VARIATION IN PERFORMANCE OF SOME MAIZE GENOTYPES UNDER WATER STRESS CONDITIONS AT DIFFERENT GROWTH STAGES

By

MOHAMMAD OMAR ABDELLATIF ELSHEIKH
B.Sc. Agric. Sci. (Agronomy), Fac. Agric., Al-Azhar Univ., 2011

THESIS

Submitted in Partial Fulfillment of the Requirements for the Degree of

MASTER

In

Agricultural Sciences
(Agronomy)

Department of Agronomy
Faculty of Agriculture
Cairo University
EGYPT

2019

Format Reviewer **Vice Dean of Graduate Studies**

APPROVAL SHEET

VARIATION IN PERFORMANCE OF SOME MAIZE GENOTYPES UNDER WATER STRESS CONDITIONS AT DIFFERENT GROWTH STAGES

M.Sc. Thesis
In
Agric. Sci. (Agronomy)

By

MOHAMMAD OMAR ABDELLATIF ELSHEIKH
B.Sc. Agric. Sci. (Agronomy), Fac. Agric., Al-Azhar Univ., 2011

APPROVAL COMMITTEE

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

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

Dr. MAGDY MOHAMED SHAFIK .....
Prof. of Agronomy, Fac. Agric., Cairo University

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

Date: 31 / 1 / 2019

SUPERVISION SHEET

VARIATION IN PERFORMANCE OF SOME MAIZE GENOTYPES UNDER WATER STRESS CONDITIONS AT DIFFERENT GROWTH STAGES

M.Sc. Thesis
In
Agricultural Sci. (Agronomy)

By

MOHAMMAD OMAR ABDELLATIF ELSHEIKH
B.Sc. Agric. Sci. (Agronomy), Fac. Agric., Al-Azhar Univ., 2011

SUPERVISION COMMITTEE

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

Dr. MAGDY MOHAMED SHAFIK
Professor of Agronomy, Fac. Agric., Cairo University

Name of Candidate: Mohammad Omar Abdellatif Elsheikh **Degree:** M.Sc.
Title of Thesis: Variation in Performance of Some Maize Genotypes Under Water Stress Conditions at Different Growth Stages
Supervisors: Dr. Ahmed Medhat Mohamed Al-Naggar
Dr. Magdy Mohamed Shafik
Department: Agronomy **Approval:** 31 / 1 / 2019

ABSTRACT

The expected future shortage in irrigation water in Egypt necessitates that maize breeders should pay great attention to develop drought tolerant maize cultivars. The presence of genotypic differences in drought tolerance would help plant breeders in initiating successful breeding programs to improve such a complicated character. The objectives were: to identify drought tolerant genotypes for use in future breeding programs, to study the response of heritability (h^2_b) and genetic advance (GA) to two types of drought, *i.e*. water stress at flowering (WSF) and at grain filling (WSG) and to identify the selection criteria and environments for drought tolerance. A two-year experiment was carried out using a split plot design in a randomized complete block arrangement with three replications at the Agricultural Experiment and Research Station, Faculty of Agriculture, Cairo University, Giza. The main plots were devoted to three irrigation regimes, namely well watering (WW), WSF and WSG and sub plots to 22 maize genotypes (10 single crosses, five 3-way crosses and 7 populations). Water stress at WSF and WSG caused a significant reduction of 35.53 % and 25.51 % in grain yield/fed (GYPF), respectively. A significant variability among the studied 22 maize genotypes was observed for all studied traits. In general, the commercial varieties P-3444, SC-128, Egaseed-77 and SC-10 showed the highest grain yield and the best root architectural traits across all studied irrigation treatments; they were the most tolerant genotypes to drought in this experiment and could be recommended for farmers and plant breeders. The results concluded that predicted selection gain would be higher if selection was practiced under WW for 10 traits, WSF for 5 traits (including grain yield) and WSG for 12 traits. Based on the correlation (r) analysis and estimates of h^2_b and GA, the best selection criteria for drought tolerance were: 100-kernel weight (100KW), chlorophyll concentration index (CCI) and root circumference (RC) under both WSF and WSG, anthesis-silking interval, upper (SDU) and lower (SDL) stalk diameters under WSF, kernels/row, ear leaf area, crown root number, length and branching and root dry weight under WSG.

Key words: Maize, Selection criteria, Heritability, Genetic advance, Water stress at flowering, Water stress at grain filling, Anthesis-silking interval, Crown roots, Brace roots, Drought tolerance index, Chlorophyll content.

DEDICATION

I dedicate this work to whom my heart felt thanks; TO MY MOTHER, AND MY FATHER, TO MY SISTERS (Asmaa, Safar and Susan) MY BROTHERS (Ahmed, Abdelmonem, Mahmoud and moaaz) AND MY FRIENDS for all the support they lovely offered along the period of my post-graduation.

ACKNOWLEDGEMENT

Thanks to ***ALLAH,*** *the most Merciful and the most Beneficial. I wish to express my deepest gratitude and appreciation to* ***Dr. Ahmed Medhat Al-Naggar*** *Professor of crop breeding, Agron. Dept., Fac. Agric., Cairo Univ. and the Chairman of the supervisors 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. Magdy Mohamed Shafik,*** *Professor of Crop Breeding, Fac. of Agric., Cairo University for his supervision, valuable advice and many helpful suggestions throughout the progress of this study.*

Many thanks are also extended to ***Dr. Abd El-Samad M. Younis,*** *Researcher, filed crops Res Dept., National Research Center, Giza, Egypt, for valuable help and effort offered during the experimental work and statistical analyses of this study.*

Many thanks are also extended to ***Maize Res. Dept. of the ARC,*** *for providing the germplasm that was used in the present study.*

CONTENTS

	Page
INTRODUCTION	**1**
REVIEW OF LITERATURE	**7**
1. Definition of drought	**7**
2. Impact of drought stress on maize	**8**
3. Genotypic differences in drought tolerance	**15**
4. Drought adaptation mechanisms	**17**
5. Role of root system architecture in drought tolerance	**28**
6. Heritability of drought adaptive traits	**35**
MATERIALS AND METHODS	**42**
RESULTS AND DISCUSSION	**55**
1. Analysis of variance	**55**
2. Effect of water stress	**68**
3. Effect of maize genotype	**78**
4. Genotype × irrigation regime interaction	**98**
5. Drought tolerance index	**136**
6. Superiority of drought tolerant to sensitive genotypes	**138**
7. Grouping genotypes	**140**
a. Based on water efficiency and responsiveness	**140**
b. Based on drought tolerance and grain yield	**144**
8. Mechanisms of drought tolerance of the most tolerant genotype	**159**
9. Trait interrelationships	**160**
10. Correlations between DTI and other traits	**173**
11. Genotypic and phenotypic coefficient of variation	**177**
12. Heritability and genetic advance	**183**
a. Agronomic and yield traits	**184**
b. Stem and root traits	**190**
CONCLUSIONS	**199**
SUMMARY	**201**
REFERENCES	**208**
ARABIC SUMMARY	

LIST OF TABLES

No.	Title	Page
1.	Designation, origin and grain color of maize genotypes under investigation.....	**42**
2.	Soil analysis at 0-30 cm depth in the experimental fields at Giza in 2016 and 2017 growing seasons.....	**45**
3.	Meteorological data during the two growing seasons of the experiment	**46**
4.	Analysis of variance and expected mean squares (EMS) across seasons.....	**53**
5.	Combined analysis of variance of split plot design for 17 studied agronomic and yield traits of 22 maize genotypes under three or four irrigation regimes (T) across 2016 and 2017 years.....	**57**
6.	Combined analysis of variance of split plot design for studied root traits of 22 maize genotypes under four irrigation regimes (T) across 2016 and 2017 years.....	**60**
7.	Combined analysis of variance of RCBD across two years for 13 studied agronomic and yield traits of 22 genotypes under three irrigations regimes.....	**62**
8.	Combined analysis of variance of RCBD across two years for 14 studied physiological and root architecture traits of 22 genotypes under four irrigations treatments (WWF, WWG, WSF and WSG)	**65**
9.	Means of studied agronomic and yield traits under WW, WSF and WSG and change % from WW to WSF and WSG combined across all genotypes and across 2016 and 2017 seasons.....	**68**