global average.

It is estimated that the NPK removal by crops in India was about 28 million tons against the fertilizer consumption of 18 million tonnes creating a gap of 10 million tonnes in 2000 (Tiwari, 2002). Further the NPK ratio of 4:2:1 considered optimum but in reality a wide ratio of 10:2.9:1 is prevalent in the country (Tandon, 2001). The use efficiency of applied fertilizer nitrogen by rice crop is very low (30-50%). Rice consumes about 40 per cent of total fertilizer nitrogen used in India. Efficiency of applied fertilizer nitrogen is low, ranges from 20-25 per cent in aerobic soil. Aerobic soil has higher rate of percolation than flooded soil. So the highly mobile nitrate ion is easily lost through leaching. When a dry soil is wetted initial rapid mineralization of soil organic matter occurs, releasing relatively significant amounts of available nitrogen. But this available nitrogen can later be immobilized and rendered unavailable for crop absorption (Hooper. 1982). Hence, effective nitrogen management such as rate and synchronized N application with the crop requirement in real time plays an important role in increasing response to added fertilizers and thereby, improving the grain yield of rice varieties including hybrids. Among the factors governing nitrogen use efficiency, rate and time of application of nitrogen plays an important role.

Fertilizer placement is an integral part of efficient crop management. Correct placement often improves the efficiency by which plants can take up nutrients and consequently encourages maximum yields of intensively managed agronomic crops. Correct fertilizer placement is especially critical for maximum crop yields under reduced tillage operations. Among the factors governing fertilizer use efficiency, application of fertilizer plays an important role. Absorption of nutrient is low at the seedling stage and peaks before the heading stage and then decreases as root activity declains (Liu *et al*, 2007).Keeping this in view, the present investigation was carried out to influence of enriched farm yard manure (FYM) and fertilizer levels on growth and yield components of aerobic rice.

MATERIALS AND METHODS

The field experiment was conducted at University of Agricultural and Horticultural Sciences, Shivamogga, India during kharif 2013,which is situated at 13° 58′ North latitude and 75° 34' East latitude with an altitude of 650 meters above mean sea level, Net plot size: 4.0 X 3.0m = 12.0 m^2. It comes under Agro-climatic Region-4 and Zone-VII (Southern Transitional Zone) of Karnataka.The soil of the experimental site was was analysed from composite soil sample from 0-15 cm depth, the soil of the experimental site was red sandy loam. The soil of the site was neutral in reaction (pH 6.4) and electrical conductivity is normal for crop (0.02 dS m^{-1}) with bulk density of 1.25 Mg m^{-3} and low organic carbon (4.2 g kg^{-1}). The available nitrogen was low (241 kg ha^{-1}), phosphorus was high (87 kg ha^{-1}) and medium potassium in potassium (131.72 kg ha^{-1}).The experiment was laid out in factorial RCBD design with three fertilizer level *viz.,* 125:62.5:62.5 NPK kg ha^{-1}, 100: 50: 50 NPK kg ha^{-1} and 75:37.5:37.5 NPK kg ha^{-1} with four methods of application *viz.,* separate application of manure and fertilizer, spot application of manure and fertilizer, broadcasting of enriched manure and spot application of enriched manurewere included in this study. The treatment combinations were T_1 – 125:62.5:62.5 levels of fertilizer and manure applied separately T_2 = 125:62.5:62.5 levels of fertilizer and manures by spot application.T_3 = 125:62.5:62.5 level of fertilizer with enriched manure by broad-casting. T_4 = 125:62.5:62.5 levelof fertilizer by enriched manure and by spot application T_5 = 100:50:50 levels of fertilizer and manure applied separately. T_6 = 100:50:50 levels of fertilizer and manure by spot application T_7 = 100:50:50 level of fertilizer by enriched manure by broad casting T_8 = 100:50:50 level of fertilizer by enriched manure and by spot application T_9 = 75:37.5:37.5 levels of fertilizer and manure applied separately T_{10} = 75:37.5:37.5 levels of fertilizer and manure by spot application T_{11} = 75:37.5:37.5 levels of fertilizer by enriched manure and broad casting T_{12} = 75:37.5:37.5 levels of fertilizer with enriched manure and by spot application.Seeds were sown with spacing of 25 X 25 cm seeds are sown with one seed per hill.

One irrigation was provided to the plots immediately after sowing. To avoid movement of fertilizer from one plot to another, each plot was irrigated separately and independently. Then subsequent irrigation was given to the crop in 5-6 days depending on weather condition to keep the soil moist. The crop was irrigated following alternate wetting and drying cycles. However, from flowering to grain filling stage, irrigation was given once in three to four days interval in order to maintain higher moisture in soil. Irrigation was withheld 10 days before the crop maturity. The soil was loosened with the help of hand hoe at 30, 45, 60 and 75 DAS. This enables easy penetration of roots and to develop good root system and inducing more number of tillers.

Londax power (Bensulfuron methyl 0.6% + Pretilachlor 6 % GR) 10 kg ha-1 was applied as pre-emergence herbicide on 2 DAS. Optimum plant population was maintained by thinning excess seedling leaving one seedling per hill. Hand weeding was done at 25 DAS. Healthy crop stand was ensured by adopting need based plant protection and recommended package of practices. Five plants were selected at random and tagged. These plants were used for recording plant height, tillers, leaf area and leaf area index. Leaf area was measured using leaf area meter and LAI was calculated as ratio of leaf area per plant to area occupied by the plant. Yield attributes like number of productive tillers hill-1, panicle length, panicle weight, grains panicle-1, 1000 grain weight, grain yield, straw yield were recorded. The data pertaining to the experiment were subjected to statistical analysis suggested by Gomez and Gomez (1984) and results were compared.

Preparation of enriched FYM

Full dose of recommended FYM has been taken and allowed to enrich with the following fertilizer levels which include 125:62.5:62.5, 100:50:50 and 75:37.5:37.5 NPK kg ha^{-1}. As per the above fertilizer level in each level nitrogen is taken as 50% of the mentioned levels. Phosphorus and potassium were taken as full dose with recommended FYM and kept for enrichment for a period of 3 days with good moisture maintenance under dark condition.Fifty per cent of nitrogen fertilizer and full dose of phosphorus and potassium were applied at the time of sowing and the remaining 50 per cent of N was top dressed at 45 days after sowing (DAS) and micronutrients were applied as per package (12.5 kg iron sulphate and 12.5 kg zinc sulphate per hectare). The fertilizer levels were worked out based on previous studies on aerobic rice. 12 FYM t ha^{-1}- 125:62.5:62.5 NPK kg ha^{-1}12 FYM t ha^{-1}- 100:50:50 NPK kg ha^{-1} and 12 FYM t ha^{-1}- 75:37.5 :37.5 NPK kg ha^{-1}

Fifty per cent of nitrogen fertilizer and full dose of phosphorus and potassium were applied at the time of sowing and the remaining 50 per cent of N was top dressed at 45 days after sowing (DAS) and micronutrients were applied as per package (12.5 kg iron sulphate and 12.5 kg zinc sulphate per hectare).

RESULTS AND DISCUSSION

Plant height (cm)

In this study, fertilizer level exhibited significant difference with respect to plant height. Significantly higher plant height of 66.07 cm (Table 1) at harvest was recorded withlevel 125:62.5:62.5 NPK kg ha^{-1} due to higher nutrient uptake because plant height tended to increase progressively with increased N levels higher nutrient availability and higher the nutrient content in soil plant became healthier through more absorption of nutrients. This clearly indicated that increase in growth parameters with successive addition of N become lower with N levels beyond 100 kg ha^{-1}. Higher fertility level increased plant height, number of tillers and leaf area eventually contributed to the increased dry matter production. These findings are in conformity with the findings of Vijaykumar (2009); Soman (2012) in rice Priteeaswathy *et al.* (2014) in maize.

Significantly higher plant height was recorded in spot application of enriched manure (66.12 cm) (Table 1). Tolessa Debele *et al.* (2001) reported that improvement in growth was attributed to increased availability of major nutrients in the enriched FYM as compared to conventional FYM, together with synergistic relationship with native soil nutrients in a way that enhanced their availability to crop. Significantly increased plant height was noticed due to interaction of fertilizer level and application methods of manure and fertilizer. Interaction of fertilizer level and spot application of enriched manure had recorded significantly higher plant height than other treatment combination (Table 1) it's mainly due to adequate supply of plant nutrients. This finding is in agreement with the findings of Bharambe et al. (1997) in cotton and, Govindan and Grace (2012) in rice.

Number of tillers

The branches that arise at basal nodes of the stem or crown in cereals are called as tillers. Rice tillering is an important

Table 1: Growth parameters of aerobic rice at harvest as influenced by fertilizer level and methods of manure application in aerobic rice

Treatments	Plant height	Number of tillers	Leaf area index	Dry matter accumulation
Level of Fertilizer (A)				
A1	66.07	37.94	3.307	103.27
A2	65.5	35.18	2.866	93.51
A3	58.37	32.33	2.734	85.49
S.Em ±	0.79	1.01	0.039	1.23
C.D. at 5%	2.33	2.97	0.113	3.61
Method of application (B)				
B1	59.38	33.44	2.638	91.27
B2	65.77	33.63	2.817	93.2
B3	61.99	36.48	3.131	94.8
B4	66.12	37.06	3.288	97.1
S.Em ±	0.92	1.17	0.044	1.42
C.D. at 5%	2.69	3.43	0.13	4.17
Interaction (A X B)				
A1B1	61.04	35.27	2.692	102.19
A1B2	71.9	36.28	2.976	102
A1B3	62.67	38.2	3.637	102.14
A1B4	68.69	42.01	3.921	106.75
A2B1	60.12	34.22	2.697	90.01
A2B2	67.83	35.3	2.826	92.5
A2B3	64.56	36.95	2.959	95.24
A2B4	69.5	34.26	2.983	96.28
A3B1	56.98	30.82	2.524	81.59
A3B2	57.58	29.32	2.649	85.1
A3B3	58.75	34.29	2.798	87.02
A3B4	60.18	34.9	2.963	88.25
S.Em ±	0.53	0.68	0.03	0.82
C.D. at 5%	1.55	1.98	0.08	2.41

agronomic trait for grain yield, but the emergence and development of tillers are greatly influenced by factors such as nitrogen supply, solar radiation and temperature (Murata, 1975). Total number of tillers plant^{-1} was significantly differed from 30 DAS onwards. Significantly highest number of tillers (37.94) was observed in A_1 *i.e.* 125:62.5:62.5 NPK kg ha^{-1}(Table 1). Higher tiller may be due to greater availability of balanced nutrition which might have stimulated faster vegetative growth which in turn leads to faster cell division and cell elongation. Similar results were reported byParashivamurthy*et al.* (2012).

Significantly higher tillers recorded in spot application of enriched manure with level 125:62.5:62.5 NPK kg ha^{-1}, the higher number of tiller might due to greater availability of nutrients that encouraged the production of more tillers. Significantly higher tillers recorded in spot application of enriched manure with level 125:62.5:62.5 NPK kg ha^{-1}the higher number of tiller might due to greater availability of nutrients that encouraged the production of more tillers. Similar findings were documented by Babu and Reddy (2000) who reported that slow release of nutrients from organic sources at later stages of crop growth had resulted in increased number of tillers at harvest. Tillering is greatly increased by spot application of enriched manure (Table 1), the higher number of tiller might due to greater availability of nutrients by mineralization of enriched FYM that encouraged more tillers.

Total dry matter accumulation (g plant^{-1})

The dry matter accumulation increased with increase in nitrogen application rates was reported by Limeng*et al.* (2009). In the present investigation A_1 *i.e.* 125:62.5:62.5 NPK kg ha^{-1} recorded significantly higher total dry matter production (103.27g plant^{-1}) (Table 1). these results are in conformity with the findings of Vasanthi and Kumarswamy (2008). Prerequisite for getting the yield in any crop is to have higher total dry matter production (TDM) and it's partitioning in to various plant parts, coupled with maximum translocation of photosynthates to sink. Spot application of enriched manure recorded significantly higher total dry matter accumulation (97.10 g plant^{-1}). Similar results were obtained by Veeraputhiran *et al.* (2002); Vijaykumar (2009); Abdelraouf et al. (2013) and Richakhanna (2013).

Performance of rice crop basically depends on its dry matter production ability, in turn is dependent on total photosynthetic area and rate of photosynthesis. In the present investigation spot application of enriched manure with 125:62.5:62.5 NPK kg ha^{-1} has recorded significantly higher total dry matter accumulation. Plant biomass is the indicator of good uptake of nutrients from the soil. When organic manure was applied with inorganic fertilizer more nutrient uptake happened in the plant system and so more plant biomass recorded. These finding is in close agreement with Kumar and Dhar, (2010) in Maize and Meena *et al.* (2013) in wheat.

Leaf area index

Leaf area index were significantly higher in plots which received A_1 *i.e.* 125:62.5:62.5 NPK kg ha^{-1} (2.78) (Table 1). This might be attributed to better root growth and its proliferation which facilitates better nutrient uptake apart from this increased cell division and enlargement resulted in increased plant height, number of tillers and leaf area.It is evident from the present study (Table 1) that LAI was significantly higher in spot application of enriched manure in due to mineralization of

Table 2: Yield and yield parameters as influenced by fertilizer level and methods of manure application in aerobic rice

Treatments	Number of panicles per plant	Panicle length (cm)	Panicle weight(g plant-1)	Number of grains per panicle	Test weight (g)	Grain yield	Straw yield	Harvest index
Level of Fertilizer (A)								
A1	33.47	20.4	3.17	126.03	21.08	53.54	61.52	0.46
A2	27.35	19.27	3.34	121.16	23.37	51.44	57.42	0.47
A3	25.7	17.85	2.79	100.35	22.78	44.4	53.3	0.46
S.Em ±	0.28	1.47	0.11	3.92	0.38	1.12	2.92	0.01
C.D. at 5%	0.83	4.32	0.34	11.49	1.11	3.28	8.57	NS
Method of application (B)								
B1	25.96	17.11	2.8	109.2	21.08	45.73	56.04	0.45
B2	27.04	18.1	3	114.18	21.89	48.54	58.01	0.46
B3	30.15	19.34	3.11	116.64	22.43	50.87	56.31	0.47
B4	32.21	22.15	3.48	123.37	24.24	54.03	59.29	0.48
S.Em ±	0.33	1.7	0.13	4.52	0.44	1.29	3.37	0.01
C.D. at 5%	0.96	4.99	0.39	13.27	1.29	3.78	NS	NS
Interaction (A X B)								
A1B1	28.12	17.81	2.8	115.55	19.92	47.94	63.64	0.43
A1B2	29.29	18.24	2.99	120.57	20.67	51.1	60.9	0.46
A1B3	36.03	19.7	3.23	127.38	21.42	54.55	57.67	0.47
A1B4	40.44	25.83	3.64	140.62	22.33	60.58	63.88	0.49
A2B1	25.27	17.21	3.07	118.04	21.75	48.19	54.83	0.47
A2B2	26.48	18.63	3.2	119.59	22.58	50.82	58.98	0.46
A2B3	28.29	19.65	3.33	121.33	23.33	52.94	58.9	0.47
A2B4	29.35	21.59	3.74	125.69	25.8	53.83	56.98	0.49
A3B1	24.5	16.3	2.53	94	21.58	41.07	49.67	0.45
A3B2	25.36	17.43	2.79	102.38	22.42	43.72	54.17	0.45
A3B3	26.11	18.67	2.78	101.2	22.53	45.13	52.35	0.47
A3B4	26.83	19.01	3.05	103.8	24.58	47.68	57.02	0.47
S.Em ±	0.19	0.98	0.08	2.61	0.25	0.75	1.95	0.01
C.D. at 5%	0.55	NS	NS	7.66	0.74	2.19	NS	NS

enriched FYM released nutrients at available time. Ali *et al.* (2003) stated that the application of 25% rice straw compost along with 75% recommended inorganic fertilizers to tomato increased the leaf area index and leaf area.

Yield components

Number of panicles significantly influenced the grain yield. Significantly higher number of panicles plant^{-1} (33.47) was recorded by fertilizer level of 125:62.5:62.5 NPK kg ha^{-1} (Table 2). The number of panicles is decided mainly during the early period from just after transplanting stage. Morepanicles plant^{-1} at harvest might be due to better availability of nutrients and reduced mortality of tillers which in turn resulted in higher uptake of nutrients. Adequate quantity of macronutrients and moisture during panicle differentiation stage might have helped to obtain higher number of grains panicle^{-1} and better availability of moisture and aeration of roots, which might have helped to retain more number of panicles plant^{-1} at harvest. These results are in conformity with findings of Jana *et al.* (2015)

The increased number of grain panicle^{-1} (126.03) was noticed in fertilizer level of 125:62.5:62.5 NPK kg ha^{-1}. Its might due to higher nutrient uptake, higher leaf area and dry matter production, these in turn might have favoured the development of large sink. Significantly higher panicle length was observed in fertilizer level A_1 *i.e.* 125:62.5:62.5 NPK kg ha^{-1} (20.40 cm) due to higher availability of nutrients, the fertilizer level A_2 *i.e.* 100:50:50 NPK kg ha^{-1} recorded higher panicle weight (3.34 g) it may be due to higher translocation of starch to panicle by higher nutrient uptake which was supported by higher leaf area. The weight of 1000 seeds was significantly higher (23.37g) (Table 2) in fertilizer level A_2 *i.e.* 100:50:50 NPK kg ha^{-1} due to higher the level of fertilizer leads to more chaffiness grains and decreases the grain filling, distribution of starch to more number of panicles leads to decreases the grain size similar observation was made by Maragatham *et al.* (2010).

Panicle length, panicle weight and test weight (22.15 cm, 3.48g and 24.24) (Table 2) were significantly higher in spot application of enriched manure which was on par with broadcasting of enriched manure it might due to enriched FYM with phosphorus conserved the nitrogen contents of the manure by reducing the losses. Supply of nitrogen is one of element to control the panicle structure, Organicmaterials, acting as slow release source of N, are expected to more closely matchN supply and rice N demand and this could reduce N losses (Backer *et al.,* 1994).Higher the number of panicles plant^{-1} normally leads to higher grains per panicle. Spot application of enriched manure with 125:62.5:62.5 NPK kg ha^{-1} has recorded

significantly higher filled grains (112.05) (Table 2) due to higher nutrient uptake This was in conformity with the findings of Sharma and Mittra (1990). Due to higher nutrient uptake resulted in negative effect on unfilled grains per panicle and chaffiness percentage. In this investigation significantly higher test weight was recorded in spot application of manure with fertilizer level 75:37.5:37.5 NPK kg ha^{-1} (24.58 g), it might be due to higher content of starch in the flag leaf in grain filling stage (Mathsushima, 1966).

Yield

The grain yield of a crop is the integrated results of a number of physiological processes. As per the farmer consultation in Shivamoga(Karnataka) situationpuddle paddy normally yields 30 to 40 quintals ha^{-1}. In this present study result showed that fertilizer levels significantly influenced the yield attributes in rice. Application of 125:62.5:62.5 NPK kg ha^{-1}recorded significantly higher grain yield (53.54 q ha^{-1}). This increase in grain yield may be due to the higher yield parameters like number panicles plant^{-1}, number of grains panicle^{-1}, panicle length and higher filled grains per panicle. Increase in filled grains panicie^{-1}, under increased nitrogen levels might be due to N induced enhancement in photosynthetic activity and thus resulted in the translocation of photosynthates and amino acids from the leaves and culms to the grain. It is in accordance with findings of Krishnakumar (1986), Dhyani and Mishra (1994). Lower sterility percent was noticed under increased levels of nitrogen. It can also be attributed to the increment in vegetative growth by higher N supply, which might have resulted in higher yield and yield components of rice. This is in harmony with findings of Dhurandhar and Tripathi (1999) and Anusha *et al.* (2015).

In this study enriched manure has recorded more yields compared to without enrichment of manures and fertilizer, spot application of enriched manure has recorded significantly higher grain yield (54.03 q ha^{-1}) (Table 2). These findings were in line with the results of a field experiment conducted to evaluate the influence of compost fertilizer mixed with chemical fertilizer on growth and yield of wheat and rice (Aslam *et al.*, 1998) and Rekha *et al.* (2015).

The grain yield significantly varies due to interaction between fertilizer level and method of application. Spot application of enriched manure along with 125:62.5:62.5 NPK kg ha^{-1} has recorded significantly higher grain yield (60.58 q ha^{-1}) (Table 2). This may be due to higher filled grain; the pounced effect of yield of rice may be due to the decomposition of FYM with easily available nutrients nitrogen, phosphorus and potassium. Farm yard manure act as a slow releasing fertilizer and it supplies plant nutrients slowlySingh *et al.* (2009). Similar results were reported by Chuan*et al.* (2013) and Meena *et al.* (2013).

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