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DROUGHT TOLERANCE INDICES FOR SCREENING SOME OF RICE GENOTYPES

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ABSTRACT
Identification of rice genotypes for water stress condition is one of priority research area therefore, in order to quantify the drought tolerance genotypes, the rate of water response and contribution of yield components due to water availability of rice with different drought tolerance/resistant indices obtained from the yield data under water stress and irrigated sets of experiment were examined with 38 rice genotypes consisting 4 check variety Sahabhagidhan, Vandana, IR-36 and IR-64 and subjected to moisture stress for twenty days at different phenological stages. Yield data at different growth stages were used for the analysis of drought tolerance indices. Drought tolerance indices were varied significantly indicating genotypic variability. Different drought indices probably measure similar aspect of drought tolerance/resistance. The stress tolerance index (STI) and yield index (YI) were superior in genotype RAU-1421-12-1-7-4-3, RAU-1397-25-8-1-2-5-4, RAU-1428-6-7-3-6 and RAU-1451-35-7-6-9-5-1 indicating that they can be used as alternative for each other to select drought tolerant genotypes with high yield performance in both conditions. The stress susceptibility index (SSI), Tolerance Index (TOL) and yield stability index (YSI) were superior in the genotype Rasi, Vandana, RAU-1428-31-5-4-3-2-2-2 closely followed by RAU-1421-15-3-2-5-7-3 and RAU-1428-31-5-4 indicated that SSI, TOL and YSI can be used to screen drought resistant and suitable genotypes under two reproductive stage drought condition.

KEYWORDS: Rice, drought stress, seed yield, tolerant and sensitive indices

INTRODUCTION

Rice consumption in the developing countries of the world had been on the rise due to changes in demographic profile of the populace (Bamidele *et al*., 2010) and the ease of its preparation (Ojogho and Erhabor, 2011). Rice production is constrained by biotic and abiotic factors, especially among resource challenged famers in India, where rainfall pattern was observed to be more erratic than before , likely to be caused by changes in global climate. India has witnessed severe drought in the year 2002, 2009 and 2012 which caused reduction of yield (21.5 in 2002 and 10.02 in 2009) million tons (Manjappa and Shailaja, 2014). The timing of drought, early season, mid-season or terminal stage, has a major influence on how much yield loss occurs (Fischer *et al*., 2003). Variability of drought and yield attributing characters are prerequisite for the identification of drought tolerant high yielding genotypes. Rice is particularly sensitive to drought stress during reproductive growth, even under moderate drought stress (Hsiao 1982 , O'Toole 1982). In rice, moderate stress can be broadly characterized by a 31 to 64% loss in grain yield as compared with non-stress conditions (Kumar *et al*., 2008). The ability of crop cultivars to perform reasonably well in drought-stressed environments is paramount for stability of production. The relative yield performance of genotypes in drought-stressed and non-stressed environments can be used as an indicator to identify drought-resistant varieties for drought-prone environments. Several drought indices have been suggested on the basis of a mathematical relationship between yield under drought conditions and non-stressed conditions. These indices are based on either drought resistance or drought susceptibility of genotypes (Raman *et al*. 2012). Therefore, in order to quantify the drought tolerance in rice genotypes and contribution of yield components due to water availability of rice with different drought tolerance/resistant indices obtained from the yield data under rainfed upland stressed and irrigated non stressed condition experiments.

MATERIALS & METHODS

38 rice genotypes consisting 4 check variety Sahabhagidhan, Vandana, IR-36 and IR-64 were tested under both water stress and irrigated conditions in RBD with three replication at experimental field of Bidhan Chandra Krishi Viswa-Vidyalaya Mohanpur, Nadia at Jaguli Instructional Farm (Gangetic Alluvial Zone) and Regional Research Station (Red & Laterite Zone) Jhargram, Paschim Medinipur, West Bengal during 2015-2016 growing season. Direct seeding was done in water stress (rainfed) set of experiment while, transplanting was done in irrigated set on same dates. The irrigated experiment was considered to be a favourable condition so that plots were watered at planting, tillering, heading, flowering and grain filling stages. Nitrogen and phosphorus Potash fertilizers were applied at the rate of 100:60:40 Kg/ha. Half dose of nitrogen + full doses of phosphorus Potash fertilizers at the time of sowing and remaining half dose of nitrogen in two equal doses at the time of tillering and panicle initiation stages of crop growth were applied. The total dry weight and grain yield were measured by harvesting per m^2 of each plot at crop

maturity. The grain yield data were recorded for each genotypes at both environment (non stress-irrigated and drought stress) and were subjected to calculate drought selection indices. The drought tolerance/ resistance indices were calculated using the following formulas:

(1) Drought Susceptibility Index (DSI)-1-Ys/Yp / 1- Mean Ys / Mean Yp (Fischer and Maurer 1978)

(2) Stress tolerance, TOL - Yp-Ys (Rosielle and Hamblin 1981)

(3) Stress tolerance index, STI-(Ys) (Yp)/ $(Yp)^2$ (Fernandez, 1992)

(4) Yield index, YI = Ys/ Mean of Ys (Gavuzzi *et al*. 1997)

(5) Yield stability index, YSI = Ys / Yp (Bouslama and Schapaugh 1984) in which *Ys* denote the mean yield of genotype under stress and *Yp* the mean yield of genotype under non-stress (irrigated) conditions.

RESULTS & DISCUSSION

Drought Indices

Different drought indices probably measure similar aspect of drought tolerance / resistance. Results obtained on mean yields of all genotypes evaluated under stress and non-stress (irrigated) conditions illustrated in Mean Table 1.

TABLE 1: Mean performance of thirty eight genotypes of rice for seven drought tolerance indices characters under stress condition

Genotype	YS	YP	DSI	TOL	STI	YI	YSI
RAU-1428-6-7-3-6	8.630	10.697	-0.557	-2.067	1.240	1	1.236
RAU-1417-2-1-5-7-7	10.630	5.630	0.356	5.000	0.532	1	0.508
RAU-11421-12-1-7-4-3	12.333	8.660	0.173	3.673	0.713	1	0.697
RAU-1415-35-76-9-5-3	13.063	12.983	-0.167	0.080	0.994	1	1.007
RAU-1401-18-1-4	10.617	4.700	0.467	5.1917	0.444	1	0.470
RAU-1401-18-1-5	8.963	5.767	0.208	3.197	0.652	1	0.633
RAU-1428-43-2-7-26	8.373	3.240	0.507	5.133	0.388	1	0.371
RAU-1478-52-2-4-6	7.993	5.080	0.200	2.913	0.636	1	0.635
RAU-1428-54-35-5-5	12.567	8.433	0.214	4.133	0.671	1	0.668
RAU-1421-15-3-2-5-3-7	8.400	5.087	0.230	3.313	0.608	1	0.590
RAU-1421-12-1-7-4-3	9.747	12.743	-0.589	-2.997	1.319	1	1.385
RAU-1477-9-7-22-5-7-3	7.333	5.033	0.122	2.300	0.691	1	0.662
RAU-1451-66-1-1-5-2	10.333	6.637	0.227	3.697	0.641	1	0.630
RAU-1416-4-2-5-2-2	11.433	4.877	0.475	6.557	0.431	1	0.410
RAU-1397-25-8-1-2-5-4	9.203	11.767	-0.579	-2.563	1.285	1	1.331
RAU-1417-11-1-74-3-2	8.113	5.993	0.082	2.120	0.747	1	0.753
RAU-1421-15-3-2-5-7-3	10.667	4.257	0.517	6.410	0.399	1	0.399
RAU-1451-35-7-6-9-5-1	8.887	10.110	-0.417	-1.223	1.141	1	1.167
RAU-1426-43-2-5-7-2	9.993	6.147	0.251	3.847	0.616	1	0.619
RAU-1428-31-5-4	14.510	7.927	0.362	6.583	0.546	1	0.557
RAU-1428-31-5-4-3-2-2-2	14.817	6.230	0.516	8.587	0.420	1	0.418
RAU-1463-16	8.393	5.140	0.237	3.253	0.615	1	0.629
RAU-1471-10	7.990	6.693	-0.055	1.297	0.837	1	0.836
RAU-1463-15	13.510	7.247	0.377	6.263	0.537	1	0.524
RAU-1453-12	8.360	4.843	0.278	3.517	0.580	1	0.588
RAU-1415-8-6-4-3-3	10.633	4.987	0.426	5.647	0.470	1	0.467
2128-BAU445-06	9.633	7.673	0.034	1.960	0.798	1	0.780
Sahbhagidhan (Check)	11.687	12.657	-0.292	-0.970	1.090	1	1.053
22823Rewa780-8	10.493	5.827	0.321	4.667	0.558	1	0.585
Richharia	14.050	9.660	0.202	4.390	0.688	1	0.677
Vandana (Check)	13.883	6.753	0.438	7.130	0.488	1	0.509
Rasi (c)	12.217	6.320	0.384	5.897	0.519	1	0.492
APO (c)	11.463	5.577	0.430	5.887	0.484	1	0.496
DULAR	9.860	5.733	0.292	4.127	0.582	1	0.631
IR-36	6.770	7.550	-0.435	-0.780	1.120	1	1.132
IR-64	8.297	6.743	-0.036	1.553	0.813	1	0.792
DHANLAXMI	11.647	8.993	0.076	2.653	0.774	1	0.743
GAUTAM	7.543	6.187	-0.065	1.357	0.827	1	0.786
MEAN	10.343	7.121	0.137	3.223	0.708	1	0.707
SE	0.353	0.42	0.047	0.552	0.046	0.054	0.047
CD 5%	1.21	1.013	0.137	1.585	0.147	0.155	0.137

(YS-Yield under Drought stress condition, YP- yield under irrigated condition, Drought Susceptibility Index (DSI), Tolerance (TOL), Stress tolerance index (STI), YI- Yield Index, Yield Stability Index (YSI).

Drought susceptibility index (DSI)

Ys and Yp are the mean yield of genotypes under stress and non stress conditions and the genotypes with lowest value of DSI are more resistant to drought conditions. Result indicated that the genotype GAUTAM, RAU-1471-10, RAU-1428-6-7-3-6, RAU-1415-3-5-76-9-5-3, RAU-1397-25-8-1-2-5-4 had the lowest DSI followed by IR-36, RAU-1451-35-7-6-9-5-1 & RAU-1421-12-1-7-4-3 exhibited resistance to drought while, genotypes RAU-1428-31-5-4-3-2-2-2, RAU-1428-43-2-7-26 followed by RAU-1401-18-1-4 and RAU-1416-4-2-5-2-2 exhibited

susceptibility and all other genotypes were intermediate in nature.

Tolerance (TOL)

The genotypes with low values of this index (TOL) are more stable in two different conditions and suitable for the screening of breeding materials for drought tolerance. Significant variability were found amongst the genotypes for tolerance (TOL) and rice genotypes IR-36, RAU-1451-35-7-6-9-5-1, RAU-1428-6-7-3-6, RAU-1397-25-8-1-2-5-4 and RAU-1421-12-1-7-4-3 exhibited the lower TOL values and Genotypes RAU-1428-31-5-4-3-2-2-2, RAU-1428-31-5-4 and RAU-1421-15-3-2-5-7-3 higher TOL values indicating non suitability for the drought conditions. Similar results were recorded by several workers for Selections based on these indices (Pantuwan *et al*., 2002, Ouk *et al*., 2006 and Sio-Se Mardeh *et al*., 2006).

Stress tolerance index (STI)

Stress tolerance index (STI) varied significantly and genotype with high values indicated the tolerance to drought condition. Genotypes RAU-1421-12-1-7-4-3, RAU-1397-25-8-1-2-5-4, RAU-1428-6-7-3-6 and RAU-1451-35-7-6-9-5-1 with high STI values indicating the tolerance towards the moisture stress.

Yield Index (YI)

The genotype with high values of Yield index (YI) found suitable for drought condition. The genotype had >1 value considered tolerant while, the genotypes having <1 value denoted as susceptible one. The genotypes RAU-1421-12-1-7-4-3, RAU-1397-25-8-1-2-5-4, RAU-1428-6-7-3-6 and RAU-1451-35-7-6-9-5-1 showing higher values as in case of STI cross testing the genotypes suitable for drought condition. Similarly lower values of YI were noted in the genotypes exhibited susceptibility to drought and all other genotypes were intermediate.

Yield Stability Index (YSI)

The genotypes with high YSI values can be regarded as stable genotypes under stress and non stress conditions. Significant differences were found amongst the genotypes for YSI and as in case of SSI the genotype Rasi, Vandana, RAU-1428-31-5-4-3-2-2-2 closely followed by RAU-1421-15-3-2-5-7-3 and RAU-1428-31-5-4 had the highest YSI exhibited stability to stress while, lower values exhibited un-stability under stress and all other genotypes were intermediate in nature. Similar findings on these indices were carried out by many authors (Garrity and O'Toole 1995, Pantuwan *et al*., 2002, Ouk *et al*., 2006, Sio-Se Mardeh *et al*., 2006, Kumar *et al*., 2008 and Raman *et al*., 2012).

CONCLUSION

Study indicated that selection based on drought indices will result in the identification of genotypes with significantly higher performance under moderate to severe drought on the cost of slightly lower yield under normal irrigated condition. Among 38 genotypes, the combination of five drought indices and deviation identified RAU-1421-12-1-7-4-3, RAU-1397-25-8-1-2-5-4, RAU-1428-6-7-3-6 and RAU-1451-35-7-6-9-5-1 as four promising high-yielding drought-tolerant genotypes as the stress tolerance index (STI) and yield index (YI) were superior indicating that they can be used as alternative for each other to select drought tolerant genotypes with high yield performance in both stress and non-stress conditions. The stress susceptibility index (DSI), tolerance (TOL), and yield stability index (YSI) were superior in the genotype Rasi, Vandana, RAU-1428-31-5-4-3-2-2-2 closely followed by RAU-1421-15-3-2-5-7-3 and RAU-1428-31-5-4 indicated that DSI, TOL and YSI can be used to screen drought resistant and suitable genotypes under two reproductive stage drought condition.

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