Proceedings of ANAS (Biological Sciences), 65(5-6): 96-98 (2010)

Pigment Content and Activity of Chloroplasts of Wheat Genotypes Grown Under Saline Environment

Ibrahim V. Azizov*, Mayakhanum A. Khanisheva
Institute of Botany, Azerbaijan National Academy of Sciences, 40 Badamdar Shosse, Baku AZ 1073, Azerbaijan

The purpose of this work was the study of salt tolerance of wheat from local selection. Twenty wheat genotypes were grown under a naturally salinized (1.5-2.0%) soil conditions and studied during the ontogenesis. The obtained results showed that the chlorophyll content and photochemical activity of chloroplasts were reduced in all the genotypes by salinity. Genotypes Giymatli-2/17, Nurlu-99, Qobustan, Azamatli-95, Saratovskaya-29 and Gyrmyzy bugda are more tolerant to salinity.

Keywords: *wheat genotypes, chlorophyll, photochemical activity*

INTRODUCTION

Soil salinity is one of the major constraints responsible for low agriculture production in many regions of Azerbaijan. Out of total hectares irrigated land, 1.3 million hectares are salt affected (Azizov and Guliyev, 1999). The major inhibitory effect of salinity on plant growth and yield has been attributed to: a) osmotic effect; b) ion toxicity; c) nutritional imbalance leading to reduction photosynthetic efficiency and other physiological disorders.

Adverse effects of salinity on seed germination and seedling growth as well as some physiological activities of cultivated plant species have been investigated previously (Khan et al., 1995; Ashraf and Khanum, 1997). Generally, the trend and magnitude of adverse changes varied with in species and genotypes according to the level of salinity.

So far little emphasis has been placed on aspects relevant to photosynthetic efficiency of plants at moderate and high salinity. It has been suggested that by increasing photosynthetic efficiency crop production could be increased (Aliyev et al., 1998).

The aim of the present paper is to study the effect of salinity on chlorophyll content and photochemical activity of chloroplasts in wheat genotypes.

MATERIALS AND METHODS

The study was conducted during the years 2006-2007 in naturally salinized privately owned farm of Akhsu district of Azerbaijan. The experimental material comprised of twenty genotypes of wheat, which was also grown in normal soil conditions, simultaneously. Chlorophyll *a* and *b* content of leaves were determined according to Arnon (Arnon, 1949). The isolation medium for chloroplasts contained 400 mM sucroze, 1 mM EDTA, 5 mM $MgCl_2$, 10 mM NaCl and 50 mM tris-HCl buffer, pH 7.8. Photochemical activity of chloroplasts were measured by monitoring oxygen evolving activity at 25°C using Clark-type oxygen electrode in presence of 0.5 mM potassium ferrycianide as acceptor of electrons from photosystem (PS) II (Aliyev et al., 1998; Azizov and Rasulova, 2000). Uncoupled PSI driven electron transport was assayed with 5mM ascorbate using 50 mM DCPIP as electron donor in the presence of 10 mM DCMU, 200 mM MV as electron acceptor, 1 mM NaN_3 and 5 mM NH_4Cl.

RESULTS AND DISCUSSION

Leaf dry weight, leaf area and yield per plant decreased significantly in response to salinity in all wheat genotypes. The biosynthesis of green pigments (chlorophyll *a*, *b*) and carotenoids also was affected with salinity stress (Table 1).

The genotypes Gyrmyzy gul, Pirshahin, Vugar-80, Shiraslan-23 and Dagdash showed maximum percent reduction over control for chlorophyll total concentration and were graded as sensitive to salinity stress. The genotypes Giymatli-2/17, Nurlu-99, Qobustan, Saratovskaya-29, Akinchi-84, Azamatli-95 and Gyrmyzy bugda demonstrated relatively less reduction in chlorophyll content and were graded as salt tolerant.

Photochemical activity of chloroplasts was

---

*E-mail: iazizov@rambler.ru

Table 1. Effect of salinity on chlorophyll and carotenoid content in different wheat genotypes grown under normal and salinity conditions (mg/g leaf)

	Chlorophyll *a*		Chlorophyll *b*		Chlorophyll (total)		Carotenoids	
Genotypes	control	salinity	control	salinity	control	salinity	control	salinity
Akinchi-84	5.4	4.4	1.8	1.5	7.2	5,9	1.8	1.9
Garagylchyg-2	6.2	4.5	2.1	1.5	8.3	6.0	1.9	2.1
Vugar-80	5.6	4.1	1.9	1.1	7.5	5.2	1.7	1.9
Shiraslan-23	5.8	3.9	2.0	1.0	7.8	4.9	1.6	1.8
Barakatli-95	6.1	4.2	2.1	1.4	8.2	5.6	2.0	2.2
Alindja-84	5.1	3.5	1.7	1.2	6.8	4.7	1.5	1.7
Tartar	6.2	3.8	2.2	1.3	8.4	5.1	1.8	2.0
Gobustan	6.3	5.6	2.1	1.8	8.4	7.4	2.1	2.2
Nurlu-99	5.9	5.5	1.9	1.8	7.8	7.3	1.9	2.1
Giymatli-2/17	6.8	6.2	2.3	2.1	9.1	8.3	2.3	2.5
Pirshahin	4.9	2.8	1.3	0.9	6.2	3.7	1.4	1.7
Gyrmyzy gul	4.8	2.6	1.4	0.8	6.2	3.4	1.5	1.8
Azamatli-95	5.4	5.0	1.7	1.5	7.1	6.5	1.8	2.0
Ruzi-84	6.1	3.5	2.0	1.1	8.1	4.6	1.7	1.9
Tale-38	6.0	3.3	2.0	1.2	8.0	4.5	1.5	1.7
Saratovskaya-29	5.1	4.9	1.7	1.6	6.8	6.5	1.4	1.5
Dagdash	5.4	2.7	1.8	0.9	7.2	3.6	1.7	2.0
Sharg	6.3	2.9	2.1	0.9	8.4	3.8	1.8	2.1
Gyrmyzy bugda	5.4	5.0	1.7	1.6	7.1	6.6	1.9	2.1
FEFWSN-4th No 1^{6}	4.6	3.5	1.8	1.1	6.4	4.6	1.2	2.0

Table 2. Effect of salinity on PSII and PSI activities of chloroplasts isolated from wheat genotypes grown under normal and saline conditions (mkmol O$_2$/mg chl h)

	PSII activity		PSI activity	
Genotypes	control	salinity	control	salinity
Akinchi-84	85.0±2.1	79.0±1.2	125.0±5.4	119.0±3.2
Garagylchyg-2	92.0±4.3	80.0±3.1	136.0±6.2	115.0±2.6
Vugar-80	89.0±3.2	75.0±2.2	129.0±4.5	110.0±3.4
Shiraslan-23	95.0±5.4	76.0±1.4	141.0±7.2	112.0±4.6
Barakatli-95	98.0±4.5	79.0±1.1	152.0±6.6	125.0±4.5
Alindja-84	82.0±1.3	70.0±1.5	123.0±5.7	99.0±3.2
Tartar	77.0±2.1	50.0±1.0	115.0±6.1	90.0±2.6
Gobustan	91.0±3.3	85.0±2.1	130.0±5.8	125.0±5.4
Nurlu-99	94.0±4.4	83.0±1.9	129.0±4.6	120.0±4.3
Giymatli-2/17	99.0±5.6	85.0±1.7	133.0±3.5	126.0±6.2
Pirshahin	87.0±2.7	60.0±2.1	109.0±2.9	90.0±3.4
Gyrmyzy gul	81.0±1.2	59.0±1.8	95.0±3.4	70.0±5.6
Azamatli-95	105.0± 3.9	95.0±1.5	150.0±5.5	130.0±6.4
Ruzi-84	93.0±2.2	70.0±2.2	110.0±4.2	95.0±3.2
Tale-38	87.0±1.5	60.0±0.8	95.0±4.3	70.0±2.1
Saratovskaya-29	96.0±4.1	90.0±1.6	121.0±3.5	109.0± 6.1
Dagdash	87.0±2.4	60.0±1.9	98.0±2.8	71.0±2.3
Sharg	102.0± 4.1	85.0±2.2	135.0±5.4	95.0± 3.4
Gyrmyzy bugda	105.0± 6.2	90.0±3.1	131.0±5.1	120.0±5.6
FEFWSNth№16	98.0±4.3	70.0±2.5	116.0± 4.4	100.0±4.2

highly stable during salt stress. Photochemical activity of PSII and PSI was unaffected by salinity in some genotypes, while severely reduces in sensitive ones (Table 2).

A decrease in leaf area and yield per plant may be attributed to early senescence and death, reduced growth rate or delayed emergence (Everad et al., 1994). The reduction in leaf area, yield and yield components under saline conditions were also due to reduced growth as a result of decreased water uptake, toxicity of sodium and chloride in the shoot cell as well as reduced photosynthesis.

Reduction in chlorophyll content is probably due to inhibitory effect of the accumulated ions of various salts on the biosynthesis of the different chlorophyll fractions. Salt tolerance is not a function of single organ on plant attribute, but it is the product of all the plant attributes (Khan et al., 1995; Ali et al., 2004). Therefore, a genotype exhibiting relative salt tolerance for all the plant attributes may be ideal one. Fortunately, the genotypes Giymatli-2/17, Nurlu-99, Qobustan, Akinchi-84, Saratovskaya-29 and Gyrmyzy bugda showed comparatively minimal reduction induced by salinity for the plant attributes. Salinity could affect chlorophyll content of leaves through inhibition of chlorophyll synthesis or an acceleration of its degradation. Impairment of the carboxylation capacity, which in turn inhibits electron transport, is also indicated by the measurements of chlorophyll fluorescence. A reduced quantum yield may result from a salt sensitivity of PSII (Everad et al., 1994), although some authors (Lu et al., 2002) found out PSII to be highly resistant to salinity stress. It has been suggested that high external salt concentrations could affect thylakoid membranes by disrupting lipid bilayer or lipid-protein associations and thus impair electron transport activity (Ashraf and Khanum, 1997). Effect of salinity on electron transport rate could be species-specific (Lutts et al., 1996).

Thus, the obtained results may be useful for breeding salt-tolerant plants.

REFERENCES

Ali Y., Aslam Z., Ashraf M.Y., Tahir G.R. (2004) Effect of salinity on chlorophyll concentration, leaf area, yield and yield components of rice genotypes grown under saline environment. Inter. J. Environ. Sci. Tech. **1(3):** 221-225.

Aliyev J.A., Azizov I.V., Gazibekova E.G. (1998) Photosynthetic capacity and development of chloroplasts in ontogenesis of wheat. Elm, Baku: 115 p. (in Russian).

Arnon D.J. (1949) Copper enzyme in isolated chloroplasts. 1. Poliphenoloxidaze in *Beta vulgaris*. Plant. Physiol. **24:** 1-15.

Ashraf M., Khanum A. (1997) Relationship between ion accumulation and growth in two-spring wheat line differing in salt tolerance of different grow stages. J. Agron. Crop Sci. **178:** 39-51.

Azizov G.Z., Guliyev A. (1999) The salted soils of Azerbaijan, their melioration and fertility increasing. Baku: 99 p. (in Azeri).

Azizov I.V., Rasulova S.M. (2000) Features of inheritance of the photochemical activity and productivity parental and hybrid wheat form in drought conditions. Proceedings of Azerbaijan National Academy of Sciences (biological sciences) **1-3:** 17-20 (in Russian).

Everard J.D., Gucci R., Khan S.C., Flure I.M., Wayne H.L. (1994) Gas exchange and carbon partitioning in the leaves of celery at various levels of root zone salinity. Plant Physiol. **106:** 281-292.

Khan A.H., Ashraf M., Naqvi S.M., Khavzada B., Ali M. (1995) Growth ion and solute contents of sorghum grown under NaCl and Na_2SO_4 salinity stress. Acta Physiol. Plant. **17:** 261-268.

Lu C.M., Qin N.W., Wang B.S., Kuang T.Y. (2002) Does salt stress lead to increased susceptibility of photosystem II, to photoinhibition and changes in photosynthetic pigment composition in halophyte *Suaeda salsa* grown out doors. Plant Sci. **114:** 1063-1068.

Lutts S., Kinet J.M., Bouharmont J. (1996) NaCl-induced senescence in leaves of rice cultivars differing in salinity resistance. Ann. Bot. **78:** 389-398.