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Effect of foliar spray of various nutrients on performance of rainfed rice (*Oryza sativa* L.)

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Abstract

A field experiment was conducted at Agronomy Research Farm of Narendra Deva University of Agriculture & Technology Kumarganj, Faizabad (U.P.) during *kharif* season of 2013 to access the effect of various nutrients on rainfed rice and to work out the best combination of foliar spray of nutrients on the performance of rice. The experiment was conducted in RBD with 3 replications with 12 nutrient management modules *viz.*, 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}. Treatment 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}) found significantly superior over all the rest treatments in all the aspects of growth parameters during the investigation. Treatment 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}) increases all the growth parameters *viz.*, plant height, number of shoots, dry matter accumulation and leaf area index. Treatment T_{12} found significantly superior and produced taller plants (76.72 cm), maximum number of shoots (432.0), dry matter accumulation (158.0) and leaf area index (4.32) as compared to the other treatments. Protein content also found maximum in Treatment T_{12} (8.875%) which was significantly superior over rest of the treatments.

Keywords: Rice, RDF, Foliar spray, Nutrient modules.

Introduction

Rice (*Oryza sativa* L.) is an important cereal crop of India and belongs to the family gramineae, genus *Oryza*. It is the staple food for two thirds of the world's population. The cultivated species are *Oryza sativa* and *Oryza glaberrima*. Rice is cultivated world-wide over an area about 156.68 m ha with an annual production of about 650.19 million tonnes. 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 rain fed lowland, 10% on the uplands, 6% in deep water and 2% in tidal wetlands of the world. 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 (Anonymous, 2013) [1]. 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. 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% fibre. 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) [12].

Boron is second emerging deficient nutrient in rice tract which is affecting crop impressively. Studies on boron fertilization revealed that rice yield consistently increased with boron application. Boron may stimulate the enzymatic activity, availability of sugar and respiration which leads towards improved pollen growth. In case of severe boron deficiency, root growth of plants ceases which leads toward the death of root tips.

Boron deficiency has been realized as the second most important micronutrient constraint in crops after that of zinc (Zn) on global scale. Boron deficiency has been reported to result considerable yield reduction in cereal mainly in rice. Zinc is a secondary plant nutrient which plays a significant role in increasing production and providing resistance against disease in rice crops. Zinc deficiency of lowland rice occurs widely in near-neutral to alkaline soils, particularly calcareous soils. In a severe case of zinc deficiency, transplanted rice seedlings may die or direct-sown seeds may fail to emerge. Sulphur is also secondary plant nutrient which plays a vital role in rice crop production as it increases root growth, seed formation and synthesis of chlorophyll. Sulphur deficiency is a common nutritional disorder in upland crops but it rarely occurs in lowland rice. 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 access the effect of various nutrients on rainfed rice and to work out the best combination of foliar spray of nutrients on the performance of rice.

Material & 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 15th to 25th June. The weekly mean maximum and minimum temperatures during the crop season ranged from 28.9 ^{0}C to 35.2 ^{0}C and 18.7 ^{0}C to 36.2 ^{0}C, 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 & Electrical Conductivity 0.23 and available N, P & K 185.0 kg ha^{-1}, 10.2 kg ha^{-1} and 215.1 kg ha^{-1} respectively. The sowing of rice cultivar NDR-97 was done on 24th 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 different growth stages of Rice. Five plants in each plot were selected randomly and marked permanently by tag, there after the height of plant was measured from the soil surface to the tip of top most leaf before the heading and from soil surface to the top of ear head after heading with the help of meter scale at 30, 60, 90 DAS and at harvest. The average value was recorded and expressed as plant height in cm. The number of shoots m^{-2} at 30, 60, 90 DAS and at harvest was counted by placing a quadrate of 50×50 cm (0.25 m^2) randomly at three places in each plot and the total number of tillers per square metre was computed. Number of ear bearing shoot m^{-2} at harvest was counted by placing a quadrate of 50 X 50 cm randomly at three places in each plot and total number of panicles per square metre was computed. Crop plants of 25 cm in border rows cut from the surface level with the help of sickle at 30, 60, 90 DAS and at harvest from three places and allow to sun dry for a week and then oven dry at 65 to 70^{oC} temp. till the constant weight is achieved. After this weight of dry matter was recorded on electronic balance and expressed it as dry matter in (g) per running meter. The leaf area was measured at 30 and 60 DAS to calculate the leaf area index (LAI). Five leaves were selected at random from the sample plants. The length and maximum width of each of the leaf was measured and multiplied each other and then product was multiplied with factor (0.75) to compute the leaf area. Leaf area per plant was calculated by total number of leaves per plant multiplied by average leaf area per plant. LAI (leaf area index) was calculated from the data on the leaf area according to the formula given by Watson (1947). The grown area covered by one plant was also worked out and leaf area index (LAI) was calculated with the help of following formula:

$$LAI = \frac{\text{Leaf area (cm}^2)}{\text{Ground area (cm}^2)}$$

Protein content in grain was estimated by multiplying the nitrogen content in grain with a common factor of 6.25.

Results and Discussion

The data on plant height recorded at various growth stages are presented in (Table 1). The rate of growth was faster up to 60 days and declined thereafter, indicating that the grand growth period of the crop lies between 30 to 90 days after sowing. Plant height was significantly influenced by various nutrient management modules at all the stages of crop growth. Maximum plant height (76.72cm) was found in 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,T_{10} and T_{11} and significantly superior over rest of the treatments at all the stages of crop growth. It is due to fact that balanced dose of nutrients is responsible for the better growth of crop. Similar results have also been reported by Lin and Lin (1985) [9] and Desmukh *et al.* (1988) [2]. The data pertaining to number of shoots m^{-2} have been presented in (Table 2). The number of shoots m^{-2} was affected significantly by various nutrient management modules at different stages of crop growth. The highest number of shoots m^{-2} (432.0) was recorded in 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, T_{10} and T_{11} and significantly superior over rest of the treatments at all the stages of crop growth. This may be attributed to the fact that 100% RDF alone gave the lower number of shoots while nutrients 100% RDF with other provided better atmosphere to have the more number of shoots. Higher number of shoots under integrated nutrients management modules has been also reported by Meena *et al.* (2003) [10], Gill *et al.* (2002) [5] and Singh and Verma (2006) [16]. The data on number of ear bearing shoots m^{-2} have been presented in (Table 3). The number of ear bearing shoots m^{-2} was significantly affected at harvest with various nutrient management modules. The highest number of ear bearing shoots (378.00 m^{-2}) was recorded in 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. The results may be attributed to the fact that under 100% RDF done gave less number of ear bearing shoots while balanced dose of nutrients resulted better number of ear bearing shoots at harvest. Similar results have also been reported by Kavitha *et al.* (2010), Jana *et al.* (2009) [7] and Shreemannarayana *et al.* (1993) [15]. The data recorded as leaf area index at 30 and 60 days after sowing have been presented in (Table 4). There was an increase in leaf area index with increase in the age of crop up to 60 days. The maximum leaf area index was recorded in 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}) (4.32%) which was at par with T_{10} and T_{11} and significantly superior over rest of the treatments at both the stages of crop growth. The results may be attributed to the fact that under 100% RDF also gave the poor growth of rice plants which attributed to less leaf area per plant while balanced dose of nutrients in resulted better growth and gave higher leaf area index. Similar results have also been reported by Lin and Lin (1985) [9] and Rao (1988) [13]. Analogous to plant height, number of shoots per running m, dry matter accumulation also increased with increase in the age of crop up to harvest. The rate of increase was rather slow up to 30 DAS but increased abruptly up to 60 DAS and ceased up to 90 DAS but further increased between 90 to harvest due to grain filling. It is quite evident from the data given in (Table 5) that maximum dry matter accumulation (158.40g) was recorded in 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 at all the stages of crop growth. These results may be attributed to the fact that better management of nutrients resulted better plant height and initial plant stand, which ultimately resulted increase in dry matter production as these growth characters have positive correlation with dry matter production. These results are in the conformity with those of Pandey *et al.* (2001) [11], Geethadevi *et al.* (2000) [4] and Guo *et al.* (2002) [6]. The protein content in grain of rice was significantly affected by various nutrient management modules (Table 6). The highest protein content (8.875 %) was recorded with the application of 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}(T_{12}) which was significantly superior over T_1, T_2 and T_3 treatments and which was at par with rest of the treatments. Protein content in grain was significantly influenced with various nutrient management modules. The highest protein content of 8.88% 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 significantly better than T_1, T_2 and T_3 treatments. The minimum protein content of 7.87% was found with T_2 (100% RDF + 3 water spray). Dwivedi *et al.* (2006) [3] also reported the similar results.

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 growth parameters of the rice crop. This clearly shows that foliar application of zinc, boron and sulphur with RDF in rice crop increases growth parameters of rice and content of protein as well.

Table 1: Effect of different nutrient management modules on plant height (cm)

Treatment	Plant height (cm)			
	30 DAS	**60 DAS**	**90 DAS**	**At harvest**
T_1- 100% RDF as basal	29.70	46.80	57.60	57.54
T_2- 100% RDF as basal+ 3 water spray	28.38	44.72	55.04	54.98
T_3- 75% RDF + 2.5 Tonnes FYM	28.71	45.24	55.68	55.62
T_4- 50% RDF + 5 Tonnes FYM	30.36	47.84	58.88	58.82
T_5- 50% RDF + 3 foliar spray of 20 kg Urea ha^{-1}	31.02	48.88	60.16	60.10
T_6- 50% RDF + 3 foliar spray of 20 kg Urea ha^{-1} +10 kg $ZnSO_4$ ha^{-1}	32.01	50.44	62.08	62.02
T_7- 100% RDF + 30 kg $ZnSO_4$ ha^{-1} as soil application	35.64	56.16	69.12	69.05
T_8- 100% RDF + 2 foliar spray of 5 kg $FeSO_4$ ha^{-1}	33.33	52.52	64.64	64.58
T_9- 100% RDF + 2 foliar spray of 10 kg Borax ha^{-1}	32.34	50.96	62.72	62.66
T_{10}- 100% RDF + 2 foliar spray of 10 kg Sulphur ha^{-1}	36.30	57.20	70.40	70.33
T_{11}- 100% RDF + 2 foliar spray of 20 kg Urea ha^{-1} + 10 kg $ZnSO_4$ ha^{-1}	38.61	60.84	74.88	74.81
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}	39.60	62.40	76.80	76.72
SEm±	1.16	1.81	2.63	2.62
C.D. (P=0.05)	3.50	5.50	7.97	7.96

Table 2: Effect of different nutrient management modules on number of shoots (m^{-2})

Treatment	Number of shoots (m^{-2})			
	30 DAS	**60 DAS**	**90 DAS**	**At harvest**
T_1- 100% RDF as basal	126.00	193.50	324.00	324.00
T_2- 100% RDF as basal + 3 water spray	120.40	184.90	309.60	309.60
T_3- 75% RDF + 2.5 Tonnes FYM	121.80	187.05	313.20	313.20
T_4- 50% RDF + 5 Tonnes FYM	128.80	197.80	331.20	331.20
T_5- 50% RDF + 3 foliar spray of 20 kg Urea ha^{-1}	131.60	202.10	338.40	338.40
T_6- 50% RDF +3 foliar spray of 20 kg Urea ha^{-1}+ 10 kg $ZnSO_4$ ha^{-1}	135.80	208.55	349.20	349.20
T_7- 100% RDF + 30 kg $ZnSO_4$ ha^{-1} as soil application	151.20	232.20	388.80	388.80
T_8- 100% RDF + 2 foliar spray of 5 kg $FeSO_4$ ha^{-1}	141.40	217.15	363.60	363.60
T_9- 100% RDF + 2 foliar spray of 10 kg Borax ha^{-1}	137.20	210.70	352.80	352.80
T_{10}- 100% RDF + 2 foliar spray of 10 kg Sulphur ha^{-1}	154.00	236.50	396.00	396.00
T_{11}- 100% RDF +2 foliar spray of 20 kg Urea ha^{-1}+ 10 kg $ZnSO_4$ ha^{-1}	163.80	251.55	421.20	421.20

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}	168.00	258.00	432.00	432.00
SEm±	5.74	7.17	15.50	15.50
C.D. (P=0.05)	17.42	21.74	47.02	47.02

Table 3: Effect of different nutrient management modules on number of ear bearing shoots (m^{-2}) at harvest

Treatment	Number of ear bearing shoots (m^{-2}) at harvest
T_1- 100% RDF as basal	283.50
T_2- 100% RDF as basal + 3 water spray	270.90
T_3- 75% RDF + 2.5 Tonnes FYM	274.05
T_4- 50% RDF + 5 Tonnes FYM	289.80
T_5- 50% RDF + 3 foliar spray of 20 kg Urea ha^{-1}	296.10
T_6- 50% RDF + 3 foliar spray of 20 kg Urea ha^{-1}+ 10 kg $ZnSO_4$ ha^{-1}	305.55
T_7- 100% RDF + 30 kg $ZnSO_4$ ha^{-1} as soil application	340.20
T_8- 100% RDF + 2 foliar spray of 5 kg $FeSO_4$ ha^{-1}	318.15
T_9- 100% RDF + 2 foliar spray of 10 kg Borax ha^{-1}	308.70
T_{10}- 100% RDF + 2 foliar spray of 10 kg Sulphur ha^{-1}	346.50
T_{11}- 100% RDF + 2 foliar spray of 20 kg Urea ha^{-1}+ 10 kg $ZnSO_4$ ha^{-1}	368.55
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
SEm±	11.74
C.D. (P=0.05)	35.60

Table 4: Effect of various nutrient management modules on leaf area index (LAI)

Treatment	Leaf area index	
	30 DAS	60DAS
T_1- 100% RDF as basal	1.71	3.24
T_2- 100% RDF as basal + 3 water spray	1.63	3.10
T_3- 75% RDF + 2.5 Tonnes FYM	1.65	3.13
T_4- 50% RDF + 5 Tonnes FYM	1.75	3.31
T_5- 50% RDF + 3 foliar spray of 20 kg Urea ha^{-1}	1.79	3.38
T_6- 50% RDF + 3 foliar spray of 20 kg Urea ha^{-1}+ 10 kg $ZnSO_4$ ha^{-1}	1.84	3.49
T_7- 100% RDF + 30 kg $ZnSO_4$ ha^{-1} as soil application	2.05	3.89
T_8- 100% RDF + 2 foliar spray of 5 kg $FeSO_4$ ha^{-1}	1.92	3.64
T_9- 100% RDF + 2 foliar spray of 10 kg Borax ha^{-1}	1.86	3.53
T_{10}- 100% RDF + 2 foliar spray of 10 kg Sulphur ha^{-1}	2.09	3.96
T_{11}- 100% RDF + 2 foliar spray of 20 kg Urea ha^{-1}+ 10 kg $ZnSO_4$ ha^{-1}	2.22	4.21
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}	2.28	4.32
SEm±	0.07	0.13
C.D. (P=0.05)	0.20	0.38

Table 5: Effect of various nutrient management modules on dry matter accumulation at different growth stages of rice

Treatment	Dry matter accumulation (g per running m)			
	30 DAS	60 DAS	90 DAS	At harvest
T_1- 100% RDF as basal	37.80	68.40	115.24	118.80
T_2- 100% RDF as basal + 3 water spray	36.12	65.36	110.11	113.52
T_3- 75% RDF + 2.5 Tonnes FYM	36.54	66.12	111.39	114.84
T_4- 50% RDF + 5 Tonnes FYM	38.64	69.92	117.80	121.44
T_5- 50% RDF + 3 foliar spray of 20 kg Urea ha^{-1}	39.48	71.44	120.36	124.08
T_6- 50% RDF + 3 foliar spray of 20 kg Urea ha^{-1}+ 10 kg $ZnSO_4$ ha^{-1}	40.74	73.72	124.20	128.04
T_7- 100% RDF + 30 kg $ZnSO_4$ ha^{-1} as soil application	45.36	82.08	138.28	142.56
T_8- 100% RDF + 2 foliar spray of 5 kg $FeSO_4$ ha^{-1}	42.42	76.76	129.32	133.32
T_9- 100% RDF + 2 foliar spray of 10 kg Borax ha^{-1}	41.16	74.48	125.48	129.36
T_{10}- 100% RDF + 2 foliar spray of 10 kg Sulphur ha^{-1}	46.20	83.60	140.84	145.20
T_{11}- 100% RDF + 2 foliar spray of 20 kg Urea ha^{-1}+ 10 kg $ZnSO_4$ ha^{-1}	49.14	88.92	149.81	154.44
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}	50.40	91.20	153.65	158.40
SEm±	1.82	2.88	4.55	4.69
C.D. (P=0.05)	5.51	8.75	13.80	14.22

Table 6: Effect of various nutrient management modules on protein content in grain of rice

Treatment	Protein content (%)
T_1- 100% RDF as basal	8.000
T_2- 100% RDF as basal + 3 water spray	7.875
T_3- 75% RDF + 2.5 Tonnes FYM	8.188
T_4- 50% RDF + 5 Tonnes FYM	8.313
T_5- 50% RDF + 3 foliar spray of 20 kg Urea ha^{-1}	8.375
T_6- 50% RDF + 3 foliar spray of 20 kg Urea ha^{-1}+ 10 kg $ZnSO_4$ ha^{-1}	8.438
T_7- 100% RDF + 30 kg $ZnSO_4$ ha^{-1} as soil application	8.438
T_8- 100% RDF + 2 foliar spray of 5 kg $FeSO_4$ ha^{-1}	8.563
T_9- 100% RDF + 2 foliar spray of 10 kg Borax ha^{-1}	8.625
T_{10}- 100% RDF + 2 foliar spray of 10 kg Sulphur ha^{-1}	8.688
T_{11}- 100% RDF + 2 foliar spray of 20 kg Urea ha^{-1}+ 10 kg $ZnSO_4$ ha^{-1}	8.750
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}	8.875
SEm±	0.20
C.D. (P=0.05)	0.62

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