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Investigating the Importance of Salicylic Acid and Mycorrhiza in Reducing the Unfavorable Effects of Stresses on Maize

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Abstract
Polycyclic aromatic hydrocarbons are an important group of pollutants that are widely distributed in the environment. The present study aimed to investigate the effect of salicylic acid (a phenolic phytohormone) and mycorrhizal fungi on the growth and phytoremediation ability of tall fescue in the soil contaminated by fluoranthene. The initial concentrations of fluoranthene in this study were 100, 200, and 300 mg kg-1. The experimental treatments were included: T0 uncultivated soil; T1 cultivated soil with tall fescue; T2 cultivated soil with tall fescue þ salicylic acid application; T3 cultivated soil with tall fescue þ application of mycorrhizal fungi; T4 cultivated soil with tall fescue þ salicylic acid and mycorrhizal fungi application; and P planting tall fescue in uncontaminated soil. The removal of fluoranthene was measured after 90 days. Furthermore, at the end of the experiment, the amount of shoot and root biomass, soil bacteria, and dehydrogenase activity were measured. According to the results, in all levels of contamination, removal of fluoranthene in cultivated treatments significantly was higher than uncultivated treatments. Increasing the concentration of fluoranthene had a negative effect on the shoot and root biomass in different treatments. Salicylic acid and mycorrhizal fungi significantly increased the shoot and root biomass and also the number of soil bacteria, dehydrogenase activity, and fluoranthene removal in T2, T3, and T4 treatments compared to T1. At the highest concentration of fluoranthene, as a result of simultaneous application of salicylic acid and mycorrhizal fungi (T4), the fluoranthene removal increased by 63, 21, 13, and 16% in comparison with T0, T1, T2, and T3, respectively. Based on the results, salicylic acid and mycorrhizal fungi, either alone or in combination, have a significant effect on the improvement of phytoremediation potential in tall fescue.

1. Introduction
When plants are exposed to environmental stress, a variety of active oxygen species (ROS) such as radical anions of superoxide (O2), hydrogen peroxide (H2O2), hydroxyl (OH) and single oxygen (O2) radicals [1], which ultimately causes the death of the cell. Zhang et al. [2] also reported that living and non-living stresses increase the concentration of free oxygen radicals such as superoxide, hydrogen peroxide and hydroxyl in the plant and damage plant cells and cause the production of these free oxygen radicals in drought stress. Electron transfer ROS may initiate oxidative degradation processes, such as lipid peroxidation, protein oxidation, and damage to nucleic acid and malondialdehyde (MDA) is the last product of lipid peroxidation, which represents oxidative damage [3].

Cattivelli et al. [4] reported that yield reduction in corn under drought stress depends on several factors such as plant development stage, severity and duration of water shortage and hybrid susceptibility. The critical stage of pollination involves the emergence of thistles and the accumulation and dispersion of pollen. Severe stresses during this period can have a lot of effects on stress per day [5]. Drought stress also affects the number of grains and tube growth in the ovary during pollination and fertilization of the corn [6]. Alloway [7] concluded that the reaction of species of cereals that have long growth, such as corn, is more affected by drought stress. It also concluded that cereal species, such as corn, have a long stigma, are more affected by drought stress. Therefore, the pollination stage and two weeks later is the most sensitive period of the plant relative to the water stress, and during this time the yield components and the number of grains in each ear are sharply reduced. During this time, the plant produces photosynthetic materials more than seeds are able to accept them, and the increase in the weight of the stems suggests this. Three weeks after pollination, water stress no longer affects the number of grain beads [8-10]

Li et al. [11] examined the drought resistance of maize at different stages of its development and concluded that drought stress at different stages significantly reduced plant height, leaf growth and dry weight, but water efficiency at stem stroke stages and the swelling of flag leaf sheath had the most inhibitory effect on growth. Plant height and dry weight were decreased by 21% to 30% and 28% to 32%, respectively [12]. The permeability of leaves decreased at all stages under drought conditions, but in the germination stage it was more than the subsequent stages, and the difference in water potential of the aerial parts increased with the age of the plant, but cultivars tolerant to drought had lower water potential and less oscillation. Drought may also delay the emergence of corn in the corn [13-14].

In the experiment, Modarresi et al. [15] reported that with increasing phosphorus, number of seeds per ear, seed filling speed, plant height, as a result of grain yield and biological yield, linearly increased, so that the grain yield The increase in phosphorus up to 150 kg / ha increased linearly. The crown part reported in the experiment, although phosphorus absorption by corn roots is roughly different at different stages of plant growth, but in the early stages of plant growth, more phosphorus is needed [16]. Yadesa et al. [17] reported a significant correlation between dry weight of aerial part, relative growth, phosphorus absorption by corn with extracted phosphorus, and phosphorus concentration in the plant only with the extracted phosphorus by the Olsen method Correlation was significant.

Some researchers believe salicylic acid is a new plant growth hormone [18-19], and can be considered as plant hormones [20]. Salicylic acid, according to reports, has many effects on plant morphology and physiology, and has been involved in stimulating supportive mechanisms to increase resistance to live and non-living stress [21]. Several studies have shown that salicylic acid is one of the essential components of plant resistance to pathogens, and in plant response to adverse environmental conditions [22]. Although not fully proven, salicylic acid has a specific support role for the plant under stress conditions [23]. The application of salicylic acid on plants has a variety of physiological effects, such as preventing the storage of dry matter and controlling ion absorption and transfer [24]. It has been reported that the activity of beneficial microorganisms such as mycorrhizal fungi and phosphorus soluble microorganisms acts in the direction of the dietary requirements of plant nutrients such as nitrogen, phosphorus and potassium, and it improves the growth and yield of crops [25-26]. Mycorrhizal fungus effectively increases the absorption capacity of high and low-energy elements by producing different enzymes such as phosphatases and the solubility of elements such as phosphorus and micronutrients, especially in drought stress conditions [27]. Since mycorrhizal fungi increase the ability of the host plant to absorb mineral elements from the soil, and in particular from inaccessible sources, it is believed that these fungi can be a good alternative to a part of The chemical fertilizers used, in particular, are phosphate fertilizers in different ecosystems [28-29].

Much research has been done on the effects of mycorrhizal coexistence on the physiological aspects of plants, and the results have shown that mycorrhizal fungi increase the absorption of Fe, Mn, Ca, Mg, K, S, P and N elements [30] and the importance of this symbiosis is more evident in the absorption of phosphorus and elements with little mobility in soil under water stress [31]. Research confirms the important role of salicylic acid in plant response to various non-living stresses, drought, salinity, cold, heat and etc. [32]. Plants produce proteins in response to live and non-living stresses, and many of these proteins are stimulated by plant hormones such as aquatic acid and salicylic acid. Considering the importance of the subject of this paper, the importance of salicylic acid and mycorrhiza in reducing the adverse effects of plant stresses is of concern [33]. In physics, it means the force input in the unit area. In biology, any negative and undesirable condition for the growth of plants is stressed. In other words, stress is the result of an abnormal process of physiological processes that results from the effects of one or a combination of environmental and environmental factors. In fact, the amount or severity of the above factors is potentially [34]. One of the climatic factors that determines the distribution and distribution of plants around the globe and may cause various morphological, physiological and biochemical changes in plants, water availability is available. Irrigation water is one of the rare and valuable inputs, and its optimum utilization in order to obtain maximum efficiency under conditions of resource constraints is very important so that the success of crop cultivation in arid and semi-arid regions is determined by the most limited source of water [35-36]. The objectives of the investigations were to (i) study the impact of long-term salinity on different stages involved in establishment in two differentially salt tolerant chickpea genotypes, (ii) test the relative role shoot fresh and dry root symbiosis in mitigating the negative effects of salt stress on growth, nutrient acquisition, ion homeostasis, carbohydrate metabolism, and grain yield, and (iii) establish whether exogenous SA treatments o mineral content would strengthen AM symbiosis and their combined treatments ameliorate salt stress more efficiently than their respective individual applications.

2. Materials and Methods

The study was carried out in Firuzabad University Research Greenhouse in 2018. The experiment soil had loamy-sandy texture. The physical and chemical properties of the soil prior to the experiment are presented in Table 1.

Table 1 *Physical and chemical properties of soil*

Value	Physical and chemical properties of soil
8.1	Electrical conductivity (dS m^{-1})
1.8	pH
3.6 mg/kg	N
12 mg/kg	P
185 mg/kg	K
2.2 mg/kg	Fe
8.4 mg/kg	Zn
1.3 mg/kg	Mn

The experiment was conducted as a factorial experiment based on a randomized complete block design with 3 replications. Experimental treatments of four levels of lead (zero), 100, 200 and 300 mg / kg of lead in the form of lead nitrate and 3 levels of salicylic acid spray (molecular weight 138.1 g / mol) at concentrations of 0, 50 and 100 ppm. (Zero, 441 and 882 µM, respectively). Lead nitrate was obtained from the Karaj and Salicylic Acid Research Center (MERK, Germany) from the Research Laboratory of Firuzabad University.

3. Drought stress or water stress

Drought stress occurs when the water in the soil decreases and the atmospheric conditions help to eliminate water through sweating and evaporation. If the stress is long, the plant may be destroyed by drying unless it has resistance mechanisms. Drought occurrence is a term of meteorology and is usually defined as a period without sufficient rainfall. Hence, lack of rainfall creates water stress and the term drought stress is defined as water stress due to lack of rain. Only It is attributed to the lack of water and not to the abundance of water. However, the term "water stress" and "drought stress" are often used synonymously. Environmental stresses have two types of mild and severe. Resistance due to mild stress is a deterrent due to severe irreversible stress. Therefore, environmental conditions are considered only when the plant is desirable, which does not cause stress. Drought stress is a mild stress. Agricultural dryness 1 indicates a situation in which rainfall and soil moisture content are insufficient to meet the optimal plant growth and optimum yield. Drought stress is a shortage of water in the plant and is created when transpiration rates increase. Water stress or water deficiency in the plant is referred to as a condition in which the cells have been exposed to inflammation. In terms of crop, water stress is a condition in which water is not sufficiently distributed to the plant in terms of quantity and distribution, so that the plant can produce its potential. Drought stress is a water shortage of plants usable in the soil, which causes internal stress in the plant and ultimately affects its growth [37].

4. Physiological effects of drought stress

Reduction of osmotic potential and total water potential along with loss of cellular swelling, stomatal closure and dwindling from drought stress symptoms. The main cause of drought stress in the plant is the increase in water loss due to insufficient water absorption or a combination of these two it reduces the leaf water potential by lowering the salicylic acid formation by less than 5 times by decreasing the leaf water potential, causing chloroplasts to be impaired 10 times. Plants that are subjected to drought stress do not only reduce their size, but also the structural characteristics and especially their leaf changes. As the leaf area, cell size, and volume of the intercellular vents usually decrease, but the amount of crotch, the number of petals, stomata, and the thickness of the parenchymal layer of the leaves increases. The result is relatively high fat and thick leaf foliage, which is characteristic of drought tolerant plants. Leaf growth is largely due to stress, sensitivity that can be used as an indicator of the time required for irrigation. Water stress 24 hours after emergence has reduced the leaf development rate due to the reduction of blue state. Therefore, the decrease of blue leaf status is effective in reducing the development of plant cells . The reduction of photosynthesis caused by drought stress apart from other factors will reduce the number of leaves. Drought stress reduces the level of leaf dry matter [38].

5. Indices of Drought Resistance:

Different indices have been proposed for selection based on yield. These indices provide plant performance in two stressed and non-stressed environments [39]. The genotypes are based on their appearance in two stressed and non-stressed environments 4 groups.

1- Genotypes that have the same expression in two stressed and non-stressed environments (Group A)

2. Genotypes that is only good in a non-stressed environment (Group B)

3. Genotypes with high performance in the stress medium (Group C)

4. Genotypes with poor presentation in both environments (group D)

the most appropriate criterion for selecting tension is the criterion that can distinguish group A from other groups.

The drought index terms are:

YP = Potential yield of each genotype in a non-stressed environment

YS = yield of each genotype in the stress medium

YP = Average yield of all genotypes in non-stressed environments

YS = The mean of all genotypes in the stress medium

Chen [14] proposed stress susceptibility index (SSI). Calculated using the following equation:

$$SI = 1 - \left(\frac{YS}{YP}\right) \quad (1)$$

$$SSI = 1 - (YS/YP) / SI$$

In the above formula, SI is the stress intensity equation. As much as SI is less, SSI will have more. Selection based on the SSI index leads to the selection of low yielding genotypes under normal, but high yield conditions under stress conditions. The main disadvantage of this is the lack of identification of group A from group C. Fernandez proposed the following index under the name of the stress tolerance index. This index is calculated as follows: STI = (YP) (YS) / (YP). The higher the STI value, the higher the drought tolerance of that specific genotype, the more distinct the group A genotypes are. The geometric mean of productivity was also introduced as an indicator (GMP) in 1992 by Fernandez, which is calculated as follows [14]:

$$GMP=\sqrt{(YP)(YS)} \quad (2)$$

This index has a higher degree of separation of group A from other groups.

Another indicator of HARM or Harmonic Average Index is as follows:

$$HM = 2\,(YP \times YS)\,/\,(YP + YS) \quad (3)$$

5.1 Importance of salicylic acid

Plant hormones are known as a strong and sustainable tool for reducing the adverse effects of live and non-polluting stresses on plants. Salicylic acid or sorbitol hydroxy benzoic acid is a phenolic compound produced in a large number of plants by root cells and plays a role in plant growth as a quasi-hormonal substance. Acid oxalicyl plays a central role in the regulation of various physiological processes such as plant growth, plant growth, ion absorption, photosynthesis and germination, processing and defense responses. Salicylic acid regulates the physiological and biochemical properties of plants under non-biological stresses and also their resistance to diseases. Asylcylic acid is known as an important molecular signal in plant fluctuations in response to environmental stresses and increases in non-biological stresses, especially drought stress in plants, and increases the content of the pigments under stress conditions. Salicylic acid acts on photosynthesis through stomatal factors, pigments, and the structure of chloroplast and enzymes involved in the photosynthesis process Acid oxalicyl regulates the physiological processes in plants and reduces the side effects of tension and can improve the undesirable effects of stress [40].

5.2 Importance of Mycorrhiza

Mycorrhiza is the most important kind of fungus in the soils that are not damaged. It is estimated that about 70% of the mass of the microbial community of the soil is the mycelium of these fungi. The term mycorrhiza consists of two words. One of the Greek words Mikes means "fungus" and the other one with the Latin root of Rhiza, which means root, and describes the symbiosis between the roots of host plants and mycorrhizal fungi. Symbiosis between most vascular plants occurs with soil mycorrhizal fungi belonging to the three classes of Basidiomycetes, Ascomycetes, Zygomycetes. Following the identification of the association of mycorrhizal symbiosis, they were categorized into three groups: ectomycorrhiza, endomycorrhiza, and octane coduria. In the case of octomycorrhiza, the end portion of the root is either completely covered in a pod or a hyphus created by the fungus, and the hyphae splits into the intercellular space of the root skin, and usually lack the enzymes that degrade cellulose and lignin, and in The whole is dependent on the carbon that the host plant provides them with. In endocardial fungi, the fungal effects on the host root are not visible and apparently do not differentiate between infected and non-contaminated roots. Since mycorrhizal fungi increase the ability of the host plant to absorb phosphorus and mineral elements from the soil, in particular from its inaccessible sources. Therefore, these beneficial microorganisms are called biological fertilizers, and it is believed that mycorrhizal fungi can be a suitable substitute for chemical fertilizers, especially phosphate fertilizers in different ecosystems. In the coexistence of mycorrhizal fungi with the host plant, a part of the carbon produced from the photosynthesis of the plant is placed on the fungus and, in return, the mycorrhizal fungus has been absorbed and transmitted by water and mineral elements from the areas for which the root system It is inaccessible to the plant, and this symbiosis helps plants to grow in difficult conditions. The effect of mycorrhiza fungi, especially in areas where soluble phosphorus is low in soil or due to drought stress, has become much more pronounced. The rate of development of extra-root hyphae in mushrooms is approximately 800 times the speed of development of the root system of the plant. Therefore, the depleted phosphorous area around the hyphae of mycorrhizal fungi is more limited than the surrounding capillary root, and therefore, more phosphorus is absorbed in mycorrhizal symbiosis. Mycorrhizal fungi in the plant can be affected by the increase in the amount of ABA host and the plant's water loss by reducing the opening of the apertures and closing the apertures Faster to do. The stomach guard cells seem to have a specific ABA receptor located on the outer wall of their plasma membrane. The presence of this receptor and its action causes a change in the opening of the ion channels and activates the slope of the protein. Mycorrhizal coexistence is one of the most common and long-standing coexistence relationships in the herd series, which is found in most ecosystems, so that most plants (about 95% of the species of vascular plants have at least one type of mycorrhiza. Mycorrhizal fungi are divided into two general categories: octomycosis and endomycorrhiza, ectomyecorosis fungi are not introduced into the root cells, and therefore their microresias are called exterior, and is a form of symbiosis in which a complex heifer network the epidermis is composed of roots and skin cells and is involved

in the spreading of soil. More than 5,000 species are involved in the formation of an outer Mycorrhiza with about two dozen species of plants (most of which are common types of leafy and broad-leaved forest trees) [41].
A group of mycorrhizal fungi that coexist with crop plants is identified as endometriosis; this type is called internal mycorrhiza due to the penetration of the gum tissue into the skin of the root skin. In this group, the mussel ion of the fungus and in and between the host plant cell Grows. A significant proportion of these fungi are classified as "mycorrhizal", "arbuscular" or "lactic" zirconium, and they coexist with many crops and gardens, the basis for the initial naming of mortal mushrooms due to the production of specific fungal organs in the form of plants Small (arbuscular) and also a compartment or bag accumulated from the storage material (vesicles) within the root of the host plants, arboscolum is usually formed in the cells of the inner part of the skin of the root. In this way, the hyphae of the fungus, after penetrating into the cell, by creating continuous bifurcation branches gradually becoming thinner and more delicate, generally produce a structure similar to a small shrub, due to the large cellular contact area. The host is able to exchange food between a specific fungus and host plant [42].

6. Result

Shoot fresh weight, shoot dry weight, root fresh weight and root dry weight of Maize plants were lower at salt stress treatment as compared to non-saline conditions ($p < 0.05$). However, exogenous SA applications increased these parameters as compared to the control under salt stress. The application of 1.00 mM SA under salt stress gave the higher values for these parameters than the other treatments except for root fresh weight. It increased by 82% the shoot fresh weight, by 62% the root fresh weight, by 37% the shoot and by 67% the root dry weight, as compared to the control. Furthermore, 1.00 mM SA application affected positively the growth of the Maize plants compared to the other treatments (Figure 1). There was no interaction between salt stress and SA treatments in relation to growth parameters. This positive effect of SA could be attributed to an increased CO2 assimilation and photosynthetic rate and increased mineral uptake by the stressed plant under SA treatment [40].

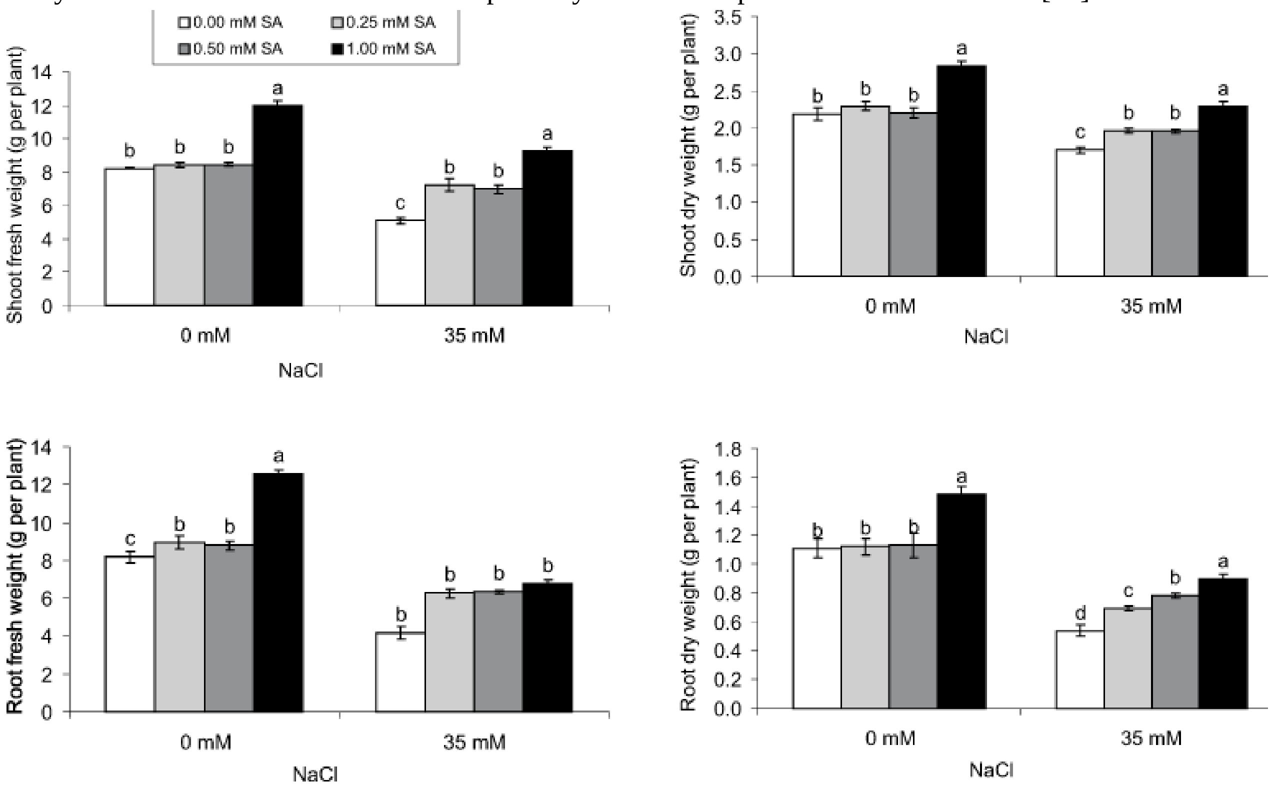

Figure 1 *Shoot fresh weight, shoot dry weight, root fresh weight and root dry weight of maize plants in response to SA applications under salt stress*

Application of the test levels of NaCl to maize plants adversely influenced their growth pattern (shoot and root length, fresh and dry weights of shoots and roots and leaf area), as compared with control plants (Table 2). These results are in agreement with those of chiara et al [43], who showed that NaCl salinity caused a marked reduction in growth parameters (leaf area, fresh and dry weight of shoots and roots of sugar beet plants. Salicylic acid-treated maize plants exhibited an increase in tolerance to salt treatment. This increase in salt tolerance was reflected in the measured growth criteria: fresh, dry and length of shoots and roots as well as leaf area were increased comparing with plants received NaCl only (Table 2). Kurepin et al [44] also reported a similar increase in the growth of shoots and roots of soybean plants in response to salicylic acid treatment.

Table 2 *Treatment with NaCl in presence or absence of salicylic acid in Maize plants*

Salicylic acid (M)	NaCl (mM)	Fresh weight (g)		Dry weight	
		Shoot	Root	Shoot	Root
0.0	0.0	16.28	3.03	2.63	0.40
	50	15.07	2.80	2.45	0.36
	100	13.17	2.67	2.09	0.30
10^{-2}	0.0	10.09	1.89	1.52	0.81
	50	20.07	6.18	3.35	0.90
	100	17.40	7.01	3.300	0.53

Figure 2 shows the effect of salt stress and SA treatments on importance of salicylic acid and mycorrhiza and electrolyte leakage of maize. Salicylic acid was affected by salinity and SA treatments ($p < 0.05$). Salt stress decreased salicylic acid reading as compared to the non-saline conditions. Furthermore, salt stress inhibits the salicylic acid content in leaves of many crops. SA applications caused increased readings except for the 0.25 mM SA treatment. The highest reading values were obtained from 1.00 mM SA application in both NaCl treatments (Figure 2). The increase in salicylic acid content with SA confirmed the reports of Faghih [45] for barley, Inal et al. [46] for maize. In this study, 0.50 and 1.00 mM SA treatments caused an increase in the salicylic acid content of Maize plants under salt stress absence (Figure 2).

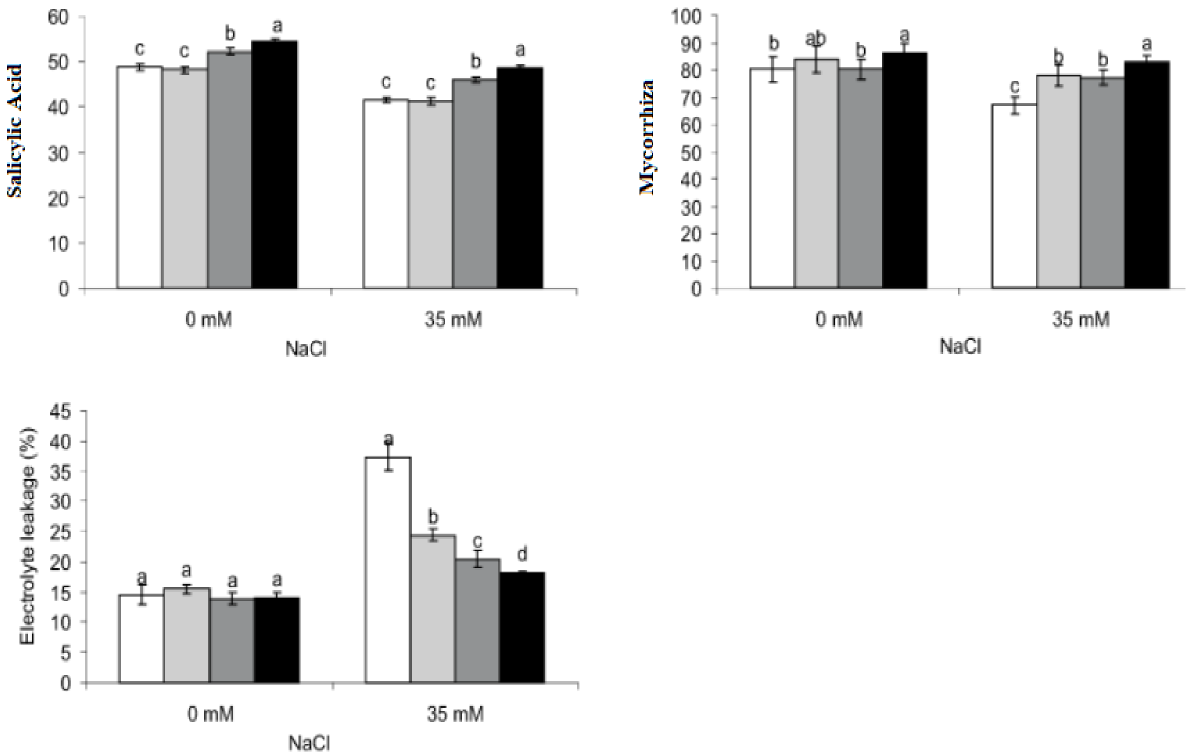

Figure 2 *Importance of Salicylic Acid and Mycorrhiza and electrolyte leakage of maize in response to SA applications under salt stress*

External NaCl salinity lowered mycorrhiza of Maize plants ($p < 0.05$) (Figure 2). Water stress often results when plants are subject to high salt concentrations. This study showed that SA treatments induced an increase in MYCORRHIZA of the salt stressed plants as compared to the control plants (Figure 2). Increases in mycorrhiza of Maize plants treated with SA were also reported for other crops grown under salt stress including barley and cucumber. This phenomenon may be attributed to the fact that foliar SA application can increase the leaf diffusive resistance and lower transpiration rates.

For the present experiment, a tendency towards elevated electrolyte leakage in leaves of salinized Maize plants was detectable (Figure 2. High concentrations of Na caused membrane disorganization pointed out that molar percentages of sterols and phospholipid decreased with increasing salinity. Electrolyte leakage enables cell membrane injury to be assessed when plants are subjected to salinity stress. Maintaining integrity of the cellular membranes under salt stress is considered an integral part of the salinity tolerance. SA treatments lowered the electrolyte leakage in salt stressed Maize plants (Figure 2). N, P, K, Ca, Mg and the other minerals in both shoot and roots of Maize plants decreased dramatically with the increasing NaCl concentration ($p < 0.05$) (Figure 3).

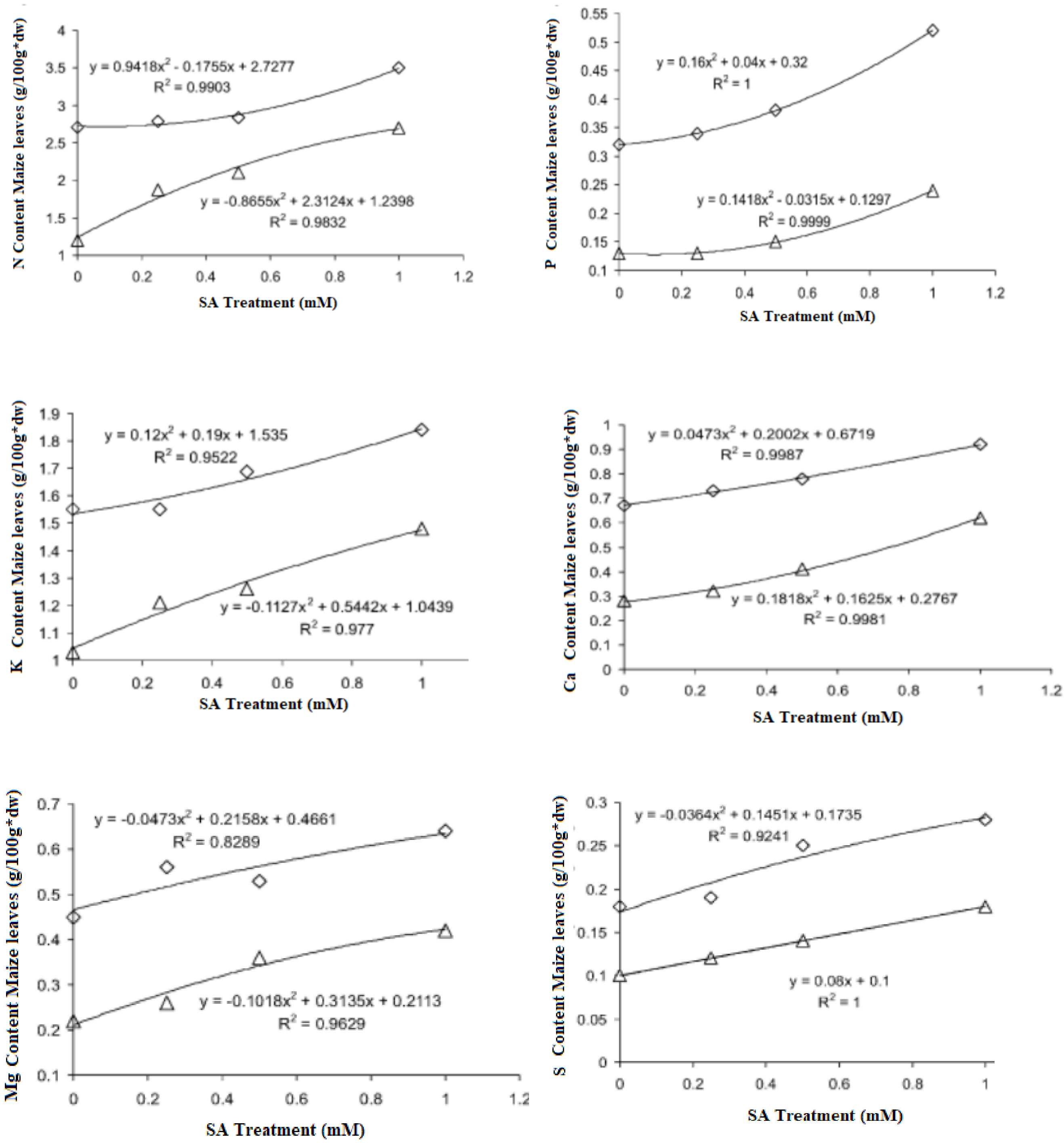

Figure 3 *effect of exogenous SA treatments of mineral content in leaves of maize under salt stress*

△35 mM saline solution ◇ without saline solution

Salinity dominated by Na and Cl ions has been shown to decrease the concentration of essential macro and micro elements in several vegetable crops. Salt stress increased the Na content in both organs of Maize plants (Figure 3). Fazeli et al. [47] found that NaCl salinity increased Na content in plant tissue of some crops. Hamayun et al. [48] reported that NaCl salinity may produce extreme ratios of Na/Ca and Na/K in the plants, causing them to be susceptible to osmotic and specific-ion injury, as well as to nutritional disorders. SA reduced the Na uptake of plants and/or increased the uptake of N, P, K, Ca, Mg and the other minerals as compared to control treatment under salt stress (Figure 3). An increase in concentration of K and Ca in plants under salt stress could ameliorate the deleterious effects of salinity on growth and yield .Alteration of mineral uptake from SA applications may be one mechanism for the alleviation of salt stress. In conclusion, exogenous SA treatments did not completely recover the deleterious effects of salt stress on the growth of Maize plants, but especially the 1.00 mM SA concentration improved plant tolerance to salinity as compared to the non-treated plants. Based on these findings, the SA treatments may ameliorate the negative effect of salinity on the growth of Maize .

Conclusion

Plant hormones are known as a strong and sustainable tool for reducing the adverse effects of live and non-polluting stresses on plants. Salicylic acid or sorbitol hydroxyl benzoic acid is a phenolic compound produced in a large number of plants by root cells and plays a role in plant growth and development as a quasi-hormonal substance. Acid oxalicyl regulates physiological processes in plants and reduces the side effects of stress and can improve the adverse effects of stress.

The coexistence of mycorrhizal fungi with most plants leads to the production of rooted colonies and under conditions of drought stress, improves the production of a number of crops. Improved production in mycorrhiza plants is associated with the absorption of most non-moving nutrients such as phosphorus, zinc and copper. There is a lot of evidence that mycorrhiza can cause changes in plant aqueous interactions and improve drought resistance or tolerance in host plants, many researchers described these properties as a secondary reaction as a result of improved absorption of nutrients. And plant root infections with mycorrhizal fungi influence parameters such as hydraulic conductivity, leaf water potential, leaf resistance and transpiration rate. Studies have shown that the cause of these changes is probably due to improved absorption of nutrients. All plants are in some way related to the relationship between mycorrhizal symbiosis. Since plants are the first producers in each ecosystem, it can be concluded that all organisms and all ecosystems from bacteria to humans and from wet soils to dry deserts are somehow dependent on the mycorrhizal coexistence relationships In the words of the symbiosis of Mycorrhiza, it is one of the most practical and, at the same time, the most extensive and most important symbiosis of the planet.

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