Internat. J. Plant Sci. Vol.2 No.1 January 2007 : 199-205

Genotypic variability for cross tolerance in rainfed lowland rice : physiological responses

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(Accepted : November, 2006)

SUMMARY
Rainfed lowland rice varieties were exposed to submergence and drought individually and also in combination (submergence + drought) at different growth stages, to study physiological traits contributing to tolerance common for both stresses viz., cross tolerance. Varieties,FR-13A and TCA-48, having good survival under submergence exhibited low stem elongation rate (SER), while varieties (Mahsuri,IR-42253) having poor survival elongated excessively. Drought reduced SER (shoot growth) of all varieties tested, however, minimum reduction percentage was found in TCA-48. It seems that low SER during submergence coupled with moderate shoot growth during drought is useful adaptive trait for cross tolerance. Varieties, FR-13A and TCA-48 maintained higher root: : shoot ratio than other varieties under submergence, while under drought and combined stress, TCA-48 had significantly higher root : shoot. ratio than FR-13A. Higher root : shoot ratio and its better recovery after stress seems a desirable trait for cross tolerance. An increase in root length and root volume of all varieties was recorded just at the end of submergence or drought at seedling stage. At recovery, submergence treated plants showed significant decrease in these characters due to decomposition of some root parts, however, drought treated plants maintained continued increase. Minimum increase in root length and root volume was observed in var. FR-13A under submergence, while maximum was found in IR-42253. Under drought and combined stresses, minimum and maximum values of root length and root volume were recorded in IR-42253 and TCA-48, respectively.

Key words: Rainfed lowland rice, Cross tolerance, Survival, Stem elongation rate, Root: : Shoot ratio.

Rice is widely grown in various ecosystems like irrigated, upland, rainfed lowland, deepwater and tidal wetland conditions. Most unexploited area of rice ecosystem is rainfed lowland which occupy about 36.4 million hectares area in south and southeast Asia (IRRI, 1997). The environments of rainfed lowland rice are highly variable over time and location (Huke, 1982). In rainfed lowlands, rice crop invariably experiences submergence followed by drought or *vice-versa* at different growth stages. The adverse effects of submergence include mechanical damage, low light, limited gas diffusion, leaching of soil nutrients, and increased susceptibility to pests and diseases (Greenway and Setter, 1996, Setter *et al*., 1995). Due to 10^4 times slower diffusion of gases under submergence (Armstrong, 1979, Greenway and Setter, 1996) normal pathway of oxidative carbohydrate metabolism is shifted to anaerobic metabolism (Crawford, 1982, Drew, 1992), a key pathway for providing energy for maintenance and survival (Ellis and Setter, 1999).

Drought stress limits yield by occurring at different stages of crop growth in rainfed lowland (Widawsky and O'Toole, 1990, IRRI, 1994), where yield averages about 2 ton per ha (IRRI, 1993). Drought at vegetative stage causes irreparable loss of canopy, whereas at flowering stage, water deficit hampers anthesis and seed setting leading to higher spikelet sterility and lower yield of rice (Ram *et al*., 1988). Mechanism of submergence tolerance are different from those of drought tolerance and that is the reason many rice genotypes which are tolerant to submergence may not able to withstand drought. There is urgent need of evaluation of genotypes which have multiple stress tolerance in their inherent system with moderate yield potential for sustainability of rainfed lowland rice *per se*. This has necessitated to understand the physiological responses of rainfed lowland rice when submergence and drought access intermittently in the single life span of rice plant i.e. search for cross tolerance.

MATERIALS AND METHODS

The experiment was conducted in earthen pots (10" dia) with four rainfed lowland rice varieties viz., FR-13A, TCA-48, Mahsuri and IR-42253 having varying degree of submergence and drought tolerance. Each pot was lined with polythene bag and filled with 8 kg well pulverized silt loam textured soil. Recommended doses

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