

**GROWTH AND PRODUCTIVITY OF WHEAT PLANTS AS  
AFFECTED BY COMPLETE FOLIAR FERTILIZER  
COMPOUNDS UNDER WATER STRESS CONDITIONS  
IN NEWLY CULTIVATED SANDY LAND**

[16]

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**ABSTRACT**

Two field experiments were carried out at the New Salheyia Region, Sharkia Governorate, during the two successive seasons 2001/2002 and 2002/2003 to study growth and productivity of wheat plants as affected by complete foliar fertilizer compounds under water stress conditions in newly cultivated sandy land.

**The results could be summarized as follows**

- 1- Plant height, number and dry weight of tillers, blades and spikes/ plant, flag leaf area, blades area/plant, SLW and LAI were significantly decreased by skipping an irrigation at tillering, heading and/or milk-ripe stage. Furthermore, wheat plants were more sensitive to skipping an irrigation in tillering stage than heading stage and milk ripe stage, respectively.
- 2- Complete foliar fertilizers compounds caused significant stimulatory effect on growth parameters, in addition, foliar spraying with Stimophole 0.6% concentration gave the highest significant values for growth characters.
- 3- The interaction between water stress and complete foliar fertilizer compounds caused significant effect on plant height, number and dry weight of blades and spikes, number of tillers/plant, flag leaf area, blades area /plant and LAI. Moreover, foliar application with Stimophole 0.6% under no skipping plants gave the highest mean values for growth characters, meanwhile, missing an irrigation at tillering stage to control unfertilized plants produced the smallest values.
- 4- Missing an irrigation decreased significantly yield and its components whereas, the greatest harmful effect was realized under skipping an irrigation at tillering stage meanwhile the smallest depression was shown under missing an irrigation at milk ripe stage.
- 5- Foliar spraying with 0.3% or 0.6% of the complete foliar fertilizers compounds, All-Graw, stimophole or Greenzit caused a significant stimulative effect on spikes dry weight/plant, grain and straw yields/plant and/ fed, biologi-

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cal yield/fed, harvest index, and RPPgr, moreover foliar application with 0.6 stimophole gave the greatest mean values from yield and its components.

The effect of the interaction between water stress treatments and complete foliar fertilizer compounds was significant on yield and its attributes except migration coefficient, crop index, harvest index, and RPPreg where the responses were not significant.

**Key words:** Wheat, Foliar fertilization, Water stress, Sandy soils

## INTRODUCTION

The importance of wheat in humans main food is the well known fact all over the world as well as in Egypt. Extensive efforts are continuously paid for increasing its productivity by means of vertical and/or horizontal planting. In the light of the present national water policy concerning saving irrigation water, expanding wheat area needs more searching for wheat cultivars produce high yield under suitable water regime. But safe saving an irrigation, beside its closely dependence on plant growth stage, is greatly influencing by a number of facts especially varieties and complete foliar fertilizers.

**Seif El-Yazal et al (1984)** found that withholding one irrigation either at milky, heading, booting or tillering stage decreased grain yield by 11, 14, 16 and 20 % respectively, compared with the check treatment received six irrigations. They added that water consumptive use was reduced from 42.28 to 35.75 cm. when one irrigation was omitted compared to check treatment. **Abdel-Gawad et al (1993)** suggested that decreasing the number of irrigations reduced yield and its components, and Sakha 8 cultivar showed relative tolerance to the water stress. **Eid and Yousef (1994)** showed that skipping an irrigation at milk or boot-

ing stage reduced grain yield by 12.8 to 18.3% as well as 14.0 and 18.2 % in the first and second seasons; respectively; compared with the check treatment received six irrigations. **Abo-Shetaia and Abd El-Gawad (1995)** reported that the grain yield was decreased by 37.7, 29.1, 23.0 and 10.8% when wheat plants were subjected to water stress at tillering, heading, milk ripe and dough-stage; respectively, compared to the well irrigation treatment. **Gad El-Rab et al (1995)** obtained maximum grain and straw yields from the plants received six irrigations. Moreover, **Sharaan et al (2000)**, reported that skipping one irrigation either at heading or at dough ripe-stage decreased all studied traits except biological and straw yields/fed. Normal irrigation produced the highest averages of different traits followed by those resulted from skipping one irrigation at dough stage, whereas the lowest values were obtained from skipping one irrigation at heading stage, also, **Abo El-Khair et al (2001)** indicated that missing one irrigation at any of the two stages (tillering and heading) significantly reduced all the tested yield attributes but the negative response of wheat plants was more pronounced at heading stage than at milk-ripe stage.

As macro and micro-nutrients added to the soil, their availability will be affected by soil environmental factors.

Foliar application techniques, as a particular way to supply macro and micro-nutrients could avoid these factors and results in rapid absorption. If applied properly, foliar spraying can be considered practical to supply nutritional plant requirements. Numerous studies confirmed positive response for the foliar application with the complete foliar fertilizers (Ahmed & Shalaby 1994; Shalaby & Ahmed, 1994; Hassanein & Ahmed, 1996 and Shalaby, 2001).

Thus the objective of this study is to investigate growth and productivity of wheat as affected by complete foliar fertilizers under water stress conditions in newly cultivated sandy land.

## MATERIAL AND METHODS

The present investigation was carried out during the two successive seasons of 2001/2002 and 2002/2003 in newly cultivated lands under sandy soil conditions at the New Salheyia Region, Sharkia Governorate to study growth and productivity of wheat as affected by complete foliar fertilizers under water stress conditions.

Each experiment was laid out in a split-plot design with four replications, where, the main plots included the irrigation treatments, while, foliar spray fertilizer treatments were distributed in the subplots. The experimental unit consisted of 15 rows, each of 3.5 meter length and 20 cm between rows, where, the size of each plot was 10.5 square meter, seeded at a rate of 60 kg/fed. Sowing took place on 24<sup>th</sup> and 27<sup>th</sup> November in 2001 and 2002 in the two seasons, respectively. The normal agronomic practices of growing wheat were practiced till harvest as recommended by Wheat Research Dept., A.R.C. , Cairo.

Each experiment included 28 treatments which were the combination of four irrigation treatments and seven foliar twice spraying with complete foliar fertilizers. The factors under study were:

### A) The irrigation treatments

- 1- Normal irrigation where wheat plants irrigated with seven days intervals up to ripe stage (140 days from sowing). (control).
- 2- Missing one irrigation at tillering stage (50 days from sowing).
- 3- Missing one irrigation at heading stage (85 days from sowing).
- 4- Missing one irrigation at milk-rip stage (120 days from sowing).

### B) Complete foliar fertilizer compounds

- 1- Tap water (control).
- 2- All-Grow manufactured by Unifert; Belgium. It contains N (10%), P (0.4%), K (7%), Zn (92 ppm), Cu (73 ppm), Mn (170 ppm) and Fe (80 ppm) using a rate of 0.3 % or 0.6% .
- 3- Stimuphol manufactured by I.C.I. Agrochemicals, Plant Production, England. It contains N (25%), P (16%), K(12%), Vitamin B<sub>1</sub> (0.004%), EDTA (3%), amino acids (1%), B (0.04), Mg (0.02), Cu (0.085%), Mn (0.085), Mo (0.001%), Co (0.001%), Fe (0.17%), Zn (0.85%) using concentration 0.3% or 0.6% .
- 4- Greenzit NPK 5144 manufactured by (IBA-GIEGY limited), Bazed, Switzerland. It contains N (70 g/l) p (30 g/l), K (39 g/l), Fe (1g/l), Mg (100 mg/l), Mn (100 mg/l), B (100

mg/l), Zn (50 mg/l), Cu (10 mg/l), Mo (5 mg/l), Ni (1mg/l), Co (1 mg/l) using the two rates 0.3% or 0.6% .

Wheat plants cv. Sakha-69 were sprayed with complete foliar fertilizer compounds on plant foliage twice during the plant growth period at 35 and 55 days after sowing. The volume of the spraying

solution was 300 L / fed for each spray. Tween-20 was added (1 ml/L) as wetting agent to the spray solution.

Samples of five guarded plants were taken at random from each plot for the four replications to measure growth characters, where plant height cm, number and dry weight of each tillers; blades and spikes, were estimated at 125 days after sowing.

Table 1. Mechanical and chemical analysis of the soil of experimental sites

Physical and chemical analysis	Seasons	
	2001/2002	2002/2003
Coarse sand %	40.0	42.0
Fine sand %	49.6	48.4
Silt %	4.6	4.3
Clay %	5.2	5.0
Texture	Sandy	Sandy
Organic matter %	0.48	0.51
Available nitrogen (p.p.m)	36.0	40.0
Available phosphorus (ppm)	9.9	12.8
Available potassium (p.p.m)	149.0	137.0
PH	7.8	8.0

Furthermore, flag leaf area ( $\text{cm}^2$ ) and baldes area ( $\text{cm}^2$  / plant) were determined according to **Bremner and Taha (1966)**; where; leaf area index (LAI) was determined according to **Watson (1952)**, meanwhile; specific leaf weight was calculated as **Pearce et al (1969)**.

At harvest, a random of ten plants was taken from middle rows of each plot to determine spikes dry weight (g / plant), grain yield (g / plant), straw yield g /

plant, where, migration coefficient (i.e spikes dry weight g/plant/grain + straw yield g / plant ratio) were estimated as **Mc-Graw (1977)**. Again; relative photosynthetic potential ratio (for each grain, biological yields and vegetative growth (i.e. RPPgr, RPPbio and RPPveg. g/ LAI) were calculated as the method described by **Vidovic and Pokorny (1973)**. In addition, grain, straw and biological yields "ton/fed" were determined from the

whole area of experimental unit and then converted to yield per feddan. Thus, harvest index (grain yield/biological yield per fed) was determined.

Again, total nitrogen in grains was determined using the micro kjeldahl's methods as described by **Cole and Parks (1946)** where protein % per grains was calculated by multiplying N content by the factor 5.75% or 6.25 % **A.O.A.C. (1970)**

All data were subjected to statical analysis according to procedure outlined by **Snedecor and Cochran (1990)**. Treatments means were compared by L.S.D test. Combined analysis was made for the two growing seasons as results followed similar trend.

## RESULTS AND DISCUSSION

### (A) Growth parameters

#### 1- Effect of water stress

Results in Table (2) reveal that plant height, number and dry weight of tillers, blades and spikes per plant, flag leaf area, blades area /plant, SLW and LAI were significantly decreased by skipping an irrigation at tillering, heading or milk-ripe stage. The depression in these growth parameters could be explained on the basis of the loss of turgor which affects the rate of cell expansion and ultimate cell size. Loss of turgor is probably the most sensitive process to water stress. Consequently, decrease growth rate, stem elongation and leaf expansion. The effect of water stress on cell division and enlargement, has been carefully discussed by **Kramer and Boyer (1995)**. Moreover, exposing, wheat plants to water shortage resulted in a significant reduction in number and dry weight of differ-

ent plant organs, i.e. tillers + sheaths, blades and spikes, flag leaf area; blades area/plant, LAI and SLW than those of adequate water supply treatment; i.e. control plants Table (2).

The data showed further that, water-stressed plants even watered regularly afterward did not recover to their normal behaviour to compensate the adverse effect caused by the exposure to drought conditions. Similar results were obtained by **Abdel Gawad et al (1993)**; **Eid & Yousef (1994)**; **Abo-Shetaia & Abdel Gawad (1995)**; **Gad El-Rab et al (1995)**; **Sharaan et al (2000)** **Abo El-Khair et al (2001)** and **Kandil et al (2001)**.

It is clear also from Table (2) that wheat plants appeared to be more sensitive to water stress during tillering stage followed by heading stage in the second order and milk rip stage in the third order, respectively. Such finding could correspond with those of **Seif El-Yazal et al (1984)**; **McMaster et al (1994)**; **Abo-Shetaia & Abdel-Gawad (1995)** and **Kandil et al (2001)**. It is noteworthy to mention that irrigation at late jointing is recommended due to its great effect on tiller survival. This implies that developmental and physiological processes at late jointing are critical in determining final grain yield, and water stress should be avoided at this growth stage. Thus it can be concluded that the decreament in growth characters resulting by skipping one irrigation in tillering stage was more pronounced; wherever plants were subjected to soil moisture stress at tillering stage. Such response might be attributed to lack of water absorbed, inadequate uptake of an essential elements, inhibition of meristematic activity and/or reduction in photosynthetic capacity under such



unfavorable conditions (**Abo-Shetaia & Abdel-Gawad, 1995; Kramer & Boyer, 1995; Shangguan *et al* 1999 and Kandil *et al* 2001**). Moreover, the reduction in assimilates translocated to new developing tillers and to the spike primordial which were not enough to maintain or develop those organs .

## 2- Effect of complete foliar fertilizers

Data reported in Table (2) show that the applied level (0.3% or 0.6%) of the different foliar fertilizer namely All – Graw, Stimophol and Greenzit have a significantly stimulatory effect on growth characters of wheat plants i.e. plant height, number and dry weight of tillers; blades and spikes, flag leaf area, blades area / plant, LAI and SLW. Data show that the highest level (0.6%) of Stimuphole compound gave the highest values of growth characters, followed by Stimuphole 3%, All Graw 0.6%, All-Graw 0.3%, Greenzit 0.6% and greenzit 0.3% in descending order, respectively, meanwhile, untreated plants (control treatment) recorded the lowest growth parameter values. It is note worthy to mention that the superiority of Stimuphol than All-graw and Greenzit complete foliar fertilizer compounds in growth characters may be attributed to its higher, content of N, P,K, vitamin B<sub>1</sub>, Mg, B, Mn, Cu, Fe and amino acids than the other two foliar fertilizers under study.

Numerous studies confirmed our positive response for the foliar application with the complete foliar fertilizers (**Ahmed & Shalaby, 1994; Shalaby & Ahmed, 1994; Hassanein & Ahmed, 1996 and Shalaby, 2001**).

## 3- Effect of interaction between water stress and complete foliar fertilizers

The interaction between water stress at certain developmental stages and complete foliar fertilizer compounds caused a significant effect on plant height, number and dry weight of blades and spikes/plant, number of Tillers/plant, flag leaf area, blades area / plant, and LAI, meanwhile, the effect on tillers sheaths dry weigh / plant and SLW failed to reach the significant level at 5% (Table 3). It can be clearly mention that foliar application with stimuphole 6% under the no skipping plant (control treatment) is considered to be the most favourable treatments of plant growth characters, meanwhile, skipping wheat plants at tillering stage gave the lowest mean values from the control plants (Tap water treatment).

## B) Yield and its components

### 1- Effect of water stress

Results illustrated in Table (4) show clearly that missing an irrigation at tillering, Heading or milk-ripe stages affected significantly each of spike dry weight /plants, grain and straw yields/plant and per fed., biological yield /fed. , harvest index, protein percentage per grains, RPPgr and RPPbio. Data also, observed that the yield and its components were significantly decreased with skipping an irrigation at those previous certain developmental stages. It is noteworthy to mention that the depression effect on yield and its components was more effective under the condition of missing an irrigation at tilelring stage followed by the shortage at heading stage and skipping







one irrigation in the milk ripe-stage in the third order. Such finding could be confirmed with those obtained by **Seif El-Yazal *et al* (1984)**; **McMaster *et al* (1994)**; **Abo-Shetaia & Abdel-Gawad (1995)**; **Kramer & Boyer (1995)**; **Shangguan *et al* (1999)** and **Kandil *et al* (2001)**. The depression in the yield parameters could be explained on the basis of the loss of turgor which affects the rate of cell expansion and ultimate cell size. Loss of turgor is probably the most sensitive process to water stress. Consequently, decrease in growth rate, stem elongation and leaf expansion. The effect of water stress on cell division and enlargement has been carefully discussed by **Kramer and Boyer (1995)**. Exposing wheat plants to water shortage resulted in a significant reduction in dry weight of wheat plant organs, thus; spikes dry weight, grain, straw and biological yields of wheat reflect significant reduction than those of adequate water supply treatment control.

The data showed further that, water stressed plants even watered regularly afterwards did not recover to their normal behaviour to compensate the adverse effect caused by the exposure to drought conditions. Such depression may be attributed to the general retardation of the enzymatic processes particularly those concerning with the reduction in photosynthetic rates (**Abdel-Gawad *et al* 1993**). It is clear also from (Table 4) that wheat plants appeared to be more sensitive to water stress during tillering stage, where, the dry matter production per plant (i.e dry weight of tillers +sheaths, blades and spikes) was more significantly reduced than control, skipping an irrigative at heading and milk-ripe stages, respectively. Such finding could be corre-

spond with those of **McMaster *et al* (1994)**; **Kandil *et al* (2001)** and **Abo El-Khair *et al* (2001)**, who mentioned that irrigation at late jointing is recommended due to its greater effect on tiller survival. This implies that developmental and physiological process at late jointing are critical in determining final grain yield and water stress should be avoided at this growth stage. The reduction grain, straw and biological yield per fed was more obvious when missing an irrigation at tillering stage where number of tillers and spikes were reduced markedly (Table 2).

## 2- Effect of complete foliar fertilizers

Data in Table (4) indicate that foliar spraying with 0.3% or 6% of the complete foliar fertilizer compounds All-Graw, Stimuphol and Greenzit caused a significant stimulate effect on spikes dry weight/plant, grain and straw yields per plant and per fed., biological yield/fed., harvest index, protein % and RPPgr. On the other hand, the effect of complete foliar fertilizers on migration coefficient, crop index, RPPbio and RPPveg failed to reach the significant level at 5% level. Data show that the highest level (0.6%) of stimuphol complete foliar fertilizer gave the greatest mean values from spikes dry weight/ plant, grain and straw yields/ plant or per fed., biological yield/ fed, harvest index, protein %, and RPPgr, whereas, stimuphol 3%, All-Graw 6%, All-Graw 0.3%, Greenzit 0.6% and greenzit 0.3% had the lowest values of yield and its components in desinding order, respectively, meanwhile control treatment (i.e untreated plants) gave the lowest yield components values. The superiority of stimuphol than. All-Graw and Greenzit complete foliar fertilizer





compounds in yield and its components may be due to its out weighted in content from N, P, K, vitamin B<sub>1</sub> Mg, B, Mn, Cu, Fe and amino acids than the others compounds, i.e All-Graw and greenzit.

Our positive response for the foliar spraying with the complete foliar fertilizers are in harmony with those obtained by **Ahmed & Shalaby (1994)**; **Shalaby and Ahmed (1994)**; **Hassanein & Ahmed (1996)** and **Shalaby (2001)**.

### 3- Effect of the interaction between water stress and complete foliar fertilizers

The interaction between water stress at certain developmental stages and complete foliar fertilizer compounds caused a significant effect on spikes dry weight/plant, grain and straw yields per plant and/ or per fed, biological yield / fed, protein/per grains, RPPgr and RPPbio, whereas, the response of migration coefficient, crop index., harvest index and RPPveg was insignificant (Table 5). Data in the same table: indicate also that foliar application with stimuphole 6% under the adequate water irrigation (control treatments) is considered the most favorable treatments of yield and its components, however, missing an irrigation at tillering stage under untreated plants with complete foliar fertilizer compounds treatment produced the lowest yield and its components values. Generally, foliar spraying with 6% Stimuphole under skipping an irrigation at milk-ripe grain stage reduced the harmful effect of water stress on yield and its components to the limit value.

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**تأثير الرش بمركبات أسمدة ورقية والإجهاد المائي على نمو و انتاجية القمح  
 فى أراضى رملية حديثة الاستزراع**

[16]

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1- قسم بحوث المحاصيل الحقلية بالمركز القومى للبحوث - الدقى - القاهرة - مصر

وكذلك فى المحصول ومكوناته عدا معامل الهجرة والامكانية التمثيلية الضوئية النسبية للنمو الخضرى بالتعرض للإجهاد المائي باسقاط رية خلال المراحل المختلفة لنمو النبات.

هذا وقد أوضحت النتائج أن نبات القمح أظهر حساسية بدرجة مرتفعة لاسقاط رية فى مرحلة التفريع القاعدى ، وحساسية أقل فى مرحلة طرد السنابل ، وحساسية أقل للإجهاد المائي فى طور النضج اللبني للحبوب.

وبالنسبة للرش بالأسمدة الورقية المتكاملة Greenzit, Stimuphole, All-Graw بتركيزات 3 ، 6 ، و % . فقد أظهرت النتائج فى السماد الورقى المتكامل ستيموفول 0.6% أعطى أفضل النتائج فى تحسين وزيادة قيم صفات النمو والمحصول ومكوناته بالمقارنة بالمركبات الأخرى بتركيزاتها المختلفة.

أجريت تجربتان حقليتان خلال العامين 2002/2001 ، 2003/2002 بمنطقة الصالحية الجديدة - محافظة الشرقية لدراسة تأثير الأسمدة الورقية المتكاملة ( اولجرو وستيموفول وجرينزت ) بتركيزين 0.3% و 0.6% لكل منهم على نمو وانتاجية القمح صنف سخا 69 تحت ظروف الإجهاد المائي والزراعة فى أرض رملية حديثة الاستزراع. هذا وقد تم تعريض نباتات القمح لإجهاد مائي نتيجة اسقاط رية خلال مراحل التفريع القاعدى ( 50 يوم ) وطرد السنابل ( 85 يوم ) وطور النضج اللبني للحبوب فى تصميم تجريبي قطع منشقه فى أربع مكررات. هذا وتوضح النتائج حدوث انخفاضاً معنوياً فى كل من ارتفاع النبات، عدد والوزن الجاف لكل من الأفرع ، الانصال، السنابل / نبات، مساحة ورقة القلم، مساحة الانصال سم<sup>2</sup>/ نبات، دليل مساحة الأوراق والكثافة النوعية للورقة

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