International Journal of Biological, Life and Agricultural Sciences
ISSN: 2415-6612
Vol:4, No:11, 2010

Chlorophyll Fluorescence as Criterion for the Diagnosis Salt Stress in Wheat (*Triticum aestivum*) Plants

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Abstract**—**To investigate effect of salt stress on Chlorophyll fluorescence four cultivars (fong,star,chamran and kharchia) of wheat (Triticum aestivum) plants subjected to salinity levels (control,8,12 and 16 dsm^{-1}) from one week after emergence to the end of stem elongation under greenhouse condition . results showed that quantum yield of photosystem II from light adopted leaves (ΦPSII), Photochemical quenching (qP) ,quantum yield of dark adopted leaves (fv/fm) and non photochemical quenching (NPq) were affected by salt stress . Salinity levels affected photosynthetic rate. Star and fong cultivars showed minimum and maximum levels of photosynthetic rate in respectively. Minimum photosynthetic rate differences between levels of salinity were shown in Kharchia. Shoot dry matter of all cultivars decreased by increasing salinity levels. Results showed that non photochemical quenching by salinity levels attribute to the decreases in shoot dry matter.

Keywords**—**salt stress, wheat, chlorophyll fluorescence, photosynthesis , shoot dry matter .

I. INTRODUCTION

SALT tolerance of crops may vary with their growth stage, in general cereal plants are the sensitive to salinity during the vegetative and early reproductive stage and less sensitive during flowering and grain filling. However a difference in salt tolerance among genotypes may also occur at different growth stage [8]. Photosynthetic response to drought and salinity stress is highly complex. It involves the interplay of limitations taking place at different sites of the cell/leaf and at different time scales in relation to plant development [13]. Photosynthesis is an important parameter used to monitor plant response to abiotic stress. A close association was found between growth and photosynthetic rate in sunflower (*Helianthus annuus L.*) [1] and wheat genotypes [8] differing in salt tolerance. Chlorophyll fluorescence is a rapid and non-intensive tool used to screen varieties for salinity tolerance [11]. Photosynthesis is particularly reduced when plants are grown under saline conditions which lead to reduced growth and productivity [15]. Chlorophyll fluorescence could be used for screening for salt tolerance varieties and modified by salinity stress [4].

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II. MATERIAL AND METHOD

This study was carried out on 2009-2010 years in Agriculture college of Shahid Chamran Univeristy of Ahvaz in Iran. Four cultivars (Fong, Star, Chamran and Kharchia) of wheat seed pre germinated in germinator and after 7 days ,each 10 seedlings transplanted in a Hogland´s solution sand culture pots in Green house condition. All samples were subjected to three levels of NaCl salt concentrations (8, 12 and 16 dsm^{-1}) and one control treatment until end of stem elongation and before anthesis. The experiment was designed as factorial on basis of randomized complete design (RCD) with three replications.

Chlorophyll fluorescence was measured with chlorophyll fluorometer, PAM-2000, Walz, Germany. Photosynthetic rate was measured with ADC portable *LCi* Ultra Compact *Photosynthesis* system, made on fully expanded youngest leaf [2]. Analysis of variance was performed by SAS and MSTATC software. The mean value was compared by Duncan's test.

III. RESULTS AND DISCUSSION

Salinity and cultivar had significant effect on shoot dry matter (Fig.1). Shoot dry weight of 4 cultivars decreased significantly by increasing NaCl concentration in Hogland's solution. Kharchia had the highest dry weight and Star had lowest among all four cultivar at the highest NaCl concentration. (16 dsm^{-1}). Salt stress result in a considerable decrease in the fresh and dry weights of leaves, stems, tillers, fertile tillers and roots [6]. Decrease in photosynthetic rate by increasing salt stress intensity was showed among cultivar and NaCl concentration (Fig. 2). Star had the lowest and Fong had the highest photosynthetic rate at the highest salt concentration, while photosynthetic rate differences at salt concentrations in Kharchia is the lowest. Effect of salinity on plant growth may result from impairment of supply of photosynthetic assimilates [3] and cell expansion in leaves can be inhibited by salt stress [7].

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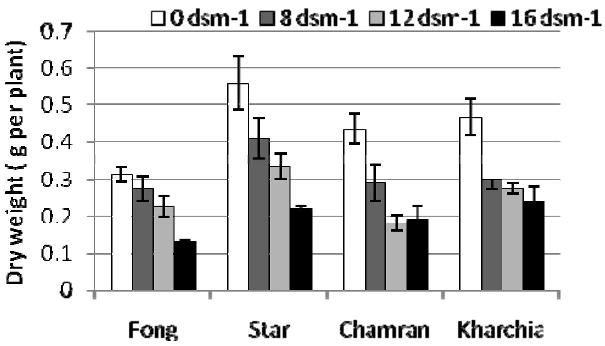

Fig. 1 Effect of salt stress levels on shoot dry weight

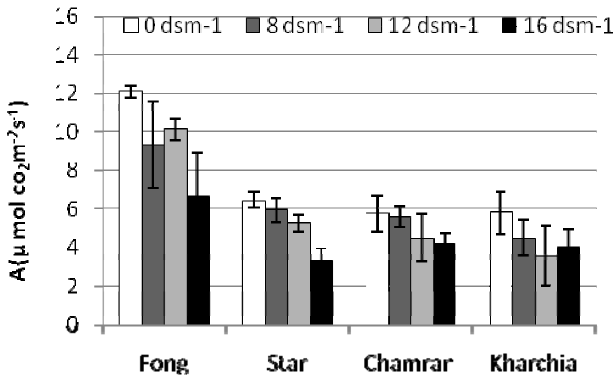

Fig. 2 Effect of salt stress levels on photosynthetic rate

Salinity concentration had no significant effect on quantum yield of dark adopted leaves (fv/fm) in two the lowest level (Fig. 3). By using chlorophyll fluorescence ,it is possible to estimate parameters of actual photosynthetic efficiency of the leaf and also the potential mximum of the quantum efficiency (fv/fm),under various condition and various times .the fv/fm ratio(maximum photochemical efficiency of PSII) has been shown to be reliable indicator of stress[11].

Fv/Fm is almost constant for different plant species measured under non-stressed conditions, with $0.80 \leq Fv/Fm \leq 0.86$ [5]. For the most severe salt stress, Fv/Fm decreases to 0.588 ± 0.019 [16]. The observed increase in Fv/Fm at these salt levels implies an increase in photochemical conversion efficiency of PSII. Furthermore, Fv/Fm was 0.79 ± 0.004 at high salt level, suggesting that only slight inhibition of photosynthesis occurred at high salt level [12].

Netando et al in sorghum, Moradi and and Ismail in rice were observed no changes in this parameter under salt stress [14] ,[13].

Kafi suggested that lower Fv/Fm in the salt stress conditions as compared to control ,indicating that RUBP regeneration ,which needs adequate electron translocation from PSII to electron acceptor ,might be disturbed by salinity[12].

Quantum yield of photosystem II (ΦPSII) decreased by increasing salt concentration (Fig. 4).

The decrease salinity concentration caused reduction of quantum yield of PSII. ΦPSII reflects electron transport rate is highest at low salt level, indicating that the wheat plants capacity to convert photon energy into chemical energy was strengthened [9].

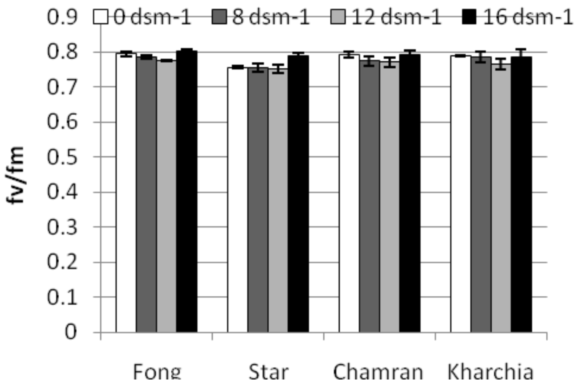

Fig. 3 Effect of salt stress levels on on quantum yield in dark adopted leaves

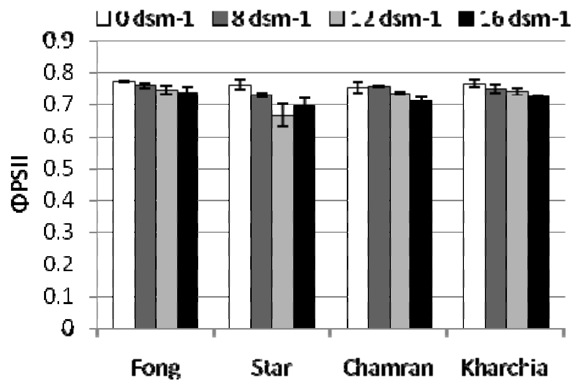

Fig .4 Effect of salt stress on quantum yield of photosystem II

In the highest level of salt concentration, significant decrease in photochemical quenching was showed (Fig. 5). There wasn't significant difference between the lowest salt concentration of NaCl and control treatment in the four cultivars.

Photochemical quenching coefficient (qP) and non-photochemical quenching coefficient (NPQ) were reduced as the salt level increased (Fig. 6). The major process involved in the protection against photo damage is probably the photochemical quenching energy dissipation, which reduces the relative quantum yield of PSII in order to maintain an adequate balance between photosynthetic electron transport and carbon metabolism [11]. Jiang et al reported that although qP showed some differences among barley *(Hordeum vulgare*

L.) genotypes, salinity did not significantly affect this parameter [10].

The negative impact of salinity on photosynthesis rate in Netondo et al studies on Sorghum, results in an increase in NPQ in all genotypes. Suhir and Murthy showed that salt stress enhances the oxigenase activity of RUBPco and can cause a decline co_2 fixation. Increase in NPQ may represent the decreased demand for product of electron transport, which has been used for assimilation and thus result in heat dissipation of light energy [14] , [13] .

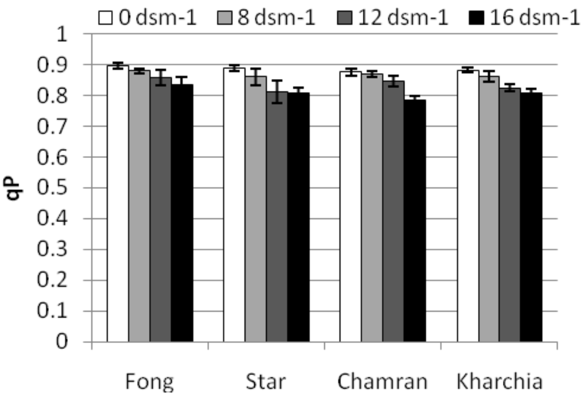

Fig. 5 Effect of salt stress levels on photochemical quenching (qP)

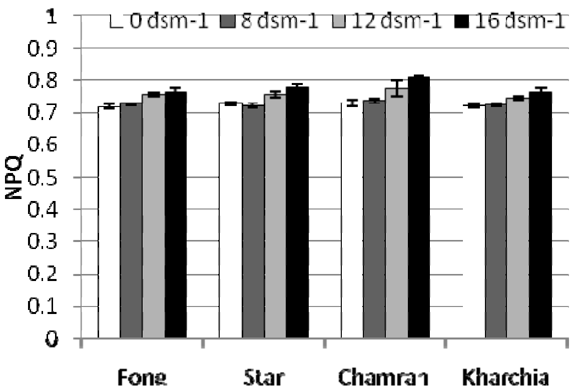

Fig. 6 Effect of salt stress levels on non photochemical quenching (NPQ)

IV. Conclusion

Results of this study showed Star cultivar has the lowest shoot dry weight and photosynthetic rate in the highest level of salt concentration, meanwhile this cultivar has showed similar results in Quantum yield of photosystem II (ΦPSII) and Fv/Fm. These parameters of chlorophyll fluorescence are appropriate criteria for the diagnosis salt stress in wheat.

Acknowledgment

This paper is part of PhD thesis, done in 2009-2010 in Agriculture College of Shahid Chamran University of Ahvaz-Iran.

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