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Studies on physiological aspects in Wheat and responses to Salinity Stress

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Abstract : A variety of physiological, biochemical, and molecular mechanisms have evolved to allow plant species to cope with salinity stress by modifying metabolic processes. Mechanisms may involve ion compartmentalization, ion transport and uptake, the synthesis of osmoprotectants, and antioxidant enzyme activation (Rathinasabapathy, 2000; Gupta and Huang, 2014). Using ion hemostats, plants can maintain ion balance within their cells, and this helps them cope with high Na+ and Cl- concentrations (Niu Xiaomu et al., 1995). Extreme ratios of Na+/Ca2+, Na+/K+, Ca2+/Mg2+, and Cl-/NO3 are formed, which in turn results in osmotic and specific ion injury (Alam, 1999; Grattana and Grieveb, 1999). Some plant species, however, have the capability of preserving tissue ion equilibrium. This mechanism primarily governs the movement of sodium inside plant cells.

Introduction : This dynamic role of yield decline takes place in a variety of salt concentrations (Maas and Hoffman, 1977; van Genuchten, 1984; Munns, 2002). Relative words and classifications are used to explain how plant species can tolerate salinity (Francois and Maas, 1999). Salinity tolerance is generally thought of in terms of plant species' intrinsic ability to absorb root-zone and surface-salt concentrations without harming the plant (Munns and James, 2003). This is also known as salinity resistance, although some people have tried to distinguish the two words (Shannon, 1998). The responses of different plant species and genetic types to salinity stress vary (Djanaguiraman and Prasad, 2013). Physiological responses of cereals to salinity stress vary during growth and development, and these responses depend on when and how much stress the cereal has been subjected to, as well as the severity of the stress. Additionaly, the salts found in the soil may have an effect on plant response to salinity stress. Saline conditions favor the growth of cereal plants, but only if they can keep salts out of their leaves through the transpiration stream (Greenway and Munns, 1980; Da-Silva et al., 2008).

Responses to Salinity Stress

Production of a plant's salt tolerance can be achieved by searching for new genetic materials that are isolated by screening for mechanisms of individual and combinations of various adaptations. As a selection criterion, different types of osmoprotectants were used, along with the exclusion of sodium and chloride, which contributed to tissue tolerance to accumulated sodium and chloride, and the detoxification of free radicals (Rathinasabapathy, 2000; Zhang et al., 2001; Munns and Tester, 2008; Ashraf et al., 2010; Djanaguiraman and Prasad, 2013). Some plant species are more tolerant of salt than others. Also, certain crops, including barley, cotton, and sugarbeet, have the ability to tolerate higher levels of salt in the soil and flourish (Maas and Grattan, 1999). While some plant species have adapted to saline environments, these species are still considered to be highly susceptible to salinity. wheat tolerates salinity (Maas and Hoffman, 1977; Acevedo, 2002). Nevertheless, there are different wheat species which tolerate the weather conditions better. Even, when it comes to salinity, bread wheat appears to be more tolerant than durum wheat (Maas and Grieve, 1986).

Effects on Physiological and Biochemical Processes

In general, water travels from states of low salt concentration to states of high salt concentration, and this phase is known as osmosis. However, when the soil's salt content is high, water transport between the soil and the root is delayed. Soil draws water from the root when the salinity of the soil is greater than that of the root cells. Plant growth and reproduction are impeded by salinity in this manner (FAO, 2005). Since high salinity reduces water intake, it may cause water stress. Ions accumulate in the leaves, causing ion toxicity. As ion levels increase, plants can have difficulty with their nutrition. Metabolic processes shift, reducing the rate of photosynthesis. This, in turn, limits cell division and expansion (Munns, 2002). Salinity can have a wide variety of negative physiological impacts, but the most severe impacts are reductions in cell growth and crop production (Shannon, 1998; Acevedo et al., 2002). Carbon buildup from photosynthesis determines the amount of plant biomass that can be produced. Crop surface area is a large component of photosynthesis, as is the rate of photosynthesis per unit leaf area (Terry and Waldron, 1984). Although there have been numerous studies that indicate a link between total cereal dry matter output and the amount of photosynthetic active radiation intercepted, these findings are not absolute (Gallagher and Biscoe, 1979). These free radicals not only cause membrane and other essential macromolecules such as chlorophyll pigments, proteins, and fats to be destroyed, but they are also thought to also facilitate premature aging and cancer (Sairam et al., 2005; Krieger-Liszkay et al., 2008; Behairy et al., 2012; Djanaguiraman and Prasad, 2013).

Effects on Growth and Yield

Germination, crop growth, and productivity are all impacted by salinity (Munns and Tester, 2008). Saline soil plants suffer yield losses because of high solute levels. The majority of plants, including crop plants, are made up of a type of plant called a glycophyte. They do not demonstrate salt tolerance, growing under low soil salinity conditions. Because of this, they won't develop in higher concentrations of salt, and they're inhibited or even killed at concentrations of 100-200 mM NaCl (Munns and Termaat, 1986). Salinity of 4.5 dS m-1 electrical conductivity and salinity of 8.8 dS m-1 is reported to reduce the percentage of plants established per unit area. Salinity above 4.5 dS m-1 and salinity of 8.8 dS m-1 are each reported to reduce the percentage of plants established per unit area. Reduced seed germination, plant growth, and plant yield are generally observed as salinity stress symptoms. The first sign of salinity stress may be a reduction in leaf area (Bernstein, 1975; Kingsbury et al., 1984; Volkmar et al., 1998; Acevedo et al., 2002; Cicek, 2002). Even though salinity is known to diminish root and shoot growth, the shoot is generally more susceptible because of the inhibition of cell division and enlargement in the growing stage, which in turn affects normal wheat growth and tillers' viability. Both primary and secondary tillers numbers decrease. Salinity during germination and during tiller emergence is said to be more notable in wheat than any other species (Ayers et al., 1952). With increasing salt concentrations, tillering potential in wheat is also reduced. the most seriously affected yield factor in wheat under saline conditions is the number of effective ears per plant (Maas and Hoffmann, 1977; Munns et al., 2006). Salinity causes the main stem and branch to lose leaves and cause the number of spikelets on the spike to decrease, resulting in decreased seed set and grain yield (Maas and Grieve, 1986; Frank et al., 1987).

This transport of the positively charged ion, Na+, to the cell's vacuole is affected by a sequence of Na+/H+ antiporters. Plasma membrane Na+/H+ antiporters regulate this process, and so do proteins and enzymes that regulate the function of those antiporters. Because of this, plants synthesize proteins that help maintain cell electrolyte balance (Niu Xiaomu et al., 1995; Hasegawa 2013). Additionally, a plant species can increase the uptake of potassium and reduce the uptake of sodium in its roots. Also, certain proteins and enzymes are involved in the regulation of this process (Sairam and Tyagi, 2004). Not only do some plants have the ability to exclude salt, but some even actively avoid it. the capacity and efficiency of root system affect plant salt tolerance (Alam, 1999). One way that plant roots, particularly in a drying soil, can detect a water shortage is by sensing the change in the soil's moisture. Crops like wheat, rye, and corn greatly rely on their root systems' ability to access water and nutrients. In fact, roots in saline soils serve as highly effective filtration devices, with approximately 95% of soil salt being held out (Gucci and Tattini, 1997). The vast majority of halophytes, and salt-tolerant crop species undergo this degree of exclusion. There are some salt-tolerant species where roots can sustain K^+ uptake even though it competes with Na^+ due to selective K^+ uptake. However, salts in the soil can affect plant root health based on a plant's susceptibility and environmental factors (Bernstein and Kafkafi, 2002). Excluding Na^+ from leaf blades is possible, but doing so by the roots results in reduced Na^+ toxicity (Munns and Tester, 2008). Furthermore, plants treated with salt have lower stomatal conductance and growth rate compared to untreated plants. A number of studies found that salt tolerance and stomatal conductance are related. Growth rate and CO_2 assimilation are also affected by stomatal conductance (Munns and Tester, 2008). Salt resistance is also provided by polyamines, such as proline, glutathione, glycine betaine, mannitol, sucrose, and polyamines, which help to establish osmotic strain (Munns and Tester, 2008). As the plant cells swell, the osmotic potential is reduced. Some plant species (such as plants that have a relatively broad salt tolerance) have an antioxidant protection system in place that neutralizes harmful ROS, such as H_2O_2, OH^-, and O_2^-, by way of processing of defensive chemicals, such as ascorbic acid and glutathione, and antioxidant enzymes, such as peroxidases, catalases, and superoxide dismutase (Gupta and Huang, 2014). Plants also use hormones such as abscisic acid and salicylic acid to endure salinity tension. As abscisic acid causes stomatal turgor loss, and because water loss is to be reduced, stomata near to limit water loss (Popova et al., 1995).

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