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STUDIES ON HIGH ACCUMULATION OF IRON AND ZINC CONTENTS IN SOME SELECTED RICE GENOTYPES

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ABSTRACT
Field experiment was conducted to study the uptake of zinc and iron in some of the genotypes during the *kharif* 2010, 2011 and 2012 at Zonal Agricultural Research Station (ZARS), V. C. Farm, Mandya, Karnataka. Nine rice genotypes were transplanted; the paddy genotypes used were IR-36, MTU3626, Aghonibora, NDR6279, TKM 9, Profulla, Vasumathi, Thanu and Gouri. Among the genotypes studied IR36 recorded maximum grain yield 6091 kg ha^{-1} (pooled) followed by Thanu (5677 kg ha^{-1}) and lowest yield recorded in Gouri (1705 kg ha^{-1}). Uptake of Iron (Fe) was maximum in MTU 3626 (126 g ha^{-1}) and lowest in Gouri (36 g ha^{-1}). Zinc (Zn) uptake was maximum in IR36 (105 g ha^{-1}) followed by Profulla (104.66 g ha^{-1}) and was lowest in MTU 3626 (28g ha^{-1}). Aghonibora was consistently found promising over the period of time(3 years) for accumulation of both Fe and Zn. Milling studies (~6% polishing) resulted in a substantial loss of 26-81% of Fe and 20-78% of Zn as compared to brown rice. The genotype profulla recorded maximum accumulation of iron and zinc in ground rice (29 and 28.66 mg kg^{-1}) as well as in brown rice (31 and 66.66 mg kg^{-1}) respectively.

KEYWORDS: Genotype, uptake, concentration, ground rice, brown rice.

INTRODUCTION
Rice is an extensively grown important staple food crop, accounting for 43% of the total food grain production of the country. Variability in nutrient acquisition and its utilization by rice genotypes for yield expression is well documented which is being exploited to develop nutrient efficient rice varieties as well as utilization in biofortification with micronutrient dense cultivars of rice is one of the important options available to fight against malnutrition of micronutrients such as iron (Fe) and zinc (Zn), reported to be widely deficient and predominant in rice eating population. In order to identify promising and stable rice germplasm for high Fe and Zn content in the endosperm and assess the influence of environment on the accumulation of micronutrients in the grain by exploiting the genetic variation in rice germplasm for use in the breeding program appears to be promising. Therefore, a field experiment was conducted to study the uptake of zinc and iron in some of the genotypes during *kharif* 2010, 2011 and 2012 at Zonal Agricultural Research Station (ZARS), V. C. Farm, Mandya, Karnataka.

MATERIALS & METHODS
A field experiment was conducted during *Kharif* season of 2009, 2010 and 2011. The experiment was conducted at Zonal Agricultural Research Station, V.C. Farm, Mandya geographically located between 12° 45' to 13° 57' N latitude and 76 °45' to 78° 24' E longitude and it is at an altitude of 695 M above MSL. The experiment was laid out in Randomized Complete Block Design with three replication with following treatments. V_1: IR-36, V_2: MTU3626, V_3: Aghonibora, V_4: NDR6279, V_5: TKM 9, V_6: Profulla, V_7: Vasumathi, V_8: Thanu and V_9: Gouri. The growth and yield observations were scientifically and timely recorded. Variety wise paddy seeds were processed to get brown rice and polished rice. Further zinc and iron concentration were characterized using Atomic Absorption Spectrophotometer at Directorate of Rice Research, Hyderabad.

RESULTS & DISCUSSION
Grain yields of different cultures used for the study showed significant differences in productivity over the period, mean yields of cultures varied from 1705 to 6091 kg ha^{-1} (Table 1). Similarly straw yields also showed significant difference. Among the cultures IR-36 recorded highest grain yield throughout the study period (6064 to 6112 kg ha^{-1}). This was on par with the local check variety Thanu (KMP-101) (5468-5867 kg ha^{-1}). Uptake of Fe (126 g ha^{-1}) was maximum in MTU 3626 and lowest in Gouri (36 g ha^{-1}) whereas Zn uptake was maximum in IR36 (105 g ha^{-1}) and lowest in MTU 3626 (28g ha^{-1}).

Zinc and iron accumulation in brown rice:
The influence of soil fertility and environment on the nutrient contents was estimated by analyzing the accumulation of zinc and iron in the brown rice *i.e,* dehusked and unpolished in all the cultures used for the study in duplicate. The zinc and iron contents varied significantly among the cultures (32.7 to 55 mg kg^{-1} pooled), indicating apparent influence of environment on accumulation of zinc in grain (Anonymous 2011). The check variety Thanu (KMP- 101) recorded highest zinc content (55 mg kg^{-1} pooled) and NDR – 6279 recorded

lowest accumulation of zinc content in grain (32.7 mg kg^{-1}). However, there was good correlation observed between micronutrient accumulations in general, zinc in particular and grain yields with respect to rice productivity.

TABLE 1. Grain and straw yield of different genotypes

Varities	Grain yield (kg ha^{-1})				Straw yield (kg ha^{-1})			
	2010	2011	2012	Average	2010	2011	2012	Average
V_1: IR-36	6112	6098	6064	6091	6125	6258	6211	6198
V_2: MTU3626	6186	5989	5698	5958	6156	6021	5938	6038
V_3: Aghonibora	2607	2855	2317	2593	2782	2954	2489	2741
V_4: NDR6279	2561	2489	2898	2649	2768	2683	2985	2812
V_5: TKM 9	4480	4233	3151	3955	4681	4338	3268	4095
V_6: Profulla	4469	4493	4663	4542	4628	4793	4837	4752
V_7: Vasumathi	2765	2783	2193	2580	2981	2983	2384	2782
V_8: Thanu	5468	5867	5696	5677	5681	5986	5827	5831
V_9: Gouri	1939	1385	1791	1705	2080	1564	1983	1875
Sem ±	-	-	-	180.99	-	-	-	176.24
CD				542.64				528.39

TABLE 2. Zinc and iron concentration in brown rice of different genotypes

Varities	Zinc content (mg kg^{-1})				Iron content (mg kg^{-1})			
	2010	2011	2012	Average	2010	2011	2012	Average
V_1: IR-36	33.2	16.7	56.3	35.40	83.4	25.4	21.6	43.47
V_2: MTU3626	48.8	22.0	53.9	41.57	36.6	13.0	19.9	23.17
V_3: Aghonibora	31	21.4	79.0	43.80	40.8	33.2	19.6	31.20
V_4: NDR6279	32.8	22.7	42.7	32.70	70.7	42.7	21.9	45.10
V_5: TKM 9	50.9	13.0	58.9	40.93	30.8	29.5	31.6	30.63
V_6: Profulla	45.3	13.0	57.1	38.47	44.1	27.0	25.5	32.20
V_7: Vasumathi	47.6	26.9	58.5	44.33	50.6	20.5	16.9	29.33
V_8: Thanu	87.2	24.8	53.0	55.00	59.8	11.8	13.3	28.30
V_9: Gouri	44.3	27.8	40.0	37.37	35.6	17.5	15.5	22.87
Sem ±	-	-	-	7.25	-	-	-	6.60
CD				NS				NS

The accumulation of iron content in brown rice varied among the cultures studied. The highest accumulation of iron was found in NDR -6279 (45.1 mg kg^{-1}) and the lowest in Gouri (22.87 mg kg^{-1}), which was on par with Thanu (KMP-101) (28.3 mg kg^{-1}). However, there was no significant difference observed among the cultures with respect to accumulation of iron (anonymous 2011).

TABLE 3. Per cent loss of zinc and iron upon milling of paddy of different genotypes (pooled)

Genotype	Grain type	Zinc content (mg kg^{-1})			Iron content (mg kg^{-1})		
		Brown rice	Milled rice	Per cent loss	Brown rice	Milled rice	Per cent loss
V_1: IR-36	Medium slender	35.40	18.7	47.38	43.47	23.00	47.00
V_2: MTU3626	Medium slender	41.57	19.4	53.16	23.17	18.60	19.72
V_3: Aghonibora	Long slender	43.80	14.3	70.56	31.20	14.3	54.16
V_4: NDR6279	Medium slender	32.70	22.1	32.42	45.10	19.60	56.5
V_5: TKM 9	Short bold	40.93	24.7	39.65	30.63	12.8	58.2
V_6: Profulla	Short bold	38.47	17.8	53.73	32.20	10.8	68.32
V_7: Vasumathi	Long slender	44.33	18.66	57.33	29.33	7.5	74.22
V_8: Thanu	Medium slender	55.00	23.50	57.27	28.30	8.8	68.90
V_9: Gouri	Short bold	37.37	16.20	56.65	22.87	12.5	45.34

The wide range in grain yield, iron and zinc contents of brown rice in each genotype was mainly due to genotypic characteristics of the rice cultures used for the study. These results of iron in present study are in agreement with earlier findings as reported by various workers for Ash, Protein, Fat and Fiber minerals (Eppendorfer *et al.* 1983; Sotelo *et al.* 1990). The genotypes selected for the study belong to long slender to short bold type of grain. The genotypes were subjected to milling (~ 6% polishing) for estimation of nutrient loss. Milling and polishing resulted in a substantial loss of 32.42 to 70.56 % of zinc content and 19.72 to 74.22 % of iron (Table. 3). Loss in micronutrient content after milling varied with grain type. The rice variety Aghonibora recorded highest per cent loss of zinc content (70.56 %) compared to local check Thanu (57.27 %). The per cent loss after milling with respect to zinc content was minimum (32.42 %) in NDR-6279. The per cent milling loss with respect to iron content varied with rice genotypes irrespective of grain type. The per cent loss was widely ranged in medium slender to long slender grains. The minimum loss was observed in MTU- 3626 which is medium slender (19.72 %) whereas maximum loss was recorded in Vasumathi which is of long slender type (74.22 %) and was on par with local check Thanu (68.90%).

CONCLUSION

In summary, the trial was conducted for three seasons in the same location with nine cultures including one local check. There is obvious differences in Fe and Zn contents among the genotypes tested, suggesting a genetic potential to increase contents of these micronutrients in rice grains without any negative impact on yield (Graham *et al* 1997). In Asia where rice supply more than fifty per cent of the dietary energy and protein any increase in its mineral concentration could significantly help to reduce Fe and Zn deficiency in humans. Therefore selection and popularization of rice varieties with bio fortification of Fe and Zn will go a long way in mitigating micronutrient deficiencies especially among populations where rice is the staple food crop.

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