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# PHYSIOLOGICAL STUDIES ON THE RELATIONSHIP BETWEEN WHEAT GRAIN TYROSINE AND PLANT DROUGHT RESISTANCE

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## ABSTRACT

Two bread wheat cultivars (*Triticum aestivum* L. cvs. Abu-Ghraib 3 and Mexipak) and two of durum wheat (*Triticum durum* Desf. Acsad-65 and Om-Rabi-5) were subjected to various levels of water stress (-0.6, -0.8, -1 Mpa in addition to -0.03 Mpa, field capacity). Phenol reaction test was substituted with tyrosine test.

Results revealed that the two bread wheat cvs. were more drought resistant than durum wheat cultivars as they were less affected by water stress and particularly Abu-Ghraib 3 which was superior over all involved cultivars. However, the reduction in total biomass and grain yield per pot was much less pronounced in Abu-Ghraib 3 than all other cultivars particularly the durum. Total biomass and grain yield were reduced as much as 83.84% and 91.06%, respectively, under the stress (-1 Mpa) in comparison to that grown under field capacity, while reductions of 85.61 % and 94.49 % were recorded for the wheat durum cultivar Om-Rabi 5. Besides, Abu-Ghraib,3 was the only cultivar which manifested the dark black coloration with tyrosine test.

These results confirm that phenol can be successfully substituted with tyrosine for wheat varietal identification as the former one is caustic, hateful and has a harmful smell. Further studies are required to compare numerous wheat cultivars, those tolerant or sensitive to drought to confirm these results.

***Key words:*** *drought resistance , tyrosine , water stress, wheat.*

## 1. INTRODUCTION

Wheat cultivars of *Triticum aestivum* L. and *Triticum durum* Desf. are among the most economic strategic cereal crops grown in Northern Iraq, as they are used for human consumption by most people in several food commodities and recipes. These crops are mostly grown under rainfall system, which is characterized by irregular precipitation incidences and poor distribution. Water availability is one of the major limiting factors in the production of these crops (Adary *et al*., 2002.). Wheat production is influenced by both amount and the interseasonal distribution of the rainfall incidences. One mean of enhancing wheat productivity is cultivar screening for drought resistance to withstand the adverse effects of soil moisture stress especially during the critical development stage which in turn reflects on the ultimate crop yield. However, water stress is a serious abiotic constraint limiting crop yield. Wheat cultivars vary in their resistance to such stresses. Investigators search for cultivars having the abilit to withstand or at least show a minimal degree of the adverse effects under such conditions. Several methods have been applied for drought resistance screening of cultivars such as proline content (Rensburg and Kruger, 1994). Phenol reaction test has been utilized for cereal varietal identification (Csala, 1972 and Jensen and Legaspi, 1979). Khalaf (1993) reported that the Iraqi bread wheat cultivar Saberbeg exhibited a dark brown coloration when phenol test was applied, while the introduced wheat cultivar Mexipak displayed a fade color. However, Ahmed and Khalaf (1985 and 1987) demonstrated the response of these two cultivars to various water stress. They found that wheat cultivar Saberbeg which showed a positive reaction with phenol possesses higher drought resistance in comparison to Mexipak of fade color. This finding prompted the setup of an experiment to investigate phenol substitution by tyrosine in some common and durum wheat to segregate the most drought resistance cultivars of the Iraqi Kurdistan Region in Northern Iraq.

## 2. MATERIALS AND METHODS

Grains of two *aestivum* (Abu-Ghraib-3; Mexipak) and two *durum* (Acsad-65 and Om-Rabi-5) wheat cultivars were exposed to tyrosine test reaction. Tyrosine was used as a substrate for tyrosinase activity determination. Three replicates each of 25 grains per cultivar were soaked for 24 hours in distilled water at ambient temperature and then transferred to a Petri-dish over a single sheet of filter paper, moistened by 3 ml of 0.2% tyrosine aqueous solution (as a substrate), thereafter incubated at 35°C for 6 hours.

Grains were then evaluated according to coloration intensity into three categories as dark brown, fade and no change.

Twenty grains of a uniform size were sown on 6/1/2006 in plastic pots (22 cm diameter and 20 cm in height), filled with 4.5 kg of silty clay soil. Pots were kept at field capacity (-0.03 Mpa) until 17/2/2006. Thereafter, wheat plants were thinned to ten per pot when they reached 15 cm in height (after 40 days from sowing). Pots were kept under polyethylene rain proof shelter with open sides. The corresponding soil moisture content of -0.03, -0.6, -0.8, and -1 Mpa was detected by a pressure membrane apparatus and it was found to be 29.6, 17.4, 16.3 and 15.1%, respectively (Fig.1). Soil water content for stress treatments was sustained by weighing the pots periodically at two day intervals till plants reached mature stage on May,15$^{th}$ 2006.

Pots were arranged as a Factorial – Randomized Complete Block Design (RCBD) to include 16 treatments (4x4), each replicated three times. The first factor (A) was soil moisture tension levels and factor (B) was the wheat cultivars.

At maturity, the plants were cut above soil surface, and the following traits were recorded: plant height (cm), number of spikes per pot, number of branches with no spikes, spike length (cm), number of grains per spike, above ground and roots dry weight (g) (oven dry at 70°C overnight). Also total dry weight (shoots and roots, g),was calculated.

Data were analyzed using SAS (2001) computer program and Duncan (1955) MRT was used for means verification.

## 3. RESULTS AND DISCUSSION

### 3.1. Tyrosine test

Wheat cultivar Abu-Ghraib 3 exhibited dark brown color with tyrosine, while Mexipak gave fade color, but the other two durum wheat cvs.*i.e.*gave negative response, no color change (Fig. 2). Khalaf (1993) demonstrated that wheat cultivar Saberbeg gave a dark brown coloration with phenol test and also referred to fade color with Mexipak and no change with some other durum wheat cultivars. Moreover, Khalaf (2008) confirmed similar results with the substitution of phenol by hydroquinone. The brown color of wheat pericarp had been attributed to the process of phenol oxidation which was influenced by enzymic as well as non-enzymic processes. Chemical reactions of nitrogen compounds (and amino acids) in the presence of metal and oxygen may be involved (Csala, 1972). Holmes (1979) stated that tyrosinase also converts tyrosine to melanin, which is responsible for a color reaction.

### 3.2. Water stress experiment

Wheat cultivars were insignificantly different in plant height and root weight; however, bread wheat cultivars were superior in straw, leaves and total biomass weight. In general, wheat cultivar Abu-Graib 3 exhibited higher values in most studied traits.

As regards the water stress, a steady reduction in all measured characters with stress levels was observed. Also, an extreme water stress hampered the above ground growth more than roots. A similar significant reduction in plant dry above ground biomass of durum and bread wheat genotypes was noticed by Saleem (2003). These results are attributed to the fact that the investigated cultivars of different genotypic configuration show different gene expression capabilities when they are grown under the same environment and population density conditions. Therefore, the observed differences might be due to photosynthetic efficiencies which are determined by genotypic expression (Klar and Hossokawa, 1996).

Ahmed and Khalaf (1985) illustrated such differences between bread wheat cultivars as they found that the local wheat cultivar Saberbeg was performed well under dry conditions in Iraq North Provinces. No significant yield reduction was found due to moderate stress exposure during boot stage to maturity , and Saberbeg produced more straw than wheat cultivar Mexipak. Moreover, in a separate experiment carried out by Khalaf (1993), cultivar Saberbeg gave dark brown coloration with phenol test. It was noticed in the present work that wheat cultivar Abu-Ghraib3 headed ten days earlier than the other cultivars, which may be considered as a criterion for drought escaping behavior. Such earliness of the first spike emergence of Abu Graib3 has been reported by Al-Nori (2005).

The results were concomitant by increasing water stress gradually, as compared to those irrigated to field capacity (-0.03Mpa) (Tables 1 and 2). The deleterious effect of severe water stress on wheat and barley growth has been reported by Ahmed and Khalaf (1987), and Al-

Haffothi, 2000). This result indicates that water stress reduces the imbibition of water by grains and negatively influences the dehydration effects through slowing down the enzymatic activities and number of grains per spike were recorded Similar to other tests, Abu-Ghraib, 3 under all stress levels gave higher values than other cultivars for these two characters.

**Table(1): Effect of water stress levels on vegetative traits of wheat cultivars.***

| Characters | | Plant hight cm | Vegetative branches/ pot | Straw w,(g) pot | Leaves D.w(g) pot | Root D.w(g) Pot | Total biomass, (g) pot |
|---|---|---|---|---|---|---|---|
| Cultivars | Abu-Ghraib,3 | 38.90[a] | 7.83[ab] | 6.72[a] | 1.008[ab] | 3.325[a] | 15.23[a] |
| | Mexipak | 37.25[a] | 7.58[ab] | 6.09[b] | 1.041[a] | 2.942[a] | 13.60[b] |
| | Acsad,65 | 38.01[a] | 5.92[b] | 5.75[bc] | 0.90[bc] | 3.100[a] | 13.11[b] |
| | Om-Rabi,5 | 36.38[a] | 8.92[a] | 5.30[c] | 0.86[c] | 3.358[a] | 13.20[b] |
| Stress, Mpa | -0.03 | 61.85[a] | 18.88[a] | 13.08[a] | 2.05[a] | 7.642[a] | 2.05[a] |
| | -0.6 | 41.70[b] | 5.00[b] | 5.01[b] | 0.79[b] | 2.050[b] | 0.79[b] |
| | -0.8 | 27.08[c] | 2.58[b] | 3.31[c] | 0.55[c] | 1.675[bc] | 0.55[c] |
| | -1 | 19.91[d] | 4.67[b] | 2.47[d] | 0.41[d] | 1.358[c] | 0.41[d] |

*Within each set mean values followed by shared letters are not significantly differ at 5% (Duncan's MRT).

**Table (2): Effect of wheat cultivars and water stress levels on yield components. ***

| Characters | | No. heads/pot | Spike length (cm) | No. seeds/spike | Total seed wT(gpot) |
|---|---|---|---|---|---|
| Cultivars | Abu-Ghraib 3 | 9.17[a] | 6.04[a] | 16.36[a] | 4.17[a] |
| | Mexipak | 8.33[a] | 5.33[b] | 12.11[b] | 3.52[b] |
| | Acsad,65 | 9.00[a] | 3.75[c] | 10.27[c] | 3.36[b] |
| | Om-Rabi,5 | 8.75[a] | 3.38[d] | 11.44[bc] | 3.28[b] |
| Stress, Mpa | -0.03 | 10.00[a] | 6.38[a] | 26.81[a] | 8.68[a] |
| | -0.6 | 10.00[a] | 4.61[b] | 12.17[b] | 3.44[b] |
| | -0.8 | 9.00[a] | 3.99[c] | 7.09[c] | 1.63[c] |
| | -1 | 6.25[b] | 3.52[d] | 4.10[d] | 0.59[d] |

* Within each set mean values followed by shared letters are not significantly different at 5% (Duncan's MRT).

and food mobilization to the embryo. These effects in turn slow embryo growth (Ahmed and Khalaf, 1987). Water stress slows shoot elongation since it lowers cell turgid pressure which is the major factor responsible for cell extension and growth (Boyers, 1970). It is worth mentioning,from grain appearance, that grains obtained from treatments irrigated to field capacity for all cultivars resulted in yellowish mottled grains (Fig, 3).

Results in Tables (3) and (4) show insignificant interaction between wheat cultivars and water stress for most measured parameters. However, significant differences in spike length

The results can clarify the estimation of reduction percentage of total biomass (shoots and roots) and total grain weight in comparison to that of unstressed plants (Table 5). In general, two points can be taken in consideration. First, the reduction percentage caused by water stress was more obvious in yield components than in vegetative growth. Second, wheat cultivar Abu-Ghraib-3 was less affected since it showed the lowest yield reduction under drought conditions. This means that it could be considered as more drought resistant in comparison to other cultivars. Also it displayed dark resistant coloration with tyrosine test.

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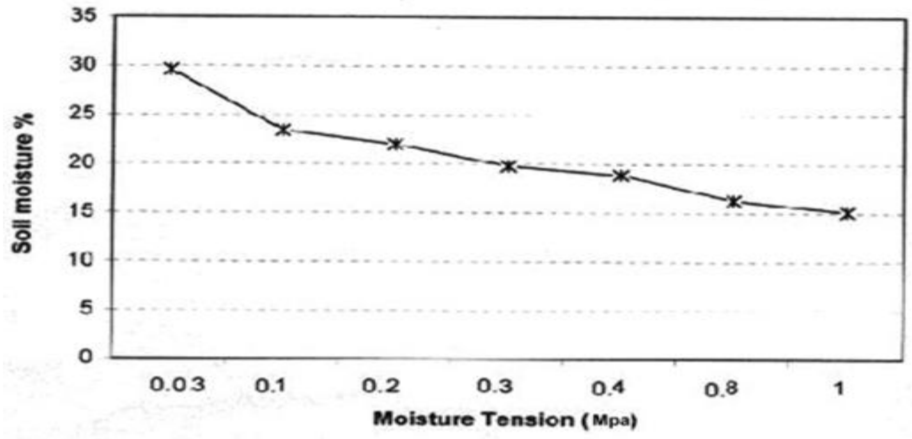


**Fig (1): Soil moisture retention curve.**

Abu-Ghraib,3 Mexipak Acsad-65 Om-Rabi-5

**Fig (2): Wheat seed coloration due to tyrosine treatment.**

-0.03 -0.6 -0.8 -1Mpa

Abu-Ghraib,3

Acsad-65

**Fig (3): Wheat seeds appearance produced under different levels of moisture stress.**


**Fig (4): Roots system for wheat cultivars grown under different moisture stress levels.**

**Table (3): Effect of wheat cultivars and water stress interaction on vegetative traits.***

| Cultivars | Stress levels Mpa | Plant ht (Cm) | Vegetative branches/ pot | Straw D.W(g /pot) | Leaves D.W,(g/ Pot) | Root D.W,(g/ pot) | Total biomass, g/pot |
|---|---|---|---|---|---|---|---|
| Abu-Ghraib,3 | $-0.0^{3}$ | $65.29^{a}$ | $19.00^{ab}$ | $14.67^{a}$ | $2.00^{a}$ | $8.068^{a}$ | $34.47^{a}$ |
| | -0.6 | $43.57^{c}$ | $7.00^{d}$ | $5.87^{c}$ | $0.86^{b}$ | $1.967^{cd}$ | $12.70^{c}$ |
| | -0.8 | $25.83^{e-g}$ | $1.67^{d}$ | $3.53^{e-g}$ | $0.70^{bcd}$ | $1.867^{cd}$ | $8.17^{de}$ |
| | -1 | $20.90f^{-h}$ | $3.67^{d}$ | $2.80f^{g}$ | $0.46^{def}$ | $1.400^{cd}$ | $5.57^{fg}$ |
| Mexipak | -0.03 | $61.93^{ab}$ | $13.33^{c}$ | $13.00^{b}$ | $2.20^{a}$ | $6.933^{b}$ | $30.93^{b}$ |
| | -0.6 | $41.60^{cd}$ | $5.00^{d}$ | $4.87^{cd}$ | $0.86^{b}$ | $2.067^{cd}$ | $11.20^{c}$ |
| | -0.8 | $26.36^{ef}$ | $2.67^{d}$ | $3.97d\text{-}^{f}$ | $0.63^{bcde}$ | $1.600^{cd}$ | $7.60^{ef}$ |
| | -1 | $19.11^{h}$ | $6.00^{d}$ | $2.53^{g}$ | $0.46^{def}$ | $1.167^{d}$ | $4.65^{g}$ |
| Acsad,65 | -0.03 | $57.85^{b}$ | $14.67^{bc}$ | $12.40^{b}$ | $2.00^{a}$ | $8.000^{a}$ | $30.77^{b}$ |
| | -0.6 | $43.85^{c}$ | $4.00^{d}$ | $5.20^{cd}$ | $0.73^{bc}$ | $1.867^{cd}$ | $10.87^{c}$ |
| | -0.8 | $29.91^{e}$ | $2.67^{d}$ | $3.10^{e-g}$ | $0.40^{ef}$ | $1.233^{d}$ | $6.17e\text{-}^{g}$ |
| | -1 | $20.44^{gh}$ | $2.33^{d}$ | $2.30^{g}$ | $0.46^{def}$ | $1.300^{d}$ | $4.64^{g}$ |
| Om-Rabi,5 | -0.03 | $62.33^{ab}$ | $21.67^{a}$ | $12.23^{b}$ | $2.00^{a}$ | $7.567^{ab}$ | $31.27^{b}$ |
| | -0.6 | $37.78^{d}$ | $4.00^{d}$ | $4.10^{de}$ | $0.70^{bcd}$ | $2.300^{c}$ | $10.40^{cd}$ |
| | -0.8 | $26.20^{ef}$ | $3.33^{d}$ | $2.63^{g}$ | $0.50^{cdef}$ | $2.000^{cd}$ | $6.73^{e-g}$ |
| | -1 | $19.20^{h}$ | $6.67^{d}$ | $2.23^{g}$ | $0.26^{f}$ | $1.567^{cd}$ | $4.50^{g}$ |

* Within each set mean values followed by shared letters are not significantly different at 5% (Duncan's MRT).

**Table (4): Effect of wheat cultivars and water stress interaction on yield components.***

| Cultivars | Stress/Mpa | No. heads/pot | Spike length(cm) | No. grains/spike | Total grains wt(g/pot) |
|---|---|---|---|---|---|
| Abu-Ghraib,3 | -0.03 | $10.00^{a}$ | $7.60^{a}$ | $34.47^{a}$ | $9.73^{a}$ |
| | -0.6 | $10.00^{a}$ | $6.22^{b}$ | $15.20^{d}$ | $4.00^{c}$ |
| | -0.8 | $10.00^{a}$ | $5.48^{c}$ | $9.03^{fg}$ | $2.07^{d}$ |
| | -1 | $6.67^{bc}$ | $4.86^{cd}$ | $6.72^{g-i}$ | $0.87^{ef}$ |
| Mexipak | -0.03 | $10.00^{a}$ | $7.70^{a}$ | $26.57^{b}$ | $8.80^{ab}$ |
| | -0.6 | $10.00^{a}$ | $5.13^{cd}$ | $12.60^{de}$ | $3.40^{c}$ |
| | -0.8 | $8.33^{a}$ | $4.62^{d}$ | $6.51^{g-i}$ | $1.40^{def}$ |
| | -1 | $5.00^{c}$ | $3.89^{e}$ | $2.74^{j}$ | $0.48^{f}$ |
| Acsad,65 | -0.03 | $10.00^{a}$ | $5.24^{cd}$ | $22.24^{c}$ | $8.37^{b}$ |
| | -0.6 | $10.00^{a}$ | $3.71^{ef}$ | $9.43^{fg}$ | $3.07^{c}$ |
| | -0.8 | $8.00^{ab}$ | $3.16^{f-h}$ | $5.49^{h-j}$ | $1.43^{def}$ |
| | -1 | $8.00^{ab}$ | $2.87^{g-i}$ | $3.90^{ij}$ | $0.57^{ef}$ |
| Om-Rabi,5 | -0.03 | $10.00^{a}$ | $4.98^{cd}$ | $23.97^{bc}$ | $7.80^{b}$ |
| | -0.6 | $10.00^{a}$ | $3.38^{e-g}$ | $11.43^{ef}$ | $3.30^{c}$ |
| | -0.8 | $9.67^{a}$ | $2.72^{hi}$ | $7.32^{gh}$ | $1.60^{de}$ |
| | -1 | $5.33^{c}$ | $2.45^{i}$ | $3.05^{j}$ | $0.43^{f}$ |

* Within each set mean values followed by shared letters are not significantly different at 5% ( Duncan's M **RT).**

**Conclusion**

Generally, the bread wheat cultivar Abu-Ghraib 3 was the only one that gave dark brown coloration with tyrosine test. Also, it was less affected in terms of yield reduction due to water stress; therefore, this cultivar is considered as more drought resistant in comparison to the others. However, further investigations are required to confirm these results.

**Table (5): Reduction percentages for some traits compared to field capacity.**

| Cultivars | Stress Mpa | Total biomass (roots and shoots) (g/pot) | Total seeds wt,(g/pot) |
|---|---|---|---|
| Abu-Ghraib 3 | -0.6 | 63.16 | 58.89 |
| | -0.8 | 76.30 | 78.73 |
| | -1 | 83.84 | 91.06 |
| Mexipak | -0.6 | 63.79 | 61.36 |
| | -0.8 | 75.43 | 84.09 |
| | -1 | 84.97 | 94.55 |
| Acsad 65 | -0.6 | 64.67 | 63.32 |
| | -0.8 | 79.95 | 82.92 |
| | -1 | 84.92 | 93.19 |
| Om-Rabi 5 | -0.6 | 66.74 | 57.69 |
| | -0.8 | 78.48 | 79.49 |
| | -1 | 85.61 | 94.49 |

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**دراسات فسيولوجية على العلاقة بين تيروسين حبوب القمح ومقاومة النبات للجفاف**

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**ملخص**

اشتملت الدراسة على تعريض صنفين من قمح الخبز(.*Triticum aestivum* L) ( ابو غريب-3 ومكسيباك ) وصنفين من قمح المكرونة (.*Triticum durum* Desf)  ( اكساد 65 وام ربيع 5) ، لعدة مستويات من الشد(الاجهاد) المائي (- 0.6 و – 8 .0 و – 1 ميجا باسكال , بالا ضافة الى – 3 0 .0 ميجاباسكال (السعة الحقلية). كما واستبدل اختبار الفينول بإختبار الـ بتيروسين.

دلت نتائج البحث على ان قمح الخبز (*Triticum aestivum* L) اكثر مقاومة للجفاف مقارنة بالقمح الخشن ( *Triticum durum* Desf) حيث كانت اقل تاثرا بالشد المائي وخاصة الصنف ابو غريب-3 , والذي كان اقل انخفاضا في صفة وزن الحاصل الحيوي ووزن البذور للإصيص والذي كان  83.84 % 06 و.91% على التوالي عند الشد المائي -1 ميكاباسكال مقارنة بالسعة الحقلية ، بينما كانت 85.61% و94.49% للصنف الخشن ام-ربيع **-5** مقارنة  بتلك النامية تحت ظروف السعة الحقلية. إضافة لذلك فان صنف أبو غريب-3 هو الصنف الوحيد الذي اظهر لونا اسود داكن مع إختبار التيروسين.

وبشكل عام أشارت النتائج بامكانية إحلال التيروسين محل الفينول في اختبار تمييز الاصناف حيث ان الأخير ذو رائحة كريهة و كاوي للجلد عند الملامسة. وبما ان صنف ابو غريب-3 الاقل ضررا للجفاف هو الذي اعطى لونا اسود داكن مع اختبار التيروسين فبذلك يمكن ان يكون له علاقة بمقاومة الجفاف.هذا ويحتاج ذلك الى العديد من الدراسات في هذا المجال وعلى العديد من الاصناف المتحملة للجفاف و الحساسة وذلك للمقارنة والتاكد من النتائج.

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