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Effect of Brassinolide in amelioration of salinity adverse effects on growth and yield of wheat

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Abstract
The present research was aimed to study the effect of Brassinolide in amelioration of salinity adverse effects on growth and yield of wheat at Department of Plant Physiology, S.K.N. College of Agriculture, Jobner, Rajasthan during *rabi*, 2013. Two wheat cultivars namely HD-2687 (salinity susceptible) and Raj-3777 (Salinity tolerant) were raised in petri-dishes and in cemented pots under salinity conditions (0, 4 and 8 dSm^{-1}) brassinolide (0.0, 0.25, 0.50 and 1.0 ppm) were also added in the saline set of petri-dishes and pots. Spray treatment with brassinolide up to 1.0 ppm significantly increased Number of spikes per plant, grain yield, biological yield per plant. The maximum increase in number of spikes per plant, grain yield, and biological yield per plant was found under non stress conditions with 1.0 ppm concentration of brassinolide in both genotypes. It may be concluded that among both the genotype Raj-3777 observed salinity tolerant and the tolerance was mediated by morphological characteristics. The experiment again reflects the significant role of brassinolide in increasing productivity of wheat by improving germination, seedling growth, yield and yield attributes under non stress and salt stress conditions.

Keywords: Brassinolide, salinity, germination %, Dry weight, fresh weight, yield

Introduction
Soil salinity is one of the major abiotic stresses affecting germination, crop growth and productivity. Crop yields start declining when pH of the soil solution exceeds 8.5 or EC value goes above 4 dS m^{-1}. Salt stress is a serious problem in crop production an excess of inorganic salts and salt accumulation in upper soil layer, such soils profoundly influences the germination, growth and yield and even existence of crops. About 10.08 million hectares of land have been affected by salinity and alkalinity problem in India (Tomar, 2005) [18]. Salt stress affects the various physiological processes of plants which reduces the yield and quality of produce. Mittova and Loganberbien (2000) [8] reported the influence of salt stress on respiration metabolism in higher plants and found that activity of glycolysis decreases significantly with increasing salinity. The salt stress developed at various phenological stages affects the yield and yield attributes differentially by manipulating various plant processes (Chongo and Vetty, 2001) [2]. The detrimental effects of salinity can be attributed to the decrease in osmotic potential and disturbances in mineral nutrition of wheat plant (Sharma, 1996b). Salinity stress disturbs the electrolyte balance, resulting in the defficiency of essential nutrients i.e. P & K (Soltanpur *et al*., 1999) [17]. Therefore, osmotic adjustment have proved more important salt tolerance mechanism in wheat, where plants are forced to decrease their internal water potential via, accumulating ions in the vacuoles. Proline, sugar, glycine, betaine etc. are some of the good osmoprotectants accumulate in the cytoplasm. The process allows turgor driven process such as stomatal opening at reduced rate by maintaining the water balance of the plant cells (Gupta *et al*., 2001) [5]. Plant height, number of tillers, leaf area index, dry matter, grain number, grain weight and harvest index are the yield contributing characters of wheat and the salinity has found to affect the yield by adversely affecting one or more of these parameters (Munns *et al*., 1995) [9]. Salinity reduced leaf area and number of tillers and increase sodium (Na+) and chloride (Cl-) concentration of leaves (Munns and Termaat, 1986) [10]. Ghane *et al*. (2009) [3] revealed that the increase of salinity of irrigation water from EC 4 to 12 dSm^{-1} decreased grain yield and productivity of wheat. There are certain chemicals which have potential to induce salt tolerance in crop plants. They are associated with several cellular and physiological processes and may be useful for protecting crop plants against abiotic stresses like salinity. Plant growth regulators (PGRS) showed tremendous potential in modulating growth, productivity and related process. They are considered as bio-software, which elicit rapid as well as long term responses in crop plants (Malik *et al*., 1996) [7].

Brassinolide has emerged as a new phytohormone with pleiotropic effect (Sasse, 1997) [13], and influences varied physiological processes like germination, growth, flowering, senescence and confers resistance to plant against various abiotic stresses. Brassinosteroids are a new group of plant hormones with growth promoting activity. The ability of certain pollen extracts to promote growth led to discovery of this group of substances in plants. As the first steroidal plant growth regulator was isolated from the pollens of rape (Brassica napus), a generic name "Brassinosteroids" has been given to this new group of phytohormones. Brassinosteroids application under various abiotic stresses polysaccharides are hydrolysed, resulting in increase in soluble sugars confer resistance against environmental stresses in crop plants such as vegetables, fruits, cereals and oil seeds and also enhances the crop productivity (Vidya Vardhini *et al*., 2006) [20]. Therefore, the present studies has been proposed to Effect of Brassinolide in amelioration of salinity adverse effects on growth and yield of wheat.

Materials and methods

The present investigations were conducted at Department of Plant Physiology, S.K.N. College of Agriculture, Jobner (Rajasthan) during *rabi*, 2013. Raj-3777 salinity tolerant and HD-2687 salinity susceptible wheat cultivars were evaluated for germination and early seedling growth in petri-dishes in laboratory. The petri-dishes thus prepared were autoclaved. Seeds of cv. Raj-3777 and HD-2687 were surface sterilized with 0.1 $HgCl_2$ for 5 min. followed by at least three washing with sterile distilled water and dried. The twenty dried seeds were raised in each petri-dish at EC 0 (Tap water), 4 and 8 dSm^{-1} for saline set of petri-dishes. Different concentrations of brassinolide (0.0, 0.25, 0.50 and 1.0 ppm) were also added in the 10 ml saline set of petri-dishes, in triplicate.

Emergence of radical (about 2 mm length) was viewed as germination and germination percentage was calculated by counting the number of seeds germinated in each petri-dish at 3 days after treatment. Five washed seedling from each petri-dish were separated into root and shoot for the determination of fresh weight (7^{th} DAT) and dry weight of seedling root and shoot. Dry weight was determined after oven drying the root, shoot samples at 70 ^{0}C until constant weight was obtained. Leaf area was measured under pot conditions with the help of leaf area meter (LICOR 3000 USA). Three plants were selected randomly and average green leaf area was calculated at 50 and 65 DAS. After harvest, plants were air dried and the grain yield (g) was taken and calculated as per plant basis. The whole plant weight (including shoot, dried leaves and spike) of three randomly selected plants was recorded as gram per plant. The experiment was factorial based on Randomized Block Design with three replications.

The total number of spike per plant was counted in each pot and then the average was calculated. After harvest, plants were air dried and the grain yield (g) was taken and calculated as per plant basis. The whole plant weight (including shoot, dried leaves and spike) of three randomly selected plants was recorded as gram per plant.

Results and Discussion

The data presented in Table 1, revealed that germination percentage of wheat cultivars distinctly differed with increase in level of salt stress. Germination percentage decreased with increasing salinity levels up to EC 8.0 dSm^{-1} and increased with increasing level of brassinolide up to 1 ppm concentration. The significantly higher germination percentage was recorded by variety Raj-3777 (7.38 per cent) than HD-2687 at 3 days after treatment under stress as well as non-stress conditions. The maximum germination percentage was recorded due to treatment with 1.0 ppm concentration of brassinolide under both non stress and salt stress conditions. Different types of brassinosteroids increased shoot length, root length, and shoot fresh weight, number of fruits per plant and total weight of tomato fruit per plant also supported by Vardhini and Rao (2001) [19]. Cultivar Raj-3777 showed marked negative effects on fresh weight and dry weight of root and shoot with increasing salinity levels than variety HD-2687 in the above Table 1. Cultivar HD-2687 recorded significantly higher fresh weight and dry weight of root whereas; in case of **s**hoot fresh weight (7 DAT) and dry weight the cultivar Raj-3777 perform better. The reduction under salt stress may be due to inhibition of hydrolysis of reserve/ synthesizing food or/ and its translocation to the growing axis (Singh and Singh 1999) [16]. Fresh weight and dry weight of root and shoot at 7 days old seedling of wheat genotypes significantly increased over control due to supplementing brassinolide in saline medium, indicating alleviating influence of brassinolide on salt stress induced inhibition of seedling growth irrespective of cultivar tested. Maximum increase observed at 1.0 ppm concentration of brassinolide. Similar result was reported by Prakash, *et al*. (2008) [11] they reported that morphological parameters like plant height, number of leaves, number of branches and LAI increased with increasing number of sprays and dosage of spray as compared to control. Salt stress was found to decreased leaf area significantly up to EC 8.0 dSm^{-1} (23.10 and 22.82 per cent) over control at 50 and 65 DAS (Table 2). Leaf area per plant increased significantly up to the 1.0 ppm level of brassinolide at 50 and 65 DAS.

Higher number of spikes per plant was recorded by variety Raj-3777 (12.36 per cent more than HD-2687). Raj-3777 significantly performing better than HD-2687 under both non stress and salt stress conditions. Salinity stress significantly decreased the number of spikes per plant up to EC 8.0 dSm^{-1}. The decrease in number of spikes per plant was recorded to the extent of 15.03 and 24.83 per cent at EC 4.0 and EC 8.0 dSm^{-1} over control. The yield per plant, fertility percentage, and number of productive tillers, panicle length and number of primary braches per panicle were reduced by salinity (Ali, Y. *et al.* 2004) [1]. A further study of the data in Table 2 indicated that application of brassinolide enhanced significantly the number of spikes per plant up to 1.0 ppm concentration under both non stress and salt stress conditions. It is clear from the data given in Table 2 that a higher grain yield per plant was achieved by variety Raj-3777 under normal and stress conditions which was higher by 23.03 per cent over HD-2687. Reduction in grain yield was significantly higher in KRL 19 than more tolerant Kharchia 65 in salinity stress as reported by Sairam *et al.* (2002) [12]. Application of saline irrigation water up to EC 8.0 dSm^{-1} bring a significant reduction in grain yield per plant (33.52 per cent) over control (normal water irrigation).

Application of brassinolide up to 1.0 ppm concentration brought significant increase in grain yield of wheat over control under non stress and salt stress conditions. The maximum increase in grain yield was recorded due to use of 1.0 ppm concentration of brassinolide which was recorded 37.32 per cent more over 0.50 ppm (25.88 per cent), 0.25 ppm (14.16 per cent) concentration and control. A significantly higher biological yield per plant was obtained by variety Raj-3777. Biological yield per plant decrease significantly with increasing level of saline irrigation water up to EC 8.0 dSm^{-1} (Table 2). The use of brassinolide up to 1.0 ppm was observed to increase significantly grain yield and biological yield, harvest index of clusterbean as reported by Gojraj Jat *et al*., (2012) [4]. The significant increase in biological yield per plant was recorded under the application of 1.0 ppm concentration of brassinolide which was recorded 27.36 per cent more over 0.50, 0.25 ppm concentration of brassinolide and control. The study seem to indicate that the productivity of the wheat cultivars raised through enhancing their biological yield as postulated by the wheat breeders and physiologists (Sharma, Natu and Ghildiyal 2005) [14].

Table 1: Effect of salinity and brassinolides on Germination %, fresh weight (7 DAT) and dry weight of root and shoot of wheat.

Treatments	Germination (%)3 DAT	Root fresh weight (mg/ seedling)	Dry weight (mg/ seedling)	Shoot fresh weight (mg/seedling)	Dry weight (mg/seedling)
Varieties					
Raj-3777	84.22	8.02	1.84	29.59	5.42
HD-2687	78.00	8.72	2.20	26.60	4.80
S.Em. +	0.68	0.20	0.05	0.30	0.08
C.D. (P=0.05)	1.92	0.58	0.15	0.86	0.22
Salinity levels (dSm-1)					
0	87.88	9.35	2.36	32.02	7.09
4	83.22	8.42	2.05	27.70	4.30
8	72.22	7.34	1.66	24.57	3.94
S.Em. +	0.83	0.25	0.06	0.37	0.09
C.D. (P=0.05)	2.35	0.71	0.18	1.05	0.27
Brassinolides (ppm)					
0	75.00	6.81	1.60	24.50	4.10
0.25	78.77	7.84	1.87	26.40	4.69
0.50	83.33	8.93	2.17	29.48	5.47
1.00	87.33	9.90	2.44	32.00	6.18
S.Em. +	0.96	0.29	0.07	0.43	0.11
C.D. (P=0.05)	2.71	0.82	0.21	1.22	0.31

Table 2: Effect of salinity and brassinolides on Leaf area, Number of Spikes, Grain yield and Biological yield of wheat.

Treatments	Leaf area per plant (cm2/plant)		Number of spikes/plant	Grain yield (g/plant)	Biological yield (g/plant)
	50 DAS	65 DAS			
Varieties					
Raj-3777	85.44	103.66	2.83	4.95	11.10
HD-2687	73.68	89.75	2.48	3.81	9.26
S.Em. +	0.63	0.76	0.031	0.03	0.08
C.D. (P=0.05)	1.78	2.14	0.088	0.09	0.23
Salinity levels (dSm-1)					
0	89.53	108.49	3.06	5.16	11.69
4	80.31	97.89	2.60	4.55	10.62
8	68.84	83.73	2.30	3.43	8.23
S.Em. +	0.77	0.93	0.038	0.04	0.10
C.D. (P=0.05)	2.18	2.63	0.108	0.11	0.28
Brassinolides (ppm)					
0	69.10	85.75	2.23	3.67	8.99
0.25	75.90	93.72	2.52	4.19	9.69
0.50	84.55	102.00	2.82	4.62	10.59
1.00	88.70	105.35	3.05	5.04	11.45
S.Em. +	0.89	1.07	0.044	0.04	0.11
C.D. (P=0.05)	2.51	3.03	0.125	0.13	0.32

Conclusion

The overall comparison of these parameters indicated that the variety Raj-3777 (Salinity tolerant) is forming better than variety HD-2687 (salinity susceptible) under salinity. Variety Raj-3777 may be recommended to farmers for cultivation in saline area up to EC 8 dSm^{-1}.

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