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EFFECT OF SOME WATER STRESS TREATMENTS ON YIELD AND SOME YIELD CHARACTERS OF SOME CORN CULTIVARS

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ABSTRACT

This investigation aimed to study the response of some corn varieties and hybrids (Giza 2, T.C. 320,t.c. 310, D.C.215 and D.C. Tabba) to water stress [Irrigation interval days such as 15 days(control), 21 days (low stress), 28 days (mid stress), and 35 days (sever stress)] during germination, growth and yield. For achieving this objective lab. Experiment using osmotic pressure treatments by Menitol solution caused 5, 7, 9, 11 and 13atmospheres, and two field experiments were carried out. A split-plot design with three replications was used, where irrigation treatments occupied the main plots, meanwhile the sup-plots were devoted to the corn cultivars. Lab. results indicated that corn cultivars vary significantly in germination velocity and germination capacity. Intermediate osmotic pressures (5, 7 and 9 atmospheres) were sometimes simulative, but high osmotic pressures (11 and 13 atmospheres) decreased germination velocity and capacity. D.C. 215 and D.C. Tabba showed the highest values of germination velocity and capacity under different osmotic pressure. Field experiments indicated that increasing irrigation interval from 15 to 21 days was not effective except in Giza 2 variety. However, significant decreased in yield and other characters occurred at 28 and 35 days intervals. T.C. 320, T.C. 310, D.C. 215 and D.C. Tabba showed variable insignificant yield differences in both seasons . Giza 2 was significantly of lower yield than D.C. 215, D.C. Tabba (1998) and T.C. 310(1999). The results showed that new water regimes(21 days &28 days withT.C.310) may be used to save about 50% of corn irrigation water but more detail studies are needed for verification.

INTRODUCTION

Plant growth is controlled directly by plant water stress and indirectly by soil water stress. Plant water stress depends on the relative rates of water absorption and water loss rather than on soil water supply alone (karmer 1963). Laboratory techniques have been employed to asses germination and seedling growth under drought condition. The efficient screening technique for drought stress appears to be possible if drought condition was simulate the laboratory. The laboratory methods were of limited value were used as osmotic agents to induce drought simulation. Menitol and begr the most widely used as osmotic agents in germination studies because they are chemically non toxic (Parmar and Moore 1966, Parmar and Moore 1968 and Morris et al 1990). Some author also stated that it is not safe to assume that a given degree of soil water stress always will be accompanied by an equivalent degree of plant water stress. Water stress could affect photosynthesis (Brix 1962). Yield reduction due to water stress was greater when stress happened during occurrence of reproductive stage compared to earlier or later stages (Robins and Domingo 1953, Denmead and Shaw 1960, Barnes and Woolley 1969 and Noureldein *et al.* 1986). The last authors found

that, increasing irrigation-interval form 15 to 30 days decreased growth parameters, yield and yield components of corn.

Some investigators stated that water stress could affect chlorophyll b content of corn leaves (Ragab *et al.* 1986).

Drought could affect germination, growth and yield of field crops. However, cultivars may vary concerning drought tolerance during these stages. Therefore, germination under stress condition could give an idea about the tolerance of corn cultivars to water stress during germination and growth.

In Egypt, farmers usually irrigate corn at 15-day intervals, but the response of the newly released varieties and hybrids to irrigation intervals is not known. Therefore, the objectives of this investigation are to study:

1- Germination capacity of some corn cultivars under different osmotic pressures.
2- Effect of irrigation intervals on yield and yield components of some corn cultivars and the cultivars differential response to water stress.

MATERIALS AND METHODS

1- Corn cultivars:

The following corn varieties were used in the lab. experiments and also the field experiments:

Giza 2 (open pollinated cv.)
T.C. 320 (three-way cross)
T.C. 310 (three-way cross)
D.C. 215 (double cross)
D.C. Tabba (double cross)

2- Lab. experiments:

For studying germination capacity of corn cultivars under stress condition, osmotic pressure treatments were performed with the aid of Menitol solution. The amount of Menitol and water to obtain the different atmospheric tensions were calculated by the following formula given by (Helmerich and Pfeiler 1954):

$$P = gRT/mV$$

P= Osmotic pressure (atm)
V= Volume in litters
M= molecular weight of Menitol
R= 0.08205 litter atmospheres per degree per mole
g= (gms of Menitol) = PVM/RT

Corn grains were placed for germination in Petri dishes using filter paper at 25± 2°C. Menitol solutions caused 5,7,9,11 and 13 atmospheres were used, in addition to control (distilled water). Germination of seeds were scored after 3 days (germination velocity) and 7 days (germination capacity). Each treatment was replicated five times and 20 grains were placed in every dish.

3- Field experiments:

Two field experiments were carried out at the experimental farm of National Research Center, at Shalakan, Klubia Governorate, Egypt during 1998 and 1999 seasons.

The experimental design was a split-plot with three replication. Main plots were devoted to four irrigation treatments, while sub-plots were occupied by five corn cultivars. The sub-plot area was 3.5 x 6.0 m (1/200 fed.).

Irrigation was at 15,21,28, and 35 days intervals. These treatments represent the following stress conditions and irrigation numbers.

Irrigation Interval Days	Stress Condition	No. of irrigations
15 (control)	no stress	6
21	low stress	5
28	mid. stress	4
35	Sever stress	3

Corn grains were planted in hills 25 cm apart within ridges 70 cm distance. Thereafter, hills were thinned to secured one plant / hill. Thirty kilograms of P_2O_5 were added during seed bed preparation and 30 kg N as Urea (46%) were added at planting time. Another 60 kg N were added after thinning just before 1st irrigation which was applied 21 days after planting.

At harvest, a random sample of 10 guarded plants was taken from each sub plot to score the following characters: plant height (cm), ear length (cm), number of grains / row, number of ears / plant, 100-grain weight (g) and grain weight /ear (g).Number of plants / feddan at harvest was counted. Grain yield per feddan (ardab) was estimated from the whole plot.

Statistical analysis and comparisons of character means were done according: to (Sendecore and Cocharan 1967).

RESULTS AND DISCUSSION

Germination velocity and germination capacity under different stress condition could give an idea about varietial tolerance to water stress during germination stage.

1- Lab. experiments:

1-1-Germination velocity:

Data in Table 1 show the germination velocity (germination % after 3 days) of corn cultivars under different osmotic pressure resulting from Menitol. Data indicated that corn cultivars varied significantly concerning germination velocity. D.C. 215 and D.C. Tabba showed the highest values with significant differences from Giza2, T.C. 320 and T.C. 310 cvs. On the other hand, T.C.320 showed the least germination velocity differing significantly from the other cultivars.

Water stress as progressive high osmotic pressure decreased germination velocity (Table 1). This reduction was more pronounced and significant when osmotic pressure reached 11 and 13.

The interaction between cultivars and osmotic pressures had a significant effect on germination velocity (Table 1). This mean that the response of corn cultivars to the used osmotic pressures was different. Data indicated that T.C. 320 showed the least velocity under all osmotic pressures including the control treatment. Under 5 atmosphere and sometimes 7 and 9 in creation varieties, germination velocity was stimulated. The germination speed of corn cultivars differs under different stress conditions.

Table 1: Germination velocity (germ.% after 3 days) of corn cultivars under different osmotic pressures.

Osmotic pressure	Cultivars					Mean
	Giza2	T.C. 320	T.C. 310	D.C.215	D.C. Tabba	
Control	72.5	57.5	75.0	80.0	72.5	71.5
5	80.0	52.5	85.0	87.5	90.0	79.0
7	77.5	27.5	77.5	97.5	82.5	72.5
9	65.0	35.0	77.5	92.5	82.5	70.5
11	37.0	10.0	27.5	35.5	47.5	31.5
13	34.5	10.0	22.5	12.0	37.5	23.3
Mean	61.8	32.1	60.8	67.5	68.8	

L.S.D. at 5% for cultivars : 6.39
L.S.D. at 5% for atmospheres: 11.36
L.S.D. at 5% for interaction : 17.20

1-2- Germination capacity:

Data in Table 2 showed that germination capacity of corn cultivars differed significantly in cultivars due to osmotic pressures and their interaction.

As observed from Table 2, some varieties i.e. T.C. 320 showed general decrease in germination capacity accompanying increase of osmotic pressure unlike ethers; i.e. D.C. Tabba which showed stimulated germination by higher osmotic pressure followed by return to control level at the two highest osmotic pressure. The results indicated that germination of corn cultivars could result in different performances under water stress.

Table 2: Germination capacity (germ.% after 7 days) for corn cultivars under different osmotic pressures.

Osmotic pressure	Cultivars					Mean
	Giza2	T.C. 320	T.C. 310	D.C.215	D.C. Tabba	
Control	82.5	82.5	77.5	92.5	75.0	82.0
5	87.5	75.0	92.5	90.0	95.0	88.0
7	70.0	47.5	82.5	100.0	82.0	76.5
9	87.5	57.5	87.5	100.0	90.0	84.5
11	70.0	35.0	52.5	60.0	77.5	59.0
13	60.0	42.5	65.0	57.5	75.0	62.0
Mean	76.3	56.7	76.3	83.3	82.3	

L.S.D. at 5% for cultivars : 8.4
L.S.D. at 5% for atmospheres: 7.2
L.S.D. at 5% for interaction : 17.6

2- Field experiments:

2-1- Effect of irrigation intervals:

Data in Table 3, (Pooled data of all varieties) indicated that increasing irrigation interval significantly decreased all the studied characters in both seasons. However, the reduction due to increasing irrigation interval from 15 (control) to 21 days (low stress) was insignificant. Thereafter, increasing interval to 28 days caused a significant reduction in grain yield/feddan. Such reduction was estimated by 54.04% (average of both seasons) compared to control treatment. It was accompanied by marked reductions in some yield attributes such as 100-grain weight, grain weight/ ear in addition to No. of ears / plant dud end of season stand.

The severe stress caused by irrigation interval of 35 days resulted in clear reduction in grain yield and its components as well as in number of plants / feddan (Table 3). This sever reduction in growth and yield of corn caused by water stress is logic due to the harmful effect of water stress on photosynthesis and translocation of metabolites, growth, reproductive organs initiation and grain filling.

Table 3: Mean characters (Pooled data of all varieties) as affected by irrigation intervals in 1998 and 1999 seasons.

Treatments characters	Irrigation intervals (days)				L.S.D. at 5%
	15	21	28	35	
1998 season					
Plant height (cm)	252.3	245.3	222.8	193.3	8.1
No. of ear / plant	1.4	1.2	1.3	0.7	0.4
Ear length (cm)	23.4	22.5	22.0	18.9	1.9
No. of grains / row	45.7	43.7	39.9	33.0	2.5
100-grain weight (g)	28.3	27.3	28.5	23.4	2.1
Grain weight / ear (g)	103.4	95.1	85.8	63.4	12.1
No. of plants / fed. $(10)^3$	22.3	21.6	18.6	14.7	3.2
Grain yield / fed. (ard.)	22.7	19.1	14.1	6.1	2.6
1999 season					
Plant height (cm)	249.9	240.3	219.3	192.3	6.9
No. of ear / plant	1.4	1.3	1.3	1.0	0.1
Ear length (cm)	24.4	23.7	22.7	20.1	2.1
No. of grains / row	45.6	44.9	41.6	33.1	2.2
100-grain weight (g)	32.6	29.8	28.0	23.7	2.90
Grain weight / ear (g)	111.5	107.1	84.9	58.9	12.5
No. of plants / fed. $(10)^3$	22.9	21.6	19.9	15.0	1.3
Grain yield / fed. (ard.)	24.9	22.4	16.8	6.6	2.8

2-2- Effect of cultivars:

Data in Table 4, showed the cultivars performance concerning yield and yield components (pooled data over irrigation intervals). Results indicate that. T.C. 320 and T.C. 310 were the tallest cultivars. T.C. 320 showed shortest ears. The hybrids corn showed generally greater number of grains / row than open pollinated cultivars (Giza 2).

Concerning grain yield per feddan, data of the first season showed inferiority of Giza 2 variety compared to the yield of D.C. 215 and D.C. Tabba.

Both hybrids ranked first and second yielder, respectively, with insignificant yield compared with T.C. 310 and the open pollinated T.C. 320 variety.

In the second season, T.C. 310 was the first yielder seconded by T.C. 320 variety. Only T.C. 310 showed significant higher yield than Giza 2, D.C. 215 and D.C. Tabba.

In both seasons, T.C. 320 variety was a good yielder with no significant difference compared with the best yielding hybrids. This occurred irrespective of the fact that this variety, had the lowest stand of plants at harvest.

Table 4: Average characters of different corn cultivars in 1998 and 1999 seasons (Pooled data over irrigation intervals).

Treatments characters	Cultivars					L.S.D. at 5%
	Giza 2	T.C. 320	T.C. 310	D.C. 215	D.C. Tabba	
1998 season						
Plant height (cm)	228.5	238.1	235.4	214.8	225.4	n.s.
No. of ear / plant	1.1	1.2	1.1	1.3	1.3	n.s.
Ear length (cm)	19.4	22.1	22.9	21.9	22.4	2.7
No. of grains / row	36.5	36.4	44.8	41.7	43.4	2.5
100-grain weight (g)	27.5	25.1	26.1	26.6	25.7	n.s.
Grain weight / ear (g)	77.0	86.6	93.3	87.0	91.0	9.4
No. of plants / fed. (10) ^{3}	19.1	18.0	20.7	20.0	18.8	2.3
Grain yield / fed. (ard.)	12.7	14.2	15.7	17.5	17.3	2.3
1999 season						
Plant height (cm)	221.4	236.3	234.8	221.1	213.6	8.0
No. of ear / plant	1.1	1.3	1.5	1.3	1.2	0.2
Ear length (cm)	20.9	22.8	24.0	23.0	23.0	2.4
No. of grains / row	38.4	37.6	42.4	44.8	43.3	2.2
100-grain weight (g)	29.4	27.5	28.4	28.7	28.6	n.s.
Grain weight / ear (g)	85.3	92.2	86.5	89.2	89.9	n.s.
No. of plants / fed. (10) ^{3}	20.5	19.4	19.8	19.8	20.1	n.s.
Grain yield / fed. (ard.)	15.5	18.2	21.7	16.7	16.2	1.9

2-3- Interaction effect:

Statistical analysis revealed that the interaction between irrigation intervals and corn cultivars had a significant effect on grain weight/ear in 1998 season, number of ears/plant and grain yield per feddan in 1999 season only (Table 5). Data in Table 5 showed that the reduction in grain weight / ear due to water stress was observed with different degrees in corn cultivars. This means that this character was more tolerant to water stress in D.C. Tabba than in other cultivars. On the other hand, in Giza 2 this character was more sensitive to water stress.

Concerning number of ears / plant, data in Table 5 showed that no clear trend was observed. However, under sever water stress the open Pollinated variety (Giza 2) showed fewer ears / plant than hybrids in general and with significant differences form D.C. 215. Also, results indicated that this character was less affected by water stress in D.C. 215 than other cultivars.

With respect to grain yield per faddan, results in Table 5 indicated that corn cultivars showed different response to water stress. For example grain

yield/fed. decreased significantly in Giza 2 only when irrigation interval increased from 15 to 21 days. Moreover, yield of all cultivars, except T.C. 310, decreased significantly if irrigation interval is increased up to 28 days. However, grain yield of all cultivars significantly decreased with 35-day irrigation interval. Results in Table 5 indicated that grain yield of T.C. 310 was relatively stable under 15, 21 and 28 days intervals. The reductions in grain yield of Giza 2, T.C. 320, T.C. 310, D.C.215 and D.C. Tabba were 55.8, 39.2, 16.5, 27.6 and 30.0%, respectively, when irrigation interval was increased from 15 to 28 days.

Table (5): Effect of interaction between irrigation interval and cultivars on grain weight / ear (g) in 1998 season and number of ears / plant as well as grain yield / fed. in 1999 season.

1998 Season				
Grain weight / ear (g)				
Treatments cultivars	**Irrigation Interval (days)**			
	15	**21**	**28**	**35**
Giza 2	90.6	88.3	84.0	44.9
T.C. 320	107.7	93.3	83.8	61.4
T.C. 310	113.8	106.1	89.1	64.0
D.C. 215	107.1	96.6	83.4	60.7
D.C. Tabba	97.9	91.4	88.7	86.1
Mean	**103.40**	**95.1**	**85.8**	**63.4**
L.S.D. at 5%	**16.3**			
1999 Season				
No. of ear / plant				
Giza 2	1.4	1.1	1.1	0.9
T.C. 320	1.5	1.6	1.3	0.9
T.C. 310	1.5	1.6	1.7	1.0
D.C. 215	1.4	1.2	1.4	1.3
D.C. Tabba	1.3	1.1	1.3	1.0
Mean	**1.4**	**1.3**	**1.4**	**1.0**
L.S.D. at 5%	**0.35**			
Grain yield / fed. (Ardab)				
Giza 2	25.80	18.01	11.40	6.60
T.C. 320	24.50	27.03	14.90	6.40
T.C. 310	29.70	26.60	24.80	5.50
D.C. 215	21.70	20.70	15.70	8.50
D.C. Tabba	22.60	19.50	16.90	5.80
Mean	**24.00**	**22.40**	**16.80**	**6.60**
L.S.D. at 5%	**2.25**			

From the pervious results the following conclusions may be drawn.

- Germination velocity and germination capacity under stress conditions had varied in different corn genotypes. This finding became more important when corn grown under different water regimes. The simulative

effects of in termediate osmotic pressures may be a safe-guard to germination and consequently growing corn in relatively less fertile jails.

- Corn genotypes showed different reactions (in terms of grain yield), to water stress. This needs to be confirmed before results could be of practical value for breeding.
- Irrigation at 21-day interval may become suitable for corn hybrids and T.C. 320 cv. because their grain yield reduction compared to 15-day interval did not reach a significant level. However, grain yield of Giza 2 had decreased significantly. Application of such treatment in corn may save about 50% of irrigation water. But the practical application of this finding has to await more detailed trials in different locations.

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تأثير بعض معاملات الإجهاد المائى على المحصول و بعض صفاته علـــى بعـض أصناف و هجن الذرة الشامية

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يهدف هذا البحث لدراسة سلوك بعض الأصناف من الهجن الجديدة من " الذرة الشامية" خـلال مرحلة الإنبات و النمو و المحصول عند تعرضها لبعض معاملات الإجهاد المائى. و لتحقيق هـذا الهدف تم إجراء تجارب معملية و حقلية ، فتم قياس سرعة و قدرة الإنبات فى خمســة أصنــاف وهجن من الذرة الشامية (جيزة ٢، هجين ثلاثى ٣٢٠ ، هجين ثلاثى ٣١٠، هجين زوجــى ٢١٥، هجين زوجى طابا) تحت ضغوط اسموزية (كنترول، ٥ ، ٧ ، ٩، ١١، ١٣ ض.ج) و ذلك فــى المعمل باستخدام سكر المانيتول.

و أقيمت تجربتان حقليتان فى موسمى ١٩٩٨، ١٩٩٩ باستخدام نفــس الأصنــاف و الــهجن السابقة مع أربعة معاملات لطول الفترة بين الريات و هى رية كل ١٥ يوم، رية كل ٢١ يوم ،رية كل ٢٨ يوم، رية كل ٣٥ يوم.وكان التصميم المستخدم هو تصميم القطــع المنشــقة فــى ثــلاث مكررات حيث كانت معاملات الرى فى القطع الرئيسية أما الأصناف والهجن كانت موزعة علــى القطع المنشقة .

و يمكن تلخيص أهم النتائج المتحصل عليها فيما يلى:

ــ أظهرت النتائج المعملية اختلاف أصناف و هجن الذرة معنويا فى سرعة و قدرة الإنبات.
ــ أدت زيادة الضغوط الاسموزية لنقص سرعة و قدرة الإنبات بصورة كبيرة عند استخدام ضغوط اسموزية قدرها ١١، ١٣ ض ج إلا إن الضغوط الأقل كانت ذات أثر منشط علــى الإنبــات وخاصة على الهجن الزوجية ٢١٥ وطابا.
ــ أدى طول الفترة بين الريات إلى ٣٥ يوما إلى نقص معظم الصفات و كذلك محصول الحبوب و مكوناته معنويا.
ــ لم يظهر تأثير كبير لطول فترة الرى من ١٥ الى ٢١ يوم إلا فى الصنف جيزة ٢.
ــ تــباين محصول الأصناف هجين ثلاثى ٣٢٠، هجين ثلاثى ٣١٠، و الهجن الزوجيــة ٢١٥، طابا فيما بينها بدون فروق معنوية خلال الموسمين إلا أن الصنف جيزة ٢ الأقل محصــول أظهر انخفاضا معنويا عن الهجن الزوجية ٢١٥،طابا (موسم ١٩٩٨) و الهجين الثلاثى ٣١٠ (موسم ١٩٩٩).
ــ أظهرت النتائج انه يمكن باستعمال معاملات الرى(كل ٢١ يوم ، كل ٢٨ يوم) ومــع الــهجين الثلاثى ٣١٠ يمكن توفير نحو ٥٠% من المياه المستخدمة فى رى الذرة.