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Effect of Salinity Stress on Growth, Yield and Quality of Roses: A Review

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Abstract

Soil salinity is one of the most important abiotic factors that adversely effect on plant growth. In addition, nursery and greenhouse industry is under pressure to recover and recycle fertilizer solution and wastes. Most of these contains significantly higher salt concentrations that could cause harm to susceptible species of plants. Rose plants are the most attractive plants in all our world. Although, the roses face serious salt stress. Globally, soil salinity is naturally occurring or by the usage of poor quality of water and the other activities of humans or use of excessive amount of fertilizer applications. Although, the level of salts tolerance among various cultivars and species can be different in roses. In this review paper, we will discuss the responses of roses to salinity and ways to combat salinity in roses production.er.

Keywords: Soil; Salinity; Roses; Production; Measures

Introduction

Salinity occurred when higher amount of salts concentrations found or dissolve in soil solution and water. Soil salinity is major issue in semi-arid and arid areas. However, the high soil salinization is a basic issue in semi-arid arid regions where the irrigation water is frequently practiced, and evapotranspiration is regularly greater higher than the quantity of the irrigation water. Globally, approximately forty-five million ha of the irrigated area is salt affected and causes an expected loss of US$ 27.3 billion per annum to agribusiness department [1-11]. The bad quality irrigation is the basic reason of salinity in soil [1-30]. The salt concentration in root zone decrease quantity of available water for plant and encourage the abscisic acid synthesis. The abscisic acid is transferred to the guard cells, permute to stomatal cessation and therefore, reduction in photosynthesis which rapidly effect and decrease the developmental rates [13]. Moreover, reduction in photosynthetic activity is also affected by structure and altered chloroplasts due to their venomous effect of variation in concentrations of Cl^- or Na^+ ions [31]. The information about salinity tolerance species is virtual for the reason that numerous crop varieties are cultivate globally regions including numerous surrounding conditions.

Rose plants are widely cultivated and the supreme imperative crop among other ornamental crops. They are cultivated for aesthetics purpose, but numerous species of roses have important pharmaceutical values. There are many cultivars and species available that are cultivated in various environments across the world. In these conditions, roses are persistently uncovered in accordance with quite a few unfavorable conditions, such as salinity. However, the salinity stress tolerance rates are still not determined among different rose species [4]. Therefore, present review is designed to study the response of roses to salinity and ways to combat salinity in roses production.

Effect of salinity on growth and yield of roses

Salinity is the main abiotic factor that decrease the vegetative growth and yield by causing hyperosmotic and hyperionic effects on soil rhizosphere. [15] studied the influence of *Rosa rubiginosa* plant against saline environment and reported that the plants lose its ability of water uptake due to accumulation of salt in leaf water and leaves started to dry. The increase in salinity level leads to significantly reduction in height of Kardinal (Rose) [3]. [10] conducted a trial to study the effects of different salinity conditions on Rosa geranium leaf (*Pelargonium graveolens* L) and reported that as salinity started plants immediately developed capitate trichome density however, rose geranium have some degree of resistance against salinity stress. [23] conducted a research to study the response of carnation plants against saline

and reported that when plants were injected by different strains, *Glomus intradices* showed tolerance against saline environment. Furthermore, color of leaves, flowers, size of flower, number of flower and plant growth were also improved by the combination of injected mycorrhiza with adequate saline concentration. [32] investigated the resistance response of Taif Roses against the salinity in the presence of gibberellic acid and results indicated that relative water, plant height, leaf area, stem dry weight, number of branches and leaf area decreased due to saline conditions whereas application of gibberellic acid reduce the bad effect of saline conditions. Furthermore, gibberellic acid enhanced the tolerance of plants against salinity and provide high activity of antioxidant enzyme preventing the ions homeostasis.

[33] conducted a research to study the response of pomegranate (*Punica granatum* L. CV 'Rabbab') against salinity levels. Results indicated that increased salinity level reduced surface area of leaf, number of internodes and stem length. They concluded that salinity stress can reduced with exogenous polyamines. [34] examined the effects of various salinity levels on freesia and observed reduction in stem length of flower, number of flowers, flower diameter and the spike length under various salinity levels. [21] conducted a research trail to evaluate the effect of saline conditions (NaCl) on rose plant. They reported that increased salinity level influenced dry weight of plant and indicated that K^+ up take process by the plants remain unaffected if the NaCl present in high amount. [24]studied the effect of saline resistance rootstocks of roses to various salinity levels. All rootstocks were survived at control 1.6, 3.0 and 6.0dS/m and the rate of survival of *Rosa odorata* was higher as compare to other two rootstocks. The survival rate of all three rootstocks were less than 30% at 9.0dS/m. All the rootstocks showed best survival and the great growth at control. [6] conducted a research trail to check the tolerance response of carnation (*Dianthus caryophillus*) and rose (*Rosa hybrida)* against salinity and recommend that never to cultivate them in tuff medium. [25] examined the effect of saline stress on stems elongation of *Rosa hybrid* L 'kardinal' and stated that elongation rate of rose flower reduced by increase in saline environment. Moreover, if rose plants treated with 10mM or 9.5dS m^{-1} salt NaCl daily bases the biomass was not changed but reduced stem length. The growth of multi-cut roses reduced due to high salt NaCl concentrations and badly effect root and shoot. Moreover, under greenhouse conditions some plant species tolerate against salinity but at high salt concentration tissues started to die. [27] conducted a research to estimate the response of bulb species and cut Roses against the saline environment and reported that root and leaf weight of bulbous species was significantly improved due to the saline conditions whereas herbaceous plants were badly affected. [29] reported that chrysanthemum and carnation Roses had low resistance against salinity. However, Hippeastrums and gerbera showed medium and anthuriums showed high sensitivity against salinity stress. Moreover, nutrient uptake of plants varied from specie to specie under saline conditions.

[6] conducted the experiment to check the impact of three level of saline irrigations on rose quality and yield of the red rose rootstocks (*Rosa canina*, Natal Briar and *Rosa indica*) and three cultivars of carnation Diana, Chad and Voyore, in two planting media, volcanic rock (tuff) and soil. Significantly size of flower was larger, flower stems were thicker and longer, number of nodes were higher, fewer blind shoots and longer internodes were created on first red rose cultivar after graft on Natal Briar rootstock treated with irrigation frequencies. Usually, better stem and flower (longer and thicker flower stalk, larger flower size, longer internodes, higher number of nodes, length and diameter) these three cultivars were developed using this saline water in the soil than in tuff. When saline water is available for irrigation, it is recommended to grow these cut flower plants in soil rather than in tuff medium. [2] conducted an experiment to check the quality of rose and bulb in tuberose to acidic environment. Varied salinity levels have been placed and two cultivars of tuberose (C_1= single and C_2= double) was used and they reported that tuberose was susceptible to soil salinity. They observed diameter and length of spike, number of florets per spike, number of spikes per plant, weight of bulb and number of underground bulbs; In controlled conditions both cultivars performed better. They also concluded that the soil salinity had adverse impact on the both single and double cultivars, but the single cultivar proved to be highly *sensitive than double cultivar to soil salinity.* [5] conducted a trail to check the impact of saline stress on growth parameters and leaf water retention and reported that plants under water and saline stress situations exposed the early reduction in leaf expansion and lower biomass, both stresses favored significant degree of stomatal regulation. [35] conducted an experiment to investigate the response of six garden roses ('Carefree Delight', 'Caldwell Pink', 'New Dawn', 'Marie Pavie', 'The Fairy' and 'RADrazz') against salt stress. The numbers flowers were reduced at maximum and moderate level of salinity in all of the cultivars except 'RADrazz' and 'New Dawn'. No. leaf stomatal conductance alterations were founded in 'RADrazz', 'The Fairy' and 'Marie Pavie'. The six rose cultivars reacted to increased salt stress in a different way.

Effect of salinity on yield and quality of Roses

Saline conditions decreased the number of flowers in Amarillo and delay time in flowering but yield of flowers was not significantly affected [36]. [34] determined the effects of various saline conditions on freesia and observed reduction of flowers yield, cormel yield, quality of cormel. [37] conducted an experiment to evaluate the effect of different levels of salts on Cucurbits family and reported that yield decreased significantly at higher level of salinity. They also observed that increasing salinity reduced crude protein, firmness but amino acid significantly improved with increasing saline conditions. [26] conducted the research trial to evaluate the impact of salinity on greenhouse roses and concluded that leaf K remain same under salinity stress of $CaCl_2$ and NaCl while the plants treated with KCL leaf K

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proportion increased due to increase in KCL in salt concentration. [7] examined different levels of salt stress on fruit quality of tomato (*Solanum lycopersicum* L.) and reported that moderate saline conditions improved outer side and inner flesh fruit in soilless medium. They also determined that higher salt levels stimulated the accretion and changes in fruit quality and metabolites.

[28] conducted a research trail to check the effect of salinity on rose plants (Kardinal) and revealed that K and NO_3 allowed the plant to change percentage of shoot nutrients and also altered leaf area. The roses chlorine amount was increased by high salinity [38]. [14] reported that plants treated with salinity produced half yield per plant as compared to control. However, pollen fertility was not significantly affected at higher salinity level. The increase in saline conditions decreased the marketable features, appearance, yield and quality of *Cucumis melo* L. [22]. [39] reported that if applications of HCO^-, Na^+ and Cl^- increases in soil and concentrations of Na^+ and Cl^- increases in the leaves than the plants produce low quality flowers. [16] conducted the research trial to determine the impact of salinity on performance, quality and yield of cut flowers and stated that osmotic upset, various physiological variations occur in, transpiration, stomatal conductance, chlorophyll content, photosynthesis, leaf and root expression change significantly. Therefore, reduction in quality of flower (size, color, length and stem thickness) and yield also be ascertained.

[19] conducted an experiment to determine the impact of a various mixture of inorganic salts on quality and physiological features of the cut flowers of Perpetual Carnation and reported that, the cut flowers placed in solution of inorganic salts showed significant variations in physiological and morphological appearances as compared to control conditions. Additionally, modifications in fresh weight, cell membrane permeability and malondialdehyde, flower diameter showed an accumulative movement first and then reduce. A downward trend was observed to the value of water balance. [8] conducted an experiment to investigate the effect of salinity stress on various physiological morphological characters of miniature rose (Rosa chinensis ***Jacq. var. minima*** Rehd.) and revealed that salt stress decreased the number of leaves and flowers, plant height, root- shoot dry weight, flower diameter, chlorophyll index, leaf area, quality and chlorophyll however, leaf ion leakage was improved. [40] conducted the research trial to evaluate the quality, yield and nutrient uptake of 'Bridal Pink' on (*R. manetti* rootstock) roses under NaCl salts and various NH_4 or NO_3 salts. They reported that roses are often more salt tolerant than their traditional sensitive classification.

[20] carried out a research to check the growth and nutrient uptake of ground cover shrubs: Cotoneaster ''Ursyno´ ***w,'' Cotoneaster*** horizontalis, Potentilla fruticosa, Spiraea ''Grefsheim,'' and ''Longacre,'' at various soil salt stress and concluded that resistance species such as Cotoneaster horizontal and Potentilla fruticosa shown significant tolerance against with salinity stress.

Approaches to combat salinity stress in Roses

[41] conducted an experiment to determine the impact of boron concentration to improve yield and growth of cut roses (*Rosa hybrida* L.) under salinity stress and reported that boron (B) concentration decreased the salt stress and influenced rose plants by developing relative water, soluble carbohydrate contents which keeps the osmotic ability that is important for plants to tolerate under salinity stress. Moreover, maintenance of ions in nutrient solution including adequate concentration of boron application will help rose plants to cope salt stress threat. [42] conducted the pot experiment to determine the effective microorganisms (EM) and humic acid (HA) on flowering and chemical composition of Chinese hibiscus (*Hibiscus rosa-sinensis* L.) and under saline conditions (CaCl2 (1:1, w/w) and NaCl). They observed that root growth and vegetative characters were reduced with the application of high salts, but they were slowly increased by increasing the rate of application of both EM and HA bio-stimulants regardless degree of salinity. [18] studied the role of potassium in improving resistance to salinity stress in Chinese roses (Rosa chinensis) and reported that high salt stress concentrations adversely affected on rose ion balance and growth, salts stress had the significant effect on relative leaf water deficit. In stem and roots, rose plants consumed Cl and Na ions and in leaves Mg, Ca and K; moreover, the damage to the leaves was still caused by higher Mg, Na / Ca / Na and especially Na / K ratio. Increasing application of Na and declining proportion of Na / K adversely affected dry matter development. However, for saline water irrigation, soluble potash should be used to enhance the uptake K, in order the effect of high Na concentrations in this soil should be better countered.

[21] conducted a trail to investigate the impact of NaCl on absorption of potassium and nitrate by roses and development of anticipating uptake reduction base on concentrations of $NO3^-$, NaCl and K^+. They reported that empirical models may help for decision taking similarly: NO_3 modification NaCl based fertilization, need for water desalination, or fixing the desired leaching fraction. [9] conducted the research trial to check the possible useful effect of silicon on flower quality, growth and yield to check the toxic impacts of NaCl salts on roses and stated that high application of NaCl in root zone reduced the roses mass, stem length, average flower volume and number of flowers. High production of Si significantly increased growth of roses enhanced the whole quality of the plants which leads to higher number of commercial flowers at low salt stress. [43] conducted a research trail to determine the combined impact of salinity and high concentration of CO_2 on 'Sonia' rose and reported that plants stopped growing when apply salts. At high CO_2 tolerance of salt stress is improved.

Effective watering systems can also be used to reduce the stress of salt and reduce the risk of saline water on salt-sensitive plants. An example of this is the drip irrigation system, it has

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many advantages for plant development by providing sufficient humidity and holding soil salinity at low level. This system of irrigation is indicated to reclaim saline soils [44]. The usage of salty water for Rosa chinensis' drip irrigation has decreased salts to leached down throughout the mechanism of reclaiming saline littoral soils [17]. Many roses plants are produced at commercial level by grafting with resistance rootstocks. The salt resistance rootstocks play a significant role in preventing damages in rose quality and yield under salinity stress [35,38,45].

Conclusion

It is concluded from the review that roses production is negatively affected due to salinity but proper measures and uses of salt tolerant root stock can reduce some losses. Moreover, more salt tolerant rootstocks need to be identified and selected for cultivation in saline areas. Additionally, water and nutrient management may be used to alleviate some aspects of salt stress.

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