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SALT STRESS EFFECTS ON PLANT GROWTH– A REVIEW

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Abstract: One of the most serious and problematic environmental issues in agriculture is ‘salinization’. This means the process of increasing the salt content. This is clearly visible in soil and water reservoirs. The addition of salt causes crop plants to be unfitted to generate the expected yield. This stress causes the plant to be stunted and yields a low yield. This adverse situation causes changes in plant’s physiology that affect plant’s growth and development that are often negative. Salt content negatively affects many aspects of plant’s growth, including seed germination, morphological parameters, growth and yield. In addition, salt levels affect the amount of carbohydrates, protein and chlorophyll in the plant. The salinity effect has a negative impact on total carbohydrate and protein levels. Plants' photosynthesis reduced when they are exposed to salt. As a result of osmotic and ionic shifts, salinization leads to reduced biomass production at the cellular level and across the plant. The establishment of a plant's stress tolerance can sometimes be aided by the physiochemical changes found in plants. In this paper, an overview of how salinity affects plant growth is presented, as well as modifications or alterations plants undergo when living under salt stress.

Key words: plant**,** salinity, seed germination, plant physiology, biochemical parameters

1. INTRODUCTION

Salt stress is defined as a stress state caused by a high salt content that is adequate to reduce the water potential. Soils classified as salinous have electrical conductivity of 4dS/m or more and interchangeable sodium of 15% within root zone (Munns, 2005; Jamil *et al*., 2011). Specifically in dry and semi-arid areas, salinity is one of the most serious environmental issues affecting plant productivity. The impacts of salinity are particularly noticeable in dry and semi-arid environments, where little rainfall, high transpiration, high temperature have been seen and also inadequate water and soil management techniques are key contributing factors to increase salinity (Azevedo Neto *et al*., 2006). As irrigation demands have increased in dry and semi-arid regions like the Mediterranean over the last 20 years, salt levels in irrigation water and soil have increased, making abiostic stress a huge problem for agriculture around the world. Around 800 million hectares of arable land are affected by soil salinity around the world (Acosta-Motos *et al.*, 2017) which is considerably a high threat to agricultural productivity.

Salinization is caused by naturally occurring capillary water levels rising and then evaporating saline groundwater. Human activities can also contribute to the salinization process. Depending on the conditions, such as the conditions in the atmosphere, the intensity of sunlight and the type of plants, salinity's toxicity varies. A plant's ability to survive in salty environments is determined by its glycophytic status or halophytic status. Another consideration is how a plant responds to salt stress in terms of intake and elimination of ions, osmotic control, CO_2coalescene, photosynthetic electron carriage, reactive oxygen species (ROS) establishment and antioxidant defenses (Tang*et al*., 2015; Munns, 2005; Koyro, 2006; Stepien and Johnson, 2009). The majority of plants' salinity adaptation processes are accompanied by morphological and anatomical alterations(Larcher, 2003).In hight salt environments, commonly known as hypersaline environments, most of crop plant which are glycophytes are incapable of developing and NaCl concentrations of 100 to 200 mM can inhibit their growth and leads to the death of the plant (Munns and Termaat, 1986) but halophytes, may survive in the presence of high NaCl concentrations (300–500 mM) because they have acquired stronger salt resistance mechanisms (Parida and Das,2005; Flowers and Colmer, 2015).

Additionally, high salt levels cause soil pH to rise and negatively impact plants. A high pH environment is not suitable for most plants. Salt stress also degrades soil structure and impairs the optimum air-water balance required for biological processes at plant roots. Crop yields are declining as a result of all the negative effects of salinization and arable land is irrevocably disappearing (Supper, 2003). But higher plants may resist high salinity by either salt exclusion or salt addition, as has been proven (sykes, 1992). By excluding salt from the entire plant or specific organs, salt excluders can help keep high salt concentrations under control, while salt accumulators work in one of two ways to dissolve the salt. Cell membranes of resistant plants can tolerate high amounts of internal salt, which is the first method, while the second is the elimination of excessive salt into the roots where the roots can absorb salt ions without being damaged (Badr and Shafei, 2002).

1.1 Impact of salt stress on plants

Physiological processes in plants are disrupted by salinity, including 1) osmoregulation is disrupted, 2) photosynthesis is disrupted, 3) aerial growth is regulated down due to a long-range signal, and 4) mineral delivery is insufficient. (Negrão *et al.*, 2017).The effects of osmotic and toxic factors on roots inhibit root growth caused by excessive salinity (Bañón *et al.*, 2012).

1.1.1 Salinity and seed germination

When salinity reduces germination in halophytes, the cause is usually osmotic effects, while in non-halophytes; it may be extra ion toxicity. (Bajji *et al.*, 2002). In contrast with non-halophytes, halophytes are able to maintain seed viability in hypersaline conditions and then germinate after the salinity stress is removed (Keiffer and Ungar, 1997).

The rate of seed germination in Tephrosia purpurea is affected by variations in the NaCl concentration. It was found that seeds were sensitive to high salinity levels during germinating stage and a 50mM NaCl concentration improved germination compared to the control. Seed germination is sensitive to high salt concentrations, which results in seed germination being reduced (Sunita K. *et al.*, 2013). The germination of wheat was continually slowed down by 50 to 400mM NaCl, but by 20 to 40mM NaCl no effect was observed. A combination of kinetin and GA, when added to NaCl salinity, it enhances wheat germination (Begum F. *et al.*, 1992).

In alkali sacaton (*Sporobolus airoides* Torr.) germination, magnesium chloride, calcium chloride, mannitol and sodium chloride were all inhibitors and this dependence is greater than that of total salt (Hyder and Yasmin, 1972).

The effects of salinity on plant growth vary by plant species and genotype. As a result, it's critical to keep track of plant species' genetic diversity between genotypes in order to improve salt tolerance (Ashraf *et al.*, 2006; Ranjbar *et al.*, 2012). Furthermore, salt stress has been shown to reduce the percentage of sweet sorghum germination and lengthen the time it takes to germinate (Almodares *et al.*, 2006). Basically, salt has the ability to affect germination by altering water absorption from seed because of the reduced osmotic potential of seed media, which inhibits water absorption and thereby lowers germination (Khan *et al.*, 2006; BAE *et al.*, 2006).

Moreover, the cytotoxic effect of ions may alter enzyme action due to salinity. This disruption of enzyme activity during plant germination might result in an abnormal nucleic acid and protein metabolism as well as hormonal balance to be upset. Additionally, salinity is believed to disrupt the metabolic process of seed germination, thereby decreasing seed use. It increases phenolic content, which interfere with metabolic processes, affecting germination (Promila &

Kumar, 2000; Ryu & Cho, 2015; Othman *etal*., 2006; Dantas *et al*., 2007; Gomes-Filho *et al*., 2008; Khan *et al*., 2006).

1.1.2 Salinity and Plant Physiology

There are a number of ways that salinity affects plant physiology, including increased respiration, ion toxicity, changes in plant development, mineral distribution, membrane instability (Marschner, 1986) and decrease photosynthetic rate (Munns, 2002; Sayed, 2003). From the time of new grown baby plant until adulthood, the plant undergoes significant changes. When subjected to salt stress, the plant cell collapses and dehydrates instantly, but it heals within several hours. Although such progress, cell extension and mitosis are hindered, leading in slowed root and leaf formation. Within a week of the commencement of salt stress, lateral shoot development is affected, and within a month, there are clear differences in overall development and damage among salt-stressed plants and their non-stressed equivalents. The osmotic influence reduces plants' absorbing capacity (Munns, 2005).

Chlorophyll Content

Chlorophyll content, Rubisco action and photosystem performance are all physiological characteristics that determine leaf photosynthetic potential (Flore and Lasko, 1989; Bowes, 1991). With a rise in salinity *Agave americana* (Siler*et al*., 2007) and *Satureja hortensis* (Najafi *et al*., 2010) have lower chlorophyll a and b concentration, as well as total chlorophyll. The reduction in photosynthetic pigments observed in plants grown in saltwater settings may be due to increased decomposition as well as lower synthesis of that pigment (Garsia-Sanchez*et al*., 2002).

Carbohydrates

The total carbohydrate content of fennel was reduced as a result of the saline effect (Abd El-Wahab, 2006). On the other hand, plants treated with NaCl have a larger concentration of soluble carbohydrates as shown on the *Satureja hortensis* (Najafi *et al*., 2010).

Lipids

Salt stress affects plant oil yield and fatty acid biosynthesis, changing fatty acid profile and considered to be important for plant salt tolerance (Malkit *et al*., 2002). It was also revealed that the total fatty acid composition of *Coriandrum sativum* leaves decreased greatly due to salt, and the proportion of -linolenic and lenoleic acids declined significantly as NaCl levels go up (Neffati and Marzouk, 2008).

Proteins

It was reported that Protein content in *Catharanthus roseus* had fallen dramatically, as had NaCl concentrations (Osman *et al*., 2007). Salinity affected chamomile and sweet marjoram had lower levels of soluble proteins (Ali R *et al*., 2007). Proteins that aggregate in plants under salinity stress may act as a storage form of nitrogen that is later re-used, as well as play a function in osmotic regulation (Singh *et al.*, 1987).

Plant Hormones

Auxins, gibberellins, cytokinins, abscisic acid and ethylene are some of the hormones produced by plants (Mehmood *et al.*, 2018). High amount of salt elevates phytohormone levels such as ABA. Abscisic acid modifies salt-induced genes, which are hypothesised to play a significant role in the salt tolerance pathway. Abscisic acid has been found to decrease ethylene synthesis and leaf defoliation during salt stress by lowering the buildup of damaging Cl- ions in the leaves. Jasmonates, which have been suggested to play a key role in salt tolerance, are another plant hormone that accumulates in the presence of salt (Omant *et al*., 2006). Extracellular plant hormonal therapy to salt-stressed plants was found to reduce the negative effects of salinity on crop morphological (leaf area, dry weight), physiological (net photosynthesis, stomatal closure, photosynthetic rate) and yield variables. (Khan *et al.*, 2019; Anuradha and Seeta Ram Rao, 2001).

Conclusion

By changing both osmotic and ionic conditions, salinization affects plant physiology in a way that impacts the whole plant and the cellular level, resulting in reduced biomass production. Salt stress has an adverse impact on the entire plant during virtually every growth stage, including seedling, vegetative and maturation phases. According to several scientific studies conducted by different scientists, salt exposure harms plant growth, which results in significant yield losses for crops. The biochemical parameters of plant such as carbohydrates, protein, lipid and hormones vary depending on plants' species and the level of concentration of salt. When salt levels increase, the amount of chlorophyll and net photosynthesis in most plants declines. While plant breeders and physicists have been successful in creating salt tolerant varieties using a variety of breeding practices such as molecular genetics and biotechnology, it is still necessary to employ multiple mechanisms and integrate the characteristics of ideal plant types in order to develop varieties that are resistant to multiple stresses, while preserving the soil.

REFERENCES

Abd El-Wahab, M. A. (2006). The efficiency of using saline and fresh water irrigation as alternating methods of irrigation on the productivity of Foeniculum vulgare Mill subsp. vulgare var. vulgare under North Sinai conditions. *Res J Agr Biol Sci*, *2*(6), 571-7.

Acosta-Motos, J. R., Ortuño, M. F., Bernal-Vicente, A., Diaz-Vivancos, P., Sanchez-Blanco, M. J., & Hernandez, J. A. (2017). Plant responses to salt stress: adaptive mechanisms. *Agronomy*, *7*(1), 18.

Ali, R. M., Abbas, H. M., & Kamal, R. K. (2007). The effects of treatment with polyamines on dry matter, oil and flavonoid contents in salinity stressed chamomile and sweet marjoram. *Plant Soil and Environment*, *53*(12), 529.

Almodares, A., Hadi, M. R., & Dosti, B. (2007). Effects of salt stress on germination percentage and seedling growth in sweet sorghum cultivars. *Journal of Biological Sciences*, *7*(8), 1492-1495.

Anuradha, S., & Seeta Ram Rao, S. (2001). Effect of brassinosteroids on salinity stress induced inhibition of seed germination and seedling growth of rice (Oryza sativa L.). *Plant Growth Regulation*, *33*(2), 151-153.

Ashraf, M. Y., Akhtar, K., Hussain, F., & Iqbal, J. (2006). Screening of different accessions of three potential grass species from Cholistan desert for salt tolerance. *Pak. J. Bot*, *38*(5), 1589-1597.

Azachi, M., Sadka, A., Fisher, M., Goldshlag, P., Gokhman, I., & Zamir, A. (2002). Salt induction of fatty acid elongase and membrane lipid modifications in the extreme halotolerant alga Dunaliella salina. *Plant physiology*, *129*(3), 1320-1329.

Badr, M., & Shafei, A. M. (2002). Salt tolerance in two wheat varieties and its relation to potassium nutrition. *Journal of Agricultural Research*, *35*, 115-28.

BAE, D., YONG, K., & CHUN, S. (2006). Effect of salt (NaCl) stress on germination and early seedling growth of four vegetables species. *Journal of Central European Agriculture*.

Bajji, M., Kinet, J. M., & Lutts, S. (2002). Osmotic and ionic effects of NaCl on germination, early seedling growth, and ion content of Atriplex halimus (Chenopodiaceae). *Canadian journal of botany*, *80*(3), 297-30

Bañón, S., Miralles, J., Ochoa, J., & Sánchez-Blanco, M. J. (2012). The effect of salinity and high boron on growth, photosynthetic activity and mineral contents of two ornamental shrubs. *Horticultural Science*, *39*(4), 188-194.

Begum, F., Karmoker, J. L., Fattah, Q. A., & Maniruzzaman, A. F. M. (1992). The effect of salinity on germination and its correlation with K+, Na+, Cl− accumulation in germinating seeds of Triticum aestivum L. cv. Akbar. *Plant and cell physiology*, *33*(7), 1009-1014.

Bowes, G. (1991). Growth at elevated CO2: photosynthetic responses mediated through Rubisco. *Plant, Cell & Environment*, *14*(8), 795-806.

Dantas, B. F., Ribeiro, L. D. S., & Aragão, C. A. (2007). Germination, initial growth and cotyledon protein content of bean cultivars under salinity stress. *Revista Brasileira de Sementes*, *29*(2), 106-110.

de Azevedo Neto, A. D., Prisco, J. T., Enéas-Filho, J., de Abreu, C. E. B., & Gomes-Filho, E. (2006). Effect of salt stress on antioxidative enzymes and lipid peroxidation in leaves and roots of salt-tolerant and salt-sensitive maize genotypes. *Environmental and Experimental Botany*, *56*(1), 87-94.

Flowers, T. J., & Colmer, T. D. (2015). Plant salt tolerance: adaptations in halophytes. *Annals of botany*, *115*(3), 327-331.

García-Sánchez, F., Jifon, J. L., Carvajal, M., & Syvertsen, J. P. (2002). Gas exchange, chlorophyll and nutrient contents in relation to Na+ and Cl− accumulation in 'Sunburst'mandarin grafted on different rootstocks. *Plant Science*, *162*(5), 705-712.

Gomes-Filho, E., Lima, C. R. F. M., Costa, J. H., da Silva, A. C. M., da Guia Silva Lima, M., de Lacerda, C. F., & Prisco, J. T. (2008). Cowpea ribonuclease: properties and effect of NaCl-salinity on its activation during seed germination and seedling establishment. *Plant Cell Reports*, *27*(1), 147-157.

Hyder, S. Z., & Yasmin, S. (1972). Salt tolerance and cation interaction in alkali sacaton at germination. *Rangeland Ecology & Management/Journal of Range Management Archives*, *25*(5), 390-392.

Jamil, A., Riaz, S., Ashraf, M., & Foolad, M. R. (2011). Gene expression profiling of plants under salt stress. *Critical Reviews in Plant Sciences*, *30*(5), 435-458.

Keiffer, C. H., & Ungar, I. A. (1997). The effect of extended exposure to hypersaline conditions on the germination of five inland halophyte species. *American Journal of Botany*, *84*(1), 104-111.

Ḵẖān, M. A., Khan, M. A., & Weber, D. J. (Eds.). (2006). *Ecophysiology of high salinity tolerant plants* (Vol. 40). Springer Science & Business Media.

Khan, N., Bano, A., Rahman, M. A., Rathinasabapathi, B., & Babar, M. A. (2019). UPLC‐HRMS‐based untargeted metabolic profiling reveals changes in chickpea (Cicer arietinum) metabolome following long‐term drought stress. *Plant, cell & environment*, *42*(1), 115-132.

Koyro, H. W. (2006). Effect of salinity on growth, photosynthesis, water relations and solute composition of the potential cash crop halophyte Plantago coronopus (L.). *Environmental and Experimental Botany*, *56*(2), 136-146.

Larcher, W. (2003). *Physiological plant ecology: ecophysiology and stress physiology of functional groups*. Springer Science & Business Media.

Marschner, H. (1986). Mineral nutrition of higher plants. Acad. Press. *Inc. London, LTD*.

Mehmood, A., Hussain, A., Irshad, M., Khan, N., Hamayun, M., Ismail, ... & Lee, I. J. (2018). IAA and flavonoids modulates the association between maize roots and phytostimulant endophytic Aspergillus fumigatus greenish. *Journal of plant interactions*, *13*(1), 532-542.

Munns, R. (2002). Comparative physiology of salt and water stress. *Plant, cell & environment*, *25*(2), 239-250.

Munns, R. (2005). Genes and salt tolerance: bringing them together. *New phytologist*, *167*(3), 645-663.

Munns, R., & Termaat, A. (1986). Whole-plant responses to salinity. *Functional Plant Biology*, *13*(1), 143-160.

Najafi, F., & Khavari-Nejad, R. A. (2010). The effects of salt stress on certain physiological parameters in summer savory (Satureja hortensis L.) plants. *Journal of Stress Physiology & Biochemistry*, *6*(1), 13-21.

Neffati, M., & Marzouk, B. (2008). Changes in essential oil and fatty acid composition in coriander (Coriandrum sativum L.) leaves under saline conditions. *Industrial crops and products*, *28*(2), 137-142.

Negrão, S., Schmöckel, S. M., & Tester, M. (2017). Evaluating physiological responses of plants to salinity stress. *Annals of botany*, *119*(1), 1-11.

Omamt, E. N., Hammes, P. S., & Robbertse, P. J. (2006). Differences in salinity tolerance for growth and water-use efficiency in some amaranth (Amaranthus spp.) genotypes. *New Zealand journal of crop and horticultural science*, *34*(1), 11-22.

Osman, M. E., Elfeky, S. S., El-Soud, K. A., & Hasan, A. M. (2007). Response of Catharanthus roseus shoots to salinity and drought in relation to vincristine alkaloid content. *Asian Journal of Plant Sciences*.

Othman, Y., Al-Karaki, G., Al-Tawaha, A. R., & Al-Horani, A. (2006). Variation in germination and ion uptake in barley genotypes under salinity conditions. *World Journal of Agricultural Sciences*, *2*(1), 11-15.

Parida, A. K., & Das, A. B. (2005). Salt tolerance and salinity effects on plants: a review. *Ecotoxicology and environmental safety*, *60*(3), 324-349.

Promila, K., & Kumar, S. (2000). Vigna radiata seed germination under salinity. *Biologia Plantarum*, *43*(3), 423-426.

Ranjbar, G. H., Cheraghi, S. A. M., & Banakar, M. H. (2008). Salt sensitivity of wheat at germination stage. *Crop and Forage Production using Saline Waters in Dry Areas. New Delhi: Daya Publishing*.

Ryu, H., & Cho, Y. G. (2015). Plant hormones in salt stress tolerance. *Journal of Plant Biology*, *58*(3), 147-155.

Sayed, O. H. (2003). Chlorophyll fluorescence as a tool in cereal crop research. *Photosynthetica*, *41*(3), 321-330.

Šiler, B., Mišić, D., Filipović, B., Popović, Z., Cvetić, T., & Mijović, A. (2007). Effects of salinity on in vitro growth and photosynthesis of common centaury (Centaurium erythraea Rafn.). *Archives of Biological Sciences*, *59*(2), 129-134.

Singh, N. K., Bracker, C. A., Hasegawa, P. M., Handa, A. K., Buckel, S., Hermodson, M. A., ... & Bressan, R. A. (1987). Characterization of osmotin: a thaumatin-like protein associated with osmotic adaptation in plant cells. *Plant physiology*, *85*(2), 529-536.

Stepien, P., & Johnson, G. N. (2009). Contrasting responses of photosynthesis to salt stress in the glycophyte Arabidopsis and the halophyte Thellungiella: role of the plastid terminal oxidase as an alternative electron sink. *Plant physiology*, *149*(2), 1154-1165.

Sunita, K., Srivastava, M., Chaturvedi, R. K., & Abbasi, P. (2013). Impact of salinity on seed germination in Tephrosia purpurea L. *Global J. Sci. Res*, *1*(1), 14-18.

Supper S (2003). Verstecktes Wasser. Sustainable Austria, Nr. 25 December

Sykes, S. R. (1992). The inheritance of salt exclusion in woody perennial fruit species. *Plant and Soil*, *146*(1), 123-129.

Tang, X., Mu, X., Shao, H., Wang, H., & Brestic, M. (2015). Global plant-responding mechanisms to salt stress: physiological and molecular levels and implications in biotechnology. *Critical reviews in biotechnology*, *35*(4), 425-437.