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EFFECT OF SOME GROWTH RETARDANTS ON GROWTH AND FLOWERING OF *HELIANTHUS ANNUUS* L. CV. SUNRICH ORANGE SUMMER 981V PLANTS
A- EFFECT OF FOLIAR SPRAY TREATMENTS WITH ANCYMIDOL, DAMINOZIDE AND ETHEPHON

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ABSTRACT: Pot experiments were carried out at the nursery of Hort. Res. Inst, Giza, Egypt throughout the two successive seasons of 2014 and 2015. The work embodied in this paper was to study the influence of some growth regulators (daminozide, ancymidol and ethephon) on sunflower (*Helianthus annuus* L. cv. Sunrich Orange Summer 981V) plant for achieving the hope of producing dwarf plant of good quality, suitable for using as a pot plant.

Results indicated that most treatments reduced stem length of the treated plants with the superiority of 2450 ppm daminozide treatment which induced 50% reduction in such trait, compared to the control plants in the two seasons. However, stem diameter and number of internodes/stem were improved in response to all the used treatments. Internode length, stem fresh and dry weights were decreased with few exceptions, but the greatest decrease in these criteria was attained by daminozide treatment at any rate and ethephon one at 250 ppm. Number of leaves/plant were increased by the various treatments. Root length increased over control with few exceptions in both seasons. However, the highest averages in most measurements were achieved by ancymidol, especially at 20 ppm level. A significant flowering earliness in the two seasons was noticed in plants sprayed with ethephon at 250 ppm. The least number of days from flower bud appearance to opening was obtained by the 20 ppm ancymidol treatment, but the plants treated with the other treatments took longer time to anthesis. Ethephon treatments elevated the mean number of lateral buds/stem to the maximum, while ancymidol ones gave the largest flower heads. Number of ray flowers/head, disc diameter and flower head fresh and dry weights were improved due to most treatments. Content of photosynthetic pigments were slightly improved with few exceptions. Total phenols content reached the maximum by ancymidol treatments, followed by the ethephon ones. However, total indoles content was not affected by most of the used treatments. In addition, the percent of total soluble sugars was increased by ancymidol at 5 ppm, daminozide at 2450 ppm and ethephon at 500 ppm treatments, while other treatments declined it. On the other hand, the percent of N, P and K was generally decreased in response to the various treatments, with few exceptions as compared to control.

Key words: Sunflower (*Helianthus annuus* L.), growth retardants, dwarfing, ancymidol, daminozide, ethephon.

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INTRODUCTION

Sunflowers (*Helianthus annuus* L. cv. Sunrich Orange Summer 981V) family Asteraceae have a great potential as an ornamental plant because of their short growing cycle and easy propagation, but mainly because they have attractive inflorescences that are much sought after as cut flowers (Anefalos and Guilhoto, 2003).

Plant growth retardants are synthetic compounds used to retard the shoot length of plants in a desired way without changing developmental patterns or evoke phototoxic effect. This has been achieved not only by reducing cell elongation but also lowering the rate of cell division and regulating the plant height physiologically (Rademacher, 1995). Most plant growth retardants inhibit the formation of growth – active gibberellin (GA_s) and can thus be used to reduce unwanted shoot elongation (Singh, 2004 and Mansuroglu *et al.*, 2009). Growth retardants have also been noticed to increase the stress tolerance of plants during shipping, handling and rebial marketing thereby improving the shelf life, an important aspect in marketing practices (Latimer, 2001). Growth retardants control excessive vegetative growth that helps to adjust a perennial plant species to an annual cycle of cultivation for trimming hedges and trees.

The mode of action of plant growth retarding chemicals varies. Ancymidol (A-Rest; Sepro Crop, Carmel. Ind.) [a-cyclopropyl - a - (*p*-methyoxy-phenyl) - 5-pyrimidinemethanol ($C_{15}H_{16}N_{202}$)] reduce stem elongation by inhibiting the Kaurene oxidation sequence of reactions in the gibberellins biosynthesis pathway (Gianfaga, 1995). Daminozide (B-Nine; Uniroyal Chemical Co.) [butonedioic acid mono (2,2-dimethyl-hydrozide)] is reported to act by inhibiting translocation of gibberellins (Menhennet, 1980) and by increasing gibberellin degradation (Takeno *et al.*, 1981). Ethephon (2-chloroethyl phosphonic acid) is an ethylene compound, and it is widely used a plant growth regulator. The effect of the application of Oxogenous gaseous ethylene or ethephon varies with plant species, chemical concentrations timing and duration of application. Ethephon regulates phases of plant growth and development by application to various growth sites (Kidd and James, 1991). Ethephon is used in the ornamental industry to delay flowering, selective to flower abortion, leaf abscision as well as to reduce stem elongation and increase stem strength (Basra, 2000). Briggs (1975) reported that stem and leaf length of Narcissus “Carlton” were effectively reduced by application of ethephon. However, sugars accumulation is promoted in tepals and pistil of tulip cv. Apeldoorn.

Concerning daminozide effect, various workers ascertained its beneficial effect in reducing plant height, suitable for different purposes. Ahmad *et al.* (2007) studied the effect of alar on *Dianthus caryophyllus* var. Red Sim for improving the production of compact plant. Two levels of hormone i.e. 200 and 400 mg l^{-1} were sprayed for the purpose. Dwarfness, number of branches and reduction in leaf area were directly correlated with the concentration of chemical. Also, alar decreased flower size considerably. George Kofidis *et al*. (2008) evaluated the effect of daminozide on certain growth characteristics of coriander (*Coriander sativum* L.). Daminozide was found effective on reducing stem elongation, that response varied with the concentration used (5000 or 1000 mg l^{-1}). Daminozide had an insignificant effect on fresh weight and chlorophyll a and b content. Mushtaq *et al.* (2011) on *Erysimum marchallii* stated that B-nine application (500, 1000 and 1500 mg l^{-1}) was not effective for decreasing plant height. The fresh and dry mass of roots, leaves and stem was decreased by the spray of B-nine. Also, B-nine applications slightly decreased the flowering yield and number of laterals. The flower diameter was slightly decreased by the spray application of B-nine. Reduced leaf area was the characteristic feature of the plants sprayed with B-nine.

Several authors investigated the effect of ethephon on dwarfying of some plants and other morphological characters, Banon *et al.* (2003) experimented the effect of ethephon (ETH) to control the growth and development of the aerial part of *Reichardia tingitana* ETH (25, 50, 75 and 100 mg/pot) doses. Results revealed that the most effective treatment was 100 mg/pot for ETH, which reduced plant height by 50.3%. ETH (≥25mg) significantly reduced plant width, aerial part dry weight, number of flowering stems and number of inflorescences per plant. ETH doses reduced inflorescence diameter. ETH (≥50mg) delayed the beginning of flowering.

Therefore, the work embodied in this paper was to study the influence of some growth regulators (daminozide, ancymidol and ethephon) on sunflower (*Helianthus annuus* L. cv. Sunrich Orange Summer 981V) plant for achieving the hope of producing dwarf plant of good quality, suitable for using as a potted plant.

MATERIALS AND METHODS

Pot experiments were carried out at the nursery of Hort. Res. Inst, Giza, Egypt throughout the two successive seasons of 2014 and 2015. The work embodied in this paper was to study the influence of some growth regulators (daminozide, ancymidol and ethephon) on sunflower (*Helianthus annuus* L. cv. Sunrich Orange Summer 981V) plant for achieving the hope of producing dwarf plant of good quality, suitable for using as a potted plant.

Seeds of annual sunflower (*Helianthus annuus* L. cv. Sunrich Orange Summer 981V, which is single-headed and has orange yellow ray florets with a black center, were imported from abroad by Floramax local commercial farm, El-Mansouria, Giza, Egypt), were sown on March, 30th for each season, in 25-cm diameter plastic pots (one seed/pot) filled with about 5 kg of sand and clay soil mixture at equal parts by volume (1:1 v/v). The physical and chemical properties of the sand and clay used in the two seasons are shown in Table (a).

Germination of the seeds was complete 6 days after sowing and 15th day after planting, plants showed two pairs of vegetative leaves.

Experiment:

In the experiment, three growth retardants, namely ancymidol at 0, 5 and 20 ppm, dominozide (B-9) at 0.0, 1250 and 2450 ppm and ethephon at 0.0, 250 and 500 ppm were sprayed 3 times with 2 weeks interval on the foliage till the run-off. Plants were arranged in a complete randomized design (7 treatments with 3 replicates. Each replicate contained 5 plants).

Control plants were sprayed with tap water. Plants under all treatments were fertilized through the course of the study with kristalon (19:19:19 + micronutrients) at the rate of 4 g/l as a liquid drench application, alternatively with growth retardants spray treatments three times (the first one was added on April, 22nd) throughout the growth cycle of plants.

Table a. Physical and chemical properties of the used sand and clay in both seasons.

Soil type	Season	Particle size distribution (%)				S.P	E.C. (ds/m)	pH	Cations (meq/l)				Anions (meq/l)		
		Coarse sand	Fine sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}
Sandy soil	2014	89.03	2.05	0.40	8.52	23.01	3.56	7.90	7.50	1.63	33.60	0.50	3.20	22.00	18.03
	2015	84.76	6.29	1.50	7.45	21.87	3.71	7.80	19.42	8.33	7.20	0.75	1.60	7.80	26.30
Loamy soil	2014	10.18	46.17	19.53	24.12	35.00	3.48	8.27	17.50	9.42	20.00	0.79	3.80	10.00	33.91
	2015	10.30	46.54	18.88	24.28	33.07	3.36	7.96	18.00	8.95	20.50	0.85	3.65	10.20	34.45

Data recorded at the end of experiment:

Plants in each treatment were observed daily until the first flower bud appeared:

- Stem length (cm)
- Stem diameter (cm)
- Number of internodes/stem
- Internodes length (cm)
- Stem fresh and dry weights (g)
- Number of leaves/plant
- Leaf length and width (cm)
- leaves fresh and dry weights (g)
- Root length (cm)
- Roots fresh and dry weights (g)
- Number of days to flower bud appear once (days)
- Number of days to flower bud opening (days)
- Number of days from flower bud appear to opening once (days)
- Number of lateral buds/stem
- Flower head diameter (cm)
- Number of ray flowers per head
- Disc diameter (cm)
- Ray flower length (cm)
- Flower heads fresh and dry weights (g)

In fresh leaf samples, the photosynthetic pigments content (chlorophyll a, b and carotenoids), total phenols, total indoles and total soluble sugars were evaluated according to the methods of Yadava (1986), William *et al*. (1965), A.O.A.C. (1990) and Dubois *et al*. (1966), respectively; In dry leaf samples the percentages of nitrogen (Pregl, 1945), phosphorus (Luatanab and Olsen, 1965) and potassium (Jackson, 1973) were evaluated.

Data were tabulated and submitted to analysis of variance using program of SAS Institute (2009) and the differences among the means of treatments were determined with respect to their homogeneity by Duncan's New Multiple Range Test (Steel and Torrie, 1980) at 5 % level.

RESULTS AND DISCUSSION

1- Effect on vegetative and root growth parameters:

Table (1) indicates that most treatments shortened stem length of sprayed plants with the supremacy of daminozide spray at 2450 ppm which reduced the mean of this trait to 32.83 and 33.00 cm versus 64.25 and 63.58 cm for the control plants in the 1st and 2nd seasons, respectively (about 50 % reduction), followed by spraying with ethephon at 500 ppm that caused about 45% reduction in this parameter. This may be due to daminozide which renders a key enzyme for GA production useless, at the end of the GA production process, thus reducing GA levels, while ethephon does not inhibit GA production. Plants takeup ethrel through the leaves and convert it to ethylene in plant cells. The increased ethylene level causes cells to limit elongation and increase width instead (Currey and Lopez, 2008). In this regard, Kazaz *et al*. (2010) stated that applying daminozide solutions to the substrate, is ineffective. In C*hrysanthemum* Similar effects were also obtained by Sabbagh *et al*. (2008) and Cuquel *et al*. (2010) on sunflower, Warner and Erwin (2003) on *Hibiscus spp*. and Krause *et al*. (2003) who revealed that spraying the foliage of *Tagetes patula*, *Impatiens walleriana* and *Petunia hybrida* with daminozide at 1275 ppm, twice inhibited growth and stimulated flowering. This was emphasized by Amling *et al*. (2005) who mentioned that daminozide (B-9) was more effective in controlling height of *Coreopsis verticillata* "Moonbeam" and *Rudbeckia fulgida* "Goldsturm", than cycocel. Moreover, Khuankaew *et al*. (2009) elicited that application of ethrel as drenching at 300 and 500 ppm concentrations decreased plant height of *Curcuma alismatifolia* rhizomatus plants, but did not affect the rhizome size (width and length).

Table 1. Effect of growth retardants spraying on stem parameters of *Helianthus annuus* L. cv. Sunrich Orange Summer-981V plants during 2014 and 2015 seasons.

Treatments	Stem length (cm)	Stem diameter (cm)	No. of internodes per stem	Internode length (cm)	Stem f.w. (g.)	Stem d.w. (g)
			First season: 2014			
Control	64.25ab	0.53c	12.00b	5.77a	24.67ab	4.45b
Ancy 5 ppm	59.33bc	0.68ab	13.00ab	4.43a-c	21.51ab	4.18b
Ancy 20 ppm	75.00a	1.08a	15.00a	5.65a	71.57a	13.13a
Dmz 1250 ppm	51.33bc	0.80ab	12.00b	3.36bc	32.60ab	6.05ab
Dmz 2450 ppm	32.83d	0.80ab	9.50c	3.03c	17.24ab	2.67b
Eth 250 ppm	45.17cd	0.60b	12.17b	3.32bc	13.92b	2.38b
Eth 500 ppm	35.83d	0.72ab	11.17bc	4.90ab	22.97ab	3.03b
			Second season: 2015			
Control	63.58a	0.52b	10.67c	5.12a-c	18.60ab	3.29a-c
Ancy 5 ppm	61.67a	0.58b	14.33a	6.12a	17.29b	3.13bc
Ancy 20 ppm	73.25a	0.96a	13.17ab	6.42a	60.64a	11.07a
Dmz 1250 ppm	41.17bc	0.63b	11.00c	3.60cd	11.93b	1.92c
Dmz 2450 ppm	33.00c	0.90a	10.67c	3.76cd	17.75b	3.16ab
Eth 250 ppm	46.17b	0.67b	12.33bc	3.31d	17.16b	3.19bc
Eth 500 ppm	35.25bc	0.60b	11.17c	4.08b-d	17.95b	2.93bc

***Ancy =Ancymidol,Dmz=Daminozide and Eth=Ethephon**

***Means within a column having the same letters are not significantly different according to Duncan's New Multiple Range Test at 5 % level.**

Concerning stem diameter and number of internodes/stem, means of these two characters improved in response to the different treatments employed, with the mastery of 20 ppm ancymidol, which scored the utmost high averages in the two seasons over all other treatments. The sole exception in these two traits is that daminozide treatment at 2450 ppm induced a significant reduction in number of internodes/stem in the first season, while in the second one, records were equal to that of control plants. On the other hand, a reduction was obtained in internode length and stem fresh and dry weights, with few exceptions, compared to control plants in the two seasons. However, the greatest reduction in such criteria was a result of spraying with either daminozide at 1250 or 2450 ppm or ethephon at 250 ppm, as these treatments gave the shortest internodes and the lightest stem fresh and dry weights in most instances of both seasons. Decreasing number of internode/stem and the length of internode by daminozide treatments may be reasonable due to the production of stunted plants.

In relation to leaf parameters, data presented in Table (2) show that number of leaves/plant increased by all treatments applied in this trial with various significant differences relative to the control plants in both seasons. The greatest number was obtained in the first season by spraying ancymidol at 5 ppm followed by spraying at 20 ppm ancymidol, 1250 ppm daminozide and 500 ppm ethephon solutions, while in the second season, that was established by 20 ppm ancymidol treatment, followed by 500 ppm ethephon one. On the other side, means of leaf length and width, as well as leaves fresh and dry weights fluctuated with non-significant differences compared to the control plants, in most instances of the two seasons. However, the highest records were recorded in both seasons by 20 ppm ancymidol treatment, whereas the least ones were found due to spraying with ethephon at 250 ppm.

It was noticed that the longest root was achieved in the 1st season by treating plants with ancymidol at any rate and ethephon at 250 ppm (Table, 3) while in the 2nd one, that was attained by either 20 ppm ancymidol or

Table 2. Effect of growth retardants spraying on leaf parameters of *Helianthus annuus* L. cv. Sunrich Orange Summer-981V plants during 2014 and 2015 seasons.

Treatments	Number of leaves/plant	Leaf length (cm)	Leaf width (cm)	Leaves f.w. (g)	Leaves d.w. (g)
			First season: 2014		
Control	13.83cd	9.75bc	6.47bc	16.24ab	2.48b
Ancy 5 ppm	19.67a	9.72bc	9.42bc	13.87ab	2.62b
Ancy 20 ppm	17.17ab	12.67a	10.28a	46.01a	9.24a
Dmz 1250 ppm	17.33ab	10.20b	7.67b	29.14ab	4.63ab
Dmz 2450 ppm	14.67bc	9.33bc	6.52bc	17.41ab	2.96ab
Eth 250 ppm	14.17c	8.30c	5.72c	9.59b	1.88b
Eth 500 ppm	17.17ab	9.66bc	6.47bc	15.93ab	2.62ab
			Second season: 2015		
Control	13.67d	9.98ab	6.82ab	12.11ab	1.97b
Ancy 5 ppm	15.83b-d	9.22b	5.78b	9.87b	1.64b
Ancy 20 ppm	19.50a	11.42a	8.97a	43.80a	7.94a
Dmz 1250 ppm	14.33c-d	9.27b	6.60b	12.62ab	2.11b
Dmz 2450 ppm	17.00a-c	9.50ab	6.90ab	23.01a	3.54ab
Eth 250 ppm	15.00cd	8.75b	5.95b	12.60ab	2.28b
Eth 500 ppm	18.00ab	8.92b	6.30b	13.93ab	2.51b

***Ancy =Ancymidol,Dmz=Daminozide and Eth=Ethephon**

***Means within a column having the same letters are not significantly different according to Duncan's New Multiple Range Test at 5 % level.**

Table 3. Effect of growth retardants spraying on root parameters of *Helianthus annuus* L. cv. Sunrich Orange Summer-981V plants during 2014 and 2015 seasons.

Treatments	Root length (cm)		Roots f.w. (g)		Roots d.w. (g)	
	2014	2015	2014	2015	2014	2015
Control	17.67ab	15.00bc	19.70a	13.08a	3.82a	2.64a
Ancy 5 ppm	21.08a	18.58ab	14.40a	10.04a	4.29a	2.13a
Ancy 20 ppm	24.82a	26.42a	23.32a	17.15a	9.06a	4.39a
Dmz 1250 ppm	12.00b	12.50c	11.63a	11.49a	2.83a	2.07a
Dmz 2450 ppm	17.50ab	20.83a	14.18a	15.32a	3.08a	3.57a
Eth 250 ppm	21.83a	15.00bc	11.17a	15.81a	3.79a	3.22a
Eth 500 ppm	19.25ab	13.75bc	16.94a	13.52a	5.43a	3.35a

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***Means within a column having the same letters are not significantly different according to Duncan's New Multiple Range Test at 5 % level.**

2450 ppm daminozide treatments. Means of roots fresh and dry weights declined generally, with few exceptions as a result of the various growth retardants used in the current study, with non-significant differences when compared to control means in the two seasons. Spraying with ancymidol at 20 ppm was the only treatment that recorded the heaviest fresh and dry weights compared to all other treatments in both seasons as the highest number of leaves were scored by this treatment.

The aforementioned gains could be interpreted and discussed as done before in case of stem length trait.

2- Effect on flowering parameters:

It is obvious from data registered in Table (4) that ethephon treatment at 250 ppm caused a significant precocity in flowering of treated plants compared to those of untreated ones, as it reduced the number of days to flower bud appearance to 46.67 and 45.67 days, against 53.00 and 53.33 days for the

Table 4. Effect of growth retardants spraying on number of days to flower bud appear and opening of *Helianthus annuus* L. cv. Sunrich Orange Summer-981V plants during 2014 and 2015 seasons.

Treatments	No. of days to flower bud appearance (days)		No. of days to flower bud opening (days)		No. of days from flower bud appearance to opening (days)	
	2014	2015	2014	2015	2014	2015
Control	53.00a	53.33a	66.00ab	65.83bc	15.33a-c	15.17a-c
Ancy 5 ppm	50.00ab	49.00bc	64.00b	64.83c	14.00b-c	18.83a-c
Ancy 20 ppm	50.67ab	50.67ab	66.33ab	66.33a-c	13.33c	13.00c
Dmz 1250 ppm	47.67ab	49.00bc	66.33ab	68.33ab	18.64a	19.33a
Dmz 2450 ppm	52.50ab	52.67a	67.00ab	68.33ab	14.50bc	15.33bc
Eth 250 ppm	46.67b	45.67c	64.67b	64.00c	18.00ab	18.33ab
Eth 500 ppm	51.83ab	51.67ab	68.67a	69.00a	16.83a-c	16.50ab

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***Means within a column having the same letters are not significantly different according to Duncan's New Multiple Range Test at 5 % level.**

control plants in the first and second seasons, respectively. A similar trend was obtained by 5 ppm ancymidol and 1250 ppm daminozide treatments in the second season only (49.00 days for each). However, all other treatments gave means closely near to those of the control plants with non-significant differences among themselves in the two seasons. Likewise, the least number of days to flower bud opening was recorded by 250 ppm ethephon spraying treatment along with 5 ppm ancymidol sprayin in the two seasons. However, the least number days passed from flower bud appearance to opening was attained by spraying with ancymidol at 20 ppm. Plants treated subjected to other treatments took longer times to anthesis compared with the control plants in both seasons. These observations are in accordance with those of Kessler and Keever (2007) who found that number of days from treatment to first flower open in *Coreopsis verticillata* "Moonbeam" plants increased linearly with increasing daminozide rate. Meanwhile Warner and Erwin (2003) noted that daminozide (2500 or 5000 ppm) did not delay flowering of *Hibiscus trionum* plants. Dole and Wilkins (1999) mentioned that growth retardants are still commercially used to inhibit stem elongation, enhance foliage colour and decrease time to flower.

The mean number of lateral buds/stem (Table, 5) was improved in both seasons by spraying with either, ancymidol or ethephon at any rate. However, the dominance was for ethephon treatments which elevated the means of this character to the maximal values in the 1st and 2nd seasons. This may be attributed to the role of ethephon in reducing the apical dominance, which can increase axillary budding and branching (Currey and Lopez, 2008). The ancymidol treatments at 5 and 20 ppm rates were the only treatments that significantly increased flower head diameter over the control plants and other treatments in most instances of both seasons, whereas daminozide and ethephon treatments at any rate decreased it with various significance levels, relative to control plants in the two seasons. A similar trend was also obtained concerning ray flower length. This may be ascribed to various active ingredients in the chemicals used. The opposite was the right in relation to number ray flowers / head, disc diameter and flower head fresh and dry weights parameters, as their means were improved, with few exceptions due to the different treatments compared to control means in the two seasons. Similar effects of chemicals used in the current study were reported by Whipker *et al*. (2004), Bonacin *et al*. (2006)

Table 5. Effect of growth retardants spraying on flowering parameters of *Helianthus annuus* L. cv. Sunrich Orange Summer-981V plants during 2014 and 2015 seasons.

Treatments	No. of lateral buds/stem	Flower head diameter (cm)	No. of ray flowers per head	Disc diameter (cm)	Ray flower length (cm)	Flower heads	
						f.w. (g)	d.w. (g)
First season: 2014							
Control	0.00b	12.27ab	23.17b	3.40ab	8.87ab	17.40a	2.58b
Ancy 5 ppm	1.00ab	13.63a	29.50ab	3.68ab	10.07a	20.06a	3.76ab
Ancy 20 ppm	1.00ab	13.75a	32.00ab	4.80a	8.83ab	26.50a	8.22a
Dmz 1250 ppm	0.00b	11.17a-c	29.33ab	3.63ab	7.53bc	22.82a	3.61ab
Dmz 2450 ppm	0.00b	9.45bc	30.00ab	3.02b	6.43b-d	14.60a	2.56b
Eth 250 ppm	2.17a	8.45c	25.50b	3.42ab	5.03d	16.27a	2.54b
Eth 500 ppm	1.17ab	9.41bc	35.50a	3.07b	6.35cd	14.79a	2.17b
Second season: 2015							
Control	0.00b	10.28b	23.67b	3.12b	7.17b	14.48b	2.09b
Ancy 5 ppm	1.00ab	12.75a	25.00b	3.37b	9.77a	15.29b	2.45b
Ancy 20 ppm	1.67ab	13.92a	27.50ab	4.48a	9.70a	23.43a	7.64a
Dmz 1250 ppm	0.67ab	10.30b	26.17b	3.17b	7.23b	17.94b	2.52b
Dmz 2450 ppm	0.00b	10.25b	33.00a	3.42b	8.83b	20.20ab	3.12ab
Eth 250 ppm	1.83a	9.62b	26.83ab	3.32b	6.30b	18.89ab	2.80b
Eth 500 ppm	2.00a	9.33b	30.33ab	3.07b	6.27b	14.43b	2.48b

***Ancy =Ancymidol,Dmz=Daminozide and Eth=Ethephon**

***Means within a column having the same letters are not significantly different according to Duncan's New Multiple Range Test at 5 % level.**

and Giuffrida *et al*. (2009) on sunflower cvs. In this connection, Krause *et al*. (2003) decided that daminozide at either 1275 ppm (drench) + 1275 ppm (spray) or 1275 ppm (drench) + 2550 ppm (spray) significantly increased number of flower buds and number of flowers/inflorescence in the treated plants of *Petunia hybrida* "Bravo Pink".

3- Effect on chemical composition of the leaves:

It is evident from data averaged in Table (6) that the content of chlorophyll a, b and carotenoids in the leaves was slightly improved, with few exceptions, compared to the same contents in leaves of control plants. The highest content of total phenols was induced by ancymidol treatments at either 5 or 20 ppm, with the superiority of the latter concentration (1.39 ppm vs. 0.19 ppm for the control plants), followed by ethephon treatment, that doubled the phenol content in treated plants compared to control ones. Total indoles content, however was unaffected pronouncedly by the used treatments, except for ethephon treatments, that induced a slight increment in content of such constituent. The percent of total soluble sugars recorded in Table (7) show that this active component only increased by 5 ppm ancymidol, 500 ppm ethephon treatments and 2450 ppm daminozide compared to the control plants, while other treatments declined it. On the other hand, a reduction was observed in the percent of nitrogen, phosphorus and potassium, due to the other used treatments, with few exceptions compared to their percentages in the control leaves.

From the aforementioned results, it is recommended to use 2450 ppm daminozide spray treatment to obtain proper midget sunflower plants with solitary stem carrying a good number of natural-sized leaves and a single flower head full of ray florets.

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Table 6. Effect of growth retardants spraying on pigments, total phenols and total indoles contents in the leaves of *Helianthus annuus* L. cv. Sunrich Orange Summer-981V plants during 2014 and 2015 seasons.

Treatments	Pigments content (mg/g. f.w)			Total phenols (ppm)	Total indoles (ppm)
	Chlorophyll (a)	Chlorophyll (b)	Carotenoids		
Control	1.19	0.42	0.24	0.19	0.08
Ancy 5 ppm	1.17	0.41	0.25	0.86	0.07
Ancy 20 ppm	1.26	0.43	0.18	1.39	0.07
Dmz 1250 ppm	1.24	0.44	0.22	0.22	0.08
Dmz 2450 ppm	1.36	0.48	0.23	0.16	0.08
Eth 250 ppm	1.48	0.53	0.23	0.37	0.09
Eth 500 ppm	1.14	0.47	0.19	0.38	0.11

***Ancy =Ancymidol,Dmz=Daminozide and Eth=Ethephon**

Table 7. Effect of growth retardants spraying on total soluble sugars, N, P and K% in the leaves of *Helianthus annuus* L. cv. Sunrich Orange Summer-981V plants during 2014 and 2015 seasons.

Treatments	Total soluble sugars (%)	N (%)	P (%)	K (%)
Control	1.23	1.74	0.40	1.76
Ancy 5 ppm	3.76	1.62	0.58	1.38
Ancy 20 ppm	0.98	1.33	0.33	1.96
Dmz 1250 ppm	0.75	1.43	0.35	1.53
Dmz 2450 ppm	1.89	1.34	0.37	1.56
Eth 250 ppm	0.79	1.17	0.54	0.55
Eth 500 ppm	3.34	1.41	0.33	1.39

***Ancy =Ancymidol,Dmz=Daminozide and Eth=Ethephon**

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تأثير بعض مثبطات النمو على نمو وإزهار نباتات عباد الشمس (صنف "Sunrich Orange Summer 981V)

أ- تأثير معاملات الرش الورقى بالأنسيميدول، الدامينوزايد والإيثيفون

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أجريت تجربه أصص خلال موسمي ٢٠١٤ و٢٠١٥، حيث استخدمت معوقات النمو التالية: الأنسيميدول (بمعدلات: صفر، ٥، ٢٠ جزء فى المليون)، الدامينوزيد (بمعدلات: صفر، ١٢٥٠، ٢٤٥٠ جزء فى المليون) والإيثيفون (بمعدلات: صفر، ٢٥٠، ٥٠٠ جزء فى المليون) وذلك رشاً على الأوراق ثلاث مرات وبفاصل أسبوعين بين كل رشتين حتى يتساقط المحلول من على الأوراق لتحديد نوع مثبط النمو والمعدل الأمثل لإنتاج نماذج مقزمة من نبات عباد الشمس الحولي (*Helianthus annuus* L. cv. Sunrich Orange Summer 981V).

وقد أوضحت النتائج أن معظم المعاملات قللت طول سيقان النباتات المعاملة بنسب متفاوتة، مع تفوق معاملة الرش بالدامينوزيد بمعدل ٢٤٥٠ جزء فى المليون والتى أحدثت ٥٠ % انخفاضا فى هذه الصفة مقارنة بالكنترول فى كلا الموسمين. إلا أن متوسطات قطر الساق وعدد السلاميات/ساق قد تحسنت استجابة لجميع المعاملات المستخدمة بهذه التجربة، باستثناء معاملة الدامينوزيد (٢٤٥٠ جزء فى المليون). ولقد انخفضت متوسطات طول السلامية والأوزان الطازجة والجافة للساق، مع بعض الاستثناءات القليلة، لكن أكبر انخفاض فى هذه الصفات أحدثته معاملة الرش بالدامينوزيد بأي تركيز ومعاملة الإيثيفون بتركيز ٢٥٠ جزء فى المليون. أما عدد الأوراق/نبات فقد زاد متأثراً بالمعاملات، بينما كانت متوسطات طول وعرض الورقة ومتوسطات الأوزان الطازجة والجافة للأوراق متقلبة وبدون فروق معنوية عند مقارنتها بمتوسطات الكنترول بكلا الموسمين. ولقد أحدثت معظم المعاملات زيادة فى متوسط طول الجذر مقارنة بالكنترول فى كلا الموسمين، بينما انخفضت متوسطات الأوزان الطازجة والجافة للجذور متأثرة بمعظم معاملات التقزيم المطبقة بهذه الدراسة وبدون فروق معنوية عند مقارنتها بالكنترول. إلا أن أعلى المتوسطات فى معظم القياسات السابقة

سجلتها معاملة الأنسيميدول، خاصة عند إضافتها بتركيز ٢٠ جزء فى المليون، بينما أعزيت أدنى المتوسطات لمعاملة الرش بالإيثيفون بمعدل ٢٥٠ جزء فى المليون.

أوضحت النتائج أيضاً حدوث تبكير معنوي فى إزهار النباتات التي رشت بالإيثيفون بتركيز ٢٥٠ جزء فى المليون بكلا الموسمين وفى تلك التي رشت إما بالإنسيميدول بتركيز ٥ جزء فى المليون أو بالدامينوزيد بمعدل ١٢٥٠ جزء فى المليون فى الموسم الثاني مقارنة بالمعاملات الأخرى. أما أقل عدد للأيام إنقضي من ظهور البرعم الزهري حتى تفتحه فقد حققته معاملة الأنسيميدول بتركيز ٢٠ جزء فى المليون. أحدثت معاملات الإيثيفون أعلى زيادة فى متوسط عدد البراعم الزهرية الجانبية/ساق، بينما أعطت معاملات الأنسيميدول أكبر نورات زهرية حجماً. أيضاً، تحسنت متوسطات عدد الأزهار الشعاعية/نورة، قطر القرص والأوزان الطازجة والجافة للنورة الزهرية بسبب إضافة معظم المعاملات. ولقد تحسن محتوى الأوراق من صبغات البناء الضوئي تحسناً طفيفاً، مع بعض الاستثناءات القليلة، بينما بلغ محتوى الفينولات الكلية أقصاه بمعاملات الأنسيميدول، والتى تلتها معاملات الأيثيفون. أما محتوى الأندولات الكلية فلم يتأثر كثيراً. النسبة المئوية للسكريات الكلية الذائبة زادت نتيجة للرش بالأنسيميدول بمعدل ٥ جزء فى المليون، الدامينوزايد بمعدل ٢٤٥٠ جزء فى المليون والإيثيفون بمعدل ٥٠٠ جزء فى المليون. النسبة المئوية للنيتروجين، الفوسفور والبوتاسيوم قد انخفضت بصفة عامة استجابة لمختلف المعاملات المستخدمة عند المقارنة بالكنترول.