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Alleviation of water Stress on Wheat by Benzyl adenine

Ahmed, M.A.*, Gehan Sh. Bakhoum , EL-Housini, Ebtesam A. and Elham, A. Badr

Field Crops Research Dept., National Research Center, Dokki, Giza, Egypt.

Abstract : Two field experiments were carried out to study alleviation of skipping an irrigation at certain development stage of growth by foliar spraying with Benzyl adenine(BA).The drought stress was imposed by missing an irrigation at tillering, heading or milk-ripe stage .Benzyl adenine was foliarly sprayed at 0.0,75nd150mg/l. Water stress significantly decreased the growth, the content of chl. a, chl. b and carotenoids per blades, total carbohydrate per dry grains, as well as, yield and its components except crop index and harvest index . The most sensitive growth stage to drought stress of wheat was the tillering stage, followed by heading stage and milk-ripe stage, respectively. On the contrary, drought stress caused significant increment in protein percentages per dry grains and crop index and harvest index compared with normal irrigation. Moreover, foliar application with BA alleviated the adverse effects of water stress on wheat plant, where growth parameters, photosynthetic pigments content per wheat blades, protein%, carbohydrate percentage per dry grains and yield and its components was increased by BA treatment. The effect of BA was more pronounced at 150 mg/l BA. The data were discussed in terms of the interaction between water stress and BA concentrations on wheat plants.
Key Words: Wheat, Water stress , BA.

Introduction

Wheat (*Triticum aestivum L.*) is considered one of the most widely grown crops of high nutritive value in the world .The grains of wheat consisted of high amount of carbohydrate, protein, some minerals and vitamins. Our local production is not sufficient to meet the annual demands. Maximizing our local wheat production is the target to cover the local consumption. This goal could be achieved by growing the highest wheat cultivar productivity especially under water stress conditions and improving the agriculture practices by using plant growth promoters as cytokinins. Cytokinins represent an important group of plant growth regulators that can modulate several biotechnological processes owing their ability to influence almost all plant development and growth stage Pliholova et al[1]. Cytokinine modify morphological and physiological characteristic of plant and may also induce better adaptation of plant to environment which improve the growth and yield. It is the generic name used to designate a plant growth promoters that play a great role in cell division and cell differentiation. The cytokinin involvement on the regulation of many aspects of growth and including cell division, apical dominance nutrient mobilization, photosynthetic pigments development, senescence and flowering is mentioned by Gupta et al [2], Gyu and Woolley[3], Sarwat and EL-Sherif [4], Ibrahm et al [5], Abdel latef et al [6],Bagdi et al[7] and Ramtin et al[8]. Benzyl adenine is one of the cytokinine which regulate different growth processes in plant such as retardation of the leaf senescence, increasing photosynthetic pigments content, improve sink and source capacity of wheat plants, increased grain weight, grain number and partitioning of dry matter between spikes and grains and grain yield Gupta et al[2], Balbaa[9] and Bagdi et al[7]. This work was performed to investigate alleviation of water stress at certain developmental stages of growth on wheat by foliar spraying with Benzyl adenine.

Material and Methods

The present study was carried out during the two successive seasons of 2013/2014and 2014/2015 in old land at private farm in Samadon, Ashmoun Menofeiya Governorate to study growth and yield of wheat as affected by benzyl adenine under water stress conditions at certain developmental stages of growth. Each experiment was laid out in split –plot design with four replication where the main plots included the water stress treatments while the benzyl adenine treatment were distributed in the sub-plots . The experimental unit consisted of 15 rows each of 3.5 meter length and 20cm apart between rows where the size of each plot was 10.5square meter seeded at rate 60 kg/fed. Sowing took place on the first week of December in 2013and 2014 in the two seasons, respectively. The normal agronomic practices of growing Wheat cv. Gemiza-9 cultivar were carried out till harvest as recommended by Wheat Research Dept., A.R.C., Egypt. Each experiment included 12 treatments which were the combination of four water stress treatments and three benzyl adenine treatments .

The factors under study were:

a- Water stress treatments :

1- Normal irrigation where wheat plants were irrigated with two weeks intervals up to ripe stage (140 days from sowing),control treatment .

2-Skipping one irrigation at tillering stage (48 days from sowing).

3-Skipping one irrigation at heading stage (90 days from sowing).

4-Skipping one irrigation at milk- ripe stage (105 days from sowing).

b-Benzyl adenine treatments:

1- Tap water (i.e control treatment)
2- 75 mg/l BA
3- 150mg/l BA

Spraying with BA was twice at 35 and 45 days after sowing, respectively. Samples of ten guarded plants were taken at random from each plot of the four application to measure characters at 110 and 120 days after sowing where plant height, number and dry weight of each one of tillers+ sheats , blades and spikes, 4th leaf blade area , flag leaf blade area and blades area/ plant were determined . Flag leaf blade area , 4th leaf blade area and blades area /plant were determined according to Bremmer and Taha [10] whereas; leaf area index (LAI) was estimated according to Watson[11] At harvest date, a sample random of ten plants were taken from the middle rows of each plot to determine spikes dry weight/plant, grain, straw and biological yield /plant (g).Furthermore, grain straw and biological yield in ton/ fed were determined from the whole area of the experiment unit and then converted into yield ton/fed. Moreover crop index (grain yield/biological yield) and harvest index (grain yield/straw yield)were estimated according to the method described by AbdelGawad et al [12]

Chemical analysis:

1-photosynthetic pigments content:

photosynthetic pigments content per blades of wheat plant(chlorophyll a, chlorophyll b and carotenoids) were determined at 110 and 120 days after sowing using a spectrophotonetic method as recommended by Van Wettestein[13] methods. Photosynthetic pigment contend was calculated as mg/g dry weight of blades.

2- Total carbohydrate :

The total carbohydrate in dry grain were determined according to the method described by Doubois et al [14]

3- Crude protein :

Total nitrogen was determined in dry grains according to A.O.A.C[15] and multiplied by 5.70 to obtain the crude protein percentage content .All data were subjected to statistical analysis according to procedure out lined by Snedecor and Cochran [16] Treatments means were compared by L.S.D test at 5%. Combined analysis was made for the two growing seasons as results followed similar trend.

Table (1): Mechanical and chemical analyses of experimental soil.

Sand%	Clay%	Loamy %	EC ds/m	PH	Total (mg/100g)			Available (ppm)		$CaCO_3$	OM%
					N	NH_4	NO_3	K	P		
21.76	29	44	1.64	7.95	1.00	3.60	5.94	4.09	10.8	3.48	1.77

A-Growth characters:

A-1 Effect of water stress:

Table(2) indicate clearly that skipping single irrigation at tillering , heading and /or milk-ripe stages significantly decreased plant length, number of tillers ,blades and spikes, dry weight of each of tillers + sheats, blades and spikes g/plant,4th leaf blade area, flag leaf blade area, blades area/plant and LAI at 110 and 120 days after sowing . Moreover, plant height , number of tillers/plant , number of blades /plant, dry weight of each of tillers+ sheats, blades "g/plant", blades area/plant and LAI tended to decrease with advancing wheat plant age over 110days after sowing, whereas number of spikes/plant, spikes dry weight /plant ,4th leaf blade area, and flag leaf blade area increased with advancing plant age until 120 days after sowing (Table 2). It is worthy that the negative significant effect in growth characters may be to the loss of truer which effects the rate of cell expansion and ultimate cell size, also, this loss of turger is probably the most sensitive development process to water stress Ahmed et al [17].Thus; a decrement in growth rate, stem elongation and leaf expansion were caused. Moreover, the decrement in cell division and enlargement has been carefully discussed by Kramer and Boyer [18] . Also, water shortage resulted in a significant decrease in number and dry weight of tillers, blades and spikes/plant 4thand flag leaf blade areas, blades area /plant and LAI compared with wheat plants those of adequate water supply treatment (Table2). Thus, results in (Table2) show that water –stressed plants even water regulatory afterward did not recover to their normal to compensate the depressive effect caused by the drought conditions. Results herein are in good agreement with previous results obtained by Kandil et al [19], Ahmed et al [20], El-Afandy[21],Hussein et al [22] and Ahmed et al [23].

The detected data in Table (2)observed that wheat plants appeared to be more sensitive to drought stress during tillering stage followed by heading stage and milk-ripe stage, respectively. Previous obtained results are in harmony with those of Ahmed et al [24] and Shehate et al [25]

In addition irrigation at late jointing is recommended due to its highest effect in tiller survival, thus developmental and physiological processes at late jointing are critical in determining the final grain yield, also, water stress should be avoided at this growth stage. Again the decrement in growth attributes by skipping one irrigation in tillering stage was more pronounced. On the other hand, plants subjected to soil moisture stress in tillering stage, some response might be due to the lack of water absorbed, inadequate uptake of an essential elements which decreased meristentic activity and for inhibition in photosynthetic capacity under such unfavorable conditions El-Afandy[21]and Ahmed et al [17]. Moreover the decrement in the assimilates translocation of the new developing tillers and to the spike primordial were completely enough to develop or mention those organs El-Afandy[21] and Amin [26]

A-2 Benzyl adenine concentrations :

Results reported in Table(2) indicate clearly that benzyl adenine (BA) concentrations affected significantly growth characters of wheat plants at 110 and 120 days after sowing .In addition plant growth attributes were increased with advancing plant age until 110 days after sowing and then declined except each one of number of spikes/plant ,spikes dry weight/plant, as well as, 4thand flag leaf blade area were increased with advancing wheat plant age from 110days until 120 days after sowing, (Table2). Moreover foliar spraying with 75mg/l BA increased significantly all growth parameters at different growth stages in comparison with control treatment. Furthermore the data reported in Table(2) show clearly that increasing BA concentration from 75 mg/l to 150 mg/l gave significant increase of plant height, number of tillers, blades and spikes/plant,4th leaf blade area, flag leaf blade area, blades area/plant and LAI at the different plant growth stages compared with the other two BA treatments .It is worthy that increment in growth characters herein caused by foliar spraying with BA on wheat plants may be due to stimulating dry mass production through enhancement of cell division and chlorophyll accumulation which lead to higher photosynthetic activity and accumulation of dry matter and then caused an increasing in translocation and accumulation of certain microelements in plant organs and in turn on their growth characters El-Abagy et al[27], AbdAlla[28]andSadak et al [29] Thus the increment in plant growth attributes could be due to the role of BA in stimulating xylem differentiation vascular strand development. Consequently, more absorption of water and nutrient from the soil which reflected in more growth. Our results are confirmed with results obtained by Patil et al [30]and Shami et al[31]

A-3: Effect of interaction between water stress and BA. conc.:

The interaction between skipping an irrigation at the three studied plant growth stages in this study and BA concentration caused significant effect on all growth character studied at 110and 120 days after sowing except on number of blades/plant at 120 days after sowing (the effect was not significant).Moreover the normal irrigation treatment (control)harvested the highest significant value of growth characters under treatment with 150 mg/l BA. On the other hand, skipping an irrigation at tillering stage under 0.0BA conc. had the lowest significant values of growth characters . Thus water stress treatment at tillering stage sprayed with tap water (0.0BA) were the more sensitive to water stress conditions, however, wheat plants under normal irrigation and 150 mg/l BA were the more favorable treatment to harvesting more wheat plant growth.

Table(2)Effect of the water stress at certain developmental stages of growth and Benzyl adenine concentration and their interaction on growth characters of wheat plants after 110 days from sowing (Average of 2013/2014and2014/15 seasons).

Treatment	Benzyl adenine mg/l	Plant height (cm)	Number / plant			Dry wt./ g/plant At 110 days after sowing			4^{th} leaf blade area cm^2	Flag leaf blade area cm^2	Blades area cm^2/plant	LAI
			Tillerst sheats	Blades	spikes	Tillerst sneats	Blades	spikes				
No. skipping (control)	Tap water (control)	165.18	5.00	38.37	4.65	11.33	4.17	9.23	35.6	36.44	970.94	6.47
	75 mg/l BA	173.0	5.67	41.97	5.33	12.44	4.74	10.00	41.74	38.48	982.21	6.55
	150mg/l BA	178.82	6.18	45.01	5.92	13.30	5.23	10.86	43.68	40.32	1016.19	6.77
Skipping at tillering stage	Tap water (control)	151.73	4.12	31.42	3.91	٨,٧٠	3.32	8.06	30.35	31.45	857.22	5.71
	75 mg/l BA	157.92	4.30	33.89	4.12	9.52	4.00	8.66	32.34	32.29	890.19	5.93
	150mg/l BA	161.45	4.64	38.45	4.46	9.81	4.34	9.41	34.13	33.18	902.21	6.02
Skipping at heading stage	Tap water (control)	157.43	4.66	34.71	4.30	10.36	3.61	8.56	32.36	39.55	908.90	6.05
	75 mg/l BA	161.32	4.82	36.46	4.46	10.64	4.10	9.22	35.18	34.13	920.43	6.13
	150mg/l BA	164.33	5.17	41.00	4.64	11.38	4.67	9.91	36.54	35.28	945.42	6.30
Skipping at milk-ripe stage	Tap water (control)	160.3	4.81	36.87	4.46	10.67	3.94	9.07	34.13	34.13	935.39	6.24
	75 mg/l BA	165.80	5.15	39.00	4.89	11.53	4.43	9.81	37.59	36.65	945.70	6.30
	150mg/l BA	171.5	5.49	43.16	5.15	12.06	4.94	10.57	38.22	37.54	972.72	6.49
LSD 5%		0.97	0.18	0.77	0.20	0.26	0.11	0.26	0.64	0.54	5.91	0.03
No.skipping (control)		172.33	5.61	41.80	5.29	12.33	4.71	10.03	40.34	38.41	989.78	6.59
Skipping at tillering stage		157.37	4.35	34.6	4.16	9.31	3.89	8.72	32.27	32.31	883.21	5.89
Skipping at heading stage		161.0	4.67	37.39	4.46	10.79	4.13	9.23	34.69	33.99	924.60	6.16
Skipping at milk-ripe stage		165.87	5.15	39.99	4.83	11.42	4.43	9.82	36.65	36.10	951.27	6.34
LSD 5%		1.57	0.22	1.11	1.21	0.76	0.16	0.17	2.35	1.06	6.91	0.06
Tap water (control)		158.63	4.64	35.34	4.33	10.27	3.78	8.74	33.11	33.64	917.87	6.12
75 mg/l BA		164.5	4.96	38.06	4.70	11.01	4.32	9.42	36.71	35.39	934.64	6.23
150 mg/l BA		169.77	5.37	41.90	5.05	11.61	4.80	10.19	38.15	36.58	959.13	6.39
LSD 5%		1.51	0.30	1.29	0.22	0.43	0.18	0.44	1.06	0.89	9.85	0.05

Con., Table(2) Effect of the water stress at certain developmental stages of growth and Benzyl adenine concentration and their interaction on growth characters of wheat plants after 120 days from sowing (Average of 2013/2014and2014/15 seasons).

	Benzyl Adenine mg/l	Plant height (cm)	Number / plant			Dry wt./ g/plant At 120days after sowing			4^{th} leaf blade area cm^2	Flag leaf blade area cm^2	Blades area cm^2/plant	LAI
			Tlerst sheats	Blades	spikes	Tillerst sneats	Blades	spikes				
No. skipping (control)	Tap water (control)	163.95	4.67	36.85	4.67	9.97	3.88	13.75	35.9	39.0	946.3	6.31
	75 mg/l BA	170.0	5.50	37.43	5.17	10.62	4.37	14.34	41.25	40.68	953.75	6.36
	150mg/l BA	177.4	6.00	42.75	6.00	12.08	4.98	15.29	42.0	41.65	978.00	6.52
Skipping at tillering stage	Tap water (control)	148.9	4.00	28.75	4.00	7.63	3.17	9.74	32.5	32.9	837.0	5.58
	75 mg/l BA	152.85	4.17	30.67	4.17	8.29	3.84	10.85	33.0	34.75	866.5	5.78
	150mg/l BA	158.75	4.50	36.44	4.5	9.00	3.99	11.90	35.22	36.24	874.0	5.83
Skipping at heading stage	Tap water (control)	152	4.50	31.85	4.5	8.15	3.41	10.19	34.0	34.0	859.47	5.73
	75 mg/l BA	158.3	4.75	32.67	4.70	9.38	4.00	12.00	35.8	36.75	880.4	5.87
	150mg/l BA	161.75	5.00	37.60	5.00	10.17	4.22	12.35	37.65	39.83	905.0	6.03
Skipping at milk-ripe stage	Tap water (control)	157.6	4.50	35.0	4.5	8.91	3.50	12.34	35.0	37.5	906.0	6.04
	75 mg/l BA	163.0	5.00	36.0	5.00	9.54	4.02	13.97	37.70	38.0	742.0	6.28
	150mg/l BA	169.4	5.50	39.0	5.5	11.00	4.50	15.00	39.00	40.0	963.4	6.42
LSD 5%		6.79	0.36	n. s	0.22	0.64	0.28	1.58	1.61	1.52	19.00	0.11
No.skipping (control)		170.45	6.39	39.01	5.39	10.89	4.41	14.46	39.72	40.48	959.35	6.40
Skipping at tillering stage		153.5	4.27	31.95	4.11	8.31	3.67	10.83	33.71	34.63	835.83	5.57
Skipping at heading stage		157.35	4.67	34.04	4.58	9.23	3.88	11.51	35.82	36.85	881.69	5.88
Skipping at milk-ripe stage		163.33	4.96	36.33	4.97	9.82	4.11	13.77	37.23	38.5	927.13	6.18
LSD 5%		2.25	0.28	1.06	0.23	0.72	0.12	0.59	1.28	1.15	20.15	0.29
Tap water (control)		155.61	4.38	33.11	4.42	8.67	3.41	11.51	34.35	35.88	887.19	5.91
75 mg/l BA		161.04	4.86	33.9	4.72	9.46	4.06	12.79	36.94	37.55	903.16	6.02
150 mg/l BA		166.83	5.25	38.95	5.25	10.56	4.42	13.65	38.47	39.43	930.1	6.20
LSD 5%		4.38	0.23	n. s	0.14	0.41	0.18	1.02	1.04	0.98	12.25	0.07

Table(3):Effect of water stress at certain developmental stage and BA concentrations on photosynthetic pigments content and wheat blades and crude protein %per grains after 120 days from sowing (Average of 2013 -2014 and 2014 - 2015 seasons)

Treatment	Benzyl adenine mg/L	Photosynthetic pigment content mg/g dry Wt.						Crude protein	Total carbohydrate
		110 days age			120 days				
		Chl.a	Chl.b	Carotenoids	Chl.a	Chl.b	Carotenoids	%	%
Control	**Tap water**	45.79	1.24	1.66	2.51	1.13	1.45	11.36	81.70
No skipping	**75 mg/L**	47.90	1.37	1.84	2.62	1.28	1.62	11.48	81.85
	150 mg/L	43.08	1.55	1.90	2.74	1.44	1.67	11.52	82.08
Skipping at tillering stage	**Tap water**	37.22	1.06	1.35	2.17	0.90	1.13	11.58	81.39
	75 mg/L	40.39	1.13	1.49	2.22	0.94	1.22	11.62	81.68
	150 mg/L	41.38	1.18	1.54	2.31	0.96	1.29	11.63	81.91
Skipping at heading stage	**Tap water**	39.51	1.12	1.41	2.23	0.98	1.20	11.89	81.46
	75 mg/L	42.67	1.17	1.56	2.31	1.04	1.31	11.89	81.71
	150 mg/L	44.76	1.28	1.63	2.45	1.07	1.37	11.91	81.98
Skipping at milk-ripe stage	**Tap water**	42.11	1.19	1.52	2.36	1.05	1.62	12.00	81.59
	75 mg/L	44.50	1.26	1.61	2.47	1.17	1.39	12.05	81.79
	150mg/L	2.88	1.44	1.80	2.64	1.19	1.52	12.14	82.01
L.S.D at 5%level		**0.09**	**0.09**	**0.19**	**0.14**	**0.05**	**0.12**	**0.06**	**0.17**
Control (No.skipping)		2.93	1.39	1.80	2.62	1.28	1.58	11.45	81.88
Skipping at tillering stage		2.32	1.12	1.46	2.23	0.93	1.21	11.48	81.66
Skipping at heading stage		2.42	1.19	1.53	2.33	1.03	1.29	11.88	81.72
Skipping at milk-ripe stage		2.72	1.30	1.64	2.49	1.14	1.39	12.06	81.79
L.S.D at 5%level		**0.09**	**0.06**	**0.05**	**0.10**	**0.08**	**0.03**	**0.02**	**0.02**
Tap water		2.41	1.15	1.49	2.32	1.02	1.26	11.62	81.54
75 mg/L		2.69	1.23	1.63	2.41	1.08	1.39	11.74	81.76
150 mg/L		2.76	1.36	1.71	2.54	1.17	1,46	11.80	82.00
L.S.D at 5%level		0.06	0.05	0.12	0.09	0.03	0.08	0.04	0.11

B-Photosynthetic pigments content : wheat blades :

B-1 Effect of water stress :

The effect of skipping an irrigation on wheat plants cv. Gemiza-9 of photosynthetic pigment content (i.e. Chl. a ; Chl. b and carotenoids) are illustrated in Table (3). Date in this table observed that water stress induced by missing an irrigation at certain development growth stage (i.e. tillering, heading and milk-ripe stage) decreased Chl. a ; Chl. b and carotenoids , in addition , the effect was more pronounced when water stress imposed at tillering stage. Again, the reduction in the photosynthetic pigments under water stress ; in this study ; was in the 2nd order when water stress caused in heading stage , whereas, the decrement was in the 3nd order under milk-ripe stage . Decrement in photo synthetic pigment content by water stress condition is confirmed with the result of Abdalla et al [32] and Ali et al [33]. It is worthy that Chl. a, Chl. b and carotenoids tended to decreased with advancing wheat plant age from 110 to 120 days after sowing , Tabel (3). Moreover, Chl. a and Chl. b play an important role in photochemical reactions Our present study showed that drought stress significantly reduced the blade Chl. a, Chl. b and carotenoids content. The decrement in chlorophyll a and b and carotenoids under drought stress is take place in order to of its photo-oxidation and degradation under drought and this may be due to the increased activity of chlorophyllase enzymes.

B-2 Effect of benzyl adenine concentration :

Data illustrated in Table (3) indicate that the effect of concentrations of BA on photosynthetic pigments content of wheat blade was significant at 110 and 120 days after sowing , in addition , the content of Chl. a, Chl. b and carotenoids decreased with advancing wheat plant age from 110 to 120 days after sowing. Moreover, folia spraying with 75 mgll BA significantly exceeded the control treatment in the content of Chl. a, Chl. b and carotenoids per wheat blader, On the other hand, increasing, AB concentration from 75 to 150 mgll BA caused another significant increase in photosynthetic pigments content per wheat blades compared with control and 75 mgll BA concentrations, respectively . The positive significant effect of foliar application with BA on photosynthetic pigments content maybe due that BA can modulate several biotechnological processes owing their ability to influence almost all plant development and growth stage Pliholova et al[1] . It is play a great role in cell division and cell differentiation , senescence , photosynthetic pigments development Gupta et al [2], Bagdi et al [7] and Ramtin et al[8]. It is worth to mention , that the results of the current study are in agreement with those obtained by Sarwat and EL-Sherif [4], Ibrahm et al [5] and Balbaa[9]

B-3 Effect of interaction between water stress and BA concentration :

Results detected in Table (3) show clearly that the effects of the interaction between skipping an irrigation at certain development stages and foliar spraying with different BA concentration on Chl. a, Chl. b and careteniods content per wheat blades at 110 and 120 days age were significant. Furthermore, the normal irrigation treatment (i.e. without missing an irrigation), had the greatest significant value from photosynthetic pigment content under foliar spraying with 150 mg ll BA , whereas, missing one irrigation at tillering stage under foliar application with tap water (O. o BA) gave the lowest values from photosynthetic pigments content and this was true at 110 and 120 days after sowing .

C - Crude protein and Total Carbohydrate percentage per grains :

C-1 Effect of water stress :

The effect of drought stress by missing one irrigation from wheat plants cv.Gemiza-9 cultivar on total carbohydrate % and protein % were report in Table (3). Date reported that water stress by skipping an irrigation caused significant increment in crude protein per dry grains, whereas caused significant decrement in total carbohydrate per grains at harvest date . The most sensitive growth stage of wheat to water stress was tillering stage. In addition, the decrement in carbohydrate% per dry grain may be due to that water stress leads to several problems such as decreased water flux, closing of stomata and production in photosynthetic CO_2 fixation and decrease in photosynthetic. whereas, the protein % was increased. It is worthy that our results in agreement with those obtained by Ahmed et al [20], EL-Afandy[21]and Malik and Ashraf [34]

C-2 Effect of BA concentration :

Table (3) show clearly that the effect of foliar spraying with different concentration of BA was significant on crude protein and total carbohydrate percentages at harvest date. In addition , foliar application with 75 mg ll BA significantly protein % and total carbohydrate % compared with control plants, also, increasing BA rates from 75 to 150 mg caused another increase in these two chemical constituents per grains compared with control and 75 mg ll respectively. The positive effect of spraying with BA maybe due to that BA can modulate several biotechnological processes owing their ability to influence almost all plant development and growth stagesPliholova[1]. BA play a great role in cell division and cell differentiation, senescence, photosynthetic pigment Sarwat and EL-Sherif[4], Abbaspour and Rezaei [35] and Ramtin et al[8]. It is worthy that increment protein content by BA treatment and this may also increase the formation of rouf endoplasmic reticulum that provides the appropriate medium for increasing polyribosome's and m RNR. There, BA enhanced the accumulation of total N and protein Toiz and Zeiger[36]. Furthermore, BA promoted RNA and protein synthetic thus, spraying wheat plants with BA induced a considerable increase in soluble and total protein contents Hasnaa and Gamal El Din [37]and Ali and Ashraf [33]

C-3 Effect of the interaction between water stress and BA concentration :

The effect of the interaction between water stress and benzyle addenin concentrations on crude protein and total carbohydrate concentrations per dry grains was significant (Table 3). In addition, the best favorable treatment to increase protein % per grains was skipping an irrigation at milk-ripe stage under foliar spraying with 150 mg ll BA , whereas the more effective treatment to overcome great total carbohydrate % value per dry grain was normal irrigation (without missing one irrigation) under foliar application with 150 mg ll BA , also.

Table (4): Effect of water stress at certain development stage of growth and benzyl adenine concentration and their interaction on wheat yield (Average of 2013/2014 and 2014/15 season)

Water stress treatment	Benzyl adenine (mg/l)	Spikes dry wt. (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)	Crop index(%)	Harvest index(%)
Control No skipping	**Tap water**	45.79	37.38	45.69	73.27	2.93	3.38	6.32	0.46	0.87
	75 mg/L	47.90	38.85	47.83	86.68	3.02	3.51	6.54	0.46	0.86
	150 mg/L	43.08	39.80	50.20	90.00	3.39	3.59	6.98	0.49	0.94
Skipping at tillering stage	**Tap water**	37.22	31.76	37.09	90.00	3.39	3.59	6.98	0.50	0.98
	75 mg/L	40.39	33.13	39.23	72.36	2.82	2.95	5.77	0.49	0.96
	150 mg/L	41.38	35.12	41.22	76.32	2.90	3.14	6.04	0.48	0.92
Skipping at heading stage	**Tap water**	39.51	33.97	39.33	73.30	2.78	3.03	5.01	0.48	0.92
	75 mg/L	42.67	36.01	42.49	78.50	2.87	3.22	6.09	0.47	0.89
	150 mg/L	44.76	37.38	44.60	81.98	3.09	3.36	6.45	0.48	0.92
Skipping at milk-ripe stage	**Tap water**	42.11	36.54	41.93	78.47	2.85	3.28	6.13	0.46	0.87
	75 mg/L	44.50	37.49	44.35	81.84	3.00	3.27	6.37	0.47	0.92
	150 mg/L	48.04	38.69	46.54	85.23	3.14	3.48	6.62	0.47	0.90
L.S.D at 5% level		0.55	0.29	0.64	1.30	0.05	0.06	0.09	0.02	0.03
Control (No.skipping)		47.97	38.82	47.90	86.72	3.04	3.50	6.54	0.46	0.87
Skipping at tillering stage		39.32	33.33	39.18	72.51	2.83	2.97	5.80	0.49	0.95
Skipping at heading stage		42.31	35.78	42.43	78.21	2.89	3.20	6.09	0.47	0.90
Skipping at milk-ripe stage		45.73	37.54	44.27	81.81	3.00	3.38	6.38	0.47	0.89
L.S.D at 5% level		1.30	1.07	1.19	1.55	0.02	0.05	0.11	0.01	0.04
Tap water		40.76	35.02	41.00	76.02	2.83	3.13	5.96	0.47	0.90
75 mg/L		43.63	36.38	43.48	79.86	2.94	3.27	6.21	0.47	0.90
150 mg/L		45.76	37.75	45.65	83.40	3.06	3.40	6.46	0.47	
L.S.D at 5% level		0.92	0.48	1.07	2.17	0.08	0.10	0.15	n.s	n.s

D - Yield and its components :

D - 1 : Effect of water stress :

Drought stress imposed by skipping one irrigation either at tillerging , heading or milk-ripe stage significantly decreased yield and its components tested in the current study (i.e spike dry weight g\ plant ; as well as ; grain ; straw and biological yields (g\plant and ton\fed) (Table 4). The negative effect on yield and its components was more pronounced at tillering stage followed by heading stage and milk-ripe stage in the end of least. On the other hand, the effect on crop index and harvest index were significant, but water stress at tillering stage had the highest significant values from crop index and harvest index (Table 4) .

It is worthy that yield reduction caused by drought stress might be due the decrement in growth charades and photosynthetic pigment content also, (Table 2 and Table 3). Decrement in yield and its components might be attributed to the water stress effects on chlorophyll synthesis, hormonal decrease and turgot loss , mean while, regular irrigation after water stress imposition did no recover the water stress adverse effects on yield reductionAhmed [et al 24]. Also, retardation of photosynthetic enzymes under water stress might cause such effect , again , since tillering stage was affected by water stress, it is suggest that water deficit induced per probation of physiological process at late jointing critical to yield production, therefore, water deficit should be avoided at this growth stage EL-Afandy[21] and Ahmed et al[24] .In the line with the results of this current study Kandil et al[19], Samia et al [38]and Ahmed et al[24] reported that drought stress decreased yield and its components of wheat plant and in full agreement with our obtained results .

D - 2 : Effect of BA concentrations :

Data illustrated in Table (4) show clearly that foliar spraying with different concentrations of BA on wheat plants caused significant effects on spikes dry weight g\plant, grain, straw and biological yields g\plant , as well as , grain , straw and biological yields (ton\fed) .On the other hand, the effect on crop index and harvest index was not significant . Moreover , from that data of the same table (i.e Table 4); foliar spraying with 75 mg ll BA increased significantly spikes dry weight g\plant , grain ; straw and biological yields per plant and \ or per fed., compared with control treatment , whereas , increasing BA concentration from 75 to 150 mg ll caused additional signification treatment in the previous yield components reported. On the other hand, crop ibex and harvest index did not affect by BA treatments. The positive effect of BA treatments on wheat plants for yield and its components might be partially attributed to the its positive effect on growth characters and photosynthetic pigments content (Tables 2 and 3). Furthermore, to the stimulating dry mass production through enhancement of cell division and chlorophyll accumulation which lead to greatest photosynthetic activity and accumulation of dry matter and then caused an increment in translation and accumulation of certain microelement in plant organs and in turn on their growth characters and yield Amin[26],Sadak et al [29] and Kang et al [39] Generally, the increase in growth parameters and consequently yield and its attributes might be par dilly attributed to the role of BA on stimulating ylem differentiation vascular strand development; consequentially more absorption of water and nutrient from the soil which reflected in more growth and then more yield and its components .

It is mole worthy to mention that results herein are in full agreement with previous results reported by Abdalla [et al 32],Patil et al[30],Ali and Ashraf [33] ,Mervat et al [40], Marwa et al [41],Moha et al [42]and Mohamed et al. [43]

D - 3 : Effect of the interaction between water stress and BA :

The effect off the interaction between water stress at certain development stage of growth and benzyl adenine concentrations on wheat yield was significant (Table 4). The most favorable treatment to harvested great significant values from yield and its components was normal irrigation (Without skipping an irrigation) and foliar spraying with 150 mg ll BA, whereas, the lowest yield and its components produced under skipping one irrigation at tillering stage and foliar application with tap water .

In conclusion, foliar spraying of BA alleviated the water stress harmful effects on growth and yield of wheat plants, BA at 150 mg ll was more effective in counteracting the water stress induced adverse effects. In addition, wheat plants was more sensitive to water stress at tillering stage compared with heading and milk-ripe growth stage .

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