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Evaluation of Rice (*Oryza sativa* L.) Genotypes for Content and Uptake of Micronutrients in Rainfed Upland Situation in Bastar

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A B S T R A C T

The present investigation was carried out during *Kharif* 2019-2020 at the Research Farm, S.G. College of Agriculture and Research Station, Jagdalpur (C.G.). The experiment was laid out with 37genotypes and 6 check varieties in randomized block design. The soil was slightly acidic in reaction and low in available macronutrients. DTPA extractable Fe, Mn, and Cu were 1.19, 18.54 and 16.72 ppm above the critical levels, while the Zn was below the critical level (0.53 ppm). Among the genotypes Anjali, JDP-1-1-1695, BRR-0007, RCPR-8, Bastar Dhan-1, Bhata Mokdo and OR-2637-1were found the tolerant genotypes for acid stress and upland condition based on higher yield and micronutrient uptake.

Introduction

Rice is an important crop as the slogan 'Rice is Life' is more appropriate for India as this crop plays a vital role in our National food security and is a means of livelihood for millions of rural household, grown in about 43.79 mha of land area in the country with the productivity of 2.65 ton/ha which is less than the productivity of many countries. Annual population growth rate of the country is about 1.8 % and if per capita consumption of rice is expected to be 400 gm of rice per day then the demand for rice in 2025 will be130 mT. In Chhattisgarh, rice grown area has increased to 3.61 mha with the production of 6.53 million tones and productivity of 1.81 t ha^{-1} (Agricultural Statistics at a glance, 2019) during 2018-19. The upland situation in Bastar Plateau zone almost constitute 39 % and have features of moisture stress, acidity, toxicity of exchangeable Al and antagonistic effect between plant nutrients in soils leading to deficiencies of one or more elements and toxicities to some.

Zinc, iron, iodine, protein, and vitamin deficiency in humans is a serious problem for

the health of an individual but also the economy of developing countries. It is estimated that more than 3.5 billion people in the world suffering from malnutrition. As per the World Health Organization, approximately 1.62 billion people are suffering from iron deficiency, and more than half of the world's population is suffering from Zn deficiency. In India, 27% of the total population is by Zn deficiency related disorder such as impairment of physical development, poor immune system and effect on brain function.

Most of the minerals come directly from plant like i.e. cereals, vegetables and fruits or indirectly from animal sources. The direct source of minerals from agricultural crops such as rice, wheat, pulses and vegetables are more sustainable and inexpensive source of micronutrient for human diet. Rice is the most important cereal, consumed as primary food component in developed and under developed countries. Looking to the micronutrient related malnutrition problems as a coordinated effort has been initiated by various agencies to enrich the grain as a consumable part of staple food like rice with more micronutrients (Fe and Zn). In this effort wide genetic variation for grain micronutrient levels has been reported. Cheng *et al.,* (2009) screened 113 rice landraces from 12 provinces of China.

They reported that japonica rice had higher Fe than that of indica rice variety. 11,400 rice samples of brown and milled rice were evaluated for Fe and Zn during 2006-2008 by Martinez *et al.,* (2010). They found that brown rice had 10-11 ppm Fe and 20-25 ppm Zn while milled rice had 2-3 ppm Fe and 16-17 ppm Zn. Banerjee *et al.,* (2010) screened 46 rice lines including cultivated and wild accessions and showed that wild rice accessions have higher grain Fe and Zn concentration. Looking to the importance of micronutrients in human and plant health a study has been planned to assess evaluation of rice (*Oryza sativa* L.) genotypes for content and upake of micronutrients in rainfed upland situation in Bastar.

Materials and Methods

The experiment was undertaken with 43 genotypes including 6 checks with randomized block design under rainfed conditions during *Kharif* 2019 at upland rice research fields of SG College of Agriculture and Research Station, Jagdalpur, IGKV, Chhattisgarh.

The data was recorded grain yield and content of Fe, Mn, Cu and Zn in rice grains of different genotypes using Varian atomic absorption spectrophotometer.

Results and Discussion

Grain yield (kg ha^{-1})

Results on grain yield are presented in Table 1 revealed that the overall mean of grain yield was found 4398.48 kg ha^{-1}. It ranged from 1267.36 to 7417.53 kg ha^{-1}. Among the genotype Anjali observed higher yield than check variety Sahbhagi Dhan. Genotype Satka produced the lowest grain yield.

Fe content and uptake by grain (g ha^{-1})

The Fe content in rice grain varied among genotypes with Sataka having 87 ppm followed by Danteshwari (86 ppm) and R-1882-1667-1-1 (81 ppm) and lowest was found in RCPR-8 (32 ppm). Results on grain Fe uptake are presented in Table 2 revealed that overall mean of grain uptake in 251.71 g ha^{-1}. It ranged from 89 to 553 g ha^{-1}. Under the genotype, Anjali recorded the highest Fe uptake in grain than the check variety. CR-40 recorded the lowest Fe uptake in grain.

Mn content and uptake by grain (g ha^{-1})

The Mn content in rice grain varied among genotypes with Foagedhan having 85.12 ppm followed by MAS-946-1 (85.09 ppm) and R-1921-167-1-109-1 (84.87 ppm) and lowest was found in R-1882-306-2-241-1 (51.69 ppm). Results on Mn uptake in grain are presented in Table 3 revealed that overall mean of Mn uptake in 313.27 g ha^{-1}. It ranged from 97.56 to 567.89 g ha^{-1}. Under the genotype Anjali was showed higher Mn uptake in grain then the check variety Sahbhagi Dhan while Satka was showed lowest.

Cu content and uptake by grain (g ha^{-1})

The Cu content in rice grain varied among genotypes with R-1921-167-1-109-1 having 25.94 ppm followed by R-1262-1667-1-1 (22.57 ppm) and Sataka (22.51 ppm) and lowest was found in Katakdhan (10.20 ppm). Results on Cu uptake in grain are presented in Table 4 revealed that overall mean of Cu uptake in 66.23 g ha^{-1}. It ranged from 17.93 to 125.75 g ha^{-1}. Under the genotype OR-2635-2 recorded higher Cu uptake then the check variety Sahbhagi Dhan, whereas Katak Dhan recoded lowest.

Table.1 Grain yield of different genotypes in upland situation in Bastar

S.N.	Genotypes	Grain Yield kg/ha	S.N.	Genotypes	Grain yield kg/ha
1	Anjali	7418	**22**	Bhata Mokdo	3672
2	Virendra	3446	**23**	Bhagi Dhan	2509
3	Sabhagi Dhan	7257	**24**	JDP-1-2-1519	4045
4	Indira barani Dhan	3815	**25**	JDP-1-1-1695	5690
5	KMP-128	5139	**26**	KAUM 259 -5-3-1-1-1	6719
6	Garenga	5599	**27**	OR 2635-2	6372
7	Sataka	1267	**28**	OR-2637-1	4102
8	MAS-946-1	4067	**29**	OR 2567-2	6037
9	CR-616	2309	**30**	RCPR-16-1R8494-143-CRA-17-1	5425
10	Danteshwari	4805	**31**	RP-5943-68-17-6-3-1-1	6623
11	Narendra-97	3507	**32**	R-1921-167-1-109-1	4271
12	RCPR_8	6029	**33**	R-2124-367-1-263-1	5026
13	BRR-007	4852	**34**	R-1882-306-2-241-1	4935
14	R-1695-2152-2-296-1	5664	**35**	IR-08LI52	4796
15	IR-84887-B-15	6124	**36**	R-1882-1667-1-1	4405
16	Sajur Senja	2465	**37**	R-1779-321-1-112-1	3016
17	Foage Dhan	2904	**38**	R-1262-1667-1-1	4844
18	CR-40	2296	**39**	IR 14L572	3490
19	IR-86857-46-1-2	6102	**40**	IR 14L594	3602
20	IR-83381-B-B-137-3	4553	**41**	IR 14L562	2455
21	Katak Dhan	1758	**42**	Vandana	1819
			43	Bastar Dhan-1	3906

Table.2 Content and uptake of Fe in grains of different genotypes grown in Bastar

S.N.	Genotypes	Fe		S.N.	Genotypes	Fe	
		Content (ppm)	Uptake (g /ha)			Content (ppm)	Uptake (g /ha)
1	Anjali	75	553	**22**	Bhata Mokdo	49	180
2	Virendra	65	222	**23**	Bhagi Dhan	52	129
3	Sabhagi Dhan	43	315	**24**	JDP-1-2-1519	39	159
4	Indira barani Dhan	32	121	**25**	JDP-1-1-1695	44	249
5	KMP-128	54	276	**26**	KAUM 259 - 5-3-1-1-1	43	289
6	Garenga	35	198	**27**	OR 2635-2	38	240
7	Sataka	87	110	**28**	OR-2637-1	65	267
8	MAS-946-1	79	320	**29**	OR 2567-2	49	295
9	CR-616	69	159	**30**	RCPR-16-1R8494-143-CRA-17-1	57	310
10	Danteshwari	86	415	**31**	RP-5943-68-17-6-3-1-1	79	521
11	Narendra-97	43	149	**32**	R-1921-167-1-109-1	79	339
12	RCPR_8	32	191	**33**	R-2124-367-1-263-1	45	226
13	BRR-007	38	184	**34**	R-1882-306-2-241-1	76	374
14	R-1695-2152-2-296-1	41	232	**35**	IR-08LI52	72	347
15	IR-84887-B-15	48	294	**36**	R-1882-1667-1-1	81	356
16	Sajur Senja	70	172	**37**	R-1779-321-1-112-1	74	223
17	Foage Dhan	47	137	**38**	R-1262-1667-1-1	62	302
18	CR-40	39	89	**39**	IR 14L572	73	255
19	IR-86857-46-1-2	63	384	**40**	IR 14L594	69	248
20	IR-83381-B-B-137-3	77	352	**41**	IR 14L562	59	146
21	Katak Dhan	64	112	**42**	Vandana	69	126
				43	Bastar Dhan-1	66	257

Table.3 Content and uptake of Mn in grains of different genotypes grown in Bastar

S.N.	Genotypes	Mn		S.N.	Genotypes	Mn	
		Content (ppm)	Uptake (g /ha)			Content (ppm)	Uptake (g /ha)
1	Anjali	76.56	568	**22**	Bhata Mokdo	77.41	284
2	Virendra	64.33	222	**23**	Bhagi Dhan	81.51	204
3	Sabhagi Dhan	67.00	486	**24**	JDP-1-2-1519	66.24	268
4	Indira barani Dhan	72.00	275	**25**	JDP-1-1-1695	64.00	364
5	KMP-128	78.67	404	**26**	KAUM 259 - 5-3-1-1-1	57.91	389
6	Garenga	82.67	463	**27**	OR 2635-2	64.33	410
7	Sataka	77.00	98	**28**	OR-2637-1	72.53	297
8	MAS-946-1	85.09	346	**29**	OR 2567-2	79.67	481
9	CR-616	66.76	154	**30**	RCPR-16-1R8494-143-CRA-17-1	68.00	369
10	Danteshwari	72.33	348	**31**	RP-5943-68-17-6-3-1-1	75.67	501
11	Narendra-97	74.00	260	**32**	R-1921-167-1-109-1	84.87	362
12	RCPR_8	72.41	437	**33**	R-2124-367-1-263-1	64.33	323
13	BRR-007	75.37	366	**34**	R-1882-306-2-241-1	51.69	255
14	R-1695-2152-2-296-1	78.00	442	**35**	IR-08LI52	67.67	325
15	IR-84887-B-15	80.51	493	**36**	R-1882-1667-1-1	78.67	347
16	Sajur Senja	65.53	162	**37**	R-1779-321-1-112-1	59.67	180
17	Foage Dhan	85.12	247	**38**	R-1262-1667-1-1	59.00	286
18	CR-40	78.00	179	**39**	IR 14L572	67.00	234
19	IR-86857-46-1-2	66.97	409	**40**	IR 14L594	73.67	265
20	IR-83381-B-B-137-3	70.00	319	**41**	IR 14L562	68.00	167
21	Katak Dhan	54.67	96	**42**	Vandana	61.37	112
				43	Bastar Dhan-1	70.67	276

Table.4 Content and uptake of Cu in grains of different genotypes grown in Bastar

S.N.	Genotypes	Cu		S.N.	Genotypes	Cu	
		Content (ppm)	Uptake (g /ha)			Content (ppm)	Uptake (g /ha)
1	Anjali	11.87	88	**22**	Bhata Mokdo	12.34	45
2	Virendra	16.98	59	**23**	Bhagi Dhan	19.15	48
3	Sabhagi Dhan	14.43	105	**24**	JDP-1-2-1519	14.87	60
4	Indira barani Dhan	21.33	81	**25**	JDP-1-1-1695	16.73	95
5	KMP-128	12.40	64	**26**	KAUM 259 - 5-3-1-1-1	16.13	108
6	Garenga	16.43	92	**27**	OR 2635-2	19.73	126
7	Sataka	22.51	29	**28**	OR-2637-1	16.03	66
8	MAS-946-1	19.13	78	**29**	OR 2567-2	13.73	83
9	CR-616	18.31	42	**30**	RCPR-16-1R8494-143-CRA-17-1	10.81	59
10	Danteshwari	14.08	68	**31**	RP-5943-68-17-6-3-1-1	16.37	108
11	Narendra-97	11.98	42	**32**	R-1921-167-1-109-1	25.94	111
12	RCPR_8	11.87	72	**33**	R-2124-367-1-263-1	15.50	78
13	BRR-007	12.91	63	**34**	R-1882-306-2-241-1	14.70	73
14	R-1695-2152-2-296-1	14.47	82	**35**	IR-08LI52	10.90	52
15	IR-84887-B-15	15.43	95	**36**	R-1882-1667-1-1	15.60	69
16	Sajur Senja	13.00	32	**37**	R-1779-321-1-112-1	11.20	34
17	Foage Dhan	8.73	25	**38**	R-1262-1667-1-1	22.57	109
18	CR-40	12.76	29	**39**	IR 14L572	13.70	48
19	IR-86857-46-1-2	10.87	66	**40**	IR 14L594	14.47	52
20	IR-83381-B-B-137-3	12.96	59	**41**	IR 14L562	20.67	51
21	Katak Dhan	10.20	18	**42**	Vandana	16.60	30
				43	Bastar Dhan-1	14.37	56

Table.5 Content and uptake of Zn in grains of different genotypes grown in Bastar

S.N.	Genotypes	Zn		S.N.	Genotypes	Zn	
		Content (ppm)	Uptake (g /ha)			Content (ppm)	Uptake (g /ha)
1	Anjali	32.67	242	22	Bhata Mokdo	25.33	
2	Virendra	27.67	95	23	Bhagi Dhan	24.00	97
3	Sabhagi Dhan	25.33	184	24	JDP-1-2-1519	29.00	165
4	Indira barani Dhan	29.33	112	25	JDP-1-1-1695	25.67	172
5	KMP-128	27.67	142	26	KAUM 259 -5-3-1-1-1	32.67	208
6	Garenga	33.33	187	27	OR 2635-2	28.00	115
7	Sataka	26.00	33	28	OR-2637-1	28.33	171
8	MAS-946-1	31.00	126	29	OR 2567-2	36.00	195
9	CR-616	25.00	58	30	RCPR-16-1R8494-143-CRA-17-1	31.67	210
10	Danteshwari	28.33	136	31	RP-5943-68-17-6-3-1-1	35.67	152
11	Narendra-97	32.33	113	32	R-1921-167-1-109-1	25.33	127
12	RCPR_8	25.67	155	33	R-2124-367-1-263-1	33.67	166
13	BRR-007	34.00	165	34	R-1882-306-2-241-1	26.67	128
14	R-1695-2152-2-296-1	35.00	198	35	IR-08LI52	33.00	145
15	IR-84887-B-15	32.33	198	36	R-1882-1667-1-1	25.33	76
16	Sajur Senja	24.00	59	37	R-1779-321-1-112-1	24.67	119
17	Foage Dhan	26.00	75	38	R-1262-1667-1-1	27.33	95
18	CR-40	32.00	73	39	IR 14L572	23.67	85
19	IR-86857-46-1-2	27.33	167	40	IR 14L594	28.00	69
20	IR-83381-B-B-137-3	25.00	114	41	IR 14L562	25.67	47
21	Katak Dhan	33.00	58	42	Vandana	26.67	86
				43	Bastar Dhan-1	26.67	104

Zn content and uptake by grain (g ha^{-1})

The Zn content in rice grain varied among genotypes with OR-2567-2 having 36 ppm followed by R-5943-6817-6-3-1-1 (35.67 ppm) and R-1695-2152-2-296-1 (35 ppm) and lowest was found in IR14L572 (23.67 ppm). Results on Zn uptake are presented in Table 5 revealed that the overall mean of Zn uptake in 128.42 g ha^{-1}. It ranged from 33 to 210 g ha^{-1}. Under the genotype RP-5943-68-17-6-3-1-1-1 was recorded highest Zn uptake in grain then the check variety Sahbhagi Dhan, Genotype Satka noticed by lowest fe uptake in grain. Parikh *et al.*, (2019) evaluated rice germplasm lines for iron and zinc content in brown and polished rice grain and found substantial variation among screened genotypes. In brown rice iron and zinc content was ranged between 6.3 µg/g -24.5 µg/g and 15.4 µg/g - 39.40 µg/g, respectively, whereas, polished rice showed iron and zinc content range from 0.1 µg/g -6.7 µg/g and 13.1 µg/g -32.6 µg/g, respectively indicating the nutritive richness of brown rice over the polished rice. Anandan *et al.*, (2011) reported that the content of Fe and Zn in traditional genotypes were significantly higher than that of improved cultivars. These result shows that there is a significant genetic diversity or variation in the existing rice germplasm.

In conclusion anjali, JDP-1-1-1695, BRR-0007, RCPR-8, Bastar Dhan-1, Bhata Mokdo and OR-2637-1 genotypes were found the most suitable based on their performance on yield and micronutrient uptake. Therefore, these genotypes of higher yield potential and micronutrient uptake can be useful to a breeding program for developing new lines of high adaptability to soil acidity and upland soil.

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