

**BREEDING OF SOME BREAD WHEAT VARIETIES
(*Triticum aestivum* L.) UNDER WATER STRESS
CONDITIONS**

By

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B.Sc.Agric.Sci. (Agronomy) Fac. Agric., Cairo Univ., 1995

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APPROVAL SHEET

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ABSTRACT

Diallel cross excluding reciprocals was used to study the performance of six bread wheat varieties (*Triticum aestivum* L.) and their hybrids under water stress conditions. These varieties were used as parents (Giza 168, Giza 170, Gemmeiza 9, Prl x Toni, Rabi x Weaver and Pastor) of diallel cross mating design. During 2003/04 season; grains were sown in the crossing blocks of wheat research section. All F₁ seeds of diallel mating design among the six parents were obtained. During 2003/04 season, the parental genotypes were sown and re-crossing for obtaining addition F₁ grains to insure sufficient hybrid grains. 2005/06 season, the parental genotypes and resultant 15 F₁ hybrids were grown under three irrigation treatments: W₁= 6 irrigations, W₂= two irrigations and W₃= one irrigation. Each treatment was conducted as a separate experiment by using Randomized Complete Block Design replicated four times. At harvest, the bordered plants in each plot were considered for collecting data. The studied characters were; plant height, biological yield, number of spikes/plant, spike length, number of spikelets/spike, number of grains/spike, 100-grain weight, grain weight/spike, grain yield/plant, peduncle length, flag leaf area, number of stomata- up, number of stomata- low and days to heading. The results of parental genotypes mean performance recorded increasing in the % of reduction between two irrigations and normal irrigation treatments for all studied traits except number of spikelets/spike, 100-grain weight, peduncle length and number of stomata- up indicating that these traits could be used as selection criteria under water stress conditions. According to drought susceptibility index, the present parental genotypes and cross combinations varied significantly in their tolerance or susceptibility to water stress conditions. But it seems that the most productive genotypes under normal irrigation are less susceptible (moderately tolerant) under water stress, also the hybrids which revealed tolerance behavior have at least one tolerant parental genotype. Therefore, using proper breeding program may enable combining high yielding ability with reliable drought tolerance. According to the heterotic effect, it could be concluded that different values of heterosis may be due to the genetic diversity of the studied parents with non-allelic interactions which increase or decrease the expression of heterosis. According to the ratio of additive to non-additive gene effects as an indication of the relative importance of both effects, the results showed that it exceeded the unity only for (spike length, number of spikelets/spike, 100-grain weight and grain weight/spike) under normal irrigation treatment (W). Moreover, under water stress, the ratio of all studied traits exceeded unity except for (biological yield, number of spikelets/spike and grain yield/plant). Thus, additive gene effects appeared to be predominant only for water stress attributes. However, under normal irrigation, most of studied traits may be influenced by non-additive gene effects than additive ones. Specific combining ability, classified the genotypes into three categories: first one included the tolerant x tolerant genotypes which may be described as greatly favourable for improving the performance under water stress (W₁) and none stressed (W) conditions. The second one comprised tolerant x susceptible genotypes which are favorable for intermediate condition of water stress (W₂). The last category included susceptible x susceptible to water stress which exhibited good performance under normal irrigation (W). From the obtained results regarding to the specific combining ability effects, it's difficult to draw general view for inclusion of various parents in the wheat crossing program. The first reason rose from the purpose of conducting the hybridization in wheat. The main objective of crossing wheat isn't to search for the best cross combination only but to select high yielding and better adapted varieties to increase cross productivity. The second reason appeared from the recorded specific combining ability effects results from present studies, which proved great variation from combination to another and also between traits. Such findings based on the fixable evaluation of parent potential as general combining ability obstacle the recommendations for choosing the tolerant parents in the cross-breeding program. However, the utilization of some tolerant genotypes could be recommended as parents for improving specific traits under water stress conditions or drought. It could be concluded that crossing of different parental genotypes that having variable reactions to water stress widen the performance of resultant combinations. Generally, the water stress tolerance of wheat was strengthened by crossing and inclusion of the superior combinations in breeding program. The better cross combinations may be subjected to isolated intercrossing together for developing elite gene pool. Such gene pool may be used for recurrent selection program or used directly as a source of drought tolerance. Regarding to the effect of water stress on anatomical studies, it was obvious that this application induced thinner leaves from the prominent reduction in the thickness of mid-vein and lamina, but the reduction in the tolerant cross was less than the reduction in the susceptible one.

Key Words: Bread wheat (*Triticum aestivum* L.) – water stress – Diallel Analysis– Heterosis – GCA, SCA – Components of variation – Anatomical studies.

DEDICATION

I dedicate this work to whom my heart felt thanks; to my mother Wedad the greatest mean of motherhood and the soul of my dearest father Hamed asking God to give him merciful and heaven, also for my husband Tamer, my children Jana and Anas, for all who offer their effort and help to me.

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INTRODUCTION

Wheat is the most important strategic cereal crop in Egypt. It's the main winter cereal crop as it occupies approximately 3 million feddan producing 7.5 million tons by Ministry of Agric., 2008. Wheat is the primary stable food source of the most Egyptian population. Moreover, its straw is an important fodder.

The long term strategic plan of wheat research program in Egypt is aiming to select the elite materials among introduced and regionally collected germplasm that possess good adaptation to the unfavorable conditions. Water stress is one of these unfavorable conditions and considered to be one of the most critical constraints for wheat productivity in such area. Besides, high yielding and early maturing, drought tolerant cultivars are required nowadays for more crop intensification as the cultivated land and irrigation water are limited. As the most important practices is water management so developing wheat cultivars that use available water more efficiency with height drought tolerance is a major goal for increasing wheat productivity in such environments (Amer, 2007). The recommended package of water for wheat is about 2000 m³/feddan (6 irrigations) and decreasing this amount may help in increasing the area we aim to reclaim and we can reach this target by one or two ways of breeding. The first one is evaluating many genotypes under different stress conditions. The other one is breeding programs, which depend on stretching the genetic base to create the variation as the best tool for breeders in which drought tolerance and yield potential can be combined (Abd Allah, 2002).

On the other hand, hybridization offers good possibilities for widening the genetic base and studying the nature of genetic systems controlling the inheritance of traits and/or transfer of characters/genes from genotype to another.

Success of any plant breeding program depends largely upon a better understanding of the genetic bases of yield and its contributing characters. Information about the adequacy of the genetic model and types of gene action for some physiological characters, yield and yield components may help the wheat breeder to formulate the most efficient breeding procedure for achievement of maximum genetic improvement among a particular set of genotypes (Moursi, 2003).

The estimates of general (GCA) and specific (SCA) combining abilities, presented by Barakat and Shehab El-Din (1993), Eissa (1993), El-Beially and El-Sayed (2002), El-Sayed (2004) and El-Sayed and Moshref (2005) indicated that both of them played an important role in the inheritance of grain yield, number of spikes/plant, number of kernels/spike and 100-kernel weight. However, Darwish (1998) and Mohammed (2001) reported that non-additive gene effects were found for grain yield/plant, number of kernel/spike and 100-kernel weight. Moreover, El-Hennawy (1991), Abd El-Majeid *et al.* (2004) found that mean squares of GCA were higher than those of SCA for yield and its components.

Heterosis and combining ability as well as the nature of genetic behavior were studied by many authors through the different methods of mating designs, i.e. diallel, line x tester, six populations' method and straight hybridization. On the other hand, heterosis in

wheat has not been exploited yet, although several authors detected significant heterosis on most crosses of wheat as reported by El-Beially and El-Sayed (2002), Abd El-Majeid *et al.* (2004) and El-Sayed and Moshref (2005).

This work was conducted to study:

1. Mean performance of six bread wheat genotypes and their hybrids without reciprocals under water stress conditions by decreasing no. of irrigations.
2. Identification to the tolerant and susceptible wheat genotypes by drought susceptibility index.
3. Assessment the adequacy of genetic model, heterosis, combining ability, types of gene action and heritability for the studied characters under normal and water stress conditions.
4. The effect of water stress on leaf anatomy for the selected hybrids and their parents.

REVIEW OF LITERATURE

1-Effect of water stress

a. Agronomic traits

On a global basis, drought is one of the most important environmental constraints that limit wheat productivity. Water stress is considered the most pronounced problem which faces many parts in the world. This problem not only draws the attention of many investigators to study the causes of drought and develop the agricultural practices for better growing under drought conditions. But also, breeding and developing new wheat genotypes tolerate to water stress. Yield and its components measured are the best and ultimate indicators of drought resistance used in wheat improvement under well-watered and water stressed conditions. Many studies were carried out and different results were obtained. In this respect, Jana and Sen (1978) studied the effect of number of irrigations during different growth stages on yield of wheat and the results indicated that increasing number of irrigations from 2 (crown-root initiation and tillering stage) to 4 (crown-root initiation, tillering, flowering and dough stage) increased plant height, spike length, number of grains spike, grain and straw yield.

Keim and Kronstad (1981) studied the response of some wheat cultivars to drought conditions and concluded that wheat cultivar Yam Hill was more tolerant to drought conditions as compared with the other studied ones. They suggested that the tolerance of this cultivar may be due to its high growth rate during heading and anthesis, heavy kernel weight as well as more number of spikes/m².

Clarke and McCaig (1982) evaluated techniques for screening drought resistance in durum and hexaploid wheat and the results showed that yield performance of the cultivars differed under rainfed and irrigated conditions. Among the durum, DT 367 and Cando had high yields under both environments while Hercules was low yielding in both. Superior adaptation to dry environments is indicated in Lakota and Pelisier which high yield rank under rainfed than under irrigated conditions. Similarly, in the hexaploid group, Echo Amy and Pitie 62 showed high and stable yield while Canuck showed improved yield rank under rainfed conditions.

Moursi *et al.* (1983) studied the effect of drought conditions at different stages of plant age on growth, yield and grain quality, they reported that skipping an irrigation at tillering decreased plant height, spike length, number of spike/m², number of spikelets/spike, number of grains/spike, 100-grain weight and straw and grain yield/feddan as compared with six irrigations at crown-root dough ripe stages. They also added that skipping an irrigation during spike initiation decreased plant height. This might be attributed to the lack of available water during spike initiation which depressed the number of spikes/plant. Furthermore, Hefni *et al.*(1983) in their trails on wheat irrigation, reported that number of grains/spike was significantly decreased by skipping an irrigation at any stage of tillering, booting and flowering.

Hassan *et al.*(1987) studied the agronomic performance of wheat as influenced by moisture stress (seven drought treatments affected by missing one or two consecutive irrigations) at various

growth stages. The results showed that with holding irrigation at any growth stage prior to anthesis had detrimental effects on most of the growth characters and stress during crown root initiation and jointing reduced most of the yield characters. With holding, irrigations at root initiation and tillering stages markedly depressed plant height, flag leaf area and number of tillers. Missing two consecutive irrigation at any given growth stage reduced grain yield more than did not missing one irrigation. The greatest reductions in grain yield were 13 and 65% when one irrigation was missed at crown root initiation and two consecutive irrigations were missed at joining (the moist sensitive growth stage), respectively. Moisture stress was also detrimental to number of spikes/m², number of fertile spikelets/spike, number of grains/spike, length of spike, 1000-grain weight and straw yield.

Schonfeld *et al.* (1988) evaluated single plants of drought resistant wheat cv. (TAM W-101) and drought susceptible cv. (Sturdy) their F₁ and F₂ progeny and back crosses of F₁ to each parent under a rain shelter. They concluded that under both droughts stressed and well watered conditions (TAM W-101) had a significant higher bio-mass, grain yield, number of head/plant and kernel weight than Sturdy cultivar. Moreover, compared to well-watered treatment, drought caused reductions in bio-mass, grain yield, number of heads/plant, kernel weight and harvest index. For both cultivars, yield reductions under drought conditions were attributable to the combined reduction in number of heads/plant and kernel weight.

Khajanji and Dwivedi (1988) studied the response of wheat variety Lo-1 to irrigation and fertilizer mixtures under late sown conditions and found that (Lok-1) under late-sown conditions gave grain yield of 1.73 t/ha with three irrigation at the crown root initiation, late joining and flowering stages; 1.5 t/ha with two irrigations at first two stages and 1.1 t/ha with one irrigation at the crown root initiation stage compared with 0.59 t/ha without irrigation.

Dawood *et al.* (1988) compared yielding ability of 8 wheat cultivars under 25, 55, and 85% of soil available water and found that the non stressed condition (85% of the soil available water) produced significantly higher grain yield per feddan than the stressed conditions of 25 and 55% of soil available moisture. Moreover, they concluded that decreasing soil moisture caused a reduction in plant height, spike length, number of spikelets/spike and number of spikes/m². The maximum value for 1000-kernel weight was obtained at 55% soil available water. These studies indicated that exposing wheat plants to soil water stress significantly reduced the yields and its components.

Winter *et al.* (1988) evaluated screening techniques for breeding drought resistance winter wheat cultivars viz. South 66, Sturdy, Tam-101, TAM 105 and TAM 108. The results revealed that the irrigation tests indicated that the cultivars reacted differently to drought stress. A significant cultivar x drought stress interaction for grain yield was occurred on two out of three years combined analysis. The low yield of (Sturdy) cultivar when drought stressed and the high yield of TAM 105