MARUMEGH

Kisaan E- Patrika

Available online at www.marumegh.com

ISSN: 2456-2904

SALINITY TOLERANCE IN WHEAT

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ABSTRACT- Wheat is one of the staple food in world as well as in India. Salinity stress undergoes in abiotic stress which is generated by mineral salts. Salinity not only harms the soil health as well as reduces the crop quality and yield. Instead, management options have been used to alleviate saline conditions and, during reclamation of salt-affected soils, farmers have limited their choice of crops to the more tolerant species now days. In this manuscript breeding for salinity tolerance of wheat is described.

Introduction: A saline soil is generally defined as one in which the electrical conductivity (EC) of the saturation extract (EC) in the root zone exceeds 4 dS m^{-1} (approximately 40 mM NaCl) at 25 °C and has an exchangeable sodium of 15%. It has been estimated that worldwide 20% of total cultivated and 33% of irrigated agricultural lands are afflicted by high salinity. salt affected soils currently constitute 6.74 million ha in different agro ecological regions, the area is likely to increase to 16.2 million ha by 2050. India's total salt affected area is 6.74 m ha, out of which 3.79 m ha is suffering from sodicity and the rest 2.95 m ha is affected with salinity problems (also includes 1.25 m ha coastal saline soils). Salt affected soils exist across the length and breadth of India covering 16 States/Union Territories. The maximum salt affected soils are in Gujarat (2.22 m ha) followed by Uttar Pradesh (1.37 m ha). Furthermore, the salinized areas are increasing at a rate of 10% annually for various reasons, including low precipitation, high surface evaporation, weathering of native rocks, irrigation with saline water, and poor cultural practices. It has been estimated that more than 50% of the arable land would be salinized by the year 2050 (Jamil *et al.*, 2011).Wheat (triticum aestivum L. en. Thell.,2n=6x=42) ranks with rice in importance as a world crop. Wheat provides 21% of the food calories and 20% of the protein for more than 4.5 billion people in 94 countries. In India wheat is the second most important cereal crop and plays a key role in food and nutritional security. India harvested a record 93.50 million tonnes (mt) of wheat during the crop year 2015-16 with a productivity of 3093kg/ha.(Directorate of Economics & Statistics, DAC&FW.)

Breeders Concern- to deal with the increasing population with increasing saline soil rate breeders need to be concerned more about breeding for salinity resistance. Some major concerns are-

(1) the technical aspects of genetic manipulations,

(2) the interactions between salt tolerance and management of soil and water, and

(3) the effects of salt on food and feed quality

Effect of Salinity on Crop Plants

Excess amount of salts in the soil affects plant from germination to harvesting. It may affect the plants in two ways:

a) By decreasing the rate of water entry in to plants- The osmotic stress immediately reduces cell expansion in root tips and young leaves, and causes stomatal closure. Munns and Tester, 2008.

b) Promoting the entry of toxic ions- generally, salinity problem increase with increasing salt concentration in irrigation water. Crop growth reduction due to salinity is generally related to the osmotic potential of the root-zone soil solution. A failure in Na+ exclusion manifests its toxic effect after days or weeks, depending on the species, and causes premature death of older leaves. James *et al.* ,2011.

Salinity class	**Conductivity (dS/m)**	**Effect on crop plants**
Non-saline	0-2	Negligible
Slightly saline	2-4	Yields of sensitive crop may be restricted
Moderately saline	4-8	Yields of many crop restricted
Strongly saline	8-16	Only tolerant crops yield satisfactorily
Very strongly saline	>16	Only very tolerant crops yield satisfactorily

The relative salt tolerance of wheat crop is 7.0 dS/m and its yield decrease is 25% at 9.0 $dS \cdot m^{-1}$ .The reduction in growth and yield varies between cultivars and salt concentrations of the medium. The recently developed cultivars form a much diversed genetic base and may therefore possess a wider range of salts stress tolerance

Salinity Tolerance Mechanism in Wheat

Bread wheat (Triticum aestivum) is moderately tolerant to salinity and durum wheat (*Triticum turgidum ssp. durum*) is less so. Tall wheat grass (*Thinopyrum ponticum,* syn. *Agropyron elongatum*) is a halophytic relative of wheat and is one of the most tolerant of the monocotyledonous species, its growth proceeds at concentrations of salt as high as in sea water, Roghieh *et al.,* 2017.

Wheat lines highly tolerant to salinity- Kharchia (from Rajasthan;eg., KR375,KR378) , Rata(from Bhal, Gujrat).Plants enact mechanisms to tolerate salinity by

a) Reducing water loss while maximizing water uptake: osmoregulation is a common mechanism that allows maintenance of turgor, avoids leaf desiccation and would result in greater leaf growth and stomata conductance.Munns(2006)

b) **Minimize the harmful effects of ionic Na^+ stress:**

(i) Na+ exclusion by roots ensures that Na does not accumulate to toxic concentrations within leaves.

(ii) Compartmentalization of ions-Tissue tolerance, i.e., tolerance of tissue to accumulated Na+, or in some species, to Cl−. Tolerance requires compartmentalization of Na+ and Cl− at the cellular and intracellular level to avoid toxic concentrations within the cytoplasm, especially in mesophyll cells in the leaf. Toxicity occurs with time, after leaf Na+ increases to high concentrations in the older leaves. James *et al.,* (2011)

(c) **Combination of both**.

Silicon Improves Salinity Tolerance in Wheat Plants:

Silicon (Si) is the second most abundant element on the surface of the earth, yet its role in plant biology has been poorly understood and the attempts to associate Si with metabolic or physiological activities have been inconclusive (Epstein, 1994). Although Si has not been classified as an essential element, it has been shown to be beneficial for the plant growth (Liang *et al.*, 1994). Silicon has been shown to ameliorate the adverse effects of salinity on plants. For example, (Ahmad *et al.* 1992) reported that salt tolerance of wheat could be markedly enhanced by the addition of a small amount of soluble Si.

Sources of Salinity Resistance-

(a) Cultivated Varieties- mostly varieties are released from CSSRI, Karnal.

Why salt tolerant varieties approach?

- Salt tolerant varieties of crops require less chemical amendments
- Varietal approach is simple, cheap and eco-friendly.
- Suitable for poor resource farmers due to low cost.

VARIETIES

1) **KRL 1-4 (1990)-** Parentage is KHARCHIA 65/WL711 having maturity duration of 132 days with salinity tolerance 7.0 dS/m and sodicity tolerance 9.3 pH2 having grain yield of 30 Q/ha in salt affected soil as compared to normal soil having 40 Q/ha. It is recommended in NWPZ and NEPZ.

2) **KRL 19(2000)-** parentage is PBW 255/KRL 1-4 having maturity duration of 132 days with salinity tolerance 7.3 dS/m and sodicity tolerance 9.3 pH2 having grain yield of 30 Q/ha in salt affected soil as compared to normal soil having 45 Q/ha. It is recommended in NWPZ and NEPZ.

3) **KRL 210 (2010)-** Parentage is PBW 65/2*PASTOR having maturity duration of 143 days with salinity tolerance 6.6 dS/m and sodicity tolerance 9.3 pH2 having grain yield of 35 Q/ha in salt affected soil as compared to normal soil having 52 Q/ha. It is recommended in NWPZ and NEPZ.

4) **KRL213 (2010)** Parentage is CNDO/R143//ENTE/MEXI_2/3/*Aegilops squarrosa*TAUS)/4/WEAVER/5/2*KAUZ having maturity duration of 145 days with salinity tolerance 6.4 dS/m and sodicity tolerance 9.2 pH2 having grain yield of 33 Q/ha in salt affected soil as compared to normal soil having 51 Q/ha. It is recommended in NWPZ and NEPZ.

b) Germplasm Collection- Kharchia wheat is adapted to salt-affected areas of Rajasthan.

c) **Related Species-** wild relatives of wheat genus Elytriga (*Agropyron*) more resistant than any wheat accession, eg., *E. elongata* and *E. pontica*.

Breeding Approaches

i) **Selection**

ii) **Hybridisation-** wheat variety KRL 1-4 is developed from cross of Kharchia 65 x WL711 through intervarietal hybridisation. Transfer of salinity resistance gene from *E. elongate* and *E. pontica* in to wheat is done through interspecific hybridisation.

iii) **Cell Selection-** somaclonal variation can be exploited to develop salt resistant lines of wheat plants**.**

iv) **Genetic Engineering-** salinity resistant transgenic plants have been produced by transferring genes from different species. Na+/K+ discrimination trait is found in locus Kna1 of chromosome 4D and 4DL in T. aestivum by marker RFLP.

Genotypes of Wheat Registered As Salt Tollerant-

1) **KRL 35(2004)**: Registration number- INGR 04013. Parentage is HD 2160/KRL1-4. It is Tolerance to sodicity, salinity and waterlogged sodic conditions. It is having maturity duration of 143 days with salinity tolerance upto 7.3 dS/m and sodicity tolerance upto 9.3 pH having grain yield of 30 Q/ha in salt affected soil as compared to normal soil having 50 Q/ha.
2) **KRL 99(2007)**: Registration number- INGR 07046. Parentage is KRL 3-4/CIMK 2//KRL 1-4. It has very high level of tolerance to sodicity, salinity and waterlogged sodic conditions. It is having maturity duration of 140 days with salinity tolerance upto 7.5 dS/m and sodicity tolerance upto 9.4 pH having grain yield of 40 Q/ha in salt affected soil as compared to normal soil having 47 Q/ha.
3) **KRL 3-4**.(2009)- Registration number-INGR 09087.Parentage is HD1982/Kharchia 65. It has very high level of tolerance to sodicity, salinity and waterlogged sodic conditions. It is having maturity duration of 150 days with salinity tolerance upto 7.5 dS/m and sodicity tolerance upto 9.4 pH having grain yield of 40 Q/ha in salt affected soil as compared to normal soil having 45 Q/ha.

Problems Breeders Facing- Michael *et al* . described as follows:

a) Creation of salinity environment is tedious. (B) Lack of simple, reliable and dependable selection criterion. (C) genetic control is complex and polygenic that makes transfers from germplasm lines and related species a very difficult task.

Conclusion-

It is intriguing to speculate that a sensitive crop plant might be genetically altered to withstand high salinities. Breeders have considered this approach for many years, but research along these lines has been neglected in favor of other problems. Instead, management options have been used to alleviate saline conditions and, during reclamation of salt-affected soils, farmers have limited their choice of crops to the more tolerant species. Yet it seems feasible to select the survivors or the plants that perform well from a crop grown in a saline environment, and thus improve salt tolerance. The genetic potential to improve crops exists, but there are limitations that until now have prevented the development of salt-tolerant varieties among sensitive crop species. Salt-tolerant species cannot substitute for good management practices that prevent salt accumulation in the soil. Such species can be valuable, however, for cropping saline soils that are undergoing gradual reclamation or that cannot be fully reclaimed because of limited natural or economic resources. Tolerant species can also be useful where good quality water is not available. Consideration could be given to developing crops that are productive when grown with saline irrigation waters, such as brackish underground well water, drain water, or even diluted sea water. It may be possible to improve the genetic tolerance of crops to salinity and thereby increase the productivity of marginal lands.

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