Alleviation of salinity stress mediated by Salicylic acid: An overview

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Abstract: Salicylic acid (SA) shows major effect on plant resistance to various environmental stress factors. Wheat plants treated with salicylic acid shows an increment in the level of cell division inside the apical meristem of seedling roots which results in increased plant growth. Adverse environmental conditions or stress like heat stress, salinity, and water stress hampers the growth of wheat. To mitigate this adverse effect of various types of stress we use SA of different concentrations in wheat either by foliar application or by seed priming. SA accelerates the growth and development of plant during stress conditions so it is known as the plant growth promoter.

Introduction:

Wheat (*Triticum aestivum L.*) is one of the chief cereal crop for the utmost of population of world. Wheat comes under family Poaceae (Gramineae). Triticeae tribe contain more than 15 genera and 300 species including wheat. Linnaeus was first person who classified wheat in year 1753. In 1918, Sakamura discovered the polyploid series for each commonly recognized type. Sakamura isolated wheat into three groups i.e diploids (2n=14), tetraploids (2n=28) and hexaploids (2n=42). Wheat is the significant staple food of about two billion people of world (i.e 36% population of the world). Wheat gives about 55% of the starches and 20% of the food calories burned through worldwide (Breiman and Graur, 1995). Wheat is getting cultivated under wide range of climatic conditions. India secured first position in area but ranks second in production after China with the average productivity of 3117 kg/ha.Wheat cultivation is supposed to begun in India 5000 years ago (Feldman, 2001). Today, India positions second in wheat production worldwide. It's area under cultivation is 28MHa. To tackle increasing demand of wheat without increasing area, we need to incorporate new physiological tools. These tools will add up for the advancement of breeding programme under abiotic stress environment.

Salicylic acid: Salicylic acid ($C_7H_6O_3$) is a beta hydroxyl acid also known as an endogenous growth regulator of phenolic type, which affects a range of different processes in plants, including seed germination, stomatal closure, ion up-take and transport, membrane permeability photosynthetic and growth rate. SA is additionally significant signal molecule for adjusting plant responses to environmental stress. SA is well known to provide protection against a number of abiotic stresses (Barkosky and Einhellig, 1993, Khan *et al.*, 2003; Harper and Balke, 1981; Cutt and Klessig, 1992; Senaratna *et al.*, 2000).

Salinity: Wheat production is significantly influenced by salinity stress. The cellulose content, lignin content of both shoots and roots show downfall with rise in Sodium Chloride concentration. Expansion in NaCl fixation results in increased Na^{2+} and Ca^{2+} accumulation and lowers K^+ and Mg^{2+} concentration in various organs of wheat plant. Soaking of grains in SA could result in handling the antagonistic impacts of NaCl salinity by inducing the accumulation of proline in wheat seedlings. Therefore, salinity plays a major role in the growth and development of wheat. Therefore, salinity should be neutralised in order to get higher wheat yields.

Salinity stress in wheat*:* High salinity results in lower germination rate, photosynthesis, transpiration, and higher accumulation of $Na+$ and $Cl-$ ions which disturb the normal metabolic processes i.e. germination, growth, photosynthesis, water relation, cellular damage, ion uptake, yield of wheat plants. Higher salinity results in stomatal closure in wheat hence reduce CO_2 availability in the leaves and inhibits carbon fixation. Hasanuzzaman *et al.*, (2017). Emergence percentage of wheat under salinity stress is greatly reduced as compared to non-saline conditions. Root dry weight and shoot dry weight also gets hampered under salinity. Chlorophyll content and osmotic potential also shows negative results in wheat due to the influence of salicylic acid.

Response of salinity stress:

1- **OS induction**: Under severe saline conditions, rate of ROS generation exceeds the scavenging potential of cellular defense system resulting in oxidative stress. Oxidative stress damages cellular components of wheat plant which results in dis-function and finally the death of plant.

2- **Reduced water uptake:** High salt accumulation leads to osmotic stress and causes low water potential which results in reduced water uptake which ultimately results in the drought stress and in severe cases death of the plant takes place.

3- **Ion toxicity:** Under saline conditions, there is higher accumulation of Na^+ and Cl^- ions which results in ion toxicity.

4- Nutrient imbalance: Under saline conditions the uptake of major primary nutrients N, P, K is greatly affected. Due to this nutrient deficiency the normal metabolic processes of wheat are hampered.

5- **Hampered growth:** Under moderate saline conditions wheat plant shows hampered growth as growth processes are hampered. There will be low germination percentage, reduction in plant height and other morphological characteristics (Nadeem *et al*., 2013).

6- **Reduction in yield:** Salinity directly affects the yield as it negatively affects the growth processes in wheat plants. Due to this detrimental effect in growth factors, normal metabolic processes are disturbed and there is reduction in yield (Zeng, 2001 and Carillo, 2001).

7- **Cellular damage**: Uncertain growth and irregular uptake of water and other essential nutrients ultimately result in destruction of cell membrane properties of wheat plants. Wheat seedlings experienced lipid peroxidation, accumulation of hydrogen peroxide (H2O2), and increased membrane permeability under salt stress. Cellular damage mainly occurs under highly saline conditions (Nxele, *et al*., 2017 and Shabala and Munns, 2012).

Role of Salicylic under Salt Stress:

Antioxidants help in maintaining the reactive oxygen species levels in plants. Phenolic compounds and tocopherol are one of the examples. The higher concentrations of antioxidants in plants help to overcome salt stress. Therefore, Salicylic acid plays a major role in controlling salinity stress by inducing antioxidants. Osmolytes are small and minute molecules which are mostly soluble (AbdElgawad et al., 2016; Gupta and Huang, 2014). To mitigate the salt stress, plants accumulate various osmolyte like proline, glycine and betaine (Qureshi *et al*., 2013 and Siddique *et al*., 2018. The phenolic group compounds are secondary metabolites in plants. Salicylic acid is also one of them. It acts a signaling molecule that respond against environmental stress in which salinity stress is one of them. Salicylic acid helps the plants in the absorption of mineral nutrients from soil during salinit y stress which helps t he plant to stay strong. lt regulates the osmotic potential in favour of the plant. Plant hormones are the chemicals that are produced within plants in minute qu ant it y that helps the plants in regu lating normal metabolic processes in adverse environmental conditions. Some pla nt hormones like Salic y lic acid produced within plants in minute quantit y which help to overcome against stress. So that overall these compou nd mediate in ROS detoxification and in the protection of phot osynt he tic system which u ltimate1 y leads in alleviating the cellu lar damage against salt stress (Das and Roychoudhury, 2014 and Sharma et al., 2012)

Conclusion:

Soil salinit y is a major issue in agriculture that leads to great loss in economics. Salinit y at lower concentrations causes hampered growth while at higher concentrations leads towards the death of the plant. Plant treated with salicylic acid, leads to produce Osmolytes, Phenolic compounds and stress growth hormone while also lead to enhance the level of nutrient and water uptake. So that over all ROS detoxification get activate hence the cell and its membrane become protected against salinit y stress.