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Research Article

Yield and Economics of Aerobic Paddy with Application of Zinc, Iron and Microbial Inoculants

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Abstract: An experiment was conducted in the Zonal agriculture research station at V.C.Farm, Mandya during *kharif* 2008 to study the yield and economics of aerobic paddy cultivation with application of zinc, iron and microbial inoculants. The results of the experiment revealed that among the different treatments RDF + FYM 10 t ha^{-1} + $ZnSO_4$ @ 20 kg ha^{-1} + VAM + Azospirillum + PSB recorded significantly higher grain yield (43.63 q ha^{-1}), cost of cultivation (Rs. 14165 ha^{-1}), gross returns (Rs. 44637 ha^{-1}) and net returns (Rs. 30472 ha^{-1}) but application of RDF alone recorded higher B:C ratio (2.28).

Key words: Zinc, Iron, Aerobic paddy, microbial inoculants

INTRODUCTION

In recent years, sustainability of irrigated rice ecosystem is threatened by water crisis. Thus in order to safeguard the food security through sustained production, preserve precious water resources and to utilize limited water most effectively, alternate ways of growing rice using minimum water must be explored for which aerobic system of rice cultivation is one such alternative method [1]. With the continuous use of high yielding and fertilizer responsive varieties, the practices of using large amount of high analysis macronutrient fertilizers together with much decreased use of organic manures, little recycling of crop residues lead to micronutrient hunger in many crops and the need of the micronutrient has been essentially and entirely met through its native reserve of soil[2] . Among the micronutrients, zinc is now being regarded as the third most limiting nutrient element in crop production [3]after N and P . The extent of iron deficiency in India is next to that of zinc[4] . In submerged soils ferric compounds are converted to ferrous form by microorganisms and large amount of iron are brought in to soil solution. Where as in aerobic situation due to absence of reduced zone the available ferrous form of iron is converted to unavailable ferric form there by making it unavailable. Further limited use of organics and absence of proper recycling of crop residues has also further added to deficiency symptoms under this system of rice cultivation.. Application of beneficial micro-organisms is known to help in mineralization and mobilization of macro and micronutrients needed by the crop.

MATERIAL AND METHODS

The field experiment as conducted during *kharif* of 2008 at Zonal agriculture research station, V.C.Farm, Mandya. Which is situated at $12^0$18' and 13^0 04' north longitude and 76^0 79' and 77^0 20' east longitude at an altitude of 695 meters above mean sea level. The area comes under the agro climatic zone 6 which is Southern Dry Zone of Karnataka. Prior to laying out of the experiment, composite soil samples were drawn from the experimental site and analyzed for physical properties, chemical properties, Available N,P_2O_5,K_2O, zinc and iron. The soil status indicated low in available nitrogen (199.9 kg ha^{-1}), medium in available phosphorus (27.0 kg ha^{-1}), available potassium (245.0 kg ha^{-1}), Low in available zinc (0.57 ppm) and high in available iron (4.59 ppm). The organic carbon content was medium (0.40 %). During crop growth period a total rainfall of 438.8 mm was received from July 2008 to December 2008. The actual rainfall was less (438.8 mm) than the normal (608.6 mm) in crop growth period. The highest rainfall of 193.00 mm was received in October and the lowest rainfall occurs in July 2008 (12.30 mm). The experimental design used was Randomized Complete Block Design with ten treatments and three replications. The cultivar used was MAS-946-1 which was newly released and drought resistance in nature.

RESULTS AND DISCUSSION

Significantly higher number of productive tillers (37.33), grain weight $panicle^{-1}$ (9.48 g), test weight (26.25 g), number of filled grains $panicle^{-1}$ (199.33), higher number of chaffy grains $panicle^{-1}$ (23.67) and lower sterility percentage (10.61) were all observed in treatment T_9 (RDF + FYM 10 t ha^{-1} + $ZnSO_4$ @ 20 kg ha^{-1} + VAM + Azospirillum + PSB). Treatment T_9 recorded 86.67 per cent higher productive tillers, 50.18 higher grain weight $panicle^{-1}$, 15.96 per cent higher test weight, 41 per cent higher number of filled grains $panicle^{-1}$, 1.45 per cent higher number of chaffy grains $panicle^{-1}$ and 33.78per cent lower sterility percentage as compare to farmers practice (150:37:37 N: P_2O_5:K_2O kg ha^{-1}) (T_1). Better performance of T_9 to all yield parameters was mainly due to higher availability of nutrients through soil application and their uptake by plants. The better growth from 60DAS upto harvest producing better growth parameters have finally culminated into producing better yield parameters. These results corroborate with the findings of many workers Jena *et al*[5]. Khanda and Dixit[6] who have also reported that soil application of zinc significantly increased yield attributes, which led to better utilization of N and P including increased metabolic activities (Table 1).

The grain yield of aerobic paddy was higher (43.63 q ha^{-1}) in T_9 with the combined application of RDF + FYM 10 t ha^{-1} + $ZnSO_4$ @ 20 kg ha^{-1} + VAM + Azospirillum + PSB, compare to application of 150:37:37 N: P_2O_5:K_2O kg ha^{-1} according farmers practice (T_1) which recorded lowest yield (29.74 q ha^{-1}). Higher rice yields were due to the higher yield parameters like higher productive tillers (table 1), higher grain weight $panicle^{-1}$ (**Table 1**), higher test weight (T**table 1**), greater number of filled grains $panicle^{-1}$ (**Table1)** and lower sterility percentage **(Table 1).**

Table- 1: Influence of zinc and iron application with or without microbial inoculants on Yield attributes and Grain yields of aerobic paddy

Treatments	Productive tillers	Grain weight/ Panicle (g)	Test weight (g)	No of filled Grains/ panicle	No of chaffy grains / panicle	Sterility %	Grain yield (q/ha)
T_1- Farmers practice (150:37:37 N :P_2O_5 :K_2O kg/ha)	20.00	6.31	22.64	141.00	23.33	14.20	29.74
T_2- RDF alone (100:50:50 N :P_2O_5 :K_2O kg/ha)	22.33	6.47	23.45	142.00	23.00	13.94	31.57
T_3- RDF + FYM 10 t ha^{-1}	23.00	6.69	23.84	150.00	20.67	12.11	34.98
T_4- RDF + FYM 10 t ha^{-1} + VAM	25.33	6.89	23.85	157.00	23.00	12.78	35.14
T_5- RDF + FYM 10 t ha^{-1} + *Azospirillum*	26.33	7.05	24.20	159.33	24.33	13.25	35.25
T_6- RDF + FYM 10 t ha^{-1} + PSB	27.67	7.36	24.53	170.67	23.33	12.03	35.27
T_7- RDF + FYM 10 t ha^{-1} + $ZnSO_4$ @ 20 kg ha^{-1}	27.67	7.46	24.77	172.33	23.33	11.93	35.90
T_8- RDF + FYM 10 t ha^{-1} + $FeSO_4$ @ 12.5 kg ha^{-1}	29.33	7.41	24.39	173.67	23.00	11.69	36.21
T_9- RDF + FYM 10 t ha^{-1} + $ZnSO_4$ @ 20 kg ha^{-1} + VAM + *Azospirillum* + PSB	37.33	9.48	26.25	199.33	23.67	10.61	43.63
T_{10}- RDF + FYM 10 t ha^{-1} + $FeSO_4$ @ 12.5 kg ha^{-1} +VAM + *Azospirillum* + PSB	35.33	9.35	25.09	197.67	23.33	10.56	42.20
SEM	1.34	0.48	0.60	7.01	0.52	0.00	1.52
CD at 5 %	3.99	1.44	1.78	20.82	1.55	_	4.51

Note: RDF- Recommended Dose of Fertilizer; FYM- Farm Yard Manure; VAM- Vesicular *arbuscular mycorrhiza (Glomus fasciculatum)* (10 kg/ha)

PSB- phosphorous solubilizing bacteria;(*Bacillus megaterium variety-phosphaticum)* (10 kg/ha)

The higher paddy yield was possibly due to enhanced synthesis of carbohydrates and their subsequent accumulation in the sink mainly triggered by better growth which in turn was mainly due to better nutrient availability. Similar observations were also recorded by Saumi and Dasgupta[7]. and Verma *et al.* [8]. Grain yield of paddy was higher in the treatment which received $ZnSO_4$ + microbial inoculants with FYM and $FeSO_4$ + microbial inoculants with FYM (T_9 and T_{10}) as against only application of $ZnSO_4$ and $FeSO_4$ singly with FYM (T_7 and T_8). These may be attributed to the role of both zinc and iron in many enzymatic reactions including their role as catalyst in various growth processes, hormone production and protein synthesis. Further the application of FYM has led to production of natural chelating agents that helped in keeping iron soluble and more available to plants and the uptake of applied nutrients. Earlier studies conducted also showed the similar results with other workers like Kulandaivel *et al*[9]. and Jayabal *et al.* [10]. It is also interesting to observe that T_9 and T_{10} recorded 39.98 per cent, and 35.39 per cent higher grain yield respectively over farmers practice (150:37:37 N: P_2O_5:K_2O kg ha^{-1}) (T_1) **(Table 1).**

Combined use of organic manures (FYM), zinc sulphate, iron sulphate and biofertilizers (PSB, *Azospirillum* & VAM) might have helped in maintaining yield stability through availability of nutrients especially micronutrients such as Zn and Fe which was found specifically deficient under aerobic condition. Further application of these micronutrients has increased the use efficiency of major nutrients, providing favorable conditions for soil microbial activity also. However, it is ultimately the combined factors totally, which have contributed to increased yield in addition to maintaining good soil health through better soil fertility status.

Table 2: Economics of different treatments in aerobic paddy as influenced by zinc and iron application with or without microbial inoculants

Treatments	Economics			
	Total cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio
T_1- Farmers practice (150:37:37 N :P_2O_5 :K_2O kg/ha)	10145	31027	20882	2.06
T_2- RDF alone (100:50:50 N :P_2O_5 :K_2O kg/ha)	10000	32809	22809	2.28
T_3- RDF + FYM 10 t ha^{-1}	12000	36196	24196	2.02
T_4- RDF + FYM 10 t ha^{-1} + VAM	12800	36342	23542	1.84
T_5- RDF + FYM 10 t ha^{-1} + *Azospirillum*	12750	36467	23717	1.86
T_6- RDF + FYM 10 t ha^{-1} + PSB	12750	36571	23821	1.87
T_7- RDF + FYM 10 t ha^{-1} + $ZnSO_4$ @ 20 kg ha^{-1}	12615	37070	24455	1.94
T_8- RDF + FYM 10 t ha^{-1} + $FeSO_4$ @ 12.5 kg ha^{-1}	12400	37361	24961	2.01
T_9- RDF + FYM 10 t ha^{-1} + $ZnSO_4$ @ 20 kg ha^{-1} + VAM + *Azospirillum* + PSB	14165	44637	30472	2.15
T_{10}- RDF + FYM 10 t ha^{-1} + $FeSO_4$ @ 12.5 kg ha^{-1} +VAM + *Azospirillum* + PSB	13950	42831	28881	2.07

Note: RDF- Recommended Dose of Fertilizer; FYM- Farm Yard Manure;VAM- Vesicular *arbuscular mycorrhiza (Glomus fasciculatum)* (10 kg/ha);PSB- phosphorous solubilizing bacteria (*Bacillus megaterium variety-phosphaticum)* (10 kg/ha);*Azospirullum brasilense* – 10 kg ha^{-1}

Higher cost of cultivation (Rs.14165 ha^{-1}) was recorded in treatment T_9 (RDF+FYM 10 t ha^{-1} + soil application of $ZnSO_4$ @ 20 kg ha^{-1} + VAM + *Azospirillum* + PSB). The higher cost of cultivation in T_9 was mainly due to additional cost of inputs like $ZnSO_4$, FYM, PSB, *Azospirillum* and VAM leading to higher combined total cost **(Table2).**

Lowest cost of cultivation was in treatment T_2 (RDF alone). Maximum net return of Rs.30472 ha^{-1} was found in T_9 treatment. However, lowest net returns of Rs.20881 ha^{-1} was recorded in treatment T_1 (Farmers practice (150:37:37 N: P2O5:K2O kg ha^{-1})). Its because the expenditure of one rupee on zinc through $ZnSO_4$ generated an additional gain of Rs.2.30. Similar such results were also reported by earlier work of Shukal and Jagadishlal[11] . The B:C ratio among the treatments indicated that, in treatment T_2 (only RDF) gave higher B:C ratio (2.28). It was mainly due to nutrients supplied through inorganic source with no usage of FYM, PSB, *Azospirillum* and VAM. Even though the treatment T_9 recorded higher yield and net returns, with a moderate B:C ratio of 2.15. This may be due to additional cost of inputs like $ZnSO_4$, FYM, PSB, *Azospirillum* and VAM leading to higher combined total cost. However, T_9 recorded net gain of Rs.3.5 for every rupee expenditure on zinc through $ZnSO_4$ and other microbial inoculants. Thus higher profit could be obtained with application of zinc as well as microbial inoculants with the recommended package (RDF + FYM 10 t ha^{-1}) indicating that the additional cost involved could be compensated by higher yields obtained.

REFERENCES

1. B.A.M.Bouman, S.Peng, A.R. Castaneda and R.M. Visperas, Yield and water use of tropical aerobic rice system. *Agric. Water. Manage*., 2005,**74** (2): 87-105.
2. V.P.Singh, Effect of organic and inorganic sources of nutrients on rain fed wheat. *Indian J. Agronomy*,1999, **44** (2): 347-352.
3. V.K.Gupta, Zinc research and agricultural production. In: Micronutrient research and agricultural production, Ed. Tandon H.L.S., 1995, 132-164.
4. G.U.Malewar, and S.Ismail, Iron research and agricultural production, In: Micronutrient Research and Agricultural Production. FDCO, New Delhi,1995,. 57-82.
5. P.K.Jena, C.P. Rao, and G.Subbaiah, Effect of zinc management practices on growth, yield and economics in rice. *Crop production*, 2006, **43** (4): 326-328.
6. C.M.Khanda,L. and Dixit, Effect of zinc and nitrogen fertilization on yield and nutrient uptake of summer rice. *Indian J. Agron.,1996*, **41** (3): 368-372.
7. R.C.Samui, and S.K.Dasgupta, Effect of soil and foliar application of zinc, boron and molybdenum on direct seeded rice, transplanted rice and berseem grown in sequence. *Indian J. Agron.*, 1982,**27** (1): 35-40.
8. C.P.Verma,H.N. Tripathy and Kedar Prasad, Effect of FYM and zinc sulphate on yield and yield attributes of rice grown after paddy nursery. *Crop. Res.,2001*, **21** (3): 382-3
9. S.Kulandaivel, B.N. Mishra,B. Gangaiah and D.K.Mishra, Effect of levels of zinc and iron and their chelation on yield and soil micronutrient status in hybrid rice-wheat cropping system. *Indian J. Agron.,2004*, **49** (2): 80-83.
10. K.Jayabal, S.P. Palaniappan, and S.Chelliah, Evaluation of integrated nutrient management techniques in rice. *Oryza.*, 1999,**36** (3): 263-265.
11. N.D.Shukla, and Jagadishlal, Economics of Sulphur and zinc in balanced fertilization under intensive cropping systems. *Fertilizer news*, 2002,**47** (5): 51-55

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