Scientific J. Flowers & Ornamental Plants
www.ssfop.com/journal
ISSN: 2356-7864

EFFECT OF SOME GROWTH RETARDANTS ON GROWTH AND FLOWERING OF *HELIANTHUS ANNUUS* L. CV. SUNRICH ORANGE SUMMER 981V PLANTS
B- APPLICATION OF ANCYMIDOL, DAMINOZIDE AND ETHEPHON IN COMBINATIONS

Azza M. Abdel-Moniem

Ornamental Plants and Landscape Gardening Res. Dept., Hort. Res. Inst., ARC, Giza, Egypt.

Scientific J. Flowers & Ornamental Plants, 3(2):119-134 (2016).

Received:
1/6/2016

Revised by:
Prof. Dr. E.S. Nofal, Kafr El-Sheikh Univ.

Prof. Dr. A.Z. Sarhan, Cairo Univ.

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.

The objective of this investigation was to detect the response of sunflower plants to tank mix ratios and application methods of ancymidol, daminozide and ethephon for production of a dwarfed and picturesque specimen in an appropriate size. The results indicated that all the used combinations significantly decreased stem length of the treated plants. The shortest stems and internodes were obtained by ancymidol at either 5 or 20 ppm (seed soaking) + 500 ppm ethephon (spray). Stem diameter was increased by all combinations to reach the maximum by 5 ppm ancymidol (spray) + 500 ppm ethephon (spray). The number of internode/stem was not greatly affected by the used combinations. However, the number of leaves/plant was significantly increased by all treatments. Also, all combinations caused a marked increment in the root length, with the superiority of 20 ppm ancymidol (seed soaking) + 2450 ppm daminozide (spray), which scored the longest roots in the two seasons. Spraying plants with 5 ppm ancymidol + 250 ppm ethephon or 20 ppm ancymidol + 500 ppm ethephons induced the greatest precocity in flower bud appearance and opening. Seed soaking in 20 ppm ancymidol solution and spraying with 1250 ppm daminozide reduced number of days from flower bud appearance to its opening . The mean number of lateral buds/stem, number of ray flowers/head and disc diameter were significantly improved, with few exceptions due to the different combinations than control plants in both seasons. Data, revealed that the highest content of chlorophyll a, b, carotenoids and total phenols were scored by spraying with either 5 or 20 ppm ancymidol + 500 ppm ethephon solutions. Total indoles and total soluble sugars were inconsistent and the percent of N was generally decreased. As for P%, it increased by most combinations, but K% increased only by combining between ancymidol + ethephon.

Key words: Sunflowers, ancymidol, daminozide, ethephon, foliar spray.

INTRODUCTION

The annual sunflower plants (*Helianthus annuus* L., Fam. Asteraceae) are naturally tall, which is unsuitable for decoration of limited spaces. In order to facilitate their production in a protected environment and in the field, growth inhibitors can be utilized to reduce the size of these plants to make them suitable for commercial production as pot-plants. Plant growth retardants have been variously used in ornamental horticultural practice (Dewir *et al*., 2007). The plant growth retardants in ornamental horticulture are utilized commercially to produce compact, sturdy potted and bedding plants. This practice reduces the cost of pruning and allows obtaining a better ratio between vegetative growth and flower production, besides reducing the space in the greenhouse required for flower production thereby improving marketing quality (Marosz and Matysiak, 2005, Bekheta *et al*., 2008). In this concern, ancymidol had a beneficial effect in reducing plant height. Chistopher and Mark (1998) stated that an experiment was conducted on Mussaenda Queen Sirikit, where the profuse upright growth habit of some Mussaenda cultivars is undesirable for pot plant culture. Results revealed that the most attractive potted plants were produced with two drench applications of ancymidol at 0.5 mg/pot. Higher concentrations or additional applications excessively reduced plant height. Kessler and Keever (2007) concluded that for producing a marketable greenhouse pot plant of *Coreopsis verticillata* L. Moonbeam, pruned plant, in 10 cm pots received one application of ancymidol medium drenches at 0, 2, 4, or 6 ppm as a linear decrease in shoot height, growth index and lateral shoot length were obtained with increasing rates of ancymidol. Maria *et al*. (2008) tested different concentration of daminozide on sunflower hybrid BRS Oasis (4,000, 6,000 and 8,000 mgl^{-1}) applied at fifteen days after planting for the aim of the reduction in size of the plant. Results demonstrated that the size of the plants was smaller than that of the control. Therefore, for economical reasons, the use of 4000 mg l^{-1} of daminozide is suggested. Soner *et al.* (2010) on *Chrysanthemum moriflolium* cvs. Yellow Reagen and White Reagen showed that daminozide significantly affected days to flower, stem length, stem diameter and flower number per stem. The results suggested that ethephon could well be used to control the stem height and improve its ornamental value. Thiraporn *et al.* (2009) reported that aqueous solution of ethephon (100 ml) at 0, 100, 300 and 500 mg l^{-1} were fed twice after 6 weeks from planting at rhizomes of *Curcuma alismetifolia* Jajnep by drenching. The results emphasized that the application of ethephon decreased plant height, especially with application at 300 mg l^{-1} and 500 mg l^{-1}. Application of ethephon also decreased the quality and quantity of flowers. At a high level of ethephon, flower stalk length and flower length were decreased. Furthermore, the number of pink and green bracts, and the number of flowers per a cluster of whole plant were decreased by ethephon application. Results indicated also that the highest concentration of ethephon (500 mg l^{-1}) reduced the accumulation of plant nutrients in above ground part organs (N, P and K) and in underground part organs (N and P).

The objective of this investigation was to detect the response of sunflower plants to tank mix ratios and application methods of ancymidol, daminozide and ethephon for production of a dwarfed and picturesque specimen in an appropriate size.

MATERIALS AND METHODS

The current work was undertaken at the nursery of Hort. Res. Inst., Giza, Egypt during 2014 and 2015 seasons in order to study the effect of some growth retardant combinations on growth performance, flowering and chemical composition of the annual sunflower plants, and to determine the most suitable combination for production of a dwarfed and picturesque specimen in an appropriate size.

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). They 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. Fifteen days after planting (on April, 15th), when the plants showed two pairs of leaves, they were subjected to a tank mix with ancymidol (A-rest) at 5 or 20 ppm concentration, applied either as soaking treatment where the seeds were soaked in the aforementioned growth retardant solutions for 30 minutes immediately before sowing, or as foliar spray till the solution was run-off, daminozide (B-Nine) at 1250 or 2450 ppm concentration as spray and ethephon at 250 or 500 ppm.

Combined treatments were as follows:

1- Control, as the plants were sprayed with tap water.

2- Ancymidol 5 ppm (spray) + daminozide at 1250 ppm (spray).

3- Ancymidol 20 ppm l (spray) + daminozide at 1250 ppm (spray).

4- Ancymidol 5 ppm (seed soaking) + daminozide at 1250 ppm (spray).

5- Ancymidol 20 ppm (seed soaking) + daminozide at 1250 ppm (spray).

6- Ancymidol 5 ppm (spray) + daminozide at 2450 ppm (spray).

7- Ancymidol 20 ppm (spray) + daminozide at 2450 ppm (spray).

8- Ancymidol 5 ppm (seed soaking) + daminozide at 2450 ppm (spray).

9- Ancymidol 20 ppm (seed soaking) + daminozide at 2450 ppm (spray).

10- Ancymidol 5 ppm l (spray) + ethephon at 250 ppm (spray).

11- Ancymidol 20 ppm (spray) + ethephon at 250 ppm (spray).

12- Ancymidol 5 ppm (seed soaking) + ethephon at 250 ppm (spray).

13- Ancymidol 20 ppm (seed soaking) + ethephon at 250 ppm (spray).

14- Ancymidol 5 ppm (spray) + ethephon at 500 ppm (spray).

15- Ancymidol 20 ppm (spray) + ethephon at 500 ppm (spray).

16- Ancymidol 5 ppm (seed soaking) + ethephon at 500 ppm (spray).

17- Ancymidol 20 ppm (seed soaking) + ethephon at 500 ppm (spray).

The layout of the experiments was a complete randomized design with three replicates, as each replicate contained 5 plants Moreover, the regular agricultural practices needed for such plantation were carried out in time.

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 each season:

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

- Stem length (cm)
- Stem diameter (cm)
- Number of internodes/stem
- Internode 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)
- Root 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 once to opening (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 weight (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, while in dry leaf ones, the percentages of nitrogen (Pregl, 1945), phosphorus (Luatanab and Olsen, 1965) and potassium (Jackson, 1973) were measured.

Data were tabulated and subjected 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

Effect of growth retardants combinations on:

1- Shoot and root growth parameters:

Data presented in Table (1) exhibit that all combined treatments used in this study significantly decreased stem length of treated plants compared to the control ones in the two seasons. The shortest length was obtained by combining between 5 ppm ancymidol soaking treatment and 500 ppm ethephon spray one, which gave the least records at all in both seasons. The second position was occupied either by the combining between seed soaking in 20 ppm ancymidol solution and spraying with ethephon at 500 ppm level or between spraying with ancymidol at 5 ppm and daminozide at 2450 ppm recorded good shortening effect on stem length in both seasons. This may be due to the synergistic effect of ancymidol which inhibits GA production within plants and ethephon which is converted to ethylene in plant cells. This increased ethylene which causes cells to limit elongation or due to lumping the dwarfing effect of both ancymidol and daminozide in superssing stem elongation by blocking GA production at similar sites in the GA production process (Currey and Lopez, 2008),

The opposite was the right concerning the means of stem diameter which was increased by all combinations employed in such work with the superiority of spraying with 5 ppm ancymidol + 500 ppm ethephon combined treatment that raised this parameter to 0.87 cm for the control plants in the two seasons versus 0.60 and 0.52 cm in the first and second seasons, respectively. In the second rank, came the combination of seed soaking in 20 ppm ancymidol solution+

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

Treatments	Stem length (cm)		Stem diameter (cm)		No. of internode per stem		Internode length (cm)		Stem f.w. (g)		Stem d.w. (g)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Control	64.25a	63.58a	0.60c	0.52f	12.00c-e	10.67de	5.78a	5.11a	24.68a-d	18.60b-f	4.45a-c	3.29b-d
Ancy 5 ppm spray + Dmz 1250 ppm spray	49.93bc	50.58c-e	0.70bc	0.68c-e	12.17c-e	12.17cd	4.80ab	4.02b-e	20.16a-d	17.47c-f	4.18a-c	3.69a-d
Ancy 20 ppm spray + Dmz 1250 ppm spray	45.25b-d	46.33ef	0.70bc	0.75a-d	13.00b-d	12.00c-e	4.05b-d	3.83c-f	26.66a-d	25.77b	5.71ab	5.37a
Ancy 5 ppm soaking + Dmz 1250 ppm spray	49.87bc	45.78ef	0.75a-c	0.80a-c	11.50c-e	11.83c-e	4.52bc	4.19a-d	21.34a-d	21.69b-d	4.82a-c	4.77ab
Ancy 20 ppm soaking + Dmz 1250 ppm spray	45.67b-d	45.50ef	0.70bc	0.73a-d	10.67e	10.83de	4.01b-d	3.46c-f	17.44b-d	21.86b-d	3.43bc	4.65ab
Ancy 5 ppm spray + Dmz 2450 ppm spray	42.00cd	41.75fg	0.72a-c	0.78a-d	11.67c-e	10.50e	3.63b-e	3.15e-g	24.14a-d	16.49d-f	4.02a-c	3.24b-d
Ancy 20 ppm spray + Dmz 2450 ppm spray	45.08b-d	44.42ef	0.75a-c	0.82a-c	11.50c-e	12.83c	3.53c-f	3.96c-f	14.07d	21.02b-e	4.02a-c	5.00ab
Ancy 5 ppm soaking + Dmz 2450 ppm spray	47.08b-d	45.50ef	0.78a-b	0.80a-c	12.33c-e	12.00c-e	3.15d-f	2.98fg	26.98a-c	22.97b-d	5.53a-c	4.26a-d
Ancy 20 ppm soaking + Dmz 2450 ppm spray	45.58b-d	47.17d-f	0.87a	0.83a-b	11.00de	10.67de	3.59c-f	3.31d-f	28.51ab	21.15b-e	6.27a	3.94a-d
Ancy 5 ppm spray + Eth 250 ppm spray	52.75b	60.58ab	0.78ab	0.70b-e	16.00a	16.67a	3.88b-d	4.37a-c	27.01a-c	24.10b-d	4.80a-c	4.42a-c
Ancy 20 ppm spray + Eth 250 ppm spray	52.50b	54.42bc	0.73a-c	0.73a-c	12.50b-e	12.67c	3.66b-e	3.97cd	20.03a-d	24.14bc	3.49bc	4.08a-d
Ancy 5 ppm soaking + Eth 250 ppm spray	45.50b-d	43.83f	0.68bc	0.65d-f	13.00b-d	12.83c	3.22d-f	3.33d-f	17.76b-d	14.14ef	4.32a-c	2.61cd
Ancy 20 ppm soaking + Eth 250 ppm spray	50.75b	53.25cd	0.80ab	0.80a-c	13.67bc	14.67b	4.25b-d	4.99ab	30.98a	34.49a	5.49a-c	5.23ab
Ancy 5 ppm spray + Eth 500 ppm spray	44.50b-d	44.33ef	0.87a	0.87a	14.67ab	13.00c	3.68b-e	4.33a-c	20.43a-d	24.11bc	3.80a-c	4.87ab
Ancy 20 ppm spray + Eth 500 ppm spray	47.58b-d	53.58cd	0.72a-c	0.75a-d	11.83c-e	12.83c	3.46c-f	3.46c-f	20.35a-d	22.12b-d	3.49bc	4.04a-d
Ancy 5 ppm soaking + Eth 500 ppm spray	40.58d	35.08g	0.67bc	0.58ef	11.50c-e	12.50c	2.61ef	3.29d-f	16.71b-d	13.02f	2.86c	2.38d
Ancy 20 ppm soaking + Eth 500 ppm spray	40.83d	42.33f	0.68bc	0.65d-f	12.83b-e	11.67c-e	2.42f	2.22g	15.31cd	13.24f	2.96c	2.34d

*** Ancy = Ancymidol, Dmz = Daminozide and Eth = Ethephon**
*** Means followed by the same letter in a column do not differ significantly according to Duncan`s New Multiple Range t-Test at P= 0.05.**

spraying with 2450 ppm daminozide one, which increased means of such trait to 0.87 cm in the 1st season and to 0.83 cm in the second one. In this connection, Currey and Lopez (2008) stated that plants take up ethephon through the leaves and converted it to ethylene in plant cells. The increased ethylene causes cells to limits elongation and increase in width instead. Moreover, Cuquel *et al*. (2010) found that control of sunflower height without decreasing stem diameter was obtained by applying daminozide twice at 6000 ppm or daminozide three times at 4000 ppm.

Number of internodes/stem was not significantly affected by the used combinations. The least values were attained in both seasons by combining between seed soaking in 20 ppm ancymidol and spraying with 1250 ppm daminozide, while the highest ones were recorded by connecting between spraying with 5 ppm ancymidol and 250 ppm ethephon. On the other side, internode length was generally decreased in response to the different applied treatments, to reach the shortest level by binding between soaking seeds in ancymidol solution at either 5 or 20 ppm and spraying with ethephon at 500 ppm. This may be attributed to the observation that soaking method is more uniform and induce seeds to absorb more amount of active ingredient at lower concentrations than spraying method Currey and Lopez (2008).Stem fresh and dry weight fluctuated with non-significant differences compared to control plants in most cases of both seasons. However, the heaviest stem fresh weight was scored in the two seasons by a combination of seed soaking in 20 ppm ancymidol + spraying with 250 ppm ethephon; The heaviest stem dry weight was registered in the 1st season by connecting between soaking the seeds in 20 ppm ancymidol and 2450 ppm daminozide spraying, and in the 2nd one by conjuncting between spraying with ancymidol at 20 ppm and daminozide at 1250 ppm. On the other hand, the lightest stem fresh and dry weights in both seasons were attained by soaking seeds in 20 ppm ancymidol and spraying with 500 ppm ethephon combined treatment, which gave the minimal records at all.

With regard to leaf parameters, data presented in Table (2) show that number of leaves/plant was significantly increased as a result of applying the different combinations, relative to control plants in most instances of both seasons. However, the excellency was for ancymidol either at 5 ppm as spray or 20 ppm as soaking + ethephon spray at 250 ppm, as well as seed soaking in 5 ppm ancymidol solution + ethephon spray at 500 ppm combined treatments, which gave the highest averages in both seasons. The opposite was the right regarding leaf length, that was slightly decreased with non-significant differences compared to control plants in the two seasons, except for combining between soaking seeds in ancymidol at 5 or 20 ppm and spraying with daminozide at 2450 ppm treatment that elevated this character to the utmost height compared to control plants in the 1st and 2nd seasons. On the other side, leaf width and leaves fresh and dry weights were unsteady in response to the various used combinations in the two seasons. However, the widest leaves and heaviest fresh and dry weights were obtained in both seasons by connecting between seed soaking either in 5 or 20 ppm ancymidol solution and spraying with 2450 ppm daminozide one, while leaves having the lightest fresh and dry weights were attained in the two seasons by a combination of seed soaking in 5 ppm ancymidol + spraying with 500 ppm ethephon.

A similar trend was also observed regarding root parameters as illustrated in Table (3), where all combinations induced a marked increment in the root length of treated plants, with the mastership of seed soaking in 20 ppm ancymidol solution + spraying with 2450 ppm daminozide combined treatment, which registered the longest root in both seasons. The means of fresh and dry weights were inconsistent. The greatest records were recorded in the two seasons by a combination of 20 ppm ancymidol soaking + 250 ppm ethephon spray.

Table 2. Effect of growth retardants combinations on leaf parameters of *Helianthus annuus* L. cv. Sunrich Orange Summar-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)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Control	13.83f	13.67e	9.75a-c	9.98b	6.47b-e	6.82b-d	16.24c	12.12d-f	2.49c-e	1.97c-e
Ancy 5 ppm spray + Dmz 1250 ppm spray	17.83a-c	16.67a-d	9.08b-d	9.25b-d	6.00c-e	5.97e-g	15.78c	13.09d-f	3.09c-e	2.71b-e
Ancy 20 ppm spray + Dmz 1250 ppm spray	19.33ab	17.17a-d	8.92c-e	8.75c-f	6.53b-d	6.40c-g	12.10c	18.67a-e	4.01a-c	3.42ab
Ancy 5 ppm soaking + Dmz 1250 ppm spray	17.00a-e	16.50a-d	8.98c-e	9.40b-d	6.53b-d	6.63b-f	17.15bc	18.28a-e	3.24a-e	3.21ab
Ancy 20 ppm soaking + Dmz 1250 ppm spray	17.33a-d	18.00a-c	8.65c-f	9.48b-d	6.72bc	6.75b-e	17.35bc	18.70a-e	2.82c-e	3.01a-d
Ancy 5 ppm spray + Dmz 2450 ppm spray	16.50b-f	17.00a-d	8.47d-f	8.83c-f	6.53b-d	6.75b-e	17.83bc	16.18c-f	3.13a-e	2.91a-d
Ancy 20 ppm spray + Dmz 2450 ppm spray	15.00c-f	18.17ab	9.00c-e	9.75bc	6.22b-e	6.82b-d	17.33bc	23.53a-c	3.03b-e	3.97a
Ancy 5 ppm soaking + Dmz 2450 ppm spray	17.50a-d	16.00b-e	10.22ab	10.22ab	8.22a	8.40a	26.28ab	20.11a-d	4.38ab	3.16a-c
Ancy 20 ppm soaking + Dmz 2450 ppm spray	17.50a-d	16.17b-e	10.85a	11.12a	8.08a	8.60a	30.03a	24.31ab	4.67a	4.11a
Ancy 5 ppm spray + Eth 250 ppm spray	19.50a	19.00a	9.17b-d	8.58d-f	6.90bc	6.17d-g	19.51bc	16.75b-e	3.61a-d	3.06a-d
Ancy 20 ppm spray + Eth 250 ppm spray	16.00c-f	15.50c-e	8.70c-f	9.27b-d	6.18b	6.72b-e	14.21c	17.27a-e	2.52c-e	3.10a-c
Ancy 5 ppm soaking + Eth 250 ppm spray	16.17c-f	16.00b-e	7.92e-g	7.90f	5.48de	5.77g	12.28c	11.19e-f	2.03e	1.87de
Ancy 20 ppm soaking + Eth 250 ppm spray	19.50a	19.00a	9.48b-d	9.68bc	7.22ab	7.13bc	21.51a-c	25.04a	3.52a-e	4.07a
Ancy 5 ppm spray + Eth 500 ppm spray	14.33ef	15.17de	7.67fg	9.78bc	5.73c-e	7.25b	12.77c	14.12d-f	2.15de	2.63b-e
Ancy 20 ppm spray + Eth 500 ppm spray	15.33c-f	15.33de	9.35b-d	9.18b-e	6.72bc	6.55c-g	14.88c	16.10c-f	2.68c-e	2.72b-e
Ancy 5 ppm soaking + Eth 500 ppm spray	19.50a	19.46a	7.28g	6.58g	5.30e	4.95h	11.95c	8.59f	2.13de	1.62e
Ancy 20 ppm soaking + Eth 500 ppm spray	14.67d-f	16.17b-e	8.73c-f	8.15ef	5.95c-e	5.83fg	12.82c	17.52a-e	2.24de	2.99a-d

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

*** Means followed by the same letter in a column do not differ significantly according to Duncan`s New Multiple Range t-Test at P= 0.05.**

Table 3. Effect of growth retardants combinations on root parameters of *Helianthus annuus* L. cv. Sunrich Orange Summar-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	17.67b-d	15.00e	19.70b	13.08c-e	5.81b-d	3.64de
Ancy 5 ppm spray + Dmz 1250 ppm spray	21.83ab	19.25b-e	16.16b	14.24c-e	4.71b-d	4.12c-e
Ancy 20 ppm spray + Dmz 1250 ppm spray	23.13a	17.80c-e	19.96b	17.41b-e	5.01b-d	4.79b-e
Ancy 5 ppm soaking + Dmz 1250 ppm spray	21.92ab	22.83a-c	18.02b	22.93b-e	4.70b-d	6.85a-e
Ancy 20 ppm soaking + Dmz 1250 ppm spray	20.80a-c	22.67a-c	18.92b	26.19a-c	4.49cd	5.50b-e
Ancy 5 ppm spray + Dmz 2450 ppm spray	20.17a-c	24.17ab	18.27b	16.26b-e	3.73d	3.67de
Ancy 20 ppm spray + Dmz 2450 ppm spray	21.58a-c	20.83a-d	16.24b	16.87b-e	4.12d	3.10e
Ancy 5 ppm soaking + Dmz 2450 ppm spray	21.50a-c	18.98b-e	21.43b	16.90b-e	8.48a-d	5.35b-e
Ancy 20 ppm soaking + Dmz 2450 ppm spray	24.82a	25.08a	27.58b	19.26b-e	7.64a-d	7.21a-e
Ancy 5 ppm spray + Eth 250 ppm spray	19.92a-c	22.08a-d	25.87b	23.33a-c	10.12ab	6.19a-e
Ancy 20 ppm spray + Eth 250 ppm spray	21.58a-c	22.00a-d	23.26b	26.38a-c	10.04a-c	9.10ab
Ancy 5 ppm soaking + Eth 250 ppm spray	16.25c-e	17.33c-e	20.62b	11.67de	5.53b-d	4.59c-e
Ancy 20 ppm soaking + Eth 250 ppm spray	19.50a-c	20.00a-e	43.55a	35.15a	11.81a	9.99a
Ancy 5 ppm spray + Eth 500 ppm spray	17.51b-e	15.05e	22.54b	24.91a-d	4.87b-d	5.10b-e
Ancy 20 ppm spray + Eth 500 ppm spray	17.50b-e	17.25c-e	21.90b	22.85b-e	8.62a-d	8.02a-d
Ancy 5 ppm soaking + Eth 500 ppm spray	13.42de	14.83e	13.68b	10.33e	5.78b-d	3.42e
Ancy 20 ppm soaking + Eth 500 ppm spray	12.25c	16.85de	15.61b	30.21ab	5.88b-d	8.50a-c

*** Ancy = Ancymidol, Dmz = Daminozide and Eth = Ethephon**
*** Means followed by the same letter in a column do not differ significantly according to Duncan`s New Multiple Range t-Test at P= 0.05.**

The variable effects of the used combinations on vegetative and root growth parameters is reasonable because of the difference in application method, type of growth retardant used and their concentration.

However, these effects were documented by Whipker and McCall (2000), Pallez *et al*. (2002), Whipker *et al*. (2004), Wanderley *et al*. (2007) and Giuffrida *et al*. (2009) on sunflower, and Kessler and Keever (2007) on "Moonbeam" coreopsis.

2- Flowering parameters:

According to data listed in Table (4), it can be concluded that the least number of days to either flower bud appearance or to its opening (day) was recorded in both seasons by either spraying with 5 ppm ancymidol + 250 ppm ethephon or spraying with 20 ppm ancymidol + 500 ppm ethephon combined treatments, which caused precocity in these two traits by about 3 days or more with significant differences compared to control in both seasons. The other treatments however induced a slight earliness with few exceptions, in such two characters with non-significant differences when compared to the control plants. On the other hand, the highest number of days to flower bud appearance and opening was due to a combination of soaking with 20 ppm ancymidol + 250 ppm ethephon solutions. In general, all combined treatments caused an increment in the number of days from flower bud appearance to its opening, especially when connecting between spraying with 5 ppm ancymidol + 500 ppm ethephon solutions, while the least records in this criterion was achieved in the two seasons by combining between seed soaking in 20 ppm ancymidol solution and spraying with 1250 daminozide one. This is reasonable because the new formed metabolites in the dwarfed plants are usually used for forcing rather than growth. In this concern, Kofidis *et al*. (2008) mentioned that prohexadione-Ca at 20 ppm induced precocious flowering in coriander plants (3-5 days earlier). Kessler and Keever (2007) postulated that number of days from treatment to first flower open in "Moonbeam" Coreopsis plants increased linearly with increasing daminozide rate.On the contrary Warner and Erwin (2003) stated that daminozide at 2500 and 5000 ppm did not delay flowering of *Hibiscus trionum* plants.

In addition, the mean number of lateral buds/stem (Table, 5) was improved generally by most combinations with the superiority of spraying with either 5 ppm ancymidol + 500 ppm ethephon or 50 ppm ancymidol + 250 ppm ethephon in the first season, and a combination of seed soaking in 5 ppm ancymidol solution + foliar spray with 500 ppm ethephon solution in the second one. This may indicate to the role of ethephon in reducing the apical dominance which can increase axillary budding and branching (Currey and Lopez, 2008). The opposite was the right regarding flower head diameter which was reduced as a result of applying most combined treatments, with non-significant differences in most instances of both seasons compared to control plants. However, the smallest diameter was recorded by the combination of 5 ppm ancymidol (spray) + 500 ppm ethephon (spray), followed by 5 ppm ancymidol (soaking) + 500 ppm ethephon (spray), and by 20 ppm ancymidol (spray) + 500 ppm ethephon (spray). The widest flower head was attained in the first season by soaking with 20 ppm ancymidol + 250 ppm ethephon solutions combined treatment and in the second season by 5 ppm ancymidol (soaking) + 2450 ppm daminozide (spray) combined treatment.

Contrary to results of flower head diameter, data presented in Table (5) cleared that number of ray flowers/head and disc diameter were increased with various significance levels relative to the control plants in the two seasons, with the mastery of both 20 ppm ancymidol (soaking) + 250 ppm ethephon (spray) and 20 ppm ancymidol (spray) + 500 ppm ethephon (spray) combined treatments that gave the highest averages in these two parameters

Table 4. Effect of growth retardants combinations on No. days to flower bud appearance and opening of *Helianthus annuus* L. cv. Sunrich Orange Summar-981V plants during 2014 and 2015 seasons.

Treatments	No. days to flower buds appearance		No. days to flower bud opening		No. days from flower bud appearance to opening	
	2014	2015	2014	2015	2014	2015
Control	50.67a-d	50.67a-e	66.00b-d	65.83c-f	15.33de	15.17de
Ancy 5 ppm spray + Dmz 1250 ppm spray	50.33a-d	48.67d-f	68.33ab	65.67f	18.00a	17.00a-d
Ancy 20 ppm spray + Dmz 1250 ppm spray	49.50b-e	51.83a-e	66.33b-d	68.67ab	16.83a-d	16.83a-d
Ancy 5 ppm soaking + Dmz 1250 ppm spray	49.67b-e	50.33a-f	65.67b-d	66.33a-f	16.00c-e	16.00b-e
Ancy 20 ppm soaking + Dmz 1250 ppm spray	51.67a-c	52.33ab	66.33b-d	66.00b-f	14.67e	13.67e
Ancy 5 ppm spray + Dmz 2450 ppm spray	48.83de	48.00d-f	64.17d	64.67ef	15.33de	16.67a-d
Ancy 20 ppm spray + Dmz 2450 ppm spray	48.83de	51.00a-d	65.67b-d	67.50a-d	16.83a-d	16.50b-d
Ancy 5 ppm soaking + Dmz 2450 ppm spray	49.83b-e	47.83ef	65.67b-d	64.67ef	15.83c-e	16.83a-d
Ancy 20 ppm soaking + Dmz 2450 ppm spray	52.17ab	49.83a-f	67.83ab	66.67a-f	15.67c-e	16.83a-d
Ancy 5 ppm spray + Eth 250 ppm spray	47.33e	47.33f	64.33d	64.50f	17.00a-d	17.17a-d
Ancy 20 ppm spray + Eth 250 ppm spray	48.50de	48.50d-f	64.67d	65.00d-f	16.17b-e	16.50b-d
Ancy 5 ppm soaking + Eth 250 ppm spray	48.33de	47.67ef	65.67b-d	65.50c-f	17.33a-d	17.83a-c
Ancy 20 ppm soaking + Eth 250 ppm spray	53.17a	52.67a	69.83a	69.00a	16.67a-e	15.33c-e
Ancy 5 ppm spray + Eth 500 ppm spray	49.00c-e	49.67b-f	67.17bc	68.83a	18.17ab	19.17a
Ancy 20 ppm spray + Eth 500 ppm spray	47.67e	47.67ef	64.17d	64.17f	16.50b-e	16.50b-d
Ancy 5 ppm soaking + Eth 500 ppm spray	49.83b-e	49.17c-f	67.33bc	65.33d-f	17.50a-c	16.17b-e
Ancy 20 ppm soaking + Eth 500 ppm spray	49.00c-e	49.00c-f	65.33cd	67.33a-e	16.33b-e	18.33ab

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

*** Means followed by the same letter in a column do not differ significantly according to Duncan`s New Multiple Range t-Test at P= 0.05.**

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

Treatments	No. of total buds per stem		Flower head diameter (cm)		No. of ray flowers per head		Disc diameter (cm)		Ray flower length (cm)		Flower head f.w. (g)		Flower head d.w. (g)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Control	0.00c	0.00b	12.27ab	12.28a-c	23.17f	23.67d	3.40a-c	3.12de	8.87a	7.17b-f	17.40b	14.48d-f	2.58a	2.09cd
Ancy 5 ppm spray + Dmz 1250 ppm spray	2.00a-c	1.00ab	12.00a-c	12.08a-d	27.83a-f	29.00a-c	3.75a-c	3.60b-e	8.25a	8.48a-d	18.87b	18.44c-f	3.06a	3.00b-d
Ancy 20 ppm spray + Dmz 1250 ppm spray	0.33c	1.33ab	12.27ab	11.05b-e	31.67a-c	32.17ab	3.67a-c	3.23de	8.62a	7.82a-e	26.49ab	19.14c-f	3.93a	3.27bc
Ancy 5 ppm soaking + Dmz 1250 ppm spray	0.67bc	0.00b	11.87a-c	12.08a-d	29.00a-f	28.33b-d	3.48a-c	3.72b-e	8.38a	8.77a-c	20.14ab	20.76cd	3.46a	3.62ab
Ancy 20 ppm soaking + Dmz 1250 ppm spray	0.00c	0.00b	10.67a-c	10.76c-f	29.67a-e	31.83ab	3.18bc	3.48c-e	7.48a-c	7.27b-f	17.36b	21.43cd	2.81a	3.33b
Ancy 5 ppm spray + Dmz 2450 ppm spray	0.83bc	1.33ab	11.33a-d	10.33d-f	30.50a-e	30.67a-c	3.75a-c	3.45c-e	7.58a-c	6.88c-f	19.24ab	11.65f	3.15a	3.15bc
Ancy 20 ppm spray + Dmz 2450 ppm spray	2.33a-c	1.50ab	10.92a-e	12.08a-d	25.00ef	28.33b-d	3.25bc	3.87a-d	7.67a-c	9.02ab	19.16ab	25.62bc	2.93a	3.90ab
Ancy 5 ppm soaking + Dmz 2450 ppm spray	1.17a-c	1.33ab	12.08a-c	13.50a	32.83ab	28.17b-d	3.77a-c	4.05a-c	8.32a	9.45a	25.78ab	22.77bc	4.09a	3.24bc
Ancy 20 ppm soaking + Dmz 2450 ppm spray	2.33a-c	1.17ab	12.02a-c	11.00b-e	31.33a-d	30.33a-c	4.43a	4.32ab	7.58a-c	6.68d-f	25.45ab	21.17cd	3.93a	3.39b
Ancy 5 ppm spray + Eth 250 ppm spray	3.17a-c	1.00ab	10.83a-e	10.38c-f	31.50a-c	32.00ab	3.42a-c	3.02e	7.42a-d	7.37b-f	25.58ab	21.75cd	3.61a	3.20bc
Ancy 20 ppm spray + Eth 250 ppm spray	2.83a-c	1.67ab	9.50c-f	10.42c-f	27.50b-f	31.17a-c	3.40a-c	3.83a-d	6.10b-e	6.58d-f	19.63ab	30.50ab	2.85a	3.99ab
Ancy 5 ppm soaking + Eth 250 ppm spray	1.67a-c	1.00ab	8.50ef	9.45e-g	26.00c-f	26.33cd	3.17bc	3.67b-e	5.33de	4.50g	15.76b	20.08c-e	2.82a	3.11bc
Ancy 20 ppm soaking + Eth 250 ppm spray	0.00c	0.00b	12.32a	12.00a-d	34.00a	33.00ab	4.49a	4.48a	8.17ab	7.52a-f	25.55ab	24.78bc	3.70a	3.62ab
Ancy 5 ppm spray + Eth 500 ppm spray	3.83ab	1.00ab	7.55f	8.17g	25.17d-f	33.67a	3.10c	3.33c-e	4.45e	4.50g	21.41ab	21.04cd	3.01a	3.34b
Ancy 20 ppm spray + Eth 500 ppm spray	2.83a-c	1.33ab	9.68b-f	11.17b-e	28.20a-f	33.67a	4.53a	4.50a	5.81c-e	6.67d-f	30.35a	33.93a	3.83a	4.67a
Ancy 5 ppm soaking + Eth 500 ppm spray	2.83a-c	2.33a	9.08d-f	8.85fg	26.67c-f	26.17cd	3.35bc	3.20de	5.73c-e	5.65fg	16.06b	12.49ef	2.34a	1.88d
Ancy 20 ppm soaking + Eth 500 ppm spray	1.50a-c	1.83ab	10.00a-f	11.25b-e	29.17a-f	32.50ab	3.92a-c	3.82a-d	6.08b-e	7.43a-f	20.50ab	22.49c	2.84a	3.10bc

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

*** Means followed by the same letter in a column do not differ significantly according to Duncan`s New Multiple Range t-Test at P= 0.05.**

over control plants and all other combinations. The binding between ancymidol and daminozide at different concentrations and application methods had no clear effect on ray flower length, while conneting between ancymidol and ethephon caused a linear decrement in this trait with increasing concentration of either of the two chemicals, to reach the minimum by a combination of 5 ppm ancymidol (spray) + 500 ppm ethephon (spray) in the two seasons. On the other hand, flower head fresh and dry weights were improved by the various combinations used in this study, with the prevalence of spraying with 20 ppm ancymidol + 500 ppm ethephon solutions which recorded the heaviest fresh and dry weights of flower heads in the two seasons.

Similar observations to the previous ones were detected by Whipker *et al*. (2004) and Giuffrida *et al*. (2009) on some cultivars of sunflower. In this concern, Krause *et al*. (2003) indicated 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 treated plants of *Petunia hybrida* "Bravo Pink".

3- Chemical composition of the leaves:

It is obvious from data registered in Table (6) that content of chlorophyll a, b and carotenoids increased slightly in the leaves of treated plants with few exceptions as compared to the same contents in control leaves. The highest content of these pigments was related to spraying with either 5 or 20 ppm ancymidol + 500 ppm ethephon combined treatments. The least content was recorded by connecting between spray with 5 ppm ancymidol + 1250 ppm daminozide solutions.

Table 6. Effect of growth retardants combinations on pigments, total phenols and total indoles content in the leaves of *Helianthus annuus* L. cv. Sunrich Orange Summar-981V plants during 2015 season.

Treatments	Pigments content (mg/g f.w.)			Total phenols (ppm)	Total indoles (ppm)
	Chlorophyll (A)	Chlorophyll (B)	Carotenoids		
Control	1.19	0.41	0.24	0.19	0.08
Ancy 5 ppm spray + Dmz 1250 ppm spray	0.76	0.20	0.18	0.29	0.05
Ancy 20 ppm spray + Dmz 1250 ppm spray	1.22	0.36	0.25	0.26	0.07
Ancy 5 ppm soaking + Dmz 1250 ppm spray	1.30	0.52	0.21	0.28	0.08
Ancy 20 ppm soaking + Dmz 1250 ppm spray	1.39	0.48	0.18	0.28	0.12
Ancy 5 ppm spray + Dmz 2450 ppm spray	0.96	0.29	0.23	0.26	0.07
Ancy 20 ppm spray + Dmz 2450 ppm spray	1.45	0.34	0.23	0.27	0.09
Ancy 5 ppm soaking + Dmz 2450 ppm spray	1.34	0.46	0.24	0.26	0.10
Ancy 20 ppm soaking + Dmz 2450 ppm spray	1.35	0.46	0.23	0.35	0.06
Ancy 5 ppm spray + Eth 250 ppm spray	1.35	0.47	0.21	0.18	0.09
Ancy 20 ppm spray + Eth 250 ppm spray	1.41	0.44	0.24	0.15	0.01
Ancy 5 ppm soaking + Eth 250 ppm spray	1.38	0.45	0.27	0.31	0.12
Ancy 20 ppm soaking + Eth 250 ppm spray	1.12	0.41	0.29	0.29	0.07
Ancy 5 ppm spray + Eth 500 ppm spray	1.50	0.51	0.29	0.17	0.08
Ancy 20 ppm spray + Eth 500 ppm spray	1.47	0.54	0.26	0.23	0.04
Ancy 5 ppm soaking + Eth 500 ppm spray	1.35	0.35	0.22	0.21	0.07
Ancy 20 ppm soaking + Eth 500 ppm spray	1.42	0.47	0.17	0.25	0.08

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

In general, all the applied combinations induced a marked increment in total phenols content, especially the combinations of 20 ppm ancymidol (soaking) + 2450 ppm daminozide (spray). On the other side, content of total indoles was changeful. The minimal content (0.01 ppm) was due to spraying with 20 ppm ancymidol + 250 ppm ethephon solutions, whereas the maximal one was scored by combining either between 20 ppm ancymidol (soaking) and 1250 ppm daminozide (spraying) or between 5 ppm ancymidol (soaking) and 250 ppm ethephon (spraying) treatments. In contradiction to the current observations, Kazaz *et al*. (2010) reported that chlorophyll a and b contents were unaffected by the sole application of daminozide, while Kofidis *et al*. (2008) revealed that coriander plants treated with 500 ppm daminozide had dark green leaves with 16% more chlorophyll than the control leaves, and those treated with 1000 ppm daminozide had leaves with 13% less chlorophyll than the controls.

It can be shown from data presented in Table (7) that the percent of total soluble sugars was unsteady in the leaves of treated plants. The highest percent was gained by combining either between 20 ppm ancymidol (spray) and 2450 daminozide (spray) or between 5 ppm ancymidol (soaking) and 2450 ppm daminozide (spray), as these two combinations raised this concentration to 3.01 and 3.00% vs. 1.23% for control plants, respectively. The nitrogen% was generally decreased in response to the different used combinations with the exception of 5 ppm ancymidol (spray) + 2450 ppm daminozide (spray) combined treatment that caused a slight rising in N%. The percent of phosphorus was increased by the applied combinations with few exceptions. The highest P% was achieved by binding between ancymidol at either 5 or 20 ppm (spray) and 250 ppm ethephon (spray). As for potassium percentage, it was improved by only combining between ancymidol treatments and ethephon ones, with the excellency of 5 ppm ancymidol (soaking) + 500 ppm ethephon (spray) combination that increased this element to 1.96% versus 1.76% for the control.

Increasing content of some constituents and decreasing content of some others is reasonable due to variance of type of the chemicals used and their concentrations, beside the difference of application method. In this regard, Khuankaew *et al*. (2009) observed that application of ethephon at 500 ppm gave the lowest of N, P and K contents in aboveground organs of curcuma plants, and similarly, N and P contents in underground organs. Amount of K in both organs is higher than the amount of N and P. The accumulation of K in aboveground part is higher than in underground one.

According to findings mentioned above, it is advised to treat "Sunrich Orange Summar-981V" sunflower plants grown in 25-cm-diameter plastic pots with ancymidol at either 5 or 20 ppm concentration as seed soaking for 30 min. plus spraying the foliage with 500 ppm ethephon solution for 3 times with 2 weeks interval to get small-sized stunted plants with proper number of leaves and flower heads full of ray florets.

RECOMMENDATION

From the results, it is recommended to treat sunflower cv. Sunrich Orange Summer 981V plants with ancymidol at either 5 or 20 ppm level as seed soaking for 30 min + spraying the foliage with 500 ppm ethephon solution for 3 times with 2 weeks interval to obtain small-sized pot-plants carrying proper number of natural-sized leaves and flower heads full of ray florets.

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

Treatments	Total soluble sugars (%)	N (%)	P (%)	K (%)
Control	1.23	1.75	0.39	1.76
Ancy 5 ppm spray + Dmz 1250 ppm spray	1.12	1.37	0.58	1.20
Ancy 20 ppm spray + Dmz 1250 ppm spray	1.42	1.50	0.42	1.39
Ancy 5 ppm soaking + Dmz 1250 ppm spray	1.01	0.82	0.46	1.61
Ancy 20 ppm soaking + Dmz 1250 ppm spray	0.89	1.15	0.57	1.59
Ancy 5 ppm spray + Dmz 2450 ppm spray	1.36	1.86	0.33	1.42
Ancy 20 ppm spray + Dmz 2450 ppm spray	3.01	1.37	0.33	1.07
Ancy 5 ppm soaking + Dmz 2450 ppm spray	3.00	1.30	0.39	1.32
Ancy 20 ppm soaking + Dmz 2450 ppm spray	1.42	1.27	0.13	1.43
Ancy 5 ppm spray + Eth 250 ppm spray	0.99	1.63	0.70	1.83
Ancy 20 ppm spray + Eth 250 ppm spray	1.07	1.43	0.73	1.54
Ancy 5 ppm soaking + Eth 250 ppm spray	1.21	1.04	0.52	1.85
Ancy 20 ppm soaking + Eth 250 ppm spray	2.35	1.58	0.56	1.83
Ancy 5 ppm spray + Eth 500 ppm spray	1.20	1.38	0.66	1.18
Ancy 20 ppm spray + Eth 500 ppm spray	1.40	1.28	0.59	1.23
Ancy 5 ppm soaking + Eth 500 ppm spray	1.13	1.30	0.54	1.96
Ancy 20 ppm soaking + Eth 500 ppm spray	1.53	1.41	0.51	1.83

*** 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)

ب- إضافة الإنسيميدول، الدامينوزيد، والإيثيفون فى توليفات

عزة محمد عبد المنعم

قسم بحوث الزينة وتنسيق الحدائق، معهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر.

أجري هذا البحث بمشتل قسم بحوث نباتات الزينة وتنسيق الحدائق بمعهد بحوث البساتين، خلال موسمي ٢٠١٤، ٢٠١٥ بهدف دراسة استجابة نباتات عباد الشمس لمعدلات الخلط وطرق الاضافة لكل من الأنسيميدول والدمينوزايد والاثيفون وذلك لانتاج نباتات مقزمة جميلة الشكل وذات أحجام مناسبة. ولقد أوضحت النتائج المتحصل عليها حدوث انخفاض معنوي لطول الساق عند المعاملة بجميع المركبات والتفاعل بينها. أقصر أطوال للسيقان وأقصر السلاميات تم الحصول عليها عند استخدام الانسيميدول بتركيز ٥ أو ٢٠ جزء في المليون (نقع البذور) + الايثيفون بتركيز ٥٠٠ جزء في المليون (رشاً). قطر الساق زاد بجميع معاملات التفاعل حيث وصل لأقصى زيادة عند استعمال الانسيميدول بتركيز ٥ جزء في المليون (رشاً) + الايثيفون بتركيز ٥٠٠ جزء في المليون. لم يتأثر عدد السلاميات كثيراً باستعمال معاملات التفاعل المختلفة بينما حدثت زيادة معنوية في عدد الأوراق/نبات باستعمال جميع المعاملات. أيضاً أدت جميع معاملات التداخل الى زيادة ملحوظة في طول الجذور وكانت أفضل المعاملات هي استخدام الانسيميدول بتركيز ٢٠ جزء في المليون (نقع البذرة) + دامينوزايد بتركيز ٢٤٥٠ جزء في المليون (رشاً) حيث أدت الى الحصول على أعلى طول للجذور خلال موسمي الدراسة.

رش النباتات بالانسيميدول بتركيز ٥ جزء في المليون + الايثيفون بتركيز ٢٥٠ جزء في المليون أو الانسيميدول بتركيز ٢٠ جزء في المليون + الايثيفون بتركيز ٥٠٠ جزء في المليون أدى الى الحصول على أعلى نشوء وظهور للبراعم الزهرية وتفتحها. نقع البذور في محلول انسيميدول بتركيز ٢٠ جزء في المليون وورش النباتات بـ ١٢٥٠ جزء في المليون دامينوزايد قللت عدد الأيام من ظهور البرعم الزهري حتى تفتحه. متوسط عدد البراعم/ساق، عدد الأزهار الشعاعية/رأس زهري وقطر القرص الزهري زادت معنوياً مقارنة بنباتات المقارنة - مع بعض الاستثناءات – باستخدام التوليفات المختلفة في كلا الموسمين. أظهرت البيانات كذلك أن أعلى محتوي من كلوروفيلات أ، ب والكاروتينويدات والفينولات الكلية تم احرازها باستخدام محلول من الانسيميدول بتركيزي ٥ أو ٢٠ جزء في المليون + الايثيفون بتركيز ٥٠٠ جزء في المليون. بينما الاندولات الكلية والسكريات الكلية الذائبة كانت متضاربة. النسبة المئوية للنيتروجين قلت بصفة عامة. فيما يتعلق بالنسبة المئوية للفوسفور فإنه زاد باستعمال أغلب التوليفات، بينما النسبة المئوية للبوتاسيوم فقد زادت باستعمال التوليفات بين الانسيميدول + الايثيفون فقط.