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Research Notes

Genotypic divergence in expression of zinc deficiency symptoms of rice genotypes

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Rice ecology is endowed with several yield depressing factors of which mineral related abiotic stresses especially those of nitrogen and zinc play a predominant role. It is estimated that about 50 % of soils used for cereal production in the world have low levels of plant available Zn (Graham and Welch, 1996). Though fertilizer recommendations exist, correction of zinc deficiency *via* fertilization does not always remain a successful strategy due to agronomic and economic factors. As a consequence of coping with low Zn availability, certain genotypes exhibit significant variation in their tolerance to zinc stress, termed as zinc efficiency (ZE) (Graham and Rengel, 1993). Hence, a more efficient and sustainable solution to zinc deficiency limitation is the development and use of zinc efficient rice genotypes with root system capable of greater mobilization that can more efficiently function under low soil zinc conditions. Hence an attempt was made to identify zinc efficient rice genotypes based on the expression of zinc deficiency symptoms at deficient zinc supply.

The solution culture experiment was conducted in the green house of the Department of Soil Science and Agricultural Chemistry, Tamil Nadu Agricultural University, Coimbatore during 2003 – '04. The experimental set up consists of plastic plates with depressions and bottom covered with nylon mesh. The plates were countersunk into plastic trays containing modified Hoagland solution (Hoagland and Arnon, 1950) as the nutrient medium. Pregerminated rice seedling (five days old) of 56 rice genotypes were raised with one seedling in each depression of the tray. The pregerminated seedlings were held above the nylon mesh and only roots were let into the nutrient solution. The solution was aerated by fabricated aerators. Five levels of zinc (0, 0.025, 0.05, 0.1 and 0.2 ppm as $ZnSO_4$) were imposed. The seedlings were screened at ten days interval adopting Standard Evaluation System of Rice (1RRI, 1980), comprising of grades from 1 to 8.

1. Growth and tillering nearly normal; healthy
2. Growth and tillering nearly normal; basal leaves slightly discoloured.
3. Stunting slight, tillering decreased, some basal leaves brown or yellow
5. Growth and tillering severely retarded, about half of all leaves brown or yellow
7. Growth and tillering ceases, most leaves brown or yellow
8. Almost all plants dead or dying

Based on the above rating, the seedlings were observed for their relative tolerance / susceptibility to zinc stress at 10 days interval for a period of one month. Genotypes were classified as zinc efficient (a), moderately zinc efficient (b) and zinc inefficient (c) based on the severity of expression of zinc deficiency symptoms.

The visual score as recorded at 15 DAS (Table) failed to portray the genotypic variation

Table 1. Score of zinc deficiency symptoms of rice genotypes at various levels of zinc supply. (a: score 1; b: scores 2,3,5; c : 7,8)

35 DAS

Genotypes Zn (mg L^{-1})	IR 8	IR 36	IR 64	IR 72	ADT1	ADT 2	ADT3	ADT7	ADT11	ADT12	ADT14	ADT15	ADT17	ADT19
Zn 0	b	b	b	b	c	c	c	b	b	b	c	c	c	c
Zn 0.025	b	b	b	b	c	c	c	b	b	b	c	c	c	c
Zn 0.05	b	b	b	b	c	c	c	b	b	b	c	c	c	c
Zn 0.1	b	b	b	b	b	b	b	b	b	b	b	b	b	b
Zn 0.2	a	a	a	a	a	a	a	a	a	a	a	a	a	a

Genotypes Zn (mg L^{-1})	ADT36	ADT37	ADT38	ADT39	ADT41	ADT43	ADT44	ADT45	ADT46	ASD16	ASD18	ASD19	ASD20	PMK1
Zn 0	c	c	c	c	c	c	c	c	c	b	b	c	b	b
Zn 0.025	b	b	c	c	b	b	b	b	b	a	b	c	b	b
Zn 0.05	b	b	c	c	b	b	b	b	b	b	b	c	b	b
Zn 0.1	b	b	b	c	b	b	b	b	b	a	b	b	b	b
Zn 0.2	a	a	a	b	a	a	a	a	a	b	a	b	a	a

Genotypes Zn (mg L^{-1})	PMK2	PMK3	TRY1	TRY2	TKM9	TKM10	TKM11	CSR10	CSR13	P.Vikas	MDU4	MDU5	CO43	CO45
Zn 0	b	c	b	b	b	c	c	c	b	b	c	c	c	b
Zn 0.025	b	c	a	b	b	c	c	c	b	b	c	c	c	b
Zn 0.05	b	c	a	b	b	c	c	b	b	a	c	b	c	b
Zn 0.1	a	b	a	b	b	b	b	b	b	a	c	b	c	b
Zn 0.2	a	b	b	b	b	a	b	b	a	a	b	b	b	a

Genotypes Zn (mg L^{-1})	CO47	W.Ponni	Poornima	Norungan	Pokkali	Triveni	Mozkaruppu	Karuvali	Rasakudam	Purple puttu	BTS24	ASs 98024	CORH2	ADTRH1
Zn 0	c	c	b	b	b	b	b	b	b	b	b	b	b	c
Zn 0.025	b	b	b	a	a	a	a	a	a	a	a	b	b	c
Zn 0.05	c	b	b	a	a	a	a	a	a	a	a	a	b	c
Zn 0.1	c	b	b	a	a	a	a	a	a	a	a	a	a	b
Zn 0.2	b	b	b	b	b	a	a	a	b	b	a	a	a	b

in zinc efficiency. Irrespective of the levels of zinc applied almost all the genotypes scored 'a'. The observation at 25 DAS brought out conspicuous variation in the expression of zinc deficiency. Visual symptoms of severe Zn deficiency were observed and in some genotypes, new leaves ceased to grow and reddish brown lesions coupled with orange discolouration developed on the older leaves. Most of the genotypes appeared chlorotic with depressed shoot growth in Zn 0 treatment but a better performance was witnessed in Zn 0.2 treatment for all the genotypes excepting ASD 16, ASD 19, ASD 20, PMK 1, TRY I, TRY 2, Norungan, Pokkali, Rasakudam and Purpleputtu wherein depression in growth was noticed.

The scenario at 35 DAS painted a predominant picture of the genotypic divergence in zinc deficiency. The leaf blades of some genotypes affected by Zn deficiency collapsed in the middle parts and had a scorched appearance. As judged from the severity of visual Zn deficiency symptoms, the genotypes ADT 38, ADT 39, ASD 19, PMK 3, TKM 10, TKM 11, MDU 4 and CO 43 exhibited their inefficiency even at elevated levels of zinc supply. As a natural corollary, all the genotypes exhibited severe to very severe deficiency symptoms at Zn 0 mg L^{-1} and remained normal or near normal at Zn 0.2 mg L^{-1}. As observed from the intermediate levels of Zn supply, it was quite clear that the genotypes TRY 1, ASD 16, Norungan, Pokkali, Triveni, Mozikaruppu, Karuvali, Purpleputtu, Rasakudam and BTS 24 were least sensitive to zinc stress among the genotypes tested.

The onset of Zn deficiency was observed 15 days after sowing portraying the fact that the seed zinc content could cater to the zinc demand till 15 DAS. The sensitive genotypes exhibited distinct severity in zinc deficiency at 25 DAS in Zn 0 mgL^{-1} but remained green in Zn 0.2 mg L^{-1}. Based on visual rating at 35 DAS, Norungan, Pokkali, Triveni, Mozikaruppu, Karuvali, Rasakudam, Purpleputtu, BTS24 and AS98024 were the most efficient genotypes while ADT1, ADI 3, ADT7, ADT8, AD 138, PMK3, TKM9 proved inefficient. Stunted growth and other deficiency symptoms were witnessed on the sensitive plants, which were consistent with several reports of Zn deficiency.

Zinc efficiency is defined as the ability of a plant to grow and yield well under Zn deficient conditions and it varies among cereal species (Graham and Rengel, 1993; Erenoglu *et al.,* 2000). Zinc efficiency has been attributed mainly to the efficiency of acquisition of Zn under conditions of low Zn availability rather than to its utilization or re - translocation within a plant. Physiological mechanism(s) conferring ZE is related to various mechanisms operative in the rhizosphere and within a plant system as higher uptake of zinc (Zn^{2+}) by roots protection against superoxide free radicals *i.e.,* efficient antioxidative defence mechanism, efficient utilization and retranslocation of Zn (Hart *et al.,* 1998; Rengel and Romheld, 2000), an efficient ionic uptake system, better root architecture *i.e.,* long and fine roots with architecture favouring exploitation of Zn from larger soil volume, higher synthesis and release of Zn - mobilising phytosiderophores by the roots and uptake of Zn-phytosiderophore complex. Seed Zn content has also been suggested to affect ZE.

Cakmak *et al.* (1996) opined that ZE of cereals is mainly related to difference in acquisition of Zn by the roots. Graham and Rengel (1993) suggested that more than one mechanism could be responsible for establishing

Zn efficiency in a genotype and it is likely that different genotypes subjected to Zn deficiency under different environmental conditions will respond by one or more different efficient mechanisms. Because of differential zinc efficiency, the expression of zinc deficiency symptoms varied among the genotypes tested.

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Research Notes

Correlation analysis in bread wheat *(Triticum aestivum* L.)

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Wheat (*Triticum aestivum* L.) is an important cereal crop of India. In a country like India, cereals are the major sources of food carbohydrate. In order to impart resistance to biotic and abiotic stresses , it is imperative to introduce desirable attributes in a good agronomic base. For this ,an inevitable requirement is to characterize the germplasm. Adams (1967) has shown that component compensation and negative correlations arise in response to competitions between developmentally flexible components. In absence of stress *viz.,* salinity or drought the correlations are trivial. In wheat the studies on correlations have been conducted by several