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Stimulatory Effect of Indole 3-Acetic Acid and Benzyladenin on Two Varieties of *Antirrhinum Majus* L. Plant

Ban A. J. Sidkey*
Central Environmental Laboratory, College of Science, University of Baghdad, Baghdad, Iraq

Abstract

This research had been conducted to investigate response of two *Antirrhinum majus* L. varieties, tall and dwarf variety to foliar application of Indole 3-acetic acid and Benzyladenin at (0, 60, 120, 180, 240 ppm), through plant height, fresh weight, dry weight of shoot, length of inflorescence (raceme), number of flowering buds per raceme and chlorophyll content in leaves at complete flowering stage.

Results of treatment of the tall variety with IAA and BA showed that IAA had the highest significant increase in plant height, while BA had the highest significant increase in chlorophyll content .Increasing concentrations of both IAA and BA resulted a significant increase in all growth parameters, this was obvious in flowering buds per raceme ,hence both IAA and BA treatment at 240 ppm was more significant than 180 ppm that was more significant than 120 ppm.

Results of treatment of the dwarf variety with IAA and BA showed that there was a significant increase in number of flowering buds per raceme, hence the treatment with BA was more significant than IAA .Increasing concentrations of both IAA and BA increased all growth parameters except chlorophyll content in leaves, this was obvious in flowering buds per raceme ,hence both IAA and BA treatment at 240 ppm was more significant than 180 ppm that was more than 120 ppm .

Keywords: *Antirrhinum majus* L. , Indole 3-acetic acid , Benzyladenin

التأثير المحفز للإندول 3-حامض الخليك والبنزيل أدنين في ضربين لنبات حلق السبع

بان عبدالجبار صدقي*
المختبر البيئي المركزي، كلية العلوم، جامعة بغداد، بغداد، العراق

الخلاصة

أجري هذا البحث للاستقصاء عن استجابة ضربين من نبات حلق السبع، الضرب الطويل والمتقزم للإضافة الورقية بالاندول3-حامض الخليك والبنزيل ادينين بالتراكيز (0و60 و120 و180 و240 جزء لكل مليون جزء) من خلال طول النبات والوزن الطري والوزن الجاف له و طول النورة الزهرية (العنقود) وعدد البراعم الزهرية في العنقود و محتوى الكلوروفيل في الاوراق عند مرحلة التزهيرالتام. تظهر نتائج معاملة الضرب الطويل بمنظمي النمو اندول 3-حامض الخليك و بنزيل ادنين ان الاندول حامض الخليك كان المسبب في الزيادة المعتوية لصفة طول النبات، في حين البنزيل ادنين ادى الى زيادة معنوية في محتوى الكلوروفيل .ادت زيادة تراكيز كلا المنظمين الى زيادة معنوية في جميع صفات النمو ، و كان هذا واضحا في عدد البراعم الزهرية للنورة العنقودية، اذ ادت كلا المعاملتين بالاندول حامض الخليك و البنزيل ادنين بالتركيز 240 ج. م. ج. الى زيادة معنوية في هذه الصفة وبزيادة معنوية عن التركيز 180 ج . م. ج و الذي بدوره اكثر معنوية من 120 ج.م.ج. اما نتائج معاملة الضرب القصير بالاندول حامض الخليك و البنزيل ادنين فقد اظهرت وجود زيادة معنوية في عدد البراعم الزهرية للنورة العنقودية، اذ ادت المعاملة بالبنزيل ادنين الى زيادة معنوية في هذه الصفة اكثر من الاندول حامض الخليك .ادت زيادة تراكيز كلا المنظمين الى زيادة معنوية في

*Email:banalsaeed@yahoo.com

جميع صفات النمو عدا محتوى الكلوروفيل في الاوراق و كان هذا واضحا في صفة عدد البراعم الزهرية للنورة العنقودية ، اذ ادت المعاملة بالتركيز 240 ج. م. ج. الى زيادة معنوية اكثر من المعاملة بالتركيز 180ج. م. ج. و التي كانت بدورها اكثر معنوية من المعاملة 120 ج. م. ج.

Introduction:

Snapdragon is the common name of *Antirrhinum majus* L. plant which is one of the special cut flowers [1]. It is used to be treated within the family scrophulariaceae , but studies of DNA sequences have led to its inclusion in a vastly enlarged family plantaginaceae [2] .The vertical flower raceme of this plant opening gradually from the bottom to the top and the plant is available in two heights: dwarf varieties grow to about 10 inches are easy to grow indoors all year long and are excellent when used outdoors in borders or in raised beds or pots. The tall varieties grow to a height of 18-24 inches, make superb cut flowers that look great planted with other tall companuls. The regulation of plant growth and reproduction could be achieved through many bioregulators . Plant growth regulators is known to change the phenotype of normal and certain varieties of dwarf plants [3]. The auxin Indole 3-acetic acid is a natural auxin found in the plants and present in a synthetic form, while the cytokinin Benzyladenin is a synthetic plant regulator [4].

Decrease of cut flowers quality at harvesting time to market is a great problem for growers. Plant growth regulators have an important role in increasing horticulture productivity [5].Therefore, the aim of this research is to investigate the stimulatory effect of these two plant growth regulators on some growth parameters and chlorophyll content in leaves of tall and dwarf varieties of *Antirrhinum majus* L. plant at complete flowering stage.

Materials and methods:

Pot experiment (Factorial Experiment 2x5) was conducted during winter / spring season 2014 in experimental greenhouse at University of Baghdad .The first factor studied was the plant growth regulators (IAA and BA) effect ,and the second factor was their concentrations (0,60,120,180,240 ppm) effect and the interaction between each plant growth regulator at different concentrations and control treatment was also studied .The seeds of tall variety of snapdragon alta and the dwarf variety nana (Hortus Sementi seeds company) were separately planted in pots (20x20 cm) filled with loamy soil and peat moss on 20 January 2014. Each pot was irrigated with tap water and the plants were grown under natural conditions: 20-30^{o}C at day, and 10-20^{o}C at night with 12-13 hours photoperiod. When the plants reached two pairs of true leaves, thinned to one plant in each pot and after one month from transplanting the plants were sprayed and saturated with the two growth regulators each separately at the concentrations (0, 60, 120, 180, 240 ppm). The spray was repeated after one, two and three weeks.

Measurements of plant height, fresh and dry weight of the shoot, length of raceme, number of flowering buds per raceme, chlorophyll content of leaves [6] were carried out after two month of the first spray. The pots were arranged in a randomized complete blocks design with 10 treatments, each treatment consist of 4 replicates. The mean of replicates of the treatment for each parameter were compared using the least significant difference test (LSD) at the level of 5% [7].

Results and Discussion:

The results of this study are presented in Table-1 for the tall variety and Table-2 for the dwarf variety. In Table-1, the data of the first factor (plant growth regulators) indicate that there is a significant increase at the treatment with IAA and BA on some growth parameters ,IAA had the significant increase in plant height ,while BA had the significant increase in chlorophyll content of leaves .The significant increase in plant height as a response to IAA application may be due to the role of IAA in increasing cellulase activity that reflect on cell wall plasticity then facilitate water and mineral uptake [8].The significant increase in chlorophyll content of leaves as a response to BA application may be due to the role of cytokinins in increasing the NADH protochlorophyllid reductase activity which is used in the biosynthesis of chlorophyll [9].

In Table-2, the data of the first factor (plant growth regulators) for the dwarf variety indicate that there is a significant increase in number of flowering buds per raceme at the treatment with IAA and BA ,the treatment with BA resulted the highest increment ,this may be due to the role of cytokinins in increasing cell division in meristems [10].

Results of effect of the second factor (concentrations of pgr)for the tall variety (Table-1) indicate that there is a significant increase in all growth parameters and chlorophyll content of leaves as a result of increasing both IAA and BA concentrations especially at the highest concentrations .This was obvious in number of flowering buds per raceme where the concentration 240 ppm had the highest significant increment then 180 ppm then 120 ppm .

In Table-2 for the dwarf variety both IAA and BA treatments at the highest concentrations resulted significant increase on all growth parameters except chlorophyll content .Increasing concentrations of both regulators gradually increased the growth parameters, that is also found on *Codiaeum variegatum* L. plant [11].

Table-1 shows also the results of effect of the interaction between each growth regulator with its different concentrations and control treatment for the tall variety. Plant height is an important factor from commercial cut flower production of view [12].Plant height increased significantly with IAA (120,180 and 240 ppm) treatment ,IAA (240ppm) treatment is more significant than IAA (120ppm) treatment .This increment may be due to the role of IAA in preventing calcium ions from conjugation with peptic acid that reflect on cell wall strength [13] ,or may be to its role in increasing glucanase and hemicellulase activity [14] . BA (180 and 240 ppm) treatment increased plant height significantly and BA (240ppm) treatment is more significant than BA (180 ppm),this may be due to the role of BA in preventing ethylene production and increasing gibberellic acid efficiency [15] ,the results are comparable with those obtained by [16] on barley and [17] on wheat .

Fresh weight of the plant is an important measure of both vegetative and flowering performance, IAA and BA (180 and 240 ppm) treatment resulted significant increase in fresh weight of shoot.

Table 1 – Effect of IAA and BA foliar application on some growth parameters and chlorophyll content in leaves of *Antirrhinum majus* var. alta (The tall variety) at complete flowering stage.

Factors	Treatments (ppm)	Plant height (cm)	Fresh weight (gm)	Dry weight (gm)	Length of raceme (cm)	Number of flowering buds per raceme	Chlorophyll content (mg/g)
		Mean	Mean	Mean	Mean	Mean	Mean
PGR	IAA	74.20 a	38.60 a	11.03 a	21.20 a	38.47 a	1.40 b
	BA	71.53 b	38.78 a	11.37 a	20.63 a	37.93 a	1.64 a
LSD P ≤ 0.05		1.50	1.01	1.13	0.71	0.99	0.10
PGR Concentrations	Control	68.00 c	36.57 c	9.42 b	16.58 d	32.50 d	1.34 b
	60	70.00 c	37.75 bc	9.92 b	17.25 d	33.17 d	1.38 b
	120	73.17 b	38.26 b	11.08 ab	21.08 c	38.50 c	1.40 b
	180	75.33 b	39.87 a	12.75 a	23.25 b	42.00 b	1.72 a
	240	77.83 a	40.99 a	12.83 a	26.42 a	44.83 a	1.76 a
LSD P ≤ 0.05		2.37	1.60	1.79	1.13	1.57	0.15
Interactions IAA X Concentrations	IAA Cont.	68.00 c	36.46 b	9.50 b	16.50 d	32.67 d	1.35 a
	IAA 60	71.33 c	37.61 b	9.83 b	17.17 d	33.33 d	1.37 a
	IAA 120	76.00 b	38.45 ab	11.33 ab	21.33 c	39.00 c	1.40 a
	IAA 180	77.67 ab	40.08 a	12.00 ab	24.50 b	42.33 b	1.42 a
	IAA 240	78.00 a	40.37 a	12.50 a	26.50 a	45.00 a	1.44 a
LSD P ≤ 0.05		3.35	2.26	2.54	1.59	2.22	0.21
Interactions BA X Concentrations	BA Cont.	68.00 c	36.67 c	9.33 b	16.67 d	32.33 d	1.33 b
	BA 60	68.67 c	37.89 bc	10.00 b	17.33 d	33.00 d	1.38 b
	BA 120	70.33 bc	38.07 bc	10.83 b	20.83 c	38.00 c	1.39 b
	BA 180	73.00 b	39.66 ab	13.50 a	23.00 b	41.67 b	2.02 a
	BA 240	77.67 a	41.60 a	13.17 a	26.33 a	44.67 a	2.09 a
LSD P ≤ 0.05		3.35	2.26	1.19	1.59	2.22	0.21

Table 2 – Effect of IAA and BA foliar application on some growth parameters and chlorophyll content in leaves of *Antirrhinum majus* var. nana (The dwarf variety) at complete flowering stage

Factors	Treatments (ppm)	Plant height (cm)	Fresh weight (gm)	Dry weight (gm)	Length of raceme (cm)	Number of flowering buds per raceme	Chlorophyll content (mg/g)
		Mean	Mean	Mean	Mean	Mean	Mean
PGR	IAA	19.63 a	28.86 a	8.00 a	9.47 a	18.33 b	1.37 a
	BA	19.70 a	28.67 a	7.92 a	9.43 a	19.53 a	1.43 a
LSD P ≤ 0.05		0.87	0.82	0.53	0.65	0.57	0.10
PGR Concentrations	Control	18.75 b	27.57 c	7.33 b	8.50 c	15.17 d	1.33 a
	60	18.75 b	27.56 c	7.52 b	8.42 c	15.67 d	1.38 a
	120	19.00 b	28.06 bc	7.62 b	9.00 bc	17.83 c	1.40 a
	180	20.00 b	28.99 b	8.17 b	9.67 b	22.00 b	1.43 a
	240	21.83 a	31.66 a	9.17 a	11.67 a	24.00 a	1.46 a
LSD P ≤ 0.05		1.38	1.30	0.84	1.03	0.91	0.16
Interactions IAA X Concentrations	IAA Cont.	18.67 b	27.55 b	7.13 b	8.50 b	15.00 d	1.30 a
	IAA 60	19.33 ab	28.51 b	7.70 b	8.67 b	15.33 d	1.32 a
	IAA 120	19.50 ab	28.52 b	7.83 b	9.17 b	17.33 c	1.38 a
	IAA 180	20.00 ab	29.05 ab	8.17 ab	9.83 ab	20.67 b	1.41 a
	IAA 240	20.67 a	30.68 a	9.17 a	11.17 a	23.33 a	1.44 a
LSD P ≤ 0.05		1.95	1.84	1.19	1.46	1.28	0.23
Interactions BA X Concentrations	BA Cont.	18.83 b	26.00 c	7.53 b	8.50 b	15.33 d	1.35 a
	BA 60	18.17 b	27.00 c	7.33 b	8.17 b	16.00 d	1.43 a
	BA 120	18.50 b	27.60 bc	7.40 b	8.83 b	18.33 c	1.42 a
	BA 180	20.00 b	28.93 b	8.17 ab	9.50 b	23.33 b	1.45 a
	BA 240	23.00 a	32.63 a	9.17 a	12.17 a	24.67 a	1.48 a
LSD P ≤ 0.05		1.95	1.84	1.19	1.46	1.28	0.23

Dry weight of the plant depicts that how efficiently the plants has absorbed the water and minerals and used them to produce the biomass and assimilation. IAA (240 ppm) and BA (180 and 240 ppm) treatment increased this parameter significantly ,these positive responses to IAA and BA may be due to their effects on enzymes activities .It was found that treating alfalfa plants with IAA and KN increased total amylase activity and reduced peroxidase and catalase activity then increase in soluble sugar content ,water and mineral uptake that reflected on plant height ,fresh and dry weight[18] .The results are comparable with those obtained by [19] on *Salvia* and [20] on *Tagetes* plants .They found that application of IAA led to increase in plant height ,fresh and dry weight as well as total carbohydrates and protein .These results are also in harmony with those obtained by [21] ,it was found that IAA application on *Jatropha curcos* L. plant increased plant height ,photosynthetic efficiency and nitrate reductase ,and also in harmony with [22] on *Hibiscus sabdariffa* L. and [23] on *Cadiaeum variegatum* L. plants ,they found that foliar application of benzyladenin influenced the growth and chlorophyll content.

Length of raceme increased significantly with IAA and BA(120,180 and 240 ppm) treatment , IAA and BA (240 ppm) treatment was more significant than IAA and BA(180 ppm) treatment ,while IAA and BA(180ppm) treatment was more significant than IAA and BA (120 ppm) treatment ,this may be due to the role of IAA in inducing differentiation of primary phloem fibers then increasing stem elongation and extension[24], and the role of cytokinins in cell division[25].

These results accompanied with significant increase in flowering buds per raceme at the treatment with IAA and BA **(** 120,180 and 240ppm), hence IAA and BA (240ppm) treatment resulted the highest increment that is more than (180ppm), and (180ppm)is more than (120ppm) significantly. These

results are comparable with those obtained by [26] and [27] who found that flower induction is connected with changes in the hormonal balance and in distribution of the assimilates in the meristems .Wardell and Skoog [28]found that IAA stimulated flower bud formation at low concentration in stem tissue excised from *Nicotiana tabacum* by tissue culture method ,while [29] found the same result at the same treatment with BA .The application of BA to the bulbs of different cultivars of Calla lilies resulted in increasing flowers number and higher greenness in leaves [30] .These results in addition to the role of IAA and BA in stimulating division and elongation may be contributed to their effects on increasing leaf area and surface of photosynthates availability and then increasing water and minerals uptake [31,32] ,and could be explained through their role in stimulating xylem differentiation and vascular strand development ,consequently more absorption of water and nutrients from the soil [33] .

The content of chlorophyll in leaves increased significantly at the treatment with BA (180 and 240ppm) only ,this may be due to the role of BA in decreasing chlorophyllase activity resulting higher chlorophyll a / chlorophyll b ratio that reflected on fresh weight [34] ,or may be contributed to the role in preventing protein breakdown ,activating protein synthesis and assembling nutrients from nearby tissues that lead to slow aging of plant organs [35] .These results are similar to those obtained by [36] on *Nicotiana tabacum* L. and [37] on barley .Chlorophyll content did not affected by the application of IAA ,while some of the auxins had opposite effects ,Karatas *et al* [38] found that treating *Tropaeolum majus* L. with IAA ,IBA and NAA accelerated the loss of chlorophyll content.

The results shows that there was a compatibility between all the parameters except chlorophyll content specially at the highest concentrations for both IAA and BA, while at the concentration 120 ppm the results differ ,hence there was a significant increase in length of raceme and flowering buds per raceme without a compatibility with the other parameters ,this may be due to the inner content of the hormones .

In return to Table-2 for the dwarf variety shows that the effect of interaction between each of IAA concentrations and control treatment was limited ,plant height , fresh and dry weight and length of raceme increased at IAA (240ppm) treatment only .Number of buds per raceme increased significantly at treatment with IAA (120,180 and 240ppm) according to control treatment and significantly between each concentration ,hence IAA (240ppm)was more than IAA (180ppm) which was more than IAA(120ppm) treatment , this was found also at treating *Targets erecta* with both IBA and NAA [39]. Chlorophyll content did not affect.

The effect of interaction between BA concentrations and control treatment was limited ,plant height increased at the treatment with BA (240ppm) only ,fresh weight increased at the treatment with BA(180 and 240ppm) ,BA(240ppm) was more significant than BA(180ppm) treatment ,dry weight and length of raceme increased at the treatment with BA(240ppm) only ,number of buds per raceme increased at the treatment with BA (120,180,240ppm) treatments ,hence BA 240 ppm more significant than 180 ppm that is more significant than 120 ppm treatment . Chlorophyll content did not affect.

The significant increment in number of buds per raceme maybe explained through the role of cytokinins in increasing the efficiency of photosynthesis that leads to increase CO2 in leaves which is the main molecule for carbohydrate synthesis [40] ,or may be contributed to its role in increasing the auxin content or transforming tryptophan to IAA that led to increase in cell division and elongation [41].

The results shows that there was a compatibility between all parameters except chlorophyll content at the treatment with both IAA and BA at 240 ppm, while at the other concentrations the results differ and there was a significant increase in number of buds per raceme between the treatments with 240, 180, 120 ppm, this may be due to the inner content of the hormones and the hormonal balance.

Conclusion:

Treating cut flowers plants (in this study two varieties of *Antirrhinum majus* L.) with plant growth regulators is important and beneficial for increasing horticultural productivity for both tall and dwarf varieties.

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