Review

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The Influence of Salinity on Plant Growth and Amendment Strategies

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Abstract: Salinity is a significant environmental issue that poses serious risks to agriculture globally. Crop yield is restricted by salt stress due to industrial expansion and/or habitat use. Agricultural land is disappearing at an alarming rate as the global population grows. Meeting the demand for food necessitates utilizing salt-affected areas. Reduced plant productivity is caused by substantial osmotic stress and nutritional disruption in plants growing in salinity stress conditions. Under salinity stress, plants exhibit a variety of reactions that alter their morphology and biochemistry. Modifying the damaging impacts of salinity on plant growth and yield requires a thorough understanding of how plants respond to salt stress as well as inclusive management approaches of physiological and biochemical features. Several studies on how plants respond to salt stress have underscored the significance of integrating multiple strategies to address the issue of salinity. This work will concentrate on the physiological and morphological changes in plants exposed to salinity, along with an outline of suitable methods for modifying plant tolerance and adaptability to salt stress.

Keywords: Salt stress, Antioxidants, Proline, Plant growth, *Trichoderma*.

1. Introduction

Salinity is a general issue in many irrigated arid and semi-arid regions of the world where rainfall is inadequate to remove salts from the root zone [1]. Saline soils are those that have enough salt in the root zone to delay crop plant growth. It is demanding to identify saline soils properly, nevertheless, because salt harm varies according to species, variety, growth stage, ambient conditions, and salt nature [2]. Na^+, Ca^{2+}, and Mg^{2+} are typical cations linked to salinity, whereas Cl^-, $SO4^{2-}$, and HCO^{3-} are common anions. But Na^+ and Cl^- ions are thought to be the most significant since they are harmful to plants and Na^+ deteriorates the soil structure [3]. The direct impact of salts on plant growth can be broadly classified into three levels, according to Carvajal et al. (1999) [4]: (i) a decrease in the soil solution's osmotic potential, which lowers the amount of water available to the plants; (ii) a deterioration in the soil's physical structure, which reduces water permeability and soil aeration; and (iii) an increase in the concentration of specific ions, which have an inhibitory influence on plant metabolism. The increase in specific ions can disrupt solute balances, damage membranes, or change the concentration of nutrients. Particular signs of plant damage include color shift, tip-burn, marginal necrosis, and succulence, which are particularly noticeable in leaves. Additionally, enzyme activity, unbalanced mitosis, and seed germination can all be impacted by salt stress on plants [5]. Thus, this review's goal is to investigate how salt affects plant growth and how management strategies can lessen salinity's negative impacts.

2. Plant Responses to salinity stress.

Plants demonstrate differential responses to NaCl salt which is efficiently expressed into physiological aspects adopting or lightening NaCl stress [6,2]. Figure 1 illustrates the plant responses under NaCl salt [1]. The initial response of plants subjected to high soil salt concentration is the slow growth of leaves. In conditions of low NaCl salinity, the growth of roots tends to be less influenced compared to the growth shoots, increasing root/shoot ratio [1]. The plant illustrates a considerable decrease in dry weight due to a reduction in shoot & root growth under higher NaCl [7]. Van Zelm et al. (2020) [8] stated that growth inhibition may result from declining rates of new cell creation. The decrease in the dry weight may be ascribed to the cell wall becoming more rigid as a result of the structure of the cell wall being changed by salinity. Osmotic stress, which results from salinity, impairs cell ion homeostasis by increasing the build-up of sodium and chloride and inhibiting the uptake of vital nutrients like potassium [9]. Under NaCl stress, a higher absorption of Na^+ competes with the uptake of other nutritional ions, particularly K^+, resulting in K^+ deficiency and a decreased K^+/Na^+ ratio [6]. Significant alterations in the physiological and biochemical individualities of NaCl-stressed plants are also obvious, including decreased levels of chlorophyll in the leaves, decreased protein biosynthesis, increased reactive oxygen species buildup, increased accumulation of compatible solutes like proline, and altered antioxidative enzyme activities [1,2].

3. Influences of salinity stress on physiological and biochemical processes

Depending on the degree and duration of the stress, salinity stress causes modifications in several biochemical and metabolic activities, which eventually inhibits crop development and productivity. By raising the soil osmotic potential and certain ion toxicities in the soil, excessive soluble salt concentrations have an impact on the biochemical characteristics of plants. Under salt stress, a variety of biochemical characteristics are significantly impacted, including the amount of chlorophyll and the buildup of osmotic solutes within cells.

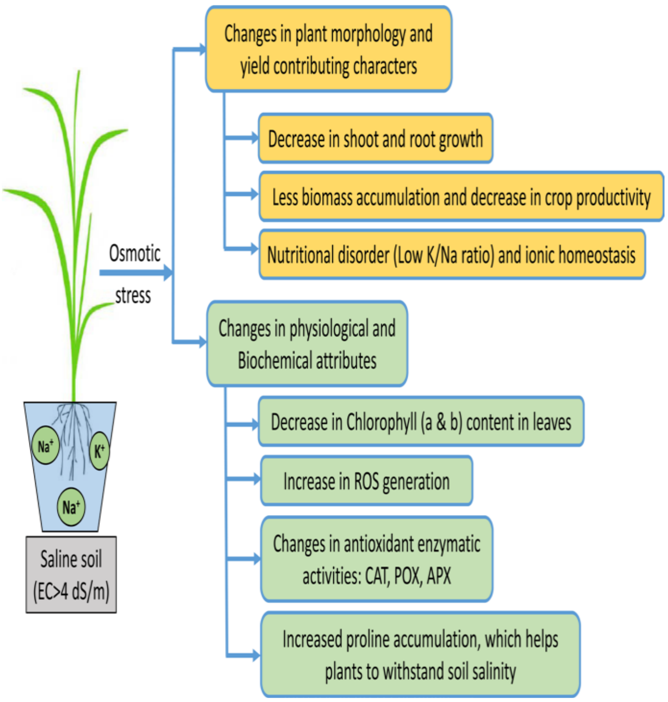

Fig. 1 represents the plant responses under salinity conditions [1].

3.1. Chlorophyll content

The most crucial element in photosynthesis is chlorophyll, and the amount of chlorophyll in plant leaves determines how quickly photosynthesis proceeds. A decrease in leaf photosynthetic capability is frequently linked to the productivity reduction that has been seen in many plant species that are stressed by salt [10]. Amirjani (2011) [11] demonstrated that the first noticeable sign in plants under NaCl salt is a decrease in the amount of chlorophyll in their leaves. Plants' ability to withstand salt affects link with how chlorophyll is changed in their leaves. Genotypes that are salt-tolerant demonstrated less chlorophyll loss than genotypes that are more susceptible to salt [12]. The lessening in chlorophyll content in salt-stressed plants is a characteristic sign of oxidative stress [13] and was appropriate to the inhibition of chlorophyll biosynthesis, collected with the stimulation of its degradation by chlorophyllase [14]. A decrease in chlorophyll levels, as a result of either slow biosynthesis or fast degradation, demonstrated that there was a photoprotection through lowering light absorbance by declining chlorophyll levels [15].

3.2. Complementary solutes accumulation

Complementary solutes are a class of chemically varied organic molecules that are produced by plants and, even at large concentrations, do not disrupt cellular metabolism [16]. A few examples of these suitable solutes are the amino acid proline, sucrose, and glycinebetaine [1]. These compounds protect cellular structures by continuously bringing in water to preserve osmotic equilibrium within the cell since their increase is balanced to the outside osmolarity [3]. Taxonomically different groups of plants accumulate proline under abiotic stress [17]. One of these compounds with several functions is proline, an amino acid that builds up in response to various forms of abiotic stress [18]. Overproduction of proline in salt-stressed plants contributes significantly to the plant's ability to tolerate NaCl [19]. This metabolite plays a variety of protective roles, such as balancing the redox status, maintaining the cytosolic pH, stabilizing protein structure, stabilizing cellular structure, reducing damage to the photosynthetic apparatus, and participating in stress signaling, which in turn influences adaptive responses [20,18]. In addition to its osmoprotective properties, it also serves as a solute in salinity stress and water deficit stress by decreasing leaf water potential, optimizing water uptake, and/or minimizing transpiration [21,22]. In addition to amino acids, plants under salt stress often accumulate sugars for example starch [23]. Under salt stress, plants accumulate carbohydrates that are crucial for osmoprotection, carbon storage, and reactive oxygen species scavenging. NaCl stress raises the concentration of reducing sugars (fructose & sucrose) in plants and shields them from osmotic damage caused by abiotic stresses like salt in the soil [1].

3.3. Production of reactive oxygen species (ROS)

Reactive oxygen species generation is one of the metabolic alte rations that occur in plants under biotic or abiotic stresses [24,25]. ROS are extremely reactive and can initiate oxidative injury to lipids, proteins, and nucleic acids, which can severely disrupt normal metabolism in the absence of any protective mechanisms [26]. ROS such as singlet oxygen, hydroxyl radical (OH−), superoxide radical, H_2O_2, and others, are potent oxidizers that can be harmful to the structural integrity of cells [27]. ROS can disrupt normal metabolism by peroxidizing membrane lipids, which is the first target of many stressed plants [27]. In salt-stressed plants, peroxidation of lipid membranes may result in structural changes for instance the denaturalization of protein and nucleic acid. Zhang et al., (2007) [28] recognized that cellular membrane lipid peroxidation reactions may be a significant factor in radical-mediated cell damage. Consequently, the level of toxicity to salt-stressed plants may be effectively determined by the activity of antioxidative enzymes. One of the main impacts of salt stress is osmotic stress, which can be caused by significant variations in soil salinity. These free radicals and other oxygen-derived compounds that are active may unavoidably arise as byproducts of physiological redox processes. High ROS levels have the potential to deactivate enzymes, harm essential cellular components, cause growth reduction in plants, and ultimately result in their death [26,29].

3.4. Enzymatic antioxidants

Plants have established several defense methods to counteract the harmful effects of salt on metabolism in plants [30]. Plants have a variety of enzymatic and non-enzymatic antioxidative protection tools to defend their cells from ROS-induced cellular damage (figure 2). Superoxide dismutase (SOD) is a significant superoxide scavenger that produces H_2O_2 and O_2 through its enzymatic function [31]. A range of antioxidative enzymes, for example, catalase (CAT), ascorbate peroxidase (APX), and guaiacol peroxidase (POX), scavenge the hydrogen peroxide that has been created. H_2O_2 is converted by catalase into molecular oxygen and water. On the other hand, peroxidase breaks down H_2O_2 by oxidizing co-substrates like antioxidants or phenolic compounds [27]. Plants often show an increase in CAT activity as NaCl in the soil increases [32], however different plant genotypes show different levels of enhanced accumulation. Depending on their tolerance to salt, plants respond to salt stress differently in terms of CAT activity. For instance, CAT activity decreases with increasing salt stress in genotypes of soybeans that are sensitive to salt [33]. However, genotypes of soybeans that are salt-tolerant showed enhanced CAT activity [34]. Barley and green beans are exposed to salt stress, there is a linear and substantial increase in the activity of CAT in response to increased salt concentration [35,36]. Based on the results of studies conducted on several crops, it can be inferred that the salt-tolerant cultivar had more CAT activity than the salt-sensitive cultivar and that this increase in CAT activity aids the plant in reducing osmotic stress brought on by NaCl in the soil [6]. Guaiacol peroxidase (POX) is regarded as one of the most significant peroxidases for defending plants from ROS. In rice varieties that are sensitive to salt, salinity dramatically increases the activity of the antioxidant enzyme peroxidase (POX) which may aid plants in reducing osmotic damage from ROS.; whereas, in resistant types, POX enzyme activity shows a diminishing trend as salt concentration increases [37]. A rise in salt level causes an enhancement in POX activity in soybeans [34]. Plants and algae are rich sources of APX, a crucial enzyme. It is dispersed throughout five distinct cellular components: mitochondria (mitAPX), stomata (sAPX), thylakoid membrane (tAPX), the membrane (mAPX), and cytoplasm (cAPX) of microbodies. Every portion of the plant contains APX, which scavenges H_2O_2 via the AsA-GSH pathway in Figure 2 (also known as the Asada–Halliwell–Foyer pathway) [27].

3.5. Nonenzymatic Antioxidants

Because of its ability to donate electrons and maintain stability as a result of electron delocalization brought about by the resonance between two forms, ascorbate (AsA) is a significant constituent of the AsA-GSH cycle, which scavenges reactive oxygen species [38]. AsA controls several phytohormone production pathways. Additionally, AsA scavenges.OH and $O_2^{\cdot-}$ to regenerate tocopherol (vitamin E) from tocopherol radical [39]. On the other hand, glutathione reductase (GSH), another essential element of the antioxidant defense system, is crucial for controlling the AsA-GSH cycle (figure 2), which scavenges cellular ROS and maintains redox homeostasis [38]. By scavenging ROS, primarily $1O_2$ and . OH, tocopherol preserves photosynthesis and safeguards the chloroplast [40]. Carotenoids represent a significant class of antioxidant molecules, recognized for their ability to neutralize deleterious free radicals and safeguard complex proteins involved in light absorption as well as the integrity of the thylakoid membrane [41]. Flavonoids, particularly dihydroxy B-ring-substituted flavones and flavonols, can decrease lipid peroxidation-induced cell damage and scavenge free radicals [42]. Furthermore, abiotic stresses activate antioxidant defense mechanisms and upregulate the expression of genes linked to the production of flavonoids [41]. Hydroxybenzoic and hydroxycinnamic acids, exhibit antioxidant action as chelators and scavengers of free radicals, particularly $O_2^{\cdot-}$,.OH, ROO$^{\cdot}$, and ONOO$^-$, make up the majority of the antioxidant phenolic acids. Alkaloids can also scavenge free radicals and prevent oxidation caused by H_2O_2 in addition to their antioxidant properties. Moreover, citrulline, ornithine, and gamma-aminobutyric acid are thought to be potent nonenzymatic antioxidants [30].

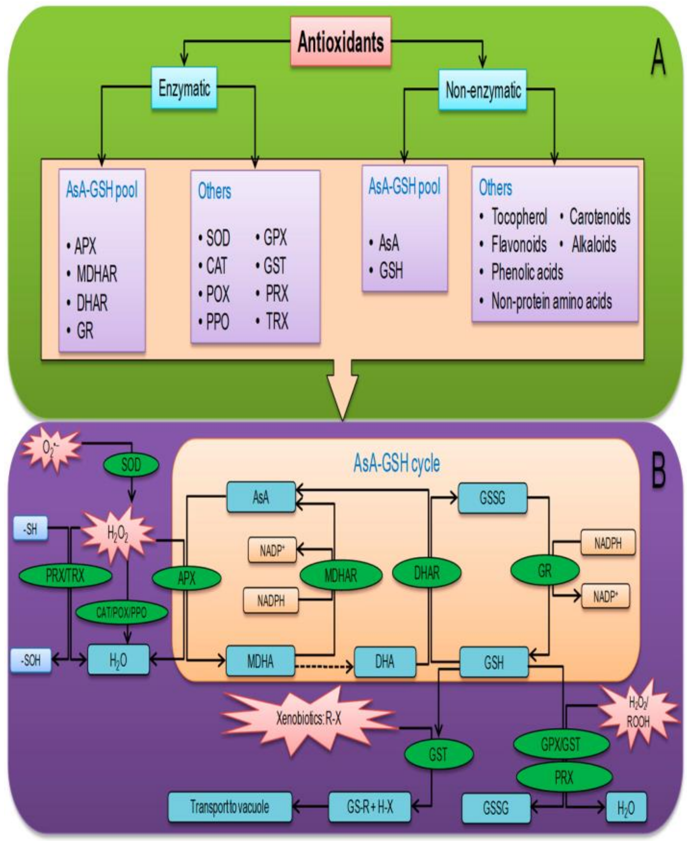

Fig. 2. Outline of plant antioxidative protection (A) forms of antioxidants and (B) linked of enzymatic and nonenzymatic antioxidants. APX, ascorbate peroxidase; AsA, ascorbic acid; CAT, catalase; DHA, dehydroascorbate; DHAR, dehydroascorbate reductase; GPX, glutathione peroxidase; GR, glutathione reductase; GSH, glutathione (reduced form); GSSG, glutathione (oxidized form); GST, glutathione S-transferase; MDHA, monodehydroascorbate; MDHAR, monodehydroascorbate reductase; NADPH, nicotinamide adenine dinucleotide phosphate; POXs, peroxidases; PRX, peroxiredoxins; R, aliphatic, aromatic, or heterocyclic group; ROOH, hydroperoxides; –SH, thiolate; SOD, superoxide dismutase; –SOH, sulfenic acid; TRX, thioredoxin; X, sulfate, nitrite, or halide group [30].

4. Strategies to lighten the harmful influences of NaCl stress.

Mitigating the impacts of salt stress is a viable way to guarantee crop yields in such unfavorable circumstances. It is successfully possible to treat seeds, seedlings, or plants chemically, biologically, or physically before their exposure to NaCl salt. We introduce some of these strategies:-

4.1. Organic amendments

Applying organic materials established substantial benefits, enhancing the saline soil biome by supplementing it with compost, poultry manure, green manure, and sugarcane residues. According to [43], the organic amendments improve the dissolving percentage of $CaCO_3$ by increasing the creation of carbonic acid and strengthening the binding of the tiny particles. This results in the formation of relatively large aggregates that are stable in water. Since the large-sized organic particles in poorly structured saline create channels and help to ameliorate soil permeability while leaking sodium from the cation exchange spots over the soil, this method works well in both calcareous and non-calcareous soils [44]. Among organic amendments, biochar has been intensively investigated recently as successfully enhancing the biological and physicochemical assets of saline soils. Biochar stabilizes the structure of the soil, improving physical properties by balancing both the air penetrability and water content, about the cation & ion exchange aptitude [45]. The application of biochar has the following positive effects: (i) it reduces transient nitrogen through adsorption; (ii) it releases macro- and micromineral nutrients; and (iii) it reduces stress features caused by osmosis by improving soil water availability [46]. Biochar can increase shoot yield, and roots length, besides harvest in potatoes [47], maize, and tomatoes [48] developed under salt stress.

4.2. Symbiotic bacteria.

A crucial naturally occurring rhizosphere–microbe relationship for reducing NaCl injury includes particular N-fixing-associated bacteria that also function as growth-promoting agents for plants. By producing particular enzymes, metal-organic complexes, and hormones, some N-fixing-associated bacteria growth enhancers improve salinity tolerance. They also fix atmospheric N_2 and provide bioavailable phosphate forms [49]. As acetylene reduction was enhanced at extreme levels of NaCl salt, the primary explanation for rhizobium-induced benefits in host plants is a more effective N_2-fixing symbiosis [50]. Song et al., 2017[51] subjected Medicago sativa plants associated with Rhizobium to salinity. The results indicated that the plants' increased resistance to salt was correlated with increased levels of antioxidants, osmolytes, organic acids, and metabolites activities (related to N-fixation) in comparison to non-symbiotic alfalfa plants. Plant species, mainly perennial (for example Rhamnaceae, Datiscaceae, and Coriariaceae), were confirmed by the *Frankia* genus (i.e., Gram+ filamentous actinobacteria). These species are not interested in crop food yields, but they are critical for the preservation of saline semi/arid (agro)ecosystems [43]. When *Frankia* strains CcI3 and CeD were injected into *C. glauca* and *C. equisetifolia* exposed to NaCl salt, the plants' height increased. They also had significantly higher biomass, dry weight, proline, and chlorophyll than the uninoculated plants [52]. Two-thirds of the strains of *Frankia* that were resistant to salt and/or osmotic stress shared 153 single-copy genes, which are the primary code region for hypothetical proteins [53].

4.3 *Trichoderma* sp.

Endophytic fungi have been shown to improve plant growth under stress, in addition to the well-known mycorrhizal fungi and plant growth-promoting rhizobacteria [54-57]. *Trichoderma* sp. is extensively employed as a biocontrol agents for plant diseases and as biofertilizer to enhance plant growth [58,59]. Plant resistance to biotic and abiotic stresses involving NaCl and drought can be increased by using certain strains of *Trichoderma* [60, 61], by promoting protection against oxidative damage, improved root growth, and increased nutrient intake. Mastouri et al. (2012) [62] found that the increased ability of *Trichoderma harzianum* (TH) T22 to scavenge reactive oxygen species and recycle oxidized ascorbate and glutathione accounts for a portion of the improved resistance of plants. *Trichoderma* species improve the soil's nutrient-absorbing capacity, allowing plants to tolerate salt stress and reducing the activity of soil illnesses that ultimately inhibit plant growth. *Trichoderma*-gene-rich plants are more resistant to abiotic conditions such as salinity. These genes are unique in that they can break down cell walls, form hyphae, adjust to stress, and fight against parasites [63]. Of the several species of *Trichoderma*, *T. harzianum* is thought to be the most successful biocontrol manager [64]. According to Zhang et al. (2019)[65], *T. longibrachiatum* T6 improved *Triticum aestivum* L.'s capacity to tolerate saline stress. *T. longibrachiatum* T6 action mode reduced levels of hydrogen peroxide and malondialdehyde (MDA) by 19% and 13%, respectively, while increasing proline by 11%, ascorbate by 15%, and glutathione by 28%.

4.4. Sliver nanoparticles

Nanomaterials (less than 100 nm) are widely used in many different industries. Silver nanoparticles (AgNPs) are generally used for varied treatments in cosmetics, pharmaceuticals, medicine, water treatment, and agriculture [66-69]. The agricultural field has seen reports of nanoparticle effects thus far, with a focus on improving photosynthetic rate, plant growth, and seed germination [70]. Since silver nanoparticles (AgNPs) have special physicochemical properties that confer antioxidant and antibacterial capabilities, they behave considerably better than other nanoparticles [71]. Moreover, AgNPs' non-toxicity and chemical stability under ambient settings made them known as "biocompatible precursors" for eliciting the particular features in plants that are accountable for their overall growth [72]. Through a series of parametric analyses, which began with an assessment of germination parameters to determine the role of AgNPs in NaCl responses. The average seed germination rate, index, and seed germination rate were all negatively affected by salinity. During salinity stress, however, the administration of AgNPs to the stressed plants counteracted these adverse influences and significantly improved germination characteristics. AgNPs' increased capacity to enter seed pores may be the cause of this [73]. This boosts the effectiveness of water absorption, causing coleoptiles to elongate and seedlings to be properly established; this causes a noticeable acceleration in the rate at which wheat seedlings germination occurs. Additionally, at the germination stage, the increased germination rate, fresh weight, and root length [74].

4.5. Ultraviolet radioactivity.

Regarding 8–9% of all solar waves are composed of ultraviolet light, which is a component of the nonionizing area of the electromagnetic spectrum [75]. The amount of ultraviolet radiation that reaches the earth's surface is rising as a result of the stratospheric ozone layer being destroyed, and interest in learning how plants could defend themselves against this threat is also growing [76]. Plants respond differently to UV radiation than other environmental stresses. By analyzing the molecular signature of these reactions, new treatments that enhance plant sensitivity to abiotic stresses like salinity may be developed. There is a dearth of information on the possible application of UV light as a salinity-reduction strategy. It was documented that lettuce seeds were exposed to UV-C radiation to increase the plant's capacity to withstand salinity. In addition to testing two different levels (0.85 and 3.42 kJ m^{-2}), nonprimed and UV-primed seedlings in either 00.00 or 100.00 mM NaCl. Salinity led to a smaller enhancement in the fresh weight of plants, accompanied by a reduction in potassium uptake, with an improvement in sodium level. These influences were relieved in plants under the UV-C treatment. The impact of UV-C at lowering salt was more prominent at 0.85 kJ m^{-2} than at 3.42 kJ m^{-2}. UV-C priming could be used to lighten NaCl-induced stress in lettuce [77]. UV-C is a strong instrument that may be used to increase the biosynthesis of health-promoting phytochemicals and strengthen plant defenses against biotic attacks [78].

4.6. Gypsum application

The most well-known technique for recovering saline soils is the use of gypsum; related amendments also involve sulfur, H_2SO_4, sulfur polysulfides, and hydrogen sulfite. Gypsum can enhance the physical (bulk density, aggregate stability, and water infiltration) and chemical (pH, nutrients availability, and organic carbon) properties of saline soils when applied including the weight of plants and productivity [79]. Applying gypsum to the soil solution improves the availability of many nutrients, including phosphorous, and encourages a balanced level of electrolytes [80,81]. In addition to improving the soil's physical and chemical characteristics, adding gypsum to the soil increases its biomass, respiration, and microbial activity [81]. The affordability and ease of use of gypsum are among its most significant contributions to the reduction of soil salinity [82]. Sedimentary rocks having significant S and Ca deposits that originated in a marine environment can be mined for gypsum. Additionally, phosphogypsum can be produced as a by-product of flue gas desulfurization and the synthesis of sulfuric and phosphoric acids [79].

4.7. Mycorrhizal fungi

Numerous microbes spontaneously colonize plants, influencing their morphological, physiological, and biochemical characteristics [83]. Arbuscular mycorrhizal fungi increase species yields by improving plant performance under stress [84]. Arbuscular mycorrhizal fungi enhance plant development and tolerance to salt through a variation of methods, involving enhancing nutrient uptake and adjusting the physiological and biochemical characteristics of plant host [85]. Numerous studies have demonstrated that arbuscular mycorrhizal fungi cause encouraging physiological and biochemical alterations in plants and in time lead to improved plant development under NaCl stress [86-89].

4.8. Leaching

Leaching soil is a simple technique that involves adding large amounts of water to the soil to remove excess salts, submerging the soil in water for a predetermined amount of time, and then draining the water into cesspools. Numerous variables might impact the chosen leaching technique, including variations in irrigation water salinity, the initial humidity level of the soil, the manner of adding water, the rate of rainfall, the ionization of mineral compounds, and the impact of soil texture on leaching effectiveness. Numerous laboratory and field studies on salt leaching have been conducted. The impact of initial moisture content, flow velocity, and chemical and physical characteristics on the leaching of salts from soil [90]. Using leaching irrigation water in conjunction with appropriate drainage systems is one of the most effective ways to remediate saline-sodic soils. Several studies, [91-93] have documented the positive impacts of leaching on crop yield and soil enhancement.

4.9. Mulching

` Mulching is a beneficial technique that can help with soil temperature changes, moisture conservation, evaporation reduction, aeration enhancement, and nutrient release in the soil profile. Mulching is the application of either inorganic, synthetic materials (such as polyethylene sheets) or organic constituents (for instance farmyard manure, straw, grasses, and crop wastes). As organic mulch breaks down due to microbial activity, it enriches the soil with nutrients and aids in the sequestration of carbon. Because straw mulch enhances residue buildup and reduces soil disorder on the soil surface, it can keep soil water and minimal temperature. Plastic mulch has a role in the crops yield by generating mechanical defense at the soil surface as well as a microclimate that is encouraging for temperature distribution, humidity holding, and the supply of CO_2 to the stomata of lower leaves of small plants. Moreover, adjusting soil temperature, suppressing weed populations, and reducing nitrate leaching [94]. Some studies indicated that plastic mulch lowers the salinity in the root zone, which increases fruit yields in plants that get salty irrigation. This has been noted for raspberries by Zhang et al. (2019) [65] and grapevines by Aragüés et al. (2014) [95].

4. Conclusion

Salinity is a widespread abiotic stress that restricts plant productivity. It causes ionic toxicity and a water deficit in plants, which slows or stops important plant functions. Salinity induces a reduction in the level of chlorophyll and an increase in the production of active oxygen species, which leads to the accumulation of osmotic solutes and an increase in the enzymatic and nonenzymatic antioxidants. There are many different treatments, whether chemical, physical, or biological, to reduce the harmful effect of salinity. It was found that organic matters, symbiotic Bacteria, *Trichoderma* sp., silver nanoparticles, ultraviolet radiation, gypsum application, mycorrhizal fungi, leaching, and mulching have a positive role in reducing the toxic effect of salinity on plants.

CRediT authorship contribution statement:

Conceptualization, K.A.M. Abo-Elyousr; investigation, S. A. Alghamdi and F. A. Al Otaibi; writing—original draft preparation, K.A.M. Abo-Elyousr and S. A. Alghamdi; writing—review and editing, F. A. Al Otaibi; supervision, K.A.M. Abo-Elyousr. All authors have read and agreed to the published version of the manuscript."

Data availability statement

The data used to support the findings of this study are available from the corresponding author upon request.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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