Research Article

Comparative Effect of sodium chloride, potassium chloride and combined salt stress on germination and growth of *Triticum aestivum* L. (Var. Atta Habib)

Kiran Natasha¹, Shah Khalid¹, Syed Inzimam Ul Haq¹, Nabila Shah Jilani², Saman Ali Khan¹ and Sher Wali¹*

1. Department of Botany, Islamia College Peshawar, Khyber Pakhtunkhwa, Pakistan
2. Institute of Plant Sciences, University of Sindh, Jamshoro, Sindh, Pakistan

*Corresponding author’s email: sherwali@icp.edu.pk

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Abstract
The impact of different concentrations (100, 150, 200 and 250 mM) of NaCl, KCl and combined (NaCl + KCl) salts stress in equal amounts was studied on germination and some growth parameters of *Triticum aestivum* L. variety Atta Habib in laboratory and field experiment. Results showed that 100 mM of NaCl and KCl had the least effect on germination and growth of Wheat. However, under all the higher concentrations 150, 200 mM of NaCl, KCl marked decrease in radicle length, plumule length, germination rate, whereas higher concentrations 150, 200 and 250 mM of NaCl, KCl effected stem length, leaf length, number of leaves, number of tillers, spike length, number of grains per spike, whole plant weight and weight of 50 grains was recorded and the comparison was done with control plants. In combined salts stress pronounced reduction was recorded at all concentrations in germination and growth processes of *Triticum aestivum* L. From the results, it was concluded that by increasing concentrations of salts the effect became more pronounced in all salt treatments. The results revealed that the effects of combined salts on the *Triticum aestivum* L. were more pronounced as compared to the effects when the plant were treated with salts alone.

Keywords: Wheat (*Triticum aestivum* L.); Poaceae; Salt stress; NaCl; KCl

Introduction
*Triticum aestivum* L. belongs to family Poaceae. It is a cereal grain and is cultivated throughout the world. Wheat is the most cultivated crop in the world after maize and rice. The total yield of wheat in the world is about 651 million tons per year. Wheat is considered the most important food crop. It is grown on more area than any other crop in the world. The barter of wheat is more than any other crop in the world. In the world, including Asia wheat is used as staple food crop. Wheat is used as a staple food daily by about one third of the world [1]. Wheat has been a major commercial crop since ancient times, and it was originated in South Western Asia. In Pakistan, wheat is grown as one of the major cereal crops but the production of wheat crop per hectare yield is not enough to country’s demand for ever increasing
population. Wheat crop is considered moderately salt tolerant therefore it is necessary to observed that among different varieties of wheat, which varieties are much salt tolerant [2]. Salinity caused oxidative stress which severely effects the growth of plants [3]. Salinity produces more reactive oxygen species (ROS) due to which ionic imbalances occur in the soil, due to which the antioxidant defense of plant decreases and disturbed the physiological activities [4]. Adilogu [5] studied NaCl and KCl effects in different concentrations on growth and biological indexes of Triticum aestivum L., and concluded that by increasing the concentrations of salt the shoot length, diameter of stem, number of leaves, fresh and dry weight of shoot was adversely effected. On comparing, NaCl adversely effected the growth of wheat more than KCl. Marvi [6] studied NaCl effect in different concentrations on morphological and physiological characteristics of different Triticum aestivum L. cultivars (Toss, Falat, Bolani, star and Roshan). From the results a marked decrease in the growth parameters (root and shoot) was observed. The results indicated that among wheat cultivars, Roshan cultivar is a salt tolerant. Rahman [7] studied NaCl effect on germination of four wheat cultivars (Zalasht, Zarlash, Raskoh and Zorghoon). From the results, it was observed that increasing salt concentration decreased the germination of seeds and uptake of water. The early growth of seedling was also effected by salt stress. The results also concluded that as compared to other three cultivars, Zalasht variety is more sensitive to salt stress at germination stage. The effect of NaCl and KCl was studied on two Acacia species. The seeds were germinated in invitro condition under NaCl and KCl stress. It was concluded from the results that Acacia species were more sensitive to KCl as compared to NaCl [8]. Naheed [9] studied the effects of NaCl salt stress and phosphorous on Oryza sativa L. The results revealed that plant length, growth of plant, fresh and dry weigh, stomatal conductance and photosynthesis rate was reduced. However, substomatal CO₂ concentration showed no adverse effect by the application of salt stress along with phosphorous. Carpici [10] studied growth parameters, biochemical and mineral contents of Maize cultivars effected by NaCl. From the results it was revealed that the growth parameters and biochemical characters were reduced at high salt concentrations, however an increase in Proline and Na+ contents were observed. Zia [11] studied the comparative effect of NaCl, KCl and mixture of both solutions in a glass experiment on four different Maize cultivars (Azam, Pop-2006, Sarhad white and Pahari). It was concluded from the results that Maize cultivars showed significant effect under NaCl stress as compared to those which were treated with KCl and mixed salt stress. On comparing the four varieties, it was revealed that Azam cultivar was more tolerant to salts followed by Pop-2006, Pahari and Sarhad white.

**Materials and Methods**

**Filter paper bioassay**

**Sterilization of petri dishes**

The petri dishes selected for the lab experiments were first washed and was the sterilized at 100°C for 72 hours in order to avoid microbial activities. The seeds of Triticum aestivum L. were germinated in these sterilized petri dishes.

**Seeds germination and salt treatments**

Stock solutions of 100, 150 and 200 mM each of NaCl and KCl. For combined effect, solutions of the respective concentrations of both the salts were mixed in equal proportion. All the solution was stored at 4 °C till use. Five seeds of wheat (Triticum aestivum L.) were placed on two-fold filter paper in three Petri dishes and were provided with 100 mM of the respective salt solution or distilled water in case of control. Control was run in
distilled water for comparison. After 10 days, different parameters like germination percentage, radicle length and plumule length of the seedlings were recorded.

**Pot culture experiment**
The experiment was performed using Randomized Complete Block Design (RCBD). Seeds of *Atta habib* variety were selected. Three sets with 15 pots each were prepared by filling each pot with 5 kg mixture of soil and sand (3:1). The pots were lined with plastic bags to prevent leaching. 10 seeds of *Triticum aestivum* L. were sown in each pot. The first set of pots was used for NaCl treatment in which each 3 pots were treated with 100, 150, 200, 250 mM salt concentrations. Similarly, set 2 and set 3, consisted of the same number of pots, in which each pot was treated with KCl (100, 150, 200, 250 mM) salt concentrations and set 3 with combined salts treatment (NaCl + KCl). For each treatment 3 pots were run as a control. Thinning of plants was done by hand picking, leaving 5 plants in each pot. A total of three salt doses of the described concentrations were applied after every seven days. The first salt stress was applied at the two-leaf stage. Data of different parameters were recorded after every 15 days. The studied parameters included stem length, leaves length, number of leaves and tillers, spike length, number of seeds per spike, plant weight, weight of 50 seeds in each concentration and control. The recorded data were then arranged into figures.

**Statistical analysis**
The experiment was performed in triplicates. The data obtained was statistically analyzed using one-way ANOVA through IBM SPSS 2.0 software, followed by Dunnett’s Multiple Comparison Test [12].

**Results**

**Germination percentage (%)**
The germination percentage was negatively affected by NaCl, KCl and combined treatment (Fig. 1). The results showed that germination percentage was significantly reduced by NaCl and was recorded minimum (20%) in T1 (NaCl - 100mM). However, at higher concentration of NaCl and KCl the germination percentage was reduced and was significantly recorded 70% in T6 (KCl - 200mM) and 80% in T8 (NaCl + KCl - 150mM) as compared to control. However, no germination was observed in T9 (NaCl + KCl - 200mM). From the results it was revealed that for plant germination KCl is stronger stressor as compared to NaCl (Fig. 1).

![Figure 1. Effect of NaCl, KCl and combined salt stress on germination percentage (%)](image-url)

T0 = Control, T1 = NaCl (100mM), T2 = NaCl (150mM), T3 = NaCl (200mM), T4 = KCl (100mM), T5 = KCl (150mM), T6 = KCl (200mM), T7 = NaCl + KCl (100mM), T8 = NaCl + KCl (150mM), T9 = NaCl + KCl (200mM). Bars with different letters represents significance difference at P=0.05.
Radicle and plumule length (cm)
The plumule length of wheat was more effected as compared to radicle length and both radicle and plumule length showed reduction as compared to control (Fig. 2). The combined treatment of NaCl and KCl showed profound effect. Results showed that maximum inhibition in radicle length (92%) and plumule length (96.55%) was significantly recorded in T8 (NaCl + KCl - 150mM), whereas minimum inhibition in radicle and plumule length was significantly observed in T1 (NaCl-100mM) and was recorded 20% and 80% each. It was also observed from the results that the effect was concentration dependent and higher concentration showed more effect as compared to lower concentration.

![Bar graph showing the effect of NaCl, KCl, and combined salt stress on radicle and plumule length (cm).](image)

**Figure 2. Effect of NaCl, KCl and combined salt stress on Radicle and Plumule length (cm)**
T0 = Control, T1 = NaCl (100mM), T2 = NaCl (150mM), T3 = NaCl (200mM), T4 = KCl (100mM), T5 = KCl (150mM), T6 = KCl (200mM), T7 = NaCl + KCl (100mM), T8 = NaCl + KCl (150mM), T9 = NaCl + KCl (200mM). Bars with different letters represents significance difference at P=0.05

Stem length (cm)
The effect of NaCl, KCl and combine treatment of both salts on stem length was recorded in four phases. The results showed that NaCl, KCl and combine treatment of both salts negatively affected the stem length of wheat in vegetative as well as in matured stage as compared to control. The (Fig. 3.1) shows that maximum effect of NaCl on stem length was observed insignificantly in T4 = (NaCl - 250mM), which reduced the stem length to 32.43% in D2, significantly in D3 (56.93%) and D4 (59.59%) whereas maximum effect was significantly recorded in D1 (15.78%) at T3 = (NaCl - 200mM). In KCl, maximum reduction in stem length was recorded significantly in D2 (45.94%), in D3 (60.14%) and in D4 (69.86%) at T4 = (KCl - 250mM), whereas in D1 maximum reduction was significantly observed (15.78%) at T2 = (KCl - 150mM) as shown in (Fig. 3.2). In combine treatment (Fig. 3.3), maximum effect was significantly observed in T4 = (NaCl + KCl - 250mM) and was recorded 11.05% in D1, insignificant in D2 (40.54%), and significant in D3 (64.49%) and D4 (81.63%).
Figure 3.1. Effect of NaCl on stem length (cm)
T0 = Control, T1 = NaCl (100mM), T2 = NaCl (150mM), T3 = NaCl (200mM), T4 = NaCl (250mM), D1= (after 15 days of treatment), D2= (after 30 days of treatment), D3= (after 45 days of treatment), D4= (after 90 days of treatment). Bars with different letters represents significance difference at P=0.05

Figure 3.2. Effect of KCl on Stem length (cm)
T0= Control, T1 = KCl (100mM), T2 = KCl (150mM), T3 = KCl (200mM), T4 = KCl (250mM), D1= (after 15 days of treatment), D2= (after 30 days of treatment), D3= (after 45 days of treatment), D4= (after 90 days of treatment). Bars with different letters represents significance difference at P=0.05
Figure 3.3: Effect of combine salt stress (NaCl + KCl) on stem length (cm)
T0 = Control, T1 = NaCl + KCl (100mM), T2 = NaCl + KCl (150mM), T3 = NaCl + KCl (200mM), T4 = NaCl + KCl (250mM), D1= (after 15 days of treatment), D2= (after 30 days of treatment), D3= (after 45 days of treatment), D4= (after 90 days of treatment). Bars with different letters represents significance difference at P=0.05

Leaf length (cm)
The leaf length of wheat was effected by different concentrations of NaCl, KCl and combine salts treatment. The results showed that the leaf length was reduced in all concentrations. The (Fig. 4.1) shows the effect of NaCl on leaf length. From the graph it was observed that maximum reduction in leaf length was significant in D2 and D4 phases and was recorded 56.75% and 47.18% in T4 = (NaCl - 250mM), whereas maximum reduction in D1 and D3 phases was not significant and was recorded 40.81% and 58.62% in T4 = (NaCl - 250mM). The (Fig. 4.2) showed the effect of KCl on leaf length. The data revealed that maximum reduction in length was significant in D1 and D4 phases and was recorded 30.61% and 40.14% in T4 = (KCl - 250mM) whereas the data recorded in D2 and D3 phases was insignificant and was recorded 45.94% and 51.72% in T4 = (KCl-250mM). In combined treatment (Fig. 4.3), maximum reduction in leaf length was significant in all four phases and was recorded 20.40% in D1, 43.24% in D2, 48.27% in D3 and 28.87% in D4 at T4 = (NaCl + KCl-250mM).
Figure 4.1. Effect of NaCl on Leaf length (cm)
T0 = Control, T1 = NaCl (100mM), T2 = NaCl (150mM), T3 = NaCl (200mM), T4 = NaCl (250mM), D1= (after 15 days of treatment), D2= (after 30 days of treatment), D3= (after 45 days of treatment), D4= (after 90 days of treatment). Bars with different letters represents significance difference at P=0.05

Figure 4.2. Effect of KCl on Leaf length (cm)
T0 = Control, T1 = KCl (100mM), T2 = KCl (150mM), T3 = KCl (200mM), T4 = KCl (250mM), D1= (after 15 days of treatment), D2= (after 30 days of treatment), D3= (after 45 days of treatment), D4= (after 90 days of treatment). Bars with different letters represents significance difference at P=0.05
Figure 4.3. Effect of combine salt stress (NaCl + KCl) on Leaf length (cm)
T0 = Control, T1 = NaCl + KCl (100mM), T2 = NaCl + KCl (150mM), T3 = NaCl + KCl (200mM), T4 = NaCl + KCl (250mM), D1= (after 15 days of treatment), D2= (after 30 days of treatment), D3= (after 45 days of treatment), D4= (after 90 days of treatment). Bars with different letters represents significance difference at P=0.05

Number of leaves
The graphs showed that as compared to control the number of leaves were decreased by NaCl, KCl and combine salts treatment. The (Fig. 5.1) showed the effect of NaCl on number of leaves. The data revealed that maximum decrease in number of leaves was recorded significant in D2 (23.73%), D3 (24.88%) and D4 (33.33%) at T4 = (NaCl - 250mM), whereas in D1 NaCl showed no effect in all concentrations. The number of leaves were decreased in all phases except D1 where no change was observed as shown in (Fig. 5.2). The results showed that maximum decrease in number of leaves was observed significant in D2 (24.74%), 27.23% in D3 and 38% in D4 at T4 = (KCl - 250mM). In combine treatment (Fig. 5.3), no effect was observed in D1 phase in all concentrations whereas significant effect was observed in D2 (27.77%), D3 (22.5%) and D4 (40%) at T4 = (NaCl + KCl - 250mM).

Figure 5.1. Effect of NaCl on No. of leaves
T0 = Control, T1 = NaCl (100mM), T2 = NaCl (150mM), T3 = NaCl (200mM), T4 = NaCl (250mM), D1= (after 15 days of treatment), D2= (after 30 days of treatment), D3= (after 45 days of treatment), D4= (after 90 days of treatment). Bars with different letters represents significance difference at P=0.05
Figure 5.2. Effect of KCl on No. of leaves
T0 = Control, T1 = KCl (100mM), T2 = KCl (150mM), T3 = KCl (200mM), T4 = KCl (250mM), D1= (after 15 days of treatment), D2= (after 30 days of treatment), D3= (after 45 days of treatment), D4= (after 90 days of treatment). Bars with different letters represents significance difference at P=0.05

Figure 5.3. Effect of combine salt stress (NaCl + KCl) on No. of Leaves
T0 = Control, T1 = NaCl + KCl (100mM), T2 = NaCl + KCl (150mM), T3 = NaCl + KCl (200mM), T4 = NaCl + KCl (250mM), D1= (after 15 days of treatment), D2= (after 30 days of treatment), D3= (after 45 days of treatment), D4= (after 90 days of treatment). Bars with different letters represents significance difference at P=0.05

Number of tillers
The effect of NaCl, KCl and combine salts treatment is shown in the (Fig. 6.1, 6.2 & 6.3). The graphs showed that no tillers were observed in D1 phase as tillers appeared after the vegetative stage. The results showed that number of tillers was reduced in all concentrations except in T1 = (NaCl - 100mM) where no change was observed. The (Fig. 6.1) showed that maximum reduction in number of tillers was significantly decreased in 42.5% in T4 = (NaCl - 250mM) at D2 phase whereas insignificant decrease in number of tillers was observed in D3 (70%) and D4 (80%) at T4 = (NaCl - 250mM). The effect of KCl on wheat tillers is shown in
From the graph, it was revealed that maximum effect of KCl on number of tillers is insignificant and was recorded 47.5% in D2, 70% in D3 and 80% in D4 at T4 = (KCl - 250mM). The of combined salts on number of tillers is shown in (Fig. 6.3). From the graph it was observed maximum decrease in number of tillers was insignificant and was recorded 50% in D2, 76% in D3 and 80% in D4 at T4 = (NaCl + KCl - 250mM).

**Figure 6.1. Effect of NaCl on No. of Tillers**

T0 = Control, T1 = NaCl (100mM), T2 = NaCl (150mM), T3 = NaCl (200mM), T4 = NaCl (250mM), D1= (after 15 days of treatment), D2= (after 30 days of treatment), D3= (after 45 days of treatment), D4= (after 90 days of treatment). Bars with different letters represents significance difference at P=0.05

**Figure 6.2. Effect of KCl on No. of Tillers**

T0 = Control, T1 = KCl (100mM), T2 = KCl (150mM), T3 = KCl (200mM), T4 = KCl (250mM), D1= (after 15 days of treatment), D2= (after 30 days of treatment), D3= (after 45 days of treatment), D4= (after 90 days of treatment). Bars with different letters represents significance difference at P=0.05
Figure 6.3. Effect of combine salt stress (NaCl + KCl) on No. of tillers
T0 = Control, T1 = NaCl + KCl (100mM), T2 = NaCl + KCl (150mM), T3 = NaCl + KCl (200mM), T4 = NaCl + KCl (250mM), D1= (after 15 days of treatment), D2= (after 30 days of treatment), D3= (after 45 days of treatment), D4= (after 90 days of treatment). Bars with different letters represents significance difference at P=0.05

Spike length (cm)
The spike length of wheat was reduced by NaCl, KCl and combine salts stress as compared to control as shown in the (Fig. 7). From the graph it was observed that maximum reduction in spike length was observed significant in T12 = (NaCl + KCl - 250mM) and was recorded 65.21%. The minimum reduction in spike length was recorded 6.45% in T1 = (NaCl - 100mM) which is insignificant.

Figure 7. Effect of NaCl, KCl and Combined treatment (NaCl + KCl) on Spike length (cm)
T0 = Control, T1 = NaCl (100mM), T2 = NaCl (150mM), T3 = NaCl (200mM), T4 = NaCl (250mM), T5 = KCl (100mM), T6 = KCl (150mM), T7 = KCl (200mM), T8 = KCl (250mM), T9 = NaCl + KCl (100mM), T10 = NaCl + KCl (150mM), T11 = NaCl + KCl (200mM), T12 = NaCl + KCl (250mM). Bars with different letters represents significance difference at P=0.05
Stem breadth (cm)
The effect of NaCl, KCl and combined salts treatment on stem breadth is shown in the (Fig. 8). The results revealed that salt stress significantly reduced the stem breadth in all concentrations except T1 = (NaCl - 100mM) where no effect was observed. From the figure it was observed that maximum reduction in stem breadth was reduced significantly in T8= (KCl - 250mM), T11 = (NaCl + KCl - 200mM) and T12 (NaCl + KCl - 250mM) and was recorded 75% each, whereas minimum reduction in stem breadth (25%) was recorded insignificantly in T2 = (NaCl - 150mM).

Number of seeds per spike
The effect of NaCl, KCl and combined salts treatment on number of seeds per spike is shown in the (Fig. 9). The results revealed that salt stress significantly decreased the number of seeds per spike in all concentrations. From the figure it was observed that maximum decrease in number of seeds per spike in was recorded significantly in T12 (NaCl + KCl - 250mM) and was recorded 81.47%, whereas minimum increase in the number of seeds per spike was significantly recorded 26.09% in T1 = (NaCl - 100mM).

Weight of 50 grains (g)
The effect of NaCl, KCl and combined salts treatment on weight of 50 grains is shown in the (Fig. 10). The results revealed that salt stress significantly decreased the weight of 50 grains in all concentrations. From the figure it was observed that maximum decrease in the weight of 50 grains was observed significantly in T12 (NaCl + KCl - 250mM) and was recorded 47.82%, whereas minimum increase in the weight of 50 grains was significantly recorded 13.63% in T1 = (NaCl - 100mM).
Figure 9. Effect of NaCl, KCl and Combined treatment (NaCl + KCl) on No. of seeds per spike
T0 = Control, T1 = NaCl (100mM), T2 = NaCl (150mM), T3 = NaCl (200mM), T4 = NaCl (250mM), T5 = KCl (100mM), T6 = KCl (150mM), T7 = KCl (200mM), T8 = KCl (250mM), T9 = NaCl + KCl (100mM), T10 = NaCl + KCl (150mM), T11 = NaCl + KCl (200mM), T12 = NaCl + KCl (250mM). Bars with different letters represents significance difference at P=0.05

Figure 10. Effect of NaCl, KCl and Combined treatment (NaCl + KCl) on Weight of 50 grains (g)
T0 = Control, T1 = NaCl (100mM), T2 = NaCl (150mM), T3 = NaCl (200mM), T4 = NaCl (250mM), T5 = KCl (100mM), T6 = KCl (150mM), T7 = KCl (200mM), T8 = KCl (250mM), T9 = NaCl + KCl (100mM), T10 = NaCl + KCl (150mM), T11 = NaCl + KCl (200mM), T12 = NaCl + KCl (250mM). Bars with different letters represents significance difference at P=0.05

Plant weight (g)
The effect of NaCl, KCl and combined salts treatment on plant weight is shown in the (Fig. 11). The results revealed that salt stress significantly decreased the plant weight in all concentrations. From the figure it was observed that maximum decrease in the plant weight was observed significantly in T12 (NaCl + KCl - 250mM) and was recorded 46.15%, whereas minimum increase in the
plant weight was significantly recorded 7.69% in $T_1 = (\text{NaCl - 100mM})$.

**Figure 11.** Effect of NaCl, KCl and Combined treatment (NaCl + KCl) on Plant weight (g)

$T_0 =$ Control, $T_1 =$ NaCl (100mM), $T_2 =$ NaCl (150mM), $T_3 =$ NaCl (200mM), $T_4 =$ NaCl (250mM), $T_5 =$ KCl (100mM), $T_6 =$ KCl (150mM), $T_7 =$ KCl (200mM), $T_8 =$ KCl (250mM), $T_9 =$ NaCl + KCl (100mM), $T_{10} =$ NaCl + KCl (150mM), $T_{11} =$ NaCl + KCl (200mM), $T_{12} =$ NaCl + KCl (250mM). Bars with different letters represents significance difference at $P=0.05$

**Discussion**

The research work was conducted to evaluate the comparative effect of NaCl, KCl and combined salts stress on germination and growth of wheat (*Triticum asetivum* L.). The annual crop yield is reduced by several abiotic stresses. The growth and yield of plant is effected by abiotic stresses like salinity, heat, cold, drought, light and water logging. These stresses directly affect plant growth and development [13]. From the results it was observed that NaCl, and KCl significantly affected the germination percentage, radicle length, plumule length, stem length, leaf length, number of leaves, number of tillers, spike length, stem breadth, number of seeds per spike, weight of 50 grains and plant weight. The germination percentage was decreased by NaCl, KCl and combine salts stress. The effect of KCl on germination percentage was more as compared to NaCl. In combined salts stress the germination percentage was profoundly affected and at higher concentration the seeds showed no germination. The results concluded that KCl is strong stressor as compared to NaCl and combined salts stress will vigorously have affected the germination percentage of wheat. The results showed that wheat seeds are more sensitive to high salts stress. The results obtained are in collaboration with the findings of Abari [8] concluded that *Acacia species* are more sensitive to KCl stress as compared to NaCl stress. Rahman [7] also reported the same effects of salt stress on germination of wheat seeds. The plumule length of wheat is more effected as compared to radicle length. At higher concentrations the effect was more pronounced as compared to lower concentrations. From the results it was observed that higher concentrations of salts stress reduced the radicle and plumule length more as compared to lower concentrations of salts stress. Our findings were in comparisons with the results of Gholamin [14] indicated that NaCl is significantly decreased the radicle and plumule length of two cultivars of wheat (*Triticum durum*). The results also show similarity with results of Natasha [15] assessed that NaCl, KCl and combine salt stress strongly effected the germination and
growth of Foxtail millet (*Setaria italica* L.). The stem length of wheat was significantly affected by NaCl, KCl and in combined salt treatments. In combined salts stress the effect was more pronounced as compared to NaCl and KCl when treated alone. Our findings were in collaboration with the results of Adiloglu [5] they reported that the stem length of wheat has been reduced many folds when grown under combine salt stress. The leaf length was reduced by NaCl, KCl and combined salts stress in different concentrations whereas maximum reduction was observed at high concentration, which showed similarity with the findings of Li and Liu [16]. They concluded that NaCl at high levels significantly reduced leaf length of *Camptotheca acuminata* seedlings. Our results are also in collaboration with the results of Rasheed [17] observed that KCl reduced the leaf length as compared to control. The number of leaves were also reduced by NaCl, KCl and combined salt stress as compared to control. The results are in comparison with the results of Jafari [18] evaluated that number of leaves were significantly affected by NaCl. The results obtained from leaf length and number of leaves showed similarity with the results of Cuartero and Fernandez –Muhoz [19] who concluded that reduction in leaf length and number of leaves has been observed depending different parameters in Tomato plant. The number of tillers were significantly affected by NaCl, KCl and combined salts stress, at high concentration the effect was more as compared to low concentration. Our findings are in collaboration with the results of Jamal [20] conducted research on the effect of seed priming on growth and biochemical traits of wheat under saline conditions and concluded that seed priming and salinity significantly affected the number of tillers plant. The spike length was also reduced by NaCl, KCl and combined salts stress. Adiloglu [5] reported that combined stress of NaCl and KCl also reduced stem diameter of wheat plant in higher salt concentrations. The number of seeds per spike, weight of 50 grains was also reduced by NaCl, KCl and combined salts stress. The plant weight was also inhibited by NaCl, KCl and combined salts stress. Similar results have been found in different plant species by Maathius and Amtmann [21] and Huang [22]. In Pakistan, Salinity is a serious threat to produce crops. In this field much research work is needed in order to cope with this problem. To increase the crop production, soil reclamation methods are required which includes proper drainage system, irrigation water applications, type of irrigation water, leaching plantation for salt tolerant crops, residues incorporation, and chemical amendments i.e. gypsum addition to sodic or saline sodic soil can be very effective [2].

**Conclusion**

From the above results it was concluded that salinity effects germination and growth parameters of wheat and the effect is more devastating at high concentrations than at low salt concentrations. On comparing the effect of NaCl with KCl, it was concluded that KCl is a strong stressor as compared to NaCl. Similarly, the effect of combine salt stress were more pronounced as compared to the effect of NaCl and KCl when treated alone.

**Authors’ contributions**

Conceived and designed the experiments: S Wali, S Khalid & NS Jilani, Performed the experiments: K Natasha, SIU Haq & SA Khan, Analyzed the data: SIU Haq & S Wali, Contributed materials/ analysis/ tools: K Natasha, S Khalid & NS Jilani, Wrote the paper: SIU Haq.

**References**

1. Shirazi MU, Asif SM, Khanzada B, Khan MA & Mohammad A (2001). Growth and ion accumulation in some Wheat genotypes
under NaCl stress. *Pak J Biol Sci* 4: 388-391.

2. Saboora A, Kiarostami K, Behrozobayati F & Hashemi SH (2006). Salinity (NaCl) tolerance of Wheat genotypes at germination and early seedling growth. *Pak J Biol Sci* 9(11): 155-164.

3. Hasegawa PM, Bressen RAP, Zhu JK & Bonnert HJ (2000). Plant cellular and molecular responses to high salinity. *Plant Mol Biol* 51: 1463-499.

4. Foyer CH & Noctor G (2003). Redox sensing and signaling associated with reactive oxygen in chloroplast peroxisomes and mitochondria. *Physiol Plant* 119: 355-364.

5. Adilogu S, Adilogue A & Ozkil M (2007). Effects of different levels of NaCl and KCl on growth and some biological indexes of wheat plant. *Pak J Biol Sci* 10(11): 1941-43.

6. Marvi H, Heidari M & Armin M (2009). Physiological and biochemical responses of wheat cultivars under salinity stress. *ARPN J Agric and Biol Sci* 6(5).

7. Rahman M, Soomro UA, Haq MZ & Gul S (2008). Effects of NaCl salinity on Wheat (*Triticum aestivum* L.) cultivars. *World J Agri Sci* 4(3): 398-403.

8. Abari AK, Nasir MH, Hojjati M & Bayat D (2011). Salt effects on seed germination and seedling emergence of two *Acacia* species. *Afri J Biotech* (1): 52-56.

9. Naheed G, Shahbaz M, Latif A & Rha ES (2007). Alleviation of the adverse effects of salt stress in Rice (*Oryza sativa* L.) by phosphorus applied through rooting medium; growth and gas exchange characteristics. *Pak j of Bot* 39(3): 729-737.

10. Carpici EB, Celik N & Bayran G (2010). The effects of salt stress on the growth, biochemical parameters and mineral element content of some maize (*Zea mays* L.) cultivars. *Afri J of Biotech* 9(41): 6937-6942.

11. Zia A, Guo B, Ullah I, Ahmad R, Khan MA, Abbasi BH & Wei Y (2011). Salinity tolerance and site of K+ accumulation in four maize varieties grown in Khyber Pakhtunkhwa region of Pakistan. *J of Med Plants Res* 5(25): 6040-6047.

12. Dunnett CW (1964). New Tables for Multiple Comparisons with a Control. *Biometrics* 20(3): 482-491.

13. Yamaguchi T & Blumwald E (2005). Developing salt tolerant crop plants challenges and opportunities. *Trends Plant Sci* 10: 615-620.

14. Gholamin R & Khayatnezhad M (2010). Effects of Polyethylene Glycol and NaCl Stress on Two Cultivars of Wheat (*Triticum durum*) at Germination and Early Seedling Stages. *American-Eurasian J Agric & Environ Sci* 9(1): 86-90.

15. Natasha K, Haq SIU, Ahmad S, Ullah Z & Rahim Z (2019). Effect of sodium chloride, potassium chloride on germination and growth of Foxtail millet (*Setaria italica* L.). *Pure Appl Biol* 8(2): 1398-1407.

16. Li Z & Liu Z (2003). Effect of NaCl on growth, morphology, and camptothecin accumulation in *Camptotheca acuminata* seedlings. *Canadian J of Plant Sci* 83(4): 931-938.

17. Rasheed D, Azorji JN, Wisal, Ali S, Nawchukwu MO & Nwachukwu CU (2020). Effect of Potassium Chloride (KCl) on Biochemical and Morphological Parameters of *Triticum aestivum* L. *Asian J of Res in Bot* 3(3): 10-17.

18. Jafari MHS, Kafi M & Astaraie A (2009). Interactive Effects of NaCl Induced Salinity, Calcium and Potassium on Physiomorphological Traits of Sorghum (*Sorghum bicolor* L.). *Pak J Bot* 41(6): 3053-3063.

19. Cuartero J & Fernandez-Muhoz FR (1999). Tomato and salinity. *Sci Hort* 78: 83-125.

20. Jamal Y, Shafi M & Bakht J (2011). Effect of seed priming on growth and biochemical traits of wheat under saline conditions. *Afr J Biotechnol* 10(75): 17127-17133.

21. Maathius FJM & Amtmann A (1999). K+ nutrition and Na+ toxicity: the basis of cellular K+/Na+ ratios. *Ann Bot* 84: 123-135.

22. Huang Y, Zhang G, Wu F, Chen J & Zhou M (2006). Differences in physiological traits among salt stressed barley genotypes. *Common. Soil Sci Plant Anal* 37: 557-570.