TOLERANCE OF SOME QUINOA GENOTYPES TO WATER STRESS

By

MAI MOGHAZI ABUL-FETOUH EL-MOGHAZI
B.Sc. Agric. Sci. (Biotechnology), Fac. Agric., Cairo Univ., 2006

THESIS
Submitted in Partial Fulfillment of the Requirements for the Degree of

MASTER OF SCIENCE

In

Agricultural Sciences
(Agronomy)

Department of Agronomy
Faculty of Agriculture
Cairo University
EGYPT

2018

APPROVAL SHEET

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APPROVAL COMMITTEE

Dr. MOHAMED SOLIMAN M. SOLIMAN ....
Head Researcher of Agronomy, Field Crops Res. Inst., ARC

Dr. MOHAMED REDA A. SHABANA ....
Prof. of Agronomy, Fac. Agric., Cairo University

Dr. AHMED MEDHAT M. AL-NAGGAR................................
Prof. of Agronomy, Fac. Agric., Cairo University

Date: 19 / 3 / 2018

SUPERVISION SHEET

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SUPERVISION COMMITTEE

Dr. AHMED MEDHAT MOHAMED AL-NAGGAR
Professor of Agronomy, Fac. Agric., Cairo University

Dr. RABIA MOHAMED ABD EL-SALAM
Assistant Professor of Agronomy, Fac. Agric., Cairo University

Dr. AYMAN EBRHIM EL-SAYED BADRAN
Assistant Researcher Professor of Plant Breeding, D.R.C.

Name of Candidate: Mai Moghazi Abul-Fetouh El-Moghazi **Degree:** M.Sc.
Title of Thesis: Tolerance of Some Quinoa Genotypes to Water Stress
Supervisors: Dr. Ahmed Medhat Mohamed Al-Naggar
Dr. Rabia Mohamed Abd El-Salam
Dr. Ayman Ebrahim El-Sayed Badran
Department: Agronomy **Approval:** 19 / 3 / 2018

ABSTRACT

Quinoa (*Chenopodium quinoa* Willd.), a pseudocereal crop has recently gained worldwide attention because of its ability to grow in various stress conditions like soil salinity, drought, etc. The objectives were: (1) studying the variability among quinoa genotypes for different traits under different water stress environments, (2) analyzing correlations, heritability and selection gain for studied traits and (3) characterizing quinoa genotypes using ISSR markers. Field experiments were carried out in two seasons at New Salhiya (sandy soil), Sharqiya Governorate and laboratorial work was carried out at laboratories of Desert Research Center, Cairo. A split plot design with 5 replications was used, where 3 irrigation regimes (achieving 95, 65 and 35% FC) were allotted to main plots and 5 quinoa genotypes to sub plots. Data indicated that irrigation regime and quinoa genotype had significant effects on all studied traits. The quinoa variety CICA-17 proved to be the highest yielder under severe water stress (35% FC) and the most drought tolerant, followed by CO-407 and Chipaya. Water stress caused significant increases in root length and water use efficiency (WUE), and significant reductions in the rest of studied traits. Results on thickness of leaf, upper and lower epidermis, palisade and spongy layers and amino acid results concluded that variety CICA-17 is drought tolerant. The best secondary traits for high seed yield, drought tolerance and high WUE of quinoa were inflorescence traits, root length, seed yield/plant and /fed, since they showed high correlation coefficient (r), high heritability (h^2_b) and high genetic advance (GA) estimates. Analysis of ISSR revealed that 10 ISSR primers produced 53 amplicons, out of which 33 were polymorphic with an average polymorphism of 61.83 %. Data showed a total number of unique ISSR markers of 24; eleven of them were positive and 13 were negative. The genetic similarity ranged from 49 % between Ollague and each of QL-3 and Chipaya to 76 % between CICA-17 and CO-407.

Key words: Quinoa, Drought tolerance index, Water use efficiency, Leaf anatomy, ISSR, Amino acids, Unique markers, Genetic diversity, Heritability, Genetic advance.

DEDICATION

I dedicate this work to whom my heart felt thanks TO MY MOTHER AND MY FATHER, TO MY BROTHERS AND MY FRIENDS for all the support they lovely offered along the period of my post-graduation.

ACKNOWLEDGEMENTS

*Thanks to **ALLAH** the most Merciful and the most Beneficial. I wish to express my deepest gratitude and appreciation to **Dr. Ahmed Medhat Mohamed Al-Naggar** Professor of Crop Breeding, Agronomy Dept., Fac. Agric., Cairo University. and the Chairman of the supervision committee for valuable guidance, great help, devoted efforts and sincere concern for supervising the study and constructive guidance throughout the experimental work and the preparation of this manuscript.*

*Sincere thanks and grateful appreciation are extended to **Dr. Rabie Mohamed Abd El-Salam** Associate Professor, Agronomy Dept., Fac. Agric., Cairo University, for his supervision, valuable guidance, great help, devoted efforts and sincere concern for preparation of this manuscript.*

*Sincere thanks and grateful appreciation are extended to **Dr. Ayman Ebrahim,** Assistant Researcher Professor of plant Breeding, Desert Research Center, Egypt, for his supervision, valuable guidance, great help, devoted efforts and sincere concern for preparation of this manuscript.*

*Sincere thanks and grateful appreciation are extended to **Dr. Sedkey Tawfik Bolous,** Researcher Professor of plant anatomy, Desert Research Center, Egypt, for his valuable guidance, great help, devoted efforts and sincere concern for preparation of this manuscript.*

Grateful appreciation is also extended to all staff members of Agronomy Department, Faculty of Agriculture, Cairo University, and Staff members of Desert Research Center.

CONTENTS

Contents (continued)

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Quinoa (Chenopodium quinoa Willd.) is a pseudocereal and is one of the 250 species included in the genus Chenopodium, commonly known as ‘goosefoot’ genus (Giusti, 1970). It is a dicotyledonous annual species belonging to the family Amaranthaceae (formerly Chenopodiaceae).It is an allotetraploid (2n = 4x = 36) annual, crop as it shows disomic inheritance for most of the traits (Ward, 2000 and Maughan et al., 2004). Quinoa is a predominantly autogamous (self-pollinated) species with varying rates of natural hybridization (10–17 %) depending upon the coincidence of flowering with the presence of pollen vectors (Mastebroek et al., 2002 and Spehar and Santos, 2005).

Quinoa has an exceptional balance between oil (4–9%), protein (averaging 16 %, with high nutritional relevance due to the ideal balance of its essential amino acid content) and carbohydrates (64 %) (Bhargava *et al.,* 2006a and Vega-Galvez *et al.,* 2010). Due to its high starch content (51–61 %) it can be used in the same way as cereals for flour production (Bhargava *et al.,* 2006a and Stikic *et al.,* 2012). In addition, quinoa is a good source of vitamins, oil with high linoleate and linolenate content (55–66 % of the lipid fraction), natural antioxidants such as a- and c-tocopherol, and a wide range of minerals (Repo-Carrasco *et al.,* 2003; Vega-Galvez *et al.,* 2010; Fuentes and Bhargava 2011 and Stikic *et al.,* 2012).

Quinoa grain also lacks gluten, which has allowed the development of various foods for consumers with celiac disease (*i.e.* people allergic to gluten) (Jacobsen, 2003). Because of its nutritional