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GROWTH AND PRODUCTIVITY OF WHEAT AS AFFECTED BY SOME GROWTH RETARDANTS UNDER WATER STRESS CONDITIONS IN NEWLY CULTIVATED SANDY LANDS

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ABSTRACT

Two Field experiments were carried out to study growth and productivity of wheat as affected by some growth retardants under water stress conditions in newly cultivated lands at sandy lands in New Salheyia Region, Sharkia Governorate . The main obtained results were :-

1- Growth parameters, i.e. plant height, number and dry weight of tillers, blades and spikes /plant, flag leaf area, blades area/plant and LAI were significantly decreased under the water stress conditions. On the contrary, SLW increased under water stress treatments. Furthermore, results indicated that wheat plants appeared to be more sensitive to water stress during tillering stage, followed by heading stage, meanwhile, the harmful effect caused under milk-ripe stage stress treatment was the lowest one. On the other hand the greatest value of SLW was obtained by skipping an irrigation at heading stage, followed by skipping an irrigation at tillering stage whereas the smallest value obtained under skipping an irrigation at milk-ripe stage.

2- Spraying wheat plants with 20 ppm uniconazole and / or 750 ppm cycocel seemed to be the most favourable treatments to increase plant height, number and dry weight of tillers, blades and spikes/plant, flag leaf area, blades area/plant and LAI, however, the greatest value of SLW produced by spraying wheat plants with 1250 ppm. cycocel.

3- Yield and its components, i.e. plant height, number of tillers and spikes/plant, number of spikelets/main spike, spikes weight/plant, grain, straw and biological yield/plant and /or fed., protein % per grain, Rpp_{gr}, RPP_{bio} and RPP_{veg} were significantly affected by water stress treatments, meanwhile, the response of crop index and harvest index failed to reach the significant level at 5%. Moreover, the previous yield and its components (except protein % per grains and RPP_{veg}) were significantly decreased by missing an irrigation in certain developmental stages of growth, however, protein % per grains and RPP_{veg} were significantly increased. Results show that wheat plants appeared to be more sensitive to water stress during tillering stage followed by heading stage and milk ripe stage, respectively.

4- Foliar application with 750 ppm cycocel produced the greatest values of yield ant its components except RPP_{gr} which produced by 1000 ppm cycocel and protein % per grains, RPP_{bio} and RPP_{veg} with 1250 ppm cycocel.
5- The effect of interaction between skipping of irrigation at different stages of growth and growth retardant concentrations indicate that wheat plants was more sensitive to water stress at tillering stage compared with heading and milk ripe stage, respectively, also, plant growth retardants play as a growth promoters at the low concentrations and play a role as growth inhibitors at the highest concentration used, where foliar application with 20 ppm uniconazole, 500 ppm cycocel and /or 750 ppm cycocel can be the lowest harmful effect in growth parameters and yield and its components caused by water stress conditions.

INTRODUCTION

The importance of wheat in human main food is the well known fact. Overall 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 Egypt, the crop covers about 2.5 million feddan distributed mainly in the old land and partially in the new land (Egypt. Stat. Agric. Rep., 1998). On the light of the present national water policy using wheat cultivars produce high yield under suitable water regime, is greatly influenced by a number of factors especially foliar spraying with growth retardants in newly cultivated sandy soils and under stress conditions of drought and salinity. Thus, this work was carried out to investigate growth and productivity of wheat as affected by some growth retardants under water stress conditions in newly cultivated lands in New Salheyia Region, Sharkia Governorate.

MATERIALS AND METHODS

The present investigation was carried out during the two successive seasons of 1999/2000 and 2000/2001 in newly cultivated lands under sandy soil conditions at the New Salheyia region, Sharkia Governorate to study growth and productivity of wheat c.v. Sakha-69 as affected by some growth retardants under water stress conditions.

Each experiment was laid out in split-plot design with four replications, where, the main plots included the irrigation treatments, while the growth retardants treatment were distributed in the sub-plots. The experimental unit consisted of 15 rows, each of 3.5 meter length and 20 cm apart 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^{th} and 27^{th} November in 1999 and 2000 in the two seasons, respectively. The normal agronomic practices of growing wheat were carried out till harvest as recommended by wheat research Dept., A.R.C.

Each experiment included 28 treatments which were the combination of four irrigation treatments and seven growth retardants treatments. The factors under study were:

A- The irrigation treatments:

1- Normal irrigation where wheat plants irrigated with seven days intervals up to ripe stage (145 days from sowing) i.e. control treatment.
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 -ripe stage (110 days from sowing).

B- Growth retardants treatments :

1- Tap water i.e. control treatment.
2- 20 ppm unicinazole.
3- 30 ppm unicinazole.
4- 500 ppm CCC.
5- 750 ppm CCC.
6- 1000 ppm CCC.
7- 1250 ppm CCC.

Uniconazole (E-1-(4-chlorophenyl)-4,4- dimethyl-2- (1, 2, 4 - triazol – 1 - yl) -1- penten - 3 - 01) and cycocel " CCC " (2- Chloroethyl trimethyl ammonium chloride) were sprayed twice after 40 and 50 days after sowing, respectively. Soil characteristics are presented in Table (1).

Table (1): Mechanical and chemical analysis of soil at experimental sites (Average of 1999 /2000 and 2000/2001 seasons).

Sand %	Silt %	Clay %	Texture	pH	Organic matter O.M. %	Available N. ppm	Available K. ppm	Available P. ppm
73.29	23.28	3.43	Sandy	8.00	0.49	43.00	134.00	12.50

Samples of five guarded plants were taken at random from each plot of the four replications to measure growth characters, where, plant height, number and dry weight of tillers, blades and spikes per plant were estimated, at 115 days after sowing. Furthermore, flag leaf area "cm^2" and blades area "cm^2/plant" were calculated according to Bremner and Taha (1966), whereas, leaf area index (LAI) was determined according to Watson (1952), meanwhile, specific leaf weight (SLW) was calculated according to the method described by Pearce *et al.*, (1969).

At harvest date, a random of ten plants were taken from the middle rows of each plot to determine plant height "cm", number of each tillers and spikes/plant, number of spikelets and grains/spike, grain; straw and biological yields/plant. In addition, relative photosynthetic potential ratio for grain yield (RPP_{gr}), biological yield (RPP_{bio}) and vegetative growth (RPP_{veg}) "g/LAI" were determined according to Vedovic and Pokorny (1973). Furthermore, grain, straw and biological yield "Ton/fed" were measured from the whole area of the plot and then converted to yield per feddan. Then, crop index (grain yield/biological yield) and harvest index (grain yield/straw yield) were calculated. Crude protein was determined according to the method described by A. O. A. C. (1984).

The data obtained were subjected to the proper statistical analysis according to Snedecor and Cochran (1990). For comparison between means L.S.D. at 0.05 level was used.

RESULTS AND DISCUSSION

A- Growth characters :

A-1. Effect of water stress:

Data reported in Table (2) show clearly that missing an irrigation at tillering, heading / or milk-ripe stages significantly decreased plant height, number and dry weight of tillers, blades and spikes/plant, flag leaf area, blades area/plant and LAI at 115 days from sowing. On the contrary, SLW significantly increased under water stress condition compared with control plants. The negative significant effect in growth characters could be explained on the basis of the loss of which effects the rate of cell expansion and ultimate cell size. Loss of turgidity is probably the most sensitive process of water stress. Thus, caused a decrement in growth rate, stem elongation and leaf expansion. The depression in cell division and enlargement has been carefully discussed by Kramer and Boyer (1995). The results show clearly that water-stressed plants even watered regulatory afterward did not recover to their normal behavior to compensate the adverse effect caused by the exposure to drought conditions. Our results confirmed with those obtained by Abd El-Gawad *et al.*, (1993), Eid and Yousef (1994), Abo Shetaia and Abd El-Gawad (1995), Gad El-Rab *et al.*, (1995), Yousef and Hanna (1998) Sharaan *et al.*, (2000), Abo El- Kheir *et al.*, (2001) and Kandil *et al.*, (2001). From the presented data in Table 2 it can be concluded that wheat plants appeared to be more sensitive to water stress during tillering stage followed by heading stage and milk-ripe stage in the end of the list order for the water stress treatments under study . Seif El-Yazal *et al.*, (1984), Mc Master *et al.*, (1994), Abo Shetaia and Abd El-Gawad (1995) and Kandil *et al.*, (2001) confirmed with our results. It is worthy 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 avoid at this growth stage. Then, the depression in growth parameters by missing an irrigation in tillering stage was more pronounced, where, ever plants were subjected to soil moisture stress at tillering stage. Such response might be attributed to lack of water absorbed, inadequate uptake of essential elements, inhibition of meristematic activity and / or reduction in photosynthetic capacity under such unfavourable conditions (Abo Shetaia and Abd El-Gawad,1995, Kramer and Boyer, 1995, Shangguan *et al.*, 1999 and Kandil *et al.*, 2001). Moreover, assimilates translocated to new developing tillers and to the spike primordial were reduced and which were not enough to mentain or develop those organs.

A-2. Effect of growth retardants concentrations :

The results presented in Table (2) indicated clearly that plant growth retardants significantly affected growth parameters of wheat plants at 115 days after sowing. It is note worthy to mention that foliar application of 20 ppm uniconazol caused significant stimulatory effect on plant height, number of blades/plant, dry weight of tillers; blades and spikes/plant, flag leaf area, blades area/plant, LAI and SLW, meanwhile, caused insignificant decrement in number of tillers and spikes/plant. Increasing concentration of uniconazole up to 30 ppm caused harmful effects for wheat plants represented in decreased plant height, number of tillers/plant, number of spikes/plant, dry weight of tillers + sheats, blades and spikes/plant, flag leaf area, blades area/plant and LAI in comparison with control and 20 ppm uniconazol, in addition, number of blades and SLW decreased compared with 20 ppm. uniconazole.

With respect to foliar spraying with cycocel, foliar application of 500 ppm cycocel increased significantly plant height, number and dry weight of tillers; blades and spikes/plant, flag leaf area, blades area/plant, LAI and SLW compared with control treatment. Moreover, the results indicate that increasing the concentration of CCC to 750 ppm gave maximum significant values of plant height, number and dry weight of tillers, blades and spikes/plant, flag leaf area, blades area/plant and LAI compared with other cycocel concentrations. However, increasing concentration of cycocel up to 1000 and 1250 ppm caused depressive effects in wheat plants in comparison with 500 and 750 ppm but increased SLW. In addition, all growth characters measured (except SLW) in this study reflect significant decrement in its values and the maximum harmful effects were recorded with the highest concentration, i.e. 1250 ppm (Table 2).

Generally, spraying wheat plants with 750 ppm cycocel was the favorable treatment to increase growth characters at 115 days age except SLW that produced under the concentration of 1250 ppm cycocel.

The enhancement in growth characters by the two favorable and suitable concentrations of the growth retardants under study (i.e. 20 ppm uniconazole and 750 ppm cycocel) might be attributed to the increment of the photosynthetic surface area, i.e. blades area and LAI (table 2), thus, photosynthetic efficiency increased the net assimilation rate (NAR) and relative growth rate (RGR). Also, the suitable concentration of growth retardants increased considerably the content of total N, ureidas, sugars and starch in shoot and root system (Shah and Prathopasenan, 1993). It is worthy to mention that Shalaby and El-Ashry (2001) and El-Ashry and Shalaby (2001) reported that plant growth retardant acts as growth promoter at the lower concentrations but acts as growth inhibitor at the higher concentrations in faba bean and chickpea, where, in the lower concentrations the content of endogenous plant growth promoters, i.e. IAA, GA_3 and cytokinins were increased, meanwhile, a remarkable decrease was detected on the content of the plant growth inhibitor ABA. On the other hand, increasing growth retardant concentrations to the highest levels caused depressive effect on the endogenous plant growth promoter content and increase ABA content. Furthermore, they found that the higher concentrations of growth retardant increased percentage of abnormal pollen mother cells (PMC_s). consequently, the meiotic abnormalities increased with the increase in the concentration of growth retardant

The results obtained in this study are in harmony with these obtained by Imam *et al.*, (1995 a and b), Abo El-Kheir *et al.*, 1999, Zaki, 1999 and Hassanein *et al.*, 2001 working on the effect of uniconazole and with those reported by Shah and Prathopasenan (1993), Shalaby (2000) and Hassanein *et al.*, (2001) on the effect of cycocel.

A-3. Effect of interaction :

Regarding the interaction effect of water stress conditions and growth retardants concentrations on growth characters data illustrated in Table (3) show clearly that the effect was significant on plant height, number and dry weight of tillers, blades and spikes/plant, flag leaf area, blades area/plant and LAI at 115 days after sowing . However, the effect of the interaction on SLW failed to reach the significant level at 5 %. Data observed that foliar spraying with 750 ppm cycocel under no skipping an irrigation treatment gave the highest significant values from growth characters (except SLW), meanwhile, foliar application with 1250 ppm cycocel with skipping an irrigation at tillering stage produced wheat plant characterized by its lowest significant values of growth characters (except SLW) and these plants had the highest insignificant value of SLW. Generally, foliar spraying with 750 ppm cycocel can overcome the depression in growth characters resulted by water stress conditions followed by 500 ppm cycocel and 20 ppm uniconazole. In addition, wheat plants were more sensitive to water stress at tillering stage compared with heading and milk-ripe stages, respectively.

B- Yield and its components :

B-1. Effect of water stress :

Data reported in Table (4) indicate that skipping an irrigation either tillering, heading /or milk-ripe stages caused significant negative effect on plant height, number of tillers and spikes / plant, number of spikelets/main spike, weight of spikes/plant, grain, straw and biological yields per plant and per fed., RPP_{gr}, RPP_{bio} and Rpp_{veg}. Meanwhile, the effect on protein percentage per grains was positive and significant. On the other hand, crop index and harvest index were insignificantly affected by water stress conditions. The depression in these previous yield components (except protein % per grain) appeared to be greatest value when the water stress caused at tillering stage followed by heading stage and skipping an irrigation in milk-ripe stage in the end of the list order, respectively. On the contrary, skipping an irrigation at tillering stage gave the highest significant value from protein percentage per grains followed by skipping at heading stage and skipping at milk-ripe stages, however, the differences between control plants and skipping at milk-ripe stage was not significant. Results obtained by Seif El-Yazal *et al.*, (1984) Mc Master *et al.*, (1994), Abo-Shetaia and Abd El-Gawad (1995), Kramer and Boyer (1995), Shangguan *et al.*, (1999), Abo El-Kheir *et al.*, (2001) and Kandil *et al.*, (2001) confirmed with our results. The negative effect of yield and its components caused by skipping an irrigation could be explained on the basis of the loss of turgidity which affects the rate of cell expansion and ultimate cell size. Loss of turgidity is probably the most sensitive process to water stress, thus, decrement in growth rate, stem elongation and leaf expansion. Thus, 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 reflect significant decrement than those of adequate water supply plants (control plants). Data indicate that water stressed plants even watered regularly afterward did note 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 reaction particularly those concerning with the reduction in photosynthetic rates (Abd El-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, dry matter production per plants was more significantly decreased than adequate water supply plants and compared with skipping an irrigation at heading and milky-ripe stages, respectively. Results in this investigation are in full agreement with those reported by and Mc Master *et al.*, (1994), Kandil *et al.*, (2001) and Abo El-Kheir *et al.*, (2001), whose mentioned that irrigation at late jointing is recommended due to its greater 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. The decrement in grains, straw and biological yields was more obvious when skipping an irrigation at tillering stage, where, number of tillers and spikes were reduced markably (Table 2).

B-2. Effect of growth retardants concentration :

It is clear from the data presented in Table (4) that wheat plants sprayed with 20 ppm uniconazole significantly increased number of tillers and spikes/plant, number of spikelets/spike, spikes weight/plant, grain; straw and biological yields per plant and/or fed., protein % per grains and RPP_{grains}. Increasing concentration of uniconazole up to 30 ppm caused depressive effect on plant height, number of tillers and spikes/plant, spikes weight/plant, number of spikelets/spike, grain, straw and biological yields per plants and / or fed. and RPP_{gr}, on the other hand, significantly increased protein % per grains compared with control and foliar spraying with 20 ppm uniconazole.

With respect to the effect of foliar application with cycocel, data illustrated in Table (4) show clearly that there are significant marked stimulatory effect on plant height, number of tillers and spikes/plant, number of spikelets/main spike, grain, straw and biological yields per plant and/or fed. recording the highest significant values by foliar spraying with 750 ppm cycocel compared with the other six concentrations of growth retardants under study. On the other hand, data showed that spraying wheat plants with 1000 ppm cycocel caused significant increment in RPP_{gr}, meanwhile, plants sprayed with 1250 ppm had the highest protein % per grains, RPP_{bio} and RPP_{veg} in comparison with 20, 30 ppm uniconazole, 500, 750 and 1000 ppm cycocel treatments under study.

The significant results obtained by uniconazole treatments are in good agreement with those obtained by Imam *et al.*, (1995 a and b), Abo El-Kheir *et al.*, (1999) Zaki (1999) and Hassanein *et al.*, (2001).

Table (2) : **Effect of water stress at certain developmental stages and growth retardants on growth characters of wheat at 115 days after sowing (Average of 1999/2000 and 2000/2001 seasons)**

Water stress treatments	Growth retardants conc.	Plant height "cm"	Number/plant			Dry weight "g/plant"			Flag leaf area "cm^2"	Blades area "cm^2/plant"	LAI	SLW "mg/cm^2"
			Tillers	Blades	Spikes	Tillers	Blades	Spikes				
No skipping		95.89	6.04	23.54	5.63	11.85	5.02	9.15	17.64	676.08	6.76	7.44
Skipping at tilering satge		92.00	5.15	20.75	4.61	10.20	4.38	7.60	15.44	545.38	5.45	8.04
Skipping at heading satge		93.01	5.43	21.83	5.20	10.91	4.70	8.02	16.04	479.29	5.79	8.11
Skipping at milk-ripe satge		94.59	5.72	22.45	5.38	11.24	4.80	8.52	16.74	632.90	6.33	7.60
L S.D at 5 % level		1.06	0.22	0.39	0.18	0.50	0.08	0.21	0.45	15.43	0.01	0.07
	Control	94.90	5.40	20.43	5.08	11.15	4.53	8.09	15.81	617.05	6.17	7.34
	20 ppm uniconazole	96.63	5.58	22.84	5.29	12.12	5.14	8.73	17.44	651.09	6.51	7.89
	30 ppm uniconazole	86.96	5.14	21.59	4.68	10.12	4.22	7.75	13.86	560.65	5.61	7.53
	500 ppm cycocel	102.28	6.81	26.18	6.54	11.95	5.25	9.75	18.46	675.90	6.76	7 77
	750 ppm cycocel	105.90	7.34	28.68	6.93	12.78	5.65	10.57	21.21	722.51	7.23	7.82
	1000 ppm cycocel	89.19	4.77	18.43	4.24	10.50	4.27	7.34	14.72	542.72	5.43	7.87
	1250 ppm cycocel	79.76	4.08	16.87	3.68	8.75	3.93	6.03	13.49	484.11	4.84	8.12
L S.D at 5 % level		1.99	0.87	1.36	0.24	0.30	0.12	0.23	0.48	15.66	0.28	0.11

Table (3) : **Effect of the interaction between water stress at certain developmental stages and growth retardants concentrations on growth characters of wheat at 115 days after sowing.(Average of 1999/2000 and 2000/2001 seasons).**

Water stress treatments	Growth retardants conc. (ppm)	Plant height "cm"	Number/plant			Dry weight "g/plant"			Flag leaf area "cm²"	Blades area "cm²/plant"	LAI	SLW "mg/cm²"
			Tillers	Blades	Spikes	Tillers	Blades	Spikes				
No skipping	Control	96.05	5.38	21.96	5.37	12.03	4.82	8.89	16.85	691.13	6.91	6.97
	20 ppm uniconazole	97.10	6.00	23.65	5.63	13.03	5.57	9.93	18.6	731.54	7.32	7.61
	30 ppm uniconazole	90.70	5.69	22.85	5.15	10.95	4.50	8.85	14.65	619.00	6.19	7.27
	500 ppm cycocel	104.30	7.58	27.85	7.10	12.74	5.54	10.63	20.1	754.00	7.54	7.35
	750 ppm cycocel	109.90	7.80	30.60	7.40	13.25	5.93	11.53	22.8	798.00	7.98	7.43
	1000 ppm cycocel	91.90	5.25	19.65	4.69	11.25	4.54	7.50	15.6	595.88	5.96	7.62
	1250 ppm cycocel	81.35	4.58	18.35	4.00	9.63	4.26	6.71	14.9	543.00	5.43	7.85
Skipping at tilering satge	Control	93.30	5.21	19.10	4.46	10.19	4.24	7.39	14.95	553.36	5.53	7.66
	20 ppm uniconazole	95.45	5.25	21.00	4.78	10.99	4.73	8.11	16.65	574.60	5.74	8.23
	30 ppm uniconazole	84.60	4.79	20.90	4.00	8.95	3.59	7.29	12.80	502.00	5.02	7.15
	500 ppm cycocel	100.40	6.11	24.75	5.90	11.28	4.95	8.92	17.59	605.40	6.05	8.18
	750 ppm cycocel	108.80	6.78	26.50	6.25	12.25	5.45	9.56	19.92	661.00	6.61	8.25
	1000 ppm cycocel	85.60	4.36	17.32	3.75	9.81	4.1	6.40	13.67	495.80	4.96	8.27
	1250 ppm cycocel	75.80	3.53	15.65	3.14	7.96	3.62	5.50	12.50	425.50	4.26	8.51
Skipping at heading satge	Control	94.75	5.38	20.00	5.18	11.08	4.47	7.86	15.35	589.24	5.89	7.59
	20 ppm uniconazole	96.50	5.45	22.90	5.30	11.81	4.99	8.27	16.80	603.00	6.03	8.28
	30 ppm uniconazole	85.75	4.96	21.00	4.75	10.29	4.51	7.26	13.90	549.00	5.49	8.21
	500 ppm cycocel	101.90	6.54	25.90	6.45	11.74	5.2	9.45	18.20	638.40	6.38	8.15
	750 ppm cycocel	109.50	7.17	22.50	6.90	12.66	5.6	10.45	20.75	692.65	6.93	8.08
	1000 ppm cycocel	89.25	4.60	18.34	4.15	10.25	4.31	7.15	14.25	518.20	5.18	8.32
	1250 ppm cycocel	78.40	3.90	16.17	3.64	8.52	3.79	5.72	13.00	465.12	4.65	8.15
Skipping at milk-ripe satge	Control	95.50	5.63	20.65	5.29	11.31	4.60	8.23	16.10	654.50	6.55	7.03
	20 ppm uniconazole	97.50	5.60	23.80	5.45	12.63	5.25	8.61	17.70	695.22	6.95	7.55
	30 ppm uniconazole	88.80	5.10	21.60	4.80	10.27	4.29	7.58	14.10	572.60	5.73	7.49
	500 ppm cycocel	102.50	7.00	26.20	6.70	12.04	5.30	10.00	19.00	705.80	7.06	7.51
	750 ppm cycocel	116.30	7.59	29.10	7.10	12.85	5.70	10.75	21.35	738.40	7.38	7.72
	1000 ppm cycocel	90.00	4.85	18.50	4.35	10.70	4.40	8.30	15.35	561.00	5.61	7.84
	1250 ppm cycocel	83.50	4.30	17.30	3.95	8.88	4.05	6.20	13.55	502.80	5.03	8.05
L.S.D. at 5 % level		3.18	1.39	2.18	0.38	0.48	0.19	0.36	0.77	25.06	0.45	n.s.

Table (4) : Effect of water stress in certain developmental stages and growth retardants concentrations on yield and its components of wheat plants.

(Average of 1999/2000 and 2000/2001 seasons).

Water stress treatments	Growth retardants conc.	Plant height "cm"	No. of tillers/plant	No. of spikes/ plant	No. of spikelets/ main spike	Spikes weight "g/plant"	Grain yield "g/plant"	Straw yield "g/plant"	Bio- yield "g/plant"	Grain yield "ton/fed."	Straw yield "ton/fed."	Bio- yield "ton/fed."	RPP_{gr} "g/LAI"	RPP_{bio} "g/LAI"	RPP_{veg} "g/LAI"	Protein % per grains	Crop index	Harvest index
No skipping		94.41	5.7	5.44	14.06	32.99	26.59	38.74	65.33	2.34	3.91	6.25	3.93	9.68	5.43	9.63	0.37	0.60
Skipping at tllering satge		88.56	4.71	4.14	13.52	25.51	19.69	31.50	51.19	1.78	3.22	5.00	3.61	9.39	5.78	10.09	0.36	0.55
Skipping at heading satge		90.62	5.06	4.64	13.72	28.96	21.75	32.25	54.00	2.00	3.41	5.41	3.76	9.33	5.57	9.90	0.37	0.59
Skipping at milk-ripe satge		92.01	5.24	4.99	13.89	31.08	24.08	35.09	59.17	2.19	3.59	5.78	3.80	9.35	5.55	9.69	0.38	0.61
L.S.D. at 5 % level		0.31	0.42	0.02	0.17	0.14	0.47	0.28	0.75	0.12	0.09	0.36	0.08	0.06	0.13	0.16	n.s.	n.s.
	Control	93.04	5.04	4.74	13.81	29.04	22.66	34.23	56.89	1.97	3.32	5.29	3.67	9.22	5.55	9.32	0.37	0.59
	20 ppm uniconazole	93.50	5.3	5.07	14.15	30.55	24.53	35.39	59.92	2.23	3.91	6.14	3.77	9.20	5.43	9.60	0.36	0.57
	30 ppm uniconazole	84.40	4.85	4.25	13.38	28.44	20.06	33.08	53.14	1.79	3.08	4.87	3.58	9.47	5.89	9.94	0.37	0.58
	500 ppm cycocel	95.59	5.96	5.85	14.28	32.86	25.71	36.96	62.67	2.32	4.01	6.33	3.80	9.27	5.47	9.69	0.37	0.58
	750 ppm cycocel	102.43	6.53	6.16	14.67	34.3	27.64	38.36	66.00	2.50	4.37	6.87	3.82	9.13	5.31	9.80	0.36	0.57
	1000 ppm cycocel	86.34	4.5	4.14	13.48	27.24	21.75	32.63	54.38	1.89	3.09	4.97	4.01	10.01	6.00	10.09	0.38	0.61
	1250 ppm cycocel	82.55	4.07	3.43	12.97	24.67	18.85	30.15	49.00	1.78	2.94	4.72	3.89	12.12	6.23	10.30	0.38	0.61
L.S.D. at 5 % level		0.61	0.23	0.11	0.09	1.74	0.2	0.10	2.30	0.04	0.07	0.06	0.03	n.s.	n.s.	0.01	n.s.	n.s

The increment in grain yield could be a reflection of the effect of uniconazole on physiological process especially photosynthesis and metabolism transport (Imam, 1995 a and b). Again, Abou El-Kheir *et al.*, (1999) noticed that uniconazole increased chlorophyll content, total soluble solids of the cell sap in the leaves which in turn positively reflected in increasing seed yield and the accumulation of metabolic products in the seed. On the other hand, our results in the case of the effect of cycocel on yield and its components are in a harmony with those obtained by Shah and Prathopasenan (1993), Shalaby (2000) and Hassanein *et al.*, (2001) . In addition, the enhancement of yield and its components by foliar spraying with the low and middle rates of cycocel (500 and 750 ppm) might be attributed to the increment of photosynthetic surface area (Table 2), hence, photosynthetic efficiency increased the NAR and RGR. In addition, suitable concentration of cycocele increased considerably the content of total N, uriedas, sugars and starch in shoot and root system Shah and Prathopasenan (1993). Also, Shalaby and El-Ashry (2001) and El Ashry and Shalaby (2001) indicated that plant growth retardants play as growth promoters at the low concentrations and play a role as growth inhibitors at highest concentrations used.

B-3. Effect of interaction :

Results in Table (5) demonstrated that there was significant effect on plant height, number of tillers and spikes/plant, spikes weight/plant, number of spikelets/main spike, grain; straw and biological yields per plant and /or fed., protein % per grains, RPP_{gr} and RPP_{bio}. of wheat as a result of the interaction between water stress conditions and growth retardants concentrations. Moreover, foliar spraying with 750 ppm cycocel under normal irrigation treatment gave the highest significant values from plant height, number of tillers and spikes/plant, spikes weight/plant, number of spikelets/spike, grain, straw and biological yields/plant. Meanwhile, spraying with 1250 ppm cycocel to normal irrigation plants produced the greatest values of RPP_{gr}, RPP_{bio}, RPP_{veg}. Generally, foliar application with 750 ppm cycocel can minimize the harmful effect on yield and its components caused by water stress conditions followed by 500 ppm cycocel and 20 ppm uniconazole. In addition, wheat plants was more sensitive to water stress at tillering compared with heading and milk-ripe stages, respectively.

Table (5): Effect of the interaction between water stress at certain developmental stages and growth retardants on yield and its components of wheat plants (Average of 1999/2000 and 2000/2001 seasons).

Water stress treatments	Growth retardants conc. (ppm)	Plant height "cm"	No. of tillers/plant	No. of spikes/plant	No. of spikelets/ main spike	Spikes weight "g/plant"	Grain yield "g/plant"	Straw yield "g/plant"	Bio-yield "g/plant"	Grain yield "ton/fed."	Straw yield "ton/fed."	Bio- yield "ton/fed."	RPP_g "g/LAI"	RPP_{bio} "g/LAI"	RPP_{stg} "g/LAI"	Protein % in grains	Crop index	Harvest index
No skipping	Control	95.33	5.33	5.30	13.90	32.19	26.46	38.70	65.16	3.32	3.91	6.23	3.83	9.43	5.60	9.32	0.37	0.59
	20 ppm uniconazole	96.00	5.70	5.80	14.51	33.50	27.81	39.89	67.7	2.50	4.09	6.59	3.80	9.25	5.45	9.54	0.38	0.61
	30 ppm uniconazole	87.30	5.30	5.08	13.60	31.06	24.34	36.48	60.82	2.11	3.61	5.72	3.93	9.82	5.89	9.76	0.37	0.58
	500 ppm cycocel	100.00	7.00	6.90	14.64	36.19	28.51	41.20	69.71	2.51	4.31	6.82	3.78	9.25	5.47	9.36	0.37	0.58
	750 ppm cycocel	106.00	7.30	7.00	15.00	38.20	29.56	42.33	71.88	2.64	4.63	7.27	3.68	8.96	5.30	9.58	0.36	0.57
	1000 ppm cycocel	91.10	5.00	4.60	13.71	31.00	25.50	37.00	62.5	2.21	3.41	5.62	4.28	10.40	6.27	9.76	0.39	0.65
	1250 ppm cycocel	85.00	4.30	3.70	13.20	28.79	24.17	35.60	59.77	2.08	3.41	5.49	4.45	11.01	6.56	10.10	0.38	0.61
Skipping at tillering stage	Control	90.11	4.67	4.00	13.43	26.05	19.52	31.25	50.77	1.70	2.88	4.58	3.53	9.18	5.65	9.57	0.37	0.59
	20 ppm uniconazole	91.20	5.00	4.67	13.81	27.90	21.86	33.42	55.28	1.95	3.64	5.59	3.81	9.63	5.82	9.68	0.35	0.51
	30 ppm uniconazole	87.18	4.30	3.33	13.04	22.40	15.7	28.70	44.40	1.45	2.75	4.20	3.13	8.84	5.71	10.40	0.35	0.53
	500 ppm cycocel	94.55	5.17	5.00	13.98	28.20	22.59	36.17	58.76	1.98	3.77	5.75	3.73	9.71	6.18	9.98	0.34	0.53
	750 ppm cycocel	100.00	6.00	5.33	14.27	30.70	25.28	37.72	63.00	2.22	4.19	6.41	3.82	9.53	5.71	9.66	0.35	0.53
	1000 ppm cycocel	81.95	4.00	3.67	13.29	23.27	17.97	28.07	46.04	1.65	2.76	4.41	3.62	9.28	5.66	10.45	0.37	0.60
	1250 ppm cycocel	80.00	3.80	3.80	12.85	20.03	14.88	25.16	40.04	1.53	2.52	4.05	3.50	9.42	5.92	10.60	0.38	0.61
Skipping at heading stage	Control	92.15	5.00	4.67	13.58	28.47	21.58	32.96	54.54	1.84	3.17	5.01	3.66	9.26	5.6	9.40	0.37	0.58
	20 ppm uniconazole	93.00	5.33	5.00	13.95	29.05	23.87	34.07	57.95	2.22	3.86	6.08	3.96	9.61	5.65	9.63	0.37	0.58
	30 ppm uniconazole	84.00	4.80	4.00	13.36	29.60	19.05	30.53	49.58	1.68	2.88	4.56	3.47	9.03	5.56	10.00	0.41	0.58
	500 ppm cycocel	95.80	5.67	5.50	14.16	32.06	24.46	35.45	59.85	2.34	3.91	6.25	3.82	9.38	5.56	9.80	0.37	0.60
	750 ppm cycocel	101.90	6.33	6.00	14.64	33.87	26.38	35.87	62.25	2.55	4.28	6.83	3.81	8.98	5.17	10.00	0.37	0.60
	1000 ppm cycocel	85.00	4.30	4.00	13.42	26.70	20.14	29.53	49.67	1.74	2.95	4.69	3.89	9.59	5.7	10.14	0.37	0.59
	1250 ppm cycocel	82.20	4.00	3.33	12.95	22.85	16.83	27.36	44.19	1.61	2.79	4.4	3.62	9.5	5.88	10.30	0.37	0.58
Skipping at milk-ripe stage	Control	93.60	5.17	5.00	13.71	29.35	23.06	34.00	57.06	2.00	3.31	5.31	3.52	8.71	5.19	9.00	0.38	0.60
	20 ppm uniconazole	93.80	5.17	5.00	14.30	31.35	24.59	34.18	58.77	2.23	4.03	6.26	3.54	8.46	4.92	9.54	0.36	0.55
	30 ppm uniconazole	85.60	5.00	4.67	13.30	30.70	21.16	36.59	57.75	1.91	3.07	4.98	3.69	6.39	2.70	9.80	0.38	0.62
	500 ppm cycocel	92.00	6.00	6.00	14.42	35.00	27.35	35.00	62.35	2.45	4.06	6.51	3.87	8.83	4.96	9.62	0.38	0.60
	750 ppm cycocel	104.80	6.50	6.30	14.71	36.18	29.52	37.50	67.02	2.60	4.38	6.98	4.00	9.08	5.08	9.65	0.37	0.58
	1000 ppm cycocel	87.30	4.70	4.30	13.50	28.00	23.40	35.90	59.30	2.35	3.23	5.58	4.17	10.57	6.40	10.05	0.42	0.73
	1250 ppm cycocel	83.00	4.17	3.67	13.10	27.00	19.50	32.47	51.97	1.79	3.05	4.84	3.88	10.33	6.45	10.20	0.37	0.59
L.S.D. at 5 % level		0.98	0.37	0.18	0.14	2.78	0.32	0.16	3.68	0.06	0.11	0.1	0.05	0.19	n.s	0.02	n.s	n.s

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تأثير بعض مثبطات النمو على نمو وإنتاجية القمح تحت ظروف الإجهاد المائي في الأراضي الرملية حديثة الاستزراع

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أجريت تجربتان حقليتان لدراسة تأثير بعض مثبطات النمو على نمو وإنتاجية القمح تحت ظروف الإجهاد المائي في الأراضي الرملية حديثة الاستزراع في منطقة الصالحية الجديدة - محافظة الشرقية. وتتلخص أهم النتائج فيما يلي :

١- أدت معاملات الإجهاد المائي إلى حدوث نقص معنوي في صفات النمو (ارتفاع النبات ، عدد والوزن الجاف لكل من الأشطاء -الأنصال -السنابل ، مساحة ورقة العلم ، مساحة أنصال النبات ودليل مساحة الأوراق) بينما حدث زيادة في الكثافة النوعية للورقة نتيجة للإجهاد المائي. هذا وقد أكدت النتائج أن نبات القمح أكثر حساسية للتعرض للإجهاد المائي خلال مرحلة التفريع ، تلاها مرحلة طرد السنابل بينما كان ضرر الإجهاد المائي على النمو أقل كثيرا عند التعرض للإجهاد المائي في مرحلة طور النضج اللبني للحبوب (عدا الكثافة النوعية للورقة) .

٢- تأثرت صفات النمو بالمعاملة بمثبطات النمو وقد أظهرت النتائج أن الرش بتركيز ٢٠ جزء في المليون من اليونيكونازول أو ٧٥٠ جزء في المليون من السيكوسيل أفضل المعاملات لزيادة صفات النمو لنبات القمح (عدا الكثافة النوعية للورقة) .

٣- حدث تأثير معنوي للإجهاد المائي على المحصول ومكوناته (عدا دليل المحصول ودليل الحصاد لم يكن معنويا عند ٥ %) هذا وقد حدث انخفاض معنوي في المحصول ومكوناته نتيجة الإجهاد المائي ووصل هذا النقص إلى قيمته القصوى عند التعرض للإجهاد المائي في مرحلة التفريع تلاه مرحلة طرد السنابل بينما كان النقص في مرحلة طور النضج اللبني للحبوب أقل قيمة .

٤- أدى الرش بتركيز ٧٥٠ جزء في المليون من السيكوسيل إلى الحصول على أفضل قيم للمحصول ومكوناته عدا الإمكانية التمثيلية الضوئية لمحصول الحبوب التي تم الحصول على أكبر قيمة لها عند الرش بتركيز ١٠٠٠ جزء في المليون من السيكوسيل بينما كانت المعاملة بتركيز ١٢٥٠ جزء في المليون هي الأفضل لكل من النسبة المئوية للبروتين بالحبوب والإمكانية التمثيلية الضوئية لكل من المحصول البيولوجي والنمو الخضري .

أوضحت نتائج تأثير التفاعل بين كل من حدوث إجهاد مائي في مراحل معينة من النمو الخضري والرش بتركيزات مختلفة من مثبطات النمو أن الإجهاد المائي كان أكثر ضررا على النمو والمحصول لنباتات القمح في مرحلة التفريع تلاه الأضرار الناتجة عن الإجهاد المائي في مرحلة طرد السنابل ثم الإجهاد المائي في طور النضج اللبني للحبوب ، كذلك فإن مثبطات النمو تعمل كمنشط نمو في حالة استخدامها في التركيزات المنخفضة منها وتعمل كمثبط نمو عند الرش بتركيزات مرتفعة ، حيث وجد أن الرش بتركيز ٢٠ جزء في المليون يونيكونازول ، أو ٥٠٠ سيكوسيل ، أو ٧٥٠ جزء في المليون سيكوسيل أدى إلى تقليل الأضرار الناتجة من الإجهاد المائي في صفات النمو والمحصول ومكوناته نتيجة الإجهاد المائي.