BREEDING STUDIES ON EARLINESS AND DROUGHT TOLERANCE IN BREAD WHEAT

BY

MOSTAFA TAG ELDEEN SHEHAB ELDEEN
B.Sc. Agric. Sci. (Agronomy), Fac. Agri., Cairo Univ., Egypt, 2004

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

2008

APPROVAL SHEET

BREEDING STUDIES ON EARLINESS AND DROUGHT TOLERANCE IN BREAD WHEAT

M.Sc. Thesis
By

MOSTAFA TAG ELDEEN SHEHAB ELDEEN
B.Sc. Agric. Sci. (Agronomy), Fac. Agric., Cairo Univ., Egypt, 2004

Approved by:

Dr. GAD ALLAH A. MORSHED.....
Professor of Crop Breeding, Fac. Agric., Azhar University

Dr. MAZHAR M. F. ABDALLA.....
Professor of Crop Breeding, Fac. Agric., Cairo University

DR. AHMED MEDHAT M. AL-NAGGAR.....
Professor of Crop Breeding, Fac. Agric., Cairo University

Date: / / 2008

SUPERVISION SHEET

BREEDING STUDIES ON EARLINESS AND DROUGHT TOLERANCE IN BREAD WHEAT

M.Sc. Thesis
By

MOSTAFA TAG ELDEEN SHEHAB ELDEEN
B.Sc. Agric. Sci. (Agronomy), Fac. Agri., Cairo Univ., Egypt, 2004

SUPERVISION COMMITTEE

DR. AHMED MEDHAT MOHAMED AL-NAGGAR
Professor of Crop Breeding, Fac. Agri., Cairo University

DR. MOUSTAFA AZAB MOUSTAFA
Head Researcher of wheat, FCRI, Agri. Res. Center, Egypt

DR. MOHAMED MOHAMED ATTA
Lecturer of Crop Breeding, Fac. Agri., Cairo University

DEDICATION

I dedicate this work to whom my heart felt thanks; to my wife and my daughter ***Sama*** *for their patience and help, as well as to my parents and brothers for all the support they lovely offered along the period of my post graduation.*

ACKNOWLEDGEMENT

The author wishes to express his deepest gratitude and appreciation to Dr. ***Ahmed Medhat Al-Naggar****, Professor of Crop Breeding, Fac. Agric., Cairo University and Chairman of the supervision committee for suggesting the research problem, valuable guidance, great help, time offered and constructive criticism throughout the course of this investigation and preparation of this manuscript.*

Sincere thanks and grateful appreciation are extended to Dr. ***Moustafa A. Moustafa****, Head of National Wheat Research Program, Field Crop Res. Institute (FCRI), Agricultural Research Center (ARC), for his supervision, valuable advice and many helpful suggestions throughout the progress of this study.*

Grateful appreciation and sincere thanks are offered to Dr. ***Mohamed M. Atta****, Lecturer of Crop Breeding, Fac. Agric., Cairo University for his supervision, valuable advice and suggestions during the course of this investigation.*

Sincere thanks and gratitude are extended to Head Researcher Dr. ***Tag El-Din M. Shehab El-Din****, Vice President of the Agric. Res. Center, Egypt for his valuable constructive criticism, assistance and guidance during the course of the work.*

Faithful thanks and appreciation are also offered to Head Researcher Dr. ***Hayam Mahgoub****, Wheat Res. Dept., ARC for her Ass)stance in the statistical and genetic analyses, encouragement and kind help During the progress of this worK.*

Special thanks and graëitude are offered to all staff members of the Wheat Research Team at Sakha Agric. Res. Station, ARC, especially, Dr. ***Abd Rabo El-Hag****, Team Leader and Dr.* ***Abd El-Qalam Menmshawy****, Sanior Researcher for their kind assistance in the statistical analysis and providing genetic materials and research facilities throughout different steps of this work.*

Faithful thanks are extended to Mr. ***Waleed Farahat****, for his assistance in the statistical analysis and Mr.* ***Mohamed Yaseen*** *for his help in recording data.*

Name of Candidate: Mostafa Tag Eldeen Shehab Eldeen **Degree:** M.Sc
Title of Thesis: Breading Studies on Earliness and Drought Tolerance in Bread Wheat.
Supervisors: Prof. Dr. Ahmed Medhat Mohamed Al-Naggar, Dr. Moustafa Azab Moustafa and Dr. Mohamed Mohamed Atta
Department: Agronomy
Branch: **Approval:** 3 /4 /2008

ABSTRACT

This study was carried out in 2004/05, 2005/06 and 2006/07 seasons at Sakha Res. Station, Agric. Res. Center, Egypt. The main objective was to study the mode of inheritance, combining ability and heritability for earliness, grain filling and agronomic and yield characteristics in some Egyptian bread wheat genotypes and their diallel F_1 crosses under two irrigation regimes. Water stress caused significant reductions in all studied traits, except kernels/ spike (K/S)and 100 kernel weight (100KW) of F_1's; with grain yield of F_1's showing maximum reduction (22.3%). Genotypic differences were found in all traits under both irrigation treatments. Line-1 and Sakha-61 x Sids-4 were early heading and maturing as well as having high yielding ability. Line-1 x Line-3 had the best yield under both irrigation regimes and the lowest reduction due to drought besides heterobeltiosis for most studied traits under both conditions. Both general (GCA) and specific (SCA) combining ability variances were significant for all studied traits; with higher magnitude for GCA than SCA. The best general combiners were Sids-4, Line-1 and Line-2 for days to heading (DTH) and to maturity (DTM) and Sakha-61, Line-3 and Gemmeiza-10 for grain filling rate (GFR) and grain yield (GY). Additive and dominance variances were significant for all studied traits; with additive was more important than dominance for DTH, DTM, GFP, GFR and K/S under both environments and S/P and 100 KW under non-stress. While, dominance was more important than additive for GY, plant height (PH) and leaf area (LA). Degree of dominance was partial for DTH, DTM, GFP and K/S, complete for GFR, and over-dominance for GY and PH under both environments. Number of genes (gene groups) controlling inheritance was one for GFP, GFR, LA, S/P, K/S and GY; two for 100KW and DTM under both environments, three for DTH and PH under non-stress and four for DTM under water stress. Narrow-sense heritability estimates were very high for DTH and GFP, high for DTM, moderate for GFR, LA and S/P and low for PH and GY under both conditions. Results suggested that early heading genotypes showed longer GFP and that S/P and GFR were the most important factors for increasing GY.

Key words: Wheat, *Triticum aestvium*, Earliness, Grain filling, Gene action, GCA, SCA, Hertibility, Hetrobeltiosis, Correlation.

CONTENTS

اسم الطالب : مصطفى تاج الدين شهاب الدين **الدرجة:** الماجستير
عنوان الرسالة : دراسات تربية على التبكير في النضج وتحمل الجفاف في قمح الخبز
المشرفون : الاستاذ الدكتور : احمد مدحت محمد النجار
الاستاذ الدكتور : مصطفى عزب مصطفى
الدكتور : محمد محمد عطا
قسم: المحاصيل **فرع:** المحاصيل **تاريخ منح الدرجة:** 3 /4 / 2008

المستخلص العربي

أجريت هذه الدراسة خلال المواسم 2005/2004, 2006/2005, 2007/2006 في المزرعة البحثية بمحطة التجارب الزراعية بسخا التابعة لمركز البحوث الزراعية. كان الهدف الرئيسي هو دراسة نوع فعل الجين والقدرة على الائتلاف وكفاءة التوريث لصفات التزهير وامتلاء الحبوب والمحصول ومكوناته في ستة تراكيب وراثية مصرية من قمح الخبز (سخا 61, سدس 4, جميزة 10, سلالة 1, سلالة 2, سلالة 3) وهجنهم التبادلية تحت نظامين من الري (الأول ري كامل والثاني اعطي رية الزراعة ورية المحاباة ثم منع الر ي بعد ذلك). تسبب الإجهاد المائي في حدوث نقص معنوي في متوسطات كل الصفات المدروسة وحدث أقصى نقص في محصول حبوب الهجن (22.3%). أظهرت النتائج وجود اختلافات معنوية بين التراكيب الوراثية في كل الصفات تحت كلا من نظامي الري وكانت السلالة-1 والهجين (سخا61 × سدس4) هما الأبكر في التزهير والنضج وفي نفس الوقت الأعلى محصولا. كما كان الهجين (سلالة-1 × سلالة-2) الأحسن محصولا تحت كلا النظامين والأقل نقصا في المحصول بسبب الجفاف ومتوسط في التكبير في النضج. أظهرت بعض الهجن قوة هجين معنوية مرغوبة بالنسبة للأب الأحسن في كل الصفات المدروسة. كانت قيم تباين القدرة العامة اكبر من قيم القدرة الخاصة على الائتلاف. كانت الآباء الأحسن في تأثيرات القدرة العامة على الائتلاف هي سدس-4 و سلالة -1 و سلالة-2 بالنسبة لصفتي عدد الأيام حتى الطرد وحتى النضج الفسيولوجي وسخا-61, وسلالة-3 وجميزة-10 بالنسبة لصفتي معدل امتلاء الحبوب ومحصول حبوب النبات. كانت التباينات المضيفة وتباينات السيادة لجميع الصفات معنوية تحت كلا من نظامي الري. كان التباين المضيف أكثر أهمية من تباين السيادة بالنسبة لعدد الأيام حتى الطرد والنضج, وفترة ومعدل امتلاء الحبوب وعدد الحبوب بالسنبلة تحت البيئتين وعدد السنابل بالنبات ووزن الـ100 حبة تحت ظروف الإجهاد. بينما كان تباين السيادة أهم من التباين المضيف بالنسبة لمحصول الحبوب وارتفاع النبات ومساحة الورقة. كانت درجة السيادة جزئية لصفات عدد الأيام حتى الطرد والنضج, وفترة امتلاء الحبوب وارتفاع النبات تحت كلا البيئتين. كان عدد الجينات (مجاميع الجينات) التي تتحكم في الوراثة هو جين واحد بالنسبة لفترة ومعدل امتلاء الحبوب ومساحة الورقة وعدد سنابل النبات وعدد حبوب السنبلة والمحصول وجينين لوزن الـ100حبة وعدد الأيام حتى النضج تحت البيئتين وثلاثة جينات لعدد الأيام حتى الطرد وارتفاع النبات تحت ظروف عدم الجفاف وأربعة جينات لعدد الأيام حتى النضج تحت ظروف الجفاف. كانت تقديرات كفاءة التوريث بالمعنى الخاص عالية جدا لصفتي عدد الأيام للطرد وفترة امتلاء الحبوب, وعالية لعدد الأيام للنضج ومتوسطة لمعدل امتلاء الحبوب ومساحة الورقة وعدد السنابل بالنبات ومنخفضة لارتفاع النبات ومحصول حبوب النبات تحت كلا النظامين من الري. اقترحت النتائج أن التراكيب المبكرة في الطرد أظهرت فترة امتلاء حبوب أطول, وأن صفتي عدد السنابل ومعدل الامتلاء هما الأهم لزيادة المحصول.

الكلمات الدالة:قمح الخبز, التبكير, تحمل الجفاف, امتلاء الحبوب, فعل الجين, القدرة على الائتلاف, كفاءة التوريث, قوة الهجين, ارتباطات.

دراسات تربية على التبكير في النضج وتحمل الجفاف

في قمح الخبز

رسالة الماجستير
في العلوم الزراعية
(محاصيل)

مقدمة من

مصطفى تاج الدين شهاب الدين
بكالوريوس فى العلوم الزراعية (محاصيل)- كلية الزراعة- جامعة القاهرة، 2004

لجنة الإشراف

الدكتور/ احمد مدحت محمد النجار
أستاذ تربية المحاصيل- كلية الزراعة- جامعة القاهرة

الدكتور / مصطفى عزب مصطفى
رئيس بحوث المحاصيل – معهد بحوث المحاصيل الحقلية - مركز البحوث الزراعية

الدكتور/ محمد محمد عطا
مدرس المحاصيل- كلية الزراعة- جامعة القاهرة

دراسات تربية على التبكير في النضج وتحمل الجفاف في قمح الخبز

رسالة الماجستير
في العلوم الزراعية
(محاصيل)

مقدمة من

مصطفى تاج الدين شهاب الدين
بكالوريوس فى العلوم الزراعية (محاصيل)- كلية الزراعة- جامعة القاهرة، 2004

لجنة إجازة الرسالة:

د. جاد الله عبد المقصود مرشد .....
أستاذ تربية المحاصيل- كلية الزراعة- جامعة الأزهر

د. مظهر محمد فوزي عبد الله.....
أستاذ تربية المحاصيل- كلية الزراعة- جامعة القاهرة

د.أحمد مدحت محمد النجار.....
أستاذ تربية المحاصيل- كلية الزراعة- جامعة القاهرة

دراسات تربية على التبكير في النضج وتحمل الجفاف في قمح الخبز

رسالة مقدمة من

مصطفى تاج الدين شهاب الدين
بكالوريوس في العلوم الزراعية (محاصيل)- كلية الزراعة- جامعة القاهرة، 2004

للحصول على

درجة الماجستير

في

العلوم الزراعية
(محاصيل)

قســـم المحاصيـــل
كليـــة الزراعـــة
جامعة القاهرة

مصـــــر

2008

INTRODUCTION

Bread wheat (*Triticum aestivum* L.) is the most important cereal crop in Egypt as well as in the world. It supplies nearly 55% of the carbohydrates consumed worldwide (Gupta *et al.*, 1999). The annual consumption of wheat grains in Egypt is about 12.4 million tons, while the annual local production is about 8.2 million tons in 2006 (Agricultural Statistics, Arab Republic of Egypt, Vol. I, 2007). Efforts of scientists to minimize the gab between local consumption and local production are directed towards two ways, i.e. expanding the cultivated wheat area and increasing the wheat productivity from the land unit area.

Expanding the cultivated area of wheat is only possible in the new reclaimed lands, where water stress is the main obstacle. Developing new varieties of wheat that tolerate water stress is of great importance and should occupy the first priority for wheat breeders.

Losses in grain yield and its components of wheat due to water stress were recorded by many investigators (Jurgens *et al.*, 1978; Talukder, 1987; Pal, 1992 and Shah, 1992). They reported that water stress can be considered as a major abiotic stress affecting wheat yield.

Developing new early-maturing cultivars of bread wheat without loss of inherent yielding ability is an objective of the Wheat Breeding Program in Egypt. Yield losses due to certain stresses may be minimized in early-maturing cultivars, since they would escape such stresses that might occur late in season (Clarke *et al.*, 1984 for drought and Menshawy, 2005 for heat stress). In Egypt, the success of wheat to

be cultivated in the rainfed area of the Northern Coast and late planting in the North Delta, may depend entirely on the early maturing cultivars. However, many investigators reported that early-maturing cultivars were more drought tolerant than late ones (Fischer and Maurer, 1978 and Kheiralla *et al.,* 1993).

The possibility of double cropping wheat and cotton in Egypt has also heightened interest in high-yielding early-maturing wheats (Menshawy, 2007a). Early harvest of the wheat crop is critical to allow botton crop sufficient time to develop and to produca an$adequate yield.

Differences among whead genotypes under water stress and non-stress conditions were reported by many researchers for earliness (Ehdaie and Waines, 1996 and Menshawy, 2007 a and b), grain filling period and rate (Gebeyhou *et al*., 1982 and Mou and Kronslad, 1994) and grain yield and its comp/nen4s (Fischer and Maurer, 1978; Edhaie *et al*., 1988; El-Danasory, 2005 and Farhat, 2005). The presence of genotypic differences in these traits suggests that wheat breeder would be able to improve such traits with the ultimate aim of improving water-stress tolerance.

A better understanding of the inheritance and type of gene action for earliness and grain filling traits would help wheat breeders to increase and stabilize grain yield. Several scientists found that maturity is controlled by one gene (Johnson *et al.,* 1966 and Shehab El-Din, 1997) with earliness being dominant or partially dominant. Other Researchers found that a two-gene model was more likely (Pinthus, 1963 and Shehab El-Din, 1997). Three)gene (Crumpacker and Adlard,

1962) and four-gene (Wehrhahn and ALlard, 1965) mÚdels have been proposed and rome data indicated the presence of another dominant gene for lateness.sModifying factors have been suggested (Klaimi and Qualset, 1973 and Pinthus, 1963). Polygenic control also has been reported (Edwards *et al.*, 1976). However, information is laking regarding inheritance of grain filling rate and duration in wheat.

Additive gene action is evidently accounted for a large amount of the variation for days to heading (Bhatt, 1972; Avey *et al.*, 1982 and Menshawy, 2000 and 2005) days to maturity (Menshawy, 2000, 2005 and 2007), grain filling duration and rate (Rasyad and Van Sanford, 1992; Beiquan and Kronstad, 1994; Mou and Kronstad, 1994 and Menshawy, 2004), but dominance also was important (Crumpacker and Allard, 1962; Avey *et al.*, 1982 and Menshawy, 2005) for earliness traits, while epistasis was reported in several studies (Amaya *et al.*, 1972; Ketata *et al.*, 1976 for earliness and Przulj and Mladenov, 1999 for grain filling traits).

To exploit different types of gene action involved in inheritance of earliness and grain filling traits of some Egyptian bread wheat genotypes, information regarding their relative magnitude and estimates of combining ability are essential. Such information will help wheat breeders in their identification of parents and selection strategies. Therefore, the objectives of the present investigation were to:

1. Study water-stress effect on earliness and grain filling traits as well as grain yield and its components of wheat.

2. Investigate the genotypic differences in such traits and identify some early maturing and high yielding genotypes under drought stress conditions.
3. Determine the mode of inheritance, heterosis, combining ability and heritability estimates for earliness, grain filling, agronomic and yield traits in some Egyptian bread wheat genotypes and their diallel F_1 crosses under different irrigation regimes.
4. Test the genetic correlations among studied traits, in order to identify the most important factors for increasing grain yield under water stress conditions.