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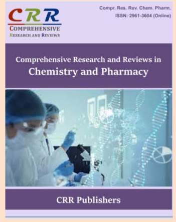

(Review Article)

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Effect of water soluble and soil soluble salts on growth and nutrient uptake pathway of halophyte

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Abstract

The area of earth affected by salinity is expanding gradually because in agribusiness, salinization of water or soil is one of the world's most genuine ecological issues. Due to presence of excess salts in soil or water, most of yield of crops affected. Most of the problems due to salinity are described by most of inorganic salts. The salinity is shaped under the most important climatic states because due to reduced molecular activity of water causes increase in water vaporization. For most of the important crops, mean yield is only a fraction, somewhere between 20% and 50% of listed yield; mostly all this waste is due to lack of rain and salinity rich soil, climatic states which will aggregate in most area as the consequence of worldwide environmental change. In addition to this, salt-effected soil is adjacent to the territories in which the salinity is produced by the low quality of the waterlogging method of moisten. The physiological and metabolic developments in plants are stimulated by the saline soil but growth is affected by it. As a result of the salinity stress, plants hold against, ovule growth, life span, yield, and its divisions. Due to salinity, photosynthesis, and rate of respiration of plants are decreased. Some of plants grow better under saline environment than normal condition. Population of world is increasing rapidly and development of industries, agricultural land is declining day by day. Therefore, it is necessary to use the affected area to fulfil the needs of food. Anyhow, there is a requirement to make the easy and low-cost biological systems which can be used in short period ways because comparable means are extensive. For salt ability to last, hereditary change will transpire to be steadily essential as it requires to be major to make the border of the soil. In conclusion both soil and water salts are major harmful threats which are adversely affecting the agricultural environment.

Keywords: Halophytes; Salt Stress; Agricultural Environment; Nutrient uptake

1. Introduction

The area of the soil that appears mostly in the dry and barren condition is called salinity. Environmental pollution, rise in the salinity of soil, and lack of water are major threats in the 21st century. Two crucial threats are present in the way of agricultural prolongation: increase in the human population and availability of the land for growing the crops. (Ashraf et al., 2013). Extraordinary salinity is present in way of required variables and production in arid place. About 37% land of the world is sodic and 235 of it is saline (Duke, 2001). By the net century, the provocation of feeding almost 10 billion peoples is changing agricultural lands into deserts that's why it occurs naturally existing only across a great development in cultivation of crops for tolerating salt stress (Yang et al., 2018). The breeding production of agricultural crops is affected by many environmental pressures like high temperature, salinity of soil, elevated current in air and dry spell. The major disastrous environmental stress is the salt stress that is the reason of decrease in crop yield (Yamaguchi et al., 2005). Ionic stress and osmotic stress are two main threats present in saline soil that effects the plant growth (Colmar, 2008). The seas and oceans focus on the soil salinity at the salts entrance and expelling points because the

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water and salt consistency are same. With the balanced control of solution beneficial molecules by plants, concentration of dissolve able salts by their high osmotic pressure effects the plant growth (Davenport et al., 2003). The metabolic and physiological developments in plants are stimulated by the saline soil. As a result of the salinity, plants hold against, root's and shoot's necrosis, ovule growth, life span, yield and its divisions (Kozlowski, 1997). By salt probating, higher plants can resist high salt anxiety (Sykes, 1922).

1.1 Salt Excluders

Salt preventing capacity is present in the salt excluders from some parts of the plants or from the entire plant. The surface difference in such types hold up the uptake of K^+ over Na^+.

1.2 Salt Accumulators

The power to change the uptake of high salts is present in the salt accumulators, it focuses by the one of two methods. By guarded flicks its normal for halophytes to go through aerial weight of intercellular salts. The Na^+ to K^+ percentage of high tissue is clear. The removal of excess salts which are entering in the plant where the salt particles are taken up by roots but deleterious effects of them are excluded and this is happening through second method (Shafer, 2001). To increase the growth of crop in the saline soils, the excess salts are needed to be excluded from the region of root.

1.3 Halophytes

Halophytes are the plants that can exclude the collected salts from the layer of the dust and can bear the sever salt anxiety (Shaba and El-Foully, 2002). Halophytes are also called "best germplasm" for the saline agriculture because they have ability to survive under the extensive intense saline conditions. **Obligate halophytes** are the halophytes that need salts continuously for their growth (Braun, 1932). The **"facultative halophytes" are** the halophytes that can grow in the salt deficient soil (Polunin, 1960). Based on endurance for sodium salt and salt requirement are referred as facultative and obligate halophytes (Grigore et al., 2012). The halophytes which have capacity to survive in salt rich soil are normally preferring to live in salt-free soil because such halophytes have different natural environment (Cushman, 2001). By intermixing research reviews with ecological factors(salinity), a new type of classification of halophytes is proposed; neophytes and extreme halophyte (irreversible and reversible) (Grigore and Toma, 2010). The halophytes which are growing exclusively in the saline environments are well adapted extreme halophytes. Moreover, such halophytes have reversible or irreversible natural environment. For imparting salinity endurance, some of salt tolerance pathways are coordinately associated because is very complex process. From the halophytes several the salt receptive genes are recorded, according to the stress, physiology of plant can be balanced because there is always a search for rising stress-reactive genes. *Salicornia* and *Aeluropus* are the halophytes which are saved for all the salts that are proponents and receptive to the genes as undeveloped postulant. Through genetic engineering, salt endurance mechanism in plants can be developed by halophytes (Tanna, 2017).

1.4 Stress of Salt

In plant body the accumulation of high amount of salt in plant body, water and soil is referred as Salinity. There are many factors which effect the growth, vintage and development of plant in numerous ways some of these abiotic stresses include salinity, drought, extreme low and high temperatures the impact of these abiotic stresses on the growth of plant yield is 50%. Salinity has the most adverse effect out of all these abiotic stresses on the life cycle of plants (Zhu and Jin *et., al*). In agriculture fields, salt stress is recently an unrecognized issue. The effect of soil salinity on different soils is measured according to percentage which explains that around 6% of the dampened land and 20% of the earth's agriculture land are affected by salt stress. It is predicted that near 2025 around 50% of the agriculture land is harmed by salinity. Environmental and anthropogenic action promote soil salinity, and which grow at much high rate with the time being.

1.5 A Glimpse of Endurance of salt in Halophyte Plants

The halophytes do well under high salinity with the help of two strategies, salt avoidance and salt tolerance because these are well developed. Mostly, halophytes follow three systems: excretion of the sodium ions, compartmentalization, reduction of Na^+ influx (Colmar, 2015). In halophytes, the distribution of secretions and salt excluding structures like (salt hairs or salt glands) is present. The excess of the salts ae removed from some halophytes which have ability to exclude the salts. These salts when exposure to air which may be visible on the leaf aspect becomes crystals. Some of the halophytes start losings the leaves which are grown under salt rich concentration. To avoid the harms of saltiness this is another strategy (Grigor et al., 2014). Halophytes impart salt tolerance at molecular level by controlling stress-reactive genes through two control mechanisms: ABA-dependent or ABA-independent. In halophytes salinity endurance is a complex system that is required in the interlinkage of multiple physiologically reactive demand by a variety of genes and various products (Grigor et al., 2014).

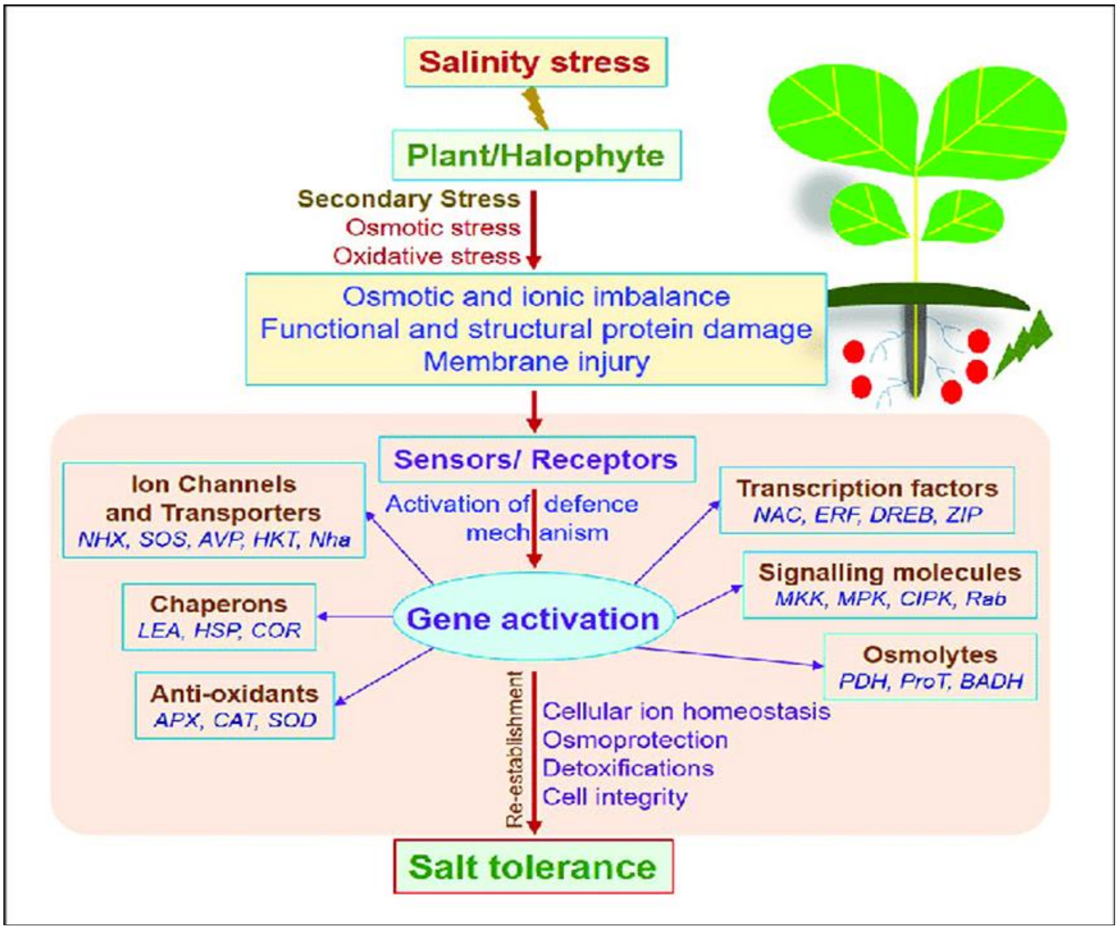

Figure 1 A generalized schematic representation of salinity stress tolerance mechanism in a plant (Mishra &Tanna, 2017).

Overall, the formation of osmo protectants, ion homeostasis (both efflux and influx) is changed and activation of crosslinked genes, induction of antioxidants and the development of the salt gland like changes are present in salt endurance mechanism of the halophytes (Shabala et al., 2014).

Table 1 Abiotic stress responsive genes of halophytic origin reported to enhance salt tolerance in glycophytic hosts (Mishra &Tanna, 2017).

Halophytes	Genes	Description	Recipient plants	References
Avicennia marina	*AmMDHAR*	Ascorbate regeneration and ROS scavenging	*Nicotiana tabacum*	Kavitha et al., 2010
Halostachys caspica	*HcNHX1*	Vacuolar Na+/H+ antiporter	*Arabidopsis*	Guan et al., 2011
Halostachys caspica	*V-ATPase*	Vacuolar-H+-pyrophosphatase	*Arabidopsis*	Hu et al., 2012
Kalidium foliatum	*V-ATPase*	Vacuolar-H+-pyrophosphatase	*Arabidopsis*	Yao et al., 2012
Salicornia brachiata	*SbGSTU*	Tau class glutathione transferases	*Nicotiana tabacum*	Jha et al., 2011

Salicornia brachiate	*SbMT-2*	Metallothionein: ROS scavenger	*Nicotiana tabacum*	Chaturvedi et al., 2014
Salicornia brachiata	*SbNHX1*	Vacuolar Na+/H+ antiporter	*Jatropha curcas*	Joshi et al., 2013
Salicornia brachiata	*SbNHX1*	Vacuolar Na+/H+ antiporter	*Ricinus communis*	Patel et al., 2015
Salicornia brachiata	*SbNHX1*	Vacuolar Na+/H+ antiporter	*Cuminum cyminum*	Pandey et al., 2016
Salicornia brachiata	*SbpAPX*	Peroxisomal ascorbate peroxidase	*Nicotiana tabacum*	Singh et al., 2014a
Salicornia brachiata	*SbpAPX*	Peroxisomal ascorbate peroxidase	*Arachis hypogea*	Singh et al., 2014b
Salicornia brachiata	*SbSDR1*	Salt and drought responsive gene	*Nicotiana tabacum*	Singh et al., 2016
Salicornia brachiata	*SbSRP*	Salt responsive protein encoding gene	*Nicotiana tabacum*	Udawat et al., 2017
Salicornia brachiata	*SbUSP*	Cytosolic universal stress protein	*Nicotiana tabacum*	Udawat et al., 2016
Salicornia europaea	*SeCMO*	Enhanced glycine betaine synthesis	*Nicotiana tabacum*	Wu et al., 2010
Salsola soda	*SsNHX1*	Vacuolar Na+/H+ antiporter	*Alfalfa*	Li et al., 2011
Spartina alterniflora	*SaVHAc1*	Vacuolar H + -ATPase subunit c1	*Oryza sativa*	Baisakh et al., 2012
Suaeda corniculata	*V-ATPase*	Vacuolar-H+-pyrophosphatase	*Arabidopsis*	Liu et al., 2011
Suaeda liaotungensis	*SlASR1*	Abscisic acid stress ripening	*Arabidopsis*	Hu et al., 2014
Suaeda liaotungensis	*SlNAC*	NAC transcription factor	*Arabidopsis*	Yang et al., 2014
Suaeda salsa	*SsCAX1*	Vacuolar H+/Ca2+ Transporter	*Arabidopsis*	Han et al., 2012
Suaeda salsa	*Ss.sAPX*	Stroma ascorbate peroxidase	*Arabidopsis*	Li et al., 2012
Suaeda salsa	*SsCHLAPX*	Chloroplastic ascorbate peroxidase	*Arabidopsis*	Pang et al., 2011
Suaeda salsa	*SsGST*	Glutathione *S* -transferase	*Oryza sativa*	Zhao and Zhang, 2006
Tamarix androssowii	*TaMnSOD*	Antioxidant: manganese superoxide dismutase	*Populus*	Wang et al., 2010
Thellungiella salsuginea	*TsLEA1*	Late embryogenesis abundant (*LEA*)	*Arabidopsis*	Zhang et al., 2012
Thellungiella salsuginea	*TsTIP1*	Tonoplast AQP gene	*Arabidopsis*	Wang et al., 2014

1.6 An Overview from Halophytes About Salt Responsive Genes

Under the pressure free environment halophytes show spreading of a higher amount of stress decreasing genes indicating set up expression of genes. Moreover, in response to abiotic stress halophytes are tolerant because of presence of highly different requirement of similar primary set of stress-reactive genes in all plants. The single species of halophytes cannot be considered as representative specie because different halophytes use different strategies to respond against the salt stress. For the avoidance of salt stress and genetic engineering of crop plants, from different halophytes salt reactive genes and proponents are introduced using transgenic technique (Avinash Mishra and Bhakti Tanna, 2017).

1.7 Effect of salt stress on nutrient uptake

Growth of plant is reduced under salt stress, disturbing supplements is affected by effecting the accessibility, division of supplements and transfer. Due to the resistance of Na^+ and Cl^- with supplements, saltiness may become relevant to the deficiency or pitted properties of supplement. For example, Ca^{2+}, No^{3-} and K^+ because of toxicity of certain particles the plant growth reduced under the saline environment (Grattan and Laments, 1999). To influence in Na^+ and Cl^-, enlarged NaCl center has been considered. It is declined in the K, Ca, P, N (Ooroj, 2006).

1.8 Osmoles and Osmoprotectant

For plant growth under salinity, plants require water pressure, turgor, and uptake of water under the soil (Analyzer and Davenport, 2003). Either by taking soil or by mixing the metabolic solutes, this drives an increase in osmotic. Cytoplasm collects low-sub-atomic mass rlies to increase the adjustment of ions in the vacuole. That best solutes on the grounds don't intrude with normal biochemical reactions. In biochemical reactions they replace water without influenced (Zhuang and Lecher, 2003). Accepted components of osmolytes are certainly of structures and osmotic correspondence keep up moving with water influx (or decreased efflux) (Hasegawa et al., 2000). K^+ like natural solute osmoles are basic key particles (Yokoi et al., 2002). Natural osmotic solutes contain of basic primary sugars (mainly, glucose and fructose), complex sugars (fructose and raffinose) and alcohol sugars (methylated and glycerol) and the solutes that assemble with different type of life and even among the species of plant. It is significant classification (Rohnert, 1996). Sugar and salts ae present in roots of plant. Water rapidly moves from the soil towards plant when the plant is growing in the moist, salt free soil because there is difference in the osmotic potential between the root sap and muddy water. On drying of the soil, the salt centers in the muddy ranging supplements and all the water lifted tightly bound to the surface of the soil molecules. Such progress is due to streaming of water into plant decrease as the muddy water potential supplement. The plant naturally holds the dust, and its growth stops at the point where the process of drying starts when the addition of water into the mud stops and the enough water is present into the roots and roots are disabled to hold more water. When fixation of the salt is higher, the less amount of muddy water is capable to reach the plant.

1.9 Effects On the physical properties of soil of salinity

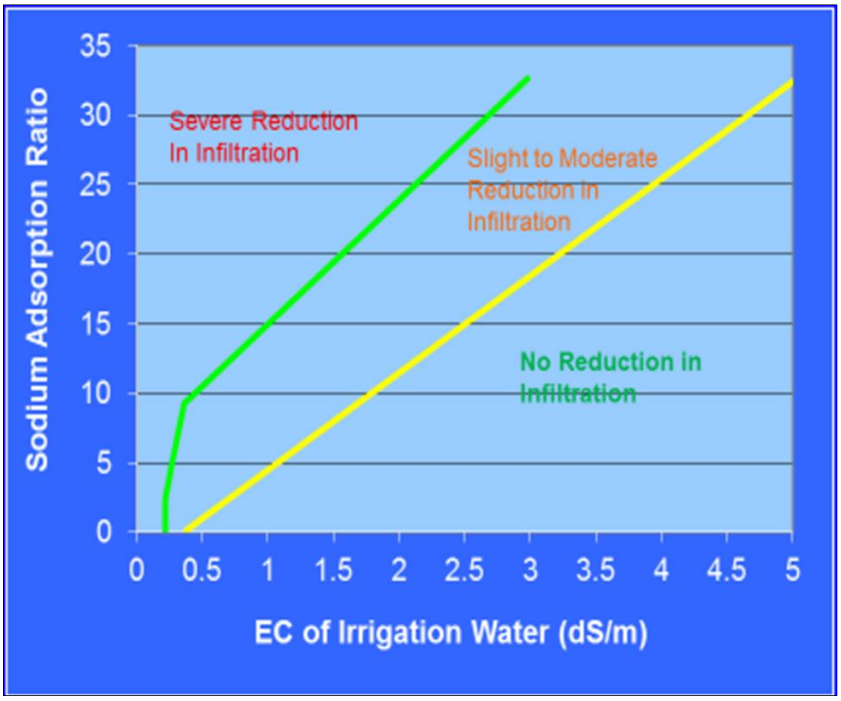

Figure 2 Effect of salinity and sodicity on physical and water contents of soil (**Pearson & Bauder, 2006)**

By giving rise to the hold together the fine particles of the soil into piles, soil water salinity can influence the physical attributes of the soil. Such a process is called "**flocculation**". In penetration of root, growth of root and soil aeration, this process is useful. Even though the impact of increase in the salinity, the solution of soil is positive for soil aggregation and soil balance but due to saline condition it have potentially adverse and negative impacts on the plants. As a conclusion, without taking in consideration the effects on the plant growth, salinity cannot be increased to balance the structure of soil (Nikos and James.,2003).

1.10 Effects of Sodium on soil physical properties

Sodium effects are opposite as compared with other salts present in soil. Aggregation, dispersion of soil and clay particles are basic physical processes that are related to the high concentration of sodium. When excessively large ions of sodium move nearer the forces that holds the clay particles with each other are retarded. Resulting in decreased permeability of soil, dispersion of soil is the reason that particles of clay are spoiled in holes. Again and again dryness and wetness of soil is due to dispersion of clay, it ameliorates again with hardens into cement-like compact mini or no structure. Three most important problems that are caused by the sodium induced dispersion are decreased hydraulic conductivity, crusting of surface and decreased infiltration. Calcium and Magnesium like salts that takes part in the saltiness have no impact like this because they are tiny and form the clump near the particles of clay.

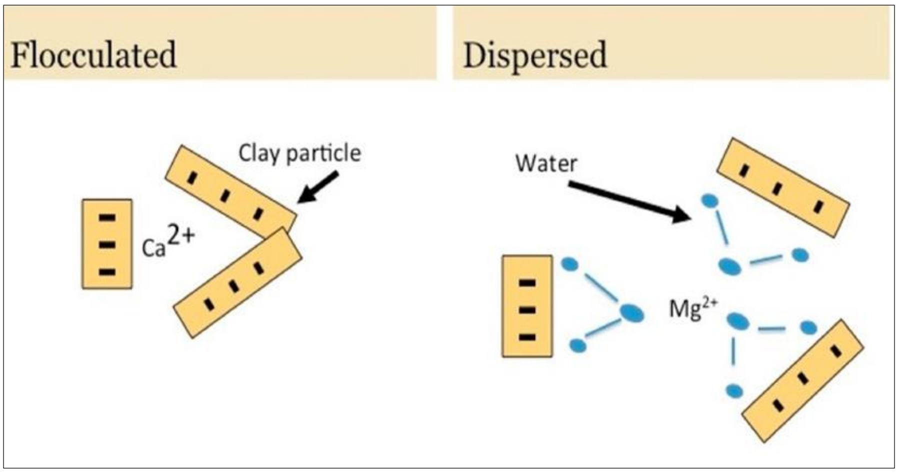

Figure 3 Tight clay soils and calcium sulphate (Nikos et al., 2003)

1.11 Relationship between physical properties of soil and salinity (EC/SAR)

When the large cation in the mud is sodium, the physical properties of soil are adversely affected. A measurement unit of salinity is described by term Ec which stands for electrical conductivity. The dirt may acquire to be **"dispersed"**, on the off chance that the sodium adsorption proportion (SAR) is extra pre-eminent than 13 or the interchangeable sodium rate (ESP) is more pre-eminent than 15. For disclosure and spreading of water, the extent is declined by the dispersed soil. If the solvent salts are minimum (EC under 4 mangos/cm) the problems of dispersion are significant. The particles of dispersed soil may cause restrictive layers into the profile of dirt and seal on the surface of soil. By the dirt, all these states block spreading of air and penetration of water. In reviving episodic soil (high SAR and ESP and low EC), a standout between the most tough problems is requirement of the water to move by the mud to remove extra salts and replace alike Na and Ca. By preference, Calcium is the most attractive particle to have as the huge dissolvable and equivalent cations, calcium charge to compensate 60 to 80 percent of the replaceable cations. The watering system waters holding devastating calcium and magnesium salts (low SAR) have a propensity to proceed more dry soil condition. Watering system waters with low calcium and high sodium percentage (high SAR) have a propensity to disperse the soil, exterior of structure, get hold of to be compressed and have low appropriation amount and hard off spreading of properties of air.

1.12 Water Stress

A condition in which plants experiences the low amount of water is called water stress. It is a condition in which plant faces decreased water potential and imbibition to the degree that plant experiences complications in carrying out daily physiological processes. Water stress appear in plant when the water rate absorbed through roots becomes less as compared to normal or the rate of transpiration in plants become relatively high (Sayed., 2012). High level of soil salinity or aridity results in water stress in plants. Sometimes water is present in soil but plant cannot intake it because: soil salinity is high or when the temperature of soil is low this situation is called “physiological drought”. Every year drought or desiccation appears in most components of the world (Musharraf., 2012). Water stress also occur components with suitable but aberrant rainfall. In 1702 the advance study on water stress resistance were begin when the existence of Rotifers was noticed in the absence of water for one month by Anthony von Leeuwenhoek’s while the information on water stress is timeworn. Non woody plants contain water from 80-90 % of the total capacity. For carry metabolites and nutrients water is the significant component and it is the essential molecule in entire physiological process of plant (Ismail and Rahman, 2012). The ability of endurance of drought is seen in the mature or developed phases of life cycle of immense diversity of plants and a small group of animals. In plants, water stress effect aridity, the in animation point accent is complex in nature and it also effect plants on assorted level of their alignment. Desiccation likewise effect plant water relation via abatement of water content, imbibition, and overall water. Drought further affects stomatal closing, lower rate of transpiration, seize carbon consumption rate and restrict gaseous transfer with the environment. Plant development is hold back and cell enlargement drop down or stops due to water desiccation.in contrast with cell division, Cell elaboration is greatly affected by water stress. Adapted Nutrient metabolism, plant hormones, translocation, carbohydrates, respiration, ion uptake and photosynthesis cause impact on plant growth. In plant, the imbibition that promote the absorption of solutes in cytosol and the water potential of plant cell is diminished by the water stress. The water stress also causes the extracellular matrices as consequence cell elaboration reduces lead to growth hindrance and generative breakdown. In case of extended desiccation numerous plants will dehumidify and eventually become mortal. This whole process occurs due to the building up of suitable osmole and abs sic acid e.g. Praline, which cause dwindling (Ismail, 2012). When this phase occurs, degeneration of radicle tramp compound like glutathione and overabundance of responsive species of oxygen and ascorbate in addition irritate the unfavorable impact. The variations in flexibility of cell wall of plants and upsetting in homeostasis and the dispersal of ions are also described due to water stress. One more issue of water stress in plant is mRNAs incorporated with desiccation counter and formation of new protein. One of the prime production restraining components is, placid to acute desiccation from the beginning of agriculture (Rouhollah et al., 2012). The commercial value of plant depends upon the capability of combating with such stress. The chief significance of water shortage at molecular and biochemical levels are not very much presumed still and such knowledge is critical but common effect of desiccation on plant development are equitably familiar. Nearly, proportions are different in species, yet the balance is present in all plants to the stress of water. However, the awareness of molecular and biochemical feedback to desiccation is crucial for a comprehensive approach of plant hostility procedure to water restricted situation in higher plants (Motafakkerazadl et al., 2012).

1.13 Plant Response to Water Stress

Along with adaption in gene expression plant modify themselves to desiccation situation by assorted physiological, biochemical, anatomical, and morphological advancement. Plants scheme to get along with desiccation ordinarily comprise a composition of stress prevention and forbearance schemes. To desiccation, the plant feedback physiology is highly complicated at the entire plant extent including malleable or unfavorable adjustment. (Rahman et al., 2012). This entanglement is because of several circumstances like species of plants, strenuous prolongation, situations of environment, expenditure of soil water, atmosphere is involved in fulfilling needs for the adjustment in water, furthermore plant growth and physiological condition in which water deficiency is progressed. Along with systemic accomplishment, the aggregation of fresh metabolism accomplice for increasing working of plant concealed desiccation stress demonstrate the accommodate of plant to desiccation stress. The primitive the feedback is the best the plant replies to desiccation stress which generally assist the plant to persist for certain time. The higher plants retaliate to water stress, analogous to further abiotic stresses, require molecular and biochemical mechanism and numerous genes. They are consecutive: translocation and perception, sense of signals and some sensors are involved in transduction such as at HK, Kinase, and secondary messenger as well as phospholipases, transcriptional factors are responsible for the control of transcription. To response to water stress in plants stomatal activity is the considerable active site of plant to water shortage. The sites of stomata closing are likewise intimately associated with soil humidity content in contrast to leaf water position and the activity of stomata is primarily supervising by chemical signals like ABA formed in dehydrating roots (Lisar et al., 2012).

1.14 Biotechnology and Water Stress

By adopting conventional genetic techniques along with enhanced plant breeding methods in biotechnology and water stress numerous accessions have been analysis to grow stress forbearance plants. By choosing genotype of the plants that have boosted output in arid climate plant forbearance and crop execution in lands where there is shortage of water can be checked. Due to heritable nature of desiccation forbearance and irregularity of precipitation this attempt is complex to achieve, however this attempt is demonstrated somewhat profitable. Exploitation of gene that defends and uphold the role and organization of cellular constituents are the basis steps for plant reformation for boosted forbearance. It is way more tough to restrict and plot the genetically complicated comebacks to abiotic stress. Modern engineering policies count on the transmission of one or many genes correlated with stress reactive trails. Type of genetically complicated methods of abiotic stress forbearance, harmful secondary effects are the significant outcomes of present determination to enhance plant stress forbearance by gene conversion methods. However, these steps create this job tremendously tough (Hossain et al., 2012).

2. Conclusion

In this review effects and problems of salinity are described shortly and they provide knowledge at molecular, physiological, and biochemical processes for tolerance of salt. To compare the salinity of many species of plants with other plants, much research has been made. Salt excluders and osmoprotectant are playing an important role in salt tolerance. As a conclusion salinity of soil and water is a major harmful threat which is affecting agricultural environment adversely. Researchers are expanding on molecular mechanism of plants to endure the salinity although objections have been made on this research, yet these researchers are providing molecular basis to endure the saltines.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declared no conflict of interest.

Author's contribution

Conceptualization of manuscript (SA, AA); Contribution of manuscript (SA, AA, AY): Data collection (AA, AY): Preparation of the manuscript (SA, AY, AA).

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