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Effect of micronutrients mixture on growth and yield of aerobic rice

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Abstract
A field experiment was conducted in college of Agriculture, V. C. Farm, Mandya during *Kharif* 2017 to study the effect of micronutrients mixture on growth and yield of aerobic rice. Treatments include micronutrients mixture combinations like foliar application (MMF @ 0.5 and 1.0 %) and soil application (MMS @ 12.5 kg ha^{-1}) and their combination of both soil and foliar applications were checked in this experiment. The results revealed that the maximum plant height, number of tillers per hill, productive tillers per hill, panicle length, panicle weight, test weight, grain yield and straw yields were recorded in treatment (T_8) with soil application of MMS @ 12.5 kg ha^{-1}+ MMF @ 1 % along with RDF and FYM. But soil application of MMS @ 12.5 kg ha^{-1}+ MMF @ 0.5 % along with RDF and FYM recorded higher B: C ratio.

Keywords: Aerobic rice, micronutrients mixture

Introduction
Rice (*Oryza sativa*) ranks first among the cereals in the country. Rice is the staple food for nearly half of the world's population and most of them living in developing countries like Asia. More than 92 per cent of the world's rice is produced and consumed in Asia (IRRI, 1998). Asia's food security depends largely on irrigated rice, which produces about three quarters of rice harvested. Scarcity of freshwater resources in the world´s leading rice-producing countries China and India has threatened the production of the irrigated rice crop (Priyanka *et al.*, 2012) [8]. Thus, in order to safeguard the food security through sustained production, conservation of precious water resources and utilization of limited water most efficiently, an alternate ways of growing rice with minimum quantity of water for which aerobic system of rice cultivation is one such alternative method (Bouman *et al.*, 2001) [2].

The low and unstable yields of aerobic rice were mainly due to low water availability and nutrient stresses. After green revolution, continuous use of high yielding varieties, large use of high analysis fertilizers, adoption of intensive mono-cropping and decreased use of organic manures lead to many micronutrients deficiencies in many crops. And also nutrients are delivered to roots primarily by mass flow and diffusion but the delivery rate decreases as the moisture content of the soil decreases. The lower soil moisture content in aerobic rice cultivation therefore reduces nutrients supply to the roots and resulted in the lower rate of plant uptake.

In aerobic situation the available ferrous form of iron is converted to unavailable ferric form thereby making it unavailable, due to absence of reduced zone. In the same way other micronutrients also converted into unavailable form and not available to the plants. Therefore, it is essential to supply those micronutrients in required quantity both foliar as well as soil application to maintain soil fertility and to obtain higher yield.

Material and Methods
A field experiment was conducted during *Kharif* 2017 at College of Agricultural, V. C. Farm, Mandya. The soil of the experimental site was sandy loam in texture having pH 7.3. The organic carbon content was medium (5.5 g kg^{-1}), available N content was low (188.16 kg ha^{-1}) while that of K_2O (229 kg ha^{-1}) and P_2O_5 (23.5 kg ha^{-1}) contents were found medium. The exchangeable Ca and Mg content (6.5 and 2.4 cmol (p+) kg^{-1}, respectively) were adequate and the available S (15.5 mg kg^{-1}) content was high. And sufficient with micronutrients like Fe (4.55 mg kg^{-1}), Mn (2.10 mg kg^{-1}), Zn (0.88 mg kg^{-1}) and Cu (0.74 mg kg^{-1}) while B (0.46 mg kg^{-1}) content was in the deficient range.

The experimental design used was Randomized Complete Block Design with eight treatments and three replications. The cultivar used was KMP-175 which was newly released and suitable for aerobic condition. The micronutrients mixture was applied to the soil at sowing and foliar application (0.5 and 1.0 %) was given after 20 and 40 days after sowing.

Results and Discussion

Growth and yield parameters of aerobic rice

The results presented in the Table. 1 indicated that the treatment with soil application of MMS @ 12.5 kg ha^{-1}+ MMF @ 1 % along with RDF and FYM (T_8) has reported significantly higher plant height (137.33 cm), number of tillers per hill (22.70), number of productive tillers per hill (22.47), panicle length (25.77 cm), panicle weight (6.09 g), test weight (22.53 g), grain yield (4352.21 kg ha^{-1}) and straw yield (6093.09 kg ha^{-1}) compared to all other treatments. Better performance of T_8 treatment was due to the increased availability of macro and micro nutrients in the balanced proportion, which helps in the better root growth and development. Combined application of micronutrients (zinc, copper, iron, manganese and boron) through both soil and foliar, enhance metabolic activity of plants that helps in flower initiation in many tillers, and also micronutrients increase the synthesis of organic compounds by the increased photosynthesis, plants use these organic compounds (starch, lipids and proteins) for cell division and multiplication that in turn resulted in increased growth and yield parameters. Similar findings were reported by Qadir *et al.*(2013) [9]; Sarwar *et al.*(2013) [12]; Esfahani *et al.* (2014) [13]; Rakesh *et al.* (2017); Gulab Singh Yadav (2016) [14]; Khanda and Dixit (1996) [6] And Mekkei and Haggan (2014) [7].

Economics of different treatments in aerobic rice

The economics of aerobic rice influenced by soil and foliar application of micronutrients mixture are presented in the Table 2. The highest cost of cultivation was recorded in the treatment T_8 with the soil application of RDF+ MMS @ 12.5 kg ha^{-1}+ foliar application of MMF @1% (Rs.37, 907)

Table 1: Influence of micronutrients mixture on growth and yield of aerobic rice

Treatments	Plant height (cm)	No. of tillers per hill	Productive tillers per hill	Panicle length (cm)	Panicle weight (g)	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T_1: Absolute control	96.20	9.40	8.70	21.17	4.23	19.17	2244.77	3142.68
T_2: RDF + FYM @ 10 t ha^{-1} (Control)	108.70	13.07	12.57	22.37	4.66	20.83	3088.77	4324.28
T_3: RDF + FYM @ 10 t ha^{-1} + $ZnSO_4$ @ 20 kg ha^{-1} (POP)	110.23	13.70	13.27	22.60	4.88	21.17	3195.55	4473.76
T_4: T_2+ Foliar spray of MMF @0.5 %	117.63	15.93	15.37	23.80	5.23	21.33	3574.44	5004.21
T_5: T_2 + Foliar Spray of MMF @ 1 %	118.23	16.50	16.20	24.13	5.27	21.50	3588.88	5024.43
T_6: T_2 + Soil application of MMS @ 12.5 kg ha^{-1}	125.47	19.47	19.17	24.53	5.44	21.33	3942.21	5519.09
T_7: T_2 + MMS @ 12.5 kg ha^{-1} + MMF @ 0.5 %	136.50	21.80	21.60	25.43	5.79	21.83	4289.99	6005.98
T_8: T_2 + MMS @12.5 kg ha^{-1} + MMF @ 1 %	137.33	22.70	22.47	25.77	6.09	22.53	4352.21	6093.09
SEm±	2.23	0.31	0.3	0.12	0.11	0.52	109.21	152.89
CD @ 5%	6.76	0.94	0.9	0.36	0.32	1.57	331.26	463.77

Table 2: Economics of aerobic rice as influenced by soil and foliar application of micronutrients mixture

Treatments	Total Cost of Cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B:C ratio
T_1: Absolute control	18,735	43328.5	24,594.00	2.31
T_2: RDF + FYM @ 10 t ha^{-1} (Control)	30,532	59616.5	59614.55	1.95
T_3: RDF + FYM @ 10 t ha^{-1} + $ZnSO_4$ @ 20 kg ha^{-1} (POP)	32,032	61682.0	29,650.00	1.93
T_4: T_2+ Foliar spray of MMF @0.5 %	32,987	68979.0	35,992.00	2.09
T_5: T_2 + Foliar Spray of MMF @ 1 %	34,442	69268.5	34,827.00	2.01
T_6: T_2 + Soil application of MMS @ 12.5 kg ha^{-1}	33,997	76083.0	42,086.00	2.24
T_7: T_2 + MMS @ 12.5 kg ha^{-1} + MMF @ 0.5 %	36,452	82770.5	46,319.00	2.27
T_8: T_2 + MMS @12.5 kg ha^{-1} + MMF @1 %	37,907	83994.0	46,087.00	2.22

followed by the treatment 7 with the soil application of RDF + MMS @ 12.5 kg ha-1 + foliar application of MMF @ 0.5% compared to control and rest of the treatments. The lowest cost of cultivation was observed in absolute control followed by control and UAS (B) package of practice. The higher net return was observed in T_7 (Rs. 46,319) with the soil application of RDF + MMS @ 12.5 kg ha^{-1} + foliar application of MMF @ 0.5% followed by T_8 (Rs.46, 087) with the soil application of RDF + MMS @ 12.5 kg ha^{-1} + foliar application of MMF @ 1%. And the lowest net return was recorded in absolute control (T_1- 24,594). Among the treatments imposed the highest B:C ratio was recorded in T_7 treatment (2.27) with the soil application of RDF + MMS @ 12.5 kg ha^{-1} + foliar application of MMF @ 0.5%, followed by T_6 (2.24) with the soil application of RDF + MMS @ 12.5 kg ha^{-1} and the lowest was observed in T_3 (1.93) with the soil application of Zn @ 20 kg ha^{-1} along with application of RDF + FYM. The economics of aerobic rice was influenced by different levels of soil and foliar application of micronutrients mixture and varied with respect to cost of cultivation and gross returns, which depends on yield of the crop and price of input and output in market, in turn varies the net return and B:C ratio. The combined application of RDF + MMS @12.5 kg ha^{-1} + foliar application of MMF @ 0.5 % found to be more profitable with B:C ratio (2.27) compared to other treatments that is due to the higher yield and less input.

In conclusion, the present study has revealed that the soil application of RDF + MMS @ 12.5 kg ha^{-1} at sowing + foliar application of MMF @ 1% at 20 and 40 DAS was recorded significantly higher growth and yield of aerobic rice compared to other treatments. And the higher B:C ratio was observed in soil application of RDF + MMS @ 12.5 kg ha^{-1} at sowing + foliar application of MMF @ 0.5 % at 20 and 40 DAS treatment.

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