Physiological changes in response to salinity stress in wheat

Thesis submitted
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قَالُوا سُبْحَانَكَ لَا عِلْمَ لَنَا إِلَّا مَا
عَلَّمْتَنَا إِنَّكَ أَنْتَ الْعَلِيمُ الْحَكِيمُ.

صَدَقَ اللهُ الْعَلِيمُ
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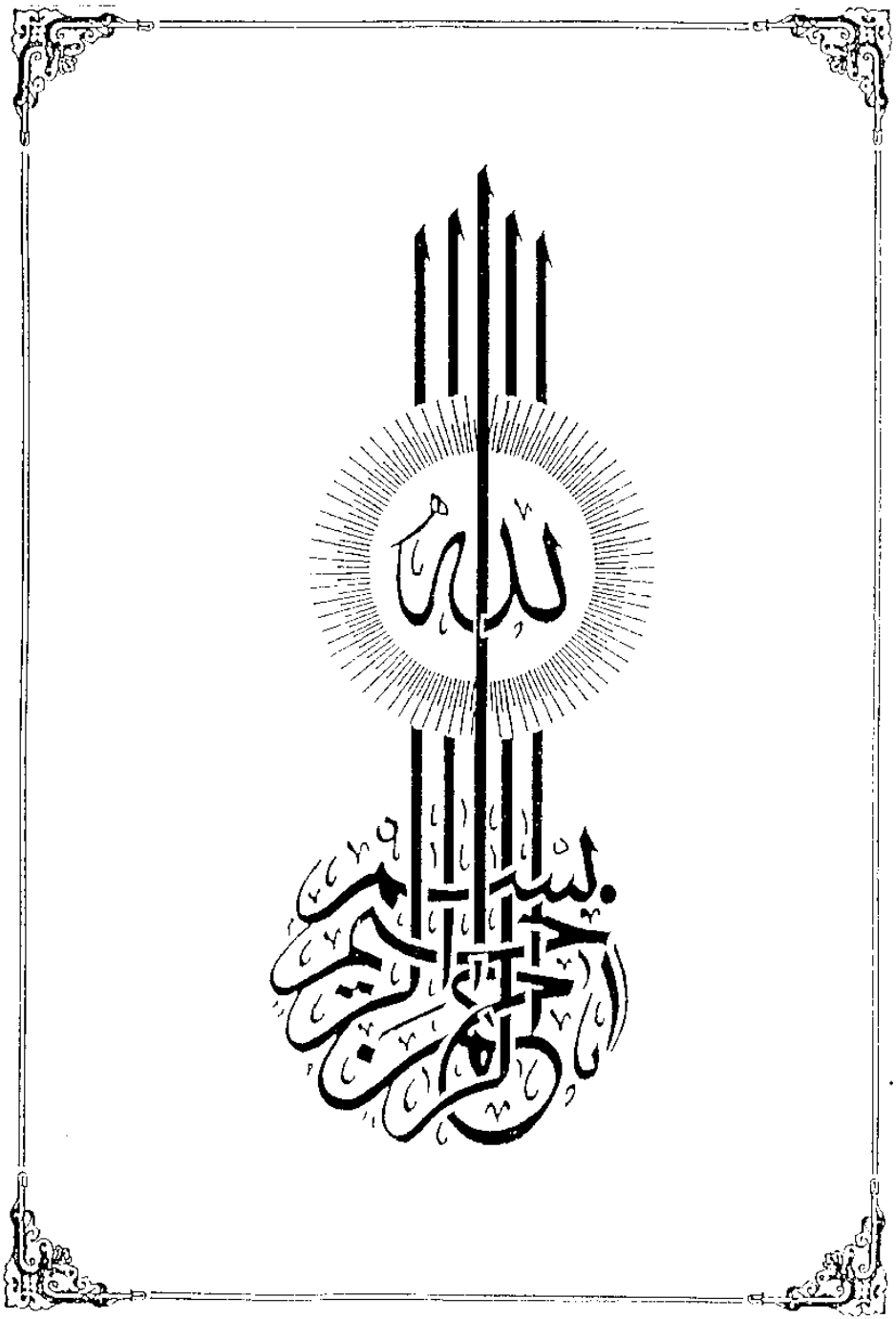

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Contents

LIST OF TABLES

CHAPTER.2

CHAPTER 3

Table

CHAPTER 4

Table

LIST OF FIGURES

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ABBREVIATIONS

CHAPTER 2.

FM	Fresh mass
DM	Dry mass
RGR	Relative growth rate
LAR	Leaf area ratio
SLA	Specific leaf area
S	Succulence
MHS	Modified Hoagland Solution

CHAPTER 3.

U	Urea
MU	Methyl urea
EU	Ethyl urea
K_s	Permeability constant
ψ_s	Solute potential

CHAPTER 4.

CHCl	Caryopses were presoaked in 5 mM choline for 24h followed by 150 mM NaCl exposure.
SC	Plants received only 150 mM NaCl exposure.
NT	Plants received neither CHCl nor NaCl.
PC	Phosphatidylcholine

ABSTRACT

The present investigation studied the physiological changes in response to NaCl stress in two wheat genotypes differing in their salt-tolerance, and tried to induce salt-tolerance in salt sensitive genotype using choline chloride presoaking of caryopses.

The two wheat genotypes were grown hydroponically under natural environmental conditions in the presence and absence of different concentrations of NaCl added to the growth medium. The effect of salt stress on vegetative growth (fresh mass, dry mass, relative growth rate, leaf area ratio, specific leaf area and succulence), ion contents of shoot and root of the two cultivars were studied after 21 days of salt exposure. Cytoplasmic characteristics, membrane permeability to non-electrolytes (urea, methylurea and ethylurea), solute potential and cytoplasmic viscosity of the two genotypes were determined after 7 days of salt exposure. Sodium and potassium were determined photometrically, whereas calcium and chloride were determined by titeration. Cell membrane permeability, solute potential and cytoplasmic viscosity were measured by plasmometric method and centrifugation, respectively.

In other experiments, caryopses of salt-sensitive cultivar were presoaked in choline chloride for 24 h. Choline chloride applied in this way was used to test its effect on salt tolerance of that genotype. The plants were then exposed to NaCl stress under natural environmental conditions. Vegetative growth was used as a measure for salt tolerance and ion contents of shoot and root were determined after 21 days of salt exposure to indicate changes in ion

absorption and translocation. The cell membrane permeability was used to probe the induced change in the lipid matrix of the membrane under choline and salt treatments.

In general, NaCl at high concentration inhibited growth in both cultivars. The effect was more pronounced in Sakha 8 (tolerant genotype). Sodium and chloride contents were increased in shoot and root of both cultivars, by increasing the salt in the external solution with a decline in K^+ level.

Salinity leads to alteration in the membrane permeability of leaf sheath subepidermal cells to non-electrolytes (U, MU, EU) and in cytoplasmic viscosity in Giza 162 (sensitive genotype). However, in Sakha 8, salt had no significant effect on these parameters. Solute potential was decreased in Sakha 8 and Giza 162 with an increase of NaCl in the root medium.

Presoaking in choline chloride improved the growth of salt-stressed seedlings of sensitive cultivar (Giza 162) used in this experiment. Presoaking in choline also reduced Na^+, Cl^- and increased K^+ contents in shoot and root of this cultivar. Choline also decreased the membrane permeability to the non-electrolyte (urea) in both shoot and root cells.

The results suggested that the two cultivars were different in response to salt stress. Both cultivars accumulated the toxic ions (Na^+, Cl^-) in shoot and root. Sakha 8 may be able to compartment the toxic ion and maintain adequate K^+ level which could contribute to salt tolerance in this cultivar. This mechanism may be lacking in Giza 162. Changes in membrane permeability to non-electrolyte and cytoplasmic viscosity suggested that the structure

and/or composition of cell membrane and cytoplasm are different in Sakha 8 and Giza 162, and these diffferences may be corrrelated with salt tolerance.

The results also indicated that choline chioride alleviated the injurious effect of salt and enhanced salt tolerance in salt-sensitive genotype through: 1) its conversion to betaine which might have adaptive functions under salt stress, and also 2) conversion of choline to phosphatidylcholine that may maintain membrane integrity and affect ion absorption under salt stress.

CHAPTER 1