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SCREENING OF F_3 SEGREGATING POPULATION FOR DROUGHT TOLERANCE THROUGH DROUGHT SUSCEPTIBILITY INDEX IN RICE

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Abstract

A field experiment was conducted to compare and evaluate sixty different rice genotypes of F_3 population grown under drought stress conditions. They were selected for estimation of drought susceptibility index (DSI) under three different water regimes. The use of DSI is likely to be most beneficial in selecting parents for development of drought resistant population, particularly when yield potential vary greatly among the tested genotypes. 36 lines in irrigated and 26 lines in direct sowing were recorded with lowest DSI (DSI<1/=1) for seed yield.

Key words : Drought susceptibility index, drought tolerance, rice.

Introduction

Drought is the most severe abiotic stress reducing rice yield in rainfed drought prone ecosystems. Variation in intensity and severity of drought from season to season and place to place requires cultivation of rice varieties with different level of drought tolerance in different areas (Jonaliza *et al*., 2004). Rice is one of the important cereals grown across the world. From the very beginning of agriculture, drought stress is one of the most important factors, causing famine and death by its influence on plant productions. There are five main reasons of the importance of drought stress; its unpredictability, the way of occurrence, intensity, time and duration of drought. On the other hand, interaction between drought stress and other abiotic stresses such as high temperature and changes in nutrition availability limits plant growth and development. Drought stress is a multidimensional stress that affects different plant growth stages (Raman *et al*., 2012). It is not only limited to arid or semi arid areas, but also sometimes, due to irregular distribution of rain, causes unfavorable conditions for plant growth and development. It's obvious that drought stress causes significant decrease of plant yield (Vikram *et al*., 2011).

Materials and Methods

The planting material was sixty F_3 segregating progenies of a cross between MTU1010 (susceptible to water stress, semi-dwarf, grains- long slender, white, resistant to blast) and IR86931-B-6 (tolerant to water stress, semi-tall, grains-medium slender) derived from (Krishnaveni × IR64 and Nagina 22). Each segregating progeny had 10 plants, under irrigated condition and under water stares condition per line single plants are selected and separate the tillers and transplanted in irrigated and water stress condition. Recorded observations under field condition - days to flowering, tillers/plant, plant height, panicle length, effective tiller/plants, grain yield.

Statistical analysis

Mean

Mean is the average value of observation of genotypes of a series. It represents the standard average value over fluctuation in the environment. Mean was calculated by the following formula

$$\overline{X} = \sum X_i / n$$

Where,

ΣX_i = Summation of all the observations

n = Total number of observations

Range

It is the difference between the highest and the lowest terms of a series of observation.

Range = X_H - X_L

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Table 1 : Symptoms of heat stress in rice plants.

Growth stage	Threshold temperature (°C)	Symptoms	References
Emergence	40	Delay and decrease in emergence	Yoshida (1978), Akman (2009)
Seedling	35	Poor growth of the seedling	Yoshida (1981)
Tillering	32	Reduced tillering and height	Yoshida (1978)
Booting	-	Decreased number of pollen grains	Shimazaki *et al.* (1964)
Anthesis	33.7	Poor anther dehiscence and sterility	Jagadish *et al.* (2007)
Flowering	35	Floret sterility	Satake and Yosida (1978)
Grain formation	34	Yield reduction	Morita *et al.* (2004)
Grain ripening	29	Reduced grain filling	Yoshida (1981)

(Source: Saha *et al.*, 2011).

Where,

X_H = Highest value

X_L = Lowest value

Drought susceptibility index (DSI)

Calculated by the formula given by Fischer and Maurer (1978).

$$DSI = (1 - Yd / Yp) / D$$

Where,

Yd = Grain yield of the genotype under moisture stress condition.

Yp = Grain yield of the genotypes under irrigated condition.

$$D = 1 - \frac{\text{Mean yield of all strains under moisture stress condition}}{\text{Mean yield of all strains under irrigated condition}}$$

Results and Discussion

The segregating population was phenotype under two set of environmental conditions, one under irrigated condition and another under moisture stress condition during wet season 2012. The mean data of irrigated and moisture stress condition were used for evaluation of drought susceptibility index (DSI) and subsequent analysis.

Drought susceptibility index (DSI)

The managed water stress protocol resulted in considerable reduction in yield compared to yield under irrigated condition. Reduction in yield ranged between 3.33-79.56%, whereas average reduction was 45.86% as compared to yield under irrigated condition. Comparison among yield at two environments indicate that the line no. 37 emerged as tolerant genotype for grain yield under both the conditions.

The use of DSI can help to distinguish suitable population for drought stress from phenology and yield potential (Mall *et al*., 2013). Large DSI values indicate greater drought susceptibility (Chauhan *et al*., 2007). Low DSI mean value (DSI<1) observed for seed yield indicated that this character is relatively resistant to stress. The list of thirty six lines in irrigated condition and twenty six lines in direct sowing condition recorded lowest DSI (DSI≤) for seed yield over the conditions, thereby indicating that the genotypes were tolerant to drought stress conditions. Phenotypic data recorded in the field was used for identification of DSI for yield under different sets of condition (irrigated, direct sowing and moisture stress condition). The mean yields of total population of sixty lines in irrigated, direct sown and moisture stress condition were 22.71g, 40.43g and 9.31g, respectively. From the total population, thirty six lines from irrigated condition had shown the DSI value <1, which shows the drought tolerance and DSI value >1 shows drought susceptible. Similarly in direct sown condition twenty six lines are drought tolerance. Same result are found that Chopra *et al.* (2013) characterization of high yielding and drought tolerant RILs identified from wheat crops WL711 × C306 RIL mapping population use, Mall *et al.* (2013) found that development of different rice varieties for drought tolerance through DSI and also same result are found Jin *et al*. (2010) root-specific expression of OsNAC10 improves drought tolerance and grain yield in rice under field drought conditions.

Table 2 : Phenotypic data of population.

S. no.	Total tiller 45 days	Seedling PH	DF	ET	PL	PH at maturity	Irrigated yield	Direct sowing yield	MS DF	MS ET	MS PL	MS yield
1.	6	41	113	6	26.5	85	15	60	104	5	22	7
2.	9	60	113	6	22.8	86	5	12	112	7	22	2
3.	5	65	110	4	25.3	93	16	36	109	5	22	7.3
4.	7	72	107	7	22	95	10	34	102	5	20	4.1
5.	4	57	111	3	23.9	100	20	50	101	5	20	7.1
6.	7	66	111	11	25.5	84	6	60	104	1	15	2.5
7.	5	66	108	18	25.5	97	55	30	106	4	25	13.7
8.	4	72	109	5	26	103	50	24	108	5	25	13.1
9.	7	76	102	8	27.5	107	80	62	102	7	23.5	18.5
10.	7	72	107	4	23	90	5	26	99	6	22	4.7
11.	15	71	103	12	29	111	35	56	103	8	24	10.7
12.	4	60	110	12	25.5	89	26.66	34	108	5	15	5.5
13.	6	72	103	3	26	95	35	25	107	4	23	18.3
14.	8	77	105	12	25.5	117	35	34	104	7	24	11.2
15.	13	78	102	8	30	108	15	54	102	8	25	13.9
16.	3	52	111	19	25.3	101	12	40	109	5	18	3.8
17.	9	65	112	4	26	99	40	42	102	4	14.5	11.4
18.	4	62	106	14	27.5	105	3.33	36	107	6	20	2.58
19.	10	66	112	8	26	104	135	30	106	9	23	27.6
20.	5	66	104	14	25	97	5	24	106	4	22	4.2
21.	5	62	95	3	27.5	102	30	28	96	3	26	10.3
22.	5	59	102	8	26	112	10	28	101	7	24	6.8
23.	4	68	103	6	26	116	62.5	40	0	6	23	20.3
24.	8	66	98	8	26	116	20	36	101	4	27	11.2
25.	5	72	100	4	27	119	42.5	50	97	5	24	9.3
26.	8	87	89	6	27.5	108	3	10	93	6	22.8	1.97
27.	7	76	102	6	28	123	34	54	104	5	26.5	11.3
28.	6	89	92	2	23	72	10	12	98	3	16	9.2
29.	5	63	104	3	25	83	3.5	50	98	4	23.5	2.37
30.	5	55	95	3	21	98	18	30	99	8	21.5	9.1
31.	21	86	102	15	28	148	77.5	48	107	8	22	21.5
32.	4	61	105	6	28	117	7.14	58	108	5	22.5	4.8
33.	7	66	95	7	28	107	13.33	32	98	5	22	7.5
34.	11	59	96	12	23.5	94	50	40	95	4	23	14.2
35.	5	55	95	5	26.5	100	6.25	36	107	5	21	4
36.	3	72	102	3	26.5	121	24.28	60	102	3	23	8.2
37.	3	68	100	6	24	119	15	32	96	4	23	14.5
38.	8	66	91	11	25	105	21.66	46	97	4	28	9.1
39.	3	58	104	3	23.5	98	33.33	34	95	4	21	15.6
40.	3	58	104	3	25	97	26.66	58	100	5	21	18.6
41.	3	70	96	4	27	104	13.33	30	98	4	21.5	7.2
42.	3	60	91	6	19.7	100	10	42	99	4	25	6.6
43.	13	60	99	11	26	115	10	76	98	10	26	8.6
44.	3	71	97	5	27.5	92	13	22	98	4	23.5	12.2
45.	3	77	96	5	28	72	17	40	96	4	27	10.5

Table 2 continued...

Table 2 continued...

46.	3	86	101	2	28	92	9	46	98	4	25.5	6.8
47.	4	58	105	1	26	96	10	50	102	4	24.2	4.2
48.	5	63	104	6	27.5	99	13.33	66	103	4	22	12.1
49.	3	61	96	3	27	113	10	20	102	4	25	7.7
50.	3	66	94	4	25	101	15	46	97	5	25	8.5
51.	7	74	102	4	30	108	12	44	106	8	22.5	3.2
52.	7	60	95	7	25.5	103	10	32	98	6	22	7.5
53.	4	70	91	13	23.5	103	14	26	94	5	21	9.5
54.	3	70	99	4	28.5	101	21	36	99	5	22	7.4
55.	3	70	93	5	24	108	16.66	84	96	3	23	8.8
56.	4	60	95	3	23	97	4.444	28	95	2	24	2.8
57.	5	85	99	3	23	116	10.55	68	97	4	23.5	7.5
58.	3	64	89	4	22.5	89	16.66	48	96	2	22	11.7
59.	3	74	99	2	26	90	10	36	102	5	20.5	5.5
60.	3	76	95	4	26.2	112	14	44	101	7	23	11.9

PH = Plant height, DF = Days to flowering, ET = Effective tiller, PL = Panicle length
MS DF = Moisture stress condition days to flowering, MS ET = Moisture stress condition effective tiller.

Table 3 : Estimation of drought susceptibility index of sixty segregating population.

S. no.	Segregating population	Under irrigated condition DSI	Under direct sowing condition DSI
1.	MTU 1010 X IR 86931-B-3	0.93	1.15
2.	MTU 1010 X IR 86931-B-3	1.05	1.08
3.	MTU 1010 X IR 86931-B-3	0.95	1.04
4.	MTU 1010 X IR 86931-B-3	1.03	1.14
5.	MTU 1010 X IR 86931-B-3	1.13	1.12
6.	MTU 1010 X IR 86931-B-3	1.02	1.25
7.	MTU 1010 X IR 86931-B-3	1.31	0.71
8.	MTU 1010 X IR 86931-B-3	1.29	0.59
9.	MTU 1010 X IR 86931-B-3	1.34	0.91
10.	MTU 1010 X IR 86931-B-3	0.10	1.07
11.	MTU 1010 X IR 86931-B-3	1.21	1.05
12.	MTU 1010 X IR 86931-B-3	1.39	1.09
13.	MTU 1010 X IR 86931-B-3	0.83	0.35
14.	MTU 1010 X IR 86931-B-3	1.19	0.87
15.	MTU 1010 X IR 86931-B-3	0.13	0.97
16.	MTU 1010 X IR 86931-B-3	1.20	1.18
17.	MTU 1010 X IR 86931-B-3	1.25	0.95
18.	MTU 1010 X IR 86931-B-3	0.40	1.21
19.	MTU 1010 X IR 86931-B-3	1.39	0.1
20.	MTU 1010 X IR 86931-B-3	0.28	1.07
21.	MTU 1010 X IR 86931-B-3	1.15	0.82
22.	MTU 1010 X IR 86931-B-3	0.56	0.98
23.	MTU 1010 X IR 86931-B-3	1.18	0.64
24.	MTU 1010 X IR 86931-B-3	0.77	0.9
25.	MTU 1010 X IR 86931-B-3	1.37	1.06
26.	MTU 1010 X IR 86931-B-3	0.60	1.04
27.	MTU 1010 X IR 86931-B-3	1.17	1.03
28.	MTU 1010 X IR 86931-B-3	0.14	0.3

Table 3 continued...

Table 3 continued...

29.	MTU 1010 X IR 86931-B-3	0.56	1.24
30.	MTU 1010 X IR 86931-B-3	0.86	0.91
31.	MTU 1010 X IR 86931-B-3	1.26	0.72
32.	MTU 1010 X IR 86931-B-3	0.57	1.19
33.	MTU 1010 X IR 86931-B-3	0.77	1
34.	MTU 1010 X IR 86931-B-3	1.25	0.84
35.	MTU 1010 X IR 86931-B-3	0.63	1.16
36.	MTU 1010 X IR 86931-B-3	1.16	1.12
37.	MTU 1010 X IR 86931-B-3	0.06	0.71
38.	MTU 1010 X IR 86931-B-3	1.01	1.04
39.	MTU 1010 X IR 86931-B-3	0.93	0.7
40.	MTU 1010 X IR 86931-B-3	0.53	0.88
41.	MTU 1010 X IR 86931-B-3	0.80	0.99
42.	MTU 1010 X IR 86931-B-3	0.59	1.1
43.	MTU 1010 X IR 86931-B-3	0.24	1.15
44.	MTU 1010 X IR 86931-B-3	0.11	0.58
45.	MTU 1010 X IR 86931-B-3	0.67	0.96
46.	MTU 1010 X IR 86931-B-3	0.43	1.11
47.	MTU 1010 X IR 86931-B-3	1.01	1.19
48.	MTU 1010 X IR 86931-B-3	0.16	1.06
49.	MTU 1010 X IR 86931-B-3	0.40	0.8
50.	MTU 1010 X IR 86931-B-3	0.76	1.06
51.	MTU 1010 X IR 86931-B-3	1.28	1.21
52.	MTU 1010 X IR 86931-B-3	0.44	1
53.	MTU 1010 X IR 86931-B-3	0.56	0.83
54.	MTU 1010 X IR 86931-B-3	1.13	1.03
55.	MTU 1010 X IR 86931-B-3	0.83	1.16
56.	MTU 1010 X IR 86931-B-3	0.65	1.17
57.	MTU 1010 X IR 86931-B-3	0.51	1.16
58.	MTU 1010 X IR 86931-B-3	0.53	0.98
59.	MTU 1010 X IR 86931-B-3	0.79	11
60.	MTU 1010 X IR 86931-B-3	0.26	0.95

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