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Effect of Nacl Salt on Seedlings and Germination Stage of *Brassica Compesrtis* and *Zea Mays*

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Abstract **Original Research Article**

Plants are very important on face of earth, both biotic and abiotic environmental factors are necessary for its growth. Salinity is a most important abiotic stress that affects plant growth and development and lead to crop yield loss. To learn the effect of salinity on the germination stage plus early seedling growth of *Brassica compestris* and *Zea mays*, experiment was conduct in the pots and Petri plates. The experiments were consisting of control and four saline water traits with NaCl concentrations of 1g, 2g, 3g, and 4g. Salinity affects germination stage of *Brassica compestris* and *Zea mays*. During early seedling growth, salinity that shows lower leaf water potential, stomatal conductance, and evapotranspiration as a symptom of water stress. The higher the salt availability, the lower the leaf area and the dry matter production so leaf, stem, and root show an almost growth reduction due to salt in soil.
Keywords: Salinity, Growth Regulation, Environamental Stress, Gremination Percentage, Salt Tolarence, Salt Resistance.

Introduction

1.1 Salinity

Salt stress one of the major ecological stress which deeply impact crop production and quality. The agglomeration of too much salt content in the soil eventually results in the inhibition of crop growth, agriculture yield, and genetic potential and affects the garden plants in ways such as ions toxicity, nutritional disorders, metabolic process alternation, oxidative stress, genotoxicity, cell division reduction, and membrane disorganization. On a global scale, salt stress is more dangerous than other toxic matter; soil salinity affects 20% of cultivated land and up to 50% of all irrigated land due to poor water soaking and the use of brackish water. Each year, salinity affects 10-35 percent of the world's agricultural production. According to Food and Agriculture Organization (FAO) statistics, more than 400 million hectares of land are currently affected by salinity, and this area is growing (Wang *et al.*, 2003).

Soil salinity is a major agricultural issue that restricts crop growth and production under irrigation. In detail, it had been predicted that the annual amount of arable land lost due to salinity is greater than the amount of land lost due to clearing (Frommer *et al.*, 1999). High salt concentrations frequently cause ion difference and hyper osmotic pressure, which eventually leads to oxidative stress in plants. Furthermore, salt stress has been shown in some plants to increase the level of stress ethylene (Mayak *et al.*, 2004), which mediates every aspect of plant development and growth, including plant responses to biotic and abiotic stresses (Mattoo and Suttle, 1991). Salinity is a major factor limiting plant growth and crop production.

Over salinity already affects roughly one-third of the world's irrigated lands (Szabolcs, 1994). It is understood that salt stress causes an imbalance in cellular ions, which causes ion toxicity and osmotic stress, jeopardising plant growth and survival (Tester and Davenport, 2003). Excessive salt accumulation in soil is a major ecological and agronomic issue (Ruiz *et al.*, 2012) with serious consequences in areas where saline water is used for irrigation (Turkani and Demiral, 2009).

Due to the mutual effects of high osmotic potential and specific ion toxicity, high levels of soil salinity can significantly reduce seed germination and seedling growth. Globally, more than 45 million hectares of irrigated land have been damaged by salt, and 1.5 million hectares are taken out of production each year as a result of high levels of soil salinity (Munns and Tester, 2008 and Carillop *et al.*, 2011).

The detrimental effects of high salinity on plants can be felt at the whole-plant level as plant death or a decrease in yield. Major processes such as photosynthesis, protein synthesis, and energy and lipid metabolism are exaggerated in the onset and formation of salt stress (Das, 2005). The salinity of the substrate influences seed germination, seedling appearance, and early survival. Salinity stress can affect seed germination via osmotic effects. Successful seedling establishment is dependent on the frequency and amount of precipitation, as well as the seed species' ability to germinate and grow as soil moisture and osmotic potentials decrease. Soil salinity is a threat to agricultural production, and developing crop plant salt tolerance will necessitate a better understanding of the physiological basis of fundamental salt stress (Chinnusamy *et al.*, 2005 and Ashraf *et al*., 2008).

Salinity stress is a main ecological constraint to crop productivity in semiarid and world's dry regions. As a result, vast areas of dry land are significantly sterile. There are many studies that irrigation type of irrigation water and irrigation systems used have played a significant role in changing dry lands to salt affected lands (Ashraf and McNeilly, 2004).

High salinity concentrations results hyper osmotic stress and ion imbalance in plants. Indirect damage, like oxidative damage, is frequently caused by these primary effects. Water potential and ion circulation homeostasis are disrupted by high salt stress. Homeostasis is disrupted at both the cellular and plant levels. Extreme changes in ion and water homeostasis cause molecular damage, halting growth and resulting in death (Zhu, 2001). Improper irrigation methods in dry climates are to blame for the salinization of 20-27 percent of the world's saline soils (Ghassemi *et al*., 1995). According to the UN, salinity affects nearly 1/2 of the world's arable soil (Flowers and Yeo, 1995).

Salinity creates an unfavourable environmental and hydrological environment, limiting crops production potential. Salt stress reduces yield by altering physiological and metabolic processes (Ahmad *et al.*, 2013, Kauser 2006 and Shah 2007). Salinity reduces leaf area and photosynthetic time and alters photosynthesis's light phase (Garcia *et al.*, 2012 and Qiu *et al.*, 2003). Many researchers have reported on the effect of salinity biochemical and morpho-physiological processes of many plant species (Quesada, 2002). Plants are thought to be more vulnerable to chloride than sodium. Chloride increases heavy metal toxicity and causes osmotic stress, both of which are harmful to plant tissues (Taiz and Zeiger, 2008).

In general, high salt levels can reduce plant productivity through osmotic stress and ion toxicity, which leads to a decrease in CO2 fixation, a reserve of protein synthesis and minerals nutrition as secondary effects (Ashraf, 2008). Salinization of soil is a main contributor to the decrease of refined soil formation and its products. Meanwhile it is not easy to predict precisely, the area and salinization of soils is increasing, and this phenomenon is especially noticeable in irrigated soils According to a study approximately 45 million hectares of irrigated land, which produces one-third of the world's food, is salt-affected (Shrivastava *et al*., 2015).

Soil salinity is a major contributor to desertification in the European Union, affecting an estimated 1 million hectares, primarily in Mediterranean countries. In Spain, 3% of the 3.5 million hectares of irrigated land has been severely damaged significantly reducing agricultural potential, while another 15% is seriously threatened. (Stolte *et al*., 2015). Germination of seeds is typically the most hazardous stage in determining crop production success and seedling establishment (Almansouri *et al*., 2001). Seed germination can be harmed by factors such as drought sensitivity and salt tolerance (Sadeghian *et al*., 2004).

Salt stress has an impact on both soil composition and soil quality (Nakashima *et al*., 2000). It has an equal and indirect impact on about 831 million hectares) of our land area (Beltran & Manzur, 2005). Many researchers have reported on the effect of salinity on the morpho-physiological and biochemical processes of many significant plant species. In several important Arabidopsis genotypes, low to high salt stress reduces normal germination rate and plant fresh and dry weight by several orders of magnitude (Quesada *et al*., 2002 and Munir *et al.*, 2013).

The important stage in establishment of seedling is that to determine crop production on salt-affected part of land is seed germination. In general, salinity during germination of seedlings delays germination, increases germination and reduce the rate of germination event dispersion (Ashraf and Foolad, 2005 and Farsiani and Ghobadi, 2009). It is important to note that early germination and seedling growth are more sensitive to salinity than later developmental stages (Goldsworthy, 1994). Salt stress inhibits seed germination primarily by lowering the osmotic potential of the soil solution, causing sodium and chloride toxicity to the embryo, or altering protein synthesis.

In a salt effecting part, hyper-osmotic stress and the toxic effects of sodium and chloride ions on germinating seeds may delay or reduce germination (Hasegawa *et al.*, 2000 and Hosseini *et al.*, 2003). However, in the second phase of salt stress, sodium toxicity, rather than chloride toxicity, is the major issue in maize. Salinity inhibits shoot growth by slowing leaf expansion and initiation, also internode growth, and by speedily cause leaf abscission (Gonzalez *et al.,* 2002 and Akram *et al.,* 2010).

1.2 *Brassica compestris*

Brassica compestris a member of the mustard family belongs to Brassicaceae, which includes about 435 genera and 3675 species worldwide, with 42 genera (20 of which are exotic) and 198 species (37 of which are exotic naturalized species) in southern Africa. Over 30 wild species and hybrids, also several hybrids and cultivates of cultivated origin, are grown. The majority of the plants are, but also some are small shrubs. Brassica *compestris* plants have attracted the interest of scientists due to their universal importance. Brassica *compestris* contains approximately 100 species, which include cabbage, cauliflower, broccoli, Brussels sprouts, turnip, mustards, and weeds (Gomez Campo, 1999). *Brassica compestris*, also known as field mustard or turnip mustard, is a plant grown for its oil, roots and leaves.

1.3 *Zea mays*

Maize (/mez/ MAYZ; Zea mays subsp. mays, from Spanish: maz after Taino: mahiz), also known as corn (North American and Australian English), is a cereal grain which was first cultivated around 10,000 years ago by indigenous peoples in southern Mexico. The plant's leafy stalks produce pollen inflorescences (or "tassels") and also have separate ovuliferous inflorescences which called ears, it produces kernels or seeds when fertilized, and are considered as fruits.

Zea mays has become a staple and most likely food in many parts of the world, with total *Zea mays* production exceeding other crops like wheat or rice. *Zea mays* is used for corn ethanol, animal feed, and other *Zea mays* products, such as corn starch and corn syrup, in addition to being consumed directly by humans (often in the form of masa). The six main varieties of *Zea mays* are dent corn, flint corn, pod corn, popcorn, flour corn, and sweet corn. Field corn varieties are typically grown for animal feed, various corn-based human food uses (such as grinding into cornmeal or masa, pressing into corn oil, and fermentation and distillation into alcoholic beverages such as bourbon whiskey), and as chemical feed stocks. Sweet corn varieties are typically grown for human consumption as kernels. Additionally, *Zea mays* are used to make ethanol and other biofuels. More *Zea mays* is produced annually than any other grain, and it is widely refined all throughout the world. With 361 million metric tons, maize is the most frequently farmed grain crop in the Americas.

AIMS AND OBJECTIVES

1) To investigate the salinity stress against *Brassica compestris* and *Zea mays.*
2) To compare the germination rate of *Brassica compestris* and *Zea mays.*
3) To find out early seedling growth of *Brassica compestris* and *Zea mays* under salt stress.
4) To analyze plants vigor index under increasing salinity.
5) To report best tolerate plant in saline soil.

METHOD AND MATERIAL

This research was carried out at the Govt. Post Graduate College for Women Mardan in Department of Botany. The main goal of this study was to assess the effect of salts on seedling germination and growth**.** *Brassica compestris* and *Zea mays*

3.1 SALT

Sodium chloride (NaCl)

3.2 CONCENTRATION

Four different concentration of sodium chloride (0g, 1g, 2g and 3g) were used Solution of 4 different concentration were prepared(S_1: contain 0g of sodium chloride act as control, S_2: it contain 1g of sodium chloride, $S_{3:}$ it contain 2g of sodium chloride, S_4: it contain 3g of sodium chloride.

3.3 PETRI DISHES AND FILTER PAPER

Petri plates (9cm) were used in this experiment which was 1st washed and then auto calved the filter paper was put in all the Petri dishes. Each Petri plate was double-lined with sterilized filter paper that had been moistened with 10ml NaCl solution. The treatment in each Petri plate was changed every day to ensure the desired salt level.

3.4 POTS

Pots (10cm) were used in this experiment which was washed. Each pot contains equal numbers of seeds moistened with NaCl solution to ensure the desired salt level.

3.5 SEED SELECTION

From the market, healthy seeds of uniform size were chosen, and 10 seeds were placed in each Petri dish .these seed were allowed to germinate in each Petri plate.

3.6 PARAMETER

The following parameters were studied in this experiment.

- Germination (%)
- Shoot length (cm)
- Root length (cm)
- Fresh weight (g)
- Dry weight (g)

3.7 SEED STERELIZATION

The seed were sterilized once by ethanol for two minute and washed extensively with distilled water to remove the germ for the purpose to remove dust particle or any germs which is attached to the seed.

3.8 GEMINATION AND EMERGENCE

Germination started after 2 days of sowing and a seed was considered germinated when the radical emerged, and data for germination up to day 14 of the experiment were collected. After recording fresh weights, plant seedlings were carefully removed from the Petri plates and separated into shoots and roots. The plant samples were dried for 24 hours at 65°C and their dry weight was determined.

3.9 STATISTICAL ANALYSIS

SPSS is applied on data.

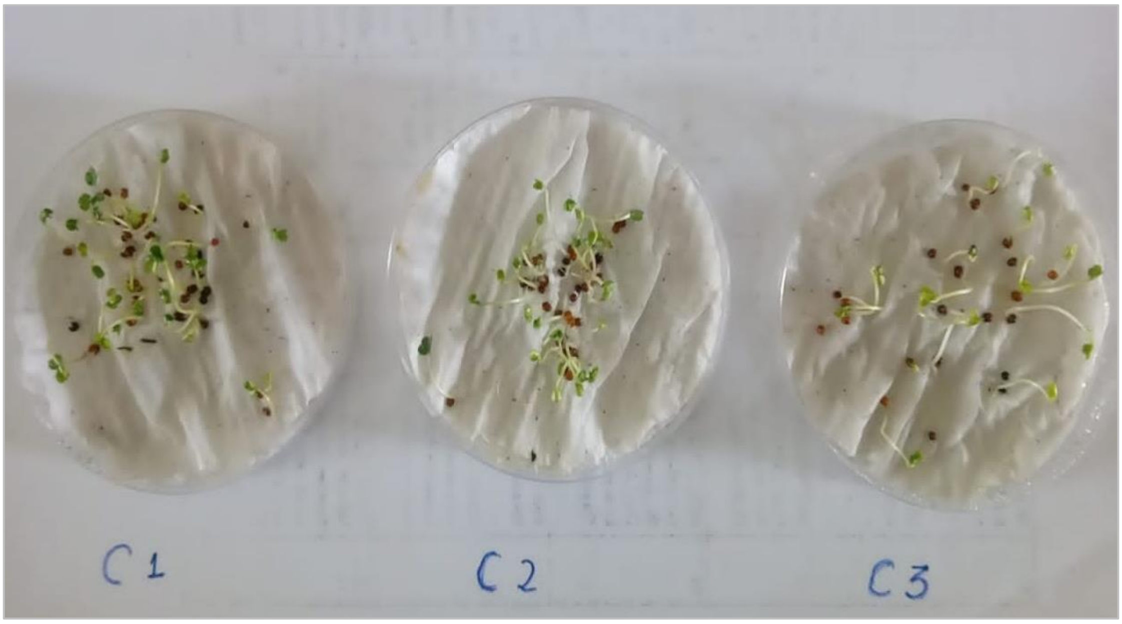

Fig 3.10 effect of different concentration of salt (NaCl) on the growth of *Brassica compestris* seedlings. Seedling were grown for ten days and taken as control

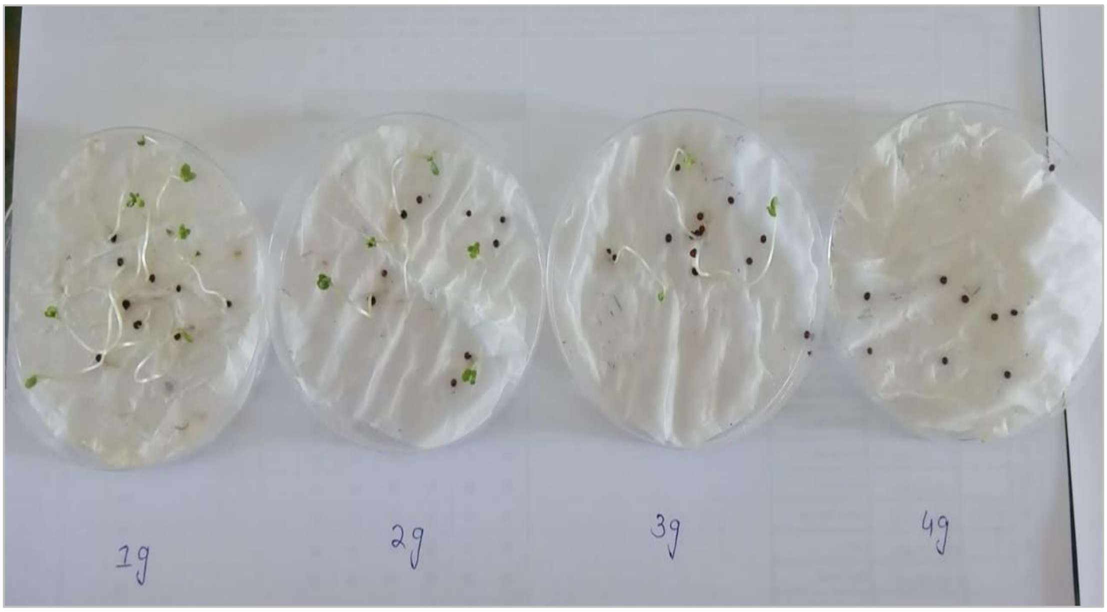

Fig 3.11 effect of different concentration of salt (NaCl) on the growth of *Brassica compestris* seedlings. Seedlings were grown for ten days and then expose to three treatments of different salt concentration at three days interval

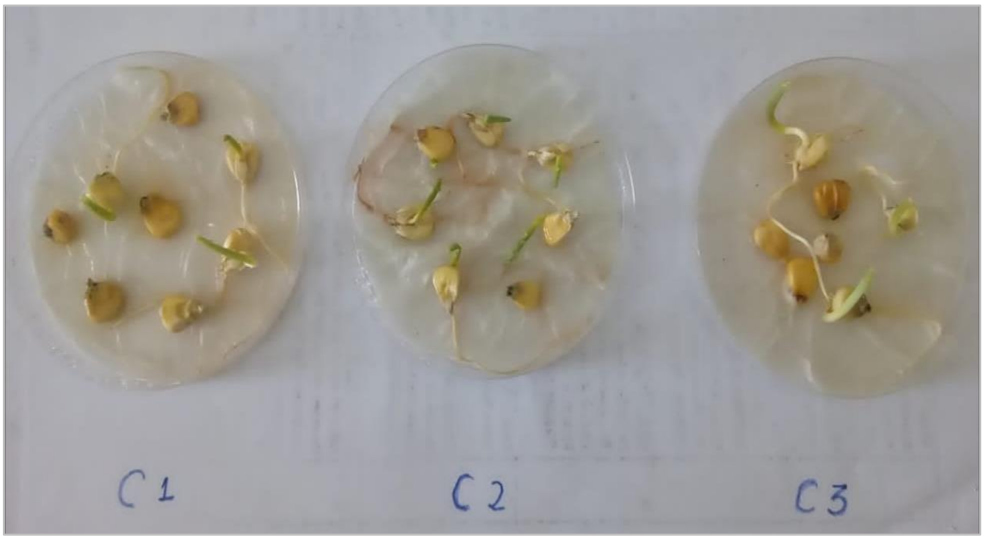

Fig 3.12 effect of different concentration of salt (NaCl) on the growth of *Zea mays* seedlings. Seedlings were grown for ten days and taken as control

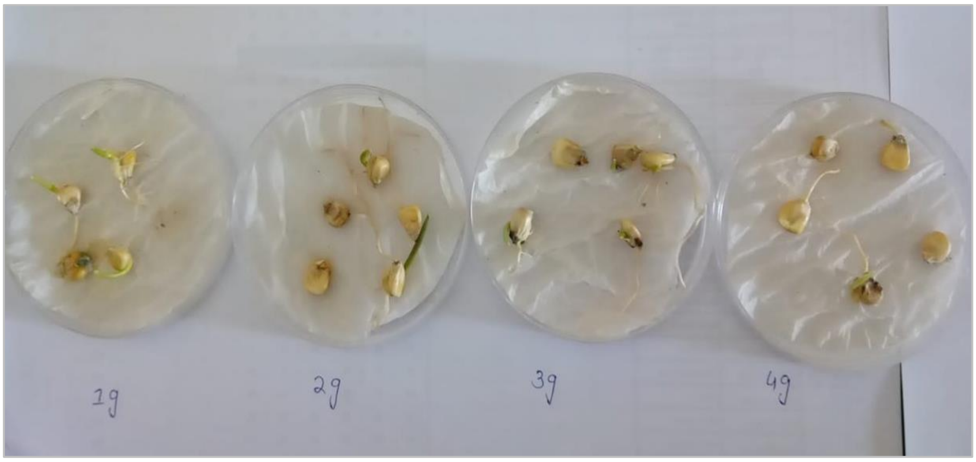

Fig 3.13 effect of different concentration of salt (NaCl) on the growth of *Zea mays* seedlings. Seedlings were grown for ten days and then expose to three treatments of different salt concentration at three days interval

Fig 3.14 effect of different concentration of salt (NaCl) on the growth of *Brassica compestris* seedlings. Seedlings were grown for ten days and then expose to three treatments of different salt concentration at three days interval.

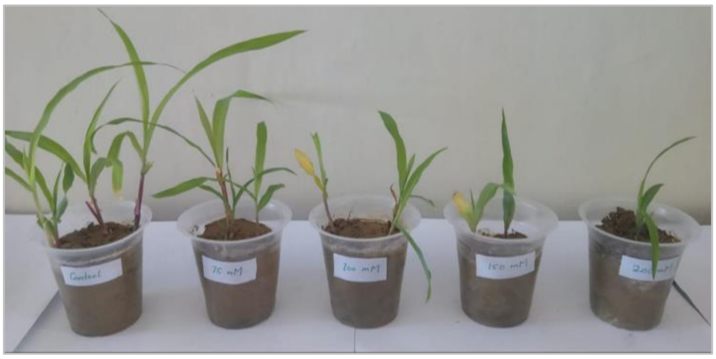

Fig 3.15 effect of different concentration of salt (NaCl) on the growth of *Zea mays* seedlings. Seedlings were grown for ten days and then expose to three treatments of different salt concentration at three days interval.

RESULTS

4.1 Petri plates experiments

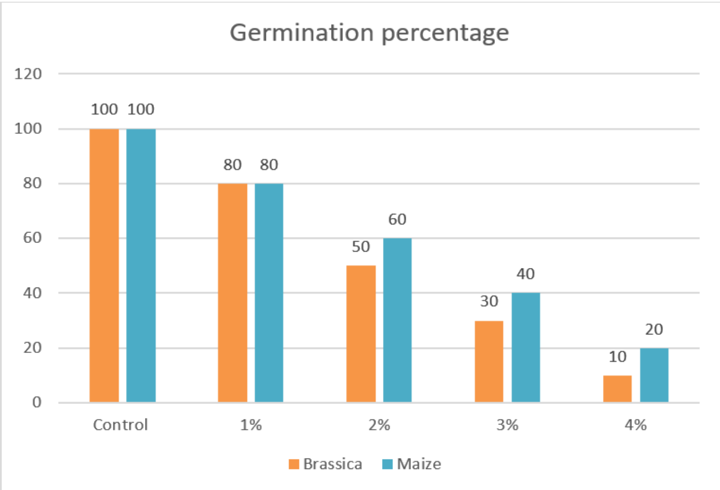

Fig.4.1: Effect of different salt concentrations on germination percentage of *Brassica compestris* and *Zea mays*

The data regarding fresh seedling weight (g) are given in Fig.4.2. The salinity stress of NaCl also adversely affected the fresh seedling of both the *Brassica compestris* and *Zea mays*. The maximum fresh seedling weight was observed in 1% of *Brassica compestris* (0.4012) and *Zea mays* (0.1825). This value was followed by 0.1733g of *Brassica compestris* which was observed in control. The minimum fresh seedling weight was recorded for 4% treatment in *Brassica compestris* 0.02g. The increasing salinity level of NaCl decreased the fresh seedling weight of both *Brassica compestris* and *Zea mays.*

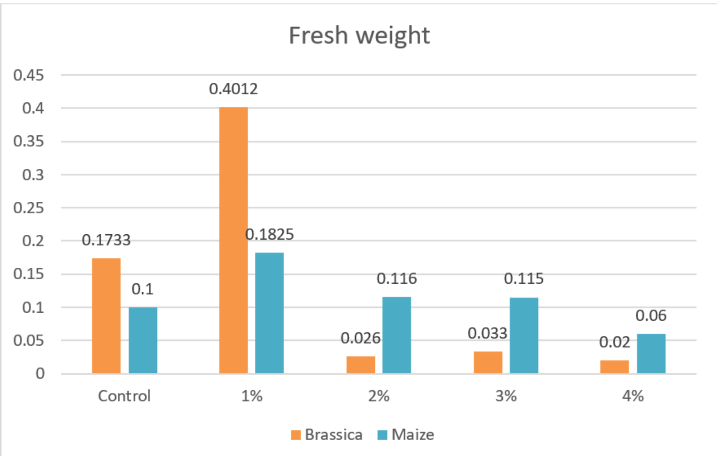

Fig.4.2: Effect of different salt concentrations on fresh seedling weight of *Brassica compestris* and *Zea mays*

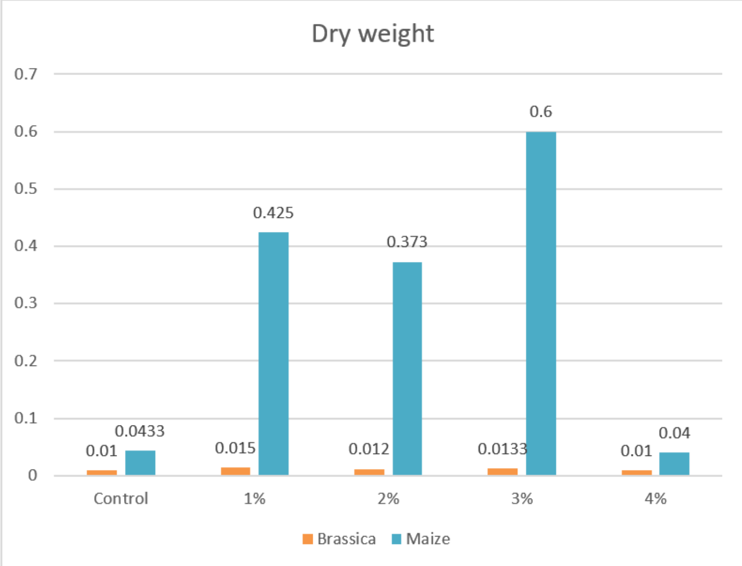

Fig.4.3: Effect of different salt concentrations on dry seedling weight of *Brassica compestris* and *Zea mays*

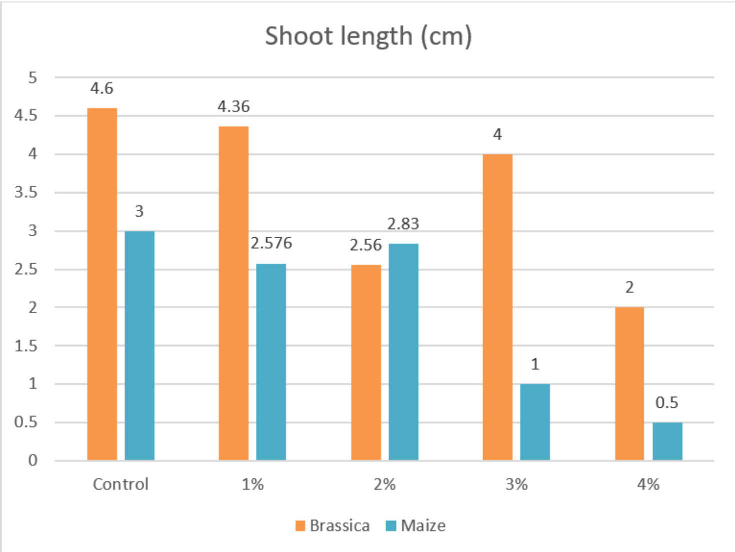

Fig.4.4: Effect of different salt concentrations on shoot length (cm) of *Brassica compestris* and *Zea mays*

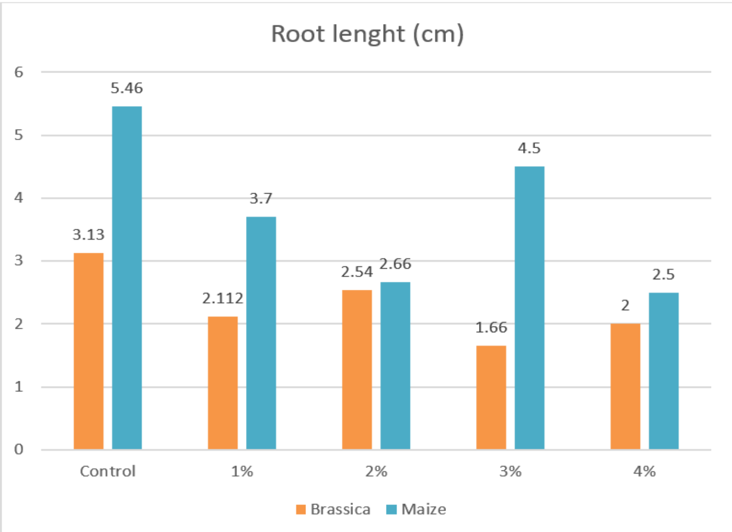

Fig.4.5: Effect of different salt concentrations on seedling root length (cm) of Brassica and Maize

4.2 Pots experiment

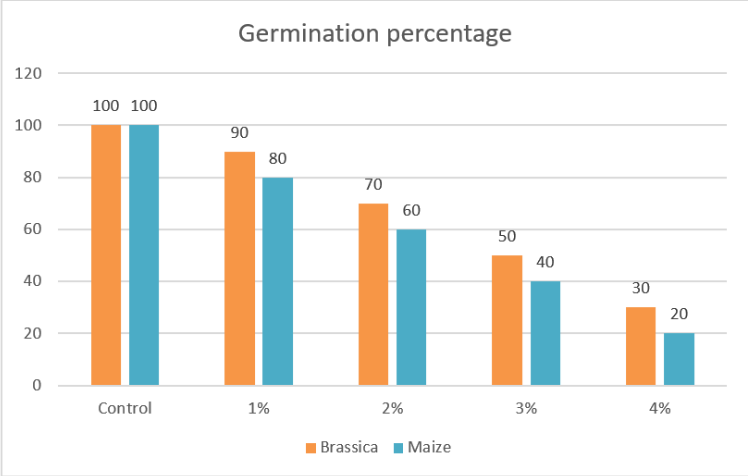

Fig.4.6: Effect of different salt concentrations on germination percentage of *Brassica compestris* and *Zea mays*

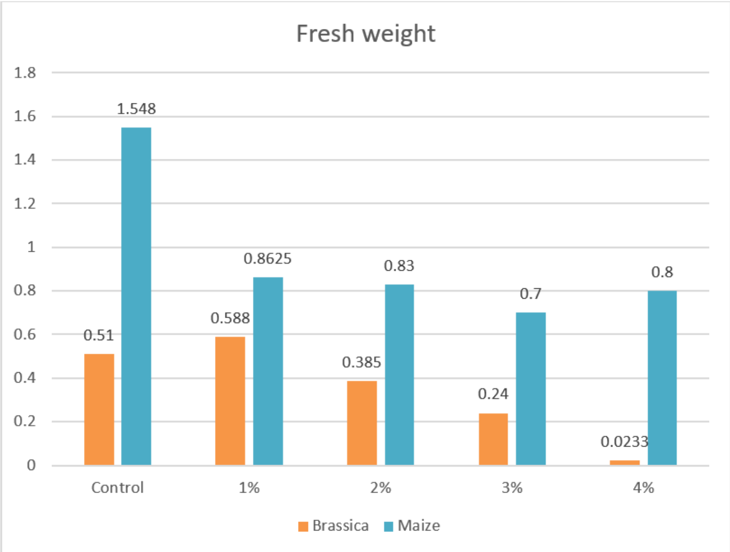

Fig.4.7: Effect of different salt concentrations on fresh seedling weight of *Brassica compestris* and *Zea mays*

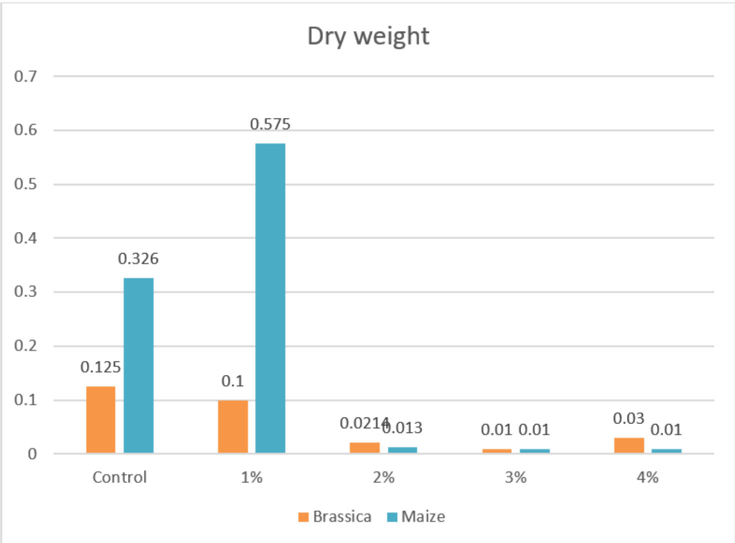

Fig.4.8: Effect of different salt concentrations on dry seedling weight of *Brassica compestris* and *Zea mays*

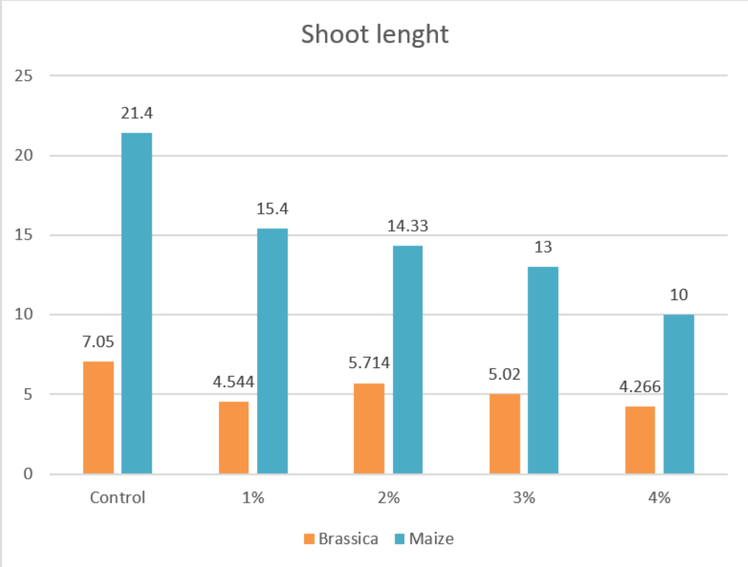

Fig.4.9: Effect of different salt concentrations on shoot length (cm) of *Brassica compestris* and *Zea mays*

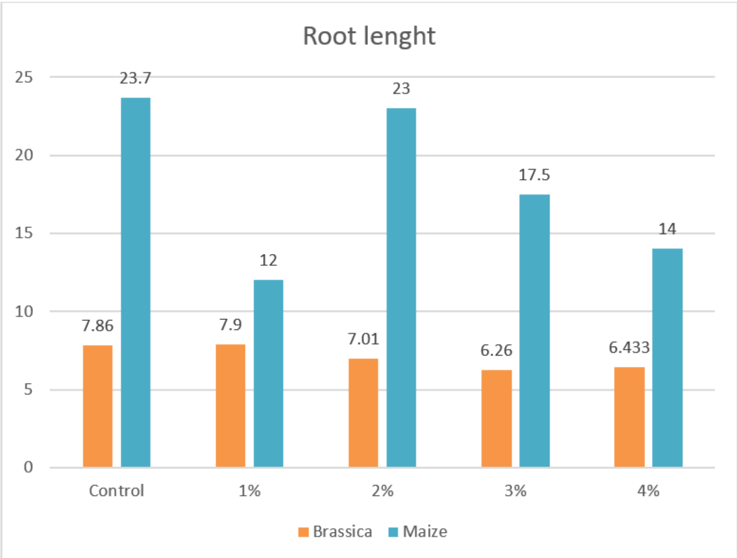

Fig.4.10: Effect of different salt concentrations on seedling root length (cm) of *Brassica compestris* and *Zea mays*

DISCUSSION

Salinity refers to the quantity of salt dissolved in water and which is absorbed by the plants. The higher level of salinity of poisonous salts in leaf causes dryness and turgor loss and death of leaf cells. Salinity stress is one of the serious problems which badly affect the growth and yield of the plants all over the world (Majeed *et al.* 2010). Soil salinity is a universal problem which affects 20% of the total cultivated earth in the world and it also affects half of all irrigated lands.

The maximum germination percentage (100) was recorded for control of petri plates experiment of *Brassica compestris* and *Zea mays* The minimum germination percentage was observed in 4% salt concentration in both *Brassica compestris* (10%) and *Zea mays* (20%). The germination percentage was decrease with increasing salinity level of NaCl.

The fresh seedling weight was also affected by the diverse levels of NaCl stress. The maximum fresh seedling weight was observed 1% of *Brassica compestris* which is 0.4012g. The *Brassica compestris* was badly affected by the NaCl stress. The results confirm that the fresh seedling mass of *Brassica compestris* was less affected by the salinity stress as compared to *Zea mays*.

The dry seedling weight of *Brassica compestris* was badly affected by the salinity stress. The maximum dry weight was observed for 3% concentration of *Zea mays* which was recorded as 0.6g. The minimum was recorded for control and 4% of *Brassica compestris* which is recorded as 0.01g.

The seedling shoot length of *Zea mays* is affected as compared to *Brassica compestris*. The maximum shoot length was recorded for control of

Brassica compestris as 4.6cm. The minimum was recorded for 4% of maize as 0.5cm.

The seedling root length of *Brassica compestris* was affected by different salinity levels of NaCl. The maximum seedling root length was observed for control of *Zea mays* which was recorded as 5.46cm. The minimum was recorded for 3% of *Brassica compestris* which is recorded as 1.66cm.

The maximum germination percentage (100) was recorded for control of pots experiment of *Brassica compestris* and *Zea mays*. The minimum germination percentage was observed in 4% salt concentration in both *Brassica compestris* (30%) and *Zea mays* (20%). The germination percentage was decrease with increasing salinity level of NaCl.

The fresh seedling weight was also affected by the different level of NaCl stress. The maximum fresh seedling weight was observed control of *Zea mays* which is 1.548g. The *Brassica compestris* was badly affected by the NaCl stress. The results confirm that fresh seedling weight of *Brassica compestris* was less affected by the salinity stress as compared to *Zea mays*.

The dry seedling weight of *Brassica compestris* was badly affected by the salinity stress. The maximum dry weight was observed for 1% concentration of *Zea mays* which was recorded as 0.575g. The minimum was recorded for control and 3% of both *Brassica compestris* and *Zea mays* which is recorded as 0.01g.

The seedling shoot length of *Zea mays* is affected as compared to *Brassica compestris*. The maximum shoot length was recorded for 3% of both *Brassica compestris* and *Zea mays* as cm. the minimum was recorded for 4% of *Zea mays* as 0.5cm.

The seedling root length of *Brassica compestris* was affected by different salinity levels of NaCl. The maximum seedling root length was observed for control of *Zea mays* which was recorded as 23.7cm. The minimum was recorded for 3% of *Brassica compestris* which is recorded as 6.26cm.

CONCLUSION

Salt stress is caused by concentration more than required for optimum growth of typical crop plant. Salt is important factor affecting crop productivity. It's productivity decrease when crop is subjected to salinity. Based on current research, It is concluded that high concentrations of NaCl solution decreased the rate of germination in experimental groups compared to the control group, but the rate of germination in the experimental groups was not found to be significantly different. Very high concentrations of NaCl solution effect the seedling shoot length, root length, fresh weight, and dry weight between experimental groups in different concentrations of NaCl as compared to the control group (no stress). It was concluded that high levels of sodium chloride in soil or water reduced germination and growth parameters in *Brassica compestris* and *Zea mays*.

RECOMMENDATION

Plant growth and metabolism are influenced by NaCl salt. So leaves become yellow and by the accumulation of the salt in leaves and plant body it will burn.

1) The salt concentration of the soil should be reduced in the crop field.
2) There should be cultivation of salt tolerant transgenic plants.
3) There should be cultivation of salt resistant transgenic plants.

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