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USE OF CHEMICAL DESICCATION EFFECT AS SELECTION TECHNIQUE FOR DROUGHT TOLERANCE IN WHEAT

A.H. Salem[1]; H.A. Awad[1] ;E.E. Hassan[2] and A.M. Morsy[3]

1- *Agron. Dept. Faculty of Agriculture Zagazig University, Egypt.*
2- *Efficient productivity Institute, Zagazig University, Egypt..*
3- *Agriculture Research Centre, Giza, Egypt.*

ABSTRACT

The aim of the present study was to evaluate whether treatments with chemical desiccants either $NaClO_3$ or Mg $(ClO_3)_2$ over the canopy of six diverse wheat genotypes during each of vegetative, flowering and filling period stages could properly memic the effects of water defficiency at the same growth stages on wheat grain yield and its components. The wheat genotypes Sakha 69, Sahel 1, Gemmeiza 5, Giza 168, Bocro- 4 and Seri 82 showed highly significant differences for grain yield and its components under the different treatments of chemical desiccation and drought stress. The highest grain yield and its components was achieved by the imported wheat genotype Seri 82 followed by Bocro- 4, Sakha 69, and Sahel 1, while Gemmeiza 5 attained the lowest values in this respect. In addition, the studied wheat genotypes revealed varied response to chemical desiccants and drought stress conditions. Wheat genotypes Seri 82 and Sakha 69 could be classified as drought tolerant, while Gemmeiza 5 and Giza 168 are sensitive to drought. The reduction of grain yield caused by drought stress, spraying $NaClO_3$ and Mg $(ClO_3)_2$ at vegetative stage were 48%, 50% and 41%, respectively. However, they were 51%, 42% and 47% at flowering stage as well as 55%, 41% and 45% at grain filling period stage in the some respect.

In general, there were positive and significant correlations between both grain yield and yield reduction under chemical desiccant treatments and drought stress at the three stages of growth, suggesting that chemical desiccation treatments either $NaClO_3$ or Mg $(ClO_3)_2$ could be used as statisfactory methods for screening wheat germplasm for drought stress instead of drought regime treatments

Keywords: Chemical desiccation, selection technique, drought tolerance, wheat

INTRODUCTION

Drought stress is the major problem in agriculture. The ability to withstand such stress is of immense economic importance. Breeding for drought resistance is very complex because it is intrinsically erratic in nature (Blum *et al*., 1983). The effect of drought stress on wheat grain yield varied according to its effects on yield components depending upon the intensity of stress and the growth stage at which it develops. An intense drought mainly affects the number of kernels per unit area through a general decrease in fertility, while a mild drought may cause only a reduction in grain weight (Giunta *et al*., 1993). Wheat breeding for dry areas has been less successful than breeding for favorable environments because of the non predictable success of cultivars (Ceccarelli and Grando, 1996).

Chemical desiccants and senessence agents have been used at precise time after anthesis for evaluation of wheat genotypes for drought tolerance (Tyagi *et al*., 2000). Many investigators reported differential ability of wheat genotypes to tolerate drought stress either due to water deficiency or chemical desiccation effects (Saadalla,2001; Bayoumi *et al*., 2008; Mahboob *et al*., 2009 and Ahmadi *et al*., 2009).

Ahmadi *et al*., (2009) reported a slight reduction in wheat grain yield and 1000-grain weight due to drought stress. They suggested that drought caused a significant increase in the remobilization of reserves to the grain. The most important advantage of this technique is that water stress situation can be artificially be created in field grown crops under irrigated conditions.

Therefore, the purose of the present study was to evaluate whether chemical treatments with either sodium chlorate ($NaClO_3$) or Magnisium chlorate [($Mg(ClO_3)_2$] over the canony during each of vegetative, flowering or grain filling period stages could properly mimic the effects of water deficiency at the same growth stages on wheat grain yield and its components.

MATERIALS AND METHODS

The present study was conducted during three successive winter seasons at Ismailia Agriculture Research station (sandy soil) to investigate the influence of water deficiency and chemical desiccation treatments [($NaClO_3$ or $Mg(ClO_3)_2$] on grain yield and its components of six genetically diverse bread wheat genotypes, four of them (Sakha 9, Sahel 1, Gemmeiza 5 and Giza 168) are local and the remaining two genotypes (Bocro-4 and Seri 82) are imported from ICARDA. The pedigree of the evaluated wheat genotypes is presented in Table (1).

Table 1. Pedigree of the evaluated bread wheat genotypes.

No	Genotype	Pedigree	Origin
1	**Sakha 69**	Inia/RL4220//7C/Yr"s"	Egypt
2	**Sahel 1**	N.S.732/Pim//Veery "s" sd735-4sd-Isd-osd	Egypt
3	**Gemmeiza 5**	Vee "s"/SWM 6525 CGM4017-1GM-6GM-3M-0GM	Egypt
4	**Giza 168**	MIL/BUC//Seri CM 93046-8M-0Y-0M-2Y-0B	Egypt
5	**Bocro-4**	CM69599-4AP-2AP-2AP-1AP-0AP	Syria
6	**Seri82**	ICW89-0462-7AP-OAP-4AP-OTS-0AP Shi#4414/Cow "S"//Seri 82	Syria

Split-plot design with three replicates was used. Water deficiency and chemical desiccation treatments were alloted to the main plots, whereas wheat genotypes were randomly distributed in the sub-plots. Sub-plot area was 3.6m^2 and consisted of 6 rows, 3m long and 20 cm apart. Wheat grains were drilled in the rows at the rate of 150 Kg/ha. on the last week of November during the three growing seasons.

The treatments of the present work were as follows:

T_1: Irrigation at 7-day intervals and served as control.
T_2: Spraying sodium chlorate (2% w/v) at vegetative growth stage
T_3: Spraying sodium chlorate (2% W/v) at flowering stage
T_4: Spraying sodium chlorate (2% W/V) at grain filling period stage
T_5: Spraying magnesium chlorate (2% W/V) at vegetative growth stage
T_6: Spraying magnesium chlorate (2% W/V) at flowering stage
T_7: Spraying magnesium chlorate (2% W/V) at grain filling period stage
T_8: Missing two consecutive irrigations at vegetative growth stage
T_9: Missing two consecutive irrigations at flowering stage
T_{10}: Missing two consecutive irrigations at grain filling period stage

Calcium superphosphate (15.5% P_2O_5) was added pre-sowing for each plot at a rate of 360 Kg/ha (130g/plot). Nitrogen fertilizer was applied in the form ammonium nitrate (33.5% N) at the rate of 285 Kg N/ha (103 g/plot) in five successive dressings before every irrigation from sowing irrigation. The normal cultured practices, except irrigation in the irrigated treatments were applied.

At harvest, number of spikes/m^2 for each plot was estimated, and then ten guarded plants were taken from each plot to measure number of grains/spike,

spike grain weight(g) and 1000-grain weight (g). Grain yield was determined from the two central rows and then grain yield ton/ha was calculated.

Drought succeptibility index(S) was estimated according to Fischer and Wood (1979) using the following formula:

$$S = (1- yd/ yp) / D$$

Where: Yd = Yield under drought, Yp = Yield under normal condition,

D = drought intensity, D = 1- (Mean of Yd for the genotypes under stress)/(Mean of yp for the same genotypes under normal conditions)

The extent of injury to final yield due to either drought stress or chemical desiccation at the different growth stages was calculated according to Blum *et al*. (1994) using the following formula.

$$\%\ Injury = (C – S/C)x\ 100$$

Where: C = Grain yield under normal conditions, S = Grain yield under stress treatments.

Statistical procedures:

The obtained data were subjected to the conventional analysis of variance for split-plot design according to Steel and Torrie (1980). Mean values were compared using least significant differences (LSD). Simple correlation between grain yield ton/ha) under drought and chemical desiccation treatments was calculated as outlined by Rangaswamy (2000).

RESULTS AND DISCUSSION

I- Genotypic differential:

Wheat grain yield and the main yield components, i.e. number of spikes/m^2, spike grain weight, number of grains/spike and 1000-grain weight are the most important traits when comparing the effect of natural stress (water deficiency) with the effect of chemically induced stresses [$NaClO_3$ and Mg $(ClO_3)_2$].

Data in Tables (2, 3 and 4) show highly significant differences between the studied wheat genotypes for grain yield and its components. These results hold true during the three growing seasons and the combined data over all the different chemical diseccation and drought stress treatments.

The highest grain yield and its components was achieved by the imported wheat genotype Seri 82 followed by Bocro- 4, Sakha 69, Giza 168 and then Sahel 1 under the studied environmental conditions. The data of the combined analysis revealed that Seri 82 displayed the highest number of spikes/m^2 (402.39), spike grain weight (1.239), number of grains/spike (29.35), 1000- grain weight (35.9 g) as well as grain yield (4.015 ton/a). Whereas wheat genotype Gemmeiza 5 attained the lowest mean values for

number of spikes/m^2 (322.01), number of grains/spike (24.77 and grain yield (2.539 ton/ha).

The high grain yield and the main yield components of such genotype under the studied conditions may be due to the ability of this genotype to tolerate the stress resulting from water deficiency or chemical desiccations. In this connection, Ahmadi *et al*., (2009) suggested that drought stress caused a significant increase in the remobilization of pre-anthesis reserves to the grain. In addition, differential ability of wheat genotypes to tolerate drought stress either due to water deficiency or chemical desiccation effects was reported by many investigators Bayoumi *et al.*, 2008 and Mahboob *et al*., 2009) which confirmed the obtained results in the present study.

II- Chemical desiccation and drought stress effects:

It is worth to mention that chemical desiccation and drought treatments significantly reduced number of spikes/m^2, spike grain weight, number of grains/spike, 1000-grain weight and grain yield /ha at the different growth stages during the three growing season and the combined. The reductions caused by drought stress and the studied chemical desiccations on wheat grain yield and its components were consistent across the three growing seasons. The reductions of grain yield valued 48%, 50% and 41% under drought stress, spraying $NaClO_3$ and Mg $(ClO_3)_2$, respectively at vegetative growth stage. Whereas at flowering stage, these reduction were 51%, 42% and 47%, in the same respect. Applying the stresses at filling period stage (after 14 days from anthesis) caused a reduction of 55%, 41% and 45% under water deficits, spraying $NaClO_3$ and Mg $(ClO_3)_2$, respectively.

III- Drought susceptibility index yield injury%:

Data presented in Table (5) revealed varied response of wheat genotypes to chemical desication agents and drought stress treatments as indicated by drought susceptibility index(s). It is evident that the wheat genotypes which exhibited drought susceptibility index less than unity are drought tolerant. In this respect, wheat genotypes Seri 82 and Sakha 69 exhibited drought susceptibility index less than unity under either chemical desiccation and water deficiency treatments during the three growing seasons, that Seri 82 and Sakha 69 performed well under both chemical desiccation and drought stress conditions and could be classified as drought tolerant ones. On the other hand, wheat genotypes Gemmeiza 5 and Giza 168 exhibited drought susceptibility index more than unity, indicating that these genotypes are sensitive to drought.

The reduction percentage (yield injury %) and drought susceptibility index as drought measurements are complementary and take the same trend in describing the drought tolerant or sensitive genotypes. Since the yield injury % of wheat genotypes Sakha 69 and Seri 82 were the lowest as compared to the other sensitive genotypes. The obtained results are in the same line with the findings of Najafian *et al*., (2004) and Mahboob *et al*., (2009).

IV- Relationship between drought stress and chemical desiccation effects:

Data presented in Table (6) show positive correlation coefficient between the effects of water deficiency and application of chemical desiccants either $NaClO_3$ or Mg $(ClO_3)_2$ at vegetative, flowering and grain filling period stages on wheat grain yield and yield reduction percentage.

Table 6. Correlation between chemical desiccation and drought treatments for grain yield.

Treatments		1st Season		2nd Season		3 rd Season	
Growth stage		**NaCl**	**MgCl**	**NaCl**	**MgCl**	**NaCl**	**MgCl**
Vegetative	**GY**	0.473*	0.572*	0.593**	0.507**	0.598**	0.470**
	RY	0.764**	0.708**	0.514*	0.505*	0.789**	0.700**
Flowering	**GY**	0.151	-0.012	0.368	0.554*	0.201	0.842**
	RY	0.684**	0.354	0.457*	0.178	0.497*	0.805**
Grain filling	**GY**	0.599**	0.055	0.675**	0.755**	0.739**	0.859**
	RY	0.327	0.205	0.590*	0.493*	0.854**	0.889**

GY = Grain yield, RY = Reduction in yield,
* Significant at $P < 0.05$ ** Significant at $P < 0.01$.

It is clear that grain yield and yield reduction % under chemical desiccants either with Na ClO_3 or Mg $(ClO_3)_2$ were positively and significantly correlated with grain yield and yield reduction % under water deficiency at vegetative and grain filling period stages during the three growing seasons. However this correlation regarding grain yield was positive but did not reach the level of significance when these treatments were applied at flowering stage; except the case of Mg $(ClO_3)_2$ in the 2nd and 3rd season. In addition, concerning yield reduction % the correlation between chemical desiccants and water deficiency effects was positive and significant at flowering stage during the three growing seasons.

The obtained results indicate that, chemical desiccation treatments by sodium chlorate or magnesium chlorate at vegetative growth flowering and grain filling stages could be used as satisfactory screening heat germplasm for stress conditions instead of drought regime treatments. In this regard, many investigators reported positively and significantly correlation between the reduction of grain yield due to chemical desiccation applied at 14 days after anthesis and the reduction in grain yield due to water stress at grain filling stage (Blum *et al*., 1983, Hossain *et al.*, 1990, Blum, 2005 and Mahboob, *et al*., 2009).

Conclusively,

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تأثير إستخدام التجفيف الكيماوى كطريقة إنتخاب لمقاومة الجفاف فى القمح

عبد الحميد حسن سالم[١]، حسن عودة عواد[١]، السيد السيد حسن[٢]، أمجد محمد مرسى[٣]
١- قسم المحاصيل- كلية الزراعة- جامعة الزقازيق - الزقازيق- مصر
٢- معهد الكفاية الإنتاجية - جامعة الزقازيق- الزقازيق- مصر
٣- مركز البحوث الزراعية- جيزة- مصر.

تهدف الدراسة الحالية إلى تقييم ستة تراكيب وراثية (سخا ٦٩، ساحل ١، جميزة ٥، جيزة ١٦٨، Bocro- 4، Seri 82) تحت معاملات التجفيف الكيماوى (كلورات الصوديوم وكلورات المغنسيوم) والإجهاد المائى أثناء مرحلة النمو الخضرى، والتزهير، وإمتلاء الحبوب لمحصول الحبوب ومكوناته وذلك لمعرفة مدى تشابه تأثير معاملات التجفيف الكيماوى مع تأثير الإجهاد المائى فى مراحل نمو القمح المختلفة.

وقد أظهرت النتائج تفوق التركيب الوراثى Seri 82 ويتبعه Bocro- 4 ثم سخا ٦٩، ساحل ١ فى محصول الحبوب ومكوناته تحت المعاملات المختلفة، بينما كان الصنف جميزه ٥ أقلها محصولا. وقد تباينت إستجابة الأصناف المختلفة لمعاملات التجفيف والإجهاد المائى، حيث أظهرت التراكيب الوراثية Seri 82 وسخا ٦٩ مقاومة للجفاف بينما كانت التراكيب الوراثية جميزة ٥ وسخا ١٦٨ حساسة للجفاف.

وعند مقارنة تأثير معاملات التجفيف الكيماوى مع تأثير الإجهاد المائى على محصول حبوب القمح، أوضحت النتائج إنخفاض محصول القمح بمعدل ٤٨%، ٥٠%، ٤١% عند المعاملة بالإجهاد المائى وكلورات الصوديوم وكلورات المغنسيوم فى مرحلة النمو الخضرى على التوالى، بينما كان معدل إنخفاض المحصول فى مرحلة التزهير هو ٥١%، ٤٢%، ٤٧% وفى مرحلة إمتلاء الحبوب كانت ٥٥%، ٤١%، ٤٥% بنفس الترتيب.

وبوجه عام فقد وجد إرتباط موجب ومعنوى بين محصول الحبوب ومعدل نقص المحصول تحت معاملات التجفيف الكيماوى والإجهاد المائى فى مراحل النمو المختلفة مما يوضح أن معاملات التجفيف الكيماوى بإستخدام كلورات الصوديوم أو كلورات المغنسيوم يمكن إستخدامها لمعرفة قدرة التراكيب الوراثية على تحمل الإجهاد المائى.