REVIEW ON EFFECT OF SALINE STRESS ON

Cyamopsis tetragonoloba

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Abstract

Guar Cyamopsis tetragonoloba is a drought tolerant summer annual legume grown in the Indian subcontinent. Guar is grown as forage, a vegetable for human consumption, green manure, as well as for the seed for export. The increasing demands of the expanding population for food and energy necessitate the increase of arable land by exploiting marginal areas such as arid and semi arid land which comprise 40% of the world's land surface. Such areas are characterized by high salinity in the soil and in the major water resources and this frequently limit or prevents crop production. Salinity is a problem of increasing importance because most crops are more or less salt sensitive. Saline irrigation as well as fertilizer application is factors most responsible for increasing salinity. One third of the world irrigated land is already affected by excess salinity.

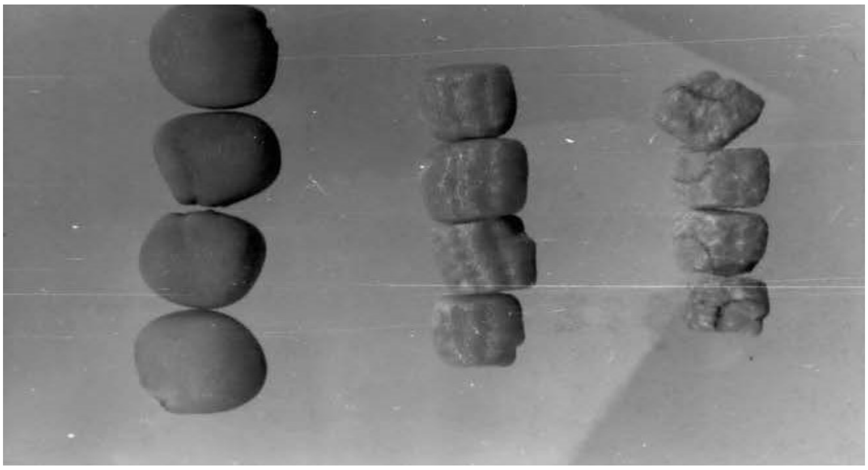
Development of salt-tolerant cultivars would complement salt management programs to help maximize yield. Identification of plant characteristics which enable the plant to tolerate saline soil during germination and stand establishment would be very useful for Guar improvement. The ability of a seed to germinate and emerge under salt conditions indicates that it has the genetic potential for Salt tolerance at least at this stage of the life cycle. However, this does not necessarily indicate that the germination of salt tolerant cultivar can complete its life cycle under salt conditions. Tolerance to salinity at germination does not insure salt tolerance of seedlings or at later stages of development. Thus, both tolerances to salinity at germination and emergence need to be studied.

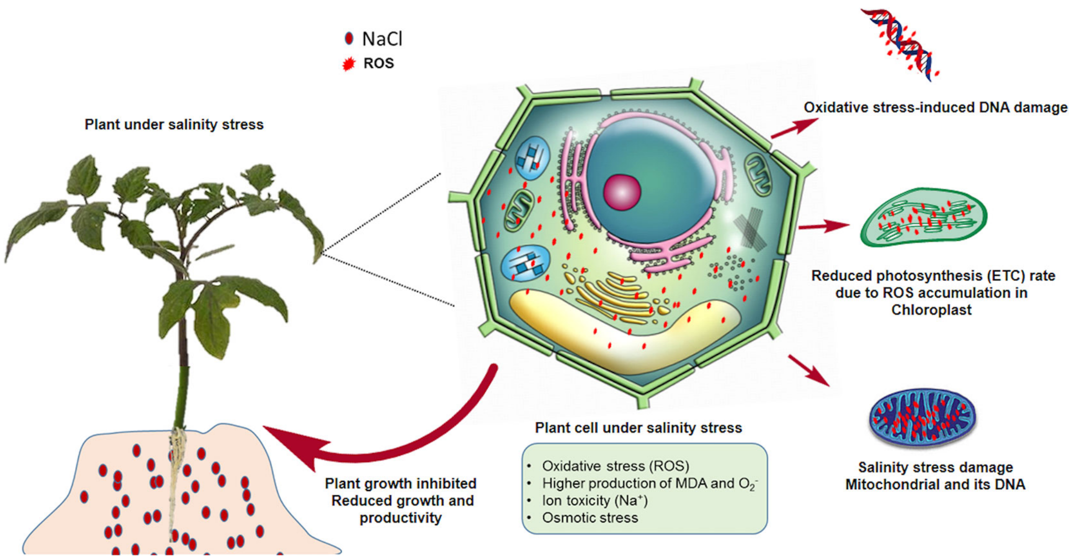
Successful breeding for Salt tolerance in guar might be made more rapidly and predictably if the morphological mechanisms that contribute to the overall response are better understood. There appears to be a lot of evidence to indicate variation in the ability of different species to withstand salts. The mechanisms adopted by plants differ by the type of salinity they encounter at certain times in their life cycle. The complexities and the varieties of ways in which plants adjust and adapt to salt are confusing, and to date, no single physiological factor has been correlated with salt tolerance.

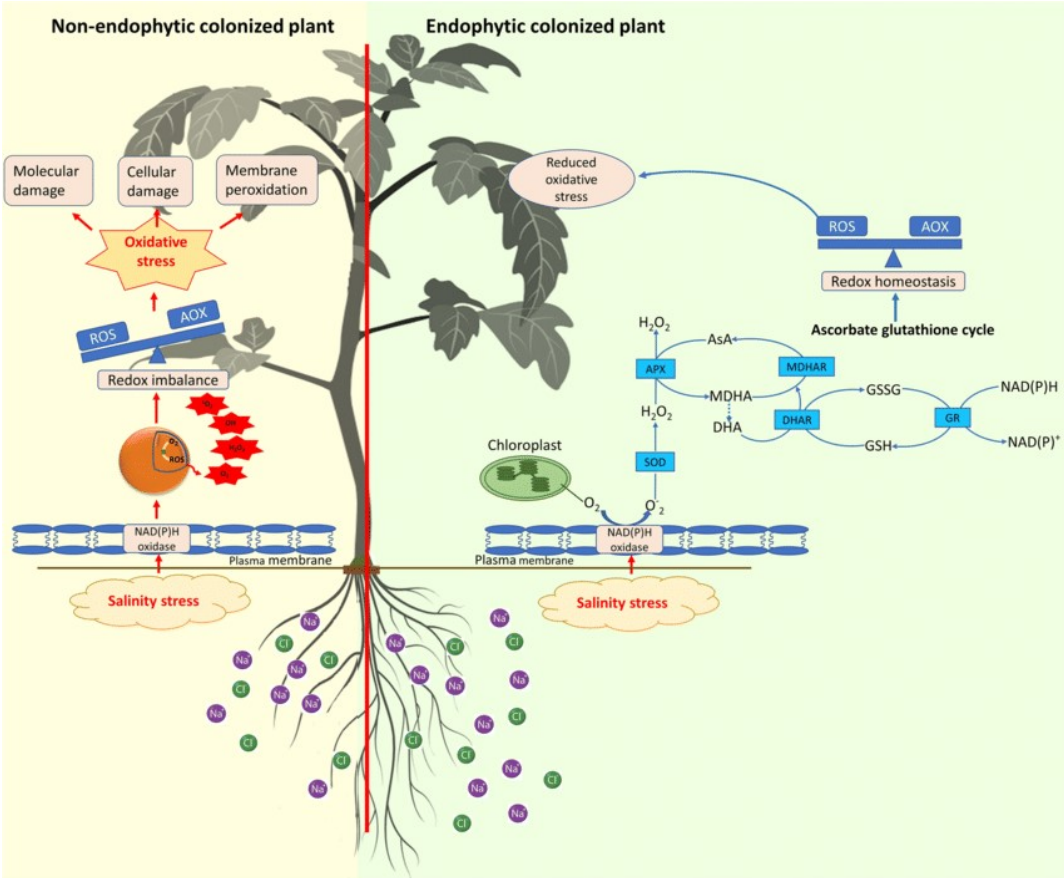
A selection criteria and a reliable procedure to screen Guar germplasm for salt tolerance would be helpful. To this end, physiological responses during germination and seedling growth were determined in order to characterize seeds and seedlings which survived high salt treatments. In addition, selections are to be made for germination salt tolerance and seedling salt tolerance, and tests need to be performed to determine if the two processes are interrelated.

Introduction

One of the major abiotic stresses limiting crop growth and development is salinity. Salinity problem mostly occurs in the arid and semi-arid regions of the world due to low rainfall resulting in inadequate high temperature and leaching resulting in evapoconcentration of salts in the root zone. In the recent years, however, growing population and changing climate have necessitated expansion of irrigation with saline groundwater to meet ever increasing fodder and food demands. From the current scenario, it is clear that freshwater scarcity will continue for a foreseeable farmers and future need to find ways to sustain agriculture with saline groundwater available in the region. Improper application of saline waters for crop production will not only affect soil quality but it also yields of susceptible crops and reduces growth. Sustainable management practices, on the other hand, including selection of salt tolerant cultivars/crops can minimize the risk of root zone salinization and improve crop yield. Hence, it is important to develop information on salt tolerant crops and cultivars appropriate to sustain agriculture in these stressed regions. Generating information on the tolerance of the cultivars and crops to salinity at different growth stages are vital for developing appropriate cropping systems and management strategies for these stressed ecosystems. Response of various crops to salinity has been noted to be different at different growth stages. Development of susceptible crops and under elevated salinity growth, especially in early growth stages, is affected by reduced ability to uptake water and nutrients. Salinity adversely affects the productivity of crops by reducing root growth, shoot growth and dry matter production. In addition, wide genotypic variations in salinity tolerance within a crop species have been observed owing to differences in their level of development of salinity tolerance mechanisms. Guar or cluster bean(Cyamopsis tetragonoloba (L.) Taub) is an economically important fast-growing legume crop. It is mostly grown in semi-arid and arid regions of the world especially in countries like India, Pakistan, Brazil, South Africa and USA. It is a multipurpose legume grown for green manure, fodder, vegetable (green pods), and industrial applications. Guar gum derived from the seed endosperm is widely used in many industries like paper manufacturing, food processing, and textile printing, pharmaceutical, mining explosive, cosmetics, and oil & gas exploration. In addition to commercial importance, this leguminous crop species can improve soil fertility and fix atmospheric nitrogen. Although guar has a reported threshold EC value of 8.8 dS m^{-1}, literature review suggests wide genotypic variation in salinity tolerance. In addition, at early growth stages, there have been a very few studies on guars responses to salinity. Hence, we hypothesize that there is a wide variability in salinity tolerance of guar genotypes at different growth stages and it is essential to select tolerant genotype(s) to ensure successful agriculture in stressed ecosystems. To test this hypothesize a study was done that evaluated (i) potential of biomass production by studying the performance of 25 guar genotypes during early vegetative growth stages under four salinity levels - 9 dS m−1 representing typical salinity of groundwater available in the region ; 6 dS m−1 and 3 dS m−1 representing intermediate salinity obtained by blending groundwater and rain water (ii) categorized salt tolerance of 25 cluster bean genotypes during early stages using plant growth parameters as well as ion (Na, K, and K/Na) concentrations in plant samples to recommend appropriate genotype for elevated salinity.







Non-endophytic colonized plant
Endophytic colonized plant
Molecular damage
Cellular damage
Membrane peroxidation
Oxidative stress
ROS
AOX
Redox imbalance
NAD(P)H oxidase
Plasma membrane
Salinity stress
Reduced oxidative stress
Redox homeostasis
Ascorbate glutathione cycle
H_2O_2
AsA
APX
MDHAR
MDHA
DHA
DHAR
GSSG
GSH
GR
NAD(P)H
NAD(P)$^+$
SOD
Chloroplast
O_2
O_2^-

Conclusions

Seed germination is inhibited by both toxic effects of specific ions and by the lowering of the osmotic potential in the germination media germination is inhibited more by osmotic effect than by toxic effect. y in guar higher respiration is a factor for salt tolerance. It may be possible that the density of the stomates is a factor for salt tolerance in guar. When a mixture of NaCl and KC1 were used in germination, more sodium, chloride and potassium is accumulated in the plants than when each one was supplied individually. It may be that Na^+ and K^+ were interacting and each one stimulated its own uptake and the uptake of the other ion in the mixture. When selected treated plants were returned to the non-saline conditions, the growth increased but not to the level of the control plants. Photosynthesis, respiration, and transpiration were all influenced by salinity. These results indicated that salt inhibits seed germination and plant growth by affecting many different physiological processes.

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