Journal of Ornamental Plants
Available online on: www.jornamental.com
ISSN (Print): 2251-6433 ISSN (Online): 2251-6441

Effect of Cycocel and Daminozide on Vegetative Growth, Flowering and the Content of Essence of Pot Marigold (*Calendula officinalis*)

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Received: 05 January 2014 Accepted: 06 March 2014
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Abstract

Pot marigold (*Calendula officinalis* L.) is a medicinal and ornamental plant. The effect of different concentrations of chlormequat (cycocel), and daminozide, two plant growth retardant, on plant height, flowering, the content of essence and some other traits in pot marigold (*Calendula officinalis*) was assessed. Plant growth retardants are commonly applied to limit stem elongation and produce a more compact plant. The experiment was done as a factorial in randomized completely blocks design (R.C.B.D.) with 16 treatments and 3 replications in Rasht. Cycocel at 4 concentrations (0, 500, 1000 and 1500 mg/L) and daminozide at 4 concentrations (0, 1500, 3000 and 4500 mg/L) were used. Investigated characteristics were plant height, leaf number, flower number, flowering time, fresh weight, dry matter, the content of essence and carotenoid in flowers. Based on analysis of variance (ANOVA), the effect of different treatments and their interaction on most traits was significant at 0.05 level of probability. The minimum height (24 cm/plant) in treatment of 500 mg/L cycocel + 3000 mg/L daminozide, the largest number of flowers (4.66 flowers/plant) in treatment of 1000 mg/L cycocel + 4500 mg/L daminozide and most essence content (0.154 mg/100 g) in treatment of 4500 mg/L daminozide without cycocel were obtained.

Keywords: Chlormequat, Drench, Plant height, Ornamental plants.

INTRODUCTION

Calendula officinalis (pot marigold) from the family Asteraceae is probably native to southern Europe. It is a short-lived aromatic perennial plant, growing to 80 cm tall, with sparsely branched lax or erect stems. The inflorescences are yellow, comprising a thick capitulum or flower head 4-7 cm diameter surrounded by two rows of hairy bracts. *Calendula* are considered by many gardening experts as one of the most versatile flowers to grow in a garden, especially since they are easy to grow, and tolerate most soils. *Calendula officinalis* L. is an annual, aromatic, medicinal and ornamental herb (Gazim *et al.*, 2008). The composite flowers blossom in the spring-summer seasons for 3 times per year (Gilman and Howe, 1999; Omidbaighi, 2005). The leaves and flowers of marigold are applied in horticulture, medicine, cosmetics, perfume, pharmaceutical preparation, food and other industries (Van Wyk and Wink, 2004; Gazim *et al.*, 2008). One of the main components of active ingredient in *Calendula officinalis* L. are essential oils which the most of them synthesize in its orange petals (Omidbaighi, 2005). Flower essence is using for food and medicine (Hamburger *et al.*, 2003; Janke, 2004; Jimenez-Medina *et al.,* 2006). Plant growth retardants are commonly applied to limit stem elongation and produce a more compact plant. Production of high quality, compact pot plants may be achieved through the use of plant growth retardants including cycocel (Tayama *et al.,* 1992). Effectiveness of plant growth retardants depends on time and method of application, concentration, type of species and cultivar, and type of target organ as well physiological and environmental conditions (Pobudkiewicz and Nowak, 1994; James *et al*., 1999). The most common methods of application of growth retardants are foliar sprays and media drenches (Al-Khassawneh *et al.*, 2006). Plant growth retardants can delay cell division and elongation of plant aerial parts as well restrict gibberellins biosynthesis, resulted in reduces internodes length and vegetative growth (Magnitskiy *et al.*, 2006). Adding cycocel has also proven to be effective in controlling growth of some other plants (Al-Khassawneh *et al.*, 2006; Rossini Pinto *et al.*, 2005; Leclerc *et al.*, 2006). Proper doses of cycocel and daminozide foliar spray and drench rate need to be assessed because they can either inhibit or promote growth and development. Therefore, the objective of the present study was to evaluate the effect of different concentrations of cycocel and daminozide on some growth characters especially plant height and the content of essence in *Calendula officinalis* L.

MATERIALS AND METHODS

Seeds of *Calendula officinalis* L. were obtained from Bazr va Nahal Company, Tehran, Iran. Investigation was carried out in an experimental field in Rasht city located in the northern part of Iran. Seeds were sown in pots filled with 60% sand, 20% cocopeat and 20% animal fertilizer on November 2011. Plants were treated with a drench application at the rate of 0, 500, 1000 and 1500 mg/L of cycocel and 0, 1500, 3000 and 4500 mg/L of daminozide 5-6 weeks after potting. Control plants were drenched with water. Investigated characteristics were the plant height, leaf number, flower number, flowering time, fresh weight, dry matter, the content of essence (essential oil) and carotenoid in flowers. Data were calculated at 60-70 days after transplanting. Plant height was measured by a ruler. Leaf number was obtained by counting leaves from center of each plot and their mean was calculated. Fresh weight of plants was weighted by a digital balance. To obtain the plant dry matter, they were cut from crown and dried at 105°C for 24 h. For determination of the essential oil, the plant materials (flowers) were dried in 45°C. The essential oil was obtained in a Clevenger apparatus by steam distillation. Thus, the 50 g of dried plant materials was extracted with 1000 ml of water. The water collected was re-extracted with 0.5 ml hexane. The essence and hexane was separated from water physically and weighted until the plant essence obtained. Leaf carotenoids were determined using acetone as extracting solvent and the absorbance was measured at 440, 645 and 663 nm. Sample extract was prepared as follows: 0.5 g of dry sample was thoroughly crushed and homogenized in a mortar with a pestle using 20 ml of 80% acetone. Filtered

extract was reached to 50 ml by adding of 80% acetone. Concentration of carotenoids was calculated by following formula after spectrophotometry:

The amount of carotenoids = $4.69 \times A_{440} - 0.268 \times (20.2) A_{645} + (8.02) A_{663}$

Where; A is wave length. Data processing of the results was carried out by an EXCEL. Analysis of variance (ANOVA) was done using SPSS statistical software and means were compared using Duncan's test.

RESULTS

The overall results of the effects of different concentrations of cycocel and daminozide on the plant height, leaf number, flower number, flowering time, fresh weight, dry matter, the content of essence and carotenoid in flowers are summarized in Tables 2 and 3.

Plant height

Based on analysis of variance (Table 2), the effect of different treatments and their interaction on the plant height was significant at 0.05 level of probability. Plant height did not decrease linearly with increasing the cycocel concentration (Table 3). *Calendula officinalis* L. plants treated with all concentrations of cycocel and daminozide were shorter than the control plants (Table 3). 500 mg/L cycocel and 4500 mg/L daminozide produced the shortest plants, individually (25.43 and 24.16 cm/plant, respectively). Among all treatments, plants treated with 500 mg/L cycocel along with 1500 mg/L daminozide (C_2D_2) had the least plant height (23.33 cm/plant) (Table 3). C_2D_3 treatment was good for control of plant height (24.00 cm/plant), too. The highest plant height (38.33 cm/plant) was obtained in C_1D_1 treatment (control). Comparison between different concentrations of cycocel and daminozide shows that daminozide is more suitable plant retardant than cycocel for reduction of plant height (Table 3).

Leaf number

Analysis of variance (Table 2) showed that the effect of different treatments and their interaction had no significant effect on leaf number. Table 3 shows that the largest number of leaf (5.00/plant) was obtained in C_1D_2 and C_2D_3. The smallest number of leaf (2.75 and 2.83/plant) was calculated in C_1 and D_1.

Flower number

Mean comparison obtained from the data showed that the maximum (4.66/plant) and minimum (1.41/plant) number of flower were obtained from plants treated with 1000 mg/L cycocel along with 4500 mg/L daminozide (C_3D_4) and C1 (control), respectively (Table 3). Plants treated with highest concentration of cycocel (C_4) had 1.58 flower/plant. Treatments of C_3D_1, C_2D_3 and C_2D_2 by induction of 4.33 flowers/plant were proper, too. Analysis of variance presented in Table 2 showed that the effect of cycocel and interaction effect of cycocel and daminozide on the number

Table 1. Treatments used in the present study and their symbols.

Treatments (mg/L)	Treatments Symbol
Cycocel 0	C_1
Cycocel 500	C_2
Cycocel 1000	C_3
Cycocel 1500	C_4
Daminozide 0	D_1
Daminozide 1500	D_2
Daminozide 3000	D_3
Daminozide 4500	D_4

Table 2. Analysis of variance (ANOVA) for the effect of different concentrations of cycocel and daminozide on plant height, leaf number, fresh weight, dry matter, flower number, time to flowering, essence and carotenoid contents of *Calendula officinalis* L.

Source of variations	df	Plant height	Leaf number	Fresh weight	Dry matter	Flower number	Time to flowering	Essence content	Carotenoid content
C	3	8.13*	2.02ns	33.05*	0.27ns	0.07*	155.96*	45.91*	12.59*
D	3	3.90*	0.58ns	9.38*	1.03ns	0.18ns	14.85*	5.32*	6.11*
C × D	9	4.37*	0.52ns	7.88*	0.05ns	0.50*	39.55*	2.55*	52.55*
Error	32	6.50	0.29	69.27	0.08	1.33	85.16	32.12	9.12
CV (%)	-	7.36	28.11	26.21	18.92	45.8	7.85	28.61	35.91

ns: Non significant, *: Significant at 5%

of flower per plant were significant at 0.05 probability. The effect of daminozide on the number of flower per plant was no significant.

Time to flowering

Variance analysis of data (Table 2) showed that the impact of cycocel, daminozide and their interaction effect was significant at 0.05 probability on time to flowering. The mean comparison of data in different treatments (Table 3) showed that the lowest time of flowering is related to C_4D_2 treatment (98.00 days). The longest time of flowering was obtained in treatments of C_1D_1 (122.60

Table 3. Mean comparison of the effect of different concentrations of cycocel and daminozide on plant height, leaf number, fresh weight, dry matter, flower number, time to flowering, essence and carotenoid contents of *Calendula officinalis L.*

Treatments (mg/L)	Plant height	Leaf number	Fresh weight	Dry matter	Flower number	Time to flowering	Essence content	Carotenoid content
C_1	35.83^{a}	2.75^{a}	24.41^{b}	4.33^{a}	1.41^{b}	119.66^{a}	0.12^{c}	5.21^{b}
C_2	25.43^{b}	4.25^{a}	32.00^{a}	5.66^{a}	2.58^{a}	114.16^{a}	0.13^{b}	5.87^{b}
C_3	34.25^{a}	4.33^{a}	32.25^{a}	5.58^{a}	2.50^{a}	104.58^{b}	0.14^{a}	6.51^{a}
C_4	34.08^{a}	3.83^{a}	33.33^{a}	5.41^{a}	1.58^{b}	121.33^{a}	0.14^{a}	6.91^{a}
D_1	35.41^{a}	2.83a^{a}	25.50^{b}	4.41^{a}	2.58^{a}	118.00^{a}	0.12^{c}	5.11^{b}
D_2	24.58^{b}	4.08^{a}	30.91^{a}	5.41^{a}	2.66^{a}	121.33^{a}	0.13^{b}	6.14^{a}
D_3	24.25^{b}	4.33^{a}	31.58^{a}	5.91^{a}	2.41^{a}	106.91^{b}	0.14^{a}	6.53^{a}
D_4	24.16^{b}	3.91^{a}	33.00^{a}	5.41^{a}	2.41^{a}	118.66^{a}	0.14^{a}	6.64^{a}
C_1D_1	38.33^{a}	4.33^{a}	21.33^{c}	5.33^{a}	2.00^{d}	122.60^{a}	0.12^{c}	5.11^{c}
C_1D2	35.00^{ab}	5.00^{a}	23.33^{c}	5.00^{a}	3.33^{b}	112.66^{b}	0.13^{b}	5.16^{bc}
C_1D3	32.23^{bc}	4.66^{a}	29.66^{b}	6.00^{a}	3.00^{c}	115.00^{b}	0.12^{c}	6.68^{b}
C_1D4	35.66^{ab}	3.33^{a}	26.33^{b}	5.00^{a}	2.33^{cd}	115.33^{ab}	0.15^{a}	7.02^{ab}
C_2D_1	24.66^{cd}	3.33^{a}	25.66^{b}	6.00^{a}	2.33^{cd}	101.66^{c}	0.14^{ab}	6.23^{b}
C_2D_2	23.33^{cd}	4.33^{a}	33.00^{a}	5.66^{a}	4.33^{a}	116.33^{ab}	0.14^{a}	6.14^{bc}
C_2D_3	24.00^{cd}	5.00^{a}	31.66^{ab}	6.33^{a}	4.33^{a}	113.33^{b}	0.13^{b}	6.58^{b}
C_2D_4	34.00^{b}	4.33^{a}	32.66^{ab}	4.66^{a}	2.33^{cd}	115.33^{ab}	0.14^{a}	7.11^{ab}
C_3D_1	34.33^{ab}	4.66^{a}	26.00^{b}	4.66^{a}	4.33^{a}	108.66^{c}	0.13^{b}	6.12^{bc}
C_3D_2	25.33^{c}	3.00^{a}	31.33^{ab}	6.00^{a}	2.66^{cd}	120.66^{a}	0.14^{ab}	6.89^{b}
C_3D_3	25.00^{cd}	3.00^{a}	31.00^{ab}	5.66^{a}	3.66^{b}	120.00^{ab}	0.14^{ab}	7.01^{ab}
C_3D_4	32.33^{bc}	3.00^{a}	34.66^{a}	6.00^{a}	4.66^{a}	117.33^{ab}	0.14^{a}	8.23^{a}
C_4D_1	34.33^{ab}	3.33^{a}	27.00^{b}	5.00^{a}	2.33^{cd}	111.33^{b}	0.12^{b}	6.35^{b}
C_4D_2	24.66^{cd}	4.00^{a}	33.00^{a}	5.00^{a}	3.00^{c}	98.33^{d}	0.14^{ab}	6.95^{ab}
C_4D_3	26.66^{c}	3.63^{a}	34.00^{a}	5.00^{a}	3.33^{b}	121.66^{a}	0.14^{ab}	7.21^{ab}
C_4D_4	26.66^{c}	4.33^{a}	34.33^{a}	6.00^{a}	3.66^{b}	119.66^{ab}	0.14^{a}	7.69^{a}

In each column means followed by the same letters are not significantly different at 5 % level of probability using Duncan's test.

days). Time to flowering in treatments of C_3 (104.58 days) and D_2 (106.91 days) were also good (Table 3). On the other hand, time to flowering in treatments of C_3D_2, C_3D_3 and C_4 (about 120.00 days for all) was not suitable (Table 3).

Fresh weight

Based on Table 2, the effect of different concentrations cycocel, daminozide and the interaction effect was significant at 0.05 probability on plant fresh weight. Among concentrations of cycocel, C_4 treatment had maximum effect on fresh weight (33.33 g/plant), also, C_1 (control) treatments with 24.41 g fresh weight was minimum (Table 3). Plant fresh weight increased as the concentration of cycocel and daminozide increased. Among concentrations of daminozide, D_4 treatment had maximum effect on fresh weight (33.00 g/plant), also, D_1 (control) treatments with 25.50 g fresh weight was minimum (Table 3). Among all treatments, maximum (34.66 and 34.33 g/plant) and minimum (21.33 g/plant) of plant fresh weight were obtained in C_3D_4, C_4D_4 and C_1D_1 (control), respectively (Table 3).

Dry matter

Table 2 shows that the effects of cycocel, daminozide and the reciprocal effect were no significant effect on plant dry matter. Table 3 shows that dry matter in plants treated with 500 mg/L cycocel along with 3000 mg/L daminozide (6.33 g/plant) was higher than that of other treatments. The 6.00 g dry matter was obtained in 5 treatments including C_1D_3, C_2D_1, C_3D_2, C_3D_4 and C_4D_4 (Table 3). Mean comparison obtained from the data showed that the least dry matter (4.33 and 4.41 g/plant) was calculated from C^1 and D_1 treatments.

Essential oil contents

The effect of cycocel, daminozide and interaction effect of these two factors were significant ($p\leq0.05$) on the content of petal essential oil (Table 2). Maximum essential oil (0.15 ml/100 g FW) was obtained when pot marigold was planted in treatment of C_1D_4 (Table 3). Minimum essential oil (0.12 ml/100 g FW) was obtained when pot marigold was planted in C_1, D_1, C_1D_1, C_1D_3 and C_4D_1 (Table 3).

Carotenoid content

ANOVA showed that the effect of cycocel, daminozide and interaction effect of these two factors were significant ($p\leq0.05$) on the content of petal carotenoid (Table 2). Maximum carotenoid (8.22 mg/L) was obtained when pot marigold plants were planted in treatment of C_3D_4 (Table 3). Minimum essential oil (5.11 mg/L) was obtained when pot marigold plants were planted in D1, C_1D_1 (Table 3).

DISCUSSION

One of the most important applications of plant growth retardant is elevation of plant quality, especially ornamental plants by reduction of vegetative growth. Plant growth retardants decrease the internodes length and eliminate the apical dominance (Lee *et al.,* 1999). Plant growth retardants increase cytokinins which enhance the amount of leaf chlorophyll (Rossini Pinto *et al.*, 2005). Some of the most important factors concerning plant growth retardants are type, time, number, application method and concentration of growth retardant (Cramer and Bridgen, 1998). Cycocel and daminozide are two important plant growth retardant. Several studies revealed effectiveness of cycocel in decreasing plant height (Rossini Pinto *et al.*, 2005; Olivera and Browing, 1993; Garner, 2004; Karlovic *et al.*, 2004; Hashemabadi and Zarchini, 2010). Studies of Al-Khassawneh *et al.* (2006) on growth and flowering of *Iris nigricans* showed that cycocel reduced plant height only at the highest drench concentration. These researchers revealed that cycocel spray at

the higher concentrations (1000-1500 mg/L) reduced plant height. In current study, cycocel caused decreasing of plant height in *Calendula officinalis* L. Karlovic *et al.* (2004) reported decreasing height in *Chrysanthemum* by 2000, 3000 and 4000 mg/L cycocel. Hashemabadi and Zarchini (2010) showed that the least stem length (29.93 cm) was obtained by using 1500 mg/L cycocel in rose. Saffari *et al.* (2004) sprayed *Rosa damascena* with cycocel and found that 3000 mg/L cycocel decreased stem length about 5 cm relative to the control. Increasing application rates did not positively influence plant development when compared to the lower rates used in the study. Cycocel (1000 and 2000 mg/L) decreased *Zinnia* plant height (Hojjati *et al.,* 2009). Current study confirms these studies. Cycocel, also, reduced plant height in *Euphorbia* and *Bougeinvillia* (Shekari *et al.*, 2004), Rosa (Saffari *et al.,* 2004) and Pelargonium (Latimer and Beden, 1994). Other plant growth retardants such as prohexadione-Ca, uniconazole, paclobutrazol and bayleton are applied for decreasing the plants growth as spray or drench (Gibson and Whipker, 2000; Bazzocchi and Giorgioni, 2003). Gholampour *et al*. (2012) showed that the 1500 mg/L of cycocel resulted in about 50 and 20% shorter *Brassica oleracea* cultivar 'Kamome White' and 'Nagoya Red' plants than the control plants, 60 and 90 days after transplant, respectively. The growth of these cultivars decreased with increasing the concentration of cycocel. Some other researches demonstrated the positive effect of cycocel and daminozide on reduction of stem length in some species such as *Euphorbia, Rosa, Pelargonium* and *Bougainvillea* (Saffari *et al.*, 2004; Joyce *et al*., 2004; Shekari, 2006).

Studies of Al-Khassawneh *et al*. (2006) on growth and flowering of *Iris nigricans* showed that maximum number of leaves (average of 12.2-13.6) was obtained when the plants were untreated with cycocel and paclobutrazol, sprayed with 250 mg/L paclobutrazol, or drenched with 0.25 mg/L. Our finding is consistent with these results. Study of Agrawal and Dikshit (2008) on *Achras sapota* L. demonstrated positive effect of cycocel on leaf number. Current study showed that the highest dry matter percentage was obtained from untreated plants with cycocel. In agreement with our finding, Al-Khassawneh *et al.* (2006) also showed that untreated plants had the highest leaf dry weight. Study of Garib Sahi (2009) on *Zinnia elegans* revealed that spraying plants with 2000 mg/L cycocel and 1 mg/L $CaCl_2$ increased leaves and roots dry weight. Our study showed the positive effect of plant growth retardants on increasing the content of essential oil and carotenoid in pot marigold petals. Some studies confirm these findings (Khalid and El-Ghorab, 2006; Gliozeris, 2007). Optimum concentrations of cycocel in these studies were 500 and 1000 mg/L. Plant growth retardants increase cytokinins synthesis and this hormones enhances the content of pigments in plants (Fletcher *et al.,* 2000).

In conclusion, some concentrations of cycocel and daminozide increased morphological and physiological characteristics in *Calendula officinalis* L. The 500 mg/L of cycocel along with 1500 mg/L daminozide resulted in shorter plants than the other concentrations and control plants. Maximum flower number, fresh weight, dry matter and carotenoid content were obtained in plants treated with 1000 mg/L cycocel along with 4500 mg/L daminozide. The 4500 mg/L caused the highest amount of essential oil.

Literature Cited

Agrawal, S. and Dikshit, S.N. 2008. Studies on the effect of plant growth regulators on growth and yield of sapota (*Achrassapota* L. cv. 'Cricket Ball'). Ind. J. Agric. Res. 42: 207-211.

Al-Khassawneh, N.M., Karam, N.S. and Shibli, R.A. 2006. Growth and flowering of black iris (*Iris nigricans* Dinsm.) following treatment with plant growth regulators. Sci. Hort. 107: 187-193.

Bazzocchi, R. and Giorgioni, M.E. 2003. Effect of prohexadione-Ca, uniconazole and paclobutrazol on ornamental kale growth and performance under high temperature. Acta Hort. 614: 499-505.

Cramer, C.S. and Bridgen, M.P. 1998. Growth regulator effects on plant height of potted Mussaenda 'Qeen Sirikit'. HortSci. 33: 78-81.

Flecher, R.A., Sankhla, G.N. and Davis, T. 2000. Triazoles as plant growth regulators and stress protectants. Hortic. Rev. 24: 55-122.
Garib Sahi, B. 2009. Effect of cycocel spray and calcium chloride on the growth and flowering of *Zinnia elegnas* Taeq. The 2th Kurdistan Conf. Biol. Sci. pp. 39-43.
Garner, W. 2004. PGR General Uses and Overview. Technical Service, 800: 4556-4647.
Gazim, Z.C., Rezende, C.M., Fraga, S.R. and Svidzinski, T.I.E. 2008. Antifungal activity of the essential oil from *Calendula officinalis* L. (Asteraceae) growing in Brazil. Braz. J. Microbiol. 39: 61-63.
Gholampour, A., Hashemabadi, D., Sedaghathoor, Sh. and Kaviani, B. 2012. Controlling ornamental cabbage and kale (*Brassica oleracea*) growth via cycocel. J. Ornamen. Hort.Plant, 2 (2): 103-112.
Gibson, B. and Whipker, B.E. 2000. Research progress report: the effect of B9, bonzi and sumagic on the growth of ornamental cabbage and kale. North Carolina Flower Growers Bulletin, 44: 6-9.
Gilman, E.F. and Howe, T. 1999. *Calendula officinalis*. Cooperative Extension Service Institute of Food and Agricultural Science, University of Florida, Fact Sheet, FPS-87.
Gliozeris, S., Tamosiunas, A. and Stuopyte, L. 2007. Effect of some growth regulators on chlorophyll fluorescence in *Viola* × *Wittrockiana* 'Wesel Ice'. Biologia, 2007. 53: 24-27.
Hamburger, M., Adler, S., Baumann, D., Forg, A. and Weinrech, B. 2003. Preparative purification of the major anti, inflammatory triterpenoid esters from marigold (*Calendula officinalis* L.). Fitorapia, 74: 328-38.
Hashemabadi, D. and Zarchini, M. 2010. Effect of some plant growth regulators on growth and flowering of *Rosa hybrida* "Poison". Plant Omics J. 3 (6): 167-171.
Hojjati, M., Etemadi, N. and Baninasab, B. 2009. Effect of paclobutrazol and cycocel on vegetative growth and flowering of *Zinnia elegans*. Agricultural sciences and Technologies and Natural Resources. 47: 649-656 (In Persian).
Karlovic, K., Vrsek, I., Sindrak, Z. and Zidovec, V. 2004. Influence of growth regulators on the height and number of inflorescence shoots in the *chrysanthemum cultivar* Revert. Agric. Conspec. Sci. 69: 63-66.
Khalid, K.A. and El-Ghorab, A.H. 2006. The effect presowing low temperature on essential oil content and chemical composition of *Calendula officinalis*. J. Essen. Oil-Bearing Plant. 9 (1): 32-41.
James, L., Gibson, B. and Whipker, E. 1999. The effect of B9 + cycocel on the growth of *Brassica juncea* var. Rugosa Red Giant. SNA Res. Con., 44: 284-287.
Janke, R. 2004. Farming a Few Acres of Herbs: Calendula, Kansas State University Agricultural Experiment Station and Cooperative Extension Service, MF- 2610.
Jimenz-Medina, E., Garcia-Lora, A., Paco, L., Algarra, I., Collado, A. and Garrido, F. 2006. A new extract of the plant *Calendula officinalis* produces a dual in vitro effect: cytotoxic anti-tumor activity and lymphocyte activation. BMC Cancer, 6: 119.
Joyce, G., Latimer, H., Scoggins, L. and Thomas, J. 2004. Using plant growth regulators on containerized herbaceous perennials. Virginia State University.
Latimer, J.G. and Beden, S.A. 1994. Persistent effect of plant growth regulators on landscape performance of seed geraniums. J. Environ. Hort. 12 (3): 150-154.
Leclerc, M., Caldwell, C.D. and Lade, R.R. 2006. Effect of plant growth regulators on propagule formation in Hemerocallis spp. and Hosta spp. HortSci. 47: 651-653.
Lee, J.H., Jin, E.S. and Kim, W.T. 1999. Inhibition of auxin-induced ethylene production by SA in mungbean hypocotyls. J. Plant Biol. 42: 1-7.
Magnitskiy, S.V., Pasian, C.C., Bennett, M.A. and Metzger, J.D. 2006. Controlling plug height of verbena, celosia, and pansy by treating seeds with paclobutrazol. HortSci. 47: 158-167.

Olivera, C.M. and Browning, G. 1993. Studies on the induction of flowering in juvenile *Prunus avium* L. J. Hort. Sci. 68: 731-739.
Omidbaigi, R. 2005. Production and processing of medicinal plants. Behnashr Publication, Mashhad, Iran.
Pobudkiewicz, A.K. and Nowak, J. 1994. The influence of florprimidol and uniconazole on growth of the CMM draft Dianthus caryophyllus L. 'Snowmass'. J. Fruit and Ornamental Plant Res. 2 (4): 135-142.
Rossini pinto, A.C., Rodrigues, Td.J.D., Leits, C.I. and Barbosa, J.C. 2005. Growth retardants on development and ornamental quality of potted. 'Liliput' *Zinnia elegans* JACQ. Sci. Agric. 62: 337-345.
Saffari, V.R., Khalighi, A., Lesani, H., Babalar, M. and Obermaier, J.F. 2004. Effect of different plant growth regulators and time of pruning on yield components of *Rosa damascena* Hill. Int. J. Agric. Biol. 6 (6): 1040-1042.
Shekari, F., Ebrahimzadeh, A. and Esmaeilpour, B. 2005. Plant Growth Regulators in Agriculture and Horticulture. Zanjan University Press, Iran (In Persian).
Tayama, H.K., Larson, R.A., Hammer, P.A. and Rolls, T.J. (eds.) (1992). Tips on the use of chemical growth regulators on floriculture crops. Ohio Florists' Assn., Columbus, Ohio.
Van Wyk BE, wink M (2004). Medicinal plants of the world. Briza Publications, Pretoria.