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INFLUENCE OF PINCHING, SOME FERTILIZATION TREATMENTS AND SPRAYING WITH ALAR ON SOLIDAGO PLANTS B. FLOWERING CHARACTERISTICS

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ABSTRACT: This study was carried out at Dept. of Ornamental Hort., Fac. Agric., Cairo Univ. and the applied part was carried out under open field conditions at the Experimental Farm of Hort. Res. Inst., ARC, Giza, Egypt during 2015 and 2016 seasons to investigate the effect of pinching, bio- and chemical fertilization (as a soil drench), foliar spraying with alar and their interactions on flowering parameters of goldenrod (*Solidago hybrida*, "Tara") with the aim of producing high quality plants appropriate to be used as flowering pot plants. Flowering stem length (cm), flowering start date (days), flowering stem fresh and dry weights (g) and number of flowering branches were greatly affected by single, double and triple treatments applied in this study.

Regarding the effect of interaction treatments between pinching, fertilization and alar, non-pinching in addition to bio-fertilization + NPK at 3 g/pot + alar at 1000 ppm resulted in the longest flowering stems. Non-pinching in addition to bio-fertilization + NPK at 1.5 g/pot + alar at 500 ppm shared some other treatments (i.e. pinching in addition to bio-fertilization + NPK at 3 g/pot + alar at 500 ppm) and resulted in the lowest flowering start date values. On the other hand, pinching in addition to bio-fertilization + NPK at either 1.5 or 3 g/pot + alar at 500 ppm produced the heaviest fresh flowering stems and to some extent the highest number of flowering branches. However, non-pinching in addition to alar at 1000 ppm + NPK at 3 g/pot either with or without bio-fertilization resulted in the heaviest flowering stems dry weight.

According to the previous findings and from an aesthetic point of view, it is recommended to treat goldenrod transplants grown in 14 cm pots with pinching in addition to bio-fertilization plus NPK at either 1.5 or 3 g/pot + spraying with alar at 500 ppm to produce high quality goldenrod plants appropriate to be used as flowering pot plants.

Key words: Goldenrod, *Solidago hybrida*, "Tara", pinching, fertilization, NPK, bio-fertilizers, alar, flowering parameters.

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INTRODUCTION

Goldenrod (*Solidago* sp.) is a genus of around 100 species of North America and Europe perennial plants. It belongs to the daisy family (Asteraceae). Scientific name comes from the Latin word *solida* which

mean “to make whole” or “to strengthen”, referring to its medicinal properties for treating arthritis, allergies, and sore throats. These plants form clumps of upright, sometimes branching stems, the upper half of which develops panicles of tiny golden yellow flowers. The elongated flower heads (panicles) are borne on stiff, branching stems and make a good cut flower for fresh or dried arrangements. The leaves may be linear, lance-shaped, or pointed oval, and usually have toothed edges. Often, by the time flowering starts in late summer, many of the lower leaves have somewhat withered. This late-flowering habit was used in the past by Native Americans as a kind of floral calendar, guiding them to when the corn would be ripe for harvest. Goldenrod could be propagated in spring from seeds, cuttings or by division (Hogan, 2004; Carter *et al.*, 2007).

Pinching is one of the most suitable tactics for successful cultivation of cut flowers as well as potted plants. Removal of shoot apex by pinching the growing tip, removes the source of apical dominance and assimilates are diverted into lateral buds and branching occurs (Cline, 1991). Abou-Dahab and Habib (2005) reported that the number of flowers/plant was increased by pinching at 5 or 10 cm.

It is well known that chemical fertilization is very important factor in production of ornamental plants along with other production factors. On *Solidago canadensis* Sodha and Dhaduk (2002) showed that the highest length of panicle, number of inflorescence branches, spread of inflorescence branches, diameter of panicle stalk, fresh and dry weight of panicle and number of panicles per plant were recorded upon treatment with the highest nitrogen rate (150 kg N/ha). Also, the highest level of nitrogen (150 kg/ha) resulted in the earliest flowering.

Bio-fertilizer is a broad term used for products containing living or dormant micro-organisms such as bacteria, fungi, actinomycetes and algae alone or in combination, which on application help in fixing atmospheric N or solubilize/ mobilize soil nutrients in addition to secreting growth-promoting substances (Roy *et al.*, 2006). Panchal *et al*. (2010) on *Chrysanthemum coronarium* L. found that application of 175 kg N/ha + *Azospirillum* + *Azotobactor* significantly produced maximum number of flowers per plant and recorded maximum flower diameter as well as weight of individual flower. Significantly maximum flower yield per plant as well as per hectare was recorded with the same treatment.

Alar, as one of growth retardants, is a commercial name for daminozide among a lot of other names. It is generally considered safe because it has short term effect (Srivastava, 2013). Alar causes suppression of the treated plant height, such suppression due to the action of alar as an antiauxin, with stimulation and dwarfing properties and suppression of apical dominance (Crafts *et al.*, 1950). Namika *et al.* (2002) sprayed *Dendranthema grandiflorum* [*Dendranthema morifolium*] cultivars Baggi, Punjab Gold, Ratlam Selection, and Regal with alar at 500, 1000, and 1500 ppm. The results showed that plants sprayed with alar at 1500 and 1000 ppm were the earliest to flower in 102.16 and 102.65 days, respectively, followed by alar at 500 ppm (106.00 days) compared to 112.78 days in the control. Alar increased the duration of flowering although alar at 500 ppm was the most effective in all the cultivars. Ahmad *et al*. (2007) treated carnation (*Dianthus caryophyllus*) with alar concentrations ranged from 200 to 400 ppm combined with pinching. Pinching and chemical application markedly reduced flower size. The lower level of alar (200 mg/liter) was not effective, but the higher concentration (400 mg/liter) had significant effects on the floral characteristics of carnation.

This study was carried out to investigate the effect of pinching, bio- and chemical fertilization (as soil drench), foliar spraying with alar (a growth retardant) and their interactions on flowering parameters of

goldenrod (*Solidago hybrida*, "Tara") with the aim of producing high quality goldenrod plants appropriate to be used as flowering pot plants.

MATERIALS AND METHODS

This study was carried out at Dept. of Ornamental Hort., Fac. Agric., Cairo Univ., Egypt and the applied part was carried out under open field conditions at the Experimental Farm of Hort. Res. Inst., ARC., Giza, Egypt during 2015 and 2016 seasons to investigate the effect of pinching, bio- and chemical fertilization (as soil drench), foliar spraying with alar (a growth retardant) and their interactions on flowering parameters of goldenrod (*Solidago hybrida*, "Tara") with the aim of producing high quality goldenrod plants appropriate to be used as flowering pot plants.

Plant material:

Two-months-old goldenrod (*Solidago hybrida*, "Tara") transplants with about 10 leaves, and 10 cm height were brought from Floramax Company, Mansoria, Giza. Transplants were planted on Jan. 1st (in both seasons) in 14 cm pots filled with a medium containing (1:1:1, peatmoss, vermiculite and sand v/v/v).

After planting, all plants were exposed to additional light (to extend the day length to 16 hours) for approximately 8 weeks to delay flowering until producing a strong vegetative growth. The additional light was provided by using 100 watt lamps placed at height of 1.5 m above plants with 3 meters in between.

Experiment treatments:

1. Pinching treatments:

After one month from planting only one time pinching treatment was done by cutting the plants at a height of 7 cm from the top surface of the pot. In this regard, the experimental plants were divided into two groups; the first group was left without pinching while the other one was pinched as described above.

2. Fertilization treatments:

A liquid bio-fertilizer (combination of nitrobein [a commercial product contains a special clone of *Azotobacter chroococcum* bacteria, conc. 10^6 cells/ml] at 8 cm^3 and phosphorein [a commercial product that contains a special clone of bacteria *Bacillus megaterium* which transfers the unavailable triphosphate to available monophosphate] at 8 cm^3 mixed together in about 72 liter of water). Commercial NPK Crystal Nasr fertilizer (20:20:20) was used as chemical fertilization at the rate of 1.5 and 3.0 g/pot. Chemical composition of crystal Nasr fertilizer is shown in Table (a).

Table a. Chemical composition of Crystal Nasr fertilizer.

N %	20
P %	20
K %	20
Zn ppm	120
Fe ppm	700
Mn ppm	420
Cu ppm	160
Mo ppm	140
B ppm	220

Chemical fertilizer rates (1.5 or 3.0 g/pot) were divided into 6 doses at 10 days intervals, while bio-fertilizer was added only one time. Both chemical and bio-fertilizers were added as soil drench.

The used fertilization treatments were as follow:

a. Control (without fertilization)

b. NPK at 1.5 g/pot.

c. NPK at 3.0 g/pot.

d. 200 ml from the above mentioned liquid bio-fertilizer/pot (bio.).

e. NPK at 1.5 g/pot + bio.

f. NPK at 3.0 g/pot + bio.

3. Alar application:

After one month from planting, three applications of alar were done at 15 days interval. Four concentrations were used in this study zero, 500, 1000 and 1500 ppm.

Alar was used as foliar spraying hence the plants were sprayed from above till runoff.

Interaction was done between the above mentioned treatments to present 48 treatments.

Experimental layout:

This experiment was carried out in 14 cm plastic pots and it was arranged in three factor completely randomized design (factorial). The first factor was pinching treatments (2 treatments), the second factor was NPK fertilization (6 treatments) and the third one was alar application (4 treatments). In this regard 48 treatments (2 × 6 × 4) were applied in this study each one containing three replicates with 5 plants/replicate.

Data recorded:

At the end of each season the following data were recorded:

1. Flowering stem length (cm).
2. Flowering start date: Number of days from planting till the first flower open, (days).
3. Flowering stems fresh weight (g).
4. Flowering stems dry weight (g): flowering stem fresh samples were placed in a drying oven at 80 °C for 24 hours, and then were weighed and re-dried several times until a constant weight for two consecutive readings was obtained.
5. Number of flowering branches/plant.

Statistical analysis:

The experimental design used was completely randomized design in a factorial experiment with three factors as described by Snedecor and Cochran (1972) at 5% probability level. The obtained data were statistically analyzed using MSTAT Computer Program (MSTAT Development Team, 1989). To verify differences among means of various treatments, means were compared using Duncan's Multiple Range Test as described by Duncan (1955).

RESULTS AND DISCUSSION

a. Effect of pinching treatments:

Data presented in Table (1) show that the effect of pinching treatments on flowering stem length, flowering start date, flowering stems fresh and dry weights and number of flowering branches was significant.

Concerning flowering stem length, non-pinching treatment was more effective than pinching procedure in increasing flower stem length to the highest significant value in both seasons as recorded 14.53 and 15.64 cm in the first and second seasons, respectively, while, pinching produced the lowest values in both seasons (11.00 and 11.90 cm in the first and second seasons, respectively).

Table 1. Effect of pinching treatments on some flowering characteristics of goldenrod (*Solidago hybrida,* "Tara") plants during 2015 and 2016 seasons.

Pinching treatments	Flowering stem length (cm)	Flowering start date (mm)	Flowering stems fresh weight (g)	Flowering stems dry weight (g)	Number of flowering branches
			1st season		
Non pinching	14.53 a	98.51 b	11.59 b	2.95 a	1.58 b
Pinching	11.00 b	100.70 a	11.85 a	2.50 b	2.44 a
			2nd season		
Non pinching	15.64 a	99.28 b	11.80 a	2.99 a	1.60 b
Pinching	11.90 b	102.50 a	11.17 b	2.53 b	2.38 a

Means having the same letter are not significantly differed at 0.05 level of probability according to Duncan's multiple range test.

Flowering start date was significantly affected due to using pinching treatments. Pinching treatment significantly increased flowering start date in both seasons as recorded 100.70 and 102.50 days in the first and second seasons, respectively. However, less time to flowering was obtained by non-pinching treatment in both seasons as recorded 98.51 and 99.28 in the first and second seasons, respectively.

Regarding fresh weight, pinching procedure was more effective than non-pinching in increasing flowering stems fresh weight to the highest significant value as recorded 11.85 g in the first season, while non-pinching produced the lowest value as recorded 11.59 g. In the contrary to the first season, this result was reversed in the second one as non-pinching produced the highest fresh weight of flowering stems as recorded 11.80 g, while pinching procedure produced the lowest value as recorded 11.17 g.

Non-pinching treatment was more effective than pinching procedure in increasing flowering stems dry weight to the highest significant value in both seasons as recorded 2.95 and 2.99 g in the first and second seasons, respectively.

Number of flowering branches/plant was also increased by pinching procedure which produced the highest significant value in both seasons as recorded 2.44 and 2.38 in the first and second seasons, respectively, while non-pinching recorded the lowest values in both seasons (1.58 and 1.60 in the first and second seasons, respectively).

b. Effect of fertilization:

A clear effect was observed of the different fertilization treatments on all studied flowering characteristics as shown in Table (2). For flowering stem length, fertilization with NPK at 1.5 g/pot only and at 3.0 g/pot + bio-fertilization significantly produced the tallest flower stem length as recorded 16.43 and 15.10 cm in the first season, and 17.49 and 16.26 cm in the second one, respectively. Fertilizing with bio-fertilization + NPK at 1.5 g/pot produced the lowest values in both seasons (12.69 and 13.80 cm in the first and second seasons, respectively).

Regarding flowering start date, control (without fertilization) and bio-fertilization only significantly increased flowering start date in both seasons without significant differences between them as recorded 105.80 and 108.70 days for control in the first and second seasons, and 103.20 and 104.60 days for bio-fertilization only in the first and second seasons, respectively. On the other hand bio-fertilization + NPK at 1.5 g/pot reduced the time required to flowering in both seasons as recorded 94.24 and 95.60 days in the first and second seasons, respectively.

Concerning flowers stems fresh weight, bio-fertilization + NPK at 1.5 g/pot significantly produced the highest fresh weight in the first season as recorded 16.54 g, while, control (without fertilization) produced the lowest fresh weight (2.50 g) in the first season, but bio-fertilization + NPK at 3 g/pot significantly produced the highest value in the second season as recorded 16.48 g. On the other hand, bio-fertilization and control (without fertilization) produced the lowest values in the second season without significant differences (3.01 and 3.57 g, respectively).

Chemical fertilization with NPK at 3 g/pot significantly produced the highest dry weight in the first and second seasons as recorded 3.78 and 4.03 g, respectively. On the other hand, bio-fertilization + NPK at 3 g/pot shared the previous mentioned treatment but it came in second position (3.87 g) in the second season. However, control (without fertilization) produced the lowest dry weight (0.81 g) in the first season, but bio-fertilization and control produced the lowest dry weight (0.59 and 0.74 in the second season, respectively) without significant differences.

Regarding number of flowering branches/plant, fertilizing with bio-

Table 2. Effect of fertilization treatments on some flowering characteristics of goldenrod (*Solidago hybrida,* "Tara") plants during 2015 and 2016 seasons.

Fertilization treatments	Flowering stem length (cm)	Flowering start date (mm)	Flowering stems fresh weight (g)	Flowering stems dry weight (g)	Number of flowering branches
			1st season		
Control	9.54 d	105.80 a	2.50 c	0.81 e	1.24 c
NPK at 1.5 g/pot	16.43 a	97.83 cd	16.24 ab	3.62 bc	1.92 b
NPK at 3 g/pot	14.48 b	99.68 bc	16.09 b	3.78 a	2.54 a
Bio.	8.36 d	103.20 ab	2.77 c	0.96 d	1.28 c
Bio.+ NPK at 1.5 g/pot	12.69 c	94.24 d	16.54 a	3.54 c	2.50 a
Bio.+ NPK at 3 g/pot	15.10 ab	96.86 cd	16.18 b	3.65 b	2.60 a
			2nd season		
Control	10.36 d	108.70 a	3.57 c	0.74 c	1.17 c
NPK at 1.5 g/pot	17.49 a	100.30 b	15.11 b	3.65 b	1.89 b
NPK at 3 g/pot	15.58 b	99.26 bc	15.53 ab	4.03 a	2.57 a
Bio.	9.13 d	104.60 a	3.01 c	0.59 c	1.24 c
Bio.+ NPK at 1.5 g/pot	13.80 c	95.60 c	15.24 b	3.66 b	2.50 a
Bio.+ NPK at 3 g/pot	16.26 ab	96.81 bc	16.48 a	3.87 a	2.57 a

Bio. = Phosphorein + Nitrobein.
Means having the same letter are not significantly differed at 0.05 level of probability according to Duncan's multiple range test.

fertilization + NPK at 3 g/pot significantly produced the highest number in the first and second seasons as recorded 2.60 and 2.57, respectively. Fertilizing with NPK at 3 g/pot shared the previous combined treatment in its effect but came in the second position without significant difference in between as recorded 2.54 and 2.57, respectively. Also, bio-fertilization with NPK at 1.5 g/pot shared the same combined treatment in its effect but came in the third position without significant difference as recorded 2.50 for both seasons. In this regard, control (without fertilization) recorded the lowest values in both seasons (1.24 and 1.17 in the first and second seasons, respectively). Bio-fertilization only shared control treatment and insignificantly produced the lowest number of branches of flowering in both seasons (1.28 and 1.24, respectively).

c. Effect of alar:

Data presented in Table (3) show the effect of alar concentrations on flowering characteristics. Alar at 1500 ppm was more effective than other treatments in increasing flowering stem length as recorded 13.81 and 14.80 cm in the first and second seasons, respectively. Alar at 1000 ppm and at zero insignificantly came in the second and third positions without significant differences between them as recorded 13.20, 12.77 cm and 14.19, 13.88 cm in the first and second seasons, respectively. However, alar concentration at 500 ppm significantly recorded the shortest flower stem length as recorded 11.28 and 12.22 cm in the first and second seasons, respectively.

Regarding flowering start date, alar at 1500 ppm was more effective than other treatments and significantly increased the

Table 3. Effect of alar concentrations on some flowering characteristics of goldenrod (*Solidago hybrida,* "Tara") plants during 2015 and 2016 seasons.

Alar concentrations	Flowering stem length (cm)	Flowering start date (mm)	Flowering stems fresh weight (g)	Flowering stems dry weight (g)	Number of flowering branches
			1st season		
Zero	12.77 a	99.71 ab	11.62 bc	2.73 c	2.20 a
500 ppm	11.28 b	97.90 b	12.04 a	2.42 d	2.19 a
1000 ppm	13.20 a	99.32 ab	11.74 b	2.81 b	1.82 b
1500 ppm	13.81 a	101.50 a	11.48 c	2.94 a	1.83 b
			2nd season		
Zero	13.88 a	100.60 a	11.18 a	2.79 ab	2.19 a
500 ppm	12.22 b	99.06 a	11.44 a	2.51 c	2.19 a
1000 ppm	14.19 a	102.10 a	11.55 a	2.95 a	1.78 b
1500 ppm	14.80 a	101.80 a	11.79 a	2.77 b	1.80 b

Means having the same letter are not significantly differed at 0.05 level of probability according to Duncan's multiple range test.

required time to flowering in the first season (101.50 days). In this regard, alar at 500 ppm recorded only 97.90 and decreased the time required to flowering in the first season. In the second season, non significant differences were recorded with all treatments, but alar at 500 ppm was more effective than other treatments in reducing the time required to flowering (99.06 days).

Flowering stems fresh weight was also influenced by the different alar concentrations, alar at 500 ppm significantly produced the highest fresh weight as recorded 12.04 g, while alar at 1500 ppm produced the lowest fresh weight values in the first season as recorded 11.48 g. On the other hand, alar at 1500 ppm produced the highest fresh weight in the second season as recorded 11.79 g.

Concerning flowering stems dry weight, alar at 1500 ppm was more effective than other treatments and significantly produced the highest value as recorded 2.94 g, while alar at zero ppm produced the lowest values in the first seasons as recorded 2.73 g, whereas alar at 1000 ppm recorded 2.95 g, but alar at 500 ppm produced the lowest values in the second season as recorded 2.51 g.

According to recorded data on number of flowering branches/plant, alar at 500 ppm treatment was more effective than alar at 1000 and 1500 ppm treatments in increasing this trait and produced the highest significant values in both seasons as recorded 2.19 for each season, control shared the previous combined treatment in its effect but came in the second position without significant difference as recorded 2.20 and 2.19, respectively, while alar 1000 ppm recorded the lowest values in both seasons (1.82 and 1.78 in the first and second seasons, respectively). Alar at 1500 ppm shared the previous combined treatment in its effect but came in the second position without significant difference as recorded 1.83 and 1.80, respectively.

d. Effect of the interaction between pinching and fertilization:

Data presented in Table (4) show the effect of the interaction between pinching and chemical and bio-fertilization on

Table 4. Effect of the interaction between pinching and fertilization treatments on some flowering characteristics of goldenrod (*Solidago hybrida,* "Tara") plants during 2015 and 2016 seasons.

Pinching treatments / Fertilization treatments	Flowering stem length (cm)		Flowering start date (mm)		Flowering stems fresh weight (g)		Flowering stems dry weight (g)		Number of flowering branches	
	Non pinching	Pinching	Non pinching	Pinching	Non pinching	Pinching	Non pinching	Pinching	Non pinching	Pinching
					1st season					
Control	10.90 ef	8.17 g	106.60 a	105.00 ab	2.77 d	2.23 e	0.95 f	0.66 g	1.19 g	1.28 fg
NPK at 1.5 g/pot	18.52 a	14.33 bc	96.08 e-g	99.58 c-f	16.36 bc	16.13 bc	4.09 a	3.14 d	1.64 e	2.20 c
NPK at 3 g/pot	15.60 b	13.36 cd	98.22 d-g	101.10 b-e	15.94 c	16.25 bc	3.99 a	3.57 b	2.00 d	3.09 b
Bio.	9.22 fg	7.49 g	102.30 a-d	104.20 a-c	2.55 de	2.98 d	1.26 e	0.65 g	1.17 g	1.39 f
Bio.+ NPK at 1.5 g/pot	14.37 bc	11.01 ef	92.97 g	95.50 fg	15.99 bc	17.09 a	3.40 c	3.68 b	1.92 d	3.08 b
Bio.+ NPK at 3 g/pot	18.58 a	11.63 de	94.92 fg	98.81 d-f	15.95 c	16.41 b	3.99 a	3.31 c	1.58 e	3.61 a
					2nd season					
Control	12.14 e	8.57 fg	108.30 ab	109.20 a	4.54 c	2.60 d	1.03 d	0.45 e	1.14 f	1.19 ef
NPK at 1.5 g/pot	19.62 a	15.37 bc	97.61 d-f	103.00 b-d	15.70 ab	14.52 b	4.13 a	3.18 c	1.64 d	2.14 c
NPK at 3 g/pot	16.69 b	14.47 cd	97.69 d-f	100.80 c-e	15.63 ab	15.42 ab	4.30 a	3.77 b	2.08 c	3.06 b
Bio.	10.11 f	8.14 g	102.40 b-d	106.80 a-c	3.42 cd	2.59 d	0.59 e	0.60 e	1.14 f	1.33 e
Bio.+ NPK at 1.5 g/pot	15.49 bc	12.12 e	93.78 f	97.42 d-f	14.93 b	15.55 ab	3.71 b	3.61 b	1.97 c	3.03 b
Bio.+ NPK at 3 g/pot	19.79 a	12.74 de	95.92 ef	97.69 d-f	16.60 a	16.35 a	4.19 a	3.55 b	1.64 d	3.50 a

Bio. = Phosphorein + Nitrobein.

Means having the same letter are not significantly differed at 0.05 level of probability according to Duncan's multiple range test.

flowering characteristics. Left plants without pinching in addition to fertilizing with bio-fertilization + NPK at 3 g/pot or at 1.5 g/pot significantly produced the highest flowering stem length values in both seasons as recorded 18.58 and 19.79 , 18.52 , 19.62 cm in both seasons, respectively. In this concern, bio-fertilization only produced the lowest values of 7.49 and 8.14 cm when combined with pinching procedure in the first and second seasons, respectively.

Also, for flowering start date, left plants without pinching and without fertilization extended the time required to flowering up to 106.60 days in the first season only. This was followed with in-significant differences by pinching without fertilization, non-pinching + bio-fertilization and pinching + bio-fertilization (105.00, 102.30 and 104.20 for these three treatments, respectively). Similar trends related to these findings were obtained in the second season with little differences. In this concern, bio-fertilization + NPK at 1.5 g/pot without pinching accelerated the flowering in both seasons as recorded 92.97 and 93.78 in the first and second seasons, respectively.

As for flowering stems fresh weight, pinching in addition to bio-fertilization with NPK at 1.5 g/pot produced the highest value in the first season as recorded 17.09 g but control (without fertilization) produced the lowest values when combined with non-pinching as recorded 2.77 g, In the second season plants without pinching in addition to bio-fertilization with NPK at 3 g/pot produced the highest value as recorded 16.60 g, but bio-fertilization only produced the lowest value (2.59 g) when combined with pinching procedure.

A clear effect of the interaction between pinching and fertilization treatments was observed on flowering stems dry weight. Left plants without pinching in addition to fertilizing with NPK at 1.5 g/pot produced the highest value (4.09 g) in the first season, while bio-fertilization produced the lowest value when combined with pinching procedure (0.65 g). In the second season left plants without pinching in addition to fertilizing with NPK at 3 g/pot produced the highest value (4.30 g), while control plants (without fertilization) produced the lowest value (0.45 g) when combined with pinching procedure.

Number of flowering branches/plant was greatly influenced by the interaction between pinching and fertilization treatments. Pinching plants in addition to fertilizing with bio-fertilization + NPK at 3 g/pot produced the highest value in both seasons and recorded 3.61 and 3.50 in the first and second seasons, respectively. In the same time non-pinching with bio- fertilization only recorded the lowest values in both seasons (1.17 and 1.14 in the first and second seasons, respectively). Non-pinching without fertilization (control) shared the previous combined treatment in its effect but came in the second position without significant difference as recorded 1.19 and 1.14, respectively.

e. Effect of the interaction between pinching and alar concentrations:

Data presented in Table (5) show the effect of the interaction between pinching and alar concentrations on flowering stem length, flowering start date, flowering stems fresh and dry weights and number of flowering branches.

For flowering stem length, it can be observed from the recorded data that non-pinched goldenrod plants significantly produced the highest values when combined with alar concentration at 1000 ppm in both studied seasons (15.47 and 16.58 cm in the first and second seasons, respectively). Pinching procedure, on the other hand, produced the lowest flowering stem length value when combined with alar at 500 ppm as recorded 9.23 cm in the first season and 10.02 cm in the second one.

Flowering start date was also affected due to using the different interactions, it can be observed that pinched goldenrod plants significantly produced the highest values when combined with alar concentration at

Table 5. Effect of the interaction between pinching and alar concentrations on some flowering characteristics of goldenrod (*Solidago hybrida,* "Tara") plants during 2015 and 2016 seasons.

Pinching treatments / Fertilization treatments	Flowering stem length (cm)		Flowering start date (mm)		flowering stems fresh weight (g)		flowering stems dry weight (g)		Number of flowering branches	
	Non pinching	Pinching	Non pinching	Pinching	Non pinching	Pinching	Non pinching	Pinching	Non pinching	Pinching
					1st season					
Zero	14.66 ab	10.89 d	98.87 a-c	100.60 a-c	11.36 c	11.88 b	2.76 c	2.70 c	1.56 c	2.85 a
500 ppm	13.33 bc	9.23 e	98.22 bc	97.57 bc	11.53 bc	12.55 a	2.47 d	2.37 d	1.67 c	2.70 a
1000 ppm	15.47 a	10.93 d	97.06 c	101.60 ab	11.88 b	11.61 bc	3.15 b	2.47 d	1.52 c	2.13 b
1500 ppm	14.67 ab	12.95 c	99.91 a-c	103.10 a	11.60 bc	11.35 c	3.41 a	2.47 d	1.59 c	2.07 b
					2nd season					
Zero	15.86 ab	11.89 d	100.60 a-c	100.60 a-c	11.64 b-d	10.72 de	2.96 b	2.62 c	1.59 c	2.80 a
500 ppm	14.41 bc	10.02 e	98.33 c	99.78 bc	10.79 c-e	12.09 ab	2.64 c	2.38 d	1.70 c	2.67 a
1000 ppm	16.58 a	11.80 d	98.63 c	105.60 a	12.89 a	10.20 e	3.37 a	2.54 cd	1.54 c	2.02 b
1500 ppm	15.70 ab	13.89 c	99.50 bc	104.00 ab	11.89 a-c	11.69 b-d	2.99 b	2.56 cd	1.57 c	2.02 b

Means having the same letter are not significantly differed at 0.05 level of probability according to Duncan's multiple range test.

1500 ppm in the first season (103.10 days), while non-pinching combined with alar concentration at 1000 ppm produced the lowest value (97.06 days). On the other hand, pinched goldenrod plants significantly produced the highest values of flowering start date when combined with alar concentration at 1000 ppm in the second season (105.60 days). Also in the second season, non-pinched plants flowered faster when combined with alar at 500 ppm, as the recorded value was only 98.33 days.

According to flowering stems fresh weight the recorded data show that, pinched goldenrod plants significantly produced the highest values of flowering stems fresh weight when combined with alar concentration at 500 ppm in the first season (12.55 g), while pinching combined with alar at 1500 ppm produced the lowest flowering stems fresh weight value in the first season (11.35 g). On the other hand, non-pinched goldenrod plants significantly produced the highest values when combined with alar at 1000 ppm in the second season (12.89 g). However, pinching combined with alar concentration at 1000 ppm produced the lowest flowering stems fresh weight value in the second season (10.20 g).

There was a significant effect of the interaction between pinching and alar treatments on flowering stems dry weight. Non-pinched goldenrod plants significantly produced the highest values of flowering stems dry weight when combined with alar concentration at 1500 ppm in the first seasons (3.41 g), while pinching combined with alar concentration at 500 ppm produced 2.37 and 2.38 g as the lowest flowering stems dry weight value in the first and second season, respectively). On the other hand non-pinched goldenrod plants significantly produced the highest values of flowering stems dry weight when combined with Alar concentration at 1000 ppm in the second season (3.37 g).

Pinched goldenrod plants significantly produced the highest number of flowering branches when combined with alar concentration at zero in both seasons as recorded 2.85 and 2.80, respectively. Pinching procedure combined with alar at 500 ppm shared the previous combined treatment in its effect but came in the second position without significant difference in between as recorded 2.70 and 2.67 in both seasons respectively. The lowest insignificant values of number of flowering branches were obtained by non-pinching treatment in addition to alar at 1000 ppm in the first and second seasons, as recorded 1.52 and 1.54 respectively.

f. Effect of the interaction between fertilization and alar concentrations:

Data presented in Table (6) show the effect of the interaction between fertilization treatments and alar concentrations on the different studied flowering characteristics. According to the recorded data, combined treatment between chemical fertilization (NPK) at 1.5 g/pot and alar concentration at 1000 ppm produced the highest flowering stem length values as recorded 18.75 and 19.85 cm in the first and second seasons, respectively. NPK at 3 g/pot in addition to alar at 1500 ppm shared the previous combined treatment in its effect but came in the second position without significant difference as recorded 17.10 and 18.22 cm in the first and second seasons, respectively. On the other hand, NPK at 1.5 g/pot in addition to alar at 1500 ppm and zero insignificantly occupied the third and fourth positions. Bio-fertilization in addition to alar at 1000 ppm produced the lowest value of flower stem length in the first season (7.80 cm), while, alar at 500 ppm without fertilization produced the lowest value of flowering stem length in the second one (8.66 cm).

Combined treatment between chemical fertilization (zero) and alar concentration at 1000 ppm produced the highest significant value of flowering start date in both seasons as recorded 111.10 and 117.30 days in the first and second seasons, respectively. Bio-fertilization + NPK at 1.5 g/pot in addition to alar concentration at 500 ppm produced the lowest significant value of flowering start

Table 6. Effect of the interaction between fertilization treatments and alar concentrations on some flowering characteristics of goldenrod (*Solidago hybrida,* "Tara") plants during 2015 and 2016 seasons.

Alar concentrations / Fertilization	1st season				2nd season			
	Zero	**500 ppm**	**1000 ppm**	**1500 ppm**	**Zero**	**500 ppm**	**1000 ppm**	**1500 ppm**
				Flowering stem length (cm)				
Control	9.51 i-l	8.15 kl	8.40 kl	12.08 f-i	10.72 h-j	8.66 j	8.85 j	13.19 e-h
NPK at 1.5 g/pot	16.33 a-d	13.94 c-g	18.75 a	16.70 a-c	17.41 a-c	15.05 c-f	19.85 a	17.66 a-c
NPK at 3 g/pot	13.82 d-g	11.61 g-j	15.38 b-e	17.10 ab	14.90 c-f	12.72 f-h	16.49 b-d	18.22 ab
Bio.	8.66 kl	8.11 kl	7.80 l	8.87 j-l	9.49 ij	8.78 j	8.85 j	9.38 ij
Bio.+ NPK at 1.5 g/pot	13.18 e-h	10.78 h-k	13.32 e-h	13.49 e-h	14.29 d-g	11.89 g-i	14.43 d-g	14.60 d-g
Bio.+ NPK at 3 g/pot	15.15 b-e	15.11 b-e	15.55 b-e	14.61 b-f	16.44 b-d	16.22 b-d	16.66 b-d	15.72 b-e
				Flowering start date (days)				
Control	107.90 ab	105.60 a-d	111.10 a	98.61 d-f	108.10 b-d	109.70 a-c	117.30 a	99.89 d-f
NPK at 1.5 g/pot	96.28 e-g	96.28 e-g	99.39 c-f	99.39 c-f	97.50 ef	98.89 ef	103.70 b-e	101.20 c-e
NPK at 3 g/pot	97.44 e-g	99.78 c-f	98.22 d-f	103.30 b-e	98.33 ef	98.44 ef	99.94 d-f	100.30 de
Bio.	107.90 ab	100.90 b-f	97.44 e-g	106.60 a-c	108.10 b-d	100.20 de	99.56 d-f	110.50 ab
Bio.+ NPK at 1.5 g/pot	94.33 fg	90.06 g	93.94 fg	98.61 d-f	95.89 ef	91.39 f	95.33 ef	99.78 d-f
Bio.+ NPK at 3 g/pot	94.33 fg	94.72 fg	95.89 e-g	102.50 b-e	95.89 ef	95.72 ef	96.72 ef	98.89 ef
				Flowering stems fresh weight (g)				
Control	2.33 k	2.61 jk	2.62 jk	2.43 jk	3.12 h-j	2.93 h-j	3.36 h-j	4.87 h
NPK at 1.5 g/pot	15.90 e-i	16.58 a-d	16.37 c-f	16.12 d-h	14.26 e-g	12.88 g	17.13 a-d	16.17 c-e
NPK at 3 g/pot	15.50 hi	16.36 c-f	16.36 c-f	16.15 c-g	14.02 fg	13.86 fg	18.16 ab	16.06 c-e
Bio.	3.01 j	2.56 jk	2.67 jk	2.84 jk	3.84 hi	2.71 ij	3.64 h-j	1.84 j
Bio.+ NPK at 1.5 g/pot	16.52 a-e	17.06 ab	16.75 a-c	15.83 f-i	15.40 d-f	18.42 a	13.34 g	13.80 fg
Bio.+ NPK at 3 g/pot	16.44 b-f	17.09 a	15.68 g-i	15.49 i	16.45 b-d	17.82 a-c	13.64 fg	18.00 a-c
				Flowering stems dry weight (g)				
Control	0.67 j	0.64 jk	0.64 jk	1.29 i	0.60 jk	0.52 jk	0.71 jk	1.13 i
NPK at 1.5 g/pot	3.84 bc	3.14 g	3.98 b	3.50 f	3.83 c-f	3.13 h	4.00 b-d	3.65 d-g
NPK at 3 g/pot	3.70 c-e	3.22 g	4.55 a	3.65 d-f	4.07 bc	3.37 gh	4.79 a	3.90 b-e
Bio.	0.49 k	0.72 j	0.77 j	1.84 h	0.45 k	0.66 jk	0.84 ij	0.43 k
Bio.+ NPK at 1.5 g/pot	3.67 c-f	3.16 g	3.75 cd	3.57 ef	3.57 e-g	3.58 e-g	4.01 b-d	3.48 f-h
Bio.+ NPK at 3 g/pot	4.01 b	3.65 d-f	3.16 g	3.78 cd	4.25 b	3.81 c-f	3.36 gh	4.06 bc
				Number of flowering branches				
Control	1.28 i-l	1.11 kl	1.33 i-l	1.22 j-l	1.28 j-m	1.00 m	1.28 j-m	1.11 lm
NPK at 1.5 g/pot	1.67 g-j	2.39 c-e	1.72 g-i	1.89 f-h	1.67 h-j	2.45 d-f	1.61 h-k	1.83 g-i
NPK at 3 g/pot	3.45 a	2.39 c-e	2.45 c-e	1.89 f-h	3.50 a	2.45 d-f	2.45 d-f	1.89 g-i
Bio.	1.22 j-l	1.56 h-k	1.28 i-l	1.06 l	1.17 k-m	1.50 i-l	1.28 j-m	1.00 m
Bio.+ NPK at 1.5 g/pot	2.61 b-d	3.06 ab	2.11 e-g	2.22 d-f	2.61 c-e	3.11 ab	2.06 f-h	2.22 e-g
Bio.+ NPK at 3 g/pot	3.00 ab	2.61 b-d	2.06 e-g	2.72 bc	2.94 bc	2.61 c-e	2.00 f-h	2.72 b-d

Bio. = Phosphorein + Nitrobein.

Means having the same letter are not significantly differed at 0.05 level of probability according to Duncan's multiple range test.

date in both seasons as recorded 90.06 and 91.39 days in the first and second seasons, respectively.

For flowering stems fresh weight it can be observed that combined treatment between bio-fertilization + (NPK) at 3 g/pot and alar concentration at 500 ppm produced the highest values as recorded 17.09 g in the first season. Control (without fertilization) with alar concentration at zero ppm produced the lowest value of flowering stems fresh weight in the first season (2.33 g), while, alar at 500 ppm with bio-fertilization + NPK at 1.5 g/pot produced the highest value (18.42 g) in the second season. However, bio-fertilization in addition to alar concentration at 1500 ppm produced the lowest value of flowering stems fresh weight in the second season (1.84 g).

Concerning flowering stems dry weight, the combined treatment between chemical fertilization (NPK) at 3 g/pot and alar concentration at 1000 ppm produced the highest values (4.55 and 4.79 g in the first and second seasons, respectively). Bio-fertilization in addition to alar concentration at zero ppm produced the lowest value of flowering stems dry weight in the first season (0.49 g). Alar at 1500 ppm with bio-fertilization produced the lowest value of flowering stems dry weight in the second season (0.43 g). Fertilizing with NPK at 3 g/pot and alar at zero ppm produced the highest significant value of number of flowering branches in the first and second seasons, respectively as recorded 3.45 and 3.50.

Fertilizing with bio-fertilization + NPK at 1.5 g/pot combined with alar concentration at 500 ppm shared the previous combined treatment in its effect but came in the second position without significant differences in between as recorded 3.06 and 3.11, respectively. Bio-fertilization in addition to alar at 1500 ppm produced the lowest values 1.06 and 1.00 in both seasons, respectively.

g. Effect of the interaction between pinching, fertilization and alar concentrations:

The effect of the interaction between pinching, fertilization and alar concentrations treatments on flower stem length was significant as shown in Table (7). In the first and second seasons non-pinched plants produced the longest flower stem (22.31 and 23.42 cm) when combined with bio-fertilization + NPK at 3 g/pot in addition to alar at 1000 ppm. Such result was significant when compared with some treatments and insignificant with other ones. Pinched plants without fertilization and with alar at 1000 ppm produced the lowest flower stem length as recorded 6.13 and 5.92 cm in the first and second seasons, respectively.

Data presented in Table (8) show that there was a significant effect of the interaction between pinching, fertilization and alar concentrations treatments on flowering start date. Pinched plants produced the highest values of flowering start date when combined with control (without fertilization) and alar at 1000 ppm in both seasons as recorded 113.00 and 124.00 days in the first and second seasons respectively. However, non-pinched plants produced the lowest values of flowering start date when combined with bio-fertilization + NPK at 1.5 g/pot and alar at 500 ppm in both seasons as recorded 86.55 and 84.44 days in the first and second seasons, respectively. On the other hand pinching combined with bio-fertilization + NPK at 1.5 g/pot and alar at 1000 ppm, shared the previous mentioned treatment and many other combined treatments and produced the lowest insignificant value in both seasons (95.11 and 96.33 days in the first and second seasons, respectively).

A clear effect of the interaction between pinching, fertilization and alar concentration treatments was observed on flowering stems fresh weight (Table, 9). In the first season pinched plants produced the highest weight (18.48 g) when combined with bio-fertilization + NPK at 3 g/pot and alar at 500

Table 7. Effect of the interaction between pinching, fertilization treatments and alar concentrations on flowering stem length (cm) of goldenrod (*Solidago hybrida,* "Tara") plants during 2015 and 2016 seasons.

Pinching	Fertilization	Flowering stem length (cm)							
		1st season				2nd season			
		Alar concentrations				Alar concentrations			
		Zero	500 ppm	1000 ppm	1500 ppm	Zero	500 ppm	1000 ppm	1500 ppm
Non pinching	Control	9.55 l-s	10.00 k-s	10.67 i-q	13.39 f-l	11.17 j-t	11.11 k-t	11.78 i-s	14.50 f-m
	NPK at 1.5 g/pot	18.67 a-c	17.68 b-e	19.90 ab	17.85 b-e	19.72 a-c	18.79 b-e	21.01 ab	18.97 b-e
	NPK at 3 g/pot	18.17 b-d	12.50 g-n	15.31 c-h	16.40 b-g	19.22 b-d	13.61 g-p	16.42 c-h	17.51 b-g
	Bio.	9.94 k-s	8.78 n-s	8.83 n-s	9.33 m-s	10.84 l-t	9.72 p-v	9.94 o-u	9.94 o-u
	Bio.+ NPK at 1.5 g/pot	14.39 d-i	13.41 f-l	15.78 c-h	13.92 e-k	15.50 d-i	14.52 f-l	16.89 c-h	15.03 e-k
	Bio.+ NPK at 3 g/pot	17.26 b-f	17.62 b-e	22.31 a	17.14 b-f	18.73 b-e	18.73 b-e	23.42 a	18.26 b-f
Pinching	Control	9.47 l-s	6.30 rs	6.13 s	10.77 i-p	10.28 n-t	6.21 uv	5.92 v	11.88 i-r
	NPK at 1.5 g/pot	13.99 e-j	10.20 j-r	17.59 b-e	15.55 c-h	15.10 e-j	11.31 j-t	18.70 b-e	16.35 c-h
	NPK at 3 g/pot	9.47 l-s	10.71 i-q	15.44 c-h	17.81 b-e	10.58 m-t	11.82 i-r	16.56 c-h	18.92 b-e
	Bio.	7.38 p-s	7.43 p-s	6.76 q-s	8.40 o-s	8.14 r-v	7.85 s-v	7.76 t-v	8.81 r-v
	Bio.+ NPK at 1.5 g/pot	11.97 h-o	8.14 o-s	10.86 i-p	13.07 g-m	13.08 h-q	9.25 q-v	11.97 i-r	14.18 g-n
	Bio.+ NPK at 3 g/pot	13.04 g-m	12.60 g-n	8.78 n-s	12.08 h-o	14.15 g-n	13.71 g-o	9.89 o-u	13.19 h-p

Bio. = Phosphorein + Nitrobein.

Means having the same letter are not significantly differed at 0.05 level of probability according to Duncan's multiple range test.

Table 8. Effect of the interaction between pinching, fertilization treatments and alar concentrations on flowering start date (days) of goldenrod (*Solidago hybrida,* "Tara") plants during 2015 and 2016 seasons.

Pinching	Fertilization	Flowering start date (days)							
		1st season				2nd season			
		Alar concentrations				Alar concentrations			
		Zero	500 ppm	1000 ppm	1500 ppm	Zero	500 ppm	1000 ppm	1500 ppm
Non pinching	Control	111.40 a-c	104.40 a-g	109.10 a-e	101.30 c-j	113.10 a-c	108.30 b-f	110.70 b-e	101.10 c-i
	NPK at 1.5 g/pot	92.78 i-k	95.11 g-k	99.00 e-j	97.44 f-j	94.00 ij	97.11 f-i	100.00 d-i	99.33 d-i
	NPK at 3 g/pot	93.56 h-k	97.45 f-j	96.67 f-k	105.20 a-g	98.00 f-i	96.22 f-j	98.89 d-i	97.67 f-i
	Bio.	103.70 a-h	109.10 a-e	93.56 h-k	102.90 a-i	103.20 c-i	106.40 b-h	95.11 h-j	104.70 b-i
	Bio.+ NPK at 1.5 g/pot	95.89 g-k	86.55 k	92.78 i-k	96.66 f-k	97.78 f-i	84.44 j	94.33 h-j	98.56 e-i
	Bio.+ NPK at 3 g/pot	95.89 g-k	96.67 f-k	91.22 jk	95.89 g-k	97.78 f-i	97.44 f-i	92.78 ij	95.67 g-j
Pinching	Control	104.40 a-g	106.80 a-f	113.00 a	95.89 g-k	103.00 c-i	111.00 b-d	124.00 a	98.67 e-i
	NPK at 1.5 g/pot	99.78 d-j	97.44 f-j	99.78 d-j	101.30 c-j	101.00 c-i	100.70 d-i	107.30 b-g	103.00 c-i
	NPK at 3 g/pot	101.30 c-j	102.10 b-i	99.78 d-j	101.30 c-j	98.67 e-i	100.70 d-i	101.00 c-i	103.00 c-i
	Bio.	112.20 ab	92.78 i-k	101.30 c-j	110.30 a-d	113.00 a-c	94.00 ij	104.00 c-i	116.30 ab
	Bio.+ NPK at 1.5 g/pot	92.78 i-k	93.56 h-k	95.11 g-k	100.60 d-j	94.00 ij	98.33 f-i	96.33 f-j	101.00 c-i
	Bio.+ NPK at 3 g/pot	92.78 i-k	92.78 i-k	100.60 d-j	109.10 a-e	94.00 ij	94.00 ij	100.70 d-i	102.10 c-i

Bio. = Phosphorein + Nitrobein.

Means having the same letter are not significantly differed at 0.05 level of probability according to Duncan's multiple range test.

Table 9. Effect of the interaction between pinching, fertilization treatments and alar concentrations on herb fresh weight (g) of goldenrod (*Solidago hybrida*, "Tara") plants during 2015 and 2016 seasons.

Pinching	Fertilization	Herb fresh weight (g)							
		1st season				2nd season			
		Alar concentrations				Alar concentrations			
		Zero	500 ppm	1000 ppm	1500 ppm	Zero	500 ppm	1000 ppm	1500 ppm
Non pinching	Control	2.71 m-q	2.70 m-q	3.57 m	2.08 p-r	3.13 n-q	3.31 n-q	4.77 m-o	6.95 m
	NPK at 1.5 g/pot	15.17 j-l	16.82 b-d	17.04 bc	16.40 c-h	14.84 e-j	14.03 g-k	20.39 a	13.52 i-k
	NPK at 3 g/pot	14.41 l	15.87 e-k	16.81 b-d	16.66 b-f	14.11 g-k	13.53 i-k	17.76 a-d	17.13 c-e
	Bio.	2.67 n-q	2.44 o-r	2.19 p-r	2.92 m-p	5.17 mn	1.97 pq	4.44 m-p	2.10 o-q
	Bio.+ NPK at 1.5 g/pot	16.47 b-h	15.65 h-k	16.20 c-i	15.63 h-k	16.12 c-i	16.35 c-h	13.02 j-l	14.22 f-k
	Bio.+ NPK at 3 g/pot	16.72 b-e	15.71 g-k	15.44 i-k	15.91 e-k	16.49 c-g	15.55 d-j	16.97 c-f	17.41 b-e
Pinching	Control	1.95 qr	2.51 n-r	1.67 r	2.78 m-q	3.10 n-q	2.55 n-q	1.95 pq	2.79 n-q
	NPK at 1.5 g/pot	16.64 b-f	16.33 c-h	15.70 g-k	15.83 f-k	13.68 h-k	11.74 kl	13.88 g-k	18.81 a-c
	NPK at 3 g/pot	16.59 b-f	16.86 b-d	15.91 e-k	15.65 h-k	13.94 g-k	14.19 g-k	18.57 a-c	14.99 e-j
	Bio.	3.36 mn	2.67 n-q	3.16 m-o	2.76 m-q	2.50 n-q	3.45 n-q	2.84 n-q	1.58 q
	Bio.+ NPK at 1.5 g/pot	16.57 b-g	18.47 a	17.30 b	16.03 d-j	14.67 e-j	20.50 a	13.66 h-k	13.38 i-k
	Bio.+ NPK at 3 g/pot	16.17 d-i	18.48 a	15.92 e-k	15.07 kl	16.41 c-h	20.10 ab	10.32 l	18.59 a-c

Bio. = Phosphorein + Nitrobein.

Means having the same letter are not significantly differed at 0.05 level of probability according to Duncan's multiple range test.

ppm, such result was significant with some treatments and insignificant with other ones. In the same season, pinched plants produced the lowest weight (1.67 g) when combined with control (without fertilization) and alar at 1000 ppm, such result was significant with some treatments and insignificant with another ones. In the second season pinched plants produced the highest weight (20.50 g) when combined with bio-fertilization + NPK at 1.5 g/pot and alar at 500 ppm, such result was significant with some treatments and insignificant with other ones. In this concern, pinched plants produced the lowest weight (1.58 g) when combined with bio-fertilization and alar at 1500 ppm, such result was significant with some treatments and insignificant with others.

According to data registered in Table (10), non-pinched plants produced the highest weight (4.97 g) when combined with bio+ NPK at 3 g/pot and alar at 1000 ppm in the first season, such result was significant with some treatments and insignificant with other ones. In this regard, non-pinched plants produced the lowest weight (0.46 g) when combined with bio-fertilization and alar at zero ppm, such result was significant with some treatments and insignificant with the others. In the second season non-pinched plants produced the highest weight (5.19 g) when combined with NPK at 3 g/pot and alar at 1000 ppm, such result was significant with some treatments and insignificant with others. Pinched plants produced the lowest insignificant weight (0.11 g) when combined with control (without fertilization) and alar at 500 ppm.

Number of flowering branches/plant was greatly influenced by the interaction between pinching, fertilization and alar concentration treatments as registered in Table (11). Pinched plants produced the highest number of flowering branches (5.22 and 5.33 in the first and second seasons, respectively) when combined with NPK at 3 g/pot in addition to alar at zero, while, pinched plants in addition to bio-fertilization only and with alar at 1000 ppm produced the lowest number of flowering branches as recorded 1.00 in the first and second seasons, respectively.

Many other treatments shared the previous mentioned treatment and recorded the same value (1.00) with insignificant differences between them i.e. non-pinching + bio-fertilization + alar at zero and 500 ppm recorded 1.00 in the first and second seasons, respectively, pinching + bio-fertilization + alar at 1500 ppm in the second season only, and non-pinching + control (without fertilization) + alar at 1000 ppm in the first and second seasons, respectively, non-pinching + control (without fertilization) + alar at 500 ppm in the second season only, pinching + control (without fertilization) + alar at 500 and 1500 ppm in the second season only and non-pinching + bio-fertilization + alar at 1500 ppm in the second season only.

It could interpret the positive effects of pinching, fertilization and alar on flowering as follows: apical meristem and young expanding leaves constitute a metabolic sink and auxin source that inhibit the outgrowth of lateral buds (Weiss and Shilo, 1988), on the other hand pinching simply means removing the terminal growing portion of stem due to apical dominance. Removal of shoot apex by pinching the growing tip, removes the source of apical dominance and assimilates are diverted into lateral buds and branching occurs (Cline, 1991). Bio-fertilizer containing living or dormant micro-organisms such as bacteria, fungi, actinomycetes and algae alone or in combination, which on application help in fixing atmospheric N or solubilize/mobilize soil nutrients in addition to secreting growth-promoting substances. They are also known as bioinoculants or microbial cultures. Strictly speaking, although widely used, the term bio-fertilizer is a misnomer. Unlike chemical fertilizers, these are not used to provide nutrients present in them, except in the case of *Azolla* used as green manure (Roy *et al.*, 2006). Alar causes suppression of the treated plant heights, such suppression due to the action of alar as an anti-auxin,

Table 10. Effect of the interaction between pinching, fertilization treatments and alar concentrations on flowering stems dry weight (g) of goldenrod (*Solidago hybrida,* "Tara") plants during 2015 and 2016 seasons.

Pinching	Fertilization	Flowering stems dry weight (g)							
		1st season				2nd season			
		Alar concentrations				Alar concentrations			
		Zero	500 ppm	1000 ppm	1500 ppm	Zero	500 ppm	1000 ppm	1500 ppm
Non pinching	Control	0.68 u-x	0.79 t-w	0.68 u-x	1.66 r	0.53 o-q	0.92 op	0.99 o	1.67 n
	NPK at 1.5 g/pot	4.16 c-e	3.82 f-h	4.71 b	3.68 h-j	4.51 b-d	3.63 g-l	4.71 a-c	3.65 f-l
	NPK at 3 g/pot	4.04 d-f	2.97 op	4.82 ab	4.13 de	4.50 b-d	3.39 i-l	5.19 a	4.10 d-g
	Bio.	0.46 x	0.57 wx	0.94 t	3.08 no	0.39 pq	0.56 o-q	0.94 op	0.47 o-q
	Bio.+ NPK at 1.5 g/pot	3.61 h-j	3.35 k-m	2.77 p	3.86 f-h	3.85 e-j	3.82 f-j	3.34 j-l	3.82 f-j
	Bio.+ NPK at 3 g/pot	3.62 h-j	3.33 k-n	4.97 a	4.03 ef	3.99 d-h	3.52 h-l	5.05 ab	4.20 c-f
Pinching	Control	0.66 v-x	0.48 x	0.59 wx	0.92 tu	0.66 o-q	0.11 q	0.44 o-q	0.59 o-q
	NPK at 1.5 g/pot	3.52 i-k	2.46 q	3.26 l-n	3.32 k-n	3.14 k-m	2.62 m	3.30 j-l	3.64 f-l
	NPK at 3 g/pot	3.36 k-m	3.47 j-l	4.29 cd	3.17 m-o	3.63 g-l	3.36 j-l	4.39 c-e	3.69 f-k
	Bio.	0.52 x	0.88 t-v	0.60 wx	0.60 wx	0.50 o-q	0.76 op	0.75 op	0.39 pq
	Bio.+ NPK at 1.5 g/pot	3.74 g-i	2.97 op	4.73 ab	3.29 k-n	3.29 j-l	3.35 j-l	4.68 a-c	3.13 lm
	Bio.+ NPK at 3 g/pot	4.39 c	3.98 e-g	1.34 s	3.53 i-k	4.50 b-d	4.10 d-g	1.67 n	3.93 e-i

Bio. = Phosphorein + Nitrobein.

Means having the same letter are not significantly differed at 0.05 level of probability according to Duncan's multiple range test.

Table 11. Effect of the interaction between pinching, fertilization treatments and alar concentrations on number of flowering branches of goldenrod (*Solidago hybrida,* "Tara") plants during 2015 and 2016 seasons.

Pinching	Fertilization	Number of flowering branches/plant							
		1st season				2nd season			
		Alar concentration				Alar concentration			
		Zero	500 ppm	1000 ppm	1500 ppm	Zero	500 ppm	1000 ppm	1500 ppm
Non pinching	Control	1.33 m-p	1.11 op	1.00 p	1.33 m-p	1.33 mn	1.00 n	1.00 n	1.22 mn
	NPK at 1.5 g/pot	1.56 k-p	1.89 h-m	1.67 j-o	1.44 l-p	1.67 j-m	2.00 g-l	1.56 k-n	1.33 mn
	NPK at 3 g/pot	1.67 j-o	2.22 f-j	2.11 g-k	2.00 g-l	1.67 j-m	2.33 e-i	2.22 f-j	2.11 f-k
	Bio.	1.00 p	1.00 p	1.55 k-p	1.11 op	1.00 n	1.00 n	1.55 k-n	1.00 n
	Bio.+ NPK at 1.5 g/pot	2.00 g-l	2.22 f-j	1.44 l-p	2.00 g-l	2.11 f-k	2.33 e-i	1.44 l-n	2.00 g-l
	Bio.+ NPK at 3 g/pot	1.78 i-n	1.56 k-p	1.33 m-p	1.67 j-o	1.78 i-m	1.56 k-n	1.44 l-n	1.78 h-m
Pinching	Control	1.22 n-p	1.11 op	1.67 j-o	1.11 op	1.22 mn	1.00 n	1.56 k-n	1.00 n
	NPK at 1.5 g/pot	1.78 i-n	2.89 de	1.78 i-n	2.33 e-i	1.67 i-m	2.89 de	1.67 i-m	2.33 e-j
	NPK at 3 g/pot	5.22 a	2.56 e-g	2.78 d-f	1.78 i-n	5.33 a	2.56 d-g	2.67 d-f	1.67 i-m
	Bio.	1.44 l-p	2.11 g-k	1.00 p	1.00 p	1.33 mn	2.00 g-l	1.00 n	1.00 n
	Bio.+ NPK at 1.5 g/pot	3.22 cd	3.89 b	2.78 d-f	2.44 e-h	3.11 cd	3.89 b	2.67 d-f	2.44 e-h
	Bio.+ NPK at 3 g/pot	4.22 b	3.67 bc	2.78 d-f	3.78 bc	4.11 b	3.67 bc	2.56 d-g	3.67 bc

Bio. = Phosphorein + Nitrobein.
Means having the same letter are not significantly differed at 0.05 level of probability according to Duncan's multiple range test.

with stimulation and dwarfing properties and suppression of apical dominance (Crafts *et al.*, 1950). The inhibition of shoot elongation in many plant species by growth retardants has been attributed by the influence of retardants on gibberellin biosynthesis as opined by Dennis *et al.* (1965) and Maynard and Barker (1972).

The previous mentioned results were in harmony with those obtained by Ryagi and Nalawadi (1996) on golden rod [*Solidago* sp.], Sodha and Dhaduk (2002) on *Solidago canadensis*, Hunmili and Paswan (2003) on gerbera cv. Popular, Lale *et al.* (2003) on golden rod, Bhalla *et al*. (2007) on *Dianthus carypohyllus*, Ahmad *et al.* (2007) on carnation (*Dianthus caryophyllus*), Asrar *et al.* (2014) on some chrysanthemum cultivars and Singh *et al*. (2016) on some carnation varieties.

From an aesthetic point of view, it is recommended to treat goldenrod transplants grown in 14 cm pots with pinching in addition to bio-fertilization (a mixture of nitrobein and phosphorein bio-fertilizers) plus NPK at1.5 or 3.0 g/pot + spraying with alar at 500 ppm to produce high quality flowering goldenrod pot plants.

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تأثير التطويش، بعض معاملات التسميد والرش بالألار على نباتات السوليداجو
ب. صفات التزهير

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تم اجراء هذه الدراسة في قسم بساتين الزينة، كلية الزراعة، جامعة القاهرة وتم اجراء الجزء التطبيقي في حقل التجارب المكشوف في معهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر خلال موسمي ٢٠١٥ و ٢٠١٦ لدراسة تأثير التطويش والتسميد الحيوي والكيماوي (كإضافة للتربة) والرش الورقي بالالار والتفاعل بينهم على النمو الزهري لنبات السوليداجو وذلك بهدف إنتاجه كنباتات اصص مزهرة ذات جودة عالية.

طول السوق الزهرية (سم)، تاريخ بدء التزهير (يوم)، وزن السوق الزهرية الطازج والجاف (جم)، وعدد السوق الزهرية تأثر كثيراً بكل المعاملات التي تم تطبيقها في هذه الدراسة سواء كانت فردية أو مزدوجة أو ثلاثية.

فيما يتعلق بتأثير معاملات التداخل بين التطويش، التسميد و الرش بالآلار أظهرت النتائج أن عدم التطويش بالإضافة إلى التسميد بالأسمدة الحيوية + التسميد بالسماد الكيماوي NPK بتركيز ٣ جم/أصيص + الآلار بتركيز ١٠٠٠ جزء في المليون أدت الى الحصول على أطول السوق الزهرية. بينما عدم التطويش بالإضافة إلى السماد الحيوي + التسميد الكيماوي NPK بتركيز ١.٥ جم/أصيص + الرش بالآلار بتركيز ٥٠٠ جزء في المليون شاركت العديد من المعاملات الأخرى (مثل اجراء التطويش + السماد الحيوي + التسميد الكيماوي NPK بتركيز ٣ جم/ أصيص + الآلار بتركيز ٥٠٠ جزء في المليون) وأدت إلى الحصول على أقل عدد من الأيام من الزراعة للتزهر. من ناحية أخرى، إجراء عملية التطويش بالإضافة إلى السماد الحيوي + التسميد بالسماد الكيماوي NPK بتركيز ١.٥ أو ٣ جم/أصيص + الرش بالآلار بتركيز ٥٠٠ جزء في المليون أدت الى الحصول على أعلى وزن طازج للسوق المزهرة ولحد ما أعلى عدد للأفرع المزهرة. بينما أدى عدم التطويش بالإضافة إلى الرش بالآلار بتركيز ١٠٠٠ جزء في المليون + التسميد الكيماوي NPK بتركيز ٣ جم/أصيص بغض النظر عن اضافة أو عدم اضافة السماد الحيوي إلى الحصول على أعلى وزن جاف للسوق المزهرة.

طبقاً لما تم عرضه سابقاً ومن وجهة نظر جمالية فإنه يستحسن معاملة نباتات السوليداجو النامية في أصص ذات قطر ١٤ سم بإجراء عملية التطويش بالإضافة إلى السماد الحيوي + السماد الكيماوي NPK بتركيز ١.٥ أو ٣ جم/أصيص + الرش بالآلار بتركيز ٥٠٠ جزء في المليون للحصول على نباتات ذات جودة عالية يمكن استعمالها كنباتات أصص مزهرة.