Proceedings of ANAS (Biological Sciences), 65(5-6): 201-204 (2010)

Nature of Physiological Reactions of Various Wheat Genotypes under Sudden and Gradual Salinity Conditions

Makhira G. Mamedova, Sadagat Sh. Asadova, Tofig H. Garagyozov*
Institute of Botany, Azerbaijan National Academy of Sciences, 40 Badamdar Shosse, Baku AZ 1073, Azerbaijan

The adaptive capacity of three wheat genotypes differed by their stability to reaction of sudden and gradual salinity was studied. The adaptability of the genotypes studied varied depending on interaction scheme and clearly displayed during ontogenesis phases and the rate of plant development between phases. The results obtained evidence different adaptability of these tolerant varieties. Proline formation as an indicator of stress effect showed that the reaction of genotypes studied on different salinity variants wasn't unequivocal. The established regularities of genotypes response on the stress factor allow classifying the genotypes under study depending on original and adaptive tolerance.

Keywords: *wheat, gradual salinity, stress, proline*

INTRODUCTION

Functioning and realization aspects of genotypically determinated tolerance systems, including both a general tolerance system and its components, namely whole plant and cellular tolerance levels has not been formulated up to now. During the ontogenetic development, plant organisms depending on the type, extent and action of stress factors within the time, have to use different adaptive mechanism for retaining organism homeostasis.

Plant tolerance may be identified as the ability of plant organism to retain homeostasis on stress background for within tolerable limits using primarily genetical determinated mechanisms, their amplifications on various ontogeny stages, and also shunting sequences or their cascades depending upon the energetic component of organism in the process of adaptation and prolongation of stress in the time.

Exiting signal systems, as evidenced by stress effects such as ethylene synthesis, new formations, identical by molecular masses with polypeptides, accumulation of organic osmoprotectors of proline type, taking part in adaptive reactions through realization of concrete physiological and biochemical processes, functioning differently depending on the genotype of plant organism (Kuznetsov et al., 1990; Timothy et al., 1995; Verslues and Sharp, 1999; Raymond and Smirnoff, 2002; Kafi et al., 2003; Lorenzo et al., 2003). Lately, to the list of signal systems low-molecular compounds of cationic nature such as polyamines, possessing the protection properties and obvious synergetic character of interaction with other signal systems are referred (Kuznetsov et al., 2006).

Nevertheless, the fact of their existence, as non-specific reaction on stress, at present is an index and characteristic of the stress effects which can to a certain extent characterize original and adaptive tolerance of plant organism depending on possible time factors of the organism response on stress effects and also for establishing the reciprocal extent of the original and adaptive tolerance.

The objective of this paper is investigating the reactions of various wheat genotypes with different tolerance when modeling the sudden single and gradual chloride salinity on the whole plant level. The experimental material given in this paper deals with studying the adaptive reactions level of wheat being realized on whole plant and cellular levels *in vivo* and *in vitro*, and the contribution of each component to total plant adaptivity, having been carried out under controlled and field conditions.

MATERIALS AND METHODS

The plants were cultivated in a sandy culture. Plant feeding was performed by ½ solution of mineral portion of Murashige and Scoog's media (1962). The plant were cultivated under phytotrone conditions within 8-hr photoperiod, light intensity 10 000 lux, temperature 20ºC in the day-time and 15ºC – at night, with relative air humidity 60-70%. Four leaves being formed were treated with NaCl following the scheme: single treatment with 200 mM and 300 mM of NaCl; gradual treatment with NaCl in the amount of 50 mM each time within equal time interval ranging from

*E-mail: tofik-ca09@mail.ru

initial – 100 mM of NaCl to final total concentration – 300 mM of NaCl. For reducing the toxic effect of NaCl, $CaCl_2$ was added to the solution so that the molar ratio of NaCl to $CaCl_2$ was 5:1. In the course of the experiment phenological observations of plant development have been conducted. Proline was determined by spectrophotometry at 520 nm (Bates et al., 1973).

RESULTS AND DISCUSSION

The experiments carried out with modeling various types of salinity showed that the adaptability of the genotypes studied varied depending on interaction scheme and clearly displayed during ontogenesis phases and the rate of plant development between phases. All genotypes affected by salinity, exhibited delay in development compared to the control plants independent of salinity modeling. Already on the 14^{th} day upon salinity with 300 mM of NaCl, Giymatli-2/17 being considered as intolerant showed the delay in formation of the 6^{th} leaf unlike Azamatli-95 and Nurlu-99. This delay was observed within the whole period of carrying out the experiment. Azamatli-95 and Nurlu-99 being superior to Giymatli-2/17 by tolerance and referring to tolerant varieties differed at various development stages though at the end of the experiment their development was the same. Azamatli-95 on the 14^{th} day affected by salt indicated some delay in forming the 6^{th} leaf but already on the 25^{th} day the formation of the 7^{th} leaf was observed and the 34^{th} day - the flag leaf. Nurlu-99 didn't show the delay in forming the next leaf and it leaves behind Azamatli-95 in formation of the 7^{th} and 8^{th} leaves on the 21^{th} and 28^{th} day upon salinity. Development levelling takes place only on the 34^{th} day of salinity.

The results obtained evidence different adaptability of these two varieties. In the case of gradual salinity, when the concentration of NaCl was evenly rising up to 300 mM (1.7%), with single applying into the substrate, the adaptability of the genotypes studied differed from that of sudden salinity variant. So Giymatli-2/17 which in the case of sudden salinity delayed in its development from other varieties, in the given variant indicated great similarity with salt-tolerant ones.

Only on the 25^{th} day upon salinity, when the concentration of NaCl reaches 250 mM, the tolerant varieties are superior to intolerant ones in forming the 8^{th} leaf. Nurlu-99 also differed from Azamatli-95 by development dynamics. The results obtained indicate that this variety is more resistant to salt balance. On the 34^{th} day, when the total concentration of NaCl added was 300 mM, earing phase was observed regarding Azamatli-95 and Nurlu-99, whereas it wasn't shown as to Giymatli-2/17. Carried out experiments illustrate various adaptability between genotypes.

Single applying high concentrations of NaCl (300 mM, 200 mM) resulted in changing plant heights and the size of leaves compared to the control variant. The leaves of upper layers even of salt-tolerant Azamatli-95 and Nurlu-99 were narrower. Significant changes were observed with Giymatli-2/17. These changes were especially noted at the stage of forming the 6^{th} leaf. In the case of gradual salinity all the genotypes studied slightly differed by the size of leaves. The existing differences evidence a considerable adaptational potential as to salt-tolerant Azamatli-95 and Nurlu-99.

Proline formation analysis, as an indicator of stress effect, showed that the reaction of genotypes studied on different salinity variants wasn't unequivocal. Thus, single applying the stressor caused sharp enhancement of proline accumulation with Giymatli-2/17 already on the 7^{th} day and the proline level corre-

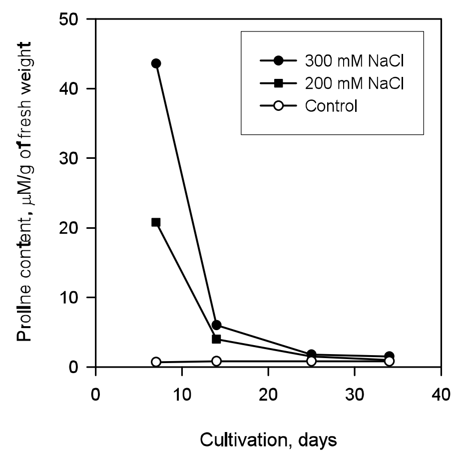

Figure 1. Proline accumulation dynamics of Giymatli-2/17 affected by sudden salinity.

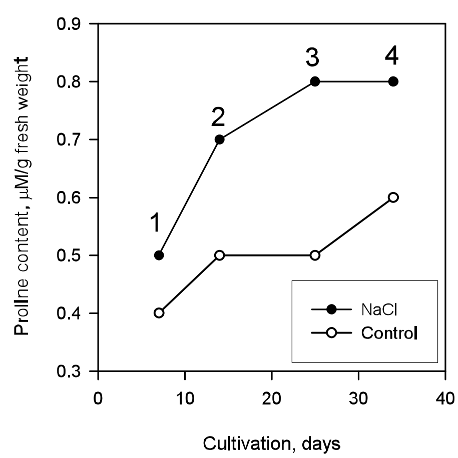

Figure 1A. Proline accumulation dynamics of Giymatli-2/17 affected by gradual salinity: 0 – 100 mM NaCl, 1 – 150 m M NaCl, 2 – 200 mM NaCl, 3 – 250 mM NaCl, 4 – 300 mM NaCl, total concentration of NaCl added.

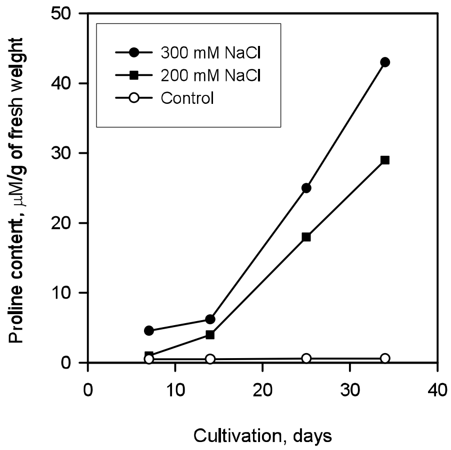

Figure 2. Proline accumulation dynamics of Azamatli-95 affected by sudden salinity.

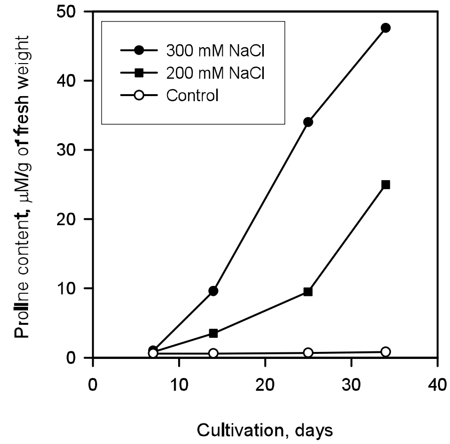

Figure 3. Proline accumulation dynamics of Nurlu-99 affected by sudden salinity.

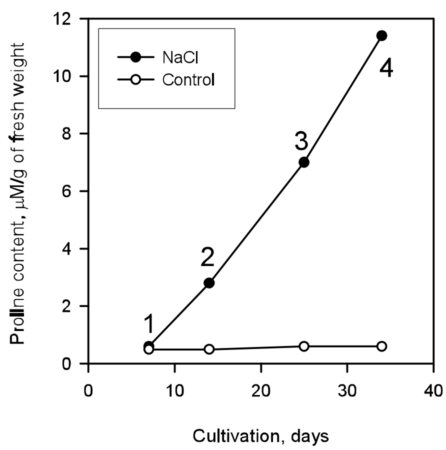

Figure 2A. Proline accumulation dynamics of Azamatli-95 affected by gradual salinity: 0 – 100 mM NaCl, 1 – 150 mM NaCl, 2 – 200 mM NaCl, 3 – 250 mM NaCl, 4 – 300 mM NaCl, total concentration of NaCl added.

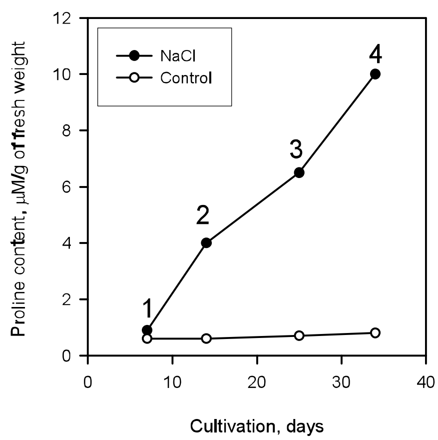

Figure 3A. Proline accumulation dynamics of Nurlu-99 affected by gradual salinity: 0 – 100 mM NaCl, 1 – 150 mM NaCl, 2 – 200 mM NaCl, 3 – 250 mM NaCl, 4 – 300 mM NaCl, total concentration of NaCl added.

lated depending on NaCl concentration. On the 14th day after applying NaCl proline content in leaves sharply decreases and by 34 day doesn't differ from its content in the control variants (Figure 1).

Gradual applying NaCl essentially slightly affected the accumulation dynamics of free proline compared to the control plants inspite of the fact that the final concentration of total NaCl was equal to 300 mM (Figure 1A). The reaction of Azamatli-95 and Nurlu-99 on stress effect differed from that of Giymatli-2/17 both by proline accumulation dynamics with single high effect and in the case of gradual enhancing the stress effect.

Proline accumulation increase in Azamatli-95 with single effect of NaCl is takes place gradually up to 34th day upon applying NaCl and more difference in variants, depending on the stress effect was observed (Figure 2).

Proline accumulation dynamics in the case of gradual salinity in similar by character with that of single applying NaCl, however, by absolute values was incomparably less (Figure 2A) and differed from the control plants.

Analogous processes of Nurlu-99 by its nature were similar with Azamatli-95, but reducing the concentration of NaCl with single salinity resulted in weakening proline accumulation of Azamatli-95 compared to Nurlu-99 (Figure 3). Though absolute values of proline accumulation with gradual salinity of Nurlu-99 were significantly higher (Figure 2A, 3A).

Field testing, using the same scheme of NaCl application showed that salt-tolerant grades differed from intolerant ones by proline accumulation level, but their changing dynamics was similar.

In the gradual applying NaCl all the varieties exhibited the similar adaptivity in proline accumulation. Apparently, when conducting field experiments, more precise identification of all possible stressors and consideration of the background conditions in plant vegetation are necessary.

Thus, the experiments carried out permitted to show varied genotype reaction on the action of a stress factor depending on single and gradual salinity. The established regularities of genotypes response on the stress factor allow to classify the genotypes under study depending on original and adaptive tolerance and to estimate interaction character of constitutive and inducible tolerance.

REFERENCES

Bates L.S., Waldren R.P., Teare I.D. (1973) Rapid determination of free proline for water stress studies. Plant Soil **39:** 205-207.

Kafi M., Styuart V.C., Borland A.M. (2003) Carbohydrate and proline content in leaves, roots and apexes of salt-tolerant and salt-sensitive wheats. Plant Physiol. **50(2):** 174-182.

Kuznetsov V.V., Radyukina N.L., Shevyakova N.I. (2006) Polyamines being stressed: biological significance, metabolism and regulation. Plant Physiol. **53(5):** 658-683.

Kuznetsov V.V., Roshchupkin B.V., Borisova N.N. (1990) Interaction of initial and adaptive tolerance under salinity. Dokl. Akad. Nauk SSSR **314(2):** 509-512.

Lorenzo O., Riquel R., Sanchez-Serrano I.I., Solano R. (2003) Ethylene response factor 1. Integrates signals from ethylene and jasmonate pathways in plant defense. Plant Cell **15:** 165-178.

Murashige T., Skoog F. (1962) A revised medium for rapid growth and bioassays with tobacco tissue cultures. Physiol. Plant. **15:** 473-497.

Raymond M.I., Smirnoff N. (2002) Proline metabolism and transport in maize seedlings at low water potential. Ann. Bot. **89:** 813-823.

Timothy D.C., Epstein E., Drovak I. (1995) Differential solute regulation in leaf blades of various ages in salt-sensitive wheat and a salt-tolerant wheat Ç *Lophopyrum elongatum* (Host.) A. Love amphiploid. Plant Physiol. **108:** 1715-1724.

Verslues P.E., Sharp R.E. (1999) Proline accumulation in maize (*Zea mays* L.). Primary roots at low water potentials. II Metabolic source of increased proline deposition in the elongation zone. Plant Physiol. **119:** 1349-1360.