Original Research Article

Effect of foliar application of nutrients on yield and nutrient uptake by rice crop

ABSTRACT-A field experiment was conducted during 2018 and 2019 at the Agronomy Research farm of A.N.D. University of Agriculture and Technology, Kumarganj, Ayodhya, UP to evaluate the effect of foliar application of macro and micronutrients on yield and nutrient uptake of rice (*Oryza sativa* L.). The experiment consists of 10 treatment combinations with some foliar application macro and micronutrients two foliar spray tillering stages and a panicle initiation stage which were laid out in randomized block design with three replications. The results revealed maximum grain yield (38.50 and 40.40 q ha^{-1}), straw (51.90 and 54.60 q ha^{-1}), and harvest index (42.64 and 42.53 %) with treatment T_{10}-75% RDF + WSCF @ 0.5 % (19:19:19) + ZnSO4 @ 0.5 % + Boron @ 0.25 % which was statistically at par with T_3- 125 % RDF and significantly superior over rest of the treatments during both the years .~~2018 and 2019 respectively~~, was recorded~~ with treatment T_{10}-75% RDF + WSCF @ 0.5 % (19:19:19) + ZnSO4 @ 0.5 % + Boron @ 0.25 % which was statistically at par with T_3- 125 % RDF and significantly superior over rest of the treatments,S~~similarly significant improvement in nutrient uptake (N, P, K, S, Zn, and B) by rice was observed in T10. Thus, it can be concluded that the application of 75% RDF + WSCF @ 0.5 % (19:19:19) + ZnSO4 @ 0.5 % + Boron @ 0.25 % can improve the yield and nutrient uptake.~~provide better in term of yield and nutrient uptake.~~

Keywords:*Rice, Foliar Spray, Nutrient Uptake, Yield.*

INTRODUCTION

The genus *Oryza* has two domesticated species and 22 wild species. Rice (*Oryza sativa* L.) is a member of the Gramineae family. Oryza sativa and *Oryza glaberrima* are the two cultivars. In contrast to *Oryza glaberrima*, which has been grown in West Africa for the past 3500 years, *Oryza sativa* is grown all over the world. About 3 billion people depend on rice, the most significant food crop in the world, for their daily needs(Foo and Hameed, 2009). It is really different in terms of how it is grown and utilised by people. Because it can thrive in humid conditions where other crops cannot, rice is exceptional. With an annual production of 109.69 million tonnes and an average productivity of 2249 kg ha^{-1}, rice is grown on an area of 43.99 million hectares in India.In Uttar Pradesh the area of rice is about 13.84 million hectares and production are 23.64 million tonnes, with productivity of 2358 kg per hectare (Ministry of Ag. 2018). Two thirds of the world's population eat it as a staple. In Asia alone, almost 2 billion people rely on rice, which has 80% carbs, 7-8% protein, 3% fat, and 3% fibre, to meet their energy needs. Despite its small size, rice protein has a great nutritional value. Animal and bird feed is made from rice bran.(Chaudhari *et al.* 2018). Rice protein, though small in amount, is of high nutritional value. Rice bran is used as cattle and poultry feed. Intensive cultivation with high yielding crop varieties, use of high analysis NPK fertilizers devoid of secondary and micronutrients, loss of top soil by erosion, loss of micro nutrients through leaching, liming of acid soils, limited use of organic manures and restricted recycling of crop residues accelerated the exhaustion of secondary and micronutrients from the soil (Thakur and Kumar, 2020One method to increase absorption effectiveness and decrease leaching losses in rice fields, which eventually lowers production costs, is to apply fertilisers topically.~~.~~On the other hand, soil application of basic fertilizers (N, P, and K) in excess quantity cause water pollution, soil toxicity and negative effects on the environment and humans(Moumeni,~~ A.,~~ 2014). So, foliar application of macro elements may enhance the yield and reducing production cost to attain sustainable agriculture.Thus, fertilizing the crop combined with reduced soil application saves the farming systems from the inherent challenges posed by low or declining nutrient use efficiencies. Keeping in view of the above points, this study was framed to assess the impact of foliar application of macro and micronutrient uptake on the yield and nutrient uptake of transplanted rice.

MATERIALS AND METHODS

A field experiment was conducted at Agronomy Research farm of A.N.D. University of Agriculture and Technology Kumarganj Ayodhya, UP to evaluate the effect of foliar application of macro and micro

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nutrients on yield and nutrient uptake of rice (*Oryza Sativa* L.).The experiment comprises of ten treatment combinations, some foliar applications of macro and micronutrients, two foliar sprays during the tillering stage, and the commencement of panicles, all of which were set up in a randomised block design with three replications.There are 10 treatments *viz.* T_1-control,$T_2$100%,RDF, $T_3$125%RDF,$T_4$75%RDF,$T_5$75RDF+25% Nitrogen through FYM, T_6 75 % RDF + Urea @ 2.0 % (Two spray at tillering +panicle in all treatments), T_7 75 % RDF + WSCF @ 0.5 % (19:19:19), T_8 75 %RDF + $ZnSO_4$ @ 0.5 %+ Boron @ 0.25 % and T_9 75 % RDF + Urea @ 2.0 % +$ZnSO_4$@0.5%+Boron@0.25%andT_{10}75%RDF+WSCF@0.5% (19:19:19) +$ZnSO_4$ @0.5% + Boron @0.25%.The total biomass of each plot was threshed and cleaned, the seeds obtained were weighed and converted into q ha^{-1}. Straw yield was also recorded from each plot by subtraction the grain yield from the total biological yield and expressed in q ha^{-1}.Plant samples at harvest from each plot were collected and oven dried at 70℃. The samples were grounded into fine powder using Willey mill and analysed for N, P, K, S, Zn and B content using standard procedures. The total uptake by the plant (grain + straw) was calculated using the formula:

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Macronutrient uptake (kg ha^{-1}) = Macronutrient concentration (%)/100 × Yield (kg ha^{-1})
Micronutrient uptake (g ha^{-1}) = Micronutrient concentration (mg kg^{-1})/1000 × Yield (kg ha^{-1})

The data recorded was statistically analysed using analysis of variance (ANOVA) technique at 5% probability level as described by (Gomez, 2010) to draw valid conclusions.

RESULTS AND DISCUSSIONS

Yield

Data depicted in the table -1 shows that the treatment T_{10}-75% RDF + two foliar sprays of WSCF @ 0.5% (19:19:19) + $ZnSO_4$ @ 0.5% + Boron @ 0.25% had the highest grain, straw yield, and harvest index; it was statistically equal to T_3- 125% RDF and considerably better than the other treatments. The treatment T_1 (control) yielded the lowest amount of grain. Zinc and boron applied together in the foliar may have a higher effect on rice grain and straw production and harvest index since both minerals are important for a variety of physiological processes in plants.Furthermore, because of the alkaline pH of the soil at the experimental site, which causes B and Zn to precipitate in the hydroxide forms, the availability of both nutrients decreased under aerobic conditions. External application therefore aided in the plant's improved growth and development. According to Wear and Haghler (1968), the higher yield characteristics may be attributable to Zn participation in the biosynthesis of Indole acetic acid (IAA) and, in particular, to its role in the commencement of primordial reproductive parts and the partitioning of photosynthates towards them. A greater partitioning of carbohydrates from the leaf to the reproductive regions led to an increase in yield, which may be attributed to improvement in yield components (Singh and Sharma, 1994). Zinc participation in a variety of enzymatic processes, as well as its involvement as a catalyst in numerous growth processes, hormone production, and protein synthesis, may be responsible for the increase in yield brought on by its administration. It could also be attributed to improvements in auxin production and the regulation of the metallo enzyme system (Sachdev *et al.*, 1988; Udayasoorian, 1988; Kumar *et al.*, 1999; and Devrajan and Krishnasamy, 1996). The soil application of $ZnSO_4$ increased straw yield significantly, according to Singh and Sharma (1994), and this was attributable to higher growth characteristics and more (tillers m^{-2}) in the field. Jena *et al.* (2006) and Uddin *et al.* (1981) both found similar results. According to Hossain *et al.* (2001), the growth and yield of the rice crop were boosted by the combination application of NPK and Zn. The highest grain production was reported by foliar treatment of B @ 20 mg L^{-1}, according to Ali *et al.* (2016). Rice grain production was improved by Zn foliar feeding (Potarzycki and Grzebisz, 2009).

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Nutrient Uptake by crop

Nutrient uptake by crop is a function of total biomass produced andpercent nutrient concentration in biomass. The differences in uptake by grainandstrawduetodifferenttreatmentsassociatedmainlywithyielddifferences and partly with nutrient content in grain and straw. The ability of plants to absorb nutrients and grow is better when there are more nutrients available in the soil.Thus, the uptake of NPK by hybrid rice was higher due to application T_{10}-75%RDF+twofoliarsprayofWSCF@0.5%(19:19:19)+$ZnSO_4$@0.5 % + Boron @ 0.25 % lower uptake was recorded in control (Table- 2 and 3). The higheruptake was attributed to improved availability of nutrients upon fertilizationandalsoduetohigheryieldofgrainandstrawinthefertilizedtreatment compared to control. This might be due to easy transformation of urea intoavailableNwithadditionofzinc,whichisverycriticalforbiomassproduction (Singh and Abrol, 1982, Mali and

Shaik, 1994, Kamalakumariand Singaram, 1996 and Kumar *et al*., 1999) and better translocation ofapplied nutrients due to correction of Zn deficiency in soil. Increase in P and Kcontentingrainaswellasinstrawmightbeduetofavorablesoilcondition which enhanced nutrient availability and nutrient uptake as well asbetter growth and activity of roots. Similar findings were also observed bySingh *et al.* (2010). The increase in total N, K and Znuptake could be attributed to synergistic effect between N and Zn and due tothepositiveinteractionofKandZn,respectively.Thepresent~~findingssupport~~findingssuptheresultsofAshoka*etal.*(2008),MorshediandFarahbakhsh(2010).

Amongtreatments, higher totalSulphur uptake werefound in T_{10}-75%RDF+WSCF@0.5%(19:19:19)+$ZnSO_4$@0.5%+Boron@0.25 %,andrecordedatparwithT_3-125%RDFduringboththeyears (Table-3).Treatment having T_9-75 % RDF + Urea @ 2.0 % + $ZnSO_4$ @ 0.5 % + Boron@ 0.25 % and T_8-75 % RDF + $ZnSO_4$ @ 0.5 %+ Boron @ 0.25 % recordedsignificantlyloweruptakeascomparedtoT_{10}.Thereweresignificantdifferences in total Sulphur uptake between T_2 and T_3, while uptake betweenT_4 to T_8 found statistically at par. Minimum Sulphur content recorded withT_1-Control.Increase inuptakemightbe duetohigheravailability oftheplant nutrients from the soil reservoir and additional quantity of nutrientssupplied by foliar application and chemical fertilizers. The higher uptake ofsulphur was also influenced by zinc sulphate application. The results of thisinvestigationareinconsonancewiththefindingofSriramachandrasekharn*et al.* (2005). Though the interaction effect was non-significant the combined application of major nutrients with S, Zn and B recorded higher uptake values which was due to the complimentary effect of combined application of major nutrients with S, Zn and B.

Micronutrientsuptakefollowedthesimilartrendasobservedinprimary and secondary nutrients uptake. Among treatments, higher Zinc andBoronwasfoundT_{10}-75%RDF+WSCF@0.5%(19:19:19)+$ZnSO_4$@ 0.5 % + Boron @ 0.25 %, and recorded at par with T_3- 125 % RDF duringboththeyears (Table-4).TreatmenthavingT_9-75% RDF+Urea@2.0% +$ZnSO_4$@ 0.5%+Boron@0.25%andT_8-75%RDF+$ZnSO_4$@0.5%+Boron@ 0.25 % recorded significantly lower uptake as compared to T_{10}. Minimum Zinc and BoroncontentrecordedwithT_1-Control.Suchincreasemightbeattributedto better growth and yield of hybrid rice due to optimum supply of bothmajor nutrients along with Zn, S and B (Chaudhary and Singh, 2007). These results are in agreement with Charati and Malakouti (2006).Higher uptake of boron was due to the application of boron fertilizer whichincreased the availability of B in the root zone and concentration in plant.Kumar *et al*. (2017) reported that soil application of $ZnSO_4$ @ 50 kg ha^{-1}recorded higher Zn content in grain which was statistically at par with foliarspray of Zn-EDTA equivalent to 0.2 per cent $ZnSO_4$. Kulhare*et al*. (2017)reported that foliar spray of one per cent Zn salt significantly increased theZnuptakebygrain.In cultivars Super basmati and Shaheen basmati, it was discovered that the amount of boron in the leaves and kernels increased with an increase in the amount of foliar B applied (Rehman *et al*., 2014).

CONCLUSION

From the above, it may be concluded thatcombined applicationof foliar and soil applied treatment records better over soil applied treatments. Among the treatments, T_{10}-75%RDF+WSCF@0.5%(19:19:19)+$ZnSO_4$@0.5%+Boron@0.25 %registered maximum yield as well as nutrient uptake by crop which was closely followed by T_3- 125 % RDF.

FUTURE SCOPE

There is future scope of foliar application which might help to reduce overdoses of fertilizer application.

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Table-1. -Effect of foliar application of nutrients on yield of rice.

Treatments	Yields (qha^{-1})							
	Grainyield		Strawyield		Biologicalyield		Harvest Index(%)	
	2018	2019	2018	2019	2018	2019	2018	2019
T_1-Control	21.10	22.15	31.00	32.50	52.10	54.65	40.49	40.59
T_2-100 %RDF (N120:P60: K40kgha^{-1})	33.00	34.65	45.90	48.30	78.90	80.55	41.47	41.45
T_3-125 %RDF	36.30	38.10	49.35	51.80	85.65	89.90	42.35	42.32
T_4-75 %RDF	26.80	28.25	37.63	39.40	64.43	67.65	41.76	41.96
T_5-75RDF+25%NitrogenthroughFYM	28.50	30.95	39.70	41.80	68.20	71.75	41.90	41.75
T_6-75 %RDF +twofoliarspraysof Urea @2.0 %	29.80	31.30	41.00	43.10	70.80	74.40	42.11	42.07
T_7-75%RDF+twofoliarsprayofWSCF@0.5% (19:19:19)	31.60	33.20	43.30	45.60	74.90	78.80	42.19	42.11
T_8-75%RDF+twofoliarspraysof$ZnSO_4$@0.5%+Boron @0.25%	29.70	31.20	41.14	43.00	70.84	74.20	42.14	42.02
T_9-75%RDF+twofoliarsprayofUrea@2.0%+$ZnSO_4$ @0.5%+Boron@0.25 %	33.50	35.20	46.52	48.30	80.02	83.50	42.25	42.15
T_{10}-75%RDF+twofoliarsprayofWSCF@0.5% (19:19:19)+$ZnSO_4$@0.5%+Boron@0.25%	38.50	40.40	51.90	54.60	90.40	95.00	42.64	42.53
SEm±	1.13	1.44	2.14	1.47	2.45	2.25	1.54	1.26
C.D.(P=0.05)	3.35	4.27	6.37	4.38	7.29	6.67	NS	NS

Table -2 Effect foliar application of nutrients on uptake of N and P in grain, straw and total.

Treatments	Nutrientuptake(kgha^{-1})											
	Nitrogen						Phosphorus					
	Grain		Straw		Total		Grain		Straw		Total	
	2018	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**
T_1-Control	23.42	24.81	25.42	26.98	48.84	51.79	8.22	8.86	6.36	6.73	14.58	15.59
T_2-100 %RDF (N120:P60: K40kgha^{-1})	40.59	42.97	42.33	44.99	82.92	87.96	14.52	15.25	10.61	11.25	25.13	26.50
T_3-125 %RDF	45.37	48.39	45.90	48.69	91.27	97.08	15.97	17.14	11.45	12.17	27.56	29.45
T_4-75 %RDF	31.08	33.05	32.25	33.88	63.34	66.93	10.98	11.86	8.06	8.47	19.16	20.20
T_5-75RDF+25%NitrogenthroughFYM	33.63	35.94	34.54	37.20	68.17	73.14	11.97	12.87	8.65	9.32	20.62	22.19
T_6-75%RDF+twofoliarsprayofUrea@2.0 %	35.76	37.87	36.49	38.79	72.25	76.66	12.81	13.44	9.14	9.70	21.95	23.14
T_7-75%RDF+twofoliarsprayofWSCF@0.5%(19:19:19)	38.24	40.50	39.10	41.04	77.21	81.54	13.58	14.27	9.74	10.26	23.32	24.53
T_8-75%RDF+twofoliarspraysof$ZnSO_4$@ 0.5%+Boron@0.25 %	35.64	37.75	36.49	38.27	72.13	76.02	12.77	13.40	9.02	9.55	21.79	22.95
T_9-75%RDF+twofoliarsprayofUrea@2.0 %+$ZnSO_4$@0.5%+Boron@ 0.25%	40.87	43.65	42.22	44.44	83.09	88.08	14.74	15.48	10.33	11.11	25.81	26.60
T_{10}-75%RDF+twofoliarsprayofWSCF@0.5% (19:19:19) +$ZnSO_4$@0.5% + Boron@ 0.25%	48.12	50.50	48.26	51.60	96.38	102.10	17.32	18.18	11.94	13.17	29.26	31.35
SEm±	0.42	2.67	1.31	3.93	3.71	4.65	0.33	1.13	3.62	0.42	1.18	1.31
C.D.(P=0.05)	1.25	7.95	3.88	8.52	8.05	13.81	0.98	3.35	10.77	1.25	3.49	3.88

Table 3: Effect foliar application of nutrients on uptake of K and S in grain, straw and total.

Treatments	Nutrientuptake(kgha^{-1})											
	Potassium						Sulphur					
	Grain		Straw		Total		Grain		Straw		Total	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
T_1-Control	12.88	13.73	37.51	39.98	50.39	53.71	1.68	1.77	1.95	2.06	3.43	3.83
T_2-100 %RDF(N120:P60:K40kgha^{-1})	22.44	23.56	62.80	66.50	85.24	90.06	3.63	3.81	4.60	4.88	8.23	8.69
T_3-125 %RDF	24.68	25.98	68.10	72.00	92.78	97.98	3.67	4.19	5.16	5.47	8.86	9.66
T_4-75 %RDF	17.15	18.08	47.63	50.04	64.78	68.12	2.41	2.14	2.89	3.06	5.30	5.20
T_5-75RDF+25%NitrogenthroughFYM	18.52	19.76	51.21	55.18	69.73	74.94	2.56	2.69	3.31	3.52	5.87	6.21
T_6-75%RDF+twofoliarsprayofUrea@2.0 %	19.67	20.97	54.12	57.32	73.79	78.29	2.98	3.13	3.82	4.06	6.80	7.19
T_7-75%RDF+twofoliarsprayofWSCF@0.5%(19:19:19)	21.17	22.24	57.59	60.65	78.76	82.89	3.16	3.32	4.22	4.49	7.38	7.81
T_8-75%RDF+twofoliarspraysof$ZnSO_4$@ 0.5%+Boron@0.25 %	19.60	20.90	54.12	56.76	73.72	77.66	2.97	3.12	3.78	4.01	6.75	7.13
T_9-75%RDF+twofoliarsprayofUrea@2.0 %+$ZnSO_4$ @0.5%+Boron@ 0.25%	22.78	23.93	61.05	65.69	83.83	89.62	3.68	3.87	4.58	4.87	8.26	8.74
T_{10}-75%RDF+twofoliarsprayofWSCF@0.5%(19:19:19)+ $ZnSO_4$@0.5%+Boron @ 0.25%	26.56	28.28	71.62	76.31	98.18	104.59	4.62	4.84	5.74	6.10	10.36	10.94
SEm±	0.82	1.04	2.67	2.35	3.93	3.62	0.19	0.19	0.16	0.17	0.36	0.42
C.D.(P=0.05)	2.43	3.10	7.95	7.00	11.68	10.77	0.55	0.57	0.48	0.50	1.07	1.24

Table 4: Effect foliar application of nutrients on uptake of Zn and B in grain, straw and total.

Treatments	Nutrientuptake(g ha^{-1})											
	Zinc						Boron					
	Grain		Straw		Total		Grain		Straw		Total	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
T_1-Control	261.85	277.31	22.88	24.28	284.73	301.63	151.92	160.86	18.30	19.42	170.22	180.28
T_2-100 %RDF(N120:P60:K40kgha^{-1})	450.12	480.36	38.10	40.49	488.22	520.73	261.16	278.58	30.48	32.50	291.64	311.08
T_3-125 %RDF	503.11	542.77	41.31	43.82	544.42	571.88	291.85	306.70	33.04	35.06	324.89	341.76
T_4-75 %RDF	347.59	369.53	29.03	30.50	376.62	400.03	201.53	214.41	23.22	24.40	224.75	238.81
T_5-75RDF+25%NitrogenthroughFYM	375.91	401.81	31.09	33.48	407.07	435.29	218.02	233.01	24.87	26.79	242.89	259.90
T_6-75%RDF+twofoliarspraysofUrea@ 2.0 %	399.91	423.42	32.84	34.91	432.64	458.33	231.84	245.70	26.27	27.93	258.11	273.63
T_7-75%RDF+twofoliarsprayofWSCF@0.5%(19:19:19)	427.53	452.83	35.07	36.94	462.55	489.77	248.06	262.64	28.06	29.55	276.12	292.19
T_8-75%RDF+twofoliarspraysof$ZnSO_4$@0.5%+ Boron@ 0.25%	398.57	422.07	32.84	34.44	431.34	456.51	231.06	244.92	26.27	27.55	257.33	272.47
T_9-75%RDF+twofoliarsprayofUrea@2.0%+$ZnSO_4$@ 0.5 %+Boron@ 0.25%	460.62	487.98	37.18	39.99	497.80	527.86	267.33	283.00	29.74	31.99	297.07	315.03
T_{10}-75%RDF+twofoliarsprayofWSCF@0.5%(19:19:19)+$ZnSO_4$@0.5%+ Boron@ 0.25 %	538.23	560.07	44.11	46.66	582.11	611.45	312.33	332.00	34.38	36.17	346.61	368.17
SEm±	20.02	24.04	1.13	0.78	14.30	15.85	10.06	6.00	1.28	1.61	11.03	5.60
C.D.(P=0.05)	59.48	71.42	3.35	2.31	42.50	47.08	29.90	17.82	3.80	4.77	32.78	16.63