

Effect of Different Seed Priming Treatments on Germination, Growth, Biochemical Changes and Yield of Wheat Varieties under Sodic Soil

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Abstract: Experiments were conducted during rabi season of 2012 and 2013 to study the effect of seed priming on germination, growth, biochemical changes and yield of tolerant KRL 210 and susceptible HD 2733 varieties under sodic soil at the research farm of Department of Genetics and Plant Breeding, Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad (U.P.). Seed priming was done by soaking the seeds for 12 hours in distilled water, KNO₃ (3%), KCl (1%), GA₃ (150 ppm) and cycocel 500 ppm. Application of primers brought a considerable increase in germination and growth parameters like plant height, tiller numbers and plant dry weight. The biochemical parameters viz., total chlorophyll content and starch content showed a significant increase due to seed priming. Seed priming also significantly enhanced the ear bearing tiller plant⁻¹, number of grain ear⁻¹ and grain yield plant⁻¹. Among different treatments, KNO₃ (3%) was found superior among all the priming treatments and significantly higher than rest of the treatments.

Keywords: KNO₃, primers, morphological, biochemical, yield and wheat

1. Introduction

Wheat (*Triticum aestivum* L.) is one of the most important crops in India, which plays a special role in people's nutrition. But unfortunately abiotic stresses, such as salinity, decrease wheat growth and productivity by reducing water uptake and cause nutrient disorders and ion toxicity in this region.

Agricultural crops are facing various types of biotic and abiotic stresses. Among the abiotic stresses, soil salinity adversely influences the crop production (Shafi *et al.*, 2009, 2010, 2011). Salts may influence plant growth by causing direct injury to the growing cells or indirectly by reducing the amount of water reaching the growing region and photosynthates (Mass and Nieman, 1978). Salt stress induces water stress by decreasing the osmotic potential of the soil solutes and thus making it very difficult for roots to extract the required water from its surrounding media. The effects of higher salt stress on plants can be observed in terms of decreased productivity or plant death (Parida and Das, 2004). Plant response to salt stress is very complex and depends upon the duration of salinity, developmental stage of plant at salt exposure, type of salt and many other factors. At higher salinity levels, the crop yield is decreased so drastically that cultivation of crop becomes uneconomical without amendments of soil.

Soil salinity is a major abiotic stress which adversely affects physiological and metabolic processes, leading to dimin-

ished growth and yield (Azizpour *et al.*, 2010). Excess amount of salt in the soil adversely affects plant growth and development. Nearly 20% of the world's cultivated area and nearly half of the world's irrigated lands are affected by salinity. Processes such as seed germination, seedling growth and vigour, vegetative growth, flowering and fruit set are adversely affected by high salt concentration. Ultimately sodic soil is reducing economic yield and also quality of produce. Salt and dehydration stress show a high degree of similarity with respect to physiological, biochemical, molecular and genetical effects. This is possible due to fact that sub-lethal salt stress condition is ultimately an osmotic effect, which is apparently similar to that brought in water deficit and to some extent by cold as well as heat stresses.

Abiotic stresses such as drought and salinity stress are widespread problems around the world (Soltani *et al.*, 2006). Therefore Esfandiari *et al.* (2007) reported that seed germination and seedling growth of wheat (*Triticum aestivum* L.), like other crops, were negatively affected by salinity stress. Seed characteristics are usually essential process in seedling establishment and plant development to obtain seedling numbers those results in higher seed crop (Almansouri *et al.*, 2001; Murungu *et al.*, 2003). Seed germination and establishment are the most sensitive stages to abiotic stresses (Patade *et al.*, 2011; Ansari *et al.*, 2012).

Ashraf and Foolad (2005) reported that seed priming is one of the methods that can be taken to counteract the adverse

effects of abiotic stress. Seed priming techniques have been used to increase germination, improve germination uniformity, improve seedling establishment and stimulate vegetative growth in more field crops (Ansari *et al.*, 2012; Patade *et al.*, 2011; Foti *et al.*, 2008) under stressed conditions. Also, Ansari and Sharif-Zadeh, (2012) reported that priming by salicylic acid and gibberellins have been used to increase germination characteristics in rye seeds. Also, the priming strategies enhanced activities of free radical scavenging enzymes such as CAT and APX (Ansari and Sharif-Zadeh, 2012; Rouhi *et al.*, 2012).

2. Material and Methods

The present investigation was conducted during *Rabi* seasons of 2012-13 and 2013-14. The investigation was carried out in field with two varieties of wheat (*Triticum aestivum* L.) HD 2733 (susceptible) and KRL 210 (tolerant). A field at the experiment at the research farm of the Department of Genetics and Plant Breeding, Narendra Deva University of Agriculture & Technology (Kumarganj), Faizabad (U.P.). The experiment was conducted in sodic soil with two varieties HD 2733 (susceptible) and KRL 210 (tolerant). The whole experiment was planned under Randomized block design (factorial) with three replications along with six treatments. Solutions of desired concentrations of plant growth regulators (PGRs) and chemicals were prepared. After that bold and healthy seeds of HD 2733 and KRL 210 were primed in the solutions of KNO₃-3%, KCl-1%, GA₃ -150 ppm and Cycocel-500 ppm for 12 hours before sowing. For hydropriming treatment, seeds were soaked in distilled water. Non primed seeds were taken as untreated control. The seeds were dried in shade for 2 hours and sowing was done with the help of chisel in the first week of December 2012 and December 2013 at a row, spacing of 22cm at depth of 4-5cm. After 15 days of sowing, thinning was done to maintain and provide proper spacing. About 30 uniform plants of same vigour were selected as well as tagged in each plot. The data regarding germination were recorded 15 days after sowing. Various data were recorded at 30, 60 and 90 Days after sowing of seeds. Plant height was measured with the help of meter scale from the base of the shoot to tip. Plants were oven dried at 80°C for 24 hours and dry weight was taken at each stages of observation. Chlorophyll content was estimated according to the method of Arnon (1949) and expressed as mg g⁻¹ fresh weight of leaves. Starch content was measured by the method of Mc Cready (1950). Both biochemical parameters (Chlorophyll content and Starch content) were recorded at reproductive stage. The statistical analysis of experimental data was done by method described by Fisher and Yates (1949) using Randomized block. Seed germination was recorded upto 14 days after start of the experiment. Germination percentage was calculated using the following formula:

$$\text{Germination (\%)} = \frac{\text{Number of seeds germinated after 14 days} \times 100}{\text{Number of seeds sown}}$$

3. Result and Discussion

Seed priming had significant positive effect on different aspects such as seed germination, growth and biochemical

parameters. Sodicity significantly reduced the seed germination percentage irrespective of wheat variety but the effect of sodicity was more pronounced in susceptible variety HD 2733 in comparison to tolerant variety KRL 210.

Seed priming significantly enhanced the seed germination percentage in wheat irrespective of variety but the effect of priming was more prominent in tolerant variety KRL 210 in comparison to susceptible variety HD 2733 (Table 1). Maximum germination percentage was recorded in KNO₃ (3%), KCl (1%) and GA₃ (150ppm) while hydropriming influenced least on germination percentage. Farooq *et al.* (2006) reported that hydropriming break down seed dormancy by the activation of hydrolytic enzymes like α -amylase. This increase in germination may also be due to the activity of α -amylase due to osmopriming. Amylases are key enzymes that play a vital role in hydrolyzing the seed starch reserve, thereby supplying sugars to the developing embryo. The improved germination of primed seeds was attributed to enhanced counteraction of free radicals and re-synthesis of membrane bound enzymes compared to unprimed seeds (Srinivasan and Saxena 2001). Similar findings were also reported by Golizadehet *et al.*, (2015) in Cannabis seed, Lara *et al.*, (2014) in tomato, Ghobadi *et al.*, (2012), Lemrasky *et al.* (2012) and Abbasdokht (2011) in wheat.

Table 1: Effect of seed priming with chemicals and PGRs on germination and biochemical changes of wheat varieties under sodic soil

Variety Treatments	Germination percentage	Total chlorophyll content	Starch content
Control	68.75	2.71	93.63
Hydropriming	73.08	2.76	102.06
Priming with KNO ₃	80.92	3.11	113.83
Priming with KCl	77.75	3.05	108.71
Priming with GA ₃	76.25	3.12	105.62
Priming with cycocel	74.50	3.04	103.09
SEm±	0.87	0.025	1.30
CD at 5%	2.55	0.073	3.82
HD 2733	72.08	2.84	100.74
KRL 210	78.33	3.09	108.24
SEm±	0.50	0.014	0.75
CD at 5%	1.47	0.042	2.21

In the present investigation, seed priming with chemicals, plant growth regulators and water had maintained significantly higher total chlorophyll in both tolerant and susceptible varieties (Table-1). Maximum chlorophyll content was recorded with KNO₃(3%) followed by KCl (1%), GA₃(150ppm), Cycocel (500ppm) and hydropriming as compared to untreated control. Chlorophyllase enzyme which is responsible for chlorophyll degradation, might have been inhibited by priming treatment. The Similar increase in chlorophyll content has been reported by Menon *et al* (2013), Wasif and Mohammad (2012) in *moringa oleifera*, Azooz (2009) in sorghum, Hamid *et al.*, (2008) in wheat and EI-Tayed (2005) in barley.

Seed priming significantly enhanced the starch content in both the wheat varieties over control (Table 1). The maximum starch content was found with KNO₃ followed by KCl, GA₃, cycocel and hydropriming as compared to untreated control. Increase in starch content might be due to

induced hydrolysis of reserve polysaccharide or rapid utilization of total soluble starch. These results are corroborated with the findings of Afzal *et al.*, (2009b) observed that seeds primed with 50 mM CaCl₂ a strong association with increased total sugars is reported in

marigold and tomato (Handa *et al.*, 1983). Iqbal *et al.* (2006) in wheat, Afzal *et al.* (2008) in wheat and Bakht *et al.* (2011) in maize.

Table 2: Effect of seed priming with chemicals and PGRs on yield and yield contributing traits of wheat varieties under sodic soil

Variety Treatments	Plant height	Number of tillers plant ⁻¹	Dry biomass plant ⁻¹	EBT plant ⁻¹	No. of grain ear ⁻¹	Grain yield plant ⁻¹
Control	82.89	6.45	27.05	5.92	33.97	7.84
Hydropriming	85.38	6.74	28.95	6.17	37.28	8.44
Priming with KNO ₃	93.70	7.92	29.59	7.42	44.78	9.51
Priming with KCl	90.65	7.33	30.43	7.39	41.50	9.34
Priming with GA ₃	89.48	7.33	29.38	7.00	39.36	8.93
Priming with cycocel	81.17	7.12	29.29	6.42	38.17	8.72
SEm±	1.29	0.30	0.502	0.31	0.71	0.21
CD at 5%	3.80	0.88	1.474	0.90	2.08	0.61
HD 2733	83.80	6.45	27.59	5.97	34.52	8.03
KRL 210	90.63	7.84	30.64	7.46	43.83	9.56
SEm±	0.74	0.17	0.290	0.18	0.41	0.12
CD at 5%	2.19	0.51	0.851	0.52	1.20	0.36

In general, plant height increases with the increase of plant age. Seed priming significantly enhanced the plant height in tolerant variety KRL 210 as compared to susceptible variety HD 2733 (Table-2). Maximum plant height was recorded with KNO₃ (3%) followed by GA₃ (150ppm) and hydropriming. However the minimum was recorded in case of cycocel (500ppm). Priming with cycocel had no effect on plant height. The increase in plant height might be due to stimulation of cell elongation, cell division and enlargement as reported by Tolbert (1974). These findings are in accordance with the results reported by Golizadehet *et al.*, (2015) in Cannabis seed, Jalilian *et al.*, (2014) in barley, Shabbir *et al.* (2013) in fennel, Abnavi and Ghabdi (2012) and Ghabdi *et al.* (2012) in wheat.

Seed priming significantly affected the number of tillers plant⁻¹. The tolerant variety KRL 210 produced more tiller as compared to susceptible variety HD 2733 (Table-2) under priming. Priming with KNO₃(3%), KCl (1%), GA₃(150ppm), cycocel (500ppm) and hydropriming had maintained more tillers plant⁻¹ while lowest number was observed in untreated control. These results are corroborated with the findings of Farooq *et al.* (2008) in wheat, Farooq *et al.* (2006) in rice, Zhang *et al.* (2005) in potato, Cox and Otis, (1989) in wheat, Child *et al.* (1988) in oil seed and Woodward and Marshall (1987) in barley.

Seed priming treatments significantly affected dry biomass plant⁻¹ in both the varieties (Table-2) but the effect of seed priming was more pronounced on tolerant variety KRL 210 as compared to susceptible variety HD 2733. Maximum dry biomass plant⁻¹ was recorded with KNO₃(3%) followed by KCl (1%), GA₃(150ppm), cycocel(500ppm) and hydropriming as compared to untreated in both the varieties. The increased vegetative growth in turn resulted into production of higher dry matter in plants. The increase in plant dry weight due to priming treatments indicated that the photosynthetic activity and efficiency of the leaves have been increased which contributed to dry matter production. The results are in agreement with the earlier findings Shabbir

et al. (2013) in fennel, Abnavi and Ghabdi (2012) in wheat, Aymen and Cherif (2013) in coriander, Ghabdi *et al.* (2012) in wheat, Hamid *et al.* (2008) in wheat, Gurmani *et al.*, (2006) in rice and Khodary (2004) in maize.

Yield is the synthesis and outcome of physiological and biochemical process. Priming with chemicals and plant growth regulators had proved significant effect on yield and yield components. Seed priming enhanced the yield and yield components (ear bearing tiller⁻¹, no. of grain ear⁻¹ and grain yield plant⁻¹) in both the varieties (Table-2). High accumulation of sodium in plant under saline soil leads to high pollen in fertility which results in increased sterility percentage. Yield is a summation of all metabolic processes and growth events during life cycle of a crop plants and any abiotic or biotic stress during their growth and development influence the potential productivity of crop yield. Plants grown under saline soil have chlorotic leaves which reduce their capacity of fix CO₂ as a result total biomass is affected. As we know total biomass is important character of maintain the grain yield under saline condition, poor translocation of metabolites to the reproductive sink may be also are of the reason for lower yield. The maximum increase in all the yield components were observed with KNO₃ (3%) followed by KCl (1%), GA₃ (150 ppm), cycocel (500 ppm) and hydropriming in both the varieties as compared to control. Similar findings are also reported by Farooq *et al.* (2006) in rice, Farooq *et al.* (2008) in wheat, Arif *et al.*, (2007) in wheat, Akhter *et al.*, (2009) in wheat, Yari *et al.* (2011) in wheat, Afzal *et al.*, (2012) in rice, Amin *et al.*, (2012) and Ali *et al.*, (2013) in wheat, Bakht *et al.* (2011) in maize.

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