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BOTANICAL STUDIES ON ROSELLE PLANTS (*Hibiscus sabdariffa* L.) AS AFFECTED BY BENZYLADENINE AND/OR DECAPITATION.

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ABSTRACT

A pot experiment was conducted during the two successive seasons 2001 and 2002 to study the effect of benzyladenine at the concentrations of 0, 100, 200 and 400 mg/l and/or decapitation on growth, yield and its components, anatomical structure and chemical constituents of roselle plants. The results showed that, application of benzyladinine at all concentrations used in the study in both intact and decapitated plants greatly increased growth characters i.e plant height, number of branches / plant as well as leaf area. The maximum values in this respect was obtained by treatment of benzyladenine at 400 mg/l in decapitated plants as compared to the control.

In both intact and decapitated plants all benzyladenine concentrations used in the study significantly increased number of fruits/plant as well as fresh and dry weights of sepals/plant. The highest increase in this concern was attained by benzyladenine at 400 mg/l in decapitated plants as compared to control intact plants.

Benzyladenine application at all concentrations used in the study in both intact and decapitated plants greatly increased the section diameter of stem and leaf petiole as well as the thickness of leaf blade and fruits sepals. This may be due to the increase in parenchymatous tissues in both cortex and pith as well as vascular tissues. Also, leaf pigments concentration such as chlorophyll a, b, carotenoids, sepals pigments such as anthocyanin, total carbohydrates and crude protein were significantly increased due to application of benzyladenine at all concentrations used in this study in both intact and decapitated plants specially the later one. The beneficial effects of benzyleadenine on growth parameters, anatomical character and chemical constituents were reflected on yield and its component mainly the fresh and dry weights of sepals/plant which increased by 333.3 and 411.5%, respectively due to the treatment of benzyladenine at 400 mg/l in decapitated plants in comparison to the control intact plants.

INTRODUCTION

Roselle (*Hibiscus sabdariffa* L.) is an annual plant known in Egypt as karkadeh, and cultivated for its dried sepals which are used for preparing cold and hot drinks. Also, roselle is used in therapeutic purpose due to its effect in reducing huperviscosity, arterial pressure and relaxing the plain muscles of the

ureters and intestines (Sharaf 1962). Roselle coloring material showed an inhibiting effect on *Mycobacterium tuberculosis*. (Sharaf and Geneidy, 1963). Red pigment of roselle sepals are used in food industries and cosmetics.

Fruits of roselle are borne on both monopodial main stem and the sympodial lateral branches which arise from the development of one or two buds in each leaf axile (Rhem and Espig, 1976). Thus, increasing the sprouting of these buds which is desirable for increasing roselle yield.

Many workers emphasized the importance of decreasing auxin: cytokinin ratio for enhancing the inhibited lateral buds (Hall, 1973; Davies 1987 and Tomkins and Hall, 1991).

Several investigators used cytokinin and/or decapitation for releasing the lateral buds from inhibition and consequently increasing the yield of various plants e. g., Zayed *et al.*, (1985a) on roselle; Khfaga, (1982); Umarov, *et al.*, (1986); Hedin *et al.*, (1988); Hofmann and Else (1989) and Oosterhuis *et al.*, (1998) on cotton plant.

The objectrive of this study was to assess the role of exogenously applied beneyladenine (as acytokinin) and/or decapitation in eliciting enhanced growth of the lateral buds, yield, chemical constituents and anatomical structure of roselle plants.

MATERIALS AD METHODS

This work was carried out at the Faculty of Agricultural, Fayoum, Cairo University, during the two sucessive seasons 2001 and 2002. Seeds of roselle plants, (*Hibiscus subdariffa* L. var. sabdariffa) were secured from the Experimental farm Medicinal and Aromatic plants, Faculty of Pharmacy, Cairo University. Seeds were sown on April 15th in both seasons in clay pots, 50 cm in diameter, each was filled with 12 kg clay soil. Five seeds were sown in each pot and were thinned to 2 plants after 21 days. Irrigation and fertilization were carried out as recommended by the Ministry of Agricultural.

Benzyladenine (6-benzylaminopurine) or BA was obtained as a pure powder from Sigma Company, Germany and was used at the concentrations of 0, 100, 200 and 400 mg/L.

Decapitation was made directly before benzyladenine application by cutting the terminal bud (about 3 cm from the top) by a sterilized razor blade. The concentrations of benzyadenine were sprayed at both intact and decapitated plants at the ages of 90 and 120 days from sowing. Plants were well sprayed in the morning until dripping. Tween 20 was added as a surfactant at the rate of 1 ml/L. Control plants were sprayed with distilled water in addition to the surfactant.

The experiment was in a complete randomized block design with 8 treatments and 3 replicates, each replicate was represented by 3 pots.

1-Morphological characters:

At the age of 150 days (at both seasons) the following morphological data were recorded:

- Plant height (cm) was measured from the lower node to plant top in intact plants and to the apex of the tallest branch in decapitated plants.
- Leaf area (cm^2): the first fully expanded leaf from the top was measured by a LI Core area meter model LI 3000.
- Number of branches/plant.

2- yield and yield components:

At the age of 160 days (at both seasons) plants were harvested and the following data were recorded:

- Number of fruits/plant.
- Sepals fresh weight/plant (g).
- Sepals dry weight/plant(g).

Sepals were dried in an electric oven at 80 c° $\pm$ 2 till constant weight .

3- Chemical analysis:

At the age of 150 days (at both seasons), samples of leaves were taken for the determination of:

- Chlorophyll a, b, and carotenoids (mg/100 g fresh leaves) were extracted and determined as mentioned by Fadeel (1962).
- Total carbohydrates (%) in dry matter of leaves were determined using the phenol-sulphoric acid reagent method as outlined by Dubois *et al.*, (1965).
- N (%) in dry matter of leaves was determined, using the Orange G dye clorimeteric method (Hafez and Hikkelsen 1981). Crude protein calculated by the formule N % x 6.25.
- Anthocyanin (mg/g) was determined according to the method described by Fahmy (1970).

4- Anatomical study:

At the age of 150 days from sowing samples from the fourth internode from the apex of the tallest branch and its leaf (petiole and blade) as well as sepals from fruits of the tallest branch were taken during the second season for anatomical study. Samples were killed and fixed in F. A. A. solution (50 ml 95% ethy/alcohol + 10 ml formalin + 5 ml glacial acetic acid + 35 ml distilled water) for 48 hours. Thereafter, samles were washed in 50% ethylalcohol, dehydrates and cleared in tertiary butyle alcohol series, embedded in paraffin wax of 54-56 c° m. p. Cross section, 20 μ thick, were cut by a rotary microtome, adhesived by Haupt's adhesive and stained with the crystal violet-erythrosine combination (Sass, 1961), cleared in carbol xylene and mounted in Canada balsam.

Measurments were done, using a micrometer eyepiece and average of readings were calculated.

Data were statistically analyzed according to Snedecor and Cochran (1982).

As no significant differences were observed between results of the two seasons of the study , the average of the two season were presented and discussed.

RESULTS AND DISCUSSION

Morphological characters

Data in Table (1) show that, the morphological characters were significantly increased by increasing the concentration of benzyladenine in both intact and decapitated plants. However, in intact plants benzyladenine at 400 mg/l significantly increased plant height, leaf area and number of branches/plant by 35.4, 21.3 and 66.9%, respectively in comparison to the control. In decapitated plants treated with benzyladenine showed similar trend but with less extend. The highest significant increase in number of branches/plant was obtained by benzyladenine at 400 mg/l in decapitated plants, which recorded an increase reaching 89.3% as compared to the control intact plants.

The beneficial effect of benzyladenine (as a cytokinin) on morphological characters i. e plant height and leaf area may be attributed to its stimulating effect on cell division, elongation and expansion as reported by Hofmann and Else (1989).

The increase of number of branches/plant by benzyladenine application could be due to the effect of exogenous application of cytokinin in reducing auxin: cytokinin ratio which encouraged the lateral buds to be released from inhibition. Also, decapitation alone increased number of branches/plant. This could be due to the role of decapitation in reducing auxin: cytokinin ratio by lowering the natural auxin (Indole-3-acetic acid). Similar results were obtained by Zayed *et al.*, (1985a) who reported that, benzyladenine at 300 mg/l induced sprouting of reproductive sympodial branches of roselle plants. Also, Talaat and Youssef (1998) showed that benzyladenine at 40 mg/l significantly promoted growth characters of roselle plants.

Yield and its components.

In both intact and decapitated plants benzyladenine at all concentrations used in the study significantly increased yield and its components as compared to the control (Table 1). The highest increase was obtained by benzyladenine at 400 mg/l in decapitated plants, the increments attained 152.0 % in number of fruits/plant, 333.3 % and 411.5% in fresh and dry weight of sepals, respectively as compared to the control intact plant. In intact plants using benzyladenine at the same concentration gave a similar trend but with less extend. The stimulating effect of benzyladenine and/or decapitation on number of branches/plant as mentioned before was reflected on the increase in number fruits/plant and consequently fresh and dry weights of sepals/plant. The present results are similar to those obtained by Zayed *et al.*, (1985a) on roselle plants.

Anatomical studies:

The stem:

Table (2) and Fig (1) show that, application of benzyladenine at all concentrations used in the study had a stimulating effect on stem tissues of both intact and decapitated plants specially the late one. However, in intact plants benzyladenine application at 400 mg/l greatly increased stem section diameter by 43.0%. this was mainly due to 35.6% increase in thickness of the vascular cylinder which was accompanied by by 13.3% increase in diameter of xylem vessels, 25.8% increase in thickness of cortex through 18.5 and 6.1% increase in the number of cell rows and average diameter of cell respectively as well as 50.4% increase in pith diameter by increasing its cell rows and diameter by 17.0 and 28.6% respectively in comparison to the control. Decapitation alone slightly increased stem section diameter by 5.9% but this increase was mainly due to the increase in pith diameter (5.0%) by increasing its cell rows and diameter. In decapitated plants application of benzyladenine at all concentrations greatly increased stem section diameter, this was due to the increase in stem tissues as compared to the control. It is clear that the response of decapitated plants was higher than that of intact plants.

Leaf petiole

Data in Table (3) and Fig (2) show that, in both intact and decapitated plants application of benzyladenine at all concentrations used in the study greatly increased section diameter of leaf peitole. However, in intact plants using benzyladenine at 400 mg/l increased section diameter of leaf peitole by 11.7%. This was mainly due to the increase in length and width of the vascular bundles by 19.3 and 18.5%, respectively and pith diameter by 20% by increasing its rows and average cell diameter over the control. In decapitated plants benzyladenine at 100 mg/l showed the maximum increase in petiole diameter (17.9%) this was due to the great increase in parenchymatous cells in cortex and pith and dimension of vascular bundles as compared to the control. Decapitation alone showed a similar trend.

Leaf blade

It is clear from Table (4) and Fig. (3) that application of benzyladenine in both intact and decapitated plants had a stimulating effect on leaf blade, as there was an increase in midvein and blade thickness. In intact plants application of benzyladenine at 400 mg/l showed the maximum increase in midvein and blade thickness by 8.3 and 23.1%, respectively. The increase in blade thickness included an increase in both spongy and palisade tissues mainly the former, the increase in midvein thickness was accompanied by an increase in dimensions of the vascular bundle, which have more number of vessels/bundle as compared to the control. Decapitation alone increased blade thickness due to the increase in both spongy and palisade tissues specially the farmer, also there was an increase in dimension of vascular bundles, which have more number of vessels/bundle as compared to the control. In decapitated plants benzyladenine application showed a similar trend.

Table (1): Effect of benzyladenine at different concentrations an d/ or decapitation on some morphological characters as well as yield and its components of roselle plants.

Treatments		Characters					
Decapitation	Benzyladenine concentrations (mg/L)	Plant height (cm)	Leaf area (cm^2)	No. of branches/plant	No. of fruits/plant	Sepals fresh weight/plant (g)	Sepals dry weight/plant (g)
Intact	0	122.3	63.8	10.3	12.5	22.1	2.6
Intact	100	132.8	67.2	12.8	16.3	45.5	5.3
Intact	200	148.7	72.9	15.6	23.8	59.4	7.3
Intact	400	165.6	77.4	17.2	25.9	85.5	11.2
Decapitated	0	115.4	59.1	13.9	16.3	30.8	3.8
Decapitated	100	120.8	63.5	15.7	22.8	55.5	6.8
Decapitated	200	136.7	69.8	18.1	27.2	73.1	9.1
Decapitated	400	155.8	73.4	19.5	31.5	95.8	13.3
L. S. D at 5%		6.5	2.9	1.3	2.5	2.8	1.1

Table (2): Effect of benzyladenine at different concentrations and/or decapitation on the structure of roselle stem.

Treatments		Characters								
			Cortex			Thickness of vascular cylinder (μ)	Av. xylem vessels diameter (μ)	Pith		
Decapitation	Benzyladenine concentrations (mg/L)	Section diameter (μ)	Thickness (μ)	No. of cell rows	Average cell diameter (μ)			Diameter (μ)	No. of rows	Av. cell diameter (μ)
Intact	0	5287.5	622.5	13.5	46.1	562.5	47.5	2975.0	44.0	67.6
Intact	100	5537.5	626.7	15.7	39.9	616.7	48.8	3400.0	54.0	62.9
Intact	200	5725.0	603.3	14.3	42.2	443.3	48.8	3500.0	50.0	70.0
Intact	400	7562.5	783.3	16.0	48.9	762.5	53.8	4475.0	51.5	86.9
Decapitated	0	5600.0	565.0	12.5	45.2	547.5	42.5	3125.0	43.5	71.8
Decapitated	100	6937.5	633.0	13.0	48.7	583.3	56.3	3375.0	45.0	75.0
Decapitated	200	6387.5	607.5	15.3	39.7	575.0	56.3	3750.0	60.5	61.9
Decapitated	400	7562.5	555.0	13.8	40.2	660.0	51.3	3650.0	40.5	90.1
L. S. D at 5%										

Table (3): Effect of benzyladenine at different concentrations and/or decapitation on the structure of roselle leaf petiole.

Treatments		Characters								
			Cortex			Vascular bundle		Pith		
Decapitation	Benzyledenine Concentrations (mg/L)	Section diameter	Diameter (μ)	No. of cell rows	Av. cell diameter (μ)	Length (μ)	Width (μ)	Diameter (μ)	No. of cell rows	Av. cell diameter (μ)
Intact	0	2450.0	500.0	13.0	38.5	285.0	498.0	975.0	18.0	54.2
Intact	100	2662.5	486.7	11.7	41.6	375.0	625.0	1060.0	19.5	54.4
Intact	200	2662.5	446.7	11.0	40.6	390.0	633.3	1125.0	8.5	60.8
Intact	400	2737.5	463.3	12.7	36.5	340.0	590.0	1170.0	19.0	61.6
Decapitated	0	2662.5	366.7	10.3	35.6	395.0	575.0	1150.0	19.5	58.9
Decapitated	100	2887.5	510.0	13.0	39.2	350.0	500.0	1000.0	19.5	51.3
Decapitated	200	2550.0	413.3	10.3	40.1	406.6	606.7	975.0	16.5	59.1
Decapitated	400	2712.5	386.7	11.3	34.2	393.0	626.7	1375.0	20.5	67.1

Table (4): Effect of benzyladenine at different concentrations and/or decapitation on the structure of roselle leaf blade.

Treatments		Characters								Av. Diameter of xylem vessels (μ)
				Mesophyll			Vascular bundle			
Decapitation	Benzyledenine Concentrations (mg/L)	Midvein thickness (μ)	Blade thickness (μ)	Palisade tissue thick (μ)	Spongy tissue thick (μ)	No. of layer	Length (μ)	Width (μ)	No. of vessels bundle	
	0	1500.0	260.0	90.0	80.0	5.0	420.0	850.0	66.0	41.3
Intact	100	1500.0	290.0	100.0	120.0	5.0	460.0	820.0	115.0	33.8
Intact	200	1600.0	330.0	120.0	150.0	5.0	400.0	860.0	105.0	41.3
Intact	400	1625.0	320.0	110.0	170.0	6.0	450.0	950.0	115.0	38.0
Decapitated	0	1400.0	310.0	110.0	150.0	5.0	470.0	800.0	125.0	35.0
Decapitated	100	1525.0	320.0	130.0	140.0	5.0	450.0	870.0	128.0	43.8
Decapitated	200	1500.0	270.0	110.0	110.0	5.0	450.0	850.0	104.0	38.8
Decapitated	400	1550.0	280.0	100.0	120.0	5.0	400.0	800.0	105.0	37.5

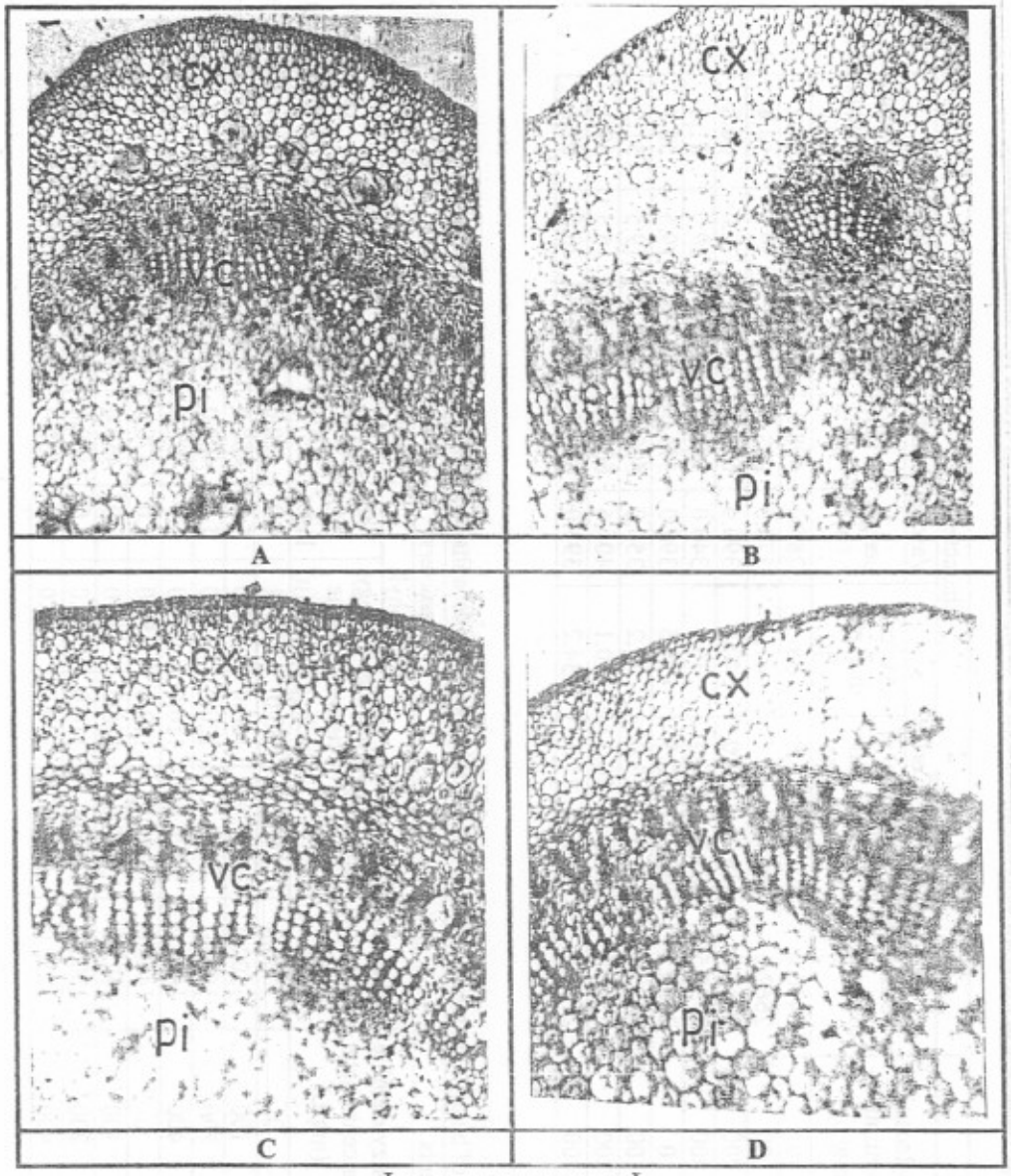

Fig. (1): Transaction of roselle stem as affected by benzyladenine and / or decapitation treatments. a- intact control plant. b- Decapitated control plant.
c- Intact plant + 400 mg benzyladenine/L.
d- Decapitated plant + 400 mg Benzyladenine
(Cx= Cotrex, pi= pith and vc = vascular cylinder)

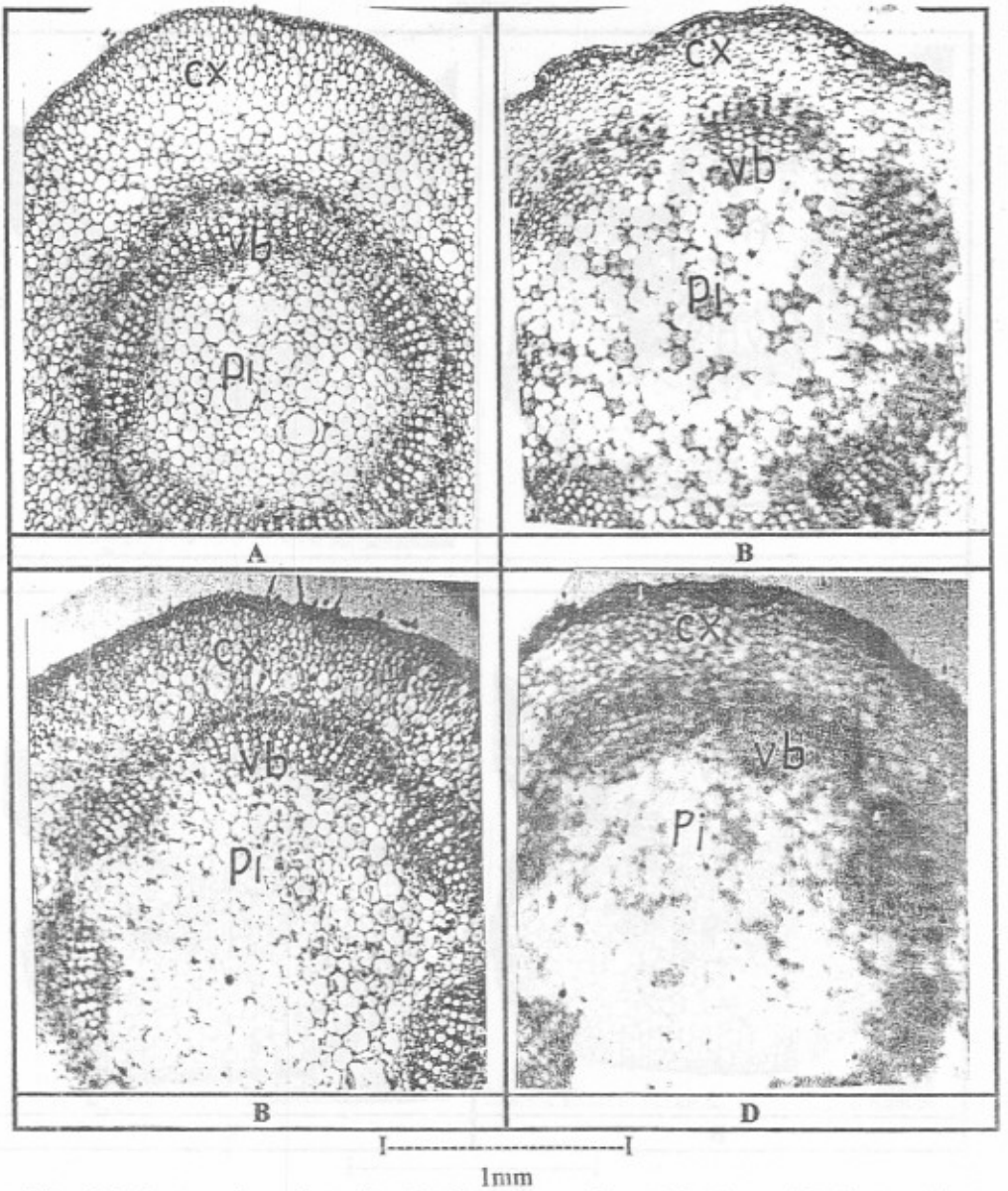

Fig. (2): Transaction of roselle leaf petiole as affected by benzyladenine and / or decapitation treatments. a- intact control plant .

b- Decapitated control plant. c- Intact plant + 400 mg benzyladenine/L.

d- Decapitated plant + 400 mg Benzyladenine

(Cx= Cotrex, pi= pith and vc = vascular cylinder)

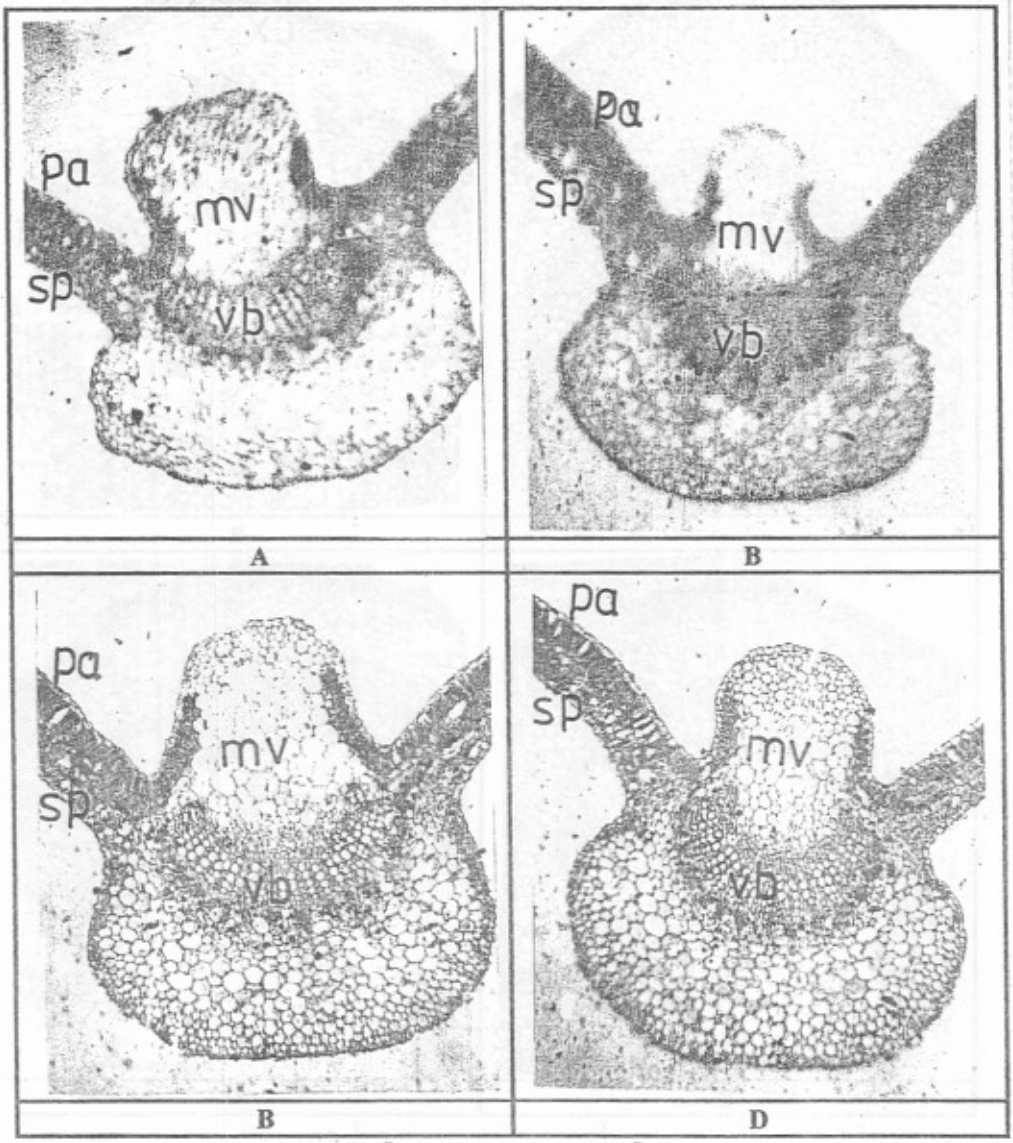

Fig. (3): Transaction of roselle leaf blade as affected by benzyladenine and / or decapitation treatments. a- intact control plant .

b- Decapitated control plant. c- Intact plant + 400 mg benzyladenine/L.

d- Decapitated plant + 400 mg Benzyladenine

(mv = midevine, pa= palisade tissue, sp= spongy tissue , vb = vascular bundle)

Sepals of fruits

Data in Table (5) and Fig. (4) show that application of benzyladenine at all concentrations used in the study in both intact and decapitated plants increased sepals thickness by increasing its cell rows and diameter as well as dimension of vascular bundles in comparison to the control. The maximum increase in sepals thickness (46.7%) was noticed in intact plants sprayed with benzyladenine application at 200 mg/l, this was mainly due to increasing average cell diameter by 52.4% and length of vascular bundle by 57.1% as compared to the control.

Decapitation alone or the combination between decapitation and benzyladenine showed a similar trend but was less extend in some cases in comparison to the control.

The increase in stem and leaf petiole diameter, as well as leaf blade and sepal thickness due to benzyladenine application (as a cytokinin) could be attributed to its stimulating effect on cell division and cell elongation (Arteca, 1996). Benzyladenine application to decapitated plants was more efficient than that in intact plants in increasing stem and leaf blade diameter as well as sepals thickness. This was due to the stimulating cumulative effect of both the benzyladenine and decaptation.

In cotton plants, Abed, (2001) showed that, benzyladenine at 300 mg/l increased stem and leaf petiole diameter as well as blade thickness.

3- Chemical constituents:

Data in Table (6) show that increasing benzyladenine concentrations caused a significant increase in the chemical constituents of both intact and decapitated plants reaching its maximum in decapitated ones which recorded the highest values. However, in intact plants benzyladenine applicationat 400 mg/l significantly increased chlorophyll a, b, carotenoids, total carbohydrates, crude protein in leaves and anthocyanin in dry sepals by 89.3, 87.2, 134.6, 46.1 30.9 and 54.8%, respectively as compared to the control.

Decapitation alone gave a similar trend but with less extend. The maximum significant increase in chemical constituents was obtained by applying benzyladenine at 400 mg/l in decapitated plants, which led to an increase of 122.1, 110.0, 157.3, 63.7,32.6 and 84.9%for chlorophyll a, b, cartenoids, total carbohydrates crude protein in leaves and anthocyanin in sepals, respectively as compared to the control.

The stimulating effect of benzyladenine in increasing leaf and sepals pigments might be attributed to its role in increasing pigments synthesis (Arteca, 1996). The stimulating role of benzyladenine and decapitation on total carbohydrates in leaves could be due to their role in increasing chlorophyll content mentioned before. Zayed *et al.*, (1985b) reported that using benzyladenine at 300 mg/l increased chlorophyll a, b, and carotenoids contents in leaves of roselle plants Talaat and Youssef (1998) showed that benzyladenine at 40mg/l increased leaf photosynthetic pigments, total carbohydrates and crude protein in roselle plants. Abed, (2001) showed that the use of benzyladenine at 300mg/l increased leaf pigments, total carbohydrates and crude protein in leaves of cotton plants.

Table (5): Effect of benzyladenine at different concentrations and/or decapitation on the structure of roselle sepals.

Treatments		Characters				
Decapitation	Benzyledenine Concentrations (mg/L)	Sepals			Vascular bundle	
		Thickness (μ)	No. of cell rows	Av. cell diameter (μ)	Length (μ)	Width (μ)
Intact	0	1125.0	26.0	43.3	350.0	350.0
Intact	100	1525.0	23.0	66.3	550.0	480.0
Intact	200	1650.0	25.0	66.0	550.0	530.0
Intact	400	1175.0	21.0	55.9	340.0	280.0
Decapitated	0	1550.0	25.0	62.0	650.0	520.0
Decapitated	100	1300.0	24.0	54.2	350.0	290.0
Decapitated	200	1155.0	24.0	45.8	300.0	300.0
Decapitated	400	1225.0	23.0	53.3	490.0	440.0

Table (6): Effect of benzyladenine at different concentrations and/or decapitation on chemical constituents of roselle plants.

Treatments		Characters					
Decapitation	Benzyladenine concentrations (mg/L)	Chlorophyll a (mg/100 fresh leaves)	Chlorophyll b (mg/100 fresh leaves)	Carotenoids (mg/100 g fresh leaves)	Total carbohydrates in dry leaves %	Crude protein in dry leaves %	Anthocyanin (mg/g) in dry sepals
Intact	0	92.8	83.7	28.6	10.2	24.2	7.3
Intact	100	115.8	97.5	36.8	12.9	26.8	8.5
Intact	200	160.5	137.8	46.3	13.3	28.1	9.8
Intact	400	175.7	156.7	67.1	14.9	31.7	11.3
Decapitated	0	99.3	85.8	33.2	11.3	28.2	8.5
Decapitated	100	136.3	121.8	47.8	13.5	29.3	10.9
Decapitated	200	181.7	156.5	68.4	14.2	31.8	11.7
Decapitated	400	206.1	175.8	73.8	16.7	32.1	13.5
L. S. Dat 5%		3.1	2.9	1.8	1.1	1.8	0.9

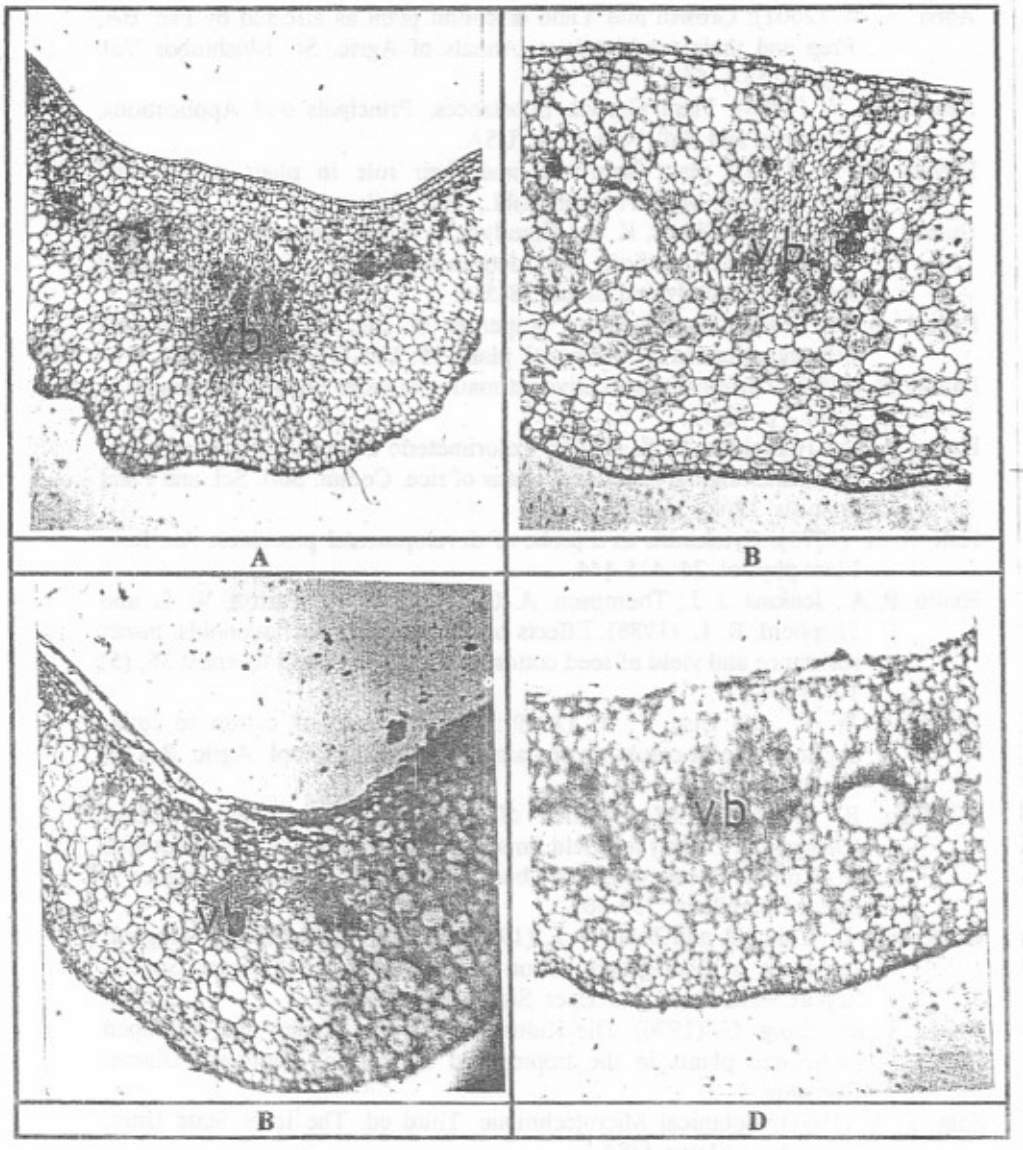

Fig. (4): Transaction of roselle sepal as affected by benzyladenine and / or decapitation treatments. a- intact control plant .

b- Decapitated control plant. c- Intact plant + 400 mg benzyladenine/L.

d- Decapitated plant + 400 mg Benzyladenine.
(vb = vascular bundle)

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دراسات نباتية على نباتات الكركديه المعاملة بالبنزيل أدينين والتطويش.

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إجريت تجربة أصص خلال موسمين متتاليين هما ٢٠٠١، ٢٠٠٢ لدراسة تأثير المعاملة بالبنزيل أدينين (بتركيزات صفر ،١٠٠ ،٢٠٠ ،٤٠٠ ملليجرام/لتر) والتطويش على صفات النمو والمحصول ومكوناته والتركيب التشريحي والمكونات الكيميائية لنباتات الكركديه. أظهرت النتائج أن معاملة النباتات السليمة والمطوشة بالبنزيل أدينين بكل تركيزاته المستخدمة فى هذه الدراسة أدى إلى حدوث زيادة كبرى في صفات النمو مثل ارتفاع النبات ومساحة الورقة وعدد الأفرع لكل نبات. أدت معاملة النباتات المطوشة بالبنزيل أدينين بتركيز ٤٠٠ ميلليجرام/لتر إلى حدوث أعلى زيادة في صفات النمو السابق ذكرها.

أدت المعاملة بالبنزيل أدينين بكل تركيزاته المستخدمة فى الدراسةعلى كل من النباتات السليمة والمطوشة إلى حدوث زيادة معنوية في عدد الثمار لكل نبات والوزن الطازج والجاف للسبلات لكل نبات ،وكانت أعلى زيادة في صفات المحصول السابقة كنتيجة للمعاملة بالبنزيل أدينين بتركيز ٤٠٠ ملليجرام/لتر في النباتات المطوشة مقارنة بالنباتات الغير معاملة.

أدت المعاملة بالبنزيل أدينين بكل تركيزاته في الدراسة على كل من النباتات السليمة والمطوشة إلى حدوث زيادة كبرى في قطر قطاعات الساق وعمق الورقة وسمك نصل الورقة وسبلات الثمرة ،وكانت هذه الزيادة ناشئة من حدوث زيادة في النسيج البارنشيمي في كل من القشرة والنخاع والأنسجة الوعائية . أدت المعاملة بالبنزيل أدينين بكل تركيزاته في كل من النباتات السليمة والمطوشة وبصفة خاصة النباتات المطوشة إلي حدوث زيادة معنوية في صبغات الأوراق مثل الكلورفيلات أ ،ب

والكاروتينويدات وكذلك صبغات سبلات الثمار مثل صبغة الأنثوسيانين بالإضافة إلـــى حدوث زيادة معنوية في محتوى الأوراق من الكربوهيدرات الكلية والبروتين الخام.

التأثيرات الإيجابية على صفات النمو والتركيب التشريحي لأعضـــاء النبـــات والمحتوى الكيميائي للاوراق انعكس بدرجة واضحة على المحصول ومكوناته وبصفة خاصة محصول الوزن الطازج والجاف للسبلات لكل نبات حيث كانت نســـبة الزيـــادة ٤١١،٥،٣٣٣،٣ % على الترتيب مقارنة بكنترول النباتات السليمة كنتيجـــة للمعاملـــة بالبنزيل أدينين بتركيز ٤٠٠ ملليجرام/لتر في النباتات المطوشة