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EFFECT OF WATER POTENTIAL TREATMENT ON SEED GERMINATION AND SEEDLINGS GROWTH OF SOME RICE CULTIVARS (*ORYZA SATIVA* L.)

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ABSTRACT

Seeds of (*Oryza sativa* L.) cultivars CSAR-13, CSAR-27, CSAR-77, CSAR-148-205, CSAR-253, CSAR-256, Pant-12, Basmati-370, IET-11120 and IR-539-30-2-2-3-3 were subjected to water stress in terms of various external water potential during seed germination and seedling growth under osmoticum solution of PEG-6000. The cumulative germination and seedling growth decreased significantly with increasing intensity of stress irrespective of cultivar tested. However, CSAR-13, CSAR-77 and CSAR-27 showed higher tolerance to decreasing water potential with respect to germination, while IET-11120 and IR-539-30-2-2-3-3 proved better for seedling growth under moisture stress condition.

INTRODUCTION

Performance of crop growth and yield are the result of genotypic expression as modulated by continuous interaction with environment. The water potential that prevents sufficient amount of water for seed germination is critical for any crop. The study of such type of stress condition for crop plants provides valuable information for agricultural workers (Levitt, 1972). Drought, a period of no rainfall or irrigation that affect plant growth is a major constraint for about 50 per cent of the world production area of the rice (Mitcell *et al*; 1998). One of the main problems of rice cultivation and production is the lack of water resources, especially during the period of no rainfall. Rice cultivars show differential tolerance to both intensity and duration of soil moisture occurring at different stages of growth (Hsiao, 1982). Some genotypes are more resistant than others, which have been exposed to same degree of water stress (Mitcell *et al*; 1998).Germinating seed in solution of different water potential is convenient method for establishing the response of germination to low water potential (Naylor, 1992).Thus identification of stress resistant mechanism is essential for genetic improvement of stress resistant in crop plants.

MATERIAL AND METHODS

A laboratory experiment was undertaken in the Department of Plant Physiology, Chandra Sekhar Azad University of Agriculture and Technology, Kanpur (UP). In a factorial experiment arranged in CRD with three replications.11.5 , 19.5, 23.5 and 28.9 g of PEG – 6000 were dissolved in 1000 ml of distilled water to develop different osmoticum solutions having water potential of -3.0, -5.0, -7.5 and -10.0 bars respectively (Hadas, 1976). Distilled water was used as control. Surface sterilized seeds were placed on moistened filter paper in each petridish separately. Filter paper was moistened after regular interval with above mentioned solutions for all observations. The petridishes were kept in laboratory under room temperature. The percentage of germination was recorded at every 24 h interval up to 10 days. Seeds were considered germinated when the radical was at least 2 mm long. Five seedlings were chosen randomly and seedling growth was measured by dry and fresh weight of root and shoot of the seedling at 192 hours. Dry weight was determined after drying in a forced air dryer at 70 ± 1^0C till the weight became constant. The length of root and shoot was measured with a ruler.

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RESULTS AND DISCUSSION

Germination per cent: The cumulative germination of all the genotypes significantly decreased with increasing the intensity of water potentials (Table 1) at 240 h under control condition, maximum genotypes attain 100% seed germination, except to CSAR- 253, Pant-12 and IR-539-30-2-2-3-3. While at -3.0, -7.5 and -10.0 bars the genotype CSAR-13 exist 98, 90 and 78 % germination respectively. This was closely fallowed by CSAR-77(76%) and CSAR-27 (72%) at -10.0 bars osmoticum. While lowest germination percentage was reported in genotype Pant-12 and CSAR-253 (44 and 46%). The reason for decreasing germination with increasing level of stress may be due to water potential and osmotic potential as mediated by solute developed additive effect on the inhibition of seed germination (Bernstein, 1961). The earlier studies revealed that seed germination and seedling emergence was significantly affected by decreasing water potential (Goswami and Baruah, 1993). Similar type of reduction in germination of different crops under moisture stress has been reported by (Winter *et al*., 1989) and (Jong and Best, 1989).

Root, shoot length and root, shoot dry weight: Increasing moisture stress resulted in the reduction of root and shoot length (Table 2) and root, shoot dry weight (Table 3) in all the genotypes. After 192 h of stress, the genotype IET-11120 maintained maximum length of root (9.1, 8.1, 7.5, 7.4 and 5.2 cm) and shoot (13.7, 10.6, 10.4, 10.1 and 10.0 cm) at -3.0, -5.0, -7.5 and -10.0 bars of water potentials. Maximum root and shoot dry weight (1.0 and 1.4 mg) was obtained in IR-539-30-2-2-3-3 at -10.0 bars under higher water stress against to CSAR-253, which reported the least dry weight(Table 3 and 4). Singh and Singh (1983) reported that higher water stress caused significant reduction in root, shoot length and root, shoot dry weight. Similar kind of reduction in root dry weight was reported by (Raggi, 1992).

TABLE 1: Effect of external water potential treatment on seed germination (%)

Cultivars	Observation at 240 hours					
	Water potential (Bars)					
	Control	-3.0	-5.0	-7.5	-10.0	Mean
CSAR-13	90.00 (100)	81.87 (98)	73.57 (92)	71.56 (90)	62.03 (78)	75.90 (91.6)
CSAR-27	90.00 (100)	78.46 (96)	75.82 (94)	71.56 (90)	58.05 (72)	73.55 (88.4)
CSAR-77	90.00 (100)	73.57 (92)	66.42 (84)	63.44 (80)	60.67 (76)	70.82 (86.4)
CSAR-148-205	90.00 (100)	63.44 (80)	59.34 (74)	53.13 (64)	50.77 (60)	63.33 (75.6)
CSAR-253	78.46 (96)	55.55 (68)	48.45 (56)	46.15 (52)	42.71 (46)	54.26 (63.6)
CSAR-256	90.00 (100)	81.87 (98)	70.63 (89)	64.90 (82)	48.45 (56)	71.17 (85)
Pant-12	81.87 (98)	64.90 (82)	50.77 (60)	45.00 (50)	41.55 (44)	56.81 (66.8)
Basmati-370	90.00 (100)	78.46 (96)	73.57 (92)	58.05 (72)	56.79 (70)	71.37 (86)
IET-11120	90.00 (100)	75.82 (94)	71.56 (90)	69.73 (88)	55.55 (68)	72.53 (86)
IR-539-30-2-2-3-3	81.87 (98)	71.50 (90)	69.73 (88)	59.34 (74)	50.77 (60)	66.85 (82)

	SE ± (diff.)	CD at 5%
Variety	0.597	1.185
Treatment	0.422	0.636
V x T	1.338	2.651

TABLE 2: Effect of external water potential treatment on root length (cm)

Cultivars	Observation at 192 hours					
	Water potential (Bars)					
	Control	-3.0	-5.0	-7.5	-10.0	Mean
CSAR-13	8.7	7.0	6.4	5.9	5.6	6.72
CSAR-27	7.6	7.4	7.2	7.2	7.1	7.30
CSAR-77	7.9	6.4	6.2	5.8	5.4	6.34
CSAR-148-205	8.2	7.6	6.6	6.2	5.9	6.90
CSAR-253	6.8	6.4	5.9	5.7	4.8	5.92
CSAR-256	8.3	7.1	6.8	6.4	5.5	6.82
Pant-12	6.5	6.4	5.8	5.2	5.2	5.82
Basmati-370	6.7	6.4	6.1	5.6	5.1	6.00
IET-11120	9.1	8.1	7.5	7.4	5.2	7.50
IR-539-30-2-2-3-3	8.0	8.0	7.4	6.5	5.1	6.40

	SE± (diff.)	CD at 5%
Variety	0.138	0.274
Treatment	0.097	0.183
V x T	0.307	0.813

TABLE 3: Effect of external water potential treatment on shoot length (cm)

Cultivars	Observation at 192 hours					
	Water potential (Bars)					
	Control	-3.0	-5.0	-7.5	-10.0	Mean
CSAR-13	10.2	9.1	9.1	8.9	8.3	9.1
CSAR-27	10.3	9.7	8.4	7.9	6.1	8.5
CSAR-77	8.5	8.1	6.7	6.2	5.9	7.1
CSAR-148-205	7.9	7.5	6.8	6.3	5.3	6.8
CSAR-253	6.7	5.3	5.2	5.0	4.1	5.3
CSAR-256	6.4	6.2	5.8	5.2	4.9	5.7
Pant-12	8.5	8.1	5.7	4.8	4.4	6.3
Basmati-370	10.5	10.3	9.7	9.1	5.7	9.1
IET-11120	13.7	10.6	10.4	10.1	10.0	11.0
IR-539-30-2-2-3-3	11.5	11.1	10.3	10.2	9.8	10.6

	SE± (diff.)	CD at 5%
Variety	0.117	0.234
Treatment	0.083	0.165
V x T	0.263	0.623

In the present study result revealed that the genotypes CSAR-13, CSAR-77 and CSAR-27 showed higher tolerance in respect to seed germination while IET-11120 and IR-539-30-2-2-3-3 give better response in respect to length and dry weight of root and shoot under higher water stress condition. Therefore it may be concluded that genotypes which have good seed germination and seedling growth (root/shoot length and its dry weight) under higher moisture stress condition proved superior to ensure good seedling establishment and further crop growth. The result of this study also showed that the

TABLE 4: Effect of external water potential treatment on root dry weight (mg)

Cultivars	Observation at 192 hours					
	Water potential (Bars)					
	Control	-3.0	-5.0	-7.5	-10.0	Mean
CSAR-13	1.0	0.9	0.9	0.8	0.6	0.78
CSAR-27	1.0	0.8	0.8	0.6	0.6	0.74
CSAR-77	1.0	0.8	0.8	0.8	0.6	0.76
CSAR-148-205	1.0	0.8	0.6	0.5	0.5	0.68
CSAR-253	1.0	0.8	0.7	0.5	0.4	0.68
CSAR-256	1.2	1.0	0.9	0.7	0.6	0.88
Pant-12	0.9	0.8	0.7	0.6	0.5	0.78
Basmati-370	1.2	0.8	0.5	0.5	0.4	0.70
IET-11120	1.2	1.0	0.8	0.7	0.7	0.86
IR-539-30-2-2-3-3	1.2	1.2	1.2	1.0	1.0	1.12

	SE± (diff.)	CD at 5%
Variety	0.19	0.038
Treatment	0.013	0.027
V x T	0.043	0.085

TABLE 5: Effect of external water potential treatment on shoot dry weight (mg)

Cultivars	Observation at 192 hours					
	Water potential (Bars)					
	Control	-3.0	-5.0	-7.5	-10.0	Mean
CSAR-13	2.6	1.8	1.8	1.6	1.3	1.84
CSAR-27	2.0	1.8	1.2	1.0	0.8	1.36
CSAR-77	2.2	2.0	1.8	1.6	1.3	1.78
CSAR-148-205	2.1	2.0	1.6	1.2	1.0	1.58
CSAR-253	2.0	1.8	1.6	1.6	1.0	1.60
CSAR-256	1.8	1.8	1.6	1.6	1.6	1.68
Pant-12	1.8	1.6	1.6	1.4	1.2	1.52
Basmati-370	2.0	1.6	1.0	0.8	0.7	1.22
IET-11120	3.0	2.6	2.1	1.8	1.0	2.10
IR-539-30-2-2-3-3	2.4	2.4	1.8	1.6	1.4	1.92

	SE± (diff.)	CD at 5%
Variety	0.058	0.112
Treatment	0.040	0.079
V x T	0.128	0.260

genotypes in same geographical area display distinct response to drought stress. In this regard genotypic variability within species offer variable tool for studying mechanism of drought.

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