

Tolerance of Ten Rice Genotypes to Zinc Deficiency

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INTRODUCTION

Zinc deficiency is the most widespread micronutrient deficiency in the world and in Turkey. Plant-available Zn concentrations are low in 50% percent of arable soils in the world (Cakmak 2004), and Zn deficiency is the most prevalent micronutrient deficiency in rice-growing areas (Fageria et al. 2002). Rice is the main diet source for 3% of the human population in the world (Liang et al. 2007), and is one of the cereals widely grown in Turkey. In this study, ten rice genotypes were tested under increasing rates of Zn application for the severity of Zn-deficiency symptoms, shoot dry matter yield, Zn efficiency (ability of a genotype to grow and yield under a deficient supply of Zn compared to other genotypes) and shoot-Zn concentration and content parameters.

METHODS

Ten rice genotypes (J79, Dular, Jalmagna, IR74, 507, 512, 597, 474, 614, 639) with varying grain-Zn concentrations (26, 24, 27, 23, 4, 19, 18, 23, 20, 20 mg kg⁻¹, respectively) were grown under different Zn-application rates (0 and 5 mg Zn kg⁻¹ soil as ZnSO₄·7H₂O) in a Zn-deficient soil that contained 0.08 mg kg⁻¹ DTPA-extractable Zn under greenhouse conditions. As basal fertilizer treatment, 200 mg N kg⁻¹ as NH₄SO₄, 100 mg P kg⁻¹ as KH₂PO₄, 2.5 mg Fe kg⁻¹ as Fe-EDTA were applied per pot. During the experiment, Zn-deficiency symptoms (chlorotic and necrotic patches on leaves) were observed according to a 1-5 scale (1:severe - 5:slight or absent Zn-deficiency symptoms). Plants were harvested after 28 days of growth in Zn-deficient soil following the development of Zn-deficiency symptoms in plants without Zn application. Plants were analyzed for dry-matter production, Zn-deficiency tolerance and shoot-Zn concentrations.

RESULTS AND DISCUSSION

Rice genotypes used in the experiment showed differential responses to Zn-deficiency stress in soil. The first characteristic reaction of the genotypes under Zn-deficient conditions was a severe reduction in plant height. While the most severe Zn-deficiency symptoms were observed in genotypes 507 and 609, genotypes Dular and 474 showed slight Zn-deficiency symptoms. Similar to Zn-deficiency symptoms, great differences in shoot-dry-matter yields were found under Zn-deficient conditions. Without Zn application, shoot-dry-matter production varied between 18 mg plant⁻¹ (genotype 507) and 60 mg plant⁻¹ (genotype Dular) with an average of 45 mg plant⁻¹ for all genotypes. There was a significant relationship between seed-Zn concentration and severity of Zn-deficiency symptoms ($R^2=0.46$), and shoot-dry-matter production ($R^2=0.86^{**}$) and Zn-efficiency values ($R^2=0.51$). Among genotypes tested, genotypes 507 and 639 had the lowest seed-Zn contents and shoot-dry-matter yields under Zn deficiency.

While there was no significant relationship between shoot-Zn concentration and Zn-efficiency rate, a close relationship was found between shoot-Zn content and Zn-efficiency

rate ($R^2=0.61^*$). These findings are in accordance with those of Torun et al. (2000). A close relationship was found between Zn-efficiency rates, seed-Zn concentrations ($R^2=0.51$) and seed-Zn contents of genotypes ($R^2=0.35$).

Table 1. Symptom score, shoot dry weight and Zn-efficiency rates of rice genotypes grown for 28 days with different Zn supply (0 and 5 mg Zn kg⁻¹ soil) in a Zn-deficient soil under greenhouse conditions.

Genotype	Syptom Score*	mg plant ⁻¹		Zn Efficiency ratio (%)
		Zn0	Zn5	
DULAR	3,5	60 ± 7,3	152 ± 34,9	39
614	2,0	51 ± 4,2	231 ± 30,0	22
IR74	2,5	53 ± 4,4	246 ± 26,5	22
474	4,0	56 ± 10,1	277 ± 27,9	20
512	2,5	43 ± 1,4	292 ± 28,9	15
639	1,0	37 ± 4,4	265 ± 18,4	14
507	1,0	18 ± 2,4	251 ± 26,4	7
J79	N.G.**	-	-	-
JALMAGNA	N.G.**	-	-	-
597	N.G.**	-	-	-
Ortalama	2,6	45	245	20

* : 1, very severe, 5, very slight or absent

** : No germination

CONCLUSIONS

Findings of the present study suggest that Zn concentrations and contents of seeds, severity of Zn-deficiency symptoms of shoots and shoot-dry-matter yields under Zn deficiency are important parameters involved in the differential expression of Zn-deficiency tolerance in rice. However, shoot-Zn concentrations could not be considered as a useful parameter for selection of genotypes.

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