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Estimation of Stress Indices of Upland Rice Landraces for Low P-Tolerance

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Soil acidity is one of the major constraints for rice production in northeast India. Due to the fixation with (Al3+) and iron (Fe+3) under low pH (< 5.0), the availability of P to the plant is often limited due to the fixation in various forms in the soil. The deficiency leads to various physiological disorders, affecting biomass accumulation, photosynthetic efficiency, and alteration of essential biochemical and metabolic path ways. As a result, phosphorus deficiency has become a limiting factor for yield in rice production. Since the primary source of phos phate fertilizer reserves is non-renewable, exploring P-efficient cultivars would be cost-effective.

Materials and Methods

Aset of 32 upland rice landraces denoting as G1 to G32 were evaluated for tolerance to low P. Experiment was carried out in low P and normal P conditions in RBD with three replications. Sowing was done in spacing of 20 x 10 cm following standard agronomic practices. To identify the low P-tolerant genotypes from graded P-levels, various stress indices were statistically analyzed to distinguish the P-deficiency tolerance or P-use efficient genotypes following the formulae:

1. Stress Tolerance Level, TOL (Rosielle and Hamblin,1981).

$$TOL = Yi_{ns} - Yi_s$$

2. Stress Tolerance Index, STI (Fernandez, 1992)

$$STI = \frac{Yi_{ns} x Yi_s}{Yi_{ns}^2}$$

3. Stress Susceptibility Index, SSI (Fischer and Maurer,1978).

$$SSI = \frac{1 - Yi_s/Yi_{ns}}{1 - Y_s/Y_{ns}}$$

4. Yield Stability Index, YSI (Bouslama and Schapaugh, 1984)

$$YSI = \frac{Yi_s}{Yi_{ns}}$$

5. Yield Reduction Ratio, YRR (Golestani-Araghi and Assad, 1998)

$$YRR = 1 - Yi_s/Yi_{ns}$$

6. Percent Yield Reduction, PYR (Golestani-Araghi and Assad, 1998)

$$PYR = (1 - Yi_s/Yi_{ns}) x 100$$

Where Yi_{ns} is the specific trait of the ith genotype under non-stress conditions; Yi_s is the particular trait of the ith genotype under stress conditions; SI (stress intensity) = 1– (Y_s/Y_{ns}); Y_s is the mean of the specific characteristic of all the genotypes evaluated under stress conditions; Y_{ns} is the mean of the particular trait of all the assessed genotypes under non-stress conditions

Results and Discussion

The grain mean yield under P-deficient varied from 10.93 q to 31.03 q/ha. While under normal condition, it ranged from 15.69 q/ha to 41.39q/ha (Fig. 1). Various stress indices such as STI, TOL, YRR, SSI, YSI and PYR varied significantly under P-deficient and sufficient conditions among the 32 genotypes (Fig. 2). TOL expresses the difference in yield in stress and non-stress environments; YSI describes the plasticity of the genotype in stress and non-stress environments for yield, while SSI describes the genotype's extent of sensitivity to stress. YR and PYR represent the yield sacrifice in a stressful environment by the genotypes. Tolerance index (TOL) values display an inverse relationship for low P-tolerance. Thus, the lower value of this index was more stable under different P-levels. However, low TOL only may not imply a high yielding genotype under low P; so, it should be taken into account along with grain yield. Although stress indices parameters helped select genotypes with high yield under stress, they may not accurately predict genotypes with good yield under typical and stress-prone environments. Because genotypes with poor yield potential may exhibit tolerance. Among these stress tolerance indices used in our study, STI and PYR were more directly proportionate to the pool mean yield potential across the different levels of phosphorus environments.

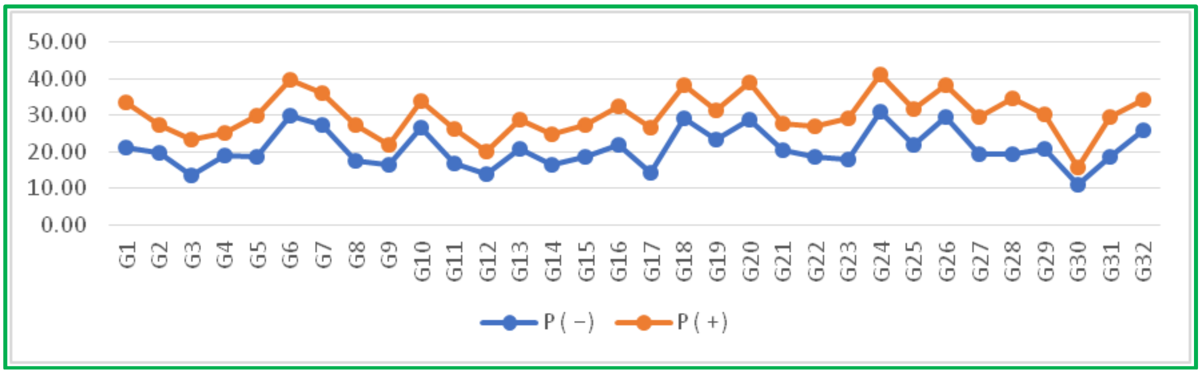

Fig.1: Pool mean variation of grain yield under low-P and normal P conditions among the 32 rice genotypes

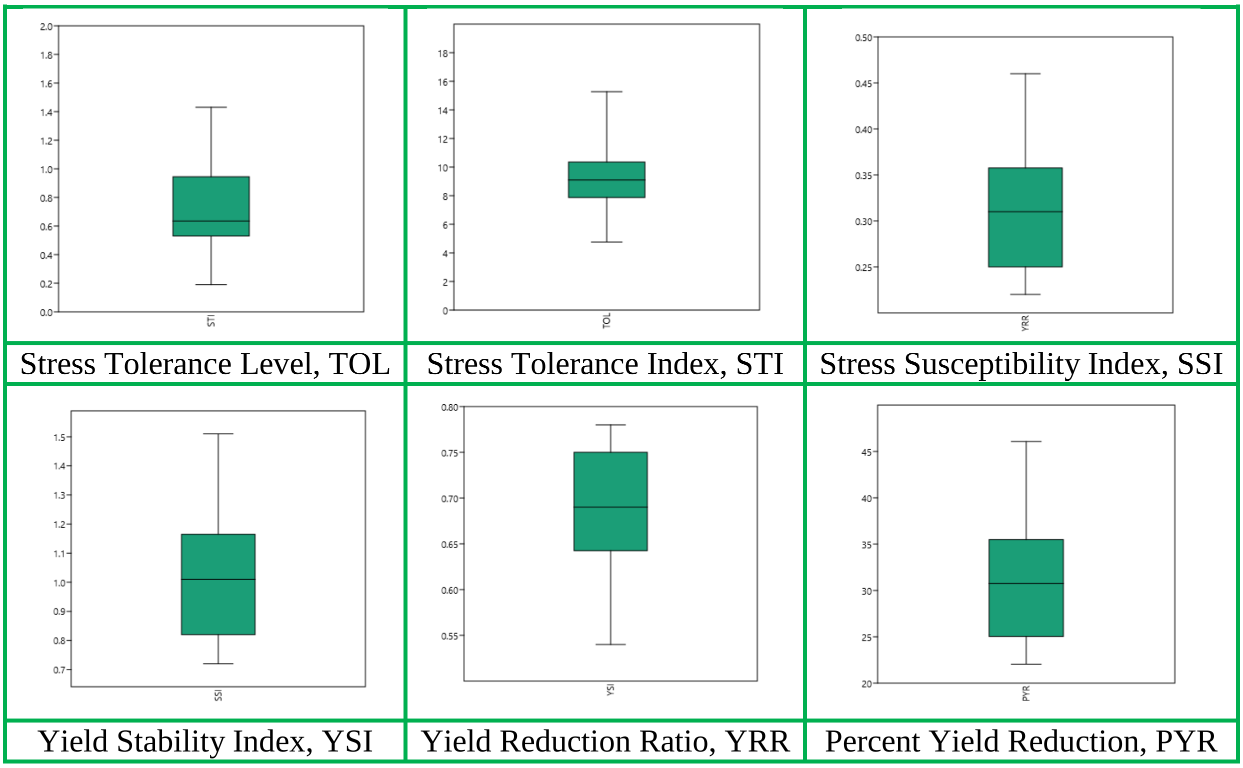

Fig.2: Illustration of variations in various stress indices for grain yield under P-deficient and sufficient conditions

Conclusion

There is a substantial genetic variability among the studied landraces of northeast for low P-tolerance. This implies the possibility and opportunity for productivity improvement in a P-deficient environment.

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