*Available online at* www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.6844

**ISSN: 2320 – 7051**

*Int. J. Pure App. Biosci.* **6 (5):** 1227-1232 (2018)

*Research Article*

International Journal of Pure & Applied Bioscience

OPEN ACCESS

# Effect of Salinity Treatments of NaCl on Germination and Early Seedling Stage in Wheat (*Triticum aestivum* L.) Cultivars

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Received: 1.09.2018 | Revised: 13.10.2018 | Accepted: 19.10.2018

## ABSTRACT

*The response of four cultivars of wheat (Triticum aestivum L.) to NaCl salinity at germination and early seedling stage was investigated. Following salinity treatments of NaCl viz., 0M, 0.01M, 0.05M, 0.10M, 0.05M and 1M were given to the seeds placed in the petriplates. The decrease in germination percentage was recorded as the concentration of NaCl increased. Increase in salt concentration also affected the seedling growth of wheat cultivars. The days to germination was increased but the C 306 cultivar showed stable performance in all the treatments. Among the cultivars under investigation C 306 cultivar appeared to be more tolerant while cultivar WH 1080 recorded to be sensitive during germination stage.*

***Key words:*** *Cultivars, Wheat, Salinity, Germination and Seedling.*

## INTRODUCTION

Wheat is a major cereal crop in many parts of the world and it is commonly known as king of cereals. Wheat is a major staple food crop for more than one third of the world population and is the main staple food of Asia[23]. The wheat crop is mainly cultivated under rain fed conditions where precipitation is less than 900 mm annually. Wheat is grown both as spring and winter crop. Winter crop is more extensively grown than spring. High substrate salinity is a major limiting factor for plants in coastal habitats that germination being one of the most critical periods in life cycle of halophytes[8] and[21] Salt stress affects germination percentage, germination rate and seedling growth in different ways depending on plant species[26] and[9] . It was reported that maximum germination of the seeds of halophytic plants occurred in distilled water or under reduced salinity and it has been found that germination percentage was reduced with a high NaCl concentrations[30,26] and[14]. High concentration of salts has detrimental effects on germination of seeds[10,19] and plant growth[17]. Many investigators have reported retardation of germination and growth of seedlings at high salinity[4]. However plant species differ in their sensitivity or tolerance to salts[25].

**Cite this article:** Attri, H., Dey, T., Sinha, B. K., Bawa, V., Effect of Salinity Treatments of NaCl on Germination and Early Seedling Stage in Wheat (*Triticum aestivum* L.) Cultivars, *Int. J. Pure App. Biosci.* **6(5):** 1227-1232 (2018). doi: http://dx.doi.org/10.18782/2320-7051.6844

The possible cause of varietal difference most likely evolves ion transport properties and cellular compartementation[16]. Schachtmann and Munns[22] reported that sodium exclusion was a general characteristic of salt tolerance in wheat lines, whereas, salt tolerant display much higher shoot sodium level than sensitive lines. The screening of salt tolerant lines/cultivars has been attempted by many researchers on various species at seedling growth stage[1]. The relation of various seedling growth parameters to seed yield and yield component under saline conditions are important for the development of salt tolerant cultivar for production under saline conditions. The study presented here deals with the response of four cultivars of wheat to NaCl stress at germination and early seedling growth stage.

## MATERIAL AND METHODS

Seeds of four wheat (*Triticum aestivum* L) cultivars viz: **Raj 3756, WH 1080, RSP 561 and C 306** were obtained from SKUAST-Jammu, Chatha The seeds were surface sterilized by dipping the seeds in 1% mercuric chloride solution for 2 minutes and rinsed thoroughly with sterilized distilled water. There were five salinity treatments having NaCl concentration of 0.01M, 0.05M, 0.1M, 0.25M, 0.50M and 1M. Treatment having NaCl concentration of 0.00M was served as control. These treatments were prepared by dissolving separately calculated amounts of NaCl in deionized water. All the experiments were conducted in Petri plate on germinating paper beds. 20 seeds were sown Petri plate on germinating paper beds, irrigated with 5 ml solution of respective treatment and incubated at 30°C. Each treatment was replicated thrice. The germinating paper beds were irrigated daily with 5 ml solution of the respective treatment. The filter beds were changed after 48 hours in order to avoid salt accumulation.

**Germination:** The emergence of radical/plumule from seed was taken as an index of germination. The germination percent was recorded after 10 days of sowing the seeds.

**Recovery test:** Recovery test was applied on those seeds which did not germinate in the scheduled time. Non-germinated seeds were washed with distilled water and sown in Petri plates on Whatmann's No.1 filter paper. 5 mL distilled water was added to each Petri plate daily.

**Root length:** The length of the roots was measured with the help of the scale.

**Chlorophyll content:** The chlorophyll content was recorded with the help of SPAD after 20 days of sowing.

**Seedling growth:** After 20 days the seedlings were harvested and the following observations were made:

Root/ Shoot Length

Root/ Shoot Biomass

**Salt tolerance:** Salt tolerance was calculated by the formula given below:

$$\text{Salt tolerance} = \frac{\text{Germination/Growth in particular treatment}}{\text{Germination / Growth in control}} \times 100$$

## RESULTS AND DISCUSSION

**Germination:** Salt tolerance at germination stage is important factor, where soil salinity is mostly dominated at surface layer. The increase in salinity not only decreased the germination but also delayed the germination initiation. The initiation of germination of cv. RSP 561was delayed up to one day by all levels of salinity while of cv. WH 1080. The increase in salinity had no effect on germination of cv. C 306 seed. The maximum decrease in germination was observed in c. v. WH 1080. The cultivars had the following order on basis of germination:

**C 306>RSP 561>Raj 3675>WH 1080**

Analysis of variance results showed that there are highly significant differences among the traits in the cultivars in view of days to germination, germination percentage, root length, root/ shoot length, chlorophyll content and salinity tolerance as shown in Table 2. The cultivars and salinity showed significant differences in all the traits but the interaction between salinity and cultivars had significant effect on some traits like chlorophyll content and salinity tolerance. From the results of this present investigation it can be concluded that seeds of four different seeds of different wheat cultivars were susceptible to higher concentrations of salt solutions in germination stage which was supported by the works of[26] and[9]. The results regarding germination percentage, chlorophyll content and mean salt tolerance were significant ($p<0.05$) for all the varieties. Our results are in line with the findings of[11] and[19] that germination was directly related to the amount of water absorbed and delay in germination to the salt concentration of the medium. Decrease and delay in germination in saline medium has also been reported by[15] and[19]. After application of seeds which did not germinated probably their embryo was damaged due to the presence of $Na^+/Cl^-$ ions. Physiologically absolute ratio of $K^+/Na^+$ in the tissue is important[7].

**Seedling growth:** Seedling growth was recorded in terms of Shoot/Root length and Shoot/Root biomass at different levels of NaCl salinity. The increase in NaCl concentrations decreased the shoot and root length and biomass of all the wheat cultivars. All cultivars responded in same manner to salinity stress. However, the intensity of stress varied with the cultivars. It had been observed that those cultivars responded poorly at germination stage showed better response at seedling stage (Fig. 1). The reduction in shoot growth was greater than root growth. The reduction in biomass production was also greater in cultivar having higher germination rates. Maximum decrease in root and shoot length was recorded in cultivar **Raj 3765** which is 80 and 81%, respectively. Salinity had reduced the biomass (weight) in the range of 69 to 90 % in root and 68 to 90% in shoot of different cultivars. In the current investigation the higher level of salinity has a more pronounced effect on root length with respect to shoot length as roots are directly exposed to salt solution. The reduction in root and shoot development may be due to toxic effects of the higher level of NaCl concentration as well as unbalanced nutrient uptake by the seedlings. High level of salinity may have also inhibit the root and shoot elongation due to slowing down the water. In term of seed germination cultivar C 306 was the highest and significantly differed from others. Seedling growth was recorded in terms of Shoot/Root length and Shoot/Root biomass at different levels of NaCl salinity. The increase in NaCl concentrations decreased the shoot and root length and biomass of all the wheat cultivars. All cultivars responded in same manner to salinity stress. Data regarding salt tolerance of different cultivars under investigation show that cultivar C 306 is most tolerant at germination stage while cultivar RSP 561 at seedling growth stage. Other researchers[2] and[3] have demonstrated that plants exhibit different sensitivities to salinity at different stages of growth. Among the varieties tested RSP 561 cultivar appeared to be more sensitive at germination stage then others. Although RSP 561 cultivar had comparatively low germination at higher salinity levels but performed quiet satisfactorily at seedling stage (Fig. 1 and 2). Ayers and Hayward[6] reported that there may not be a positive correlation between salt tolerance at germination stage and during later phases of growth as observed in the present studies (Table 2). Many plants are most sensitive to ion stress during germination or young seedling growth[24]. Mahmood and Malik[12] observed greater salt tolerance at growth than germination stage. It is clear from the results that behavior of cultivars varies both at germination and seedling growth stages. This shows that species /varieties can never be selected simply on the basis of higher germination percentage.

**Salt tolerance:** Data regarding salt tolerance of different cultivars under investigation (Table 1) show that cultivar C 306 is most tolerant at germination stage while cultivar RSP 561 at seedling growth stage. On the basis of tolerance at germination and seedling growth stage, the cultivars can be arranged as follows:

**Germination: C 306>RSP 561>Raj 3765>WH 1080**

**Seedling growth: RSP 561> WH 1080>C 306>Raj 3765**

**Table 1: Effects of salinity on salt tolerance index of wheat (*Triticum aestivum* L.) cultivars at germination and seedling growth stage.**

| | Cultivars | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **C 306** | | **RSP 561** | | **Raj 3765** | | **WH 1080** | |
| | Germination | Growth | Germination | Growth | Germination | Growth | Germination | Growth |
| 0 M | 99.33 | 83.33 | 98.33 | 81.24 | 97.00 | 80.25 | 95.67 | 78.63 |
| 0.01 | 92.33 | 76.55 | 87.33 | 70.15 | 85.33 | 69.56 | 81.33 | 65.52 |
| 0.05 | 86.33 | 63.45 | 84.33 | 60.33 | 82.67 | 54.36 | 80.00 | 51.22 |
| 0.10 | 82.00 | 45.22 | 81.67 | 34.22 | 67.67 | 51.26 | 66.00 | 42.33 |
| 0.50 | 69.67 | 26.77 | 65.67 | 20.12 | 55.33 | 40.36 | 46.00 | 24.22 |
| 1M | 19.33 | 9.25 | 10.67 | 8.33 | 5.00 | 3.44 | 2.67 | 1.33 |

**Table 2: Analysis of variance for days to germination, germination %age, root length, root/shoot length, chlorophyll content and salinity tolerance**

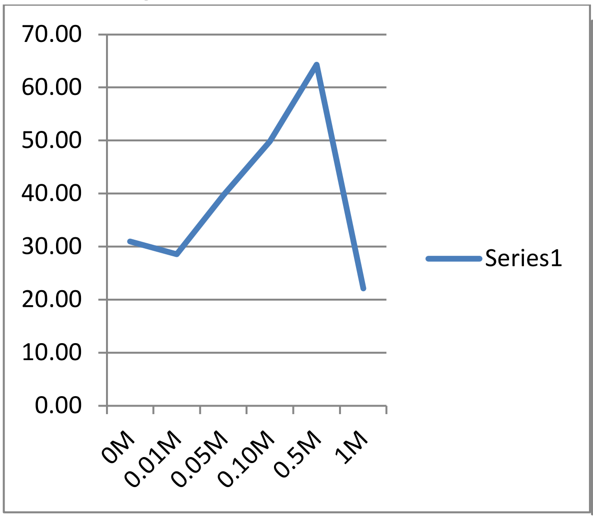
| **Source of variance** | **Days to germination** | **Germination %age** | **Root length** | **Root/Shoot length** | **Chlorophyll content** | **Salinity tolerance** |
|---|---|---|---|---|---|---|
| Cultivar | 28.62* | 12275.43* | 6.06* | 3.24* | 562.83* | 1632.83* |
| Salinity | 6.54* | 230.79* | 16.78* | 1.20* | 65.98* | 100.33* |
| Cultivar x salinity | 1.15 | 141.87 | 0.64 | 0.30 | 16.68 * | 161.80* |
| Error | 1.29 | 17.49 | 0.67 | 0.33 | 5.98 | 6.79 |

*represents significance at 5%

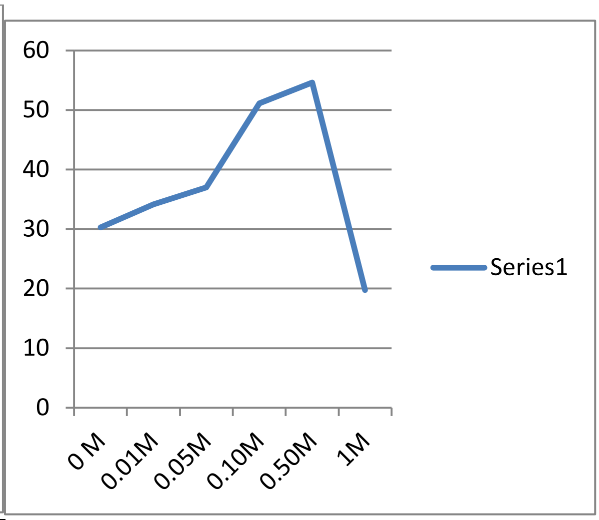
**Table 3: Mean and range of the traits on different concentration of salt treatments.**

| **6** | **Germination %age** | | | | **Chl. Contt.** | | | | **Salinity tolerance** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **C 306** | **RSP 561** | **Raj 3765** | **WH 1080** | **C 306** | **RSP 561** | **Raj 3765** | **WH 1080** | **C 306** | **RSP 561** | **Raj 3765** | **WH 1080** |
| **0M** | | | | | | | | | | | | |
| **Mean** | 99.3 | 98.3 | 97.0 | 95.6 | 24.53 | 20.37 | 18.07 | 17.03 | 30.95 | 30.29 | 27.69 | 27.28 |
| **Range** | 98-100 | 97-100 | 95-100 | 90-100 | 20.50-27.50 | 15.70-24.80 | 14.60-20.10 | 15.20-18.30 | 26.99-34.70 | 26.35-35.73 | 25.40-30.53 | 25.91-29.00 |
| **0.01M** | | | | | | | | | | | | |
| **Mean** | 92.3 | 87.3 | 85.3 | 81.3 | 24.30 | 21.57 | 16.40 | 19.57 | 40.62 | 35.59 | 34.15 | 28.54 |
| **Range** | 90-95 | 85-90 | 83-88 | 80-84 | 22.40-26.40 | 18.90-25.70 | 13.80-19.20 | 17.20-22.60 | 39.00-42.59 | 33.09-38.88 | 30.92-37.94 | 27.69- 29.73 |
| **0.05M** | | | | | | | | | | | | |
| **Mean** | 92.33 | 89.33 | 82.67 | 80.00 | 22.93 | 21.63 | 17.13 | 15.07 | 39.78 | 39.69 | 37.00 | 33.75 |
| **Range** | 90-95 | 86-92 | 80-85 | 70-90 | 15.60-19.60 | 19.10-24.60 | 20.20-26.30 | 13.80-16.80 | 37.52-42.48 | 38.35-41.32 | 35.79-38.82 | 33.09-34.76 |
| **0.10M** | | | | | | | | | | | | |
| **Mean** | 82.00 | 81.67 | 67.67 | 66.00 | 21.03 | 16.57 | 15.17 | 13.97 | 58.22 | 51.09 | 49.84 | 48.70 |
| **Range** | 78-85 | 79-84 | 62-73 | 62-70 | 19.20-23.50 | 14.90-18.50 | 12.30-15.30 | 13.20-16.50 | 56.29-60.13 | 47.06-54.21 | 47.41-51.41 | 44.89-52.42 |
| **0.50M** | | | | | | | | | | | | |
| **Mean** | 69.67 | 65.67 | 55.33 | 46.00 | 20.13 | 17.03 | 16.67 | 16.60 | 64.30 | 54.62 | 33.70 | 32.75 |
| **Range** | 69-74 | 63-65 | 51-59 | 43-50 | 17.60-23.60 | 13.50-19.50 | 14.80-19.50 | 15.60-18.20 | 63.29-65.80 | 52.30-57.35 | 30.59-36.99 | 28.73-36.63 |
| **1M** | | | | | | | | | | | | |
| **Mean** | 19.33 | 10.67 | 5.00 | 2.67 | 3.53 | 3.33 | 1.40 | 1.27 | 22.09 | 19.75 | 19.01 | 17.67 |
| **Range** | 15-23 | 9-13 | 3-7 | 1-4 | 2.60-4.50 | 2.60-4.20 | 1.20-1.60 | 1.00-1.70 | 20.70-23.11 | 18.91-20.79 | 17.05-20.70 | 16.32-18.72 |

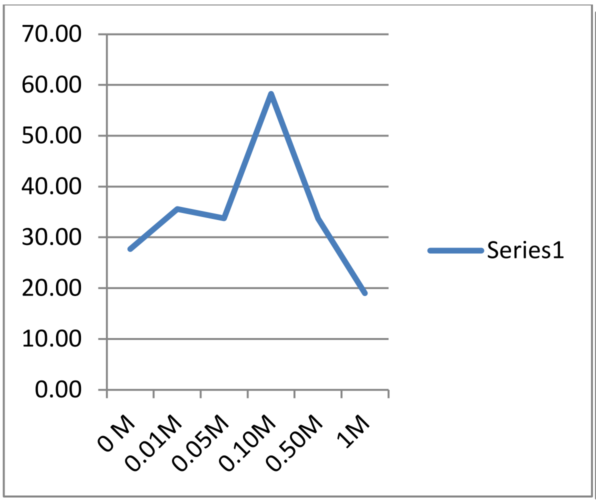
**Fig: 1. Effects of NaCl on salinity tolerance of wheat (*Triticum aestivum* L.) cultivars**



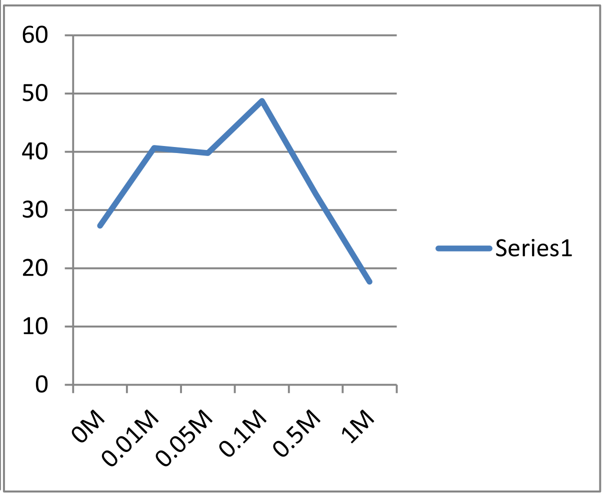

**a) Cultivar C 306**




**b) Cultivar RSP 561**




**c) Cultivar Raj 3765**




**d) Cultivar WH 1080**

**Acknowledgement**

We express our appreciation and gratitude to the Sher- e – Kashmir University of Agricultural Science and Technology, Jammu study.

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