

## Physiological Effect of Indole - 3 - Butyric Acid and Salicylic Acid on Growth, Yield and Chemical Constituents of Onion Plants

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**Abstract:** Two field experiments were carried out at the National Research Center ( Research and Production Station, Nubaria) during the two successive seasons of 2005/2006 and 2006/2007 to study the effect of indole - 3 – butyric acid ( 25, 50 and 100 mg/l ) and salicylic acid ( 50, 100 and 200 mg/l) as well as their combinations on vegetative growth, photosynthetic pigments content of leaves, yield and its quality and some biochemical constituents of onion plants. The results indicated that foliar application of indole - 3 – butyric acid with different concentrations led to significant increases in vegetative growth; plant height, number of leaves// plant, fresh and dry weight/ plant, leaf area, leaf area/plant, bulb length, bulb diameter and bulb weight. Also, increasing concentration of indole - 3 – butyric acid from 25 to 100 mg/l caused increase in photosynthetic pigments content / leaves, yield and its quality as well as biochemical constituents of onion bulb. The higher concentration ( 100 mg/l) was more effective than other concentrations. Spraying salicylic acid caused significant increase in most growth characters, photosynthetic pigments content/ leaves, yield and its quality, total soluble sugars, total free amino acids, total phenols and total indoles. The lower and moderate concentrations ( 50 & 100 mg/l) were more effective than the higher ones ( 200 mg/l). The combination between indole - 3 – butyric acid and salicylic acid concentrations showed significant increase on most growth characters, yield and its quality, total soluble sugars, total free amino acids, total phenols and total indoles of onion plants in comparison with individual effect of salicylic acid concentrations or untreated plants, especially the combinations between indole - 3 – butyric acid at 100 mg/l and salicylic acid at 50 or 100 mg/l which were more effective than other combinations in this respect.

**Keywords:** Onion, Indole - 3 - Butyric Acid, Salicylic Acid, Growth, Yield

### INTRODUCTION

Onion (*Allium cepa* L.) is one of the most important vegetable crops in Egypt for local consumption and exportation. Growth substances are used to regulate growth and improve productivity and quality of various plant species. Indole - 3 – butyric acid has different effects on plant growth and development when applied exogenously<sup>[1]</sup>. Dipping roots of onion seedling in 20 ppm indole acetic acid (IAA) or indole-3-butyric acid (IBA) solution before transplanting increased average number of leaves and fresh weight of bulbs<sup>[2,3]</sup>. Also, Rizk *et al.*<sup>[4]</sup> and El-Mergawi *et al.*<sup>[5]</sup> mentioned that spraying IAA and NAA had a favourable effect on growth characters and yield production of onion. Indole-3-butyric acid significantly increased vegetative growth and improve average yield and its quality of onion<sup>[6,9]</sup>. Salicylic acid ( SA ) is a common plant-produced phenolic compound. It is an endogenous growth regulator, which participates in the regulation of physiological processes

in plants. Exogenous application of salicylic acid may influence stomata closure<sup>[10]</sup>, ion uptake and transport<sup>[11]</sup>, inhibition of ethylene biosynthesis, transpiration and stress tolerance<sup>[12,13]</sup>. The effect of salicylic acid on the physiological processes variable, promoting some processes and inhibiting others depending on its concentration, plant species, development stages and environmental condition<sup>[14,16]</sup>. Considering combination effect, Zaghlool *et al.*<sup>[17]</sup> found that the combination effect of salicylic acid and naphthalene acetic acid markedly increased the seed yield of *Phaseolus vulgaris* L. Also, combination treatments between indole acetic acid and salicylic acid led to increases in the majority of cases in growth parameters of rosemary plants in compared with the individual effect of phenols<sup>[18]</sup>. This work is an attempt to evaluate the importance of spraying indole-3-butyric acid and salicylic acid on growth and yield, in addition to using indole-3-butyric acid which was sprayed first, aiming to enhance vegetative growth followed by salicylic acid aiming to increase onion yield.

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## MATERIALS AND METHODS

Two field experiments were carried at National Research Centre (Research and production Station, Nubaria ), during two successive seasons of 2005/2006 and 2006/2007 to study the effect of foliar application of different concentrations of indole-3-butyric acid and salicylic acid as well as combination on growth, photosynthetic pigments content/leaves, yield and its quality and biochemical constituents of onion plant. Seeds of onion ( *Allium cepa* L. ) cv. Giza red were cultivated in the nursery at 10<sup>th</sup> November in both seasons. After 70 days from sowing, the seedlings were transplanted to the experiment field at 10 cm spacing. The plants were placed in plots ( 3.5 × 3.0 m area ) with five rows 60 cm apart. Each experiment included 10 treatments which were the combination of three concentrations of indole-3-butyric acid at 25, 50 and 100 mg/l and three concentrations of salicylic acid at 50, 100 and 200 mg/l in addition to untreated plants ( control ). Onion plants were sprayed with indole-3-butyric acid after 30 days from transplanting and salicylic acid 30 days later. The experimental design was split-plot with four replications. The main plots assigned to indole-3-butyric acid and the sub-plots devoted to salicylic acid treatments. After 90 days from transplanting, growth characters were recorded expressed as plant height, number of leaves/plant, fresh weight of leaves/plant, fresh and dry weight/plant, leaf area (cm<sup>2</sup>), leaf area /plant(cm<sup>2</sup>), bulb length, bulb diameter, bulb weight and photosynthetic pigments content of leaves were determined<sup>[19]</sup> at 75 and 90 days from transplanting. At harvest time ( 120 days after sowing ), ten bulbs were chosen at random from every plot and the following data were recorded, bulb length, bulb diameter, bulb weight, dry weight % and total yield of onion. Moreover, samples of fresh bulb were chosen to determine soluble sugars<sup>[20]</sup>, total soluble amino acid<sup>[21]</sup>, total soluble phenols<sup>[22]</sup> and total soluble indoles<sup>[23]</sup>.

The data were statistically analyzed for each season and then combined analysis of the two seasons was carried out according to procedure outlined by<sup>[24]</sup>. For comparison between means, L.S.D. test at 5 % was calculated.

## RESULTS AND DISCUSSIONS

**Effect of Indole-3-butyric Acid and Salicylic Acid on Growth Characters:** Data presented in Table (1) indicated that plant height, number of leaves/plant, leaves weight/plant, fresh and dry weight/plant leaf area, leaf area/plant, bulb length, bulb diameter and

bulb weight significantly increased due to different treatments of indole-3-butyric acid especially at 100 mg/l as compared with other treatments. This increase might be due to stimulating dry mass production through enhancement of cell division and chlorophyll accumulation and in turn reflected on the increasing in vegetative growth of onion plants<sup>[2,5]</sup>. However, Omran *et al.*<sup>[25]</sup> and Sing *et al.*<sup>[3]</sup> found that foliar application of IAA caused bulbing of onion plants. Also, an increase in the neck diameter of onion bulb, number of tubular blades and the fresh weight of bulbs results by IAA.

These results are in agreement with several investigators Abou El-Magd *et al.*<sup>[26]</sup> on onion, Chhun *et al.*<sup>[27]</sup> on rice. Moreover, Amin *et al.*<sup>[9]</sup> mentioned that foliar application of indole-3-butyric acid increased vegetative growth of maize plants at the different stages of growth.

Concerning the effect of salicylic acid on growth characters data in the same Table showed that plant height, number of leaves/plant, leaves weight/plant, fresh and dry weight/plant, leaf area, leaf area/plant, bulb length, bulb diameters and bulb weight were significantly increased in most cases as a result of foliar application with salicylic acid at the lower and the moderate concentrations (50 and 100 mg/l) compared with control treatments. However, foliar application at the higher concentration of SA (200 mg/l) was less effective than other concentrations for increasing the above mentioned characteristics, in addition to resulted in significant decrease in plant height and leaf area of onion plant.

In this respect, low salicylic acid doses enhanced soybean growth (Gutierrez-Coronado *et al.*<sup>[28]</sup>, Shakirova *et al.*<sup>[29]</sup>, on wheat and Shehata *et al.*<sup>[30]</sup> and Iqbal and Ashraf<sup>[31]</sup> on maize. Whereas, salicylic acid at relatively high doses caused an inhibitory effect on plant growth of tomato, lupine and maize as mentioned by Kord and Hathout<sup>[32]</sup>, Habba<sup>[8]</sup> and Abd El-Wahed *et al.*<sup>[33]</sup>. Concerning the combined effect of indole-3-butyric acid and salicylic acid treatments, significant increases were obtained in the same mentioned characteristics of growth in comparison with individual effect of salicylic acid concentrations or untreated plants. Data in Tables (4 and 5) showed that the most promising treatments of the combined effect of these two bioregulators was noticed with indole-3-butyric acid at 100 mg/l and salicylic acid at 50 or 100 mg/l. at the 90 and 120 days from transplanting, respectively for increasing vegetative growth of onion plants.

**Effect of Indole-3-butyric Acid and Salicylic Acid on Photosynthetic Pigments Content:** Photosynthetic pigments content; chlorophyll (a), chlorophyll (b) and

**Table 1:** Effect of indole-3-butyric acid and salicylic acid on some growth characters of onion plants after 90 days from transplanting. (Combined analysis of 2005/2006 and 2006/2007 ).

Treatments (mg/l)		Plant height (cm)	No. of leaves /plant	Leaves weight (g)	Fresh weight/plant (g)	Dry weight /plant (g)	Leaf area (cm <sup>2</sup> )	Leaf area/plant (cm <sup>2</sup> )	Bulb length (cm)	Bulb diameter (cm)	Bulb weight (g)
IBA	Control	66.29	8.80	54.77	140.43	23.26	100.90	842.09	4.39	3.69	84.67
	25	73.16	9.91	68.25	165.35	27.39	107.21	1048.29	5.56	3.94	94.88
	50	76.03	10.62	72.22	176.26	29.02	110.01	1189.54	5.89	4.59	104.04
	100	79.90	11.80	76.90	179.71	29.90	113.11	1209.20	6.01	4.62	102.81
	L.S.D. at 5%	5.33	1.01	12.86	16.69	3.49	5.39	149.08	0.68	0.23	4.22
SA	Control	66.90	8.61	54.90	140.97	23.56	102.31	839.96	4.41	3.72	84.94
	50	78.98	10.96	75.89	178.90	29.60	111.96	1179.60	5.93	4.37	98.96
	100	75.94	10.54	71.90	175.89	28.13	108.90	1056.99	5.81	4.51	103.89
	200	70.30	9.89	69.31	163.92	27.09	105.89	952.79	4.77	3.62	96.99
	L.S.D. at 5%	3.01	1.20	5.60	12.01	2.11	2.66	80.90	0.21	0.12	2.99

**Table 2:** Effect of indole-3-butyric acid and salicylic acid on yield and its quality of onion plants after 120 days from transplanting. (Combined analysis of 2005/2006 and 2006/2007 ).

Characters		Bulb length (cm)	Bulb diameter (cm)	Bulb weight (g)	Dry weight (Dw. g/100 Fw.)	Yield onion (ton/fed.)	Total soluble sugars %	Free amino acid (mg/100g)	Total phenols (mg/100g)	Total indoles (mg/100g)
IBA	Control	6.11	4.42	144.70	14.27	10.29	12.55	68.77	43.79	4.62
	25	6.49	5.70	165.86	15.89	12.88	13.77	75.80	55.40	6.71
	50	7.60	5.87	191.59	16.06	15.35	15.80	79.69	58.72	6.86
	100	7.74	6.93	207.34	14.90	15.83	14.89	83.11	61.39	5.64
	L.S.D. at 5% level	0.31	1.21	19.66	0.59	1.33	1.11	4.44	9.88	0.79
SA	Control	6.01	4.38	145.45	14.32	10.26	12.86	68.13	44.26	4.38
	50	6.99	5.56	173.67	15.59	12.97	14.93	76.96	54.76	5.79
	100	7.86	5.69	189.33	15.76	14.62	14.82	80.78	59.87	6.39
	200	6.32	4.63	201.60	14.80	14.83	13.79	78.90	59.90	5.63
	L.S.D. at 5% level	0.23	0.15	26.55	0.34	1.45	0.90	3.39	4.01	1.19

total carotenoids as affected by the used bio-regulators are presented in Table (3). The data showed that different photosynthetic pigments (chl. a, chl. b and total carotenoids) were significantly increased with increasing the applied concentration of IBA up to 100 mg/l. in the leaves of onion plants. These results are in agreement with those results obtained by Abu Grab and Ibrahim<sup>[34]</sup> on onion and Abdel-Wahed *et al.*,<sup>[33]</sup> on maize.

According to Midan *et al.*,<sup>[6]</sup> Ludwig Muller *et al.*,<sup>[35]</sup> and Ludwig Muller<sup>[1]</sup> found that IBA at 50 mg/l gave the highest photosynthetic pigments content due to the stimulatory effect on the amount of

metabolites synthesized through enhancement of cell division and chlorophyll accumulation which led to higher rate of photosynthesis. Also, Shaddad and El-Tayeb<sup>[36]</sup> and Abd El-Wahed *et al.*,<sup>[33]</sup> on maize, as they reported considerable increases in photosynthetic pigment content of the leaves in IBA treated plants. Considering phenols effect, the lower and the moderate concentrations of Salicylic acid (50 and 100 mg/l) recorded the highest values of chlorophyll a,b and total carotenoids. While, Salicylic acid at relatively high dose ( 200 mg/L ) caused significant decrease in chlorophyll contents. However, Gutierrez Coronado *et al.*,<sup>[28]</sup> on Soybean, Anaieva *et al.*,<sup>[37]</sup> on barley,

**Table 3:** Effect of indole-3-butyric acid and salicylic acid on pigments content of onion leaves (mg/g F.W.)

Characters		(Combined analysis of 2005/2006 and 2006/2007 ).					
Treatments (mg/l)		Chl. a (mg/g)		Chl. b (mg/g)		Total carotenoids (mg/g)	
		A	B	A	B	A	B
IBA	Control	0.77	0.80	0.25	0.27	0.36	0.50
	25	0.79	0.86	0.28	0.30	0.39	0.57
	50	0.82	0.90	0.29	0.32	0.42	0.59
	100	0.88	0.98	0.30	0.33	0.44	0.61
L.S.D. at 5% level		0.01	0.05	0.02	0.02	0.04	0.06
SA	Control	0.76	0.79	0.25	0.27	0.36	0.51
	50	0.82	0.88	0.29	0.32	0.41	0.59
	100	0.86	0.96	0.29	0.32	0.43	0.60
	200	0.84	0.92	0.28	0.31	0.40	0.59
L.S.D. at 5% level		0.03	0.04	0.02	0.03	0.03	0.04

A: 75 days from transplanting

B: 90 days from transplanting

**Table 4:** Effect of interaction between foliar application of indole-3-butyric acid and salicylic acid on growth characters of onion plants at 90 days from transplanting.

Characters		(Combined analysis of 2005/2006 and 2006/2007 ).					
Growth regulators		Plant height (cm)	No. of leaves/plant	Leaves weight (g)	Fresh weight /plant (g)	Dry weight /plant (g)	Leaf area (cm <sup>2</sup> )
IBA (mg/l)	SA (mg/l)						
0.0	0.0	71.77	8.67	59.71	140.59	23.29	100.09
	50	69.90	8.92	61.43	146.78	24.32	97.89
	100	65.98	8.81	60.69	149.90	24.90	95.87
	200	63.86	7.69	52.96	145.86	23.89	92.11
25	0.0	75.90	9.58	65.98	164.64	27.33	109.70
	50	72.88	9.96	69.59	169.90	28.15	107.55
	100	68.92	9.91	68.25	164.68	27.30	105.90
	200	67.89	8.56	58.95	159.70	26.56	102.82
50	0.0	78.65	10.55	72.66	177.35	29.38	110.97
	50	74.72	10.79	74.31	174.91	29.09	109.89
	100	72.96	10.93	76.07	170.50	29.24	107.90
	200	70.58	9.67	66.60	167.29	27.71	105.93
100	0.0	79.94	11.30	78.80	179.90	29.90	113.73
	50	78.83	10.91	75.14	176.82	29.29	110.92
	100	76.91	10.94	76.01	172.41	28.56	106.87
	200	73.67	10.81	74.49	169.61	28.09	103.80
L.S.D. at 5% level		1.26	0.29	2.59	2.41	0.51	0.44

**Table 5:** Effect of interaction between foliar application of indole-3-butyric acid and salicylic acid on growth characters of onion plants at 90 days from transplanting.

(Combined analysis of 2005/2006 and 2006/2007 ).

Characters					
Growth regulators		Leaf area/plant (cm <sup>2</sup> )	Bulb length (cm)	Bulb diameter (cm)	Bulb weight (g)
IBA (mg/l)	SA (mg/l)				
0.0	0.0	898.35	4.77	3.69	84.96
	50	846.71	4.51	3.41	88.78
	100	791.53	3.90	3.11	94.86
	200	696.44	3.30	2.91	92.70
25	0.0	1097.97	5.82	4.01	89.11
	50	1001.52	5.62	4.39	92.26
	100	998.56	4.01	3.78	96.81
	200	980.67	4.49	3.59	98.50
50	0.0	1184.68	5.93	4.36	97.33
	50	1090.99	5.73	4.51	99.61
	100	1044.61	5.41	4.49	100.56
	200	1015.59	4.52	3.79	101.41
100	0.0	1273.85	6.04	4.89	99.67
	50	1204.35	5.89	4.69	101.88
	100	1171.84	5.82	4.56	102.70
	200	1084.06	5.61	3.90	104.59
L.S.D. at 5% level		33.90	0.49	0.06	2.59

Rashad<sup>[18]</sup> and Iqbal *et al.*,<sup>[16]</sup> on wheat showed that salicylic acid at lower concentration caused significant increases in photosynthetic pigment content. While, Khadiga<sup>[11]</sup>, Shakirova *et al.*,<sup>[29]</sup> on wheat and Abdel-Wahed *et al.*<sup>[33]</sup> on maize found that salicylic acid at high concentration caused significant decreases in chlorophyll content.

Concerning combination effect, all the used combinations resulted in slightly increase in chlorophyll a , b and total carotenoids in compared with untreated plant in most cases. Also, the combinations between indole-3-butyric acid (at 100 or 50 mg/l) and the lower and moderate concentration of salicylic acid ( 50 and 100 mg/l ) showed higher content of pigments at 75 and 90 days from transplanting (data in Table, 8).

**Effect of Indole-3-butyric Acid and Salicylic Acid on Yield and its Quality:** The data presented in Table (2) indicated that bulb length, bulb diameter, mean bulb

weight, dry weight percentage and yield of bulb onion significantly increased due to different treatment of indole-3-butyric acid. The highest values were obtained with indole-3-butyric acid at 50 and 100 mg / L. These results are in agreement with those results obtained by Rizk *et al.*,<sup>[4]</sup> and Lipe<sup>[38]</sup> on cotton, El-Mergawi *et al.*,<sup>[5]</sup> on onion. The increase in yield of onion plants by using growth promoter (IBA) might be due enhanced assimilation nutrient uptake, nitrate reduction and photosynthesis, improved flow assimilates (translocation and cytoplasmic streaming ) and increased cell integrity and in turn reflected on the increasing yield of onion plants. However, Baraldi *et al.*,<sup>[39]</sup> Shafey *et al.*,<sup>[40]</sup> and Chhun *et al.*,<sup>[27]</sup> indicated that foliar application with indole-3-butyric acid at the concentration 50 and 100 mg/l increased yield of rice and wheat. In addition, dipping roots of onion seedling in 20 ppm indole acetic acid IAA or IBA solution before transplanting increased average number of leaves

**Table 6:** Effect of the interaction between foliar application of indole-3-butyric acid and salicylic acid on onion yield and its quality at 120 days from transplanting.

(Combined analysis of 2005/2006 and 2006/2007 ).

Characters		Bulb length (cm)	Bulb diameter (cm)	Bulb weight (g)	Dry weight (Dw. g/100 Fw.)	Yield onion (ton/fed.)
Growth regulators						
IBA (mg/l)	SA (mg/l)					
0.0	0.0	5.59	4.10	139.52	13.78	10.39
	50	5.36	4.78	144.90	14.32	11.80
	100	5.58	4.50	152.62	14.86	12.66
	200	4.41	4.96	167.07	14.40	11.97
25	0.0	6.50	4.87	152.36	14.69	11.63
	50	6.41	4.62	170.92	15.62	12.94
	100	5.78	4.69	181.53	15.77	13.86
	200	5.32	4.35	192.83	15.31	12.91
50	0.0	6.41	5.46	167.72	15.50	12.72
	50	6.50	5.52	184.80	15.31	13.87
	100	6.69	5.77	195.46	15.68	14.75
	200	5.42	4.41	201.29	15.72	13.82
100	0.0	7.32	5.62	176.81	15.41	13.91
	50	7.59	5.76	169.74	15.92	15.79
	100	6.50	5.87	202.52	15.59	15.40
	200	6.21	5.32	205.31	14.51	14.73
L.S.D. at 5% level		0.01	0.21	3.89	0.19	0.15

and fresh weight and yield of onion plants<sup>[2,3]</sup>. Also, indole-3-butyric acid significantly increased vegetative growth, yield & its components and chemical constituents of maize grains<sup>[9]</sup>. Concerning the effect of salicylic acid on yield of onion plants data in Table (2) indicated that bulb length, bulb diameter, bulb weight, dry weight percentage and yield of onion were significant increased in most cases as a result of foliar application with salicylic acid at the concentration of 50 to 200 mg/l compared the control. The maximum significant values for yield of onion were obtained as a results of salicylic acid at 100 mg/l. in most cases Shehata *et al.*,<sup>[30]</sup> on maize, Shakirova *et al.*,<sup>[29]</sup> and Iqbal and Ashraf<sup>[31]</sup> on wheat, found that low rate of salicylic acid increased yield and its components while, high rates of salicylic acid showed depressed effect on yield components. Concerning the combined effect of indole-3-butyric acid and salicylic acid treatments significant increase were obtained in the same

mentioned characteristics of yield. Data in Table (6) showed that the most promising of the combined effect of these two bioregulators was notices with indole-3-butyric acid at 100 mg / l and salicylic acid at 50 and 100 mg/l., in addition to the combined treatment of indole-3-butyric acid at 50 mg/l and salicylic acid at 50 mg/l were more effective than other combinations for increasing yield of onion plants in compared with the individual effect of salicylic acid treatments or untreated plants for increasing bulb length, bulb diameter, bulb weight, dry weight percentage and yield of onion bulb.

**Effect of Indole-3-butyric Acid and Salicylic Acid on Chemical Constituents:** Data reported in Table (2) show that indole-3-butyric acid has a significant effect on total soluble sugars, free amino acid, total phenols and total indoles. However, foliar application of indole-3-butyric acid at the concentration of 50 and 100 mg/l

**Table 7:** Effect of the interaction between foliar application of indole-3-butyric acid and salicylic acid on onion yield and its quality at 120 days from transplanting.

(Combined analysis of 2005/2006 and 2006/2007 ).

Characters		Total soluble sugars ( % )	Free amino acid (mg/100g)	Total phenols (mg/100g)	Total indoles (mg/100g)
Growth regulators					
IBA (mg/l)	SA (mg/l)				
0.0	0.0	12.69	66.73	45.67	4.67
	50	12.42	69.82	47.90	4.82
	100	12.81	70.44	43.89	4.78
	200	11.64	64.42	41.80	4.51
25	0.0	13.57	78.60	57.79	5.58
	50	13.71	75.90	55.80	5.91
	100	14.73	77.20	52.76	5.37
	200	13.83	70.50	49.90	4.64
50	0.0	14.84	81.59	59.49	6.49
	50	15.70	77.09	58.03	6.01
	100	15.64	79.39	59.80	4.66
	200	14.92	74.64	54.89	5.33
100	0.0	15.93	83.47	62.30	6.30
	50	14.90	81.35	60.90	5.69
	100	13.59	79.23	59.77	5.55
	200	14.77	76.71	53.71	4.72
L.S.D. at 5% level		0.10	0.29	1.03	0.12

gave the highest values for total soluble sugars, free amino acid, total phenols and total indoles. Concerning, Midan *et al.*,<sup>[6]</sup> on cotton, El-Habbasha *et al.*,<sup>[41]</sup> Sing *et al.*,<sup>[42]</sup> Habba<sup>[8]</sup> on onion and Amin *et al.*<sup>[9]</sup> on maize indicated that foliar application of indole-3-butyric acid at the concentration 50 and 100 mg/l to maize plants were the most effective treatments for increasing chemical constituents as compared with control. IBA treated plants showed significant increases in most mentioned constituent.

Data on total soluble sugars, free amino acid, total phenols as well as total indoles as affected by salicylic acid are presented in Table (2) showed that foliar application of salicylic acid at the concentration of 50 and 100 mg/l gave the highest values for chemical constituents of onion bulb compared with the higher concentration (200 mg/l) or untreated plants.

This effect might be due to these substances on enzymatic activity and translocation of the metabolites

to onion bulb. These results are agreement with those obtained by Shehata *et al.*,<sup>[30]</sup> Raskin<sup>[43]</sup>, Shakivova *et al.*<sup>[29]</sup> Also, Rashad<sup>[18]</sup> found that SA. Treated plants showed decreases total carbohydrates, total soluble indole and indoles / phenol ratio in most cases in rosemary plants. El-Mergawi and Abdel-Wahed<sup>[15]</sup> reported that low dose of salicylic acid (2.5  $\mu$ M) resulted in significant increase in total carbohydrate content. While, the high doses (5 and 10  $\mu$ M ) significantly decreased it. Phenols content in maize leaves significantly increased by acetyl salicylic acid application (20 and 40  $\mu$ M) as reported by Shehata *et al.*,<sup>[30]</sup>. Also, Abd El-Wahed *et al.*,<sup>[33]</sup> found that foliar application of salicylic acid at low dose of 1  $\mu$ M and 2  $\mu$ M resulted in significant increase in total sugars, crude protein, oil and total carotenoids content of yellow maize grains, while, the high doses (3  $\mu$ M) significantly decreased it. The maximum values of biochemical content in onion bulb

**Table 8:** Effect of the interaction between foliar application of indole-3-butyric acid and salicylic acid on pigments content of onion leaves (mg/g. f.w. )

(Combined analysis of 2005/2006 and 2006/2007 ).

Growth regulators		Chl. (a)(mg/g)		Chl. (b) (mg/g)		Total carotenoids (mg/g)	
IBA (mg/l)	SA (mg/l)	A	B	A	B	A	B
0.0	0.0	0.75	0.79	0.25	0.28	0.36	0.49
	50	0.79	0.84	0.26	0.29	0.39	0.52
	100	0.78	0.81	0.27	0.30	0.40	0.54
	200	0.77	0.79	0.24	0.30	0.38	0.51
25	0.0	0.79	0.84	0.27	0.29	0.39	0.52
	50	0.80	0.89	0.27	0.30	0.40	0.54
	100	0.82	0.86	0.28	0.31	0.42	0.57
	200	0.81	0.85	0.26	0.31	0.41	0.53
50	0.0	0.84	0.89	0.29	0.31	0.42	0.59
	50	0.88	0.94	0.28	0.32	0.43	0.59
	100	0.92	0.97	0.29	0.33	0.44	0.60
	200	0.84	0.89	0.28	0.31	0.41	0.59
100	0.0	0.86	0.96	0.30	0.33	0.44	0.62
	50	0.90	0.99	0.30	0.32	0.45	0.60
	100	0.89	0.95	0.29	0.31	0.46	0.64
	200	0.86	0.92	0.27	0.31	0.43	0.59
L.S.D. at 5% level		0.02	0.01	n.s	0.01	0.02	0.03

A: 75 days from transplanting

B: 90 days from transplanting

were obtained by salicylic acid treatment (100 mg/l) on total soluble sugars, free amino acid and total phenols. The combined treatments enhanced the above mentioned biochemical constituents in most cases compared with the individual effect of salicylic acid treatments or untreated plants. Also, the combinations between indole-3-butyric acid at 100 or 50 mg/l and the lower and the moderate concentration of salicylic acid ( 50 or 100 mg / l ) showed higher total soluble sugars, free amino acids, total phenols and total indoles in compared with SA- treated plants or untreated plants (data in Table, 7).

From the above mentioned results, it could be concluded that foliar application of indole-3-butyric acid at 100 mg/l alone or in combination with salicylic acid at 50 or 100 mg/l to onion plants (Giza-red ), improved growth, yield and its quality and some biochemical constituents of onion plants.

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