Electronic Journal of Plant Breeding, 5(3): 331-339 (Sep 2014)
ISSN 0975-928X

Research Article

Effect of water stress at reproductive stage on yield potential and stability of rice (*Oryza sativa* L.) genotypes grown in rainfed lowland conditions

Santosh Kumar*, Sharad Kumar Dwivedi and S S Singh

Division of Crop Research, ICAR Research Complex for Eastern Region, Patna 800014 (Bihar)
*Email: santosh9239@gmail.com

(Received: 03 Feb 2014; Accepted:26 May 2014)

Abstract
The present study was conducted at ICAR research complex for eastern region, Patna during *kharif* 2012 and 2013 with objective to identify rice genotypes having high yield potential and stability under water stress (drought) conditions. Fifteen rice (*Oryza sativa* L.) genotypes were grown under irrigated and water stress conditions. Water stress was imposed at reproductive stage by withholding irrigation supply. Yield and yield attributesof rice genotypes under water stress condition were recorded. The effects of water stress on various physio-morphological traits associated with drought tolerance were also studied at reproductive stage. Results revealed that, significant yield decline was observed in most of the genotypes grown under stress condition compared to non-stress condition. Drought susceptibility index (DSI) and relative grain yield (RY) were used to illustrate yield stability and yield potential, respectively. Significant variation in drought susceptibility index and relative yield values within genotypes were observed. The DSI values ranged from 0.68 to 1.46 and the mean RY values were 0.85 for irrigated plots and 0.77 for water stressed plots. The rice genotypes IR 83376-B-B-24-2, IR 83373-B-B-24-3 IR 84895-B-B-127-CRA-5-1-1 and IR83387-B-B-27-4 showed high yield potential and stability (i.e. DSI<1; and RY>mean RY). These drought tolerant genotypes were also superior in terms of grain yield and higher content of desired physio-morphological traits in terms of plant biomass, relative water content, soluble protein and proline content. These drought tolerant rice genotypes may be adopted in large area in rainfed lowland ecosystem where drought is frequent, particularly at reproductive stage.

Key words:
Rice, drought, water stress, yield potential, yield stability.

Introduction:
Rice (*Oryza sativa* L.) is one of the most important cereal and staple food of about 65% of the world's population. It is cultivated under diverse ecologies ranging from irrigated to rainfed and upland to lowland to deep water system. Rainfed rice accounts for around 45% of the world's rice area. Rainfed rice-growing areas are highly prone to abiotic stresses such as drought or submergence depending upon the amount and distribution of rainfall and topography of the region. Among the different stresses, drought is the single largest yield reducing factor in rainfed areas of South and Southeast Asia, with production losses upto 23 million ha (Huke and Huke, 1997)). Losses due to reproductive-stage drought stress are most severe in the key rice-producing states of eastern India: Chhattisgarh, Orissa, Jharkhand, Bihar, and eastern Uttar Pradesh. Most traditional as well as present high yielding varieties of the eastern region are highly susceptible to drought, particularly at reproductive stage. Degree and duration of drought stress during the reproductive stage in rainfed lowland rice is in need of identification and development of drought tolerant rice cultivars (Kamoshita *et al*., 2008) which have high yield potential and stability under water stress condition imposed at reproductive stage.

The ability of a cultivar to produce high and acceptable yield under stress and non-stress environment is very important. Finlay (1968) believed that stability over environments and yield potential are more or less independent of each other. Blum (1979) suggested that breeding for increased performance under water stressed condition might be to breed for superior yield under optimum conditions on the assumption that the best lines would also perform well under sub optimum conditions. Sojka *et al*. (1981), however, pointed out that a high yield baseline that allows a cultivar to do well over a range of environments does not imply drought resistance. They defined drought resistance as the ability to minimize yield loss in the absence of soil water availability. The ideal situation would be to have a highly stable genotype with higher yield potential (Smith, 1982).

The most widely used criteria for selecting genotypes with high grain yield performance are mean yield, mean productivity (average yield performance under stress and non-stress conditions) and relative yield performance in drought-stressed and more favourable irrigated environments. Relative yield (yield of an individual genotype under drought relative to that of the highest yielding genotype in the population) performance could be used to assess the yield potential of a genotype under water stressed conditions. Higher relative yield shows that the genotype performed relatively well under drought stress condition. Ahmad *et al.* (1999) found relative grain yield to be a useful criterion for assessing drought response.

Grain yield stability for each genotype is estimated by drought susceptibility index, developed on the basis of a mathematical relationship between yield under drought stress conditions and non-stressed conditions (Blum *et al.* 1989). Fisher and Maurer (1978) and Langer *et al*. (1979) used drought susceptibility index (DSI), which characterizes the yield stability between two environments. The drought susceptibility index (DSI), the ability of crop cultivars to perform reasonably well in drought stressed environments is paramount for stability of production.

Lower DSI values indicate lower difference in yield across stress level, in other words, more resistant to drought. There are many reports in literature on the use of DSI for identifying genotypes with yield stability in moisture limited environment (Clarke *et al*., 1984, Bruckner & Frohberg, 1987, Puri *et al*. 2010, Raman *et al.* 2012). The combination of high yield stability and high relative yield under drought has been proposed as useful selection criterion for charactering genotypic performance under varying degree of water stress (Pinter *et al.*, 1990).

Rice plants respond to drought through alternation in morpho-physiological and biochemical traits. Hence, traits associated with improved performance under water limited condition or improved survivals to extremely low water availability are diverse (Slafer *et al.* 2005). Drought impacts include growth, yield, membrane integrity, pigment content, osmotic adjustment, water relation and photosynthetic activities (Praba *et al.* 2009). Physiological and biochemical basis of yield gap between drought stress and irrigated condition has not been studied extensively. Understanding of physiological and biochemical mechanism that enable plants to adapt to water deficit and maintain growth and productivity during stress period could help in screening and selection of tolerant genotypes and using these traits in breeding programme (Zaharieva *et al*. 2001). Therefore, selection using morph-physiological and metabolic traits can improved the drought tolerance at reproductive stage in rice. Variation in maintaining internal plant water status at flowering was associated with grain yield under drought condition (Pantuwan *et al*. 2001). The maintenance of plant water status, more than plant functions, controls crop performance under drought (Blum 2002). Leaf rolling is one of the visible physiological responses to plant water deficit. It is an adaptive response to water deficit which helps in maintaining favourable water balance within plant tissues with resultant benefit to plants under conditions of water scarcity and depleting soil moisture (Singh and Singh, 2000). Plant recovery from desiccation in agricultural crops is primarily a function of the capacity for maintaining higher relative water content (RWC) during desiccation (Blum *et al.* 1999). There is need to establish reason of physiological and biochemical basis for yield gap among genotypes between reproductive stage stress and irrigated situation.

In this context, the objective of this study were to screen and identify rice genotype having high yield potential and stability under drought stress conditions at reproductive stage and to study the effect of water stress on physio-morphological and biochemical traits associated with drought tolerance in rice genotypes under rainfed condition of eastern India.

Material and methods

Experimental site:The field experiments were carried out at the experimental farm of the ICAR Research Complex for Eastern Region, Patna, India (latitude 25.30°N., longitude 85.15°E) during 2012-2013. The experimental site was typical rainfed having clay loam soil with pH 7.5, organic carbon 0.67 %, bulk density 1.47 g/cm^3, electrical conductivity 0.26 dS/m, available nitrogen 227 kg/ha, available phosphorous 28.4 kg/ha, and exchangeable potassium 218 kg /ha. The total rainfall was 617 and 591 mm during crop growth periods in 2012 and 2013, respectively.

Plant materials: Fifteen rice genotypes comprising of advanced breeding lines of 120-140 days of maturity duration, traditional drought tolerance landraces and check varieties of the eastern region *viz.*, Shusk Samrat, Swarna, Sambha Mahsuri, Lalat and Rajendra Sweta were used for testing under irrigated and reproductive stage stress condition. The advanced breeding lines have been generated by Intrnational Rice Research Institute under drought breeding network programme. The rice genotypes used under present study were collected from International Rice Research Institute (IRRI), Philippines and Central Rice Research Institute (CRRI), Cuttack.

Field experiments: The field experiments were conducted under reproductive stage drought stress and irrigated non-stress (control) condition. Experiments were laid out in an alpha lattice design with three replications. Twenty one days old seedlings were transplanted in 5m^2 plot. The single rice seedlings were transplanted manually in puddle field spaced 15 cm apart. Row to row space was maintained at 20 cm. After 7 days, missing hills were again re-transplanted fresh. In each plot a uniform plant stand were maintained and standard agronomic practices were followed for raising and maintenance of plants. Both stress and non-stress control field were fertilized at the rate of 100:60 : 40 kg ha^{-1} N, P_2O_5 and K_2O, respectively. Nitrogen was applied on three occasions (1/3 each at basal, maximum tillering and panicle initiation stage), while the P_2O_5 and K_2O were applied as a basal application.

In non-stress experiments, standing water was maintained from transplanting to 20 days before maturity by providing irrigation as and when required. The reproductive stage drought stress experiment was irrigated like the non-stress (control) experiments by keeping standing water up to 28 days after transplanting. Thereafter, the stress field were drained to allow them dry and for stress to develop. The drought stress experiments were not provided any supplemental irrigation after drainage till the susceptible checks shown permanent wilting. During the reproductive stage stress period soil moisture content status was monitored through periodical soil sampling at 15 and 30 cm soil depth after suspension water. Water table depth was also monitored during the stress period. The drought scores, leaf rolling, leaf drying and stress recovery observations were taken as per SES method, 1 to 9 scales (IRRI, 1996). Observations of yield and yield contributing traits i.e. days to 50% flowering (DFF), plant height (PH), tiller numbers per plant (TN/P), spikelet per panicle, percentage spikelet sterility and harvest index (HI) were recorded on ten randomly selected plants per genotype per replication.

Drought susceptibility index (DSI): Grain yield stability for each genotype is estimated by drought susceptibility index. Drought susceptibility index (DSI) that assesses the reduction in yield caused by unfavourable (stress) compared to favourable irrigated environments were suggested by Fisher and Maurer (1978). DSI is expressed by

$$DSI = [1- ((Y_i)_S / (Y_i)_{NS}] / SI$$

$(Y_i)_S$ and $(Y_i)_{NS}$ denote the yield of the i^{th} genotype under stress and non-stress (irrigated) condition, respectively. SI, the stress intensity is estimated as SI = 1- (Y_S/Y_{NS}). Y_S and Y_{NS} denote the mean yield of all genotypes evaluated under stress and non stress environments, respectively.

Yield potential: The relative yield (yield potential) under drought stress was calculated as the yield of specific genotypes under drought divided by that of the highest yielding genotype in the population.

Studies of Physiological and biochemical parameters: Physiological and biochemical parameters i.e., Plant biomass, relative water content (RWC), total soluble protein and proline content. Leaf relative water content (RWC) was estimated by recording the turgid weight of 0.5 g fresh leaf sample by keeping in water for 4 hours, followed by drying in hot air oven till constant weight is achieved (Weatherly, 1950).

$$Relative\ water\ content\ (\%) = \frac{(Fresh\ weight - Oven\ dry\ weight)}{turgid\ weight - oven\ dry\ weight} x\ 100$$

Observation on soluble protein (Lowry *et al*. 1951) and proline (Bates *et al*., 1973) were also recorded at reproductive stage.

Data analysis: The agro-morphological data were analyzed by appropriate statistical analysis (Gomez and Gomez, 1984) using CropStat 7.2 (IRRI 2009) programme. Physiological data was analyzed using OPSTAT software of Hisar Agricultural University, Hisar.

Results and discussion

Performance of grain yield and yield attributes under stress and non-stress condition: The results related to yield and yield attributes of rice genotypes under drought stress at reproductive stage and irrigated condition has been presented in Table 1. Rice genotypes grown under water stress condition produced significantly lower grain yields than flooded (non-stress) rice during both years. Yield decline was observed almost in all the rice genotypes grown under drought stress condition compared to irrigated situation. yield declined was ranged from 1.89 to 4.71 t ha^{-1} under water stress condition compared to non-stress (irrigated). Genotype mean yields ranged from 4.28 t ha^{-1} to 6.55 t ha^{-1} under non-stress irrigated condition and from 1.84 t ha^{-1} to 3.74 t ha^{-1} under stress condition. The yield reduction difference between drought stress and non-stress rice ranged between 33.5-71.9%. Minimum yield reduction was observed in IR83376-B-B-24-2 (33.5%). A similar result of yield reduction (12 to 46%) under drought stress condition was reported by Ouk *et al*., (2006). In other studies in Cambodia, Basnayake *et al.* (2004) estimated yield reduction due to drought from 9 to 51% in rice genotypes in multi-locational trial conducted in three year in the target environment. Under drought stress condition, the highest grain yields was observed in IR83376-B-B-24-2 (3.74 t ha^{-1}) followed by IR84895-B-127-CRA-5-1-1(3.57 t ha^{-1}) and IR83373-B-B-24-3 (3.53 t ha^{-1}). The grain yield of check varieties Swarna, Sambha Mahsuri, Lalat, Rajendra Sweta and Shusk samrat in drought stress condition was 1.84, 2.03, 2.31, 2.01 and 2.37 t ha^{-1} respectively. Heritability of grain yield under stress and non-stress condition were 0.85 and 0,69, respectively.

In general, across genotypes in both years a slight but insignificant delay in fifty percent flowering was observed under water stress condition as compared to non-stress irrigated situation; however, the responses varied among genotypes. Similar finding was also reported by Kumar *et al.*, (2009). High heritability was observed for days to fifty percent flowering under both stress and non-strss condition (Table1). Significant decrease in plant height was also observed in rice genotypes grown under drought stress condition. Singh (2000) reported that plant height reduced significantly due to drought in rice cultivars. Rice grown in drought stress condition produced significantly less total biomass than irrigated rice (Table 2). The Similar trends were observed for effective tiller number, harvest index and test weight. Under drought stress condition, genotypes had lower test weight (1000 grain weight) and grain filling percentage than irrigated rice. Drought tolerant genotypes IR83376-B-B-24-2 (87.1%) followed by IR83373-B-B-24-3 (86.3%) and IR84895-B-127-CRA-5-1-1(85.5%) showed high percent spikelet fertility than susceptible and check varieties. Similar findings were reported in rice by Garrity *et al.* (1994). This result suggested that spikelet fertility is a reliable parameter for the screening of genotypes for yield response subjected to water deficit stress at reproductive stage. Depletion of soil moisture during the reproductive stage increased the percent spikelet sterility, might have resulted in decreased grain yield under stress condition. Non-significant differences were observed for sterility percentage, harvest index, plant biomass and protein content under non-stress (control) condition.

Significant variations were observed among genotypes for drought tolerance parameters such as leaf rolling, leaf drying and stress recovery. Drought tolerance genotypes viz., IR83376-B-B-24-2, IR84895-B-127-CRA-5-1-1, and IR83373-B-B-24-3 had lesser leaf rolling, leaf drying and better stress recovery (Table 2). They showed the delayed leaf rolling and drying. Leaf rolling was induced by the loss of turgor and poor osmotic adjustment in rice and delayed leaf rolling is an indication of turgor maintenance and dehydration avoidance. Leaf rolling and drying showed negative correlation with plant biomass. Beena *et al.* (2012) have also reported similar finding in rice. Mackill (1991) reported that delayed leaf rolling was positively related to drought resistance and recovery from drought.

<u>Drought Susceptibility index:</u> Drought susceptibility index assess the reduction in yield caused by unfavourable environment compared to favourable. DSI is a measure of yield stability. The drought susceptibility index values (Table 3) ranged from 0.68 to 1.46. The rice genotypes IR83376-B-B-24-2 (0.69), IR833373-B-B-107-3 (0.75), IR83387-B-B-27-4 (0.79), IR83373-B-B-24-3 (0.81) and IR84895-B-127-CRA-5-1-1 (0.83) were relatively drought tolerant (DSI values < 1) while the genotypes IR83377-B-B-123-2 (1.09), Swarna (1.46), Sambha Mahsuri (1.36), Lalat (1.19), Rajendra Sweta (1.32) were relatively drought susceptibility (DSI values > 1). Lower DSI values indicate the lower differences in yield between non-stress and stress condition, in other words more tolerance to drought. Timing of drought stress in relation to the development of different genotypes or lack of adaptation to unfavourable environments could be other possible reason of variation in DSI. The results of this study are in good agreement with the earlier finding of Clarke *et al.* (1992), Prakash (2007) and Raman *et al.* (2012). Genotypes with low DSI values (less than I) can be considered to be drought resistant (Chauhan *et al*., 2007) because they exhibited smaller yield reductions under water stress compared with well-watered conditions than the mean of all genotypes. Drought susceptibility index is therefore more useful for identifying stress tolerant genotypes that perform well in stress environment. The DSI has sometime been represented as providing a measure of genotypic yield potential under water stress conditions (Brukner and Frohberg, 1987). However, DSI does not account for differences in yield potential among genotypes (Clarke *et al.,* 1992). DSI actually provide a measure of yield stability based on minimization of yield loss under stressed compared to non stressed conditions rather than on yield level under dry conditions per se (Clarke *et al.*, 1984). Therefore, stress tolerant genotypes as defined by DSI, need necessarily not to have a high yield potential.

The mean relative grain yield values under drought stress and non-stress irrigated treatments were 0.77 and 0.85, respectively (Table 3). In case of drought stress, mean relative yield less than that of non-stress irrigated condition. Drought tolerant genotypes viz. IR83376-B-B-24-2, IR83373-B-B-24-3, IR84895-B-127-CRA-5-1-1, IR833373-B-B-107-3 and IR83387-B-B-27-4 were relatively high yielding under drought stress (RY > mean RY) while susceptible genotypes Swarna, Sambha Mahsuri, Lalat and Rajendra Sweta were relatively low yielding (RY < mean RY) in this treatment. This was in agreement with the results of Ahmad *et al.* (2003).

<u>Physiological and biochemical parameters response:</u> Physiological and biochemical traits *viz.* Plant biomass, relative water content (RWC), total soluble protein and proline content influence greatly under drought stress at reproductive stage condition.

The capacity to maintain higher relative water content (RWC) under drought stress condition has been suggested as a possible water scarcity tolerance mechanism in rice (O'Toole and Moya

1978). A significant difference in RWC was observed among genotypes between drought stress and non-stress condition. In water stress condition, higher value of RWC was recorded in water deficit stress tolerant rice genotypes as compared to susceptible one at reproductive stage. Highest value of RWC was observed in IR83373-B-B-24-3 (65.3%) followed by IR83387-B-B-27-4 (64.1%) and IR83376-B-B-24-2 (61.9%) (Table 2). Study revealed that relative water content of all genotypes reduced significantly under drought stress situation as compared to non-stress (control) condition.

Under drought stress condition, the genotypes, IR83387-B-B-40-1, IR83376-B-B-24-2 and IR84895-B-127-CRA-5-1-1 showed less reduction in total soluble protein content compared to other genotypes and check varieties (Table 2). This was in agreement with the results of Jha and Singh (1997) and Beena *et al*. (2012) that water scarcity stress tolerant rice genotypes had comparatively higher protein content than susceptible lines under drought stress condition. Reduction of soluble protein under water stress condition suggested that lipid production products hydrolyze protein mRNAs (Jiang *et al.*, 1991). Drought stress condition caused average increased in proline content (54.87 %) across genotypes as compared to irrigated. Highest value of proline content was observed in IR83376-B-B-24-2 followed by IR83373-B-B-24-3 and IR84895-B-127-CRA-5-1-1 under drought stress condition (Table 2).

Overall, it was observed in present study that water stress imposed at flowering stage significantly reduced grain yield in all rice genotypes. The differential responses of genotypes to imposed water stress condition indicated its drought tolerance ability. This study also indicated that selection based on drought susceptibility index will results in the identification of drought tolerant genotypes with significantly superior and stable performance of yield and yield attributes, physiological and biochemical traits over current cultivated varieties under water stress condition in rainfed lowland drought prone ecosystem. The genotypes, IR 83376-B-B-24-2, IR 83373-B-B-24-3 IR 84895-B-B-127-CRA-5-1-1 and IR83387-B-B-27-4 showed high yield potential and stability. They showed highest yield under normal irrigated condition and good yield under drought stress condition through better maintenance of desired physiological and biochemical activities. These drought tolerant rice genotypes may be adopted in large area of rainfed lowland ecosystem where drought is frequent, particularly at reproductive stage.

Acknowledgement: Authors profoundly acknowledge Dr. Arvind Kumar, Senior Scientist, IRRI, Philippines for providing seed material for this study.

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Electronic Journal of Plant Breeding, 5(3): 331-339 (Sep 2014)
ISSN 0975-928X

Table 1. Yield and yield attributes of rice genotypes and check varieties to drought stress and irrigated condition (mean of two year).

SI. No	Genotypes	DFF		PH (cm)		Grain yield (t//ha)		Number of effective tiller/m^2		Test weight (g)		Sterility (%)		HI	
		RSS	IC	RSS	IC	RSS	IC	RSS	IC	RSS	IC	RSS	IC	RSS	IC
1	IR83373-B-B-24-3	88	82	116	131	3.53	5.83	362	477	21.9	23.8	13.7	7.9	0.40	0.45
2	IR83387-B-B-27-4	92	90	107	121	3.45	5.61	345	471	23.1	24.5	15.9	8.1	0.39	0.48
3	IR833373-B-B-107-3	85	83	124	135	3.25	5.14	332	459	21.5	22.9	18.5	9.4	0.36	0.41
4	IR83376-B-B-24-2	86	82	121	134	3.74	5.63	344	481	23.7	25.1	12.9	5.9	0.41	0.46
5	IR83377-B-B-123-2	87	84	113	124	2.54	5.48	327	399	20.9	23.7	16.2	6.9	0.34	0.42
6	IR84895-B-127-CRA-5-1-1	90	86	115	129	3.57	5.96	368	493	24.1	24.9	14.5	6.8	0.38	0.44
7	RR 272-28-2	89	88	133	142	3.01	5.38	326	439	22.1	23.4	15.7	10.5	0.33	0.38
8	IR87747-13-3-1-1	90	87	122	134	3.06	5.21	345	462	23.3	23.8	17.8	8.9	0.35	0.41
9	IR87751-20-3-2-1	88	85	117	129	3.42	6.06	351	426	23.6	24.7	19.3	11.8	0.38	0.44
10	IR87753-11-2-1-2	89	85	119	137	3.09	5.65	323	443	22.8	24.4	22.6	13.7	0.34	0.42
11	Swarna	109	106	91	103	1.84	6.55	241	468	19.1	23.8	29.8	7.8	0.31	0.45
12	Sambha Mahsuri	111	107	96	112	2.03	6.06	218	439	20.3	24.1	31.1	10.8	0.29	0.42
13	Lalat	85	86	108	121	2.31	5.51	247	445	17.8	25.4	28.4	7.8	0.32	0.46
14	Rajendra Sweta	106	103	97	112	2.01	5.7	211	427	18.9	22.7	35.6	11.1	0.25	0.41
15	Shusk Samrat (check)	84	85	118	130	2.23	4.28	278	396	19.2	23.8	24.3	10.9	0.34	0.41
	Mean	91.93	89.27	113.13	126	2.87	5.61	307	448	21.49	24.07	21.09	9.22	0.35	0.43
	CV (%)	1.37	1.92	4.29	4.18	7.02	6.55	6.27	7.52	7.69	5.28	8.92	7.63	8.13	11.28
	LSD (5%)	1.98	2.74	8.33	9.67	0.33	0.61	18.76	24.32	0.87	1.11	2.06	1.84	0.04	0.06
	F-statistics	17.54	21.88	3.51	10.43	27.28	14.32	16.59	5.82	12.55	8.66	6.29	1.31(NS)	18.91	2.57(NS
	SED	3.05	0.98	5.66	4.36	0.34	0.42	21.71	34.8	1.68	2.24	1.97	2.61	0.02	0.04
	Heritabilty	0.94	0.99	0.91	0.93	0.85	0.69	0.88	0.91	0.79	0.84	0.87	0.91	0.93	0.71

RSS (Reproductive stage stress), IC (Irrigated condition), DFF (Days to fifty percent flowering), Plant height (PH) and Harvest Index (HI), SED (Standard error of differences)

Table 2. Plant biomass, relative water content (RWC), total soluble protein and proline content (mg g-1) and leaf rolling, leaf drying and stress recovery of rice genotypes and check varieties to drought stress and irrigated condition (mean of two years).

SI. No	Genotypes	Plant biomass ($g\ plant^{-1}$)		RWC		Soluble protein ($mg\ g^{-1}$)		Proline content (mg g-1)		Leaf rolling (LR), leaf drying (LD) and stress recovery (SR) under RSS		
		RSS	IC	RSS	IC	RSS	IC	RSS	IC	LR	LD	SR
1	IR83373-B-B-24-3	19.8	25.9	65.3	86.4	17.1	24.9	1.18	0.44	2.3	1.67	5.7
2	IR83387-B-B-27-4	23.2	28.6	64.1	80.7	16.5	25.2	1.05	0.39	3.0	3.7	4.7
3	IR833373-B-B-107-3	21.5	25.7	61.4	82.5	12.7	24.3	0.88	0.34	2.3	2.3	4.7
4	IR83376-B-B-24-2	23.7	26.8	61.9	86.2	17.9	24.8	1.28	0.47	1.0	1.3	6.3
5	IR83377-B-B-123-2	23.2	25.9	57.8	80.7	14.5	26.2	0.95	0.35	3.0	3.7	4.7
6	IR84895-B-127-CRA-5-1-1	19.9	27.5	61.7	84.9	15.8	21.6	1.12	0.41	1.0	1.7	6.7
7	RR 272-28-2	19.6	26.1	60.8	81.9	13.2	22.7	0.95	0.36	3.3	2.3	4.7
8	IR87747-13-3-1-1	18.8	25.4	61.5	84.1	13.7	23.1	1.01	0.40	3.7	4.3	5.7
9	IR87751-20-3-2-1	19.2	26.5	58.7	77.8	15.4	25.4	0.87	0.36	3.0	3.3	5.7
10	IR87753-11-2-1-2	21.3	28.1	60.4	79.1	14.6	22.8	1.04	0.41	4.3	2.7	6.3
11	Swarna	15.6	26.5	46.2	85.3	10.6	22.9	0.61	0.37	3.0	3.0	2.3
12	Sambha Mahsuri	13.9	27.8	42.8	81..9	11.3	23.9	0.54	0.35	3.7	3.7	2.3
13	Lalat	17.2	27.3	51.3	82.7	12.5	25.6	0.72	0.39	6.3	7.0	4.3
14	Rajendra Sweta	14.7	27.1	45.8	78.8	09.5	26.1	0.58	0.34	4.7	4.3	2.3
15	Shusk Samrat (check)	16.9	25.8	53.7	80.4	13.2	23.4	0.70	0.40	4.3	4.3	4.7
	Mean	19.23	26.73	56.89	82.25	13.90	24.19	0.90	0.39	3.26	3.28	4.74
	CV (%)	5.13	4.88	7.23	6.81	5.27	4.79	6.87	6.11	3.92	4.65	4.18
	LSD (5%)	0.67	0.83	1.64	1.88	0.72	1.18	0.16	0.07	0.26	0.22	0.33
	F-statistics	4.78	1.06(NS)	8.43	3.47	5.91	1.28(NS)	12.52	3.22	6.17	4.92	7.85
	SED	4.48	5.83	5.14	8.26	1.31	2.74	0.06	0.03	0.61	0.82	0.46
	Heritability	0.86	0.65	0.81	0.77	0.91	0.85	0.83	0.89	0.91	0.86	0.84

RSS (Reproductive stage stress), IC (Irrigated condition), RWC (relative water content), SED (Standard error of differences)

Electronic Journal of Plant Breeding, 5(3): 331-339 (Sep 2014)
ISSN 0975-928X

Table 3. Grain yield, drought susceptibility index values and relative yield in fifteen rice genotypes under drought stress condition.

Genotypes	Grain yield in (t//ha)		Yd	MP	RY_W	RY_S	DSI
	IC	RSS					
IR83373-B-B-24-3	5.83	3.53	2.3	4.68	0.89	0.94	0.81
IR83387-B-B-27-4	5.61	3.45	2.16	4.53	0.86	0.92	0.79
IR833373-B-B-107-3	5.14	3.25	1.89	4.20	0.78	0.87	0.75
IR83376-B-B-24-2	5.63	3.74	1.89	4.69	0.86	1.00	0.69
IR83377-B-B-123-2	5.48	2.54	2.94	4.01	0.84	0.68	1.09
IR84895-B-127-CRA-5-1-1	5.96	3.54	2.42	4.75	0.91	0.95	0.83
RR 272-28-2	5.38	3.01	2.37	4.20	0.82	0.80	0.90
IR87747-13-3-1-1	5.21	3.06	2.15	4.14	0.80	0.82	0.84
IR87751-20-3-2-1	6.06	3.42	2.64	4.74	0.93	0.91	0.89
IR87753-11-2-1-2	5.65	3.09	2.56	4.37	0.86	0.83	0.92
Swarna	6.55	1.84	4.71	4.20	1.00	0.49	1.47
Sambha Mahsuri	6.06	2.03	4.03	4.05	0.93	0.54	1.36
Lalat	5.51	2.31	3.2	3.91	0.84	0.62	1.19
Rajendra Sweta	5.7	2.01	3.69	3.86	0.87	0.54	1.32
Shusk Samrat (check)	4.28	2.37	1.91	3.33	0.65	0.63	0.91
Mean	5.60	2.87	2.72	4.24	0.86	0.77	0.98
CV	6.55	7.02	3.57	5.91	8.22	5.31	7.82
LSD	0.61	0.33	0.21	0.13	0.08	0.06	0.10

IC=irrigated condition (Non-stress), RSS= reproductive stage drought stress, Yd= yield differences between non-stress and stress condition, MP= mean productivity, RY_W= relative yield under control, RY_S= relative yield under stress, DSI= Drought susceptibility index.