

Influence of Enriched FYM and Fertilizer Levels on Yield and Economics of Aerobic Rice (*Oryza sativa* L.)

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Studies were conducted to evaluate the effect of enriched farm yard manure and fertilizer levels on yield and economics of aerobic rice, results showed that application of 125:62.5:62.5 NPK kg ha⁻¹ recorded higher grain yield (53.54 q ha⁻¹) and filled grain (111.86) but less unfilled grains panicle⁻¹(12.83) recorded in application 75:37.5:37.5 NPK kg ha⁻¹ which was on par with level 100:50:50 NPK kg ha⁻¹ (12.26). 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 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 grain yield (60.58 q ha⁻¹) and filled grains panicle⁻¹ (128.75). Significantly higher 1000 grain weight (25.80 g) in spot application of enriched manure with 100:50:50 NPK kg ha⁻¹. Higher gross returns (Rs. 90,870 ha⁻¹), net returns (Rs. 65, 319.74 ha⁻¹) and B: C ratio (1: 2.56) was observed in spot application of enriched manure with fertilizer level 125:62.5:62.5 NPK kg ha⁻¹.

Keywords: Aerobi rice; Enriched farm yard manure; B:C ratio; Goss returns; Net returns.

Rice has shaped the cultures, diets and economies of thousands of millions of people. Rice (*Oryza sativa* L.) is being cultivated in more than hundred countries and undoubtedly a dominant staple food of world. But 91 per cent of the world's rice is grown and consumed in Asia (Dobermann and Witt, 2003). The food security in Asia is challenged by increasing food demand and is threatened by declining water availability with growing populations, increased urbanisation and environmental degradation. Projections indicated that most of the Asian countries will have a severe water problems by 2025, however a "physical water scarcity" is expected in Asia for more than 2 million hectares of irrigated dry-season rice and 13 million

hectares of irrigated wet-season rice (Tuong and Bouman, 2003) Puddling and water logging practices destroy the soil structure and degenerate about 70 per cent of the root system (Tuong and Bouman, 2003). Moreover, lack of rainfall is a major production constraint in rainfed areas, which led to the development of alternative methods of cultivation *i.e.*, alternate wetting and drying (AWD), saturated soil culture (SSC) and aerobic rice. Rice is normally mesophytic plant but forcibly it can grown as hydrophytic crop. Aerobic rice is the latest technology that reduces water inputs by growing rice as any other irrigated upland crop (Joshi Rohit *et al*, 2009).

In organic farming, nitrogen is supplied through organic amendments in the form of manure. The incorporated use of organic sources of nutrients not only supply essential nutrients but also has some positive interaction with chemical fertilizers to increase their efficiency and

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thereby to improve the soil structure (Elfstrand *et al.*, 2007).

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.

Use of enriched FYM is one of the methods to decrease the nutrient losses. For tillering, rice crop requires more nutrients to improve the yield components in rice crop (Matsushima, 1966). 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.

Economics is the ultimate criteria for acceptance or rejection and wider adoption of any technology. The aerobic rice is no exception to this. Among the different indicators of economic efficiency in any production system, net return has greater impact on the practical utility and acceptance of the technology by the farmers.

MATERIALS AND METHODS

Investigation was carried out during *kharif* Season of 2013 to investigate the effect of enriched FYM and fertilizer levels on aerobic rice, the site is located in University of Agricultural and Horticultural Sciences, Shimoga, 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 m². It comes under Agro-climatic Region-4 and Zone-VII (Southern Transitional Zone) of Karnataka. 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 manure. Seeds were sown with spacing of 25 X 25 cm seeds are sown with one seed per hill.

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).

For the observations like dry weight of the plants, leaf area etc, the plants from the outside the net plot were uprooted and brought to laboratory for measurement.

RESULTS AND DISCUSSION

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. More panicles 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 Ravi and Srivastava (1997).

Use of higher dose of N might have helped in inducing good vegetative growth and thus produced higher number of panicles leading to higher yield (Dhurandher and Tripathi, 1999). 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. The results of the present investigation are in conformation with the findings of Ahmed *et al.* (1990).

Significantly higher panicle length was observed in fertilizer level A₁ *i.e.* 125:62.5:62.5 NPK kg ha⁻¹ (20.40 cm) due to higher availability of nutrients, the fertilizer level A₂ *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) in fertilizer level A₂ *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). Venkateshwaralu and Mahatim Singh (1980) reported that yield attributes increased with increase in the fertilizer levels.

Table 1. Yield, yield parameters, filled grain, chaffy grains panicle⁻¹ and chaffiness (%) as influenced by fertilizer level and methods of manure application in aerobic rice

Treatments	Number of Panicles per plant	Number of grains per panicle	Grain yield	Straw yield	Filled grain	Chaffiness grains panicle ⁻¹	Chaffiness(%)
Level of Fertilizer (A)							
A1	33.47	126.03	53.54	61.52	111.86	14.17	11.40
A2	27.35	121.16	51.44	57.42	108.90	12.26	10.16
A3	25.7	100.35	44.4	53.3	87.51	12.83	12.74
S.Em±	0.28	3.92	1.12	2.92	4.14	0.52	0.65
C.D. at 5%	0.83	11.49	3.28	8.57	12.15	1.52	1.91
Method of application (B)							
B1	25.96	109.2	45.73	56.04	94.80	14.40	13.26
B2	27.04	114.18	48.54	58.01	100.12	14.06	12.34
B3	30.15	116.64	50.87	56.31	104.06	12.58	10.76
B4	32.21	123.37	54.03	59.29	112.05	11.32	9.38
S.Em±	0.33	4.52	1.29	3.37	4.78	0.60	0.75
C.D. at 5%	0.96	13.27	3.78	NS	14.02	1.75	2.21
Interaction (A X B)							
A1B1	28.12	115.55	47.94	63.64	100.00	15.55	13.48
A1B2	29.29	120.57	51.1	60.9	105.54	15.02	12.48
A1B3	36.03	127.38	54.55	57.67	113.13	14.25	11.18
A1B4	40.44	140.62	60.58	63.88	128.75	11.87	8.47
A2B1	25.27	118.04	48.19	54.83	104.01	14.03	11.90
A2B2	26.48	119.59	50.82	58.98	105.44	14.15	11.83
A2B3	28.29	121.33	52.94	58.9	110.47	10.86	8.95
A2B4	29.35	125.69	53.83	56.98	115.68	10.01	7.97
A3B1	24.5	94	41.07	49.67	80.38	13.62	14.39
A3B2	25.36	102.38	43.72	54.17	89.37	13.01	12.71
A3B3	26.11	101.2	45.13	52.35	88.58	12.62	12.16
A3B4	26.83	103.8	47.68	57.02	91.73	12.07	11.70
S.Em±	0.19	2.61	0.75	1.95	2.76	0.35	0.43
C.D. at 5%	0.55	7.66	2.19	NS	8.10	1.01	1.27

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, Organic materials, acting as slow release source of N, are expected to more closely match N 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 Mitra (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).

The grain yield of a crop is the integrated results of a number of physiological processes. As per the farmer consultation in Shimoga (Karnataka) situation puddle 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 and higher filled grains per panicle. The results of this present investigation are in conformation with the findings of Ahmed *et al.* (1990). Use of higher dose of N might have helped in inducing good vegetative growth and thus produced higher number of panicles leading to higher yield (Dhurandher and Tripathi, 1999). Increase in filled grains panicle⁻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 Krishnakumar (1986) and Dhurandhar and Tripathi (1999). Thousand-grain weight was higher in the highest level of nitrogen. This might be due to the enhanced photosynthetic activity and translocation of photosynthates and amino acids from the leaves and culms to grain under higher N levels (Dhyani and Mishra, 1994).

In this study enriched manure has recorded more yields compared to without enrichment of manures and fertilizer, spot

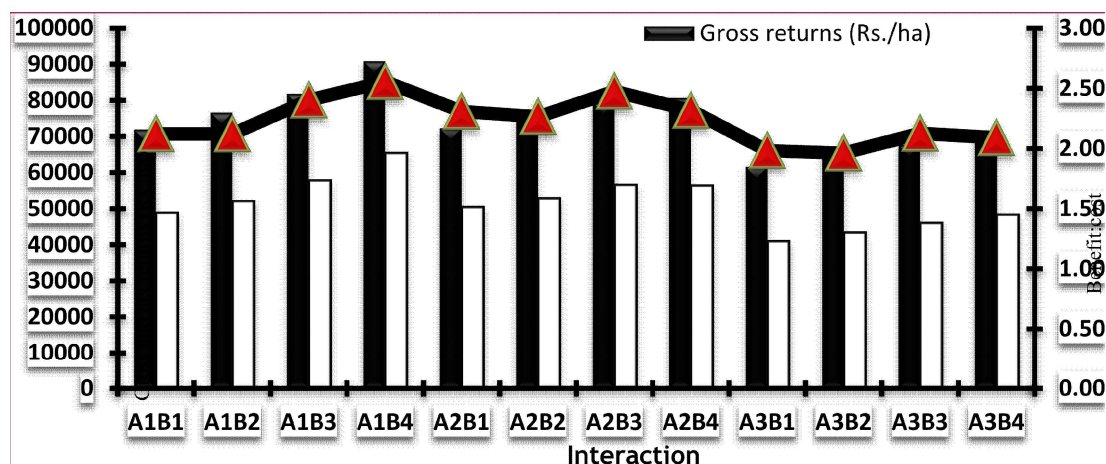


Fig. 1. Gross returns (Rs. ha⁻¹), net returns (Rs. ha⁻¹) and B: C ratio as influenced by fertilizer level and methods of manure application in aerobic rice

application of enriched manure has recorded significantly higher grain yield (54.03 q ha^{-1}) (Table 1). 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). They reported significant improvements in growth and yield. Similarly, Singh and Singh *et al.* (1999) reported the effect of compost plus nitrogen on grain yield, straw yield and total biomass of wheat, which were highest with compost plus nitrogen. It is very likely that N-losses due to volatilization, leaching or denitrification might be reduced due to mixing of N fertilizer with organic compost resulting in greater N. These results are in line with the earlier findings of Jagathjothi and his co workers (2008).

Significantly less unfilled grains panicle⁻¹ (10.01) and chaffiness (7.97%) (Table 1) was recorded in spot application of enriched manure along with fertilizer level 100:50:50 NPK kg ha⁻¹ might be due higher the nutrient uptake in flowering period results more number of spikelets panicle⁻¹, but it lead to increases the unfilled grain panicle⁻¹ (Mathsushima 1966), ammonium ions are the principal form of nitrogen available to paddy rice and as such are toxic to many metabolic systems, rice must maintain an adequate supply of carbohydrates (presumably keto acids) to insure prompt conversion to amino acids. It is possible that spikelet degeneration could be due to excess free ammonia in the spikelets rather than the lack of carbohydrates in the whole plant as suggested by Murata (1969) (a negative correlation between carbohydrate content and spikelet degeneration).

Increase in filled grains panicle⁻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 Krishnakumar (1986) and Dhurandhar and Tripathi (1999). Thousand-grain weight was higher in the highest level of

nitrogen. This might be due to the enhanced photosynthetic activity and translocation of photosynthates and amino acids from the leaves and culms to grain under higher N levels (Dhyani and Mishra, 1994).

More number of filled grains (112.05), less chaffy grains panicle⁻¹ (11.32) and less chaffiness (9.38%) (Table 1) was observed in spot application of enriched manure than other methods. This may be due to less leaching loss of nutrients and more starch stored in flag leaf and more availability of photosynthates for better grain filling as a consequence of increased green leaves plant⁻¹, higher leaf area and higher dry matter (Siddaram *et al.*, 2010). Increase in filled grain and thousand grain weight due to N induced enhancement in photosynthetic activity and greater translocation of photosynthates and amino acids from the leaves and culms to the grain. The present findings are in accordance with the findings of Belder *et al.* (2005) and Dhyani and Mishra (1994).

Economics

Economics is the ultimate criteria for acceptance or rejection and wider adoption of any technology. The aerobic rice is no exception to this. Among the different indicators of economic efficiency in any production system, net return has greater impact on the practical utility and acceptance of the technology by the farmers.

Assessment of treatments in terms of economic traits revealed that the gross return, net returns and benefit cost (B: C) ratio differed due to fertilizer level and method of application of manures. among the different treatment combinations fertilizer level 125:62.5:62.5 NPK kg ha⁻¹ with spot application of enriched manure recorded higher cost (Rs. 25,550.26), higher gross returns (Rs. 90,870), higher net returns (Rs. 65,319.74) and higher benefit to cost ratio (2.56) than other combination due to higher grain yield and straw yield (Fig.1). The higher gross return and net returns was mainly due to higher grain yield and straw yields. Similar findings were also observed by Mehla and Panwar (2000), Aravind Kumar and Prasad (2002). Higher benefit to cost ratio is due to higher grain yield by combining the enriched FYM and fertilizer level results higher income per rupee investment similar results was reported by Pradeep Gopakkali *et al.* (2012) and Jagathjothi *et al.* (2008).

CONCLUSION

Summarizing the effect of enriched farm yard manure and fertilizer levels on economics of aerobic rice, it could be inferred that treatment consist interaction of enriched FYM with 125:62.5:62.5 NPK kg ha⁻¹ got higher net returns. This indicated that further crop improvement and management strategies intended for stabilizing the yield under aerobic environment should be aimed at stabilizing the economics by increasing the capacity of yield by adopting different management factors

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