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Foliar application of putricine enhances salt stress tolerance in sunflower (*Helianthus annuus*)

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Abstract

The occurrence of salt in soil and water is the most vital and serious problem in agricultural land which hampers crop productivity all over the world. There are different techniques to beat the salt-forced impact on the development of the plant and its yield. This project was designed to observe the ameliorative role of exogenously applied putricine concerning growth, yield, and biochemical parameters of *Helianthus annuus* grown under salinity stress. The experiment was a completely randomized blocked design and plants were irrigated with different concentrations of salt (50mM, 100mM, and 150mM) as well as foliarly applied with different doses of putricine (0.1 mM, 1 mM, and 2 mM). Observations of the current study revealed, a significant reduction in different growth parameters (Root length, shoot length, fresh and dry biomass, number of leaves, seed weight, and seed number per plant), different biochemical aspects (IAA content, photosynthetic pigments, non-reducing sugars, total carbohydrates, and total proteins). Under the same environment, secondary metabolites (Phenols, lycopene, beta carotene, terpenoids, and total antioxidants) increased under stressed conditions. Foliarly applied putricine induced stimulatory effect and improved above mentioned parameters under normal and stressed conditions. Results of the current investigation suggested, that foliar application of putricine may have a protective role for *Helianthus annuus* and create a perspective for increasing tolerance in this plant for salinity stress. It is recommended that putricine application @ 2 mM is considered as the best dose for sunflower growth and better yield under a normal and stressed environment.

Keywords: Antioxidants, Carbohydrates, Chlorophyll, Growth parameters, Phenols, Putricine, Terpenoids

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Introduction

Non-living factors that affect particular environments and conditions on living organisms in an ecosystem are known as abiotic stresses. The influence of all environmental factors on population performance and individual organism physiology was studied, and these influences were significant and beyond the normal range of non-living factors (Wiegand et al., 2020). The formation of salt, an ionic compound, results from the neutralization reactions of base and alkali. Salt stress has a variety of effects on crop growth and yield. Salinity had two major properties of salt stress: ionic toxicity and osmotic stress, which cause various secondary problems such as reduced membrane cell development and the production of various assailants, reduced membrane cell development and the production of various assimilates with reactive oxygen species production, as well as decreased cytosolic metabolism (Yang et al., 2020).

Sunflower (*Helianthus annuus*) is a member of the family Asteraceae and grown in different countries with the semi-arid condition in different marginal soils. In such an environment different abiotic stresses act as hazardous and growth-limiting factors for different crops every year. Sunflower has the best structure and organs that suit to endure different stress conditions in the field (El Moukhtari et al., 2020). So, this crop is regarded as drought resistant and grown in different semi-arid regions with hot climatic conditions. Different sunflower breeding programs concerning high temperatures and drought are the main and important objectives.

Polyamines are characterized as moment all-inclusive polycations in a few cycles of plant development and advancement. These particles are most popular for their enemy of senescence and anti-stress impacts in plants as a result of cancer prevention agents, the balance of acids of these atoms their cell divider, and layer settling properties. These atoms have been read for their crucial functions in the variety of security reaction of plants to invalidate various anxieties present in the climate, that incorporates oxidative pressure, metal poisonousness (Arif et al., 2020), dry season chilling pressure (Sarker & Oba, 2020) and saltiness. It has likewise been contemplated that foliar use of polyamines is viewed as a powerful procedure to create persistence of harvest to explicit worry for improved efficiency of the yield. Exogenous utilization of putrescine has been seen as a helpful and effective procedure used to grow hefty metals, saltiness, flooding and waterlogging (Khan et al., 2020), cold, high-temperature, dry season, osmotic pressure resilience of plants (Van Zelm et al., 2020). This task was intended to assess the mitigative impact of putricine on sunflower developed under salt pressure. The ameliorative effect was studied concerning the change in vegetative and reproductive growth, oil content, and biochemical attributes under both putricine treated and non-treated plants irrigated and with saline irrigation water.

Materials and Methods

Seeds of *Helianthus annuus* were obtained from Agriculture Research Institute Tarnab, Peshawar, Khyber Pukhtunkhwa, Pakistan. For this investigation, a total of 48 pots divided into four additional sets were used. There were four treatments in total, as shown here:
Treatment 1: Control with no putricine and three salt treatments (50mM, 100mM, and 150mM).
Treatment 2: Putricine 0.1mM polyamine the set includes a control and three salt treatments (50mM, 100mM, and 150mM). Treatment 3: Polyamine was given as putricine at a concentration of 1 mM in a set that included a control and three salt treatments (50 mM, 100 mM, and 150 mM). Treatment 4: Polyamine given as putricine 2mM, with a control and three salt treatments included in the set (50 mM, 100 mM, and 150 mM).

In this project, 45 cm significant plastic pots were used, with 12 pots in each set and three pots retained for each treatment out of 48 pots. I) non-saline control, II) 50 mMNaCl, III) 100 mMNaCl, and IV) 150 mMNaCl each pot was stacked with sandy topsoil soil that had been cleaned. Each bottle's soil was soaked in a different amount, and added Hoagland solution normally.

Around uniform assessed and indistinguishable measures of seeds were surface cleaned with 0.1% mercuric chloride for one second and from that point washed with refined water. 4 seeds were planted in each pot. They were then ventured by step inundated with an indistinguishable complete i.e., 50 ml of apparatus water. Precisely when seedlings were reached at 3 leaves stage, they were dissipated as one seedling for each pot. All these 48 pots were then sorted out in a randomized game plan (CRD) in the Botanical Garden of the Department of Botany, Abdul Wali Khan University, Mardan.

Salt treatment was given and a brief timeframe later, each pot was submerged with 1.5L of nozzle water multiple times every week. Precisely when salt treatment was done in pots, various centralizations of polyamine (putricine) were applied foliar in various sets.

Agronomic traits

Agronomic boundaries were estimated at end of the investigation and plant tallness, root length, number of leaves, new and dry biomass, number of seed/plant, and seed weight/plant were recorded.

Biochemical attributes determination

Fresh leaves were collected at a grand period of growth for determination of the amount of chlorophyll a, chlorophyll b, total chlorophyll, non-reducing sugars, reducing sugars, carbohydrates, proteins, IAA, phenols, β carotene, lycopene, total terpenoids, and total antioxidant status.

Chlorophyll extraction and estimation

The assessment of chlorophyll was implemented by a spectrophotometric strategy depicted by (Lan et al., 2020).

Non-reducing and reducing sugars determination

The assurance of diminishing sugars was performed by the spectrophotometric technique depicted by (Oliveira et al., 2020).

Total carbohydrates estimation

The number of absolute starches was broken down utilizing the spectrophotometric strategy (Kunji et al., 2020).

Determination of proteins

The process is fast and delicate aimed at the estimation of microgram measures of proteins utilizing the rule of protein-shading definitive (Kunji et al., 2020).

Endogenous IAA determination

For assurance of indole acidic corrosive (IAA) plant tests were dissected by (elite fluid chromatography) HPLC, as portrayed by (Pérez-Pastrana et al., 2021).

Total phenol determination

The number of all-out phenolics was examined utilizing the Folin–Ciocalteu (FC) spectrophotometric strategy depicted already by (Yuri et al., 2020).

Lycopene and β carotenes

β-Carotene and lycopene were resolved by the strategy for (Yin et al., 2020).

Total terpenoids

Total terpenoids in plants were determined according to the method of (Ahammed et al., 2020).

Total antioxidants/enzymatic antioxidants

The ferric particle's lessening power ability of tests was dictated by utilizing the changed spectrophotometric technique (Iqbal et al., 2020).

Statistical analysis

The exploratory arrangement was Completely Randomized Design (CRD) bearing three salt levels to three reproduces. Results were dissected by single direction ANOVA utilizing SPSS 21.0 factual programming and noteworthy contrasts between the methods for boundaries were dictated by utilizing the Duncan's Multiple Range Test (P < 0.05).

Results

Agronomic traits

The results of this project revealed that plant height, fresh and dry weights, and leaf number per plant were all significantly reduced (P< 0.0001) under different NaCl doses (Fig. 1, 2, 3, 4). Our experimental results were matching with the conclusion of different authors in salt irrigated plants e.g. mung bean, sunflower (Sedlar et al., 2020). Leaf number and chlorophyll contents of plants are decreased salt irrigated water. A decrease in dry biomass, number of leaves was recorded in the *Phaseolus* plant when treated with salinity stress (Fig. 3, 6). When the level of polyamine, putrescine foliar application reached 5mM, it significantly increases chlorophyll a, b, and carotenoids of wheat (*Triticum aestivum* L.) which increase the fresh biomass of the plant (Fig 7; 8; 9; 10; 11). As the number and weight of seeds/plants are concerned the sensitivity of the plants increased when salt concentrations were increased in the medium and these parameters showed decreased (P< 0.05) values in the present project (Fig. 6). The number of pods and the weight of seed are two main components of yield which reflects the performance of any plant during the plant's previous stages of vegetative growth and flowering status. It means that when the requirements of the plant are completed in their agronomic growth period it will produce bitter seeds.

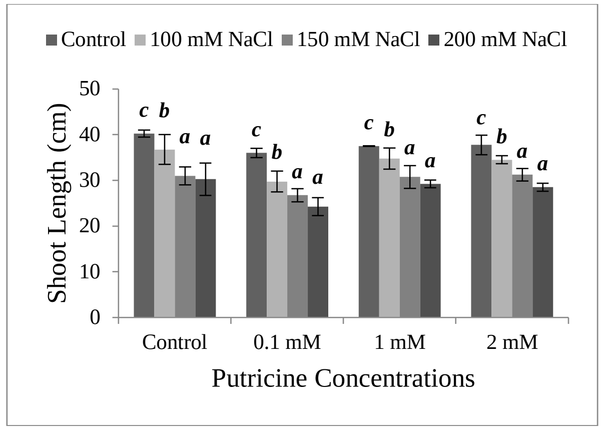

Fig. 1 Impact of different doses of putricine on shoot length *Helianthus annuus* grown under salt stress. Values are the means ± SD (n=3) and the bars indicate SD. Different letters denote statistically significant differences (P< 0.05) between salt and putricine concentrations LSD (least significant difference) ANOVA post-hoc test.

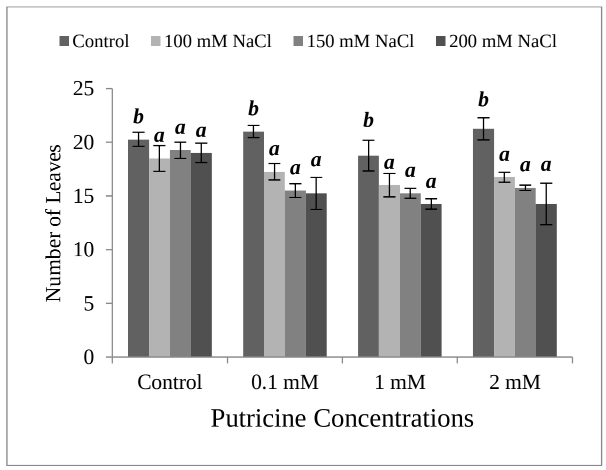

Fig. 2 Impact of different doses of putricine on the no. of leaves *Helianthus annuus* grown under salt stress. Values are the means ± SD (n=3) and the bars indicate SD. Different letters denote statistically significant differences (P< 0.05) between salt and putricine concentrations LSD (least significant difference) ANOVA posthoc test.

Sugars and proteins

After application of salt stress plants normally copes in different ways and among those accumulations of proteins and compatible solutes such as glycine betaine, soluble sugars, prolines, and different sugar alcohols with their function in osmotic adjustment in plants Concerning reducing and non-reducing sugars different salt concentrations in growth medium were found to significantly (P< 0.001) reduce their content (Fig. 12, 14).

In salt stress conditions, sugars (non-reducing and reducing) accumulations are observed in the literature and this accumulation allows osmotic adjustment in plants (Depaepe et al., 2021). In the present study, the putricine treated plant showed a significant decrease. After foliar application of putricine treated plants showed a significant (P< 0.001) increase in non-reducing and reducing sugar under salt stress and normal conditions. In the present study saline medium significantly (P< 0.001) reduces the total carbohydrates (Fig. 13), observed that *Olea europaea* L. shoots showed a decrease in total carbohydrates under salt stress conditions. The reason for the decrease was due to osmotic stress and also because of the presence of toxic Na^+ and Cl^- ions. Application of different concentrations of putricine as foliar spray reduced the effect of salinity on total carbohydrates of sunflower plants. Analysis of variance of the data presented indicated that salt stress significantly (P<0.001) reduces (Fig. 16) total proteins in sunflower plants. It has been observed and reported that in the mulberry plant, the soluble protein was promoted by low salt levels and decreased by increased salt levels respectively. It was found that in mung bean, protein content has been improved after polyamines application with saline soil, worked on wheat plant and declared polyamine compounds as the most effective compounds for an increase in plant proteins under stress and normal environment.

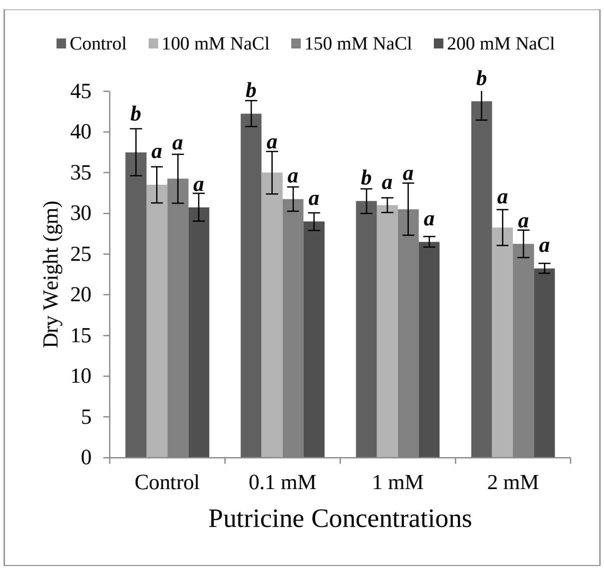

Fig. 3 Impact of different doses of putricine on dry weight *Helianthus annuus* grown under salt stress. Values are the means ± SD (n=3) and the bars indicate SD. Different letters denote statistically significant differences (P< 0.05) between salt and putricine concentrations LSD (least significant difference) ANOVA posthoc test.

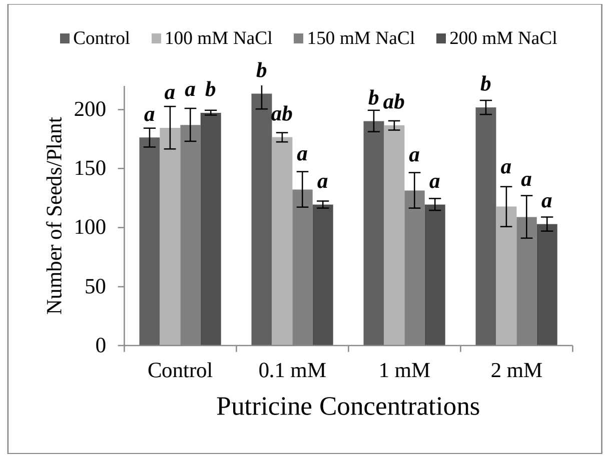

Fig. 4 Impact of different doses of putricine on the number of seeds *Helianthus annuus* grown under salt stress. Values are the means ± SD (n = 3) and the bars indicate SD. Different letters denote statistically significant differences (P< 0.05) between salt and putricine concentrations LSD (least significant difference) ANOVA posthoc test.

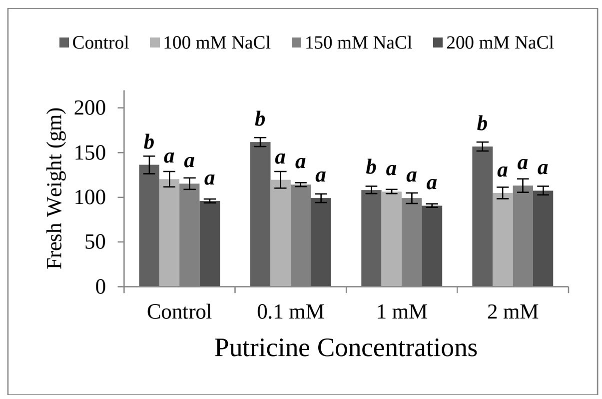

Fig. 5 Impact of different doses of putricine on fresh weight *Helianthus annuus* grown under salt stress. Values are the means ± SD (n=3) and the bars indicate SD. Different letters denote statistically significant differences (P< 0.05) between salt and putricine concentrations LSD (least significant difference) ANOVA posthoc test.

Endogenous IAA concentration

In-plant growth and yield, specifically Indole acetic acid (IAA) are very helpful under salinity with the help of other growth promoters. It is believed that auxin has a key role in the uptake of inorganic mineral nutrients and sugar in crops. Salinity harms endogenous auxin (Qian et al., 2021). Endogenous IAA showed a decrease in the value (P< 0.05) as salt increased in the soil. Stomatal induction of putricine in the plant in both medium (saline and non-saline) increased (P< 0.05) values of the same parameter (Fig. 17).

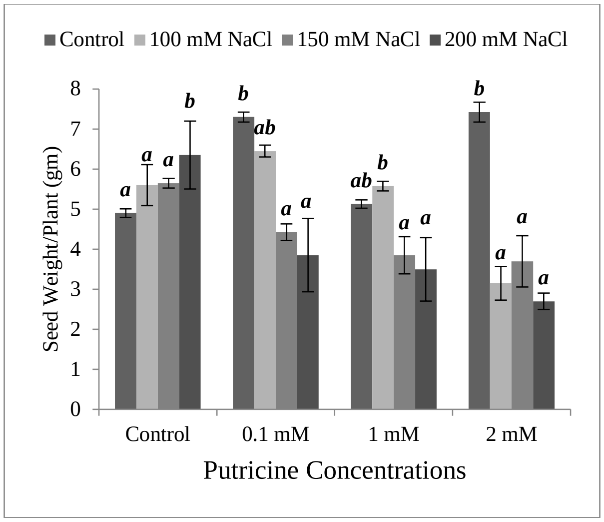

Fig. 6 Impact of different doses of putricine on seed weight of *Helianthus annuus* grown under salt stress. Values are the means ± SD (n=3) and the bars indicate SD. Different letters denote statistically significant differences (P< 0.05) between salt and putricine concentrations LSD (least significant difference) ANOVA posthoc test.

Secondary metabolites

During abiotic stresses, optional metabolites were gathered in the plant, and this expansion of metabolites in the cytosol can protect the phone from particle-induced oxidative damage by restricting the particles. Various phenols assume an indispensable part as substrates and free extreme foragers for some cell reinforcement chemicals. In the present investigation, different concentrations of salt were found to have a significant (P< 0.05) increase in total phenols of plants (Fig. 18), reported in their study that the polyphenols accumulate under moderate salinity in the mangrove. The foliar application of putrescine revealed a positive but non-significant effect as an increase in the phenols in stressed and normal sunflower plants. When cowpea was studied it was observed that different phenolic compounds were accumulated in shoots and roots as a result of their promoted biosynthesis under stressed conditions. There are numerous reports referred to in the writing about the expansion in complete phenols in various plants when developed under focused conditions. In the current investigation, it was seen that putricine plants demonstrated a huge (P< 0.01) decline in this boundary in the non-saline and saline climate. The accumulation of lycopene in plants depends on indifference in the water relation of the rhizosphere as well as minerals and plant hormones. Salinity prevents the uptake of water by roots, resulting in decreased enzyme and hormone production (Pappalardo et al., 2020).

It was proved that polyamines had a very positive effect on lycopene production in sunflower. In the present study, it was observed that after putricine spray plants showed a significant (Fig. 20; P < 0.01) decrease in this parameter in the non-saline and saline environment. It was stated that polyamines indirectly and lycopene directly helped the plant by the enzymatic cleavage of lycopene (carotenes) in increasing the rate of photosynthesis producing a positive effect on growth and yield (Bacchetta et al., 2020). These β carotenes help in photosynthesis and protect the plant from oxidative stresses. However, high salt stress sharply affects β carotene of the plants. The level of β carotene was increased (Fig. 21; P<0.0001) as salt concentration increased in the medium. As for short-term salt stress, β carotene was unaffected. The unaffectedness of β carotene to lower salt stress may be due to good tolerance (Ribeiro et al., 2020). The level of β carotene was variable to polyamines and salt. The application of putricine through stomata decreased (P<0.0001) the value of this parameter in both saline and nonsaline medium. Apocarotenoids are synthesized by the combination of enzymes and carotenoids which is very useful for plant photosynthesis, protection of plants from light intensity, and growth and yield. According to Vasconsuelo and Bo, there is a close relationship has been recognized between the plant's defense response and secondary metabolism. Increase in the value of terpenoids in plants was noticed significant (P< 0.05) as salt increased in the soil. Stomatal induction of putricine in the plant in both medium (saline and non-saline) lowered (P< 0.05) values of the same parameter.

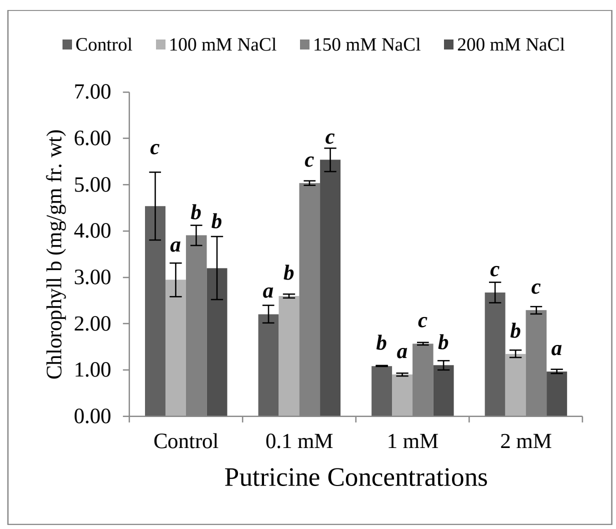

Fig. 7 Impact of different doses of putricine on chlorophyll b of *Helianthus annuus* grown under salt stress. Values are the means ± SD (n=3) and the bars indicate SD. Different letters denote statistically significant differences (P< 0.05) between salt and putricine concentrations LSD (least significant difference) ANOVA posthoc test.

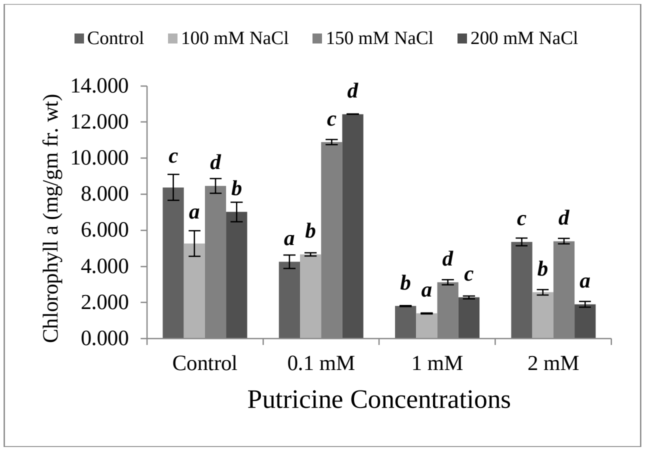

Fig. 8 Impact of different doses of putricine on chlorophyll a of *Helianthus annuus* grown under salt stress. Values are the means ± SD (n=3) and the bars indicate SD. Different letters denote statistically significant differences ($P < 0.05$) between salt and putricine concentrations LSD (least significant difference) ANOVA posthoc test.

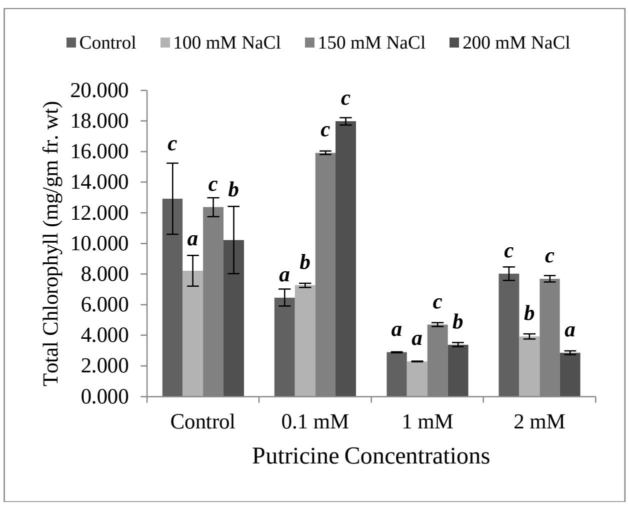

Fig. 9 Impact of different doses of putricine on total Chlorophyll of *Helianthus annuus* grown under salt stress. Values are the means ± SD (n=3) and the bars indicate SD. Different letters denote statistically significant differences ($P < 0.05$) between salt and putricine concentrations LSD (least significant difference) ANOVA posthoc test.

Total antioxidants

The absolute cancer prevention agent exercises of the readied tests were controlled by utilizing the decreasing capacity of ferric to ferrous measures. The information on absolute cell reinforcements delineates that distinctive salt dosages had a huge ($P < 0.01$) increment in all-out cancer prevention agents of regarded plants when contrasted with ordinary plants (Fig. 22). Utilization of foliar putricine had a positive impact as a huge ($P < 0.001$) increment in absolute cell reinforcements under ordinary and focused on conditions in the current examination.

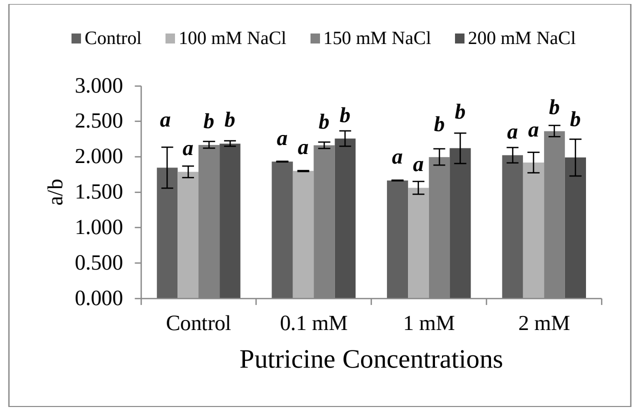

Fig. 10 Impact of different doses of putricine on chlorophyll a/b of *Helianthus annuus* grown under salt stress. Values are the means ± SD (n=3) and the bars indicate SD. Different letters denote statistically significant differences ($P < 0.05$) between salt and putricine concentrations LSD (least significant difference) ANOVA posthoc test.

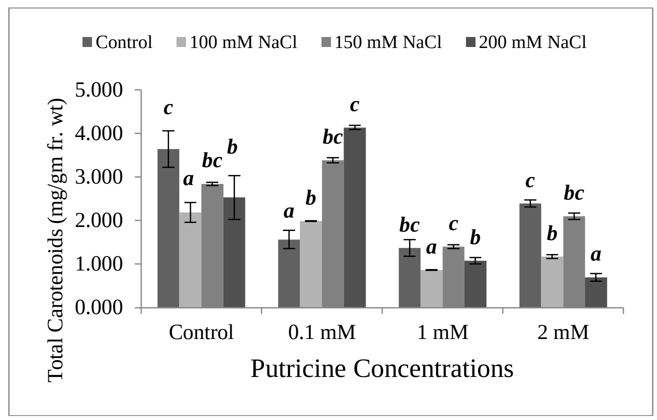

Fig. 11 Impact of different doses of putricine on total carotenoids of *Helianthus annuus* grown under salt stress. Values are the means ± SD (n=3) and the bars indicate SD. Different letters denote statistically significant differences ($P < 0.05$) between salt and putricine concentrations LSD (least significant difference) ANOVA posthoc test.

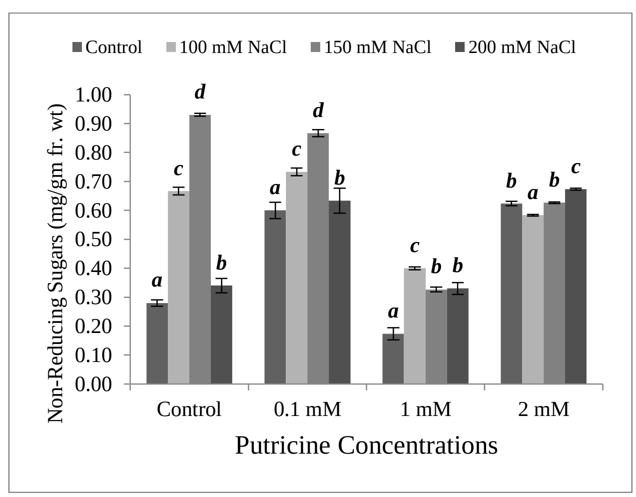

Fig. 12 Impact of different doses of putricine on non-reducing sugar of *Helianthus annuus* grown under salt stress. Values are the means ± SD (n=3) and the bars indicate SD. Different letters denote statistically significant differences (P<0.05) between salt and putricine concentrations LSD (least significant difference) ANOVA posthoc test.

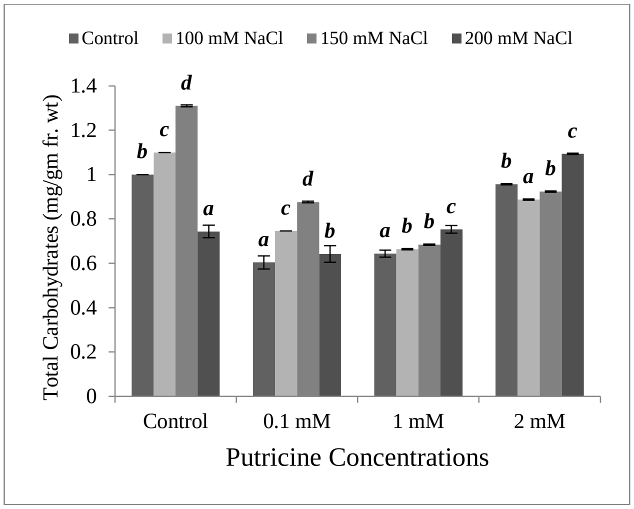

Fig. 13 Impact of different doses of putricine on carbohydrates of *Helianthus annuus* grown under salt stress. Values are the means ± SD (n=3) and the bars indicate SD. Different letters denote statistically significant differences (P< 0.05) between salt and putricine concentrations LSD (least significant difference) ANOVA posthoc test.

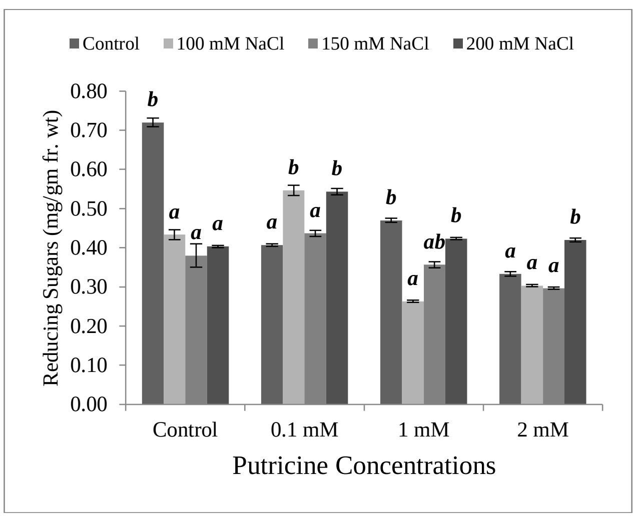

Fig. 14 Impact of different doses of putricine on reducing of *Helianthus annuus* grown under salt stress. Values are the means ± SD (n=3) and the bars indicate SD. Different letters denote statistically significant differences (P< 0.05) between salt and putricine concentrations LSD (least significant difference) ANOVA posthoc test.

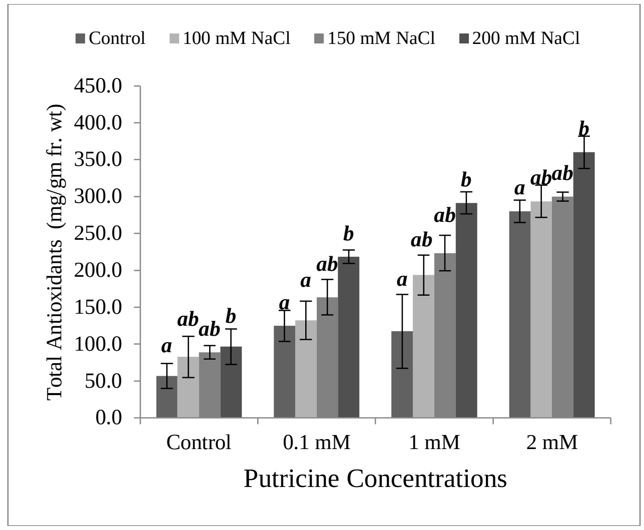

Fig. 15 Impact of different doses of putricine on antioxidant of *Helianthus annuus* grown under salt stress. Values are the means ± SD (n=3) and the bars indicate SD. Different letters denote statistically significant differences (P< 0.05) between salt and putricine concentrations LSD (least significant difference) ANOVA posthoc test.

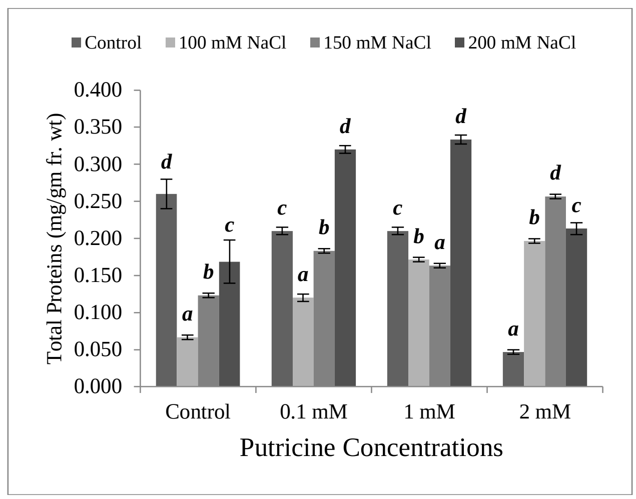

Fig. 16 Impact of different doses of putricine on the total protein of *Helianthus annuus* grown under salt stress. Values are the means ± SD (n=3) and the bars indicate SD. Different letters denote statistically significant differences (P< 0.05) between salt and putricine concentrations LSD (least significant difference) ANOVA posthoc test.

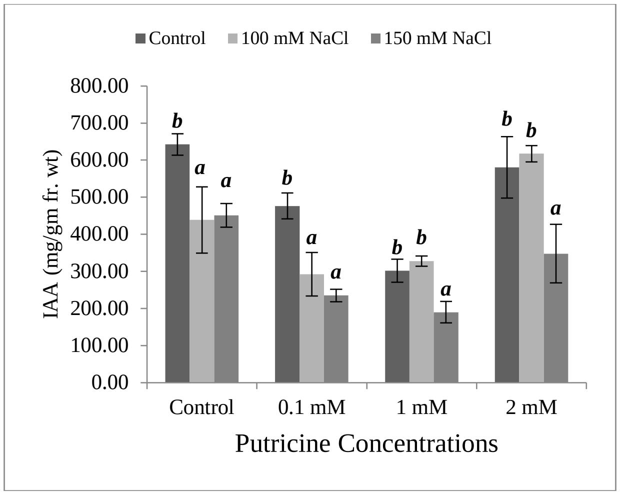

Fig. 17 Impact of different doses of putricine on IAA content of *Helianthus annuus* grown under salt stress. Values are the means ± SD (n=3) and the bars indicate SD. Different letters denote statistically significant differences ($P<0.05$) between salt and putricine concentrations LSD (least significant difference) ANOVA posthoc test.

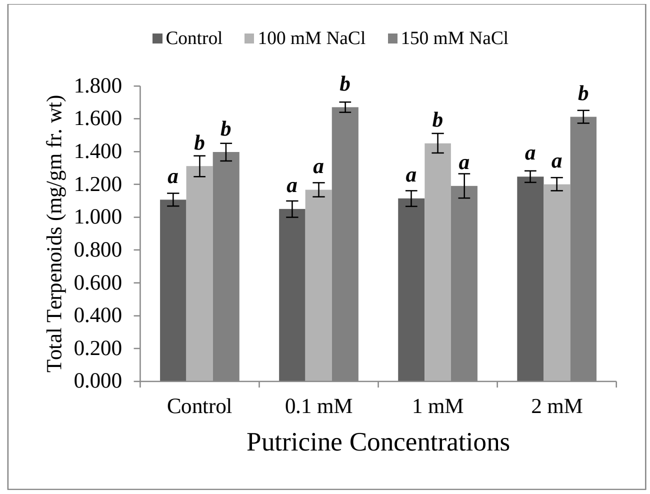

Fig. 19 Impact of different doses of putricine on Terpenoids of *Helianthus annuus* grown under salt stress. Values are the means ± SD (n=3) and the bars indicate SD. Different letters denote statistically significant differences ($P< 0.05$) between salt and putricine concentrations LSD (least significant difference) ANOVA posthoc test.

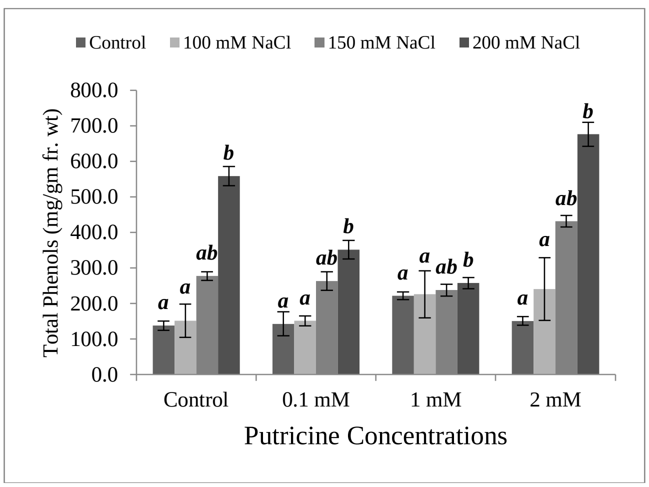

Fig. 18 Impact of different doses of putricine on Phenols of *Helianthus annuus* grown under salt stress. Values are the means ± SD (n=3) and the bars indicate SD. Different letters denote statistically significant differences ($P< 0.05$) between salt and putricine concentrations LSD (least significant difference) ANOVA posthoc test.

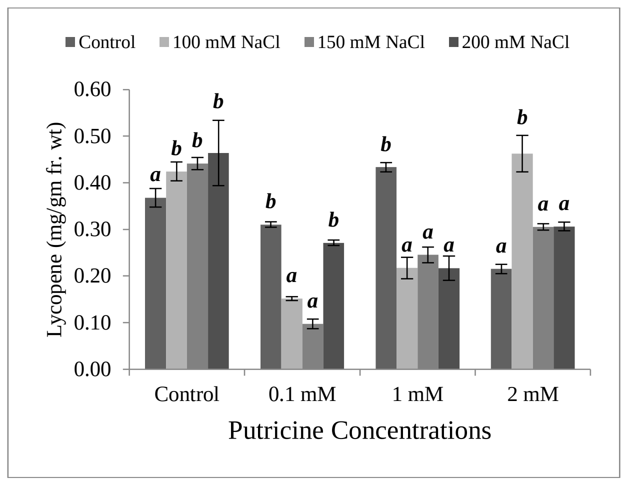

Fig. 20 Impact of different doses of putricine on Lycopene of *Helianthus annuus* grown under salt stress. Values are the means ± SD (n=3) and the bars indicate SD. Different letters denote statistically significant differences ($P< 0.05$) between salt and putricine concentrations LSD (least significant difference) ANOVA posthoc test.

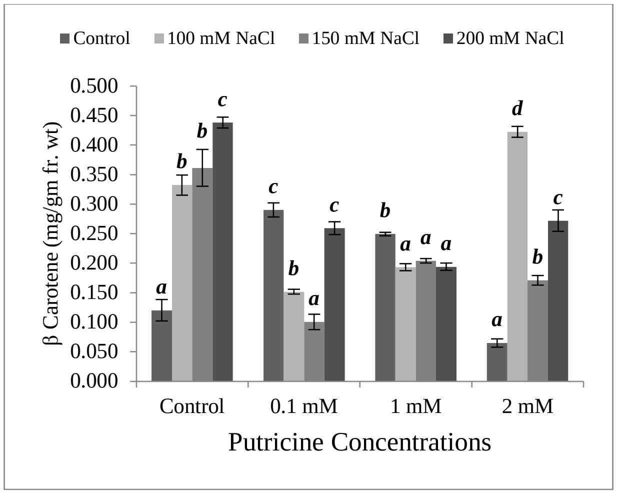

Fig. 21 Impact of different doses of putricine on β Carotene of *Helianthus annuus* grown under salt stress. Values are the means ± SD (n=3) and the bars indicate SD. Different letters denote statistically significant differences (P< 0.05) between salt and putricine concentrations LSD (least significant difference) ANOVA posthoc test.

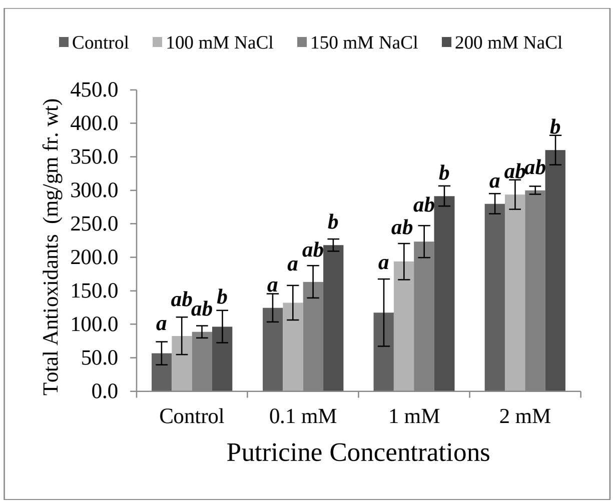

Fig. 22 Impact of different doses of putricine on total antioxidant of *Helianthus annuus* grown under salt stress. Values are the means ± SD (n=3) and the bars indicate SD. Different letters denote statistically significant differences (P< 0.05) between salt and putricine concentrations LSD (least significant difference) ANOVA posthoc test.

Discussion

The impact of salt application on the growth and biochemistry of *Helianthus annuus* was studied in this study. Furthermore, the behavior of the same plant was also studied with similar parameters after exposure to different doses of putricine. Salinity provides an increase in sodium and chlorine ions concentrations which minimize the growth of plants and yield by reduction rate of respiration and photosynthesis. Salt irrigated water has a direct negative impact on the number of leaves/plants (Arif et al., 2020). Salinity reduces plant photosynthesis efficiency through stomatal functions such as stomatal closure, Rubisco inhibition, and chlorophyll content loss.

As it is discussed that salinity causes a decrease in the quality and quantity of crop plants, so non-conventional methods cannot protect crops from salinity. One of the scientific methods used globally is the foliar application of hormones on plants. The results of most researchers showed a positive impact of polyamine on plants in salt stress. On *gladiolus* at 200 ppm concentration of spermidine and putrescine foliar application significantly increased plant height A similar trend was also observed in the present study where foliar application putricine showed non-significant improvement in these parameters. A higher concentration of spermidine foliar application significantly promoted leaves number per plant compared to non-sprayed plants. Studied *Origanum majorana* under NaCl stress with exogenous application of polyamines and observed a rise in shoot fresh and dry biomass and number of flowers (Molina-Montenegro et al., 2020).

In most crops when plants exposed to salt stress at any developmental phase of the plant led to minimizing reproductive and vegetative growth components. Another cause of the decrease in the number of seeds is a reduction in pollen viability and non-receptiveness of the stigmatic area. Salinity induced number of seed/plant reduces because of many biochemical and physiological disturbances in non-halophytic plants which grown in saline condition (Feng et al., 2020). A vital role of polyamines in growth and yield, growth of a plant, and yield depends on polyamines ratio. When the ratio of polyamines increases, the number of seeds also increases in each head of the sunflower. Application of putricine improved seed number and weight per plant non significantly under non-saline as well as saline conditions (Fig. 1). Our results were also supported by those who observed that the number of seeds/plants was maximum with 2mM spermidine concentration. When the concentration of polyamines increased the values of total dry biomass also enhanced which in turn increased seed number and weight of seeds/plant. Our result was the same as the result shown by where treatment with Spermidine improved grain yield *Oryza sativa* per plant (62% increases). So, under saline conditions, exogenous utilization of plant development controllers, for example, polyamines produces an expansion like development just as each harvest yield (Feng et al., 2020).

Numerous researchers announced that chlorophyll a, b, total chlorophyll, and carotenoids decline under the use of salt stress. Results acquired by cotton proposed that the decrease of chlorophyll fixation could be utilized for screening of plants for saltiness resistance. The information introduced in Figure 2 shows a critical decline in chlorophyll content because of salt pressure. Ainsworth and Long (2021) noticed that expansion in saltiness indicated decreased chlorophyll substance of kakooti (*Ziziphora clinopodioides*), thyme (*Zataria multiflora*), feline thyme (*Teucrium polium*), and garden thyme (*Thymus vulgaris*) plants. The application of different stresses on plants resulted in an increase in total carbohydrates in a reaction as an adaptation (Xue et al., 2021). Soluble sugars play a role as osmoprotectants for the protein under the stressed condition in addition to osmoregulatory (Molina et al., 2021). Hussein et al. (2006) observed that improvement in carbohydrate content and plant growth increased salt stress tolerance of plants which reflects the role of putricine in an increase in sugar concentration. Talaat et al. (2005) observed that treatment of putricine showed an increase in total soluble sugars, total insoluble sugars, and total protein of *Catharanthus roseus*. After the application of polyamines on *Ctenanthe setosa* leaves changes were investigated in proline, reducing sugar, level of soluble protein, and peroxidase activity. An increase in activity of peroxidase enzyme, while a decrease in the level of soluble proteins was observed after polyamine application, on the other hand, an increase in proline content and level of reducing sugars, was also observed after application of putricine and spermidine (Li et al., 2020).

The previous study also supported these results: investigated that increase the sugars concentration by putricine application may be due to the role of putricine in improving plant growth. Peng et al., (2020) studied wheat plants under putricine application and observed an increase in the total carbohydrates content which reflects an increase in the efficiency of the photosynthetic process and leaf carbon dioxide net assimilation rate which is the main and basic unit of carbohydrate. Experiments on *Dianthus caryophyllus* by and on *Bougainvillea glabra* by revealed that the application of putricine with different concentrations causes an increase in the level of carbohydrate content. During flower development competition for carbohydrate content occur and this phenomenon is observed in excised flowers (Quiroga et al., 2020). Plant respiration increase during senescence for the production of energy for maintaining living cells and this phenomenon attributed to a decrease in total carbohydrate content. The application of putricine causes the accumulation of different sugars in the tomato plant, demonstrated that in soybean, salt stress adverse effects on IAA. A little bit of contrast with our result found the addition of putrescine on root hair of *Cichorium intybus* with the concentration of its maximum 1.5mM produced an increased level of IAA than control. The influence of polyamines on *Origanum majorana* depends on a specific amine group of polyamines since this variation is due to the polyamines pool in the plant which is altered by foliar application of polyamines. The foliar spray of polyamines on Inqlab-91 has been increased the level of IAA under salinity (Molina et al., 2021).

Lycopene is valuable for plants' photosynthesis, insurance of plants from the light force, and development and yield. Lycopene was seen through mean information, as salt focus expanded, absolute lycopene of plants was all together ($P<0.05$) expanded (Fig. 4). The amassing of lycopene in plants relies upon reserve in the water connection of the rhizosphere just as minerals and plant hormones. Saltiness forestalls the take-up of water by roots, bringing about diminished catalysts and hormone creation. It was demonstrated that polyamines had an exceptionally constructive outcome on lycopene creation in sunflower (Kossler et al., 2021).

There are many reports concerning terpenoids that showing their increased concentration during stressed conditions which are the ultimate result of a reduction in biomass under the same condition (Peng et al., 2020). This increased result was also observed on whole plant bases under stressed conditions. In another case detected similar observations with increased monoterpenes with a corresponding loss in biomass in *Melissa officinalis*, *Nepeta cataria*, and *Salvia officinalis* under a stressed condition. The marvel was examined that in the pressure conditions cell reinforcements sum was expanded in the plant tissues. Saltiness expanded the cancer prevention agent action of leaves of the halophyte Cakile oceanic. The past writing about putrescine proposed that it might initiate antioxygenic proteins and improve cancer prevention agents in virginia pine seedlings and Indian mustard when developed under saline climate.

Conclusion

Based on the current investigation it is concluded that salt stress causes adverse effects on sunflower growth and biochemistry. The agronomic traits were significantly affected by different NaCl doses. As it is discussed that salinity causes a decrease in the quality and quantity of crop plants, so non-conventional methods cannot protect crops from salinity. One of the scientific methods used globally is the foliar application of hormones on plants. It is also observed that with the application Putricine, chlorophyll, sugar, and protein content, as well as IAA and secondary metabolites, are significantly affected. Therefore, the application of putricine seems to be an ameliorative factor, after observing the improvement and growth, yield, and biochemical attributes of the plant. Further, through the results of this project, it is recommended that putricine @ 2 mM foliar application on plants is more effective for the better growth of crops.

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