



Evaluation of Rice (*Oryza sativa* L.) Genotypes for Drought Tolerance at Germination and Early Seedling Stage

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Abstract

Drought stress is a major constraint to the production and yield stability of crops. Rice (*Oryza sativa* L.) is considered as a drought-sensitive crop species. Within this species, there are considerable varietal differences in sensitivity to this environmental stress. An experiment was conducted at the laboratory of the Department of Agronomy, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Bangladesh during April to September 2016 to evaluate 100 rice genotypes for drought tolerance during germination and early seedling growth stage. The genotypes were tested against five levels of drought stress imposed by Polyethylene glycol 6000 (PEG-6000) @ 0, 5, 10, 15 and 20%. The experiment was laid out in a complete randomized design with four replications. The results showed that with increasing water stress, germination in all the genotypes decreased from 95.8% in control to 6.6 % in highest stress (20% PEG) level. Seedling height and dry weight also decreased in all rice genotypes with the increase in water stress level. Based on Standard Evaluation System (SES), 18 genotypes were selected primarily. Among the 18 genotypes, Ratoil and Chinisakkar showed higher germination index, relative seedling height and relative seedling dry weight than the check drought tolerant BRRI dhan43 at 20% PEG. Beside these, performance of Kumridhan, Pusur and Somondori was also well at this level compared to BRRI dhan43. The genotypes Ratoil, Chinisakkar, Kumridhan, Pusur and Somondori showed the best performance under drought condition.

Keywords: Drought stress, seed germination, seedling growth, rice genotypes, tolerance.

1. Introduction

Water is already a scarce commodity in many parts of the world, and predicted climate changes will aggravate the situation in future. Water deficit causes extensive loss to agricultural production worldwide, thus being a severe threat to sustainable agriculture. Rice plays a major role as a staple food, supporting more than three billion people and comprising 50% to 80% of their daily calorie intake (Khush, 2005). Drought

stress severely impairs rice production. Drought affects more than 23 million hectares of rainfed rice in Asia (Kumbhar *et al.*, 2015). The present and anticipated global food demands necessitate a significant increase in crop productivity on these less favourable rainfed lands. With diminishing water supplies for agriculture worldwide, the needs to improve drought adaptation of rice and to screen resistant varieties are becoming increasingly important (Pandey and Sukla, 2015). Understanding plant diversity

is relevant to assess plant behaviour in relation to adaptation to drought-prone environments, and designing an effective phenotyping strategy requires thorough understanding of plant survival under stress (Sarkar *et al.*, 2013). Therefore, assessment of genotypic variability under different water stress conditions is an important precondition for a successful screening program focused on drought tolerance.

Rice (*Oryza sativa* L.) is sensitive to water stress and shows several morphological changes at different growth stages in response to drought stress (Henry *et al.*, 2016). These involve plant height reduction, leaf rolling, leaf senescence, stomatal closure, decreased leaf elongation and lower dry matter production (Kumar *et al.*, 2015). However, the sensitivity of rice to drought or water stress varies with timing, duration, severity of drought stress, variety and the growth stage of rice (Sokoto and Muhammad, 2014). Drought stress induces the reduction of rice growth and development. Due to the reduction in turgor pressure under stress, cell growth is severely impaired (Taiz and Zeiger, 2006). Drought affects both elongation as well as expansion of growth, and inhibits cell enlargement more than cell division (Jaleel *et al.*, 2009). It has been reported that seed germination and early seedling growth are potentially the most critical stages for water stress (Ahmad *et al.*, 2009) and many researchers also reported that drought stress impairs the seed germination (Swain *et al.*, 2014) seedling height (Sokoto and Muhammad, 2014) and tiller number of rice (Bunnag and Pongthai, 2013). Farooq *et al.* (2010) stated that the common adverse effect of drought is the reduction in biomass production. It was also showed that drought significantly decrease fresh and dry weight of seedling (Ji *et al.*, 2012).

However, the impact of drought stress on various morpho-physiological changes significantly differs among rice cultivars (Kumar *et al.*, 2015) which underscore the importance of screening rice germplasm for drought tolerance. On the other hand, responses to environmental stress in

plants are complex and multigenic, and the functions of many induced genes are still a matter of conjecture. Because of this complexity, selection and breeding of drought-tolerant genotypes are extremely difficult (Tirado and Cotter, 2010). Therefore, for easy selection of rice genotypes under drought stress, it is necessary to do a proper drought screening, which clearly distinguishes drought-susceptible genotypes from drought-tolerant genotypes (Swamy *et al.*, 2012). Seed germination and seedling development is very important for early establishment of plants under stress condition. Selecting genotypes for rapid and uniform germination under water stress conditions can contribute towards early seedling establishment. Hence analysis of germination and seedling growth traits and their response to drought can be useful for selection of rice genotypes tolerant to drought. Drought scoring was also used as a primary criterion for screening rice genotypes for drought tolerance (IRRI, 2014). Leaf rolling with tip drying is one of the acclimation responses of rice and is used as a criterion for scoring drought tolerance. Leaf rolling with tip drying is hydronasty that leads to reduced light interception, transpiration and leaf dehydration (Kadioglu and Terzi, 2007). It may help in maintaining internal plant water status (Ha, 2014). If cell turgor is maintained under drought stress, it will result in delayed leaf rolling and drying. Modern rice cultivars tolerant to drought are few in number. However, it is essential to develop drought tolerant rice varieties to fulfill the future food demand for added population of the country. Therefore, the objective of the present study was to analyze genotypic variations in drought tolerance of rice at germination and early seedling stage.

2. Materials and Methods

A laboratory experiment was conducted at the Department of Agronomy, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh during April to September, 2016. One hundred rice (*Oryza sativa* L.) genotypes along with check variety

BRR1 dhan43 were used in this experiment. Seeds of different genotypes were collected from drought-prone area of Bangladesh, Bangladesh Rice Research Institute (BRR1), Bangladesh Institute of Nuclear Agriculture (BINA), and also from Genetic Resources Unit of BSMRAU.

Seeds of each genotype were surface sterilized with 70% ethanol solution for 5 minutes. The seeds were then washed three times with sterilized distilled water. Germination assays were performed by evenly distributing the seeds in a 10-cm-diameter sterilized Petri dish with two layers of whatman No. 1 filter paper. Each dish was moistened with 10 ml distilled water or uniform amounts of desired osmotic solutions to mimic drought stress. During screening, water-deficit stress is artificially induced by desired strengths of polyethylene glycol 6000 (PEG-6000; Sigma Chemicals). Polyethylene glycol has been used to simulate water stress effects in plants (Swapna and Shylaraj, 2017). The experiment was laid out in a complete randomized design (CRD) with five levels of drought stress and four replications. Distilled water was used as a control (0 MPa) and osmotic potentials -0.3, -0.6, -0.9 and -1.2 MPa were created by adding PEG-6000 @ 5, 10, 15 and 20 g per 100 ml distilled water. Four replicates of 50 seeds of each osmotic potential were used to

assess the germination percentage. This experiment was carried out in growth chamber at $25\pm 0.5^\circ\text{C}$ and $80\%\pm 1$ of relative humidity. The number of germinated seed was recorded at 24 hours interval. The seedling height and seedling dry weights were measured on the 14th day. Seeds were considered germinated when both plumule and radicle extended to more than 2 mm from the seeds. The Standard Evaluation System (SES) for rice (IRRI, 1980) was used for screening of drought tolerant rice genotypes (Table 1). Visual scores for stress symptoms on scale 0 to 9, where lower score denotes the tolerance and higher score denotes susceptible.

2.1. Germination Index

The germination index was calculated after final germination using the following equation:

$$GI = \frac{\text{Germination percentage in each treatment}}{\text{Germination percentage in the control}} \times 100$$

2.2. Seedling height and dry weight

Ten seedling were chosen randomly and seedling height was measured. The lengths of seedling were measured with a ruler. Dry weight was determined after drying the seedlings at 70°C for 48 h. Data on germination and seedling characteristics for each treatment were compared with control for determining the drought tolerant rice genotypes.

Table 1. Standard Evaluation System (SES) for rice (IRRI, 1980)

Description	Drought score
No symptoms of stress effects	0
Slight leaf rolling and tip drying	1
Leaf rolling and tip drying extended to 1/4 length in 25% of all leaves (normally the older leaves)	2
Leaf rolling and tip drying extended to 1/4 length or more in at most 50% of all leaves	3
Leaf rolling and tip drying extended to 1/4 length or more in 50% of all leaves with 25% of leaves fully rolled and dried	4
50% of all leaves fully rolled and dried	5
More than 50% but less than 70% of all leaves fully rolled and dried	6
Seventy percent of all leaves fully rolled and dried	7
More than 70% of all leaves fully rolled and dried	8
All plants apparently dead	9

2.3. Relative seedling height

The relative seedling height (RSH) was calculated using the following equation:

$$\text{RSH (\%)} = \frac{\text{Plant height under drought condition}}{\text{Plant height under control condition}} \times 100$$

2.4. Relative dry weight

The relative dry weight (RDW) was calculated using the following equation

$$\text{RDW (\%)} = \frac{\text{Total dry weight under drought condition}}{\text{Total dry weight under control condition}} \times 100$$

2.5. Statistical analysis

The collected data were analyzed to assess their statistical significance. Statistix 10 program were

used to perform statistical analysis. Means were separated by least significant difference (LSD).

3. Results and Discussion

3.1. Visual scoring of drought injury at seedling stage

Drought score is treated as an alternative approach to determine plant drought tolerance (Fen *et al.*, 2015). Visual scoring is a reliable measure of tolerance for the estimation of oxidative damage in plants, and reflects dehydration of the plant tissue (Cabuslay *et al.*, 2002). When water stress develops, the plants naturally have evolved a defensive mechanism for abbreviating the energy load on the leaf (Chaturvedi *et al.*, 2012) and experienced leaf rolling and drying to reduce net radiation load on the leaf.

Table 2. Visual score at seedling stage of different rice genotypes under varied PEG levels.

Genotypes	Visual score				
	Control	5	10	15	20
	%PEG				
Dharial	0.33	2.33	4.33	5.33	8.00
Majoaishe	0.33	2.67	5.33	6.33	8.33
Pusur	0.00	0.33	1.33	3.33	6.33
Mongthong	0.00	1.00	3.00	4.33	7.33
Kaisha pajra	0.33	2.00	4.00	5.33	8.33
Lal aus	0.00	2.67	5.33	7.33	8.33
Sadaaus	0.33	2.33	4.00	6.33	8.33
Saita	0.00	0.33	2.33	4.33	7.33
Kumridhan	0.00	0.00	1.33	3.33	6.00
Ratoil	0.00	0.00	0.67	1.67	4.67
Sili	0.00	1.33	4.00	5.33	8.33
Pidi 1	0.00	2.67	5.33	7.33	8.33
Shamraj	0.33	1.33	4.33	5.33	8.33
Chinisakkar	0.00	0.00	0.67	2.33	5.33
Somondori	0.00	0.00	1.33	3.33	5.67
Nadinggoga pro	0.33	0.33	5.00	6.33	8.33
Glongdhan	0.00	0.33	5.33	6.00	8.33
BRRI dhan43 (CK)	0.00	0.00	0.67	2.33	5.33
CV (%)	300	51.35	23.38	12.74	8.77
LSD _(0.05)	0.55	0.93	1.25	1.01	1.06
SE (± 0.05)	0.2722	0.4581	0.6186	0.4969	0.5212

In rice, leaf rolling and tip drying factor under drought stress was studied as one of the best criteria in estimating levels of drought tolerance in a large scale screening (Pandey and Shukla, 2015). In this study, the Standard Evaluation System (SES) for rice (IRRI, 1980) was used for screening of 100 rice genotypes at early seedling stage. Visual score 1 indicate highly tolerant, 2-3 indicate tolerant, 4-5 indicate moderately tolerant and 6-9 indicate susceptible to highly susceptible. Out of 100 genotypes only 18 genotypes were found tolerant at 5% PEG. However, all the selected genotypes were found moderately tolerant at 10 and 15% PEG and only 2 genotypes were found moderately tolerant at 20% PEG (Table 2). Therefore, only 18

genotypes were considered for further discussion.

3.2. Germination and germination index (GI)

Germination is one of the most critical periods in the life cycle of plants. The effect of increasing concentrations of PEG on seed germination was measured to determine the tolerance of rice genotypes to water deficit. Seed germination was reduced as the PEG concentration increased in the nutrient solution and different PEG concentration had significant effect on percent seed germination of different rice genotypes (Table 3). The maximum percentage of germination was found in control condition and the minimum was at 20% PEG (Table 3).

Table 3. Germination percentage of different rice genotypes under varied PEG levels

Genotypes	Germination (%)				
	Control	5	10	15	20
	%PEG				
Dharial	94.0 ab	85.2 c	72.5 cd	45.3 g	17.5gh
Majoaishe	92.0 ab	82.7 c	68.1 e	39.3 j	14.5 j
Pusur	94.6 ab	91.2 a	81.8 ab	59.0 d	33.2 c
Mongthong	91.7 ab	86.3bc	75.3 c	48.4 f	21.6 e
Kaisha pajra	90.0 b	82.3 c	71.0 de	44.7gh	16.8gh
Lal aus	92.7 ab	83.4 c	70.3 de	35.2 k	14.8ij
Sadaaus	92.2 ab	86.1 c	73.2 cd	40.5ij	16.6gi
Saita	95.8 a	86.7bc	79.8 b	55.3 e	28.2 d
Kumridhan	94.8 ab	91.7 a	83.8 a	62.3bc	34.6bc
Ratoil	95.6 a	93.6 a	85.4 a	65.5 a	37.7 a
Sili	92.3 ab	86.8bc	72.3 cd	42.9 h	19.7 f
Pidi 1	90.1 b	83.0 c	69.7 de	33.6 k	14.8ij
Shamraj	93.1 ab	85.0 c	71.7cde	42.7 hi	18.4fg
Chinisakkar	94.7 ab	91.2 a	84.7 a	63.9 ab	36.8 a
Somondori	94.7 ab	91.3 a	82.3 ab	61.3 c	34.8bc
Nadinggoga pro	92.4 ab	85.3 c	75.3 c	33.4 k	16.3hij
Glongdhan	92.6 ab	84.5 c	74.9 c	34.1 k	16.2hij
BRRI dhan43 (CK)	93.8ab	90.5 ab	83.5 a	63.4abc	36.4 ab
CV (%)	3.45	2.99	2.87	2.83	4.61
LSD _(0.05)	5.33	4.31	3.63	2.26	1.82
SE (± 0.05)	2.6270	2.1273	1.7888	1.1187	0.8963

Note: Figure having common letter(s) in a column do not differ significantly at 5% level of significance.

In general, germination was severely affected by 20% PEG and all the selected genotypes had germination less than 40%. However, differential tolerance of rice genotypes was observed; for example, Ratoil, Chinisakkar, Somondori and Kumridhan showed 37.7, 36.8, 34.8 and 34.6% germination in the presence of 20% PEG, whereas the values for Majoaishe and Pidi 1 in the same treatment were 14.5 and 14.8%, respectively. The germination index (GI) also decreased with the increase in drought stress. In drought stress the highest GI was recorded at control and lowest at 20% PEG concentration. However, the GI of Ratoil, Chinisakkar, Somondori and Kumridhan was found similar to that of the check BRRI dhan43 (Table 4). The results further indicated that these materials showed superiority over the rest selected

genotypes in relation to germination. In the present investigation drought stress greatly affects seed germination, but the response intensity and adverse effect of stress depend on the genotypes (Table 3). It has been reported that drought stress adversely affect the seed germination, and seedling growth (Sokoto and Muhammad, 2014; Swain *et al.*, 2014). Under water stress, low water potential is a determining factor for inhibiting seed germination (Wang *et al.*, 2002). PEG is an osmotic agent, which play an important role in the regulation of mineral elements, hormone, protein metabolism and effects of signal transduction (Verlues *et al.*, 1998). The main function of PEG is to slow down the moisture rate of seeds (Jiao *et al.*, 2009).

Table 4. Germination index of different rice genotypes under varied PEG levels

Genotypes	Germination Index				
	Control	5	10	15	20
	%PEG				
Dharial	-	90.6 cd	77.1efg	48.2gh	18.6gh
Majoaishe	-	89.9 d	74.0 g	42.7 j	15.8i
Pusur	-	96.4 ab	86.5 a	62.4 d	35.1 c
Mongthong	-	94.1 a-d	82.1bc	52.8 f	23.6 e
Kaisha pajra	-	91.4 a-d	78.9 c-f	49.7 g	18.7gh
Lal aus	-	90.0 d	75.8fg	38.0 k	16.0i
Sadaaus	-	93.4a-d	79.4cde	43.9ij	18.0ghi
Saita	-	90.5 d	83.3 b	57.7 e	29.4 d
Kumridhan	-	96.7 ab	88.4 a	65.7bc	36.5bc
Ratoil	-	97.9 a	89.3 a	68.5 a	39.4 a
Sili	-	94.0 a-d	78.3def	46.5 hi	21.3ef
Pidi 1	-	92.1 a-d	77.4ef	37.3 k	16.4 hi
Shamraj	-	91.3bcd	77.0efg	45.9 hi	19.8fg
Chinisakkar	-	96.3abc	89.4 a	67.5abc	38.9 ab
Somondori	-	96.4 ab	86.9 a	64.7 cd	36.7bc
Nadinggoga pro	-	92.3 a-d	81.5bcd	36.1 k	17.6ghi
Glongdhan	-	91.3bcd	80.9bcd	36.8 k	17.5ghi
BRRI dhan43 (CK)	-	96.5 ab	89.0 a	67.6 ab	38.8 ab
CV (%)		3.67	2.35	3.27	5.90
LSD _(0.05)		5.68	3.19	2.81	2.49
SE (± 0.05)		2.7987	1.5728	1.3836	1.2274

Note: Figure having common letter(s) in a column do not differ significantly at 5% level of significance.

The inhibiting action of water stress on the rice germination was increased with PEG concentration increasing (Table 3). It seems that lowering the osmotic potential with PEG decrease water availability for seeds and then caused low germination. The physical process of water uptake leads to activation of metabolic process, as the dormancy of the seed is broken following hydration. Elevated drought stress slows down water uptake by seeds, thereby inhibiting their germination and root-shoot elongation.

3.3. Seedling height and relative seedling height
Seedling height also decreased as the PEG concentration increased and seedling height of different rice varieties were significantly affected by water stress (Table 5). The maximum seedling height was observed in the controlled

condition and the minimum in the highest drought stress level (Table 5). At all the drought levels, the maximum seedling height were found in Ratoil, Chinisakkar, Pusur, Kumridhan and Somondori (Table 5). Relative seedling height (RSH) was decreased with the increase in drought level. The highest RSH (83.15%) was recorded at control and the lowest (4.31%) was recorded at 20% PEG concentration (Fig. 1). However, the %RSH at 20% PEG was far higher in Ratoil, Chinisakkar, Pusur, Kumridhan and Somondori other than check variety (Fig. 1). Under water stress, it has been shown that the inhibition of radicle emergence is mainly because of decrease in water potential gradient between the external environment and the seed and consequently impairs seedling height (Sokoto and Muhammad, 2014).

Table 5. Seedling height of different rice genotypes under varied PEG levels

Genotypes	Seedling height (cm)				
	Control	5	10	15	20
	%PEG				
Dharial	21.46abc	16.12bc	9.94 de	5.01 f	1.38def
Majoaishe	21.33abc	14.56def	8.27 hi	4.44gh	0.92 hi
Pusur	20.22 b-f	15.71bcd	10.46 cd	6.51 c	2.04bc
Mongthong	21.06 a-d	14.31efg	9.22efg	5.51 e	1.48 d
Kaisha pajra	19.94 c-f	14.54 d-g	8.86 f-i	4.79fg	1.25efg
Lal aus	19.27ef	13.28fgh	8.31ghi	4.31 h	0.88i
Sadaaus	20.77 b-e	14.95cde	9.11 e-h	4.68fgh	1.19fg
Saita	21.81 ab	16.23bc	10.56bcd	6.06 d	1.95 c
Kumridhan	22.44 a	17.85 a	11.59 a	7.22 a	2.25 ab
Ratoil	21.42abc	17.81 a	11.46 ab	7.26 a	2.39 a
Sili	21.54abc	14.31efg	9.38ef	4.98 f	1.45 de
Pidi 1	19.23ef	11.23i	8.16i	4.34 h	0.91 hi
Shamraj	18.64 f	12.52 hi	8.89 f-i	4.68fgh	1.17fg
Chinisakkar	21.33abc	16.87 ab	11.38abc	6.97 ab	2.22 ab
Somondori	20.84 a-e	16.23bc	10.65 a-d	6.63bc	2.08bc
Nadinggoga pro	21.03 a-d	13.26gh	8.88 f-i	4.67fgh	1.13gh
Glongdhan	19.52def	12.42 hi	8.79 f-i	4.69fgh	1.21fg
BRR1 dhan43(CK)	20.61 b-e	16.47 b	10.98abc	6.89abc	2.12bc
CV (%)	4.81	5.23	5.86	4.48	8.66
LSD (0.05)	1.65	1.29	0.94	0.41	0.22
SE (±0.05)	0.8119	0.6369	0.4646	0.2023	0.1100

Note: Figure having common letter(s) in a column do not differ significantly at 5% level of significance.

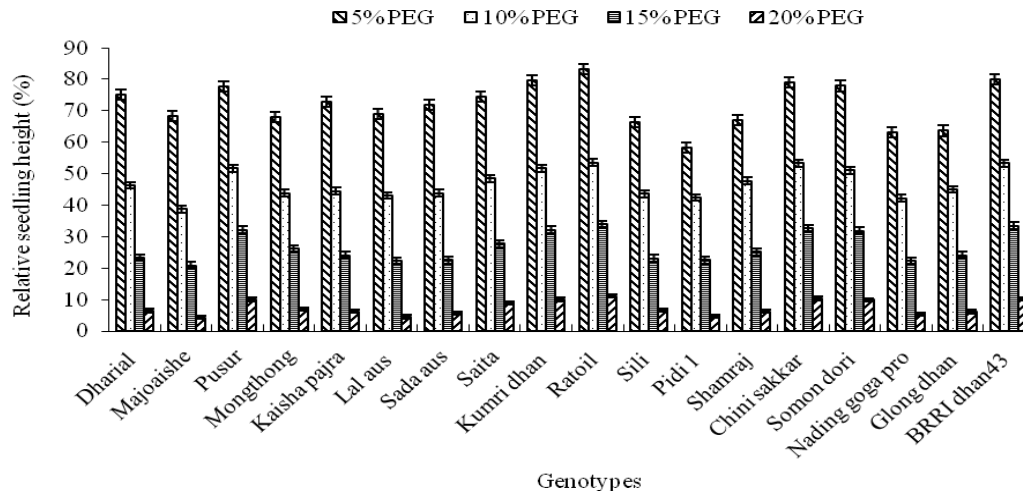


Figure 1. Relative seedling height (%) of different rice genotypes under varied PEG level. Averages from three independent experiments are shown. Error bars represent the SE.

Table 6. Seedling dry weight of different rice genotypes under varied PEG levels

Genotypes	Seedling dry weight (mg)				
	Control	5	10	15	20
	%PEG				
Dharial	10.10 h	7.90ij	4.30 h	1.69jk	0.38 g
Majoaishe	8.50i	6.10 k	3.60i	1.36k	0.14 h
Pusur	14.30 a	11.80abc	7.60 cd	3.54cd	1.25 b
Mongthong	13.60abc	10.90cde	6.05ef	2.34efg	0.61 d
Kaisha pajra	11.40fg	8.80 hi	4.90 g	1.98hij	0.48 f
Lal aus	10.80gh	7.60 j	4.10 h	1.66jk	0.18 h
Sadaaus	12.90bcd	10.10efg	5.60 f	2.23fgh	0.56 de
Saita	11.70efg	9.60fgh	6.00ef	2.69e	0.85 c
Kumridhan	14.60 a	12.40 ab	8.30 ab	3.98ab	1.36 a
Ratoil	13.80 ab	12.80 a	8.70 a	4.13 a	1.37 a
Sili	12.60cde	10.30ef	5.70 f	2.13ghi	0.50ef
Pidi 1	11.70efg	9.10gh	4.90 g	1.81ij	0.31 g
Shamraj	10.80gh	8.56hij	4.80 g	1.86ij	0.35 g
Chinisakkar	12.90bcd	12.10 ab	8.00bc	3.83abc	1.25 b
Somondori	13.80 ab	11.60bc	7.40 d	3.27 d	1.19 b
Nadinggoga pro	13.60abc	10.50def	6.20 e	2.62 e	0.58 d
Glongdhan	12.80 b-e	10.10efg	5.90ef	2.55ef	0.57 d
BRRI dhan43(CK)	12.30def	11.40bcd	7.40 d	3.68bc	1.19 b
CV (%)	5.75	6.42	4.54	8.17	6.39
LSD (0.05)	1.18	1.07	0.46	0.36	0.08
SE (±0.05)	0.5794	0.5287	0.2253	0.1754	0.0380

Note: Figure having common letter(s) in a column do not differ significantly at 5% level of significance.

3.4. Seedling dry weight and relative dry weight

The seedling dry weight and relative dry weight (RDW) of different rice genotypes were influenced by drought stress. In all the genotypes the seedling dry weight and percent relative dry weight decreased due to increasing the PEG concentration (Table 6 and 7). At 20% PEG, the highest RDW was found in Ratoil (9.93%) and the lowest (1.65%) was found in Majoaishe (Table 7). Chinisakkar (9.69%), Kumridhan (9.32%), Pusur (8.74%), and Somondori (8.62%) also perform better compared to others genotypes (Table 7). The result indicated that as the drought level increased, seedling dry weight and percent relative dry weight decreased. The RDW value of a plant reflects its vigour and is

considered a good index of its exposure to stresses of all sorts (Xu *et al.*, 2006). The RDW response of rice seedlings exposed to increasing PEG concentrations, revealed a decrease for seedling height (Table 5). This may reflect the impact of water stress on root cell development, which would likely impair nutrient uptake as well as having detrimental effects on photosynthesis, essential for biomass accumulation and therefore on shoot and root elongation. Water stress therefore appears to reduce the absorption and utilization of water to such an extent that the tolerance mechanisms employed by these plants in a drought are insufficient to maintain normal growth.

Table 7. Relative dry weight of different rice genotypes under varied PEG levels

Genotypes	Relative dry weight (%)				
	Control	5	10	15	20
	%PEG				
Dharial	-	78.22e	42.57 g	16.73fg	3.76 g
Majoaishe	-	71.76f	42.35 g	16.00fgh	1.65 j
Pusur	-	82.52bc	53.15 d	24.76 c	8.74 c
Mongthong	-	80.15cde	44.49efg	17.21 f	4.49 e
Kaisha pajra	-	77.19e	42.98fg	17.37 f	4.21ef
Lal aus	-	70.37f	37.96 h	15.37 h	1.67 j
Sadaaus	-	78.29e	43.41fg	17.29 f	4.34ef
Saita	-	82.05bcd	51.28 d	22.99 d	7.26 d
Kumridhan	-	84.93b	56.85 c	27.26 b	9.32 b
Ratoil	-	92.75a	63.04 a	29.93 a	9.93 a
Sili	-	81.75bcd	45.24ef	16.90 f	3.97fg
Pidi 1	-	77.78e	41.88 g	15.47gh	2.65i
Shamraj	-	79.26cde	44.44efg	17.22 f	3.24 h
Chinisakkar	-	93.80a	62.02 ab	29.69 a	9.69ab
Somondori	-	84.06b	53.62 d	23.70 cd	8.62 c
Nadinggoga pro	-	77.21e	45.59ef	19.26 e	4.26ef
Glongdhan	-	78.91de	46.09 e	19.92 e	4.45 e
BRRI dhan43 (CK)	-	92.68a	60.16 b	29.92 a	9.67 ab
CV (%)		2.44	3.28	3.86	4.38
LSD _(0.05)		3.29	2.65	1.34	0.41
SE (± 0.05)		1.6216	1.3072	0.6603	0.2027

Note: Figure having common letter(s) in a column do not differ significantly at 5% level of significance.

4. Conclusions

In conclusion, rice genotypes were very sensitive to drought stress. From the results of present investigation it can also be concluded that with increasing levels of water stress, seed germination and early seedling growth were adversely affected in all rice genotypes. However, for all the physiological parameters like germination percentage, seedling height, dry weight of seedling varietal differences were recorded and the difference was maximum towards higher stress levels. In response to water stress Ratoil, Chinisakkar, Pusur and Kumridhan showed better performance in terms of germination, relative seedling height and relative dry weight as compared to others.

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