

Response of Some White Maize Hybrids to Foliar Spray with Benzyl Adenine

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Abstract: Two field experiments were carried out at the experimental station of the National Research Centre at Shalakan Kalubia Governorate during the two successive seasons of 2005 and 2006 to study the response of some white maize hybrids to foliar spray with benzyl adenine. The results showed that there were significant differences between maize hybrids (S.C. 10, S.C. 123, S.C. 124, T.W. 310, T.W. 321, T.W. 322, T.W. 323 and T.W. 324) in growth characters at different stages of growth as well as photosynthetic pigments in the blades at 60, 75 and 90 days from sowing (except chl. b at 60 and 75 days from sowing). In addition, there were significant differences between maize hybrids in yield and its components (except number of rows / ear and harvest index). Foliar application of benzyl adenine (50 and 100 mg/l) caused significant increase in growth characters and photosynthetic pigments in blades at different stages of growth. Increasing concentration of benzyl adenine from 50 to 100 mg/l accompanied with significant increase in yield and its components (except number of rows / ear and harvest index). Interaction between maize hybrids and benzyl adenine concentrations caused significant increase in plant height at silky and milky ripe stages, stem diameter at milky and ripe stages, 4th leaf area at silky and milky stages, dry weight / plant at silky and milky stages, chl. a and b at milky stages, total carotenoids at milky and ripe stages, as well as, 100 grain weight and grain yield / plant at harvest. The response of maize hybrids was raising under higher concentration of benzyl adenine (100 mg / l) than the lower ones (50 mg / l) especially S.C. 10 for the highest grain index (100-grain weight) and grain yield / plant over the other maize hybrids or untreated plants.

Keywords: benzyl adenine, white maize hybrids, growth, yield and biochemical constituents.

INTRODUCTION

Maize plant is considered as one of the most important cereal crops used in human consumption, animal feeding, starch industry and oil production. Therefore, continuous attempts were carried out for increasing its productivity to face urgent demands of increasing population especially in Egypt through the last period. This can be obtained through breeding programs to produce highly productive and qualitative gene forms as well as adjusting the growth regulators in respect to arrive to that strategy. Applying growth regulators may especially cytokinin modify morphological and physiological characteristic of plant and may also induce better adaptation of plant to environment which improve the growth and yield. Cytokinin is the generic name used to designate a plant growth substance that plays a major role in cell division and cell differentiation. Such compounds induce cell division and organogenesis in plant cell cultures and affect many other physiological and developmental processes in plants^[1,3]. The involvement of cytokinin in the regulation of many aspects of

growth and including cell division, apical dominance, nutrient mobilization, chloroplast development, senescence and flowering is well documented was mentioned by Virendranath and Srivastava^[4], Farahat *et al.*,^[5], Gupta *et al.*,^[6] and Gyu and Woolley^[7]. Benzyl adenine is one of the cytokinins which regulates various growth processes in plant and to improve yield and chemical constituents of many crops^[8,11].

Retardation of the leaf senescence for maize plants and increasing the photosynthetic pigments in response to different benzyl adenine treatment were reported by Rani *et al.*,^[12], Ibrahim *et al.*,^[13] and Abo-Alla^[14]. Benzyl adenine increased grain weight, grain number and partitioning of dry matter between ear and seed, grain yield, crop weight, mobilization index and crop index^[15,17].

Also, Shehata *et al.*,^[18], Amin^[19], Gad^[20] and Shani *et al.*,^[21] indicated that benzyl adenine was used to improve sink and source capacity of wheat plants to increase grain yield, this plant growth regulators are effective in very small amount that fact as signaling to stimulate growth or regulate some development program.

This work was performed to study the physiological response of eight maize hybrids to different level of benzyl adenine aiming to enhance growth, photosynthetic activity and productivity of plant.

MATERIALS AND METHODS

Two filed experiments were carried out in the agricultural experimental station of national research centre at Shalakan, Kalubia Governorate during the two successive seasons of 2005 and 2006 to study the response of some maize hybrids to benzyl adenine concentrations. Each experimental included 24 treatments which were the combinations of eight white maize hybrids (i.e., three single crosses, S.C. 10, S.C. 123 and S.C. 124, the five three way hybrids T.W. 310, T.W. 321, T.W. 322, T.W. 323 and T.W. 324) and three concentrations of benzyl adenine (0, 50 and 100 mg/l). The experiments were laid in a split-plot design with six replications, where, white maize hybrids occupied the main plots and benzyl adenine treatments were allocated at random in sub-plots. The experimental unit consisted of seven ridges 5 meters in length and 60 cm width ($21 \text{ m}^2 = 1 / 200 \text{ feddan}$). Grains of white maize hybrids were sown on the first and the second weeks of June in both seasons respectively, in hills spaced 25 cm along, three kernels per hill. Thinning to one plant per hill was done at 21 days after planting. Nitrogen fertilizer as ammonium nitrate (33.5 % N) was applied at the rate of 120 kg N / fed. in two equal doses, before the first and the second irrigation (21 and 35 days after planting). Irrigation, pest control and other cultural practices were carried out as recommended. The plants were sprayed two times during the elongation stage (30 and 45 days from sowing). Photosynthetic pigments content of leaves were determined Saric *et al.*,^[22], at 60, 75 and 90 days of plant age.

The following growth attributes were recorded on three samples of five guarded plants, each was taken randomly at silky stage (60 days from sowing), milky ripe stage (75 days from sowing) and ripe stage (90 days from sowing) i.e. plant height (cm), stem diameter (cm), number of blades / plant, total dry weight / plant (g). Flag leaf area (cm^2), 4th leaf area / plant (cm^2) were calculated according to Bremner and Taha^[23], meanwhile, leaf area index (LAI) cm^2 according to Watson^[24]. Specific leaf weight (SLW) (mg / cm^2) calculated according to Pearce *et al.*,^[25], whereas crop growth rate (CGR) ($\text{mg} / \text{cm}^2 / \text{day}$) according to Abd El-Gawad *et al.*^[26].

At harvest ten guarded plants were taken out at random from the middle two ridges of each plot to determine ear diameter (cm), ear length (cm), number of rows / ear, number of grains / row, grain index (g)

(100-grain weight), grain yield (g) / plant, harvest index and shelling percentage. In addition, grain yield (ton / fed.) was determined from the other three middle rows of each plot. Crude protein and oil percentage were determined to the method described in A.O.A.C.^[27]. Total carbohydrates were also determined according to Dubois *et al.*^[28].

Statistical analysis was performed according to Snedecor and Cochran^[29]. Treatment means were compared by L.S.D test. Combined analysis was made for the two growing seasons as results followed similar trend.

RESULTS AND DISCUSSIONS

Growth Characters:

Hybrids Differences: Data presented in Table (1), show that there were significant differences between maize hybrids in growth characters, i.e. plant height, number of blades / plant, stem diameter, dry weight / plant, flag leaf area, 4th leaf area, leaf area index, specific leaf weight and crop growth rate at the different stages of growth. However, single cross (S.C. 10) exceeded significantly other maize hybrids i.e., S.C. 123, S.C. 124, T.W. 310T.W. 321, T.W. 322, T.W. 323, and T.W. 324 in plant height, number of leaves / plant, LAI and SLW at the three physiological stages. Also, S.C. 123 hybrid surpassed the seven hybrids in crop growth rate at 60, 75 and 90 days after sowing.

Furthermore, plant height, stem diameter, dry weight / plant and crop growth rate under study tended to increase with advance of plant age up to 90 days after sowing, while each of flag leaf area, 4th leaf area, LAI and SLW were increased up to 75 days after sowing and then decreased with advancing age. It is noteworthy to mention that hybrid differences in growth parameters are in a harmony with the results obtained by Salama *et al.*^[30], Sadek *et al.*^[31], Clark *et al.*^[32], Zaki *et al.*^[33] and Sadek *et al.*^[34,35].

In addition, varietal differences in growth parameters in this study may be due to the differences in genetic structure and to the varietal differences in photosynthates partitioning^[36]. On the other hand, the in constant line of maize hybrids in dry weight / plant, SLW in their variation with advancing plant age could be attributed to the hybrid differences in migration of dry matter from vegetative organs to ears and also to hybrids differences in photosynthates partitioning^[31,34,37].

Effect of Benzyl Adenine Concentrations: The results presented in Table (1) indicated that foliar application with benzyl adenine treatment caused significant increases in growth characters at all growth stages. It is worthy to mention that foliar application with 50

Table 1: Effect of varietal differences and benzyladenine concentrations on growth characters of maize at the different stages of growth. (Combined analysis of 2005 and 2006 seasons).

(Controlled analysis of 2005 and 2006 seasons).																
Growth characters		Plant height (cm)			Number of blades/plant			Stem diameter (cm)			Flag leaf area (cm2)			4th leaf area (cm2)		
		A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Hybrids	S.C. 10	185.19	278.47	300.89	17.66	16.80	15.90	1.86	2.28	2.50	139.55	179.09	160.29	372.47	529.28	486.43
	S.C. 123	176.71	266.13	285.03	16.90	16.22	15.50	1.67	2.02	2.38	134.23	169.44	152.65	352.88	494.54	472.65
	S.C. 124	174.01	262.94	277.76	16.71	16.46	15.34	1.59	1.96	2.34	132.12	166.01	150.80	339.11	489.34	466.02
	T.W. 310	181.46	273.27	296.13	17.60	16.61	15.96	1.79	2.20	2.43	135.42	171.25	156.15	345.38	469.11	390.84
	T.W. 321	165.09	267.77	281.02	15.40	14.36	13.67	1.60	1.89	2.26	133.52	164.16	146.57	335.46	392.56	376.77
	T.W. 322	170.36	258.47	285.39	15.16	15.42	14.51	1.68	2.08	2.37	132.68	162.70	147.38	337.41	429.60	396.47
	T.W. 323	168.90	263.80	279.89	14.68	13.30	13.09	1.56	1.84	2.11	130.90	158.39	143.55	333.66	440.72	409.45
	T.W. 324	172.94	266.14	285.71	15.14	14.56	14.26	1.70	2.01	2.21	131.69	160.77	144.70	327.56	389.81	368.33
L.S.D. at 5 %		4.11	3.16	5.28	0.74	0.89	n.s	0.04	0.03	0.05	2.88	3.59	2.69	2.65	7.53	13.45
BA (mg/L)	0.0	166.38	255.08	278.30	15.01	14.69	13.66	1.54	1.86	2.22	132.05	159.33	147.23	329.40	447.52	416.56
	50	174.09	268.44	287.08	16.79	16.40	15.19	1.69	2.26	2.39	134.21	163.29	150.09	341.61	451.22	429.92
	100	184.26	277.80	294.24	17.68	16.24	15.33	2.12	2.35	2.50	137.01	177.80	155.16	357.33	516.09	466.60
L.S.D. at 5 %		3.06	2.48	4.55	0.44	0.78	n.s	0.03	0.05	0.10	4.57	2.52	1.28	2.65	3.01	4.11
Growth characters		Leaf area index (LAI)			Dry weight (g)/plant			Specific leaf weight (SLW) (mg/cm2)			Crop growth rate (CGR) (mg/cm2/day)					
		A	B	C	A	B	C	A	B	C	A-B	B-C				
Hybrids	S.C. 10	4.84	5.33	4.70	228.42	295.17	385.09	7.89	8.49	8.01	5.67	6.77				
	S.C. 123	3.66	4.47	4.15	218.54	280.96	378.87	6.84	7.59	7.33	5.27	6.73				
	S.C. 124	3.59	4.38	4.29	216.73	277.43	376.90	6.79	7.50	7.21	4.79	6.70				
	T.W. 310	4.75	5.21	4.51	224.21	289.77	380.62	7.63	8.39	7.44	5.80	6.51				
	T.W. 321	3.77	4.39	4.11	212.48	276.61	378.01	6.34	5.90	4.58	4.58	6.66				
	T.W. 322	2.96	4.09	3.88	220.43	274.78	374.12	6.90	7.79	7.50	4.41	5.72				
	T.W. 323	3.59	4.44	3.46	213.32	272.49	376.47	6.86	7.76	7.21	4.59	5.69				
	T.W. 324	2.89	3.90	3.69	210.91	270.93	370.60	6.29	5.82	5.44	5.70	5.76				
L.S.D. at 5 %		0.18	0.15	0.20	2.29	3.41	1.83	0.21	0.46	0.34	0.36	0.33				
BA (mg/L)	0	3.98	4.09	3.76	211.78	268.59	349.33	6.56	6.89	6.34	4.76	6.39				
	50	4.76	4.86	4.04	218.56	276.49	367.50	6.86	7.35	6.69	5.29	6.62				
	100	5.39	5.49	4.59	229.08	295.01	381.66	7.29	7.78	7.09	5.31	6.70				
L.S.D. at 5 %		0.56	0.66	0.21	5.09	3.89	3.73	0.54	0.37	0.22	0.14	0.10				

A: silky stage
 B: milky ripe stage
 C: ripe stage

and 100 mg/l benzyl adenine generally caused significant stimulatory effect on plant height, number of blades / plant, stem diameter, dry weight / plant, flag leaf area, 4th leaf area, leaf area index, specific leaf weight and crop growth rate at 60, 75 and 90 days after sowing compared with control treatment. The higher concentration (100 mg / l) of benzyl adenine gave the highest values characteristics of growth at the

different stages of growth in compared with the lower ones (50 mg / l) or untreated plants.

The increase in these growth characters by benzyl adenine treatment could be due to stimulating dry mass production through enhancement of cell division and chlorophyll accumulation which leads to higher photosynthetic activity and accumulation of dry matter and in turn reflected on the increasing in

Table 2: Effect of varietal differences and benzyladenine concentrations on pigments content of the blades (mg/g) of maize at the different stages of growth. (Combined analysis of 2005 and 2006 seasons)

Growth characters		Chl a			Chl b			Total carotenoids		
		A	B	C	A	B	C	A	B	C
Hybrids	S.C. 10	0.64	0.79	0.82	0.29	0.37	0.39	0.49	0.54	0.57
	S.C. 123	0.57	0.77	0.79	0.26	0.34	0.36	0.44	0.50	0.51
	S.C. 124	0.59	0.75	0.78	0.24	0.32	0.34	0.42	0.48	0.51
	T.W. 310	0.62	0.78	0.80	0.28	0.35	0.38	0.45	0.52	0.56
	T.W. 321	0.57	0.75	0.79	0.23	0.29	0.32	0.40	0.50	0.55
	T.W. 322	0.56	0.74	0.76	0.22	0.27	0.31	0.38	0.46	0.50
	T.W. 323	0.58	0.76	0.78	0.24	0.30	0.33	0.39	0.49	0.53
	T.W. 324	0.51	0.70	0.75	0.21	0.29	0.33	0.36	0.51	0.55
L.S.D. at 5 %		0.02	0.04	0.03	n.s	n.s	0.02	0.03	0.05	0.02
BA (mg/L)	0	0.54	0.69	0.77	0.22	0.27	0.32	0.39	0.46	0.49
	50	0.29	0.78	0.80	0.26	0.32	0.35	0.42	0.51	0.54
	100	0.64	0.80	0.82	0.29	0.36	0.39	0.48	0.53	0.58
L.S.D. at 5 %		0.04	0.05	0.04	0.02	0.03	0.03	0.04	0.04	0.03

Table 3: Effect of interaction between hybrids and benzyladenine treatments on growth characters of eight maize hybrids. (Combined analysis of 2005 and 2006 seasons).

BA mg/l	Hybrids	Plant height (cm)		Stem diameter (cm)		4th leaf area (cm ²)		Plant dry weight (g)		Chl a (mg/g)	Chl b (mg/g)	Total carotenoids (mg/g)	
		silky stage	milky ripe stage	silky stage	milky ripe stage	silky stages	milky ripe stage	silky stage	milky ripe stage	milky ripe stage	milky ripe stages	milky ripe stage	milky ripe stage
0.0 mg/L	S.C. 10	181.20	271.50	1.91	2.41	370.18	491.51	220.43	281.31	0.80	0.29	0.51	0.54
	S.C. 123	170.28	262.09	1.86	2.18	350.90	480.42	212.53	271.24	0.72	0.27	0.49	0.52
	S.C. 124	169.55	259.96	1.85	2.23	325.93	474.33	199.26	269.33	0.70	0.26	0.47	0.50
	T.W. 310	179.71	269.78	1.87	2.31	336.48	489.60	216.71	279.26	0.79	0.28	0.50	0.53
	T.W. 321	168.15	258.16	1.78	2.20	331.99	447.51	203.38	274.71	0.69	0.24	0.44	0.49
	T.W. 322	163.54	256.65	1.76	2.18	333.89	439.67	211.89	276.26	0.66	0.26	0.46	0.50
	T.W. 323	166.56	259.33	1.85	2.11	328.95	441.79	208.60	277.39	0.64	0.25	0.47	0.51
	T.W. 324	164.41	251.09	1.75	2.15	323.26	431.38	198.41	272.18	0.59	0.23	0.43	0.49
50 mg/L	S.C. 10	186.36	278.59	2.41	2.48	372.55	508.09	229.24	286.72	0.83	0.33	0.54	0.57
	S.C. 123	175.59	266.36	2.34	2.37	352.20	487.37	218.23	280.63	0.78	0.30	0.52	0.55
	S.C. 124	173.32	264.24	2.28	2.41	337.01	472.16	216.84	279.54	0.77	0.29	0.50	0.53
	T.W. 310	183.50	274.89	2.39	2.44	347.50	491.25	221.65	284.45	0.81	0.31	0.53	0.56
	T.W. 321	173.03	262.69	2.36	2.40	334.26	459.34	216.46	279.36	0.75	0.28	0.48	0.52
	T.W. 322	169.95	259.70	2.38	2.38	336.22	449.44	220.27	280.27	0.73	0.30	0.49	0.51
	T.W. 323	170.72	260.42	2.32	2.35	332.07	443.53	219.08	282.18	0.71	0.29	0.50	0.54
	T.W. 324	167.67	259.15	2.34	2.39	326.64	439.36	209.94	277.93	0.68	0.28	0.47	0.51
100 mg/L	S.C. 10	189.50	287.55	2.44	2.60	374.67	524.17	233.80	294.80	0.87	0.39	0.57	0.61
	S.C. 123	180.96	277.39	2.41	2.48	355.55	496.38	229.71	288.71	0.84	0.35	0.55	0.57
	S.C. 124	179.32	274.26	2.39	2.50	346.20	486.29	226.62	284.66	0.82	0.33	0.52	0.55
	T.W. 310	187.92	285.68	2.42	2.55	352.17	501.20	230.53	291.53	0.85	0.36	0.56	0.59
	T.W. 321	179.40	270.44	2.41	2.54	340.13	466.27	218.44	286.44	0.81	0.33	0.50	0.53
	T.W. 322	178.86	266.61	2.40	2.51	342.10	456.32	227.35	283.35	0.80	0.34	0.51	0.54
	T.W. 323	177.40	271.37	2.38	2.49	339.96	450.80	225.62	285.62	0.79	0.35	0.54	0.57
	T.W. 324	176.64	268.61	2.41	2.50	331.09	444.56	220.71	281.71	0.77	0.32	0.52	0.55
L.S.D. at 5%		2.33	4.56	0.03	0.06	4.23	6.89	3.44	3.66	0.04	0.02	0.03	0.02

translocation and accumulation of certain microelements in plant organs and this in turn on their growth characters^[15,4, 11,14]. In this respect, Vijay and Laxmi^[10] explained the increment in plant weight could be through the role of benzyl adenine in stimulating xylem differentiation vascular strand development, consequently more absorption of water and nutrient from the soil which reflected in more growth. Similar results were obtained by Patil *et al.*,^[2] Amin^[19] and Shani *et al.*^[21].

Photosynthetic Pigments Content:

Hybrids Differences: Data recorded in Table (2) shows clearly that maize hybrids i.e., S.C. 10, S.C. 123, S.C. 124, T.W. 310, T.W. 321, T.W. 322, T.W. 323 and T.W. 324. significantly differed in chlorophyll a,b and total carotenoids at 60, 75 and 90days after sowing (except chlorophyll b at 60 and 75 days after sowing). Furthermore, T. W. 310 surpassed significantly the other seven hybrids in chlorophyll a at 60, 75 and 90 days after sowing, while S.C. 10 gave the highest mean values from chl. b at 90 days from sowing and total carotenoids at 60, 75 and 90 days after sowing. Moreover, each chlorophyll a, b and total carotenoids were increased with plant age up to 90 days after sowing.

Effect of Benzyl Adenine Concentration: Results listed in Table (2) indicated that foliar application with benzyl adenine treatment caused significant increase in the contents of chlorophyll a, b and total carotenoids at the different stage of growth. Concerning the effect of the relatively high concentration of benzyl adenine 100 mg/l caused significant increment in chlorophyll a, b and total carotenoids at 60, 75 and 90 days after sowing in comparison with control treatment. In this respect, Raafat and Herwing^[38], Rabie^[39], Rani *et al.*^[12], Patil *et al.*^[2], El-Abagy *et al.*^[11] and Gad^[20] found that benzyl adenine showed a strong retardation of the leaf senescence of bean plants by retarding the terminal changes in chlorophyll or by preserving much of the chlorophyll. Also, Srivastava *et al.*^[40] on *Phaseolus vulgaris*, Metwally *et al.*^[41] on bean plants, Abd-Alla^[42] on pea plants reported that spraying benzyl adenine at 10 to 30 mg / l significantly increased chlorophyll a, b and carotenoids content of leaves.

Effect of the Interaction Between Maize Hybrids and Benzyl Adenine Concentration on Growth Characters and Photosynthetic Pigments: Data in Table (3) show that plant height at 60 and 75 days, stem diameter at 75 and 90 days, 4th leaf area at 60 and 75 days and dry weight/plant at 60 and 75 days

after sowing significantly responded to the interaction between maize hybrids and benzyl adenine.

However, chlorophyll a at 75 days, chlorophyll b at 75 days and total carotenoids at 75 and 90 days after sowing significantly responded to the interaction between maize hybrids and benzyl adenine concentrations (Table 3).

It is noteworthy to mention that foliar application with 100 mg / l benzyl adenine was the most favourable growth regulator treatment with S.C. 10 for plant height, stem diameter, 4th leaf area, dry weight / plant at 60 and 75 days after sowing, stem diameter and chlorophyll a and b at 75 days after sowing and total carotenoids at 90 days after sowing, while, spraying T.W. 310 with 100 mg / l gave the greatest mean value from stem diameter at 90 days after sowing.

Yield and its Components:

Hybrids Differences: Data in Table (4) indicated that there were significant differences among maize hybrids, i.e. S.C. 10, S.C. 123, S.C. 124, T.W. 310, T.W. 321, T.W. 322, T.W. 323 and T.W. 324 in ear diameter, ear length, number of grains / row, 100 grain weight, grain yield (g) / plant, grain yield / (ton/fed), shelling percentage, total carbohydrate, crude protein and oil percentage in grains, meanwhile, differences in number of rows / ear and harvest index failed to reach significant level at 5 %. Moreover, it is clear from Table (4) that single hybrid S.C. 10 had the highest mean values from ear diameter, ear length, 100-grain weight (g), grain yield per plant and per fed., shelling percentage, total carbohydrate and oil percentage, while, three way hybrids T.W. 310 and T.W. 321 had the highest values for number of grains / row and crude protein, respectively.

The differences between maize hybrids in yield and its components might be reflected the differences between maize hybrids in dry matter. The superiority of single cross hybrid S.C. 10 in grain yield / fed. over the other hybrids might be due to the increase in growth characters, ear length, grain index, grain yield / plant and shelling percentage compared with other seven cultivars under study.

It is note worthy to mention that the results of genotypes differences in yield and its components may be due to the differences in genetic structure between the eight white maize hybrids in this study and, also, the widely differences between maize hybrids for mineral concentrations^[32].

Hybrid differences in yield and its components in this study are in harmony with the results obtained by Sadek *et al.*^[37], Zaki *et al.*^[33], Ahmed and Hassanein^[43], Iken *et al.*^[44], Mohamed and Abdel-Aal^[45] and Sadek *et al.*^[34,35].

Table 4: Effect of varietal differences and benzyladenine concentrations on yield and its components of maize hybrides. (Combined analysis of 2005 and 2006 seasons).

Growth characters		Ear diameter (cm)	Ear length (cm)	No. of rows/ear	No. of grains/row	Grain index (g)	Grain yield (g/plant)	Grain yield (ton/fed)	Shelling %	Harvest index	Total carbohydrate %	Crude protein %	Oil percentage %
Hybrids	S.C. 10	5.08	25	14.97	47.21	42.01	287.09	4.67	84.72	0.80	80.32	7.43	6.08
	S.C. 123	4.86	24.35	14.45	45.55	39.66	276.81	3.79	82.64	0.75	79.15	8.01	5.74
	S.C. 124	4.94	24.49	14.69	46.11	40.13	279.55	3.86	83.67	0.77	78.27	7.66	5.90
	T.W. 310	5.01	24.97	14.79	46.61	41.22	281.28	3.91	83.11	0.77	79.50	8.24	5.54
	T.W. 321	3.98	24.29	12.29	44.98	39.56	259.26	3.72	80.57	0.75	76.47	9.39	4.89
	T.W. 322	4.90	23.91	12.87	45.73	40.01	277.63	3.76	80.21	0.74	78.68	8.6	4.93
	T.W. 323	4.82	24.02	14.58	44.48	39.50	264.59	3.79	81.41	0.73	78.37	8.9	5.06
	T.W. 324	3.94	23.86	12.66	44.1	38.76	260.94	3.60	78.41	0.73	75.34	9.25	4.67
L.S.D. at 5 %		0.22	0.30	n.s	0.51	0.75	2.77	0.16	1.43	n.s	1.11	0.54	0.18
BA (mg/L)	0.0	3.96	23.56	12.74	44.29	38.90	262.41	3.39	80.52	0.74	76.29	8.40	4.90
	50	4.92	24.77	13.86	45.62	40.62	275.59	3.89	82.24	0.78	79.01	8.68	5.77
	100	5.09	24.94	14.87	47.01	41.32	284.01	4.41	83.06	0.80	80.34	9.09	6.32
L.S.D. at 5 %		0.54	0.66	n.s	0.76	0.59	2.23	0.47	1.12	n.s	1.20	0.34	0.48

Table 5: Effect of interaction between eight maize hybrids and benzyladenine concentrations on 100-grain weight and grain yield /plant. (Combined analysis of 2005 and 2006 seasons)

Treatments	Benzyladenine (mg/L)					
	0.0	50	100	0.0	50	100
Hybrids	100-grain weight (g)			Grain yield / plant (g)		
S.C. 10	39.09	40.76	42.34	270.61	286.03	296.11
S.C. 123	38.59	39.87	40.81	266.01	276.92	285.31
S.C. 124	39.32	40.49	40.92	262.79	274.80	282.42
T.W. 310	39.50	40.88	41.76	269.91	281.73	290.23
T.W. 321	37.90	38.66	39.67	261.72	269.64	279.93
T.W. 322	38.69	38.89	40.78	267.79	272.55	281.41
T.W. 323	39.21	40.78	41.58	259.85	270.46	280.57
T.W. 324	39.09	39.86	40.90	251.47	266.37	277.62
L.S.D at 5%	0.55	1.01	0.12	2.33	2.21	1.67

Effect of Benzyl Adenine Concentration: Data in Table (4) clearly show that there are significant marked stimulatory effect on ear diameter, ear length, number of grains / row, 100-grains weight (g), grain yield per plant and per fed., shelling percentage, crude protein, total carbohydrate and oil percentage in maize grains, while, number of rows / ear and harvest index was insignificantly affected in treated plants with 50 and 100 mg / l of benzyl adenine. Concerning the effect of the relatively high concentration of benzyl adenine 100 mg/l, this caused significant increment in yield and its components in comparison with control or 50 mg / l

benzyl adenine in this connection. Lyubarskaya *et al.*^[46] and Sharma and Walia^[47] reported that external application of cytokinins may enhance grain yield. Also, Rani *et al.*^[12], Nagel *et al.*^[48] and Cho *et al.*^[49] found that foliar application with 25 and 50 mg / l benzyl adenine at the pre-anthesis stage of mungbean plants increased the number of pods / m², dry matter, seed yield, harvest index and 100-seed weight as compared with control.

This increase in yield attributes might be due to an increased rate of assimilate transport from the source to the developing grains a decrease the aborting of

reproductive organs. This possibility is supported by the finding that exogenous the grain number per ear by up to 30 % in maize^[50,51,6,17]. However, increase yield might be due to more grains per spike and increased assimilate partitioning from leaves to grains, as suggested by the 1000 – grain weight^[4,16,3]. The data reveal also that spraying maize hybrids with benzyl adenine concentrations significantly increased protein, carbohydrate and oil content in the maize grains as compared to the untreated ones. Sayed^[52], Amin^[19], El-Abagy *et al.*^[11], Gad^[20] and Abo-Alla^[14] found that foliar application of soybean, faba bean and wheat plants with benzyl adenine at 50 mg/l significantly increased crude protein, total carbohydrate and oil content in grains. This may be due to the stimulation and enhancement of cell division and chlorophyll accumulation and enhancement of maize growth and increase protein and soluble sugar accumulation in maize grain^[53,51,44]. This highest values of protein, carbohydrate and oil percentage were obtained when the concentration benzyl adenine increased from 50 to 100 mg/l.^[18,54]

Effect of Interaction Between Maize Hybrids and Benzyl Adenine Concentration: Data in Table (5) indicated that ear diameter, ear length, number of grains / row, grain yield (ton/fed), shelling percentage, harvest index, total carbohydrate, crude protein and oil content of grains were not significantly affected by the interaction between maize hybrids and the different concentrations of benzyl adenine. However, 100-grain weight and grain yield (g) / plant under this study showed significant response to the interaction (Table 5).

It is noteworthy to mention that foliar application of S.C. 10 with 100 mg / l benzyl adenine was the most favourable treatment for 100-grain weight and grain yield / plant.

From the above mentioned results, it can be concluded that the application of different concentrations of benzyl adenine on white maize hybrids result in pronounced increases in growth characters, yield and its components and some biochemical constituents in grains. However, most of the previous characteristics were increased by increasing benzyl adenine treatment from 50 to 100 mg/l.

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