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Assessment of NaCl stress on morphological behavior of *Gazania*

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Key words: Salinity, Morphological Behaviour, *Gazania*.

Abstract

NaCl causes stress situation in soil which gives outcome like minimized growth owing to variations in whole plant structure. The study was constructed for exploring the morphological behavior of *Gazania* grown-up under dissimilar salinity grades (25, 50, 75 and 100 mgl^{-1} of NaCl). The pot based experiment was arranged out in the design (CRD) with 4 repetitions. Observation data to various traits was collected and subjected to analyze using standard statistical procedures. The results showed that salinity has negative impact on morphological characters like Root & shoot dry wt. ratio, Root & shoot fresh wt. ratio, Root dry wt. (g), Root fresh wt. (g), Shoot dry wt. (g), Shoot Fresh Wt. (g), Root length (cm), Shoot length (cm), Size of flower (cm), Number of flowers $plant^{-1}$,Time of Flower (MET) [Days], Leaf Area (cm^2), Number of leaves/plant, Plant height (cm). The study exposed that control treatment (T_0) displayed utmost consequences relatively to other altered treatments under saline condition. Salinity revealed the -ive impact on *Gazania* growth behavior.

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Introduction

The salinity is a major problem in all the countries of world. Agricultural yield is brutally affected by high amount salts presented in soil and owing to the damaging effect of this salt accumulation in agricultural soils has become an important environmental concern (Jaleel *et al.,* 2007). Most of the saline soil has arisen from natural causes, by the accumulation of salt for long term in different arid to semi arid regions of the world (Rengasamy, 2002). The total global area of salt-affected soils has been recorded to be about 830 million hectares (Martinez-Beltran and Manzur, 2005). Agricultural productivity is affected by different types of soil salinity, such as irrigation-induced salinity and 'transient' dry-land salinity (Rengasamy, 2006). Ornamental plants can be considered all the species and varieties that provide aesthetic pleasure, improve the environment and the quality of our lives (Save, 2009). *Gazania harlequin* is an ornamental and decorative plant which is only cultivated in parks and these annuals are usually used for ornamental purpose (Vicki and Chan, 2008). High salinity levels affect all aspects of plant growth and development and plants adapt to their environment through a complex regulatory network (Gong *et al.,* 2001). Growth, yield and quality reduction may occur due to a decrease in the ability of plants to take up water from the soil solution and the destruction of soil structure (Barrett-Lennard, 2003). Among various abiotic stresses, NaCl induced salinity is the major factor that hampers the plant growth and development, decreases germination and ultimately reduces plant establishment and yield. Growth, yield and quality reduction under saline conditions occurred due to a decrease in the ability of plants to uptake water from the soil solution and the destruction of soil structure (Barret-Lennard, 2003). The negative effect of salinity on growth was reported by Hussein *et al.,* (2009) and Saffan, (2008). Most of the studies have been conducted on salt stress in food crops, but fewer found in ornamental plants. For that reason, it is the necessity of time to discover those ornate plants that are tolerant to salt stress; it will help out landscapers to select resistant plants in all designs in saline locations.

Keeping in view the potential of flora to tolerate salt, the current investigation was taken in to judge the outcome of salinity on morphological behavior of *Gazania harlequin* L.

Materials and methods

Experimental Site and design

A CRD experiment in pots with 4 repetitions was taken under study in the green house area of University of Agriculture, Faisalabad Pakistan, during the year of 2012-13. The investigation was continued for the special effects of different salinity grades on morphological traits in *Gazania*. 1 month later of sowing, the emerged seedlings of *G. harlequin* were shifted into the pots containing the mixture of silt and leaf manure growth media. These transplanted seedlings were set aside for twenty days for proper settlement before appliance of diff. salinity grades (25, 50, 75, 100 mgl-1 of NaCl solution). Before filling the pots, soil was weighed and 1.5 kg mixed media soil was put in every pot and the artificial salinity solution of 25, 50, 75, and 100 mgl^{-1} sodium chloride salt was applied respectively but the control was without salinity.

Statistical Analysis

Traits data was taken after 90 days of shafting. Statistical analysis was carried out by using Fishers' analysis of variance (ANOVA) techniques. The mean values were compared with least significance difference test (LSD) following Steel *et al.,* (1997).

Observation data (Morphological)

Plant height (cm): Height of the plants was measured with the help of measuring tape in cm and average was completed (Wood and Roper, 2000).

Number of leaves per plant: Leaves of each plant were counted and recorded. Every visible leaf on the plant was counted; including the tips of new leaves just beginning to emerge (Wood and Roper, 2000).

Leaf Area (cm^2): Leaf area of third leaf from tip of branches all plants were measured in (cm^2) with help of leaf area meter and the average was worked out.

Mean Emergence Time of Flower (MET) [Days]: Mean emergence time (MET) was calculated according to following equation of Ellis and Roberts, (1981):

$$MET = \frac{\sum Dn}{\sum n}$$

Where n is the number of flower and D is the number of days counted from the beginning of flower emergence.

Number of flowers plant^{-1}: The numbers of flowers plant-1 were counted regularly during blooming period of the crop and then average was worked out.
Size of flower (cm): Diameter of all flowers was measured in cm with the help of vernier caliper and their average was taken out.

Shoot length (cm): Length of shoots from each plant was measured with the help of measuring tape in cm and average was calculated.

Root length (cm): Plants were removed from soil and washed off any loose soil. Plants were cleaned gently with soft paper towel to remove any free surface moisture. Then measure the root length through a measuring scale. Roots of *Gazania* are very delectate, so they were measured very carefully (Munns, 2002).
Shoot Fresh Weight (g): Shoot from each plant was collected and weight for its fresh weight in grams on electric balance and their average was worked out.

Shoot dry weight (g): Shoots were dried in oven at 65^{o}C for 48 hours and then weight on electric balance. In this way, dry weight of shoots (g) was recorded.

Root fresh weight: Plants were removed from the soil and their roots were separated, calculated weight on electric balance and their mean values were used. Root dry weight: Roots were dried in oven at 65^{o}C for 48 hours and then weight on electric balance.

Root shoot fresh weight ratio: The difference between root and shoot fresh weight was calculated and their average ratio was computed.

Root shoot dry weight ratio: The difference between root and shoot dry weight was calculated and average ratio was computed.

Results and discussion

Effect of different salinity levels on plant height of Gazania

Data regarding the number of leaves per plant is shown in fig.1. Maximum plant height was observed in T_0 (23.26cm) followed by T_1 (22.75cm), T_2 (20.50cm) and T_3 (20.10cm) while minimum plant height was observed in plants treated with 100 ppm (19.59cm) solution of salts at LSD value at 0.05 (1.690).

There was statistically no difference in plant height in those pots where salinity was not applied and where the salinity level was kept 25 ppm.

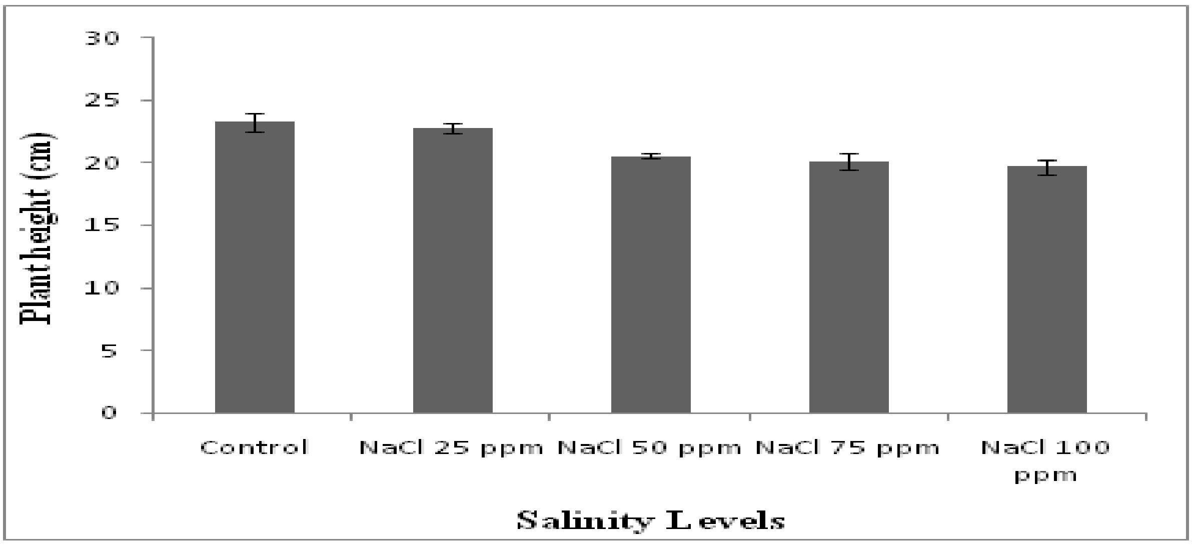

Fig. 1. Effect of different salinity levels on plant height of *Gazania*

These plants produced statistically same plant height as produced in control. But there was statistically great significant difference found where the salinity levels were kept 75 ppm and 100 ppm as compared to control treatment. Whereas lower doses have lesser effect as compared to higher concentrations on plants. Plant height is an important morphological attribute; it is a function of combined effects of genetic makeup of a plant, soil nutrient status, seed vigor and the environmental conditions under which it was grown. Plant height is positively correlated with flower quality, numbers of leaves, number of branches, number of flower , fresh weight, dry weight, flower diameter and leaf area.

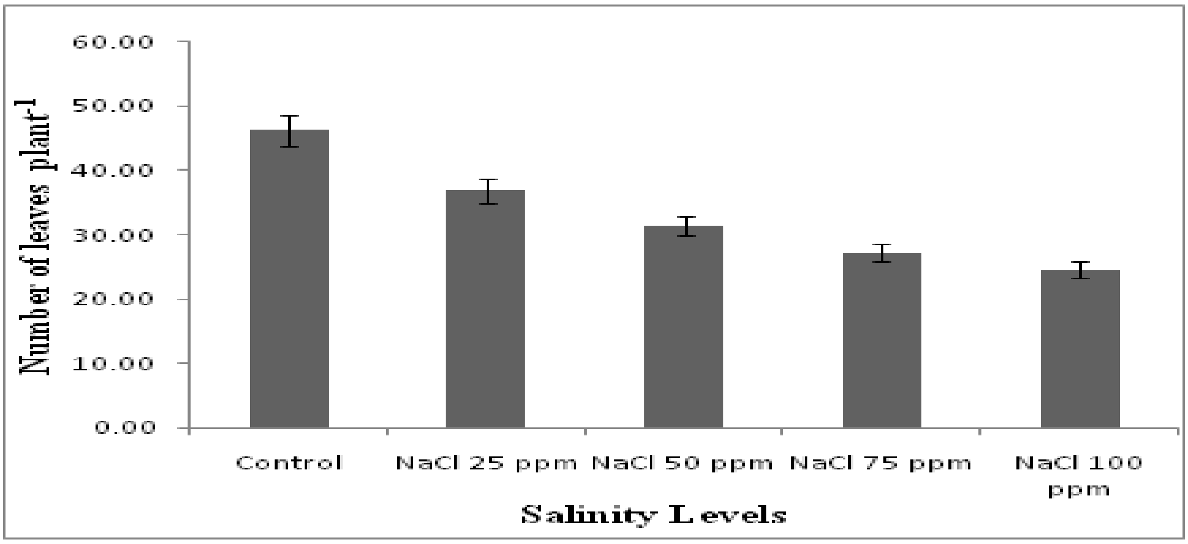

Fig. 2. Effect of different salinity levels on number of leaves per plant of *Gazania*.

These result shows that plant height increases the flower quality, numbers of leaves, number of branches, number of flower , fresh weight, dry weight, flower diameter and leaf area. Similar results found by Jayanthi *et al.,* (2007). The results achieved for plant height, were found to be significant. Jaleel *et al.,* (2008) conducted different experiment and found that plant height was decreased up to 7 % and 34 % under low and high salinity respectively when compared to the control plants. Current study also confirmed that plant height was reduced when they were exposed to salt stress.

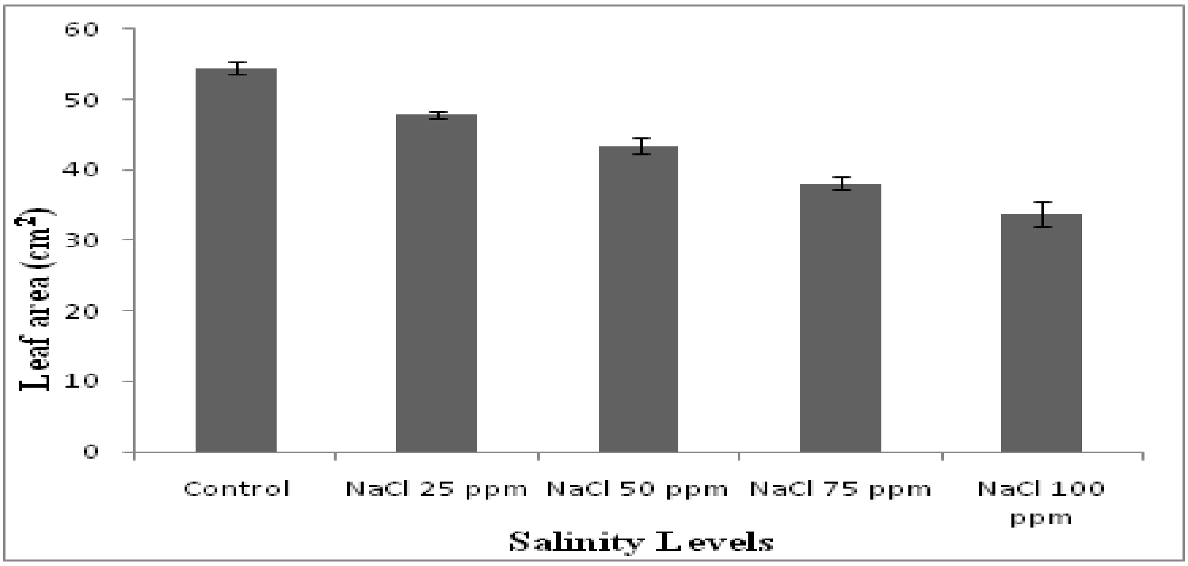

Fig. 3. Effect of different salinity levels on leaf area of *Gazania*.

It was also reported that salinity stress adversely affected the action, functioning and synthesis of plant hormone. So, reduction in plant height in the present study might be due to reduction in synthesis of gibberellins hormone, which dependable for cell elongation and IAA (Indole Acetic Acid) for cell division (Abid *et al.,* 2002). Emdad and Fardad, (2000) observed that by increasing the salinity levels it cause retardation in plant growth and development. Therefore due to retardation in growth it reduced plant height and also causes reduction in shoot elongation. Similar conditions were seen in present conducted experiment where control T_0 gives better result as compared to treatment where salinity was applied.

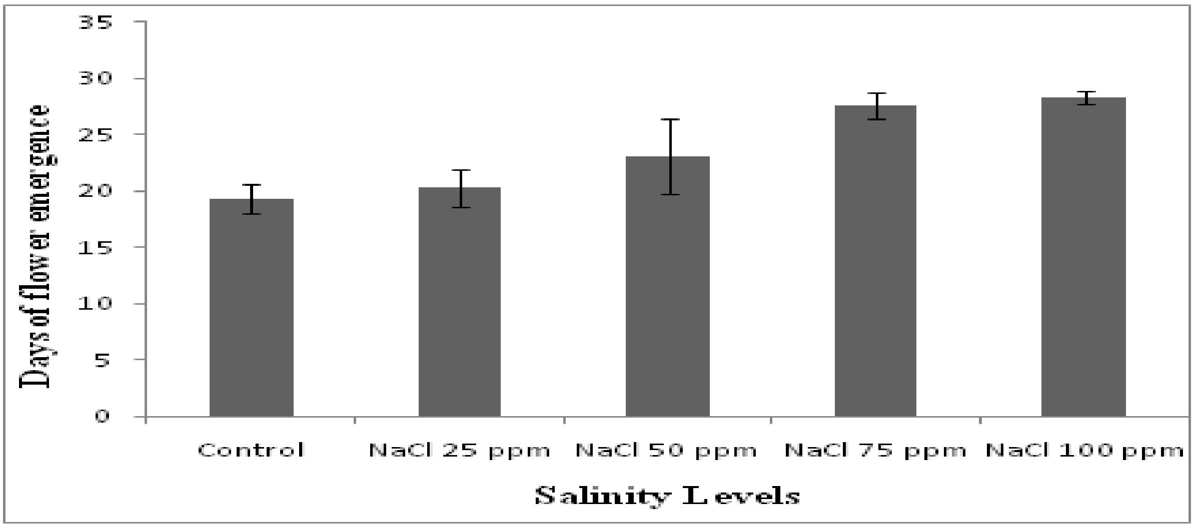

Fig. 4. Effect of different salinity levels on days of flower emergence of *Gazania*.

Effect of different salinity levels on number of leaves per plant of Gazania

Data regarding the number of leaves per plant is shown in fig.2. Almost all the treatments produced significant results. The statistical data indicates that with increase in salinity level there was significantly decreased in the number of leaves per plant as compared to control as shown in. Maximum number of leaves were produced in control T_0 (46.18) followed by T_1 (36.81), T_2 (31.43) and T_3 (27.18) while minimum number of leaves were counted in plants treated with 100 ppm (24.50) solution of salts at LSD value at 0.05 (15.79).

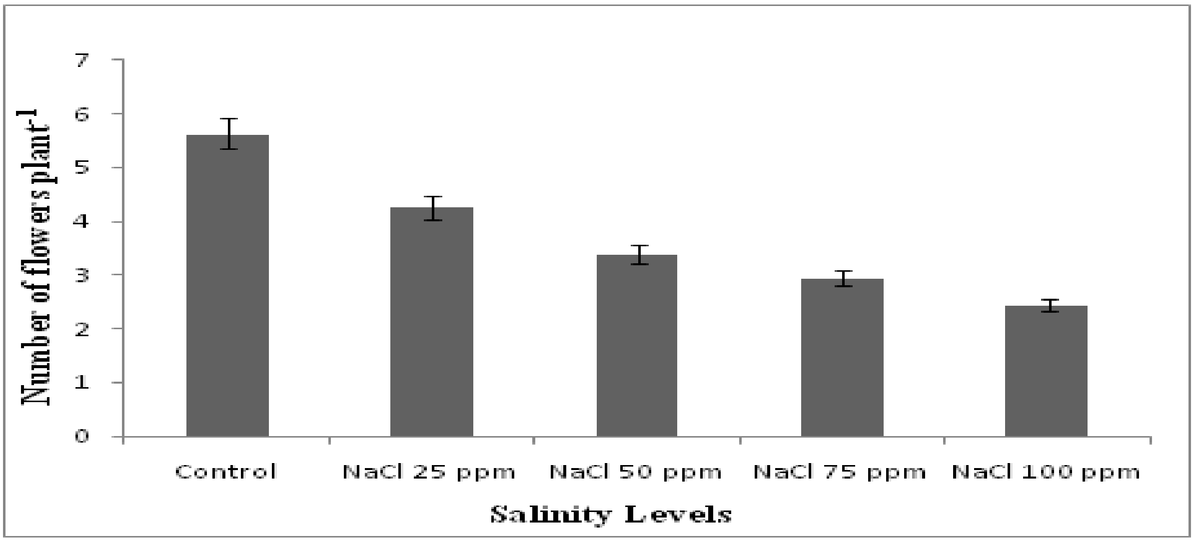

Fig. 5. Effect of different salinity levels on number of flower per plant of *Gazania*.

These plants produced statistically same number of leaves as produced in control. Whereas lower doses have lesser effect as compared to higher concentrations on plants. Leaves are important morphological attribute; it is a function of combined effects of genetic makeup of a plant and play vital role in photosynthesis. The reduction in growth of plant under salt stress condition can be attributed to necrosis of leaves which reduces the photo synthetically active area. Salinity reduced leaf photosynthesis.

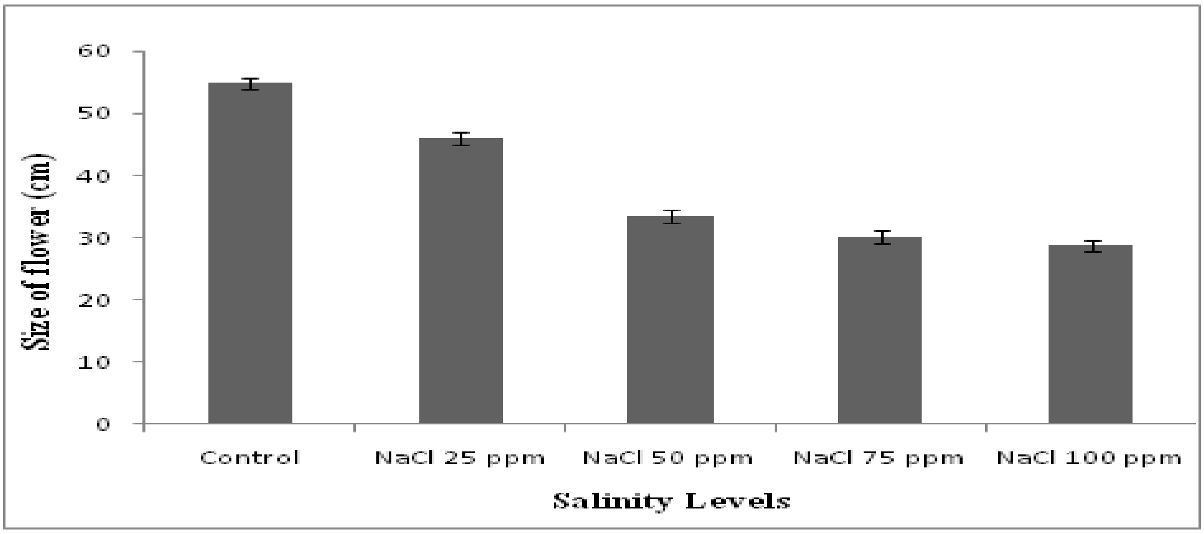

Fig. 6. Effect of different salinity levels on Size of flower of *Gazania*.

These results match with findings of Werner and (Stelzer, 1990; *Parida et al.,* 2003) who observed that salinity reduced leaf photosynthesis in mangrove plants. Hui *et al.,* (2004) conduct an experiment and concluded that the inhibition of photosynthesis in *Lycium barbarum* is occur due to salt stress which is mainly caused by temporary stomatal limitations, whereas non stomatal limitations cause to the reduction in photosynthesis when salinity is of longer duration. It was observed as salinity levels increased there was gradually decreased in number of leaves per plant. Similar conditions were seen in present conducted experiment where control T_0 gives better result as compared to treatment where salinity was applied.

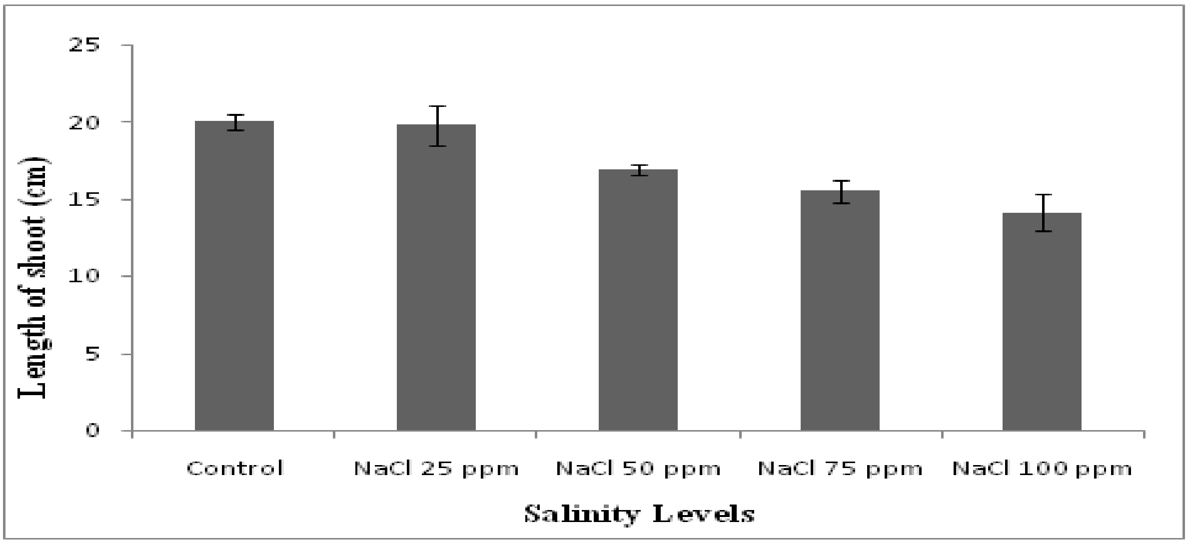

Fig. 7. Effect of different salinity levels on length of shoot of *Gazania*.

Effect of different salinity levels on leaf area of Gazania

Data regarding the number of leaves per plant is shown in fig.3. Maximum leaf area was observed in control T_0 (54.52cm²) followed by T_1 (47.89cm²), T_2 (43.37cm²) and T_3 (38.12cm²) while minimum leaf area was counted in plants treated with 100 ppm (33.75cm²) solution of salts at LSD value at 0.05 (3.386). There was statistically more significantly difference in leaf area in each treatment.

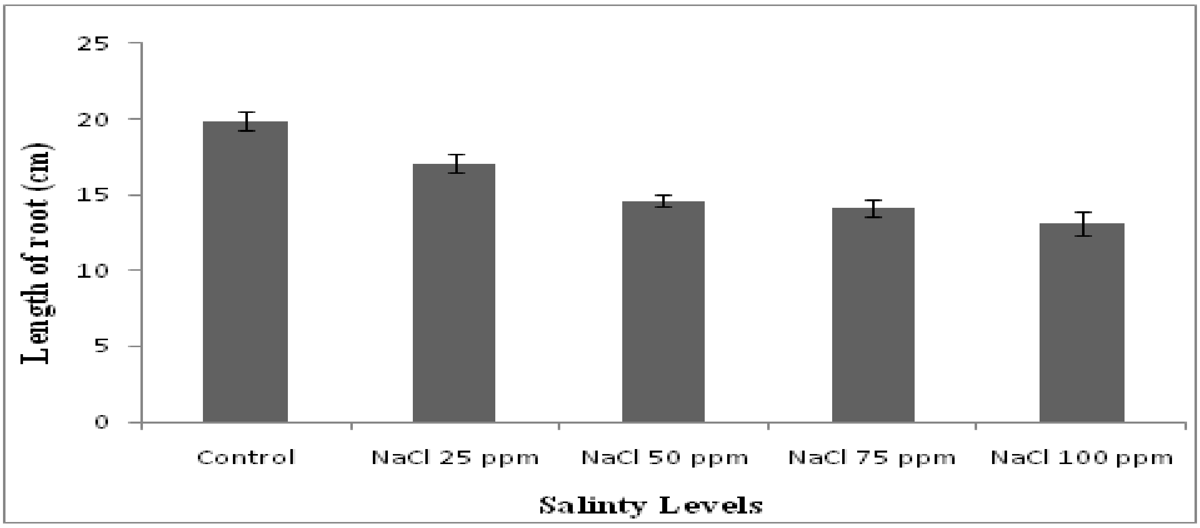

Fig. 8. Effect of different salinity levels on length of root of *Gazania*.

These plants produced statistically different size of leaves as produced in control. Similar results were found by Ergazieva and Rakhimbaev, (1978) who observed significant decreases in leaf area with increase in salinity level in irrigation water for lilac. Leaf area reduction caused by a decrease in turgor in the leaves, as a consequence of changes in cell wall properties or a reduction in photosynthetic rate Franco *et al.,* (1997). As the less water availability and salt stress condition individually applied or in unite form causes considerable decline in leaf area (Shaheen and Hood-Nowotny, 2005).

The earliest response to salt stress in plants is a reduction in the rate of leaf surface expansion, followed by a cessation of expansion as the stress intensifies (Parida and Das, 2005). Meinzer *et al.,* (1994) found that salinity stress reduced photosynthetic efficiency and certain specific changes that take place in the plant leaf. Marcelis and Hooijdonk, (1999) observed that reduction in leaf area expansion and lower light interception under salinity stress also causes growth reduction. Similar conditions were seen in present conducted experiment where control T_0 gives better result as compared to treatment where salinity was applied.

Effect of different salinity levels on days of flower emergence of Gazania

Data pertaining to days of flower emergence as affected by various salinity levels presented in fig.4. Minimum number of days of flower emergence were produced in control T_0 (19.25) followed by T_1 (20.25), T_2 (23.00) and T_3 (27.50) while maximum days of flower emergence were counted in plants treated with 100 ppm (28.25) solution of salts at LSD value at 0.05 (5.690). There was statistically no difference in days of flower emergence in those plots where salinity was not applied and where the salinity levels were kept 25 and 50 ppm of NaCl. These plants produced statistically same days of flower emergence as produced in control. But there was statistically significant difference where the salinity levels were kept 75 ppm and 100 ppm as compare to control treatment. These results match with findings of Nadejda and Atanassova, (2008) they observed that the plant mechanism was changed by increasing concentration of sodium chloride and the plants, to which the sodium chloride was applied, contain prior and shorter flowering time than the plant to which NaCl was not applied. So, by increasing of NaCl concentration there is decreasing of flowering time up to 52 days in Marigold and up to 72 days in Ageratum.

However, as the NaCl concentrations increased up to 50 mM or above, flowering in Arabidopsis thaliana was significantly delayed. The flowering time was about 13 days later under high salt stress (100 mM NaCl); plant flowered under severe salt stress (≥150 mM NaCl) in a 45-days period. So, the results indicated a significant difference in flowering time under various salinity conditions (Kexue *et al.*, 2007). Present study verified that the days of flower emergence of Gazania were increased as salinity levels were increased.

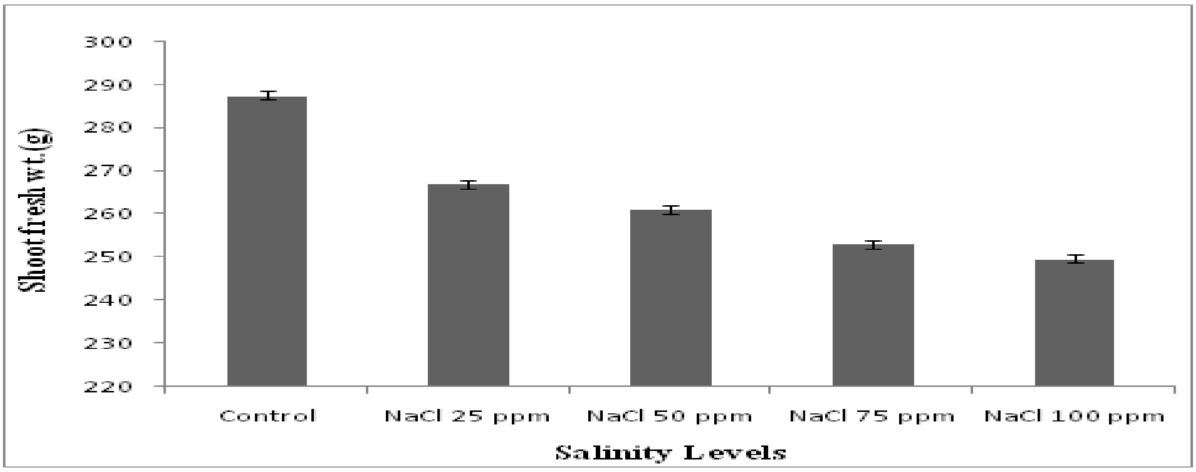

Fig. 9. Effect of different salinity levels on shoot fresh wt. of *Gazania*.

Effect of different salinity levels on number of flower per plant of Gazania

Data pertaining to number of flower per plant as affected by various salinity levels presented in fig.5. Maximum number of flowers per plant were produced in control T_0 (5.62) followed by T_1 (4.25), T_2 (3.37) and T_3 (2.93) while minimum number of flowers per plant were counted in plants treated with 100 ppm (2.43) solution of salts at LSD value at 0.05 (1.738).

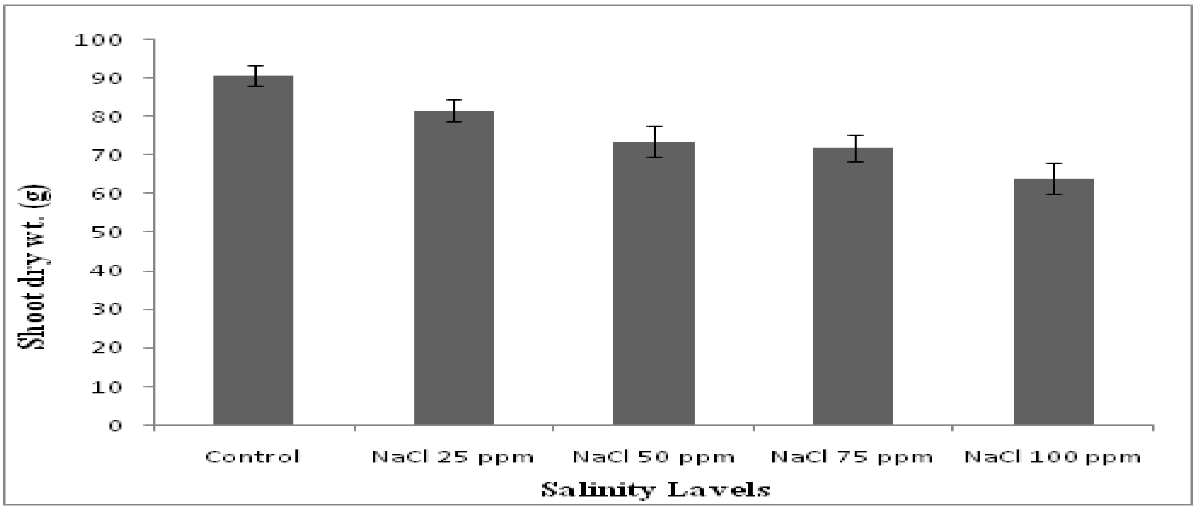

Fig. 10. Effect of different salinity levels on shoot dry wt. of *Gazania*.

There was statistically no difference in number of flowers per plant in those plots where salinity levels were kept 25, 50, 75 and 100 ppm. These plants produced statistically same number of flowers per plant while in control where salinity was not applied produce maximum number of flowers per plant and statistically show great significant difference from each treatment where the different salinity levels were applied. Whereas lower doses have lesser effect as compared to higher concentrations on plants.

Number of flowers per plant is positively correlated with fresh weight, dry weight, flower diameter and leaf area, while number of flowers per plant has negative associated with ratio of fresh and dry weight.

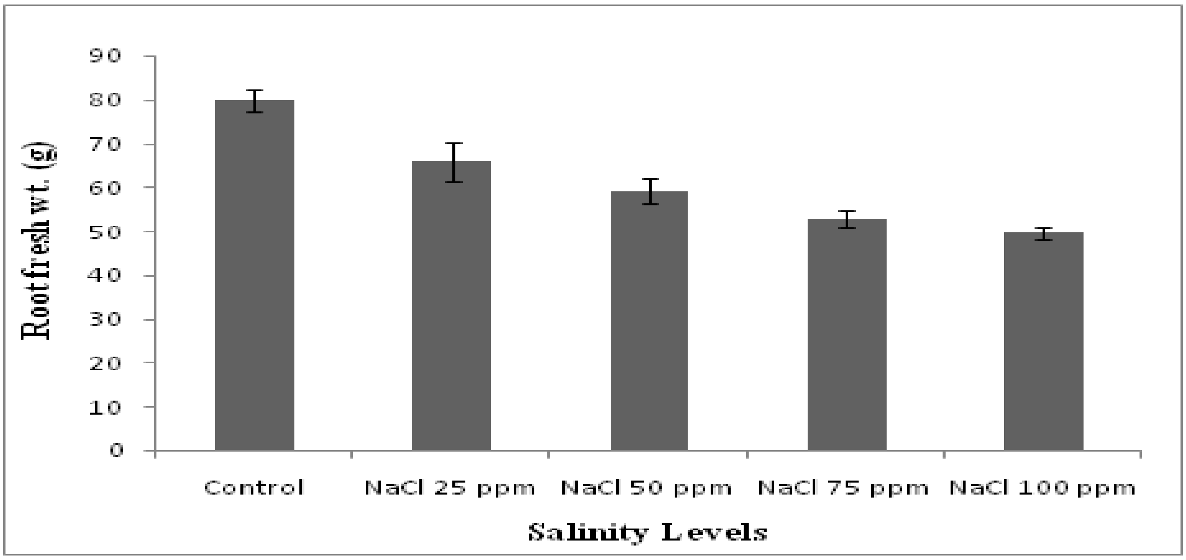

Fig. 11. Effect of different salinity levels on root fresh wt. of *Gazania*.

The salinity has negative effect on plant growth was reported by different investigators and different plants due to which fresh weight of *Gazania* is negatively affected due to salt stress (Bry *et al.,* 2000; Wu *et al.,* 2007).

The negative effect of salinity on growth was reported by Hussein *et al.,* (2009). These results were in accordance with Speck and Sonneveld, (1985) in an experiment they studied the effect of various salt concentrations on the flower production of Anthurium. Excess of NaCl, Na_2SO_4 or $MgCl_2$ was highly detrimental, lowering flower production by 40-60 %.

Francois, (1986) compared the soil salinity impact on growth and yield of kochia, parthenium and simmondisa. High salinity levels decline yield for kochia and parthenium at 2.3 and 1.3 dS m^{-1} and Soil salinity greater than 6.1 dS m^{-1} significantly reduced stem diameter and flowers counting was reduced at a soil salinity of 14 dS m^{-1}.

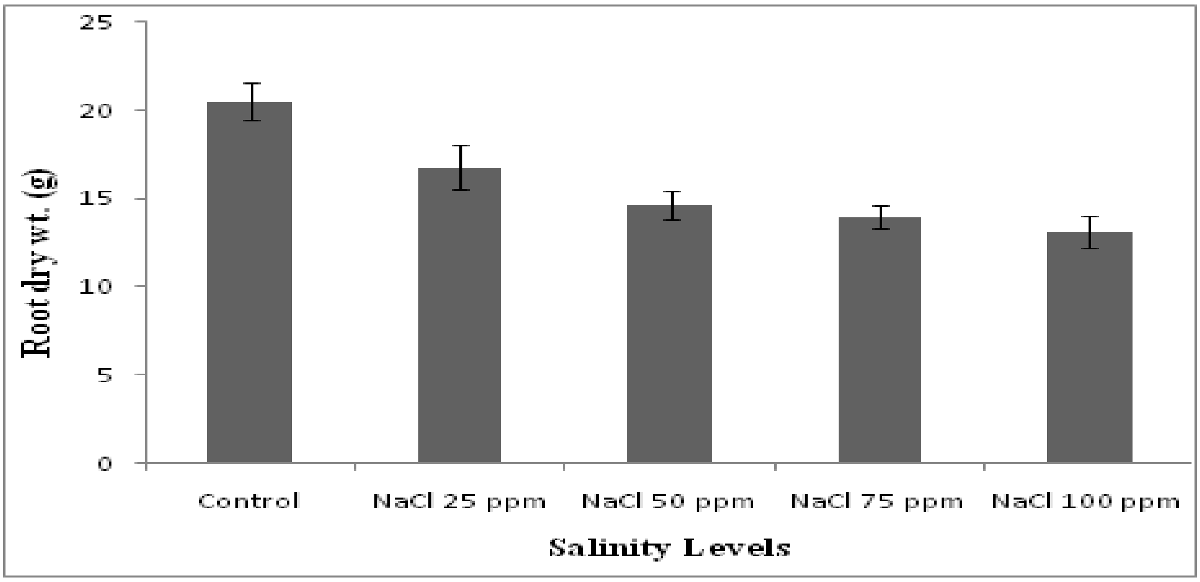

Fig. 12. Effect of different salinity levels on root dry weight of *Gazania*

Effect of different salinity levels on size of flower of Gazania

Data pertaining to size of flowering as affected by various salinity levels presented in fig.6. Large size of flower were produced in control T_0 (54.80cm^2) followed by T_1 (45.95cm^2), T_2 (33.37cm^2) and T_3 (30.20cm^2) while smaller size of flowers were counted in plants treated with 100 ppm (28.75cm^2) solution of salts at LSD value at 0.05 (5.831). There was statistically significant difference at salinity levels of 25 ppm and 50 ppm of NaCl. But no difference was found in 50, 75 and 100 ppm of NaCl salt of solution. These plants produced statistically same size of flower as compared to control. Whereas lower doses have lesser effect as compared to higher concentrations. Flower diameter has positively correlated with leaf area. It indicates that diameter of flower decreased by increasing salinity in many ornamental plants.

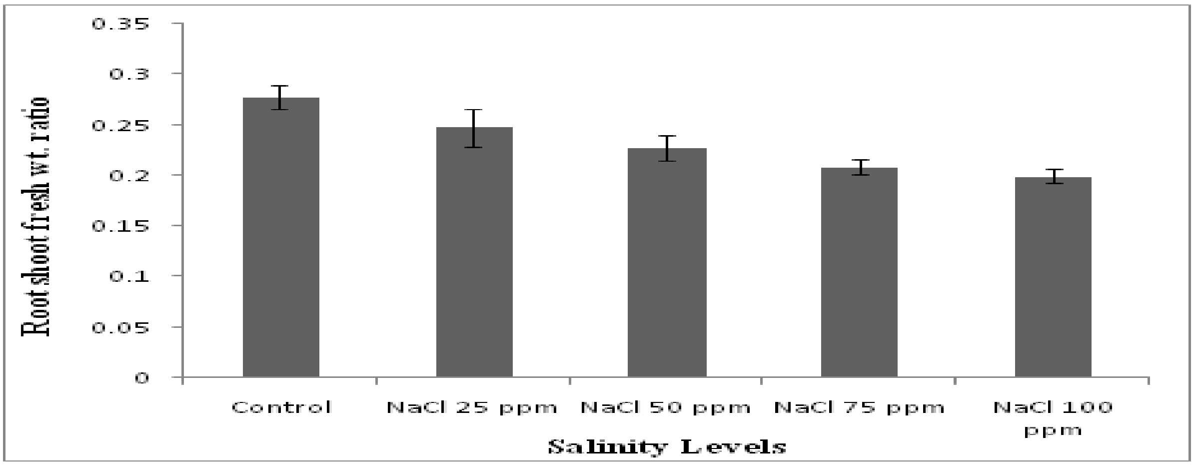

Fig. 13. Effect of diff. salinity levels on root shoot fresh wt. ratio of *Gazania*.

The negative effect of salinity on growth was reported by Hussein *et al.,* (2009). Similarly findings were also reported by Rutland, (1972) observed in chrysanthemum that reduction in flower size and shorter vase life of flower were produced at EC level of 3.6 mmhos cm^{-1} than that of 1.8 mmhos cm^{-1}. Therefore he suggested that with increasing salinity level there was significantly decreased in flower size in each treatment as compare to control. Jesche and Stelter, (1983) reported that by increasing salinity levels results a negative effect on flower size in roses. Devitt and Morris, (1987) while studying the morphological response of flowering annuals to salinity of ECe 0.8, 1.5, 3.0, or 4.5 d Sm^{-1}, noted that the relative number of flowers decreased significantly with increased salinity. Vegetative growth of *Gazania* was affected by salinity which affects the osmotic potential, nutritional availability and cell membrane permeability which affect the growth, reason could be that the less availability of nutrients and osmotic potential cause reduction in flower diameter (Al-Harbi *et al.,* 2002).

Growth, yield, quality and reduction in flower size may occur due to decrease in the ability of plants to take up water from the soil solution and the destruction of soil structure (Barrett-Lennard, 2003). Present study verified this, that flower size of *Gazania* was reduced as salinity levels were increased but the treatment T_0 (control) showed best performance where salinity was not applied. So it could be concluded that optimum levels of salinity is very important in order to get the best flower quality with good marketable size.

Effect of different salinity levels on length of shoot of Gazania

Data pertaining for length of shoot shown in fig.7. Maximum Length of shoot was found in control (20.00cm) while the mean values of other treatments followed by T_1 (19.81cm), T_2 (16.87cm) and T_3 (15.50cm) and the minimum length of shoot was found in plants treated with 100 ppm (14.12cm) solution of salts at LSD value at 0.05 (9.966).

Whereas lower doses have lower effect as compared to higher concentrations on length of shoot. Shoot length is a quality increasing parameter in most ornamental flower. The present study shows the non significant result with different salinity level of NaCl. Similar results were obtained by Lorenzo and Ruano, (2000) studied that the effects of sodium (Na^{+}) ion concentration on shoot elongation reductase in rose plant (*Rosa hybrid* cv. Lambada). They observed that shoot elongation was negatively correlated with sodium concentration and results show statistically non-significant. Ishida *et al.,* (1978) observed that roses are more resistant to salinity than their distinctive arrangement and has been found that average shoot length reduced in rose plants, when grown under salt stress conditions but statistically no difference was found in control and the treatments where the salinity was applied. Similar conditions were seen in present conducted experiment where control T_0 gives better result as compared to treatment where salinity was applied but statistically no significant difference was found.

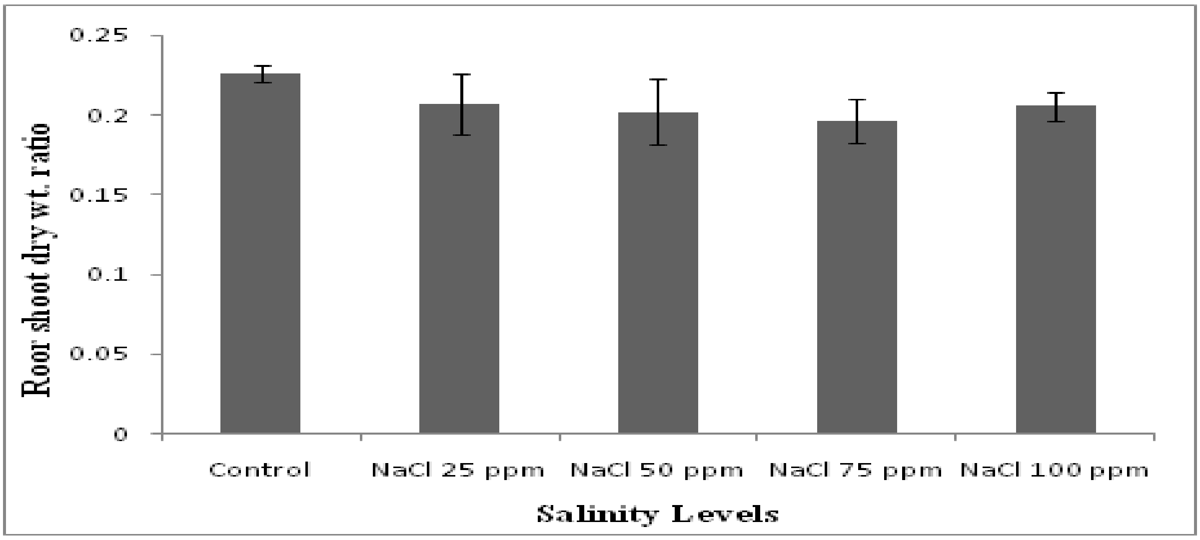

Fig. 14. Effect of different salinity levels on root shoot dry wt. ratio of *Gazania*.

Effect of different salinity levels on length of root of Gazania

Data pertaining to root fresh wt. as affected by various salinity levels presented in fig. 8. Maximum length of root was found in control (19.89cm) while the mean values of other treatments followed by T_1 (17.06cm), T_2 (14.62cm) and T_3 (14.12cm) and the minimum length of root was found in plants treated with 100 ppm (13.12cm) solution of salts at LSD value at 0.05 (1.881). There was statistically no difference in the length of root in those plots where salinity levels were kept 50, 75 and 100 ppm of NaCl salt. These plants produced statistically same length of root in each treatment. While there was a significant difference was found when compare the treatment T_0 (control) with all other treatment where salinity was applied. Whereas lower doses have lower effect as compared to higher concentrations on length of root. There are many findings which indicated that root length was abridged due to saline conditions. Patil and Waghmare, (1984) assessed the plants grown at four salinity levels (20, 30, 40, 60 ESP) for height, number of leaves stem diameter and other different plant parts and root length. Excess salts in the root zone hindered plant roots from withdrawing water from surrounding soil. This lowers the amount of water available to the plant, regardless of the amount of water actually in the root zone (Abu-Shara *et al.,* 1992). Jaleel *et al.*, (2008b) observed that root length of the plants showed a reduction up to 30 % and 53 % under 50 and 100 mM NaCl treatment respectively in comparison with the untreated plants. Same situation was observed in the present conducted experiment where control (T_0) gives better result as compared to treatment with different levels of salinity and statistically significant difference was found.

Effect of different salinity levels on shoot fresh weight of Gazania

Data pertaining to shoot fresh wt. as affected by various salinity levels presented in fig.9. Maximum shoot fresh weight was found in control T_0 (287.50g) followed by T_1 (266.87g), T_2 (261.0g) and T_3 (252.87g) while minimum shoot fresh weight was found in plants treated with 100 ppm (249.63g) solution of salts at LSD value at 0.05 (13.931). There was statistically great difference was found in shoot fresh weight in those pots where a salinity level was not applied and the pots where salinity level were kept 25, 50, 75 and 100 ppm. Whereas lower doses have lesser effect as compared to higher concentrations on plants. The negative effect of salinity on growth was reported by different investigators and different plants due to which fresh weight of *Gazania* is negatively affected due to salt stress (Bry *et al.,* 2000, Wu *et al.,* 2007). When salinity was applied to plants, it affected the metabolism of the plant due to which plant functioned slowly (Al-Harbi *et al.,* 2002). Salt stress caused a significant reduction in the shoot fresh and dry weights. Similar results were obtained by Khan *et al.,* (2006) who conducted an experiment and assessed that the plants growth greatly stress when salt concentration increases up to 150 mM NaCl and the growth of the plants was highly affected and reduced the fresh and dry weight of shoots with compared to control plants where the salinity was not applied. Ishida *et al.,* (1979) who conduct experiment on carnation and found that when Cl^- concentration increase up to 300 ppm cause injury to plant and reduces height and fresh top weight of the flowering plant and flowering was also delayed at higher level of Cl^- (500 ppm). Current study results revealed that fresh weight is reduced when we increased the salt concentration. Treatment T_0 (control) showed best performance.

Effect of different salinity levels on shoot dry wt. of Gazania

Data pertaining to shoot dry weight as affected by various salinity levels presented in fig.10. Maximum Shoot dry weight were observed in control T_0 (90.62g) followed by T_1 (81.62g), T_2 (73.62g) and T_3 (71.87g) while minimum shoot dry weight were counted in plants treated with 100 ppm (64.00g) solution of salts at LSD value at 0.05 (10.447). There was statistically no difference in shoot dry weight in treatment T_0 and in pots where salinity levels was kept 25 ppm of NaCl solution of salt. These plants produced statistically same shoot dry weight as produced in control. Whereas lower doses have lesser effect as compared to higher concentrations on plants. Same results were concluded by Emdad and Fardad, (2000) observed that by increasing the salinity levels it cause retardation in plant growth and development. Therefore due to retardation in growth the plants height and root are not fully developed it reduced dry weight of roots and shoots. Patil and Waghmare, (1984) in an experiment assessed the plants grown at four salinity levels (20, 30, 40, 60 ESP) for height, fresh and dry weight of different plant parts and root length. The results attained for dry weight were significant. As the less water availability and salt stress condition individually applied or in unite form causes considerable decline in an extraordinary decrease of the plant dry material addition (Shaheen and Hood-Nowotny, 2005). Dry weight of *Gazania* was significantly reduced when high salt concentration was applied (Savvas and Lenz, 2000). Current study also confirmed that dry weight was reduced when they were exposed to salt stress. The treatment T_0 (control) showed best performance under saline conditions. Foolad and Jones, (1993) in experiment assessed that quantitative traits influences maximal plant yield and productivity but the plants growth greatly stress when salt concentration increases and therefore it reduces the fresh and dry weight of shoots by increasing salinity levels. Similar conditions were seen in the present experiment where control T_0 gives better result as compared to treatment where salinity was applied.

Effect of different salinity levels on root fresh wt. of Gazania

Data pertaining to root fresh wt. as affected by various salinity levels presented in fig.11. The control (T_0) treatment gave highest fresh weight (79.87g), followed by, T_1 (66.00g), T_2 (59.12g) T_3 (52.75g).

The salinity level of 100 ppm of NaCl (T_4) showed minimum score of fresh weight (49.62g) at LSD value at 0.05 (8.612). There was statistically significant difference was observed in root fresh weight in each treatment. As increased in salinity level there was a significant decrease in root fresh weight as compared to control. Whereas lower doses have lower effect as compared to higher concentrations on root fresh weight. The root with increasing levels of salinity, in the fresh weight of roots levels decreased which indicating the increased osmotic pressure and water absorption. This reports agreed with the results of (Aboutalebi *et al.,* 2008). Mostafa *et al.* (1984) reported that the plant height and fresh weight of root, stems and leaves of *Datura innoxia* significantly decreased when the salinity levels increased up to 0.4 % air dry soils. Patil and Waghmare, (1984) in an experiment assessed the plants grown at four salinity levels (20, 30, 40, 60 ESP) for height, fresh and dry weight of different plant parts and root length. When salinity was applied to plants, it affected the metabolism of the plant due to which plant functioned slowly (Al-Harbi *et al.,* 2002). Current study results revealed that fresh weight is reduced when we increased the salt concentration. Treatment T_0 (control) showed best performance. Dagar *et al.,* (2004) conducted an experiment and assessed that the plants growth greatly stress when salt concentration increases up to 100 mM NaCl and the growth of the plants was highly affected and reduced the fresh weight of roots and shoots by about 25 % and 26 % when compared to control plants where the salinity was not applied. Present study verified this, that root fresh weight of *Gazania* was gradually decreased with increasing salinity levels but the treatment T_0 (control) showed best performance where salinity was not applied.

Effect of different salinity levels on root dry wt. of Gazania

Data pertaining to root dry wt. as affected by various salinity levels presented in fig.12. The control (T_0) treatment gave highest root dry weight (20.50g), followed by T_1 (16.75g), T_2 (14.62g) and T_3 (14.00g). The salinity level of 100 ppm of NaCl (T_4) showed minimum score of root dry wt. of *Gazania* (13.12g) at LSD value at 0.05 (2.849). There was statistically significant difference in root dry weight in treatment T_0 and in pots where salinity levels were kept 25, 50, 75 and 100 ppm. These observations were supported by the findings of Devitt and Morris, (1987) who observed significantly decline in dry weight with increased salinity levels for petunia. Patil and Waghmare, (1984) in an experiment assessed the plants grown at four salinity levels (20, 30, 40, 60 ESP) for height, fresh and dry weight of different plant parts and root length. The results attained for dry weight were significant. Dry weight of *Gazania* was significantly reduced when high salt concentration was applied these results match with study of Savvas and Lenz, (2000). Current study also confirmed that dry weight was reduced when they were exposed to salt stress. The treatment T_0 (control) showed best performance under saline conditions. Emdad and Fardad, (2000) observed that by increasing the salinity levels it cause retardation in plant growth and development. Therefore due to retardation in growth the plants height and root are not fully developed and it reduced dry weight of roots and shoots. Dagar *et al.,* (2004) assessed that the plants growth greatly stress when salt concentration increases up to 100 mM NaCl and the growth of the plants was highly affected and reduced the dry weight of roots and shoots by about 25 % and 26 % when compared to control plants where the salinity was not applied. Current study results revealed that dry weight is reduced when we increased the salt concentration. Treatment T_0 (control) showed best performance as compare to treatment where different salinity levels were applied.

Effect of different salinity levels on root shoot fresh wt. ratio of Gazania

Data pertaining to root dry wt. as affected by various salinity levels presented in fig.13. Treatment means revealed that control T_0 where salinity was not applied secured top position regarding root shoot fresh weight ratio (0.27) followed by T_1 (0.24), T_2 (0.23) and T_3 (0.20) while minimum root shoot fresh weight ratio was observed in plants treated with 100 ppm (0.20) solution of salts at LSD value at 0.05 (.037).

The treatments T_0 and T_1 statistically showed the similar results, but when we compare the results of treatments T_0 and T_1 with the treatment of T_2, T_3 and T_4 showed a statistically significant difference. Lower doses have lesser effect as compared to higher concentrations on plants. Root shoot fresh wt. ratio is negatively correlated with flower diameter, leaf area and plant height. The decrease of total root and shoot weight of *Gazania* was affected relatively by decrease in number of flowers and number of leaves and also related to decrease of the weight per flower. The results are in line with findings of Ishida *et al*., (1979) who conduct experiment on carnation and found that when Cl^- concentration increase up to 300 ppm cause injury to plant and reduces height and fresh top weight of the flowering plant and flowering was also delayed at higher level of Cl^- (500 ppm). Current study results revealed that root shoot fresh wt. ratio give statistically significant results under salt stress condition.

Effect of different salinity levels on root shoot dry weight ratio of Gazania

Data pertaining to root dry wt. as affected by various salinity levels presented in fig.14. As increased in salinity level there was a decrease in root shoot dry weight ratio as compared to control but statistically this decline is non-significant. Maximum root shoot dry weight was found in control (0.22) and the mean values of other treatments followed by T_1 (0.20), T_2 (0.20) and T_4 (0.20) while minimum root shoot dry weight ratio was found in plants treated with 75 ppm (0.19) solution of salts at LSD value at 0.05 (.045). All the treatments statistically non significant because these plants produced statistically same root shoot dry weight ratio as produced in control. The impact of salinity on fresh and dry weight ratio of different plant organs, significant differences were not observed in the treatments, but in the root with increasing levels of salinity, in the fresh and dry weight of roots levels decreased which indicating the increased osmotic pressure and water absorption by the inability of this limb. These findings agreed with the results of (Aboutalebi *et al.,* 2008). Effect of salinity on fresh and dry weight ratio of the root and shoot showed no significant difference as well as in control.

Present study verified that root dry weight of *Gazania* was gradually decreased with increasing salinity levels but the statistically non significant while the treatment T_0 (control) showed best performance where salinity was not applied as compare with other treatments.

Conclusion

Our study clearly evidenced that salt stress situation has decisive result on morphological pattern of plant development. As the salinity level become high then it causes inauspicious effect on morphological individuality of the plant. In five flanked levels of salinity, control level appeared as good treatment without any harmful effects comparatively other salinity treatments. So there is a need to develop the salt tolerant plant varieties of ornamental flower.

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