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 $KNO_3$-3%, KCl-1%, $GA_3$ -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 $80^0$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:

$$\text{Germination (\%)} = \frac{\text{Number of seeds germinated after 14 days x100}}{\text{Number of seeds sown}}$$

## 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 $KNO_3$ (3%), KCl (1%) and $GA_3$ (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 Golizadeh*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 $KNO_3$(3%) followed by KCl (1%), $GA_3$(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 Mohammd (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 $KNO_3$ followed by KCl, $GA_3$, 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 $CaCl_2$ 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 $KNO_3$ (3%) followed by $GA_3$ (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 byGolizadeh*et al*., (2015) in Cannabis seed, Jalilian *et al*., (2014) in barley, Shabbir *et al.* (2013) in fennel, Abnavi and Ghbadi (2012) and Ghobadi *et al*. (2012) in wheat.

Seed priming significantly affected the number of tillers plant$^{-1}$. The tolerant variety KRL 210produced more tiller as compared to susceptible variety HD 2733 (Table-2) under priming. Priming with $KNO_3$(3%), KCl (1%), $GA_3$(150ppm),cycocel (500ppm) and hydropriming had maintained more tillers plant$^{-1}$ while lowest number was observed in untreatedcontrol. 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 $KNO_3$(3%) followed by KCl (1%), $GA_3$(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 findingsShabbir *et al.* (2013) in fennel,Abnavi and Ghbadi (2012) in wheat, Aymen and Cherif (2013) in coriander,Ghobadi *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 $CO_2$ 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 $KNO_3$ (3%) followed by KCl (1%), $GA_3$ (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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