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Genetic variability for ^{65}Zn uptake and transport in leaves and roots of rice (*Oryza sativa* L.) genotypes

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ABSTRACT : Based on seed and leaf zinc (Zn) content, contrasting rice genotypes were identified from the previous study. To know the relationship between uptake and translocation in rice, an experiment was conducted using radio labelled ^{65}Zn with these selected genotypes in hydroponic solution culture containing radioactive ^{65}Zn. Plants were harvested 6, 24 and 48 hrs after the treatment imposition. Activity of ^{65}Zn was estimated using liquid scintillation counter. Zinc uptake was measured both in leaf and root samples. High Zn types showed high uptake compared to low Zn types. The shoot content was also high in high types. It can be inferred that the observed genotypic variation in Zn content was predominantly due to differences in uptake of Zn by roots. After 24 hrs after exposing the seedlings to ^{65}Zn, the root Zn content was almost twice high in high Zn types compared to low Zn types. These results indicate that variability in Zn levels is attributed to differences in ^{65}Zn uptake subsequent to its transport to shoot.

KEY WORDS : Leaf zinc, Radioactive ^{65}Zn, Rice genotypes, Seed zinc

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Zinc is an essential nutrient as a trace element for animals, plants, and micro-organisms. Studies with wheat showed good transport of Zn from stalks and leaves to developing grain (Pearson *et al*., 1996 and Pearson and Rengal, 1995), as well as from one root to another (Pearson and Rengel, 1995), indicating involvement of phloem transport. The movement of foliar applied Zn to plant roots was demonstrated in small number of studies (Haslett *et al*., 2001). Transport of metals in plants within phloem is due to positive hydrostatic pressure gradient developed due to the loading of sucrose in phloem from leaves and it's unloading in growing tissues, apical root zone and reproductive organs (Macrobbie, 1971; Hocking, 1980 and Welch, 1995).

RESEARCH PROCEDURE

To assess the genetic variability in different rice germplasm lines for their seed and leaf Zn content, an experiment was conducted with 320 rice genotypes. The range for seed Zn content was from 0.84 to 5.00 mg/100 g DW and for leaves it was from 1.26 to 14.88 mg/100g DW (Nagarathna *et al*., 2010). To identify the contrasting genotypes differing in acquisition of Zn and transport to seed, Z-distribution was made. Based on the Z-distribution data genotypes were selected and classified them as high leaf high seed Zn types (HLHS), low leaf high seed Zn types (LLHS), low leaf low seed Zn types (LLLS) and high leaf low seed Zn types (HLLS) (Table A). Further, 10 contrasting genotypes including varieties were selected

Table A : Mean and range values for four contrast groups						
Groups	Leaf zinc (mg/100g DW)			Seed zinc (mg/100g DW)		
	Range	Mean	S.D.	Range	Mean	S.D.
LLHS	1.26-7.57	4.49	1.81	0.84-3.95	2.36	1.79
HLHS	7.77-14.88	11.22	1.813	2.37-5.00	3.35	0.66
HLLS	7.74-14.08	10.89	2.02	1.06-2.19	1.6	0.37
LLLS	1.40-4.94	3.11	1.01	0.84-3.03	1.97	0.72

Table B : The list of genotypes used to study the uptake and translocation using ^{65}Zn		
Sr. No.	Groups	Genotypes
1.	HLHS	IR 20
2.		C 4938-B-B-1-1
3.		BPT 5204
4.	HLLS	IR 73898-71-2-6-3
5.		JING-XIAN-89
6.		TOX 3749-34-3-1
7.	LLHS	IET 18912
8.	LLLS	Thanu
9.		IET 17913
10.		IR 59656-5K-2

to study the relationship between uptake and translocation in rice (Table B).

The seeds of rice genotypes were sown in thermocole cups. In order to facilitate emergence of roots through cup 5-6 holes were made at the bottom of the cups. These cups were filled with vermiculite. They were placed on sand bed and five to eight seeds were sown in each cup. After10 days, extra seedlings were removed and one plant per cup was maintained. At the age of 25 days the seedlings were taken out of the sand bed and the cups cups along with the hanging roots were transferred to plastic trays containing 3 litres of half strength Hoagland's solution (Hoagland and Arnon, 1935). Six such cups for each genotype were placed per in two replications. The seedlings were allowed to acclimatize, and after 7-8 days of adaptation, half strength Hoagland's solution was decanted. Plants were transferred to small plastic containers.

$Ci^{65}Zn$ in HCl solution (1.09 m) having specific activity of 2.27 Ci was procured from BRIT (Board of

Table 1 : Radioactive Zn uptake in root and shoot and their per cent translocation from root to shoot in diverse groups of genotypes													
Groups	Genotypes	Root			Shoot			Total uptake			% Translocation from root to shoot		
		6 hrs	24 hrs	48 hrs	6 hrs	24 hrs	48 hrs	6 hrs	24 hrs	48 hrs	6 hrs	24 hrs	48 hrs
HLHS	IR-20	24676.93	70330.14	109850.30	2981.80	4519.9	6114	27659	74850	115964	10.78	6.039	5.2722
	C 4938-B-B-1-1	23154.81	68082.93	121625.60	2541.90	5591	8621	25697	73674	130246	9.892	7.589	6.6189
	BPT	23564.42	95217.86	137428.90	1955.89	3141.5	6883	25520	98359	144312	7.664	3.194	4.7693
	Mean	23798.72	77876.98	122968.27	2493.20	4417.4	7206	26292	82294	130174	9.446	5.607	5.5535
HLLS	IR 73898-71-2-6-3	19435.8	61216.53	104901.70	1148.01	2798.1	3817	20584	64014.6	108718	5.577	4.371	3.5105
	JING-XIAN-89	20761.6	75549.78	108472.6	2247.5	4842.2	6756	23009	80392	115228	9.768	6.023	5.8629
	TOX 3749-34-3-1	21439.9	81193.6	140532.50	2486.36	5178.9	7467	23926	86372.5	147999	10.39	7.072	5.045
	Mean	20545.8	72653.3	117968.93	1960.62	4273.1	6013	22506	76926.4	123982	8.579	5.822	4.8061
LLHS	IET 18912	20734.7	32920.0	91655.40	1013.72	1265.4	4118	21748	34185	95774	4.661	3.702	4.3002
	Mean	20734.7	32920.0	91655.40	1013.72	1265.4	4118	21748	34185	95774	4.661	3.702	4.3002
LLLS	Thanu	19770.3	45616.8	92156.83	552.1	1674.7	2824	20322	47291	94980	2.717	3.541	2.9728
	IET 17913	14952.3	43549.15	83748.56	1437	2219.9	2732	16389	45769	86481	8.768	4.85	3.1594
	IR 59656	19079.1	69860.02	74011.58	1617.6	2972.7	3041	20697	72833	77053	7.816	4.082	3.9469
	Mean	17933.9	53008.66	83305.66	1914.9	1243.1	2866	19136	55298	86171	6.433	4.158	3.3597

Radiation and Isotope Technology), Mumbai, diluted to 500 ml using distilled water out of which 10 ml was added to each plastic container. The plants were harvested after 6, 24 and 48 hrs. The root and shoot portions of each plant were separated, washed in 5 per cent calcium sulphate solution, blotted and their fresh weights were measured.

The fresh root and shoot samples were ground to a fine paste using liquid nitrogen. A known quantity of sample was taken in a vial containing 4 ml of scintillation cocktail and blank readings were recorded by taking only the vials which were washed with concentrated HCl before adding the actual samples.

Activity of ^{65}Zn was determined using Wallac 1409 liquid scintillation counter (LSC) and counts per minute (cpm) were recorded. Zinc uptake was measured both in leaf and root sample separately using the following formula;

$$\text{Zn activity per weight} = \frac{\text{(Sample cpm - Blank cpm) x Weight of the sample taken for grinding (g)}}{\text{Total fresh weight of the sample (g)}}$$

Research Analysis and Reasoning

Zinc uptake and its transport to shoot increased with increase in time. However, there was significant variability in Zn uptake among the genotypes. Interestingly the shoot Zn content was also high in high Zn types (high seed and leaf Zn content) indicating relatively higher translocation of Zn to shoot in these genotypes. For instance, after 24 hrs the shoot Zn radioactivity in high Zn types was around 4300 unit cpm as against 1200 unit cpm in low types. This was clearly reflected in per cent translocation of Zn in high types compared to low Zn types (Table 1).

Among the high Zn types (IR 20, C 4938-B-B-1-1, BPT 5204) which differ in seed Zn types, there was no difference in uptake by roots or its transport to shoot. Therefore, it can be inferred that factors that are influencing the transport of Zn may not be the major contributing factors for the variation in seed Zn content. The higher seed Zn in high Zn types could be due to re mobilization of Zn to seed during grain development or due to variation in grain filling period or duration of Zn transport to seed. Among the varieties, the Zn transport studies using ^{65}Zn clearly demonstrated that the significantly high uptake and translocation of Zn was observed in BPT when compared to Thanu. The outcome of ^{65}Zn studies is that variability in Zn levels is attributed to differences in ^{65}Zn uptake subsequent to its transport to shoot.

Literature Cited

Haslett, B.S., Reid, R.J. and Rengel, Z. (2001). Zinc mobility in wheat: uptake and distribution of zinc applied to leaves or roots. *Ann. Bot.*, **87** (3) : 379-386.

Hoagland, D.R. and Arnon, D.I. (1935). The water culture method for growing plants without soil. California Agriculture Experimental Station Circular, 347. Berkley, California, USA.

Hocking, P.J. (1980). The composition of phloem exudate and xylem sap from the tobacco (*Nicotiana glauca* Grah.). *Ann. Bot.*, **45** (6) : 633-643.

Macrobbie, E.A.C. (1971). Phloem translocation. facts and mechanisms: A comparative survey. *Biol. Rev. (Camb.),* **46** (4) : 429-481.

Nagarathna, T.K., Shankar, A.G. and Udayakumar, M. (2010). Assessment of genetic variation in zinc acquisition and transport to seed in diversified germplasm lines of rice (*Oryza sativa* L.). *J Agric Tech*., **6** : 171– 178.

Pearson, J.N. and Rengel, Z. (1995). Uptake and distribution of ^{65}Zn and ^{54}Mn in wheat grown at sufficient and deficient levels of Zn and Mn during vegetative growth. *J. Exp. Bot.*, **46** (7) : 833-839.

Pearson, J.N., Rengel, Z., Jenner, C.F. and Graham, R.D. (1996). Manipulation of xylem transport affects Zn and Mn transport into developing wheat grains of cultured ears. *Physiol. Plantarum,* **98** (2) : 229-234.

Welch, R.M. (1995). Micronutrient nutrition of plants. *Crit. Rev. Pl. Sci.*, **14**: 49-82.

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