A STUDY ON SODIUM CHLORIDE'S (NACL) IMPACT ON PEA PLANT (PISUM SATIVUM L.) GERMINATION, GROWTH, AND YIELD

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Abstract

The current research examined the growth, yield, and germination of photosynthetic pigments in Pisum sativum var. P. Arkel under salt stress. NaCl-induced salinity is an abiotic stressor that may lead to metabolic and morphological abnormalities. The plants were subjected to varying concentrations of NaCl in the pot experiment. Data was collected at 65 and 75 days after sowing (DAS). NaCl concentrations of 4 mmhos/cm, 8 mmhos/cm, and 12 mmhos/cm have been shown to affect the morphological and physiological characteristics of peas. In 12 mmhos/cm of NaCl, a significant decrease in salinity-affected plant length, shoot and root biomass, root nodules, and leaf area was noted. Because of the osmotic impact or ion toxicity, higher salinity causes germination to be reduced, delayed, or even completely inhibited. At every salinity level, all growth characteristics, including plant length, leaf number, and leaf area, diminish. Enhanced osmotic pressure caused by salt (NaCl) stress results in decreased germination, growth, and plant production. Plant growth, development, and yield quality are all impacted by the physiological and metabolic disruptions that saline soil causes in plants. Plants under salt stress often have higher levels of proline but lower levels of carotenoids and chlorophyll.

Keywords: Proline stomatal index, Pisum sativum, toxicity, salt stress, and NaCl

Introduction

According to Yildirim et al. (2009) and Qin et al. (2010), salinity restricts plant development and production, making it a major issue in global agriculture. According to Munns et al. (2008), salinity is a significant abiotic stressor that has a significant impact on crop output due to the buildup of Na+ and Clions and nutritional imbalance. Soil salinity affects about 800 million hectares of land, or more than 6% of the Earth's total land area (FAO et al., 2008). In Egypt and other dry and semiarid locations, poor drainage, little rainfall, poor irrigation water that contains salts that build up in the surface layer, high evaporation, and proximity to the sea are some of the factors that contribute to soil salinization (Rady et al., 2013). According to Munns et al. (2002), soil salinity reduces plant growth and production via increasing water usage efficiency and plant metabolism.

Plants cultivated in salinity are essentially stressed in three ways: phytotoxicity of Clions and Na+, decreased rhizopheric water potential, which results in nutrient imbalance and water deficit, and an increase in soluble salts, which slows down the uptake of nutrients and water, leading to osmotic effects and toxicity (Yang et al. 2009; Jiang et al. 2014).

The pea (Pisum sativum) is a significant vegetable legume. Both as a vegetable and as a grain legume, it is eaten. The temperate zone is where it is most often cultivated, with a smaller amount of it found in the colder tropical and subtropical areas during the winter months. The fabaceae family includes Pisum sativum, an annual plant with a one-year life cycle. Determining the degree of Pisum sativum (var. P. Arkel) resistance to salt stress and examining the impact of salinity on germination growth yield and biochemical activity were the goals of this research.

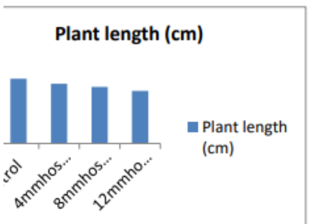
METHOD AND MATERIAL

For consistent germination, the seeds of Pisum sativum (Var.P. Arkel) were surface sterilized for 20 minutes using 20% sodium hypochlorite, washed, and then immersed in sterile water for 1 hour at 4 ′C. In the Agriculture Farm, the seeds were moved to 12 cm plastic pots that were partially controlled and filled with 2.0 kg pot^{-1} of reconstituted soil. The soil was treated with NaCl at concentrations of 4 mmhos/cm, 8 mmhos/cm, and 12 mmhos/cm. Various salinity levels were created using sodium chloride (NaCl) (Richard, 1954). A fully randomized design was used to organize the treatments, and three replications of each treatment were conducted. Atomic absorption spectroscopy is used to determine sodium chloride (NaCl). Plant growth and other indicators were sampled at 65- and 75-days following sowing.

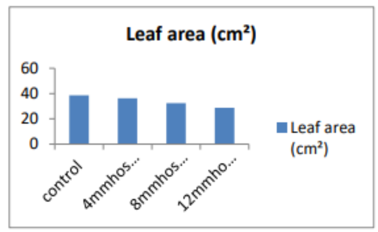
A ruler was used to measure the length of the plants. Using an electronic scale, the fresh and dry masses of the plants were weighed separately, and the leaf area was calculated in accordance with Gabal et al. (1984). Fruit production was determined by counting the number of fruits per plant after 105 days. The Arnon (1949) technique was used to determine the amount of carotenoid and chlorophyll. Using transparent nail paint imprints on the leaf epidermis, stomatal density was investigated using Teare et al.'s (1971) methodology. The Bates et al. (1973) technique was used to assess the proline content of the control and NaCl-treated plants. Under a light microscope, the number of stomata on the adaxial and abaxial surfaces within a cm2 eye piece region (equivalent to 0.41 mm2 of leaf surface) was counted.

RESULT AND DISCUSSIONS: -

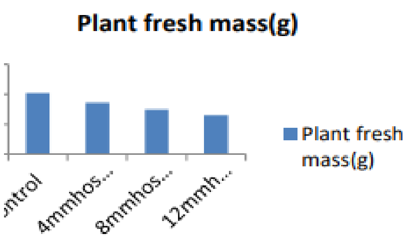
The process by which an organism develops from a seed is called germination. The results indicates that in the chosen variety, P. Arkel, 95% of the seeds germinated in the control. As the salinity level of sodium chloride grew, there was a steady decline in the germination stage; it was observed that a higher dosage of sodium chloride (12 mmhos/cm salinity level) resulted in a greater reduction in seed germination. By altering the osmotic component, or the ionic component, such as the buildup of Na and Cl, salinity may have an impact on germination (ZIVKOVIC et al., 2007). One important element that significantly impacts plant development and metabolism is salt stress. Even when the soil is moist or soggy, plants may show symptoms of dryness because too much salt draws water and prevents it from being absorbed. The plant lengths of the pea plants treated with 4 mmhos/cm to 8 mmhos/cm of NaCl in Figures a. to k.did not differ much from those of the control plants. However, the pea plant's length was greatly decreased by the greater dosage (12 mmhos/cm). The most crucial factors for salt stress are shoot and root lengths because roots directly collect water from the soil, and shoots then allow the plant as a whole to receive it. Because of this, the lengths of the shoots and roots provide crucial clues about how plants react to salt stress. Jamil et al. (2004). The fresh and dry weight of the plant is shown in figures c and d, which also show how the salt treatment at various intervals has influenced the fresh and dry weight. Regardless of variety P. Arkel, the data shows that the control group had a higher fresh and dry weight of plant in comparison to salinity levels of 4 mmhos/cm, 8 mmhos/cm, and 12 mmhos/cm of sodium chloride. The current study's findings support those of other researchers who found that for some plants, plant weight dropped as NaCl salt levels increased (Kaya et al., 2005). As salt stress increased, both fresh and dry biomass decreased, as noted by Badr-uz-Zaman et al. in 2006 and 2010.



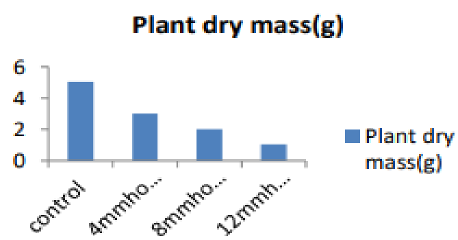
(fig.a)



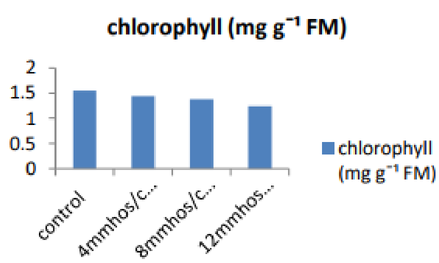
(fig.b)



(Fig. c)

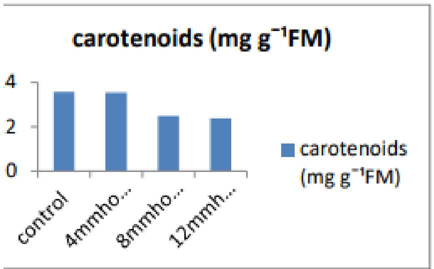


(fig. d)

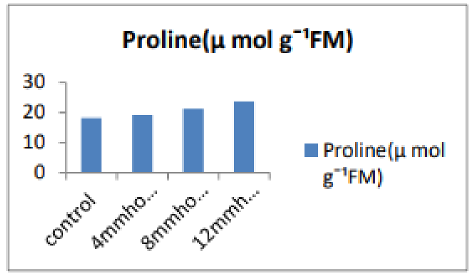


(Fig .e)

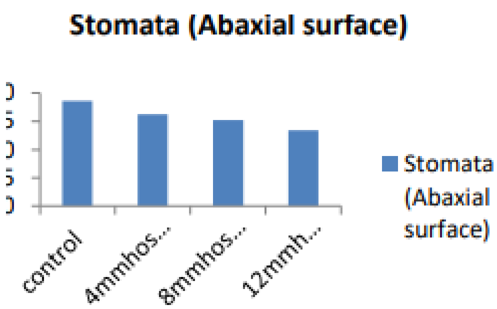
(fig: a to e) shows effect of NaCl treatment (0,4mmhos/cm,8mmhos/cm and 12 mmhos/cm) on plant length(cm),leaf area (cm2),plant fresh and dry mass (g) and chlorophyll (mg g-1 FM) of Pisum sativum (var.Arkel) at 65 DAS.



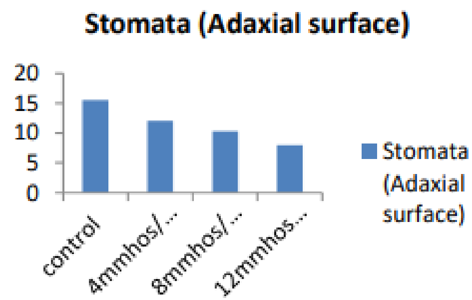
(fig.f)



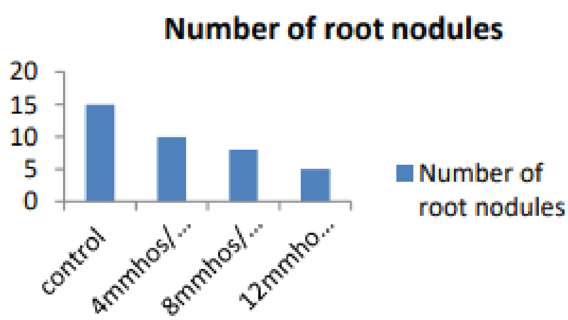
(fig.g)



(fig. h)



(fig. i)



(fig. j)

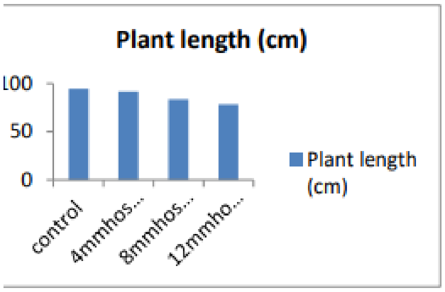
(fig: f to j) shows effect of NaCl treatment (0,4mmhos/cm,8mmhos/cm and 12 mmhos/cm) on carotenoids (mg g-1 FM), proline(µ mol g^{-1}FM),stomata (Abaxial and Adaxial surface), number of root nodules of Pisum sativum (var.Arkel) at 65 DAS.

As the dosage of NaCl was increased, the number of leaves consistently decreased. The leaf size (area) was shown to be the most significantly affected by NaCl. The leaf area decreased in Figures B and L as the NaCl content rose. Hoffman (1981) ascribed leaf damage in salt-affected crops to the particular action of Cl ions, but Ulrich et al. (1980) suggested that it may be caused by the buildup of Na ions in the leaf.

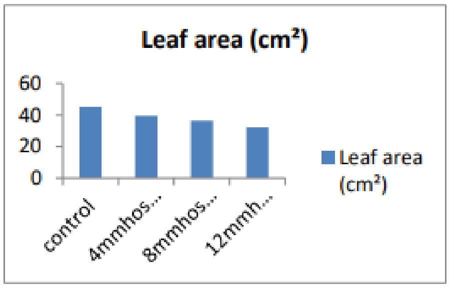
Higher concentrations of NaCl cause a reduction in the amount of chlorophyll (mg g-1 FW). The development stages of 65 DAS (fig. no.e) and 75 DAS (fig. no.o) both showed a decrease in chlorophyll content. At 75 DAS, the amount of chlorophyll in the leaves decreased more than at 65 DAS.

According to a number of studies, plants' ability to withstand salt is indicated biochemically by their chlorophyll concentration. It has been shown that whereas chlorophyll concentrations dropped in salt-sensitive plants, they grew or remained constant in salt-tolerant plants (Stepien and Johonson, 2009; Ashraf and Harris, 2013).

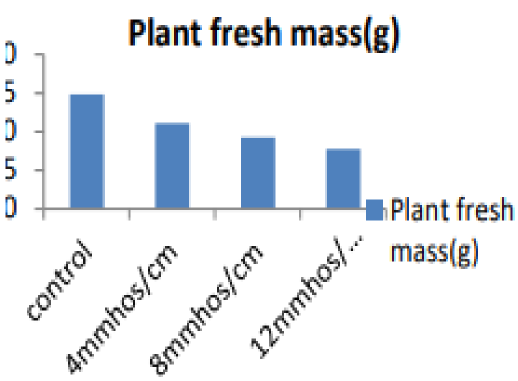
In both leaf surfaces, the stomatal frequency dropped in direct proportion to the varying NaCl dosages. There are more stomata on the abaxial side of the athmosomatic lamina. In both the adaxial and abaxial surfaces, the impact of salt on the number of stomata increased when NaCl was present (fig.h and fig.r). Under saline conditions, osmotic pressure causes stomatal closure and toxic levels of Na+ to accumulate in the cytosol of the cell. This reduces a plant's ability to fully utilize light absorbed by the photosynthetic pigments and causes a variety of reactive oxygen species to form (E. Tavakkoli, et al., 2011).



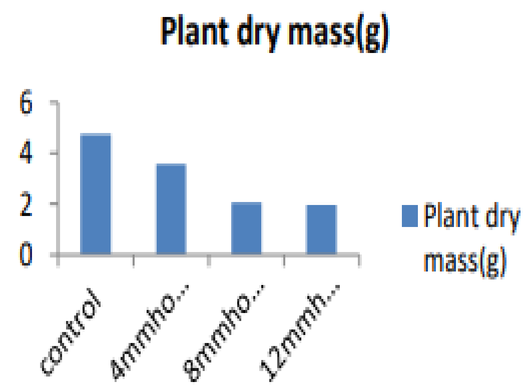
(fig.k)



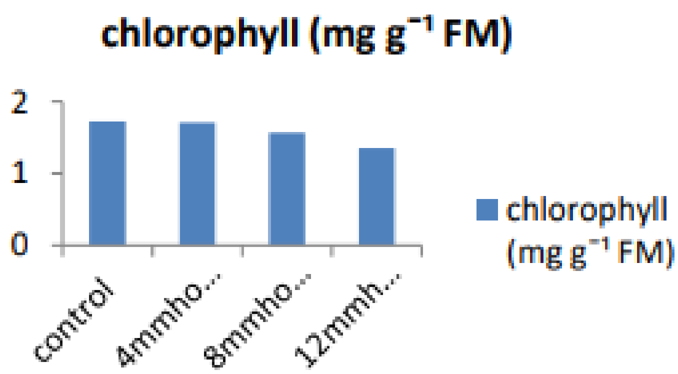
(fig.l)



(fig.m)



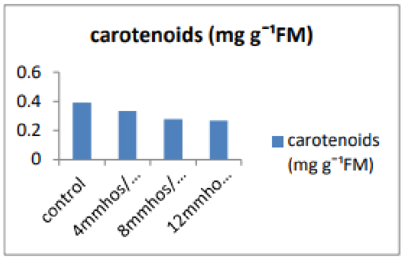
(fig.n)



(fig. o)

(fig: k to o) shows effect of NaCl treatment (0,4mmhos/cm,8mmhos/cm and 12 mmhos/cm) on plant length(cm),leaf area (cm2),plant fresh and dry weight.

Carotenoids (mg g-1 FM) were reduced by NaCl at three distinct concentrations: 4 mmhos/cm, 8 mmhos/cm, and 12 mmhos/cm. The greatest decrease was seen at a level of 12 mmhos/cm (fig.f) as opposed to 4 and 8 mmhos/cm (fig.p), respectively. Through their ability to intercept chlorophyll triplet states, carotenoids are essential in inhibiting the chlorophyllphotosensitized production of O2 (Demmig-Adams and Adams, 1996).



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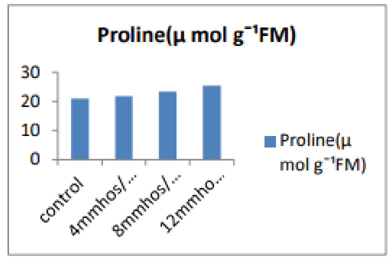
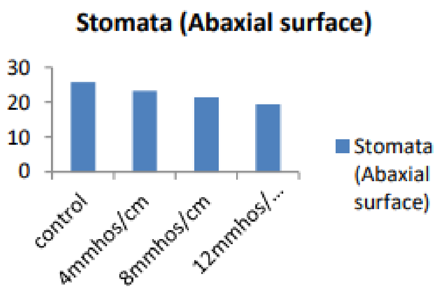
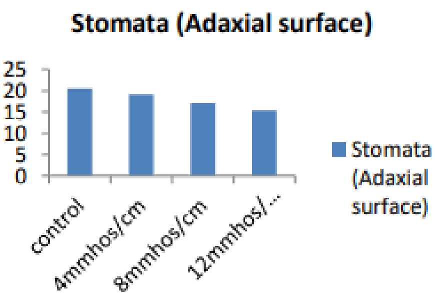


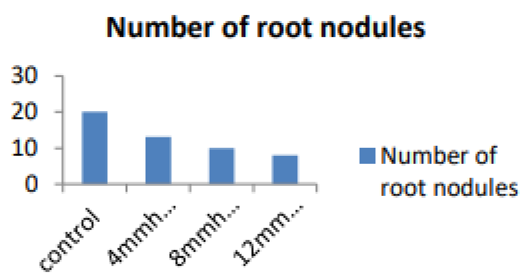
(fig.q)



(fig.r)



(fig.s)



(fig.t)

(fig: p to t) shows effect of NaCl treatment (0,4mmhos/cm,8mmhos/cm and 12 mmhos/cm) on carotenoids (mg g-1 FM), proline(µ mol g^{-1}FM),stomata (Abaxial and Adaxial surface), number of root nodules of Pisum sativum (var.Arkel) at 75 DAS.

One crucial metric for assessing a plant's ability to withstand stress is proline (µ mol g-1 FM). Figures g and q make it clear that adding NaCl to the soil increased the proline content significantly at each development stage in a concentration-dependent manner (0, 4 mmhos/cm, 8 mmhos/cm, and 12 mmhos/cm). In comparison to the control plant, the highest concentration of NaCl (12 mmhos/cm) resulted in the greatest accumulation of proline. Proline accumulation in plants under environmental stress has also been shown (Ahmad and Jhon, 2005; Ahmad et al., 2006; Ahmad et al., 2008). Decreased degradation, de novo synthesis, or both may be the cause of an increase in proline content (Kasai et al., 1998).

The nodule number as influenced by length and treatments is shown in fig. j. In general, after 65 days after planting, the number of root nodules in Pisum sativum (var. P Arkel) was significantly reduced by all salinity levels of sodium chloride. When compared to the corresponding control, the number of root nodules per plant in the chosen cultivar at 65 to 75 DAS was considerably decreased by the salinity level of 12 mmhos/cm salt treatment. The decrease in nodule number and nodule fresh dry mass under salt (NaCl) stress in this research is consistent with the results that have been published (Ashraf and Bashir, 2003).

The plant's yield metrics as impacted by salt treatments are shown in (fig.t). According to the findings, the control group had more pods per plant when compared to the salt treatment at salinity levels of 4 mmhos/cm, 8 mmhos/cm, and 12 mmhos/cm. This may provide a novel strategy to boost yield on saline soils, together with the discovery of the molecular elements in crop species that can be altered to enhance the amount of energy available for harvestable output (Amthor et al., 2019). At moderate to low salinities, changes in growth rate or yield are often the sole outward manifestation of salt tolerance (Shannon, 1985).

CONCLUSION: -

The improvement of photosynthetic qualities at lower salt (NaCl) concentrations indicates that Pisum sativum var. P arkel may withstand stress at lower concentrations. The chosen pea cultivar (Pisum sativum var. P arkel) is susceptible to increased NaCl concentrations. Higher dosages at a rate of 12 mmhos/cm may affect both fruit setting and blooming. It is determined that, in comparison to the control, sodium chloride treatment significantly reduced the number of leaves plant-1, shoot and root length, fresh and dry weights, leaf area, root nodules, photosynthetic pigmens, and stomata numbers in peas (Pisum sativum L.). The elevated proline level indicated that plants under stress were exposed to varying salinity levels, namely 4 mmhos/cm, 8 mmhos/cm, and 12 mmhos/cm.

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