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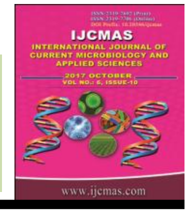

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Effect of Foliar Spray of Various Nutrients on Yield Attributes, Yield and Economics of Rainfed Rice

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A B S T R A C T

A field experiment was conducted at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology Kumarganj, Faizabad (U.P.) during *kharif* season of 2013 to find out the nutrient economy through foliar application of fertilizer and to assess the economic feasibility of various treatments. The experiment was conducted in RBD with 3 replications and 12 treatments of nutrient management modules*viz.*,T_1-100% RDF as basal,T_2-100% RDF as basal + 3 water sprays,T_3-75% RDF + 2.5 Tonnes FYM, T_4-50% RDF + 5 Tonnes FYM, T_5-50% RDF + 3 foliar sprays of 20 kg Urea ha^{-1},T_6-50% RDF + 3 foliar sprays of 20 kg Urea ha^{-1}+ 10 kg $ZnSO_4$ ha^{-1},T_7-100% RDF + 30 kg $ZnSO_4$ ha^{-1} as soil application,T_8-100% RDF + 2 foliar sprays of 5 kg $FeSO_4$ ha^{-1}, T_9-100% RDF + 2 foliar sprays of 10 kg Borax ha^{-1},T_{10}-100% RDF + 2 foliar sprays of 10 kg Sulphur ha^{-1}, T_{11}-100% RDF + 2 foliar sprays of 20 Urea ha^{-1}+ 10 kg $ZnSO_4$ ha^{-1} and T_{12}-100% RDF + 2 foliar spray of 10 kg $ZnSO_4$ ha^{-1}+ 5 kg $FeSO_4$ ha^{-1}+ 10 kg Borax ha^{-1}+10 kg Sulphur ha^{-1}. Treatment T_{12} (100% RDF + 2foliar sprays of 10 kg $ZnSO_4$ ha^{-1} + 5 kg $FeSO_4$ ha^{-1} + 10 kg Borax ha^{-1} + 10 kg Sulphur ha^{-1}) found significantly superior over rest of the treatments in all the aspects. Treatment T_{12} (100% RDF + 2foliar sprays of10 kg $ZnSO_4$ ha^{-1} + 5 kg $FeSO_4$ ha^{-1} + 10 kg Borax ha^{-1} + 10 kg Sulphur ha^{-1}) increases all the yield attributing characters *viz.*, number of panicles (378 m^{-2}), length of panicle (21.60 cm), number of grains per panicle (79.20) and test weight (23.10 g) of rice which undoubtedly results in increase in yield of rice crop. Treatment T_{12} found significantly superior and produced higher grain and straw yields as compared to the other treatments. Treatment $T_{12}$was found economically best in respect to gross return (Rs. 45170) and net return (Rs. 23521) while B:C found best with Treatment (T_{11}) (2.23) which was found superior over rest of the treatments.

Keywords

Rice, Foliar spray, Nutrient modules, Yield, Economics.

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Introduction

Rice (*Oryza sativa L.*) belongs to the family graminae, genus *Oryza* has two cultivated and 22 wild species. The cultivated species are *Oryza sativa* and *Oryza glaberrima*. *Oryza sativa* is grown all over the world while *Oryzagla berrima* has been cultivated in West Africa for the last 3500 years. Rice is grown under many different conditions.

Rice is the only cereal crop that can grow in standing water. 57% of rice is grown on irrigated land, 25% on rainfed lowland, 10% on the uplands, 6% in deep water and 2% in tidal wetlands of the world. Rice is cultivated world-wide over an area about 156.68 m ha with an annual production of about 650.19 million tonnes (Anonymous, 2013). In India, rice is cultivated on an area of about 39.47 million hectares with an annual production of about 87.10 million tonnes with average productivity of 2207 kg per hectare. In Uttar Pradesh the area of rice is about 13.84 million hectares and production is 23.64 million tonnes, with productivity of 2358 kg per hectare. It is the staple food for two thirds of the world's population. Over 2 billion people in Asia alone derive 80% of their energy needs from rice, which contains 80% carbohydrates, 7–8% protein, 3% fat, and 3% fiber. Rice protein, though small in amount, is of high nutritional value. Rice bran is used as cattle and poultry feed. Nutrient deficiency is considered as one of the major causes of the declining productivity trends, observed in rice growing countries. Sodic, upland and calcareous coarse-textured soils with low organic matter content suffer from Fe deficiency. Foliar sprays are widely used to apply nutrients, especially iron and manganese for many crops. Correction of deficiency symptoms usually occurs within the first several days and then the entire field could be sprayed with the appropriate nutrient source.

However, rice has shown signs of fatigue and evidences suggest that a decline in natural resources and micronutrient are two major reasons for reduction of productivity in this system (Prasad 2005).A recent trend in the fertilizer industry to shift from ammonium sulphate to urea and from superphosphate to non-sulphur phosphatic fertilizer may induce more widespread sulphur deficiency in lowland rice. Keeping all above facts in view the present study was undertaken to find out the nutrient economy through foliar application of fertilizer and to assess the economic feasibility of various treatments.

Materials and Methods

The present investigation entitled "Effect of foliar spray of various nutrients on performance of rainfed rice" was conducted at the Agronomy Research Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (UP). The experiment was conducted during *kharif* season of the year 2013. The experimental site falls under subtropical climate in Indo-Gangetic plains having alluvial calcareous soil and lies between 26°47' North latitude and 82°12' East longitude at an altitude of 113 m from mean sea level. The region receives annual rainfall ranging from 1000-1200 mm and 90 per cent of which is received in Mid-June to end of September of the region is about 1100 mm and 90 per cent of which is received from July to September. The expected time of onset of monsoon is between 15^{th} to 25^{th} June. The weekly mean maximum and minimum temperatures during the crop season ranged from 28.9^0C to 35.2^0C and 18.7^0C to 36.2^0C, respectively. The maximum rainfall of 312.3 mm was recorded in the fourth week of June, 2013. The soil of the experimental field was silt loam, having pH 8.0, organic carbon 0.35 and Electrical Conductivity 0.23 and available N, P and K 185.0 kgha^{-1}, 10.2 kgha^{-1} and 215.1 kgha^{-1} respectively. The sowing of rice cultivar NDR-97 was done on 24^{th} June, 2013 at the spacing of 20x10 cm. There were twelve treatment combinations as detailed below:

T_1-100% RDF as basal, T_2-100% RDF as basal + 3 water spray,T_3-75% RDF + 2.5 Tonnes FYM, T_4-50% RDF + 5 Tonnes FYM, T_5-50% RDF + 3 foliar spray of 20 kg Urea ha^{-1},T_6-50% RDF + 3 foliar spray of 20 kg Urea ha^{-1}+ 10 kg $ZnSO_4$ ha^{-1},T_7-100% RDF + 30 kg $ZnSO_4$ ha^{-1} as soil application,T_8-100% RDF + 2 foliar spray of 5 kg $FeSO_4$ ha^{-1}, T_9-100% RDF + 2 foliar spray of 10 kg Borax ha^{-1}, T_{10}-100% RDF + 2 foliar spray of 10 kg Sulphur ha^{-1},T_{11}-100% RDF + 2 foliar spray of 20 Urea ha^{-1}+ 10 kg $ZnSO_4$ ha^{-1} and T_{12}-100% RDF + 2 foliar spray of 10 kg $ZnSO_4$ ha^{-1} + 5 kg $FeSO_4$ ha^{-1}+ 10 kg Borax ha^{-1}+10 kg Sulphur ha^{-1}.

Observations were recorded at harvest stage of Rice. Number of panicles per square meter at harvest was counted by placing a quadrate of 50 X 50 cm at three places at random in each plot and total number of panicles per square meter were computed. Five panicles were sampled randomly at maturity stage from each plot and their length was measured and averaged values were recorded in cm. After taking weight selected five panicles were threshed and number of filled grains were counted and there after the mean number of grains per panicle were computed. A composite sample of grains was collected from the produce of each plot after drying and cleaning. Thousand grains were counted from the sample and their weight was recorded in gram. Threshing was done plot-wise manually. The thrashed grains were sun dried to bring the moisture content at a standard level of 14 per cent and cleaned thoroughly before taking the final weight in kg per plot, which in largely computed as qha^{-1}. The straw yield was computed by deducting the grain yield from the total biomass from each plot and expressed in qha^{-1}. The recovery of grains in total dry matter of crop was considered as harvest index. It was calculated with the help of following formula.

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

Results and Discussion

The data on yield attributing characters recorded at harvest stage are presented in (Table 1). All the yield contributing character *viz.,* number of panicle m^{-2}, length of panicle (cm), number of grains $panicle^{-1}$ and test weight were significantly influence of due to various nutrient management modules. The highest number of panicles m^{-2} was observed with T_{12} (100% RDF + 2 foliar spray of 10 kg $ZnSO_4$ ha^{-1} + 5 kg $FeSO_4$ ha^{-1} + 10 kg Borax ha^{-1} + 10 kg Sulphur ha^{-1}) which was at par with T_{10} and T_{11} and significantly superior over rest of the treatments. This was mainly due to increase in number of tillers m^{-2} under balanced doses of nutrients which resulted increase in number of panicles m^{-2}. Similar findings have also been reported by Singh *et al.,* (1998) and Hollena *et al.,* (2008). The length of panicle was significantly affected by various nutrient management modules.

The maximum panicle length was recorded with application of nutrients management modules of T_{12} (100% RDF + 2 foliar spray of 10 kg $ZnSO_4$ ha^{-1} + 5 kg $FeSO_4$ ha^{-1} + 10 kg Borax ha^{-1} + 10 kg Sulphur ha^{-1}) which was at par with T_{11} and significantly superior over other nutrient management modules. The increase in panicle length may be attributed to more uptake of nutrients under balanced dose of nutrients which increased the sink size vis-à-vis panicle length as compared to other nutrient management modules. Ramesh *et al.,* (2007) and Singh *et al.,* (1998) have also reported more panicles length with the balanced dose of nutrients.

The number of grains $panicle^{-1}$ significantly influenced by various nutrient management modules. The maximum number of grains $panicle^{-1}$ was found with T_{12} (100% RDF + 2 foliar sprays of 10 kg $ZnSO_4$ ha^{-1} +5 kg $FeSO_4$ ha^{-1}+10 kg Borax ha^{-1}+10 kg Sulphur ha^{-1}) which were at par with T_{10} and T_{11} and significantly superior over other nutrient management modules. These results may be attributed to the fact that balanced nutrients application resulted better growth of root and shoots which resulted higher nutrient uptake and more production of photosynthates and its translocation to sink (spikelets) vis-à-vis filled grain $panicle^{-1}$. These results are in agreement with those of Ramesh *et al.,* (2007) and Shekara *et al.,* (2011). Various nutrient management modules significantly influenced the test weight of rice.

Table.1 Effect of various nutrient management modules on yield attributes of rice

Treatments	Number of panicles (m^{-2})	Length of panicle (cm)	Number of grains panicle^{-1}	Test weight (g)
T_1- 100% RDF as basal	283.50	16.20	59.40	20.95
T_2- 100% RDF as basal + 3 water spray	270.90	15.48	56.76	20.60
T_3- 75% RDF + 2.5 Tonnes FYM	274.05	15.66	57.42	21.30
T_4- 50% RDF + 5 Tonnes FYM	289.80	16.56	60.72	21.65
T_5- 50% RDF + 3 foliar spray of 20 kg Urea ha^{-1}	296.10	16.92	62.04	21.85
T_6- 50% RDF +3 foliar spray of 20 kg Urea ha^{-1}+ 10 kg $ZnSO_4$ ha^{-1}	305.55	17.46	64.02	22.00
T_7- 100% RDF + 30 kg $ZnSO_4$ ha^{-1} as soil application	340.20	19.44	71.28	22.20
T_8- 100% RDF + 2 foliar spray of 5 kg $FeSO_4$ ha^{-1}	318.15	18.18	66.66	22.40
T_9- 100% RDF + 2 foliar spray of 10 kg Borax ha^{-1}	308.70	17.64	64.68	22.50
T_{10}- 100% RDF + 2 foliar spray of 10 kg Sulphur ha^{-1}	346.50	19.80	72.60	22.65
T_{11}- 100% RDF + 2 foliar spray of 20 kg Urea ha^{-1}+ 10 kg $ZnSO_4$ ha^{-1}	368.55	21.06	77.22	22.85
T_{12}- 100% RDF + 2 foliar spray of 10 kg $ZnSO_4$ ha^{-1}+5 kg $FeSO_4$ ha^{-1}+10 kg Borax ha^{-1}+10 kg Sulphur ha^{-1}	378.00	21.60	79.20	23.10
SEm±	11.74	0.55	2.22	0.41
C.D. (P=0.05)	35.60	1.67	6.74	1.25

Table.2 Effect of various nutrient management modules on grain yield, straw yield and harvest index of rice

Treatment	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)
T_1- 100% RDF as basal	23.20	31.92	42.04
T_2- 100% RDF as basal + 3 water spray	25.20	33.76	42.70
T_3- 75% RDF + 2.5 Tonnes FYM	22.50	31.68	41.53
T_4- 50% RDF + 5 Tonnes FYM	21.40	30.04	41.60
T_5- 50% RDF + 3 foliar spray of 20 kg Urea ha^{-1}	22.60	32.96	40.72
T_6- 50% RDF + 3 foliar spray of 20 kg Urea ha^{-1}+ 10 kg $ZnSO_4$ ha^{-1}	24.00	33.28	41.83
T_7- 100% RDF + 30 kg $ZnSO_4$ ha^{-1} as soil application	26.80	36.60	41.00
T_8- 100% RDF + 2 foliar spray of 5 kg $FeSO_4$ ha^{-1}	25.00	33.80	42.60
T_9- 100% RDF + 2 foliar spray of 10 kg Borax ha^{-1}	25.20	32.52	43.66
T_{10}- 100% RDF + 2 foliar spray of 10 kg Sulphur ha^{-1}	25.40	35.60	42.95
T_{11}- 100% RDF + 2 foliar spray of 20 kg Urea ha^{-1}+ 10 kg $ZnSO_4$ ha^{-1}	27.50	37.40	42.32
T_{12}- 100% RDF + 2 foliar spray of 10 kg $ZnSO_4$ ha^{-1}+5 kg $FeSO_4$ ha^{-1}+10 kg Borax ha^{-1} + 10 kg Sulphur ha^{-1}	29.10	41.00	41.50
SEm±	0.80	0.78	_
C.D. (P=0.05)	2.44	2.35	_

Table.3 Effect of various nutrient management modules on economics of rice

Treatments	Total cost of cultivation (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	Benefit-cost ratio
T_1- 100% RDF as basal	17749	35820	18071	2.02
T_2- 100% RDF as basal + 3 water spray	18874	38680	19806	2.05
T_3- 75% RDF + 2.5 Tonnes FYM	18737	34920	16183	1.86
T_4- 50% RDF + 5 Tonnes FYM	19600	33190	13591	1.69
T_5- 50% RDF + 3 foliar spray of 20 kg Urea ha^{-1}	17482	35360	17879	2.02
T_6- 50% RDF + 3 foliar spray of 20 kg Urea ha^{-1}+ 10 kg $ZnSO_4$ ha^{-1}	17832	37120	19289	2.08
T_7- 100% RDF + 30 kg $ZnSO_4$ ha^{-1} as soil application	18924	41310	22386	2.18
T_8- 100% RDF + 2 foliar spray of 5 kg $FeSO_4$ ha^{-1}	19124	38450	19326	2.01
T_9- 100% RDF + 2 foliar spray of 10 kg Borax ha^{-1}	19099	38370	19271	2.01
T_{10}- 100% RDF + 2 foliar spray of 10 kg Sulphur ha^{-1}	19699	39380	19681	2.00
T_{11}- 100% RDF + 2 foliar spray of 20 kg Urea ha^{-1} + 10kg $ZnSO_4$ ha^{-1}	18981	42350	23369	2.23
T_{12}- 100% RDF + 2 foliar spray of 10 kg $ZnSO_4$ ha^{-1}+5kg $FeSO_4$ ha^{-1}+10 kg Borax ha^{-1}+10 kg Sulphur ha^{-1}	21649	45170	23521	2.09

The maximum test weight was registered with T_{12} (100% RDF + 2 foliar spray of 10 kg $ZnSO_4$ ha^{-1} + 5 kg $FeSO_4$ ha^{-1} + 10 kg Borax ha^{-1} + 10 kg Sulphur ha^{-1}) which was at par with T_5 and T_{11} and significantly superior over rest of the treatments. The balanced doses of nutrients resulted increase in photosynthetic efficiency and its translocation towards sink (grains) which resulted heavier grains. Qian *et al.,* (2009) and Reddy and Reddy (1989) have also been reported better test weight with balanced doses of nutrients. The grain yield was significantly influenced by various nutrient management modules. The maximum grain yield of 29.10 q ha^{-1} was recorded with T_{12} (100% RDF + 2 foliar spray of 10 kg $ZnSO_4$ ha^{-1} + 5 kg $FeSO_4$ ha^{-1} + 10 kg Borax ha^{-1} + 10 kg Sulphur ha^{-1}) which was at par with T_7 (100% RDF + 30 kg $ZnSO_4$ ha^{-1} as soil application) and T_{11} (100% RDF + 2 foliar spray of 20 kg Urea ha^{-1}+ 10 kg $ZnSO_4$ ha^{-1}) and significantly superior over rest of the treatments (Tables 2 and 3). Those results may be attributed to the fact that balanced nutrient modules, resulted balanced availability of nutrients and their uptake resulting better sink capacity which ultimately increased the grain yield. Similar findings have also been reported by Qian *et al.*, (2009) and Singh *et al.*, (1998). The straw yield was significantly affected with various nutrient management modules. The maximum straw yield of 41.00 q ha-1 was recorded with T12 (100% RDF + 2 foliar sprays of 10 kg ZnSO4 ha^{-1} + 5 kg $FeSO_4$ ha^{-1} + 10 kg Borax ha^{-1} + 10 kg Sulphur ha^{-1}) which were significantly superior over other nutrient management modules. The balanced dose of nutrients increased all the growths characters viz., plant height, initial plant stand, number of shoots m^{-2}, number of ear bearing shoots m-2 as well as dry matter production which resulted increase in straw yield. Similar findings have also been reported by Kumar *et al.*, (2005) and Malik and Kaleem (2007). Harvest index is the function of grain yield to the total biological yield (grain + straw). Harvest index was also influenced significantly due to various nutrient management modules. The higher harvest index was recorded with T9 (100% RDF +2 foliar sprays of 10 kg Borax ha^{-1}) treatment. Similar findings have also been reported by Muhammad *et al.,* (2012).

On the basis of experimental result, it may be concluded that foliar spray of nutrients in an appropriate quantity with recommended doses of fertilizer (RDF) increases the yield attributing characters and grain and straw yields of the crop. This clearly shows that foliar application of zinc, boron and sulphur with RDF in rice crop increases yield attributes as well as yield of rice because of the availability of micro nutrients.

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