Int.J.Curr.Microbiol.App.Sci (2020) Special Issue-11: 3840-3847

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Special Issue-11 pp. 3840-3847**
Journal homepage: http://www.ijcmas.com

Original Research Article

Study the Effect of PEG 6000 on *Brassica* Genotypes Germination and Growth Parameters under Drought Condition

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A B S T R A C T

The experiment entitled growth parameter sunder drought in mustard genotypes was conducted during *rabi* 2017 at seed technology research, RARI, Durgapura, Jaipur. Ten genotypes of mustard were taken for study which includes RB 50, RGN 48, Urvashi, Geeta, RH 819, RGN 229, RH 406, RH 749, NRCHB 101 and NRCDR 02. These genotypes were grown in plastic pots and drought conditions were created by irrigating the pots with PEG 6000. The controlled plants were irrigated with distilled water. Observations on growth parameters such as shoot length, root length, seedling dry weight, seedling vigor index I and seedling vigor index II were recorded at 10 and 20 DAS. It was observed that PEG induced drought conditions reduced the seedling length, weight, and seedling vigour index significantly in all the genotypes. The genotypic difference was also found significant. RGN 229 perform best both under control and PEG induced water stress.

Keywords

Drought, PEG, growth parameters

Introduction

Indian mustard accounts for almost 80 per cent of the region under these crops in the country. This crop is cultivated in a number of agro-ecological conditions, such as timely/late seedlings, rainfed and irrigated crops, single and mixed cereal crops (wheat, barley etc.). Gaseous emissions related to human activity contribute greatly to the ambient concentration of greenhouse gases, in particular CO2, methane, chlorofluorocarbons and nitrous oxides. Drought is the most severe issue for global agriculture affecting nearly 40% of the world's land area. Indian mustard is very susceptible to early seedling water stress. There are records that there is a great deal of resistance to water stress in Indian mustard germplasm than in other species of oil and *Brassica*. Yang chun-jie *et al.,* (2007) performed a rapeseed var trial. The outcome shows that the relative vigor index of the seedlings ranged from 0.32 to 0.70, with an average of 0.49. Drought stress greatly affected (P0.01) seedling height, fresh weight and survival relative to water management, 10 per cent PEG 6000 treatment decreased seedling height by 40-68 per cent, fresh weight by 34.2 per cent and survival by 18 per cent on average. Pace *et al.,* (2009) reported that the impact of salt level and

timing and osmotic stress on the germination and growth of rapeseed (Brassica napus var. oleifera D el.) cultivars with different stress tolerances. Final percentage of germination, time to 50% of germination and base water capacity of seeds, dry and fresh weights and root lengths of seedlings at the end of the growth cycle and associated relative growth rates between start and end of the growth period. Abdollah Youssefi *et al.,* (2011) was experimented in RCBD with three replicates and under two conditions, including drought stress and control with nine cultivars and results of combined study of variances showed that drought stress final plant height, yield of seeds, number of seeds per pod and number of lateral branches were significantly affected by water stress at 1% and of levels.

Materials and Methods

The investigations were carried out using 10 mustard genotypes (RB 50, RGN 48, Urvashi, Geeta, RH 819, RGN 229, RH 40,6 RH 749, NRCHB 101 and NRCDR 02).

20 seeds are sown in small plastic pots filled with potting mixture. Plants were allowed to germinate and irrigated regularly.

Stress conditions were created with PEG 6000 (5% and 10%) which was applied as irrigation water. The control plants were irrigated with distilled water. Leaf samples from control and the two stress treatments (5% and10% PEG) were collected at two different stages i.e. 10 DAS and 20 DAS for analysis.

Preparation of PEG-6000 solutions

5 per cent and 10 per cent polyethylene glycol (PEG) 6000 solutions were prepared by 5 g and 10 g polyethylene glycol (PEG 6000), respectively, dissolved in 100 ml distilled water.

Germination percentage

Emergence of radical was viewed as germination and germination percentage was calculated by counting the number of seeds germinated in paper towel at 7^{th} day.

Shoot Length

The shoot length was measured at 10^{th} and 20^{th} days with the help of meter scale and thread.

Root Length

The root length was measured at 10^{th} and 20^{th} day with the help of meter scale and thread.

Seedling dry weight

Fresh weight of seedling was taken by measuring the whole seedling after thoroughly washing and drying the extra water from seedling surface.

Dry weight was obtained after drying the seedlings in oven at 60°C till constant weight obtained.

Seedling Vigour Index I

Seedling vigour index at 10^{th} and 20^{th} day old seedlings were measured by the formula given by Singh and Kakralya (1995)

SV I = Germination % × (mean of seedling length (root + shoot)/100

Seedling Vigour Index II

Seedling vigour index at 10^{th} and 20^{th} day old seedlings were measured by the formula given by Singh and Kakralya (1995).

SV II = Germination % × seedling dry weight

Statistical Analysis

The observations were taken in triplicate and data were analyzed using completely randomized block design (CRD).

Results and Discussion

Mustard crop responds to water stress in the form of changes in various growth parameters. Studies conducted on PEG induced drought tolerance in mustar dat 10 and 20 days after sowing.

Shoot length

Data presented in table 1.0 shows the effect of PEG induced water stress on shoots length of 10 genotypes of mustard. Result showed that at 10 DAS there was significant difference among 10 mustard genotypes as well as at 20 DAS the varietal difference is found to be significant. It is also found that shoot length decreases with increase in PEG concentration significantly at 10 DAS as well as 20 DAS.

Results showed that the shoot length was reduced in all the genotypes by applying PEG 5% and 10%. RH 749 exhibited maximum reduction in shoot length (16.61%) and Geeta exhibited minimum (1.61%) at PEG 5% treatment whereas at PEG 10% RB 50 has highest reduction (21.8%) and minimum in RH 819 (8.3%).

Root length

Root length of 10 genotypes of mustard have been depicted in table 2.0. The pattern observed in the plants treated with 10%PEG was slightly different. It was highest in RGN 229 with root length of 5.70 cm but minimum in NRCHB 101 (3.24cm). Maximum reduction in root length at 5% PEG was found in Geeta(17.46%) and minimum in RH 406(7.11%) whereas at 10%PEG treatment the maximum reduction in root length was observed in NRCHB 101(37.9%) and minimum in RH 749 with 12.2% decrease.

Seedling dry weight (mg)

Data presented in table 3.0 shows the effect of PEG induced water stress on seedling dry weight of 10 genotypes of mustard. At both the stages, Result showed a general reduction in seedling dry weight on account of PEG induced water stress treatment. At 10 DAS, the highest seedling dry weight was found in RGN 229 in control and PEG induced water stress treatment. Highest reduction in seedling dry weight was recorded in RH 749 followed by NRCHB 101 in 5%PEG treated plants. At 10 % PEG stress, highest reduction was in RH 749.

At 20 DAS, the trend was found same i.e. seedling dry weight was recorded highest in RGN 229 at control as well stress conditions. Maximum reduction was observed in the Geeta followed by RB 50 in 5% PEG treated plants whereas in 10% PEG treated plants maximum reduction was found in RB 50.

Seedling vigour index I

Table 5.0 shows the effect of water stress created by PEG on seedling vigour index I. All the 10 genotypes under consideration were significantly different with each other and showing similar pattern of reduction in seedling vigour from control to stress treatments (5% and 10%) at both the stages i.e. at 10 DAS and 20 DAS. It is highest in RGN 229 and lowest in NRCHB 101.At 10 DAS, it ranged from 14.66 (RGN 229) to 9.73 (NRCHB 101) in control. At PEG 5% treatment, SVI ranged 11.91 (RGN 229) to 7.91 (NRCHB 101) whereas at 10% PEG treatment range was 10.22 (RGN 229) to 5.73 (NRCHB 101). The maximum reduction was

found to be in RGN 48 (24.39%) with minimum in RB 50 (16.27%) in 5% PEG. In 10% PEG treatment, maximum and minimum reduction in SVI was found in NRCHB 101 (41.1%) and RH 819 (24%) respectively.

Seedling vigour index II

Table 6.0 shows the data of SVI II of 10 mustard genotypes. All 10 genotypes are found to be significant with maximum values in RGN 229 in all treatment (0%, 5%, 10% PEG) and minimum in NRCHB 101 in (0%, 5%PEG) treatment and in 10% PEG treatment minimum SVI II was recorded in RH 749. The maximum reduction of 28.95% was in RH 749 and minimum in RB 50 with 16.35% reduction at 5% PEG treatment but the results in 10% PEG treatment was slight different with maximum reduction in RH 406(52.5%) and minimum in RGN 229 (35.2%).At 20 DAS, the pattern of seedling vigour index II was similar in all treatments (0%,5%,10% PEG) with maximum in RGN 229 and minimum in RH 749 in (0%,5%) treatment and 10% PEG minimum was observed in NRCDR 02. It ranged from 5.90 (RGN 229) in control to 2.93 in (NRCDR 02) 10 % PEG treatment. The maximum reduction was observed in RH 406(21.95%) and minimum in NRCHB 101(12.5%) at 5%.In 10% PEG maximum reduction was found in RH 406(33.4%) and minimum in RGN 229(26.9%). In the age of climate change, drought salinity and high temperatures have arisen as significant threats to agriculture. These droughts are very significant because, in recent years, well-watered growing areas have been turned into drought-prone areas due to a dwindling trend of rainfall in the world. Drought stress contributes to a number of morphological, physiological, biochemical and molecular modifications that adversely affect plant growth and productivity. Mustard is one of the most valuable crops grown in the world for oil purposes. Environmental tension, such as drought, salinity and temperature, is a crucial factor in restricting the development and productivity of *Brassica* varieties by disrupting intracellular water balance, pigment synthesis, osmolytes, antioxidants and growth and yield parameters. It's the *Brassica* spp. Medium resistance to drought and temperature conditions is considered. A considerable number of *Brassica* varieties have been produced in India over the last decade, which are drought resistant and have a high output potential. In the present investigation, 10 genotypes of mustard have been taken and have been grown under control conditions. Drought conditions is triggered by irrigation of 5% to 10% PEG plants. Control plants have been supplied with purified water. In present investigation shoot length was measured in 10 genotypes at 10 and 20 DAS under control as well as PEG induced water stress. There was significant decline in shoot length of all genotypes on account of PEG treatment at 10 and 20 DAS. The percent decline varied from 8.3 % in RH 819 to 21.8% in RB 50 at 10 DAS and 2.2 % in RH 819 to 16.5 % in RGN 48 at 20 DAS.

Root length is an important parameter which helps in imparting drought tolerance. Seedling length decreased significantly under PEG induced water stress conditions at both the stages. The root length also decreased with PEG induced water stress. Our results showed a significant variation in root length of 10 genotypes irrigated with distilled water. The water stress treatment reduced root length in all genotypes. Among genotypes RGN 229 exhibited maximum root length under control as well as stress conditions at both stages. The maximum per cent reduction was observed in NRCHB 101. The roots are the powerful way to impart drought tolerance by exploiting water from deeper reservoirs.

Table.1 Effect of PEG induced water stress on shoot length (cm) of diverse mustard genotypes

S.No.	Treatments	Shoot length (cm)							
		10 DAS				20 DAS			
		Control	5% PEG	10% PEG	Mean	Control	5% PEG	10% PEG	Mean
1	RB 50	6.76	6.06	5.28	**6.03**	13.12	12.44	11.54	**12.37**
2	RGN 48	6.40	5.60	5.34	**5.78**	13.62	12.64	11.36	**12.54**
3	Urvashi	6.56	6.11	5.36	**6.01**	13.32	12.70	11.90	**12.64**
4	Geeta	6.20	6.10	5.60	**5.97**	13.16	12.60	11.70	**12.49**
5	RH 819	6.46	6.21	5.92	**6.20**	12.24	12.96	11.96	**12.39**
6	RGN 229	6.82	6.40	6.16	**6.46**	13.54	13.04	12.18	**12.92**
7	RH 406	5.92	5.48	5.12	**5.51**	12.62	11.54	11.10	**11.75**
8	RH 749	5.90	4.92	4.70	**5.17**	12.18	11.80	11.20	**11.73**
9	NRCHB 101	5.60	4.82	4.40	**4.94**	12.14	11.18	10.50	**11.27**
10	NRCDR 02	5.60	5.34	4.70	**5.21**	12.40	11.40	11.02	**11.61**
	Mean	**6.22**	**5.70**	**5.26**		**12.83**	**12.23**	**11.45**	
		SEm+		**CD (p=0.05)**		**SEm+**		**CD (p=0.05)**	
	Variety(v)	0.17		0.49		0.36		1.03	
	Treatment(T)	0.09		0.27		0.19		0.56	
	V x T	0.29		0.85		0.62		1.78	

Table.2 Effect of PEG induced water stress on Root length (cm) of diverse mustard genotypes

S.No.	Treatments	Root length (cm)							
		10 DAS				20 DAS			
		Control	5% PEG	10% PEG	Mean	Control	5% PEG	10% PEG	Mean
1	RB 50	7.58	6.74	5.18	**6.50**	10.66	9.70	9.00	**9.79**
2	RGN 48	7.40	6.18	5.22	**6.27**	10.48	9.32	8.96	**9.59**
3	Urvashi	6.88	6.12	5.62	**6.21**	9.92	9.80	9.14	**9.62**
4	Geeta	7.56	6.24	5.22	**6.34**	10.80	9.78	9.20	**9.93**
5	RH 819	6.72	5.80	5.11	**5.88**	10.08	9.76	9.10	**9.65**
6	RGN 229	7.84	6.88	5.70	**6.81**	11.76	10.86	9.84	**10.82**
7	RH 406	6.18	5.74	4.61	**5.51**	9.80	9.16	8.48	**9.15**
8	RH 749	5.54	5.24	4.86	**5.21**	9.16	8.44	8.28	**8.63**
9	NRCHB 101	5.22	4.60	3.24	**4.35**	9.04	8.90	7.88	**8.61**
10	NRCDR 02	6.23	5.76	4.56	**5.52**	9.50	8.06	8.12	**8.56**
	Mean	**6.72**	**5.93**	**4.93**		**10.12**	**9.38**	**8.80**	
		SEm+		**CD (p=0.05)**		**SEm+**		**CD (p=0.05)**	
	Variety(v)	0.17		0.50		0.28		0.81	
	Treatment(T)	0.10		0.28		0.15		0.44	
	VxT	0.30		0.87		0.49		1.40	

Table.3 Effect of PEG induced water stress on seedling dry weight (mg) of diverse mustard genotypes

S.No.	Treatments	Seedling dry weight (mg)							
		10 DAS				20 DAS			
		Control	5% PEG	10% PEG	Mean	Control	5% PEG	10% PEG	Mean
1	RB 50	28.00	25.00	21.00	**24.67**	52.00	47.00	42.00	**47.00**
2	RGN 48	29.00	24.00	19.00	**24.00**	51.00	48.00	44.00	**47.67**
3	Urvashi	30.00	26.00	21.00	**25.67**	54.00	49.00	45.00	**49.33**
4	Geeta	29.00	25.00	20.00	**24.67**	54.00	47.00	43.00	**48.00**
5	RH 819	33.00	29.00	22.00	**28.00**	52.00	47.00	42.00	**47.00**
6	RGN 229	38.00	32.00	28.00	**32.67**	59.00	54.00	49.00	**54.00**
7	RH 406	27.00	23.00	16.00	**22.00**	48.00	44.00	40.00	**44.00**
8	RH 749	24.00	19.00	14.00	**19.00**	46.00	42.00	39.00	**42.33**
9	NRCHB 101	22.00	18.00	15.00	**18.33**	48.00	45.00	41.00	**44.67**
10	NRCDR 02	26.00	23.00	17.00	**22.00**	47.00	44.00	39.00	**43.33**
	Mean	**28.60**	**24.40**	**19.30**		**51.10**	**46.70**	**42.40**	
		SEm+		**CD (p=0.05)**		**SEm+**		**CD (p=0.05)**	
	Variety(v)	0.74		2.14		1.38		3.98	
	Treatment(T)	0.41		1.17		0.75		2.18	
	V x T	1.28		3.71		2.39		6.89	

Table.4 Effect of PEG induced water stress on seedling vigour index I of diverse mustard genotypes

S.No.	Treatments	Seedling vigour index I							
		10 DAS				20 DAS			
		Control	5% PEG	10% PEG	Mean	Control	5% PEG	10% PEG	Mean
1	RB 50	13.76	11.52	8.58	**11.29**	22.84	19.92	16.84	**19.87**
2	RGN 48	13.24	10.01	8.44	**10.56**	22.65	18.66	16.25	**19.19**
3	Urvashi	12.76	10.39	8.78	**10.64**	22.07	19.12	16.83	**19.34**
4	Geeta	13.07	11.10	9.19	**11.12**	22.76	20.14	16.72	**19.87**
5	RH 819	11.86	10.00	9.01	**10.29**	20.98	19.31	16.84	**19.04**
6	RGN 229	14.66	11.91	10.22	**12.26**	25.30	21.74	19.37	**22.14**
7	RH 406	11.37	8.97	7.29	**9.21**	21.07	16.56	14.68	**17.44**
8	RH 749	10.52	8.43	7.45	**8.80**	19.63	16.79	15.19	**17.20**
9	NRCHB 101	9.73	7.91	5.73	**7.79**	19.06	16.86	13.78	**16.57**
10	NRCDR 02	10.64	8.88	6.94	**8.82**	19.71	15.56	14.35	**16.54**
	Mean	**12.16**	**9.91**	**8.16**		**21.61**	**18.47**	**16.09**	
		SEm+		**CD (p=0.05)**		**SEm+**		**CD (p=0.05)**	
	Variety(v)	0.31		0.89		0.56		1.62	
	Treatment(T)	0.17		0.49		0.31		0.89	
	V x T	0.53		1.54		0.97		2.81	

Table.5 Effect of PEG induced water stress on seedling vigour index II of diverse mustard genotypes

S.No.	Treatments	seedling vigour index II							
		10 DAS				20 DAS			
		Control	5% PEG	10% PEG	Mean	Control	5% PEG	10% PEG	Mean
1	RB 50	2.69	2.25	1.72	**2.22**	4.99	4.23	3.44	**4.22**
2	RGN 48	2.78	2.04	1.52	**2.11**	4.89	4.08	3.52	**4.16**
3	Urvashi	2.85	2.21	1.68	**2.25**	5.13	4.16	3.60	**4.30**
4	Geeta	2.75	2.25	1.70	**2.23**	5.13	4.23	3.65	**4.34**
5	RH 819	2.97	2.46	1.76	**2.40**	4.68	3.99	3.36	**4.01**
6	RGN 229	3.80	2.91	2.46	**3.06**	5.90	4.91	4.31	**5.04**
7	RH 406	2.53	1.84	1.20	**1.86**	4.51	3.52	3.00	**3.68**
8	RH 749	2.21	1.57	1.09	**1.62**	4.23	3.48	3.04	**3.58**
9	NRCHB 101	1.98	1.44	1.12	**1.51**	4.32	3.78	3.07	**3.72**
10	NRCDR 02	2.34	1.84	1.27	**1.82**	4.23	3.52	2.93	**3.56**
	Mean	**2.69**	**2.08**	**1.55**		**4.80**	**3.99**	**3.39**	
		SEm+		**CD (p=0.05)**			**SEm+**	**CD (p=0.05)**	
	Variety(v)	0.07		0.19			0.12	0.35	
	Treatment(T)	0.04		0.11			0.07	0.19	
	V x T	0.12		0.33			0.21	0.61	

The better root system in RGN 229 might be beneficial to impart drought tolerance by their extending root length.

The shoot length of these genotypes was also maximum indicating that the deeper root system has helped in better shoot development.

Variations in shoot and root length were found significant in all 10 genotypes. The effect of root, shoot length has also been reflected on the dry weight of seedlings. As expected, it was maximum in RGN 229.

A comparison of concentration of PEG suggested that 10% PEG at 20 DAS was better to get clear to end. These observations indicate that the shoot length is another important parameter for measuring the drought susceptibility. Our results on seedling dry weight showed that there were significant variations among 10 genotypes of mustard under control as well as PEG induced water stress conditions. There was an expected decline in seedling dry weight on account of water stress treatment. However, it varied from 39 mg in RH 749 to 49 mg in RGN 229 at 20 DAS under 10% PEG.

Seedling dry weight, Seedling vigour index I and Seedling vigour index II decreased significantly under PEG induced water stress conditions in all the genotypes.

Variations were significant in all 10 genotypes. RGN 229 exhibited highest value of seedling dry weight as well as seedling vigour index under stress conditions.

Acknowledgement

The authors are thankful to the Dean, S.K.N. College of Agriculture, Jobner for providing necessary facilities and permission to conduct the study.

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