

INFLUENCE OF PINCHING, SOME FERTILIZATION TREATMENTS AND SPRAYING WITH ALAR ON SOLIDAGO PLANTS A. VEGETATIVE GROWTH CHARACTERISTICS

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ABSTRACT: An open field study was carried out at Dept. of Ornamental Hort. Fac. Agric., Cairo Univ., and the applied part was carried out 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 vegetative growth of goldenrod (*Solidago hybrida*, "Tara") with the aim of producing high quality plants appropriate to be used as pot plants.

Non-pinching was more effective than pinching procedure in increasing plant height, stem diameter and leaf area while pinching produced the highest values in terms of herb fresh and dry weights. Chemical fertilization with NPK at either 1.5 or 3 g/pot with or without bio-fertilization resulted in the highest values when compared with the other fertilization treatments. Alar at 1500 ppm produced the highest values in of plant height, stem diameter and leaf area (first season only), while alar at zero ppm produced the heaviest fresh and dry herb weights and the widest leaves (in the second season only). Non-pinching treatments increased plant height, stem diameter and leaf area to the highest values when combined with NPK at only 1.5 g/pot, while pinching treatments combined with all fertilization treatments (except for bio-fertilizer only and control) presented the highest herb fresh and dry weights. Non-pinching in addition to alar at 1000 ppm presented the highest values of plant height and stem diameter, while non-pinching in addition to alar at 500 ppm produced the highest leaf area. Pinching goldenrod plants in addition to spraying with alar at zero or 500 ppm increased herb fresh and dry weights. NPK at only 1.5 g/pot in addition to alar at 1000 or 1500 ppm produced the highest values of plant height and stem diameter. In this concern the highest fresh and dry weights were obtained by treating with bio-fertilization plus NPK at 3 g/pot in addition to alar at 500 or 1500 ppm. NPK at 1.5 g/pot + alar at 1500 ppm produced the highest leaf area in the first season, while in the second one bio-fertilizer + NPK at 1.5 g/pot + alar at zero ppm was more effective. Triple combined treatments showed a great variation in effects on vegetative growth characteristics, in general non-pinching treatments in addition to all fertilization treatments (except for bio-fertilizer only) and alar at all concentrations led to increase plant height, stem diameter and leaf area. However,



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pinching treatments in addition to bio-fertilization + NPK at 3 g/pot + alar at either 500 or 1500 ppm presented the highest fresh and dry weights, respectively.

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 3 g/pot + spraying with alar at 1500 ppm to produce high quality goldenrod plants appropriate to be used as pot plants.

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

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 withered somewhat. 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 number of leaves/plant was increased by pinching at a

height of 5 cm, while, number of flowers/plant was increased by pinching at 5 or 10 cm. The fresh and dry weights of aerial parts and roots were increased by pinching, especially at a height of 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 plant height, number of leaves, number of suckers, plant spread and fresh and dry weights of plant were recorded upon treatment with the highest nitrogen rate (150 kg N/ha). On goldenrod (*Solidagi virgaurea* subsp. *virgaurea*), Kolodziej (2007) indicated that application of N, especially along with P and K, produced higher number of dark green leaves and stems.

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). Attia and Saad (2001) obtained an improvement in plant height, branch number/plant and herb fresh and dry weights/plant due to inoculating *Catharanthus roseus* plants with nitrobein at 250 g/fed.

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 heights, 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 alar at 1500 ppm resulted in maximum reduction in plant height in Baggi cultivar.

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

MATERIALS AND METHODS

This study was carried out at Dept. of Ornamental Hort., Fac. Agric., Cairo Univ., and the applied part was carried out in open field 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 vegetative growth of goldenrod (*Solidago hybrida*, "Tara") with the aim of producing high quality goldenrod appropriate to be used as 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 height of 7 cm from the top surface of the pot. In this regard, the experimental plants were divided in to 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. 10⁶ cells/ml] at 8 cm³ and phosphorein [a commercial product that contains a special clone of bacteria *Bacillus megaterium* which transfers the unavailable triphosphate to available monophosphate] at 8 cm³ mixed together in 72 liter of water). Commercial NPK crystal Nasr fertilizers (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 intervals. Four concentrations were used in this study as 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 factors completely randomized design (Factorial). The first factor was pinching treatments (2 treatments), the second factor was fertilization (6 treatments) and the third one was alar application (4 treatments). In this regard 48 treatments ($2 \times 6 \times 4$) 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- Plant height (cm).
- 2- Stem diameter (mm).
- 3- Herb fresh weight (g).
- 4- Herb dry weight (g): fresh herb samples were placed in a drying oven at 80 °C for 24 hours, then were weighed and re-dried several times until a constant weight for two consecutive readings were obtained.

- 5- Leaf area (cm²): hence fresh leaves were scanned using digital scanner device (BenQ, S2W 3300 U) and the output images were saved and subjected to leave area calculating by using ImageJ software as described by Ferreira and Rasband (2012).

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 non-pinching was more effective than pinching procedure in increasing plant height, stem diameter and leaf area to the highest values in both seasons. On the other hand, pinching produced the highest values in terms of herb fresh and dry weights. Non-pinching recorded 50.35 and 53.43 cm for plant height, 3.85 and 4.04 mm for stem diameter and 7.79 and 7.88 cm² for leaf area, in both seasons, respectively. However pinching procedure recorded 15.64 and 15.20 g for herb fresh weight and 3.24 and 3.59 g for herb dry weight in both seasons, respectively.

b. Effect of fertilization treatments

Data presented in Table (2) show the effect of fertilization treatments on vegetative growth characteristics of goldenrod plants. Chemical fertilization with NPK at 1.5 and 3.0 g/pot significantly produced the tallest plants in the first season as recorded 56.00 and 54.35 cm for these two treatments, respectively when compared with control (without fertilization) which recorded only 34.39 cm in the first season.

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

Pinching treatments	Plant height (cm)	Stem diameter (mm)	1 st season		
			Herb fresh weight (g)	Herb dry weight (g)	Leaf area (cm ²)
Non pinching	50.35 a	3.85 a	13.30 b	3.08 b	7.79 a
Pinching	45.03 b	3.36 b	15.64 a	3.24 a	6.98 b
2 nd season					
Non pinching	53.43 a	4.04 a	14.66 a	3.53 a	7.88 a
Pinching	48.77 b	3.43 b	15.20 a	3.59 a	6.08 b

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

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

Fertilization treatments	Plant height (cm)	Stem diameter (mm)	1 st season		
			Herb fresh weight (g)	Herb dry weight (g)	Leaf area (cm ²)
Control	34.39 c	2.63 d	5.39 b	1.26 c	5.05 b
NPK at 1.5 g/pot	56.00 a	4.54 a	19.36 a	4.00 b	8.98 a
NPK at 3 g/pot	54.35 ab	4.20 b	19.29 a	4.21 a	9.16 a
Bio.	34.51 c	2.22 e	3.91 c	1.34 c	4.09 c
Bio.+ NPK at 1.5 g/pot	53.77 b	4.08 bc	19.34 a	4.19 a	8.49 a
Bio.+ NPK at 3 g/pot	53.13 b	3.97 c	19.51 a	3.96 b	8.55 a
2 nd season					
Control	35.74 c	2.46 c	6.24 b	1.53 d	4.53 c
NPK at 1.5 g/pot	61.99 a	4.68 a	19.17 a	4.81 a	9.13 a
NPK at 3 g/pot	57.85 b	4.40 b	18.70 a	4.61 b	7.96 b
Bio.	34.61 c	2.27 c	6.77 b	1.42 d	3.44 c
Bio.+ NPK at 1.5 g/pot	58.65 b	4.37 b	19.77 a	4.67 ab	8.40 ab
Bio.+ NPK at 3 g/pot	57.77 b	4.22 b	18.91 a	4.30 c	8.42 ab

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.

In the second season fertilization with NPK only at 1.5 g/pot significantly produced the tallest plants (61.99 cm) when compared with control (35.74 cm).

Concerning the effect of fertilization treatments on stem diameter, chemical fertilization with NPK at 1.5 g/pot significantly produced the thickest stems in both seasons as recorded 4.54 and 4.68 mm for both seasons, respectively when compared with bio-fertilization which recorded 2.22 and 2.27 mm in the first and second seasons, respectively.

In term of herb fresh weight there were significant differences in herb fresh weight of goldenrod plants due to using the different fertilizers. Bio-fertilization + NPK at 3 or 1.5 g/pot and Chemical fertilization with NPK only at 1.5 or 3 g/pot significantly produced the heaviest herb fresh weight in the first season as recorded 19.51, 19.34 g and 19.36, 19.29 g for the four treatments, respectively when compared with bio-fertilization which recorded only 3.91 g in the first season. However, bio-fertilization + NPK at 1.5, 3 g/pot and chemical fertilization with NPK only at either 1.5 or 3 g/pot significantly produced the highest herb fresh weight values in the second season as recorded 19.77, 18.91g and 19.17, 18.70 g for the four treatments, respectively when compared with control and bio-fertilization which recorded 6.24 g and 6.77 in the second season without significant differences.

There were significant differences in herb dry weight of goldenrod plants due to using the different fertilizers. Chemical fertilization with NPK at 3 g/pot and bio-fertilization + NPK at 1.5 g/pot significantly produced the highest herb dry weight values in the first season as recorded 4.21 and 4.19 g for both treatments, respectively when compared with control (without fertilization) and bio-fertilization which recorded 1.26 and 1.34 g in the first season. However, chemical fertilization with NPK at 1.5 g/pot and bio-fertilization + NPK at 1.5 g/pot significantly produced the highest herb dry weight values in the second season as recorded 4.81 and

4.67 g for both treatments, respectively when compared with bio-fertilization and control which recorded 1.42 g and 1.53 in the second season without significant differences.

Significant differences in leaf area of goldenrod plants due to using the different fertilizers were observed. Chemical fertilization with NPK at either 3.0 or 1.5 g/pot significantly produced the highest leaf area in the first season as recorded 9.16 and 8.98 cm² for both treatments, respectively when compared with bio-fertilization which recorded 4.09 and 3.44 cm² in the first and second seasons, respectively. In the second season fertilization with NPK only at 1.5 g/pot significantly produced the highest value (9.13 cm²) when compared with bio-fertilization and control (3.44 and 4.53 cm²).

c. Effect of alar concentrations:

Illustrated data in Table (3) show the effect of spraying with alar at different concentrations on vegetative growth characteristics of goldenrod plants. The influence of alar concentrations on plant height was significant. Alar at 1500 ppm was more effective than other treatments and significantly produced the tallest plants in both seasons (50.08 and 53.94 cm in the first and second seasons, respectively). In this concern alar at zero and 500 ppm recorded the lowest values (45.94 and 49.79 cm in the first and second seasons, respectively).

Alar at 1500 ppm significantly increased stem diameter in both seasons (3.71 and 3.90 mm in the first and second seasons, respectively). Alar at 500 ppm recorded only 3.36 and 3.53 mm in the first and second seasons, respectively.

The influence of alar concentrations on herb fresh weight of golden rod was significant. Alar at zero ppm was more effective than other treatments and significantly produced the highest herb fresh weight values in both seasons (15.07 and 15.60 g in the first and second seasons, respectively), while alar at 1500 concentration recorded only 13.82 g in the

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

Alar concentrations	Plant height (cm)	Stem diameter (mm)	1 st season		
			Herb fresh weight (g)	Herb dry weight (g)	Leaf area (cm ²)
Zero	45.94 c	3.66 a	15.07 a	3.40 a	7.46 a
500 ppm	47.10 bc	3.36 b	14.67 b	3.07 b	7.25 a
1000 ppm	47.65 b	3.69 a	14.31 c	3.03 b	7.19 a
1500 ppm	50.08 a	3.71 a	13.82 d	3.13 b	7.64 a
2 nd season					
Zero	50.82 b	3.83 a	15.60 a	3.76 a	8.05 a
500 ppm	49.79 b	3.53 b	15.34 ab	3.36 b	6.53 b
1000 ppm	49.86 b	3.67 b	14.37 b	3.46 b	6.46 b
1500 ppm	53.94 a	3.90 a	14.40 b	3.65 a	6.88 b

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

first seasons. Alar at 1000 and 1500 concentration recorded only 14.37 and 14.40 g in the second season without significant differences for both treatments, respectively.

Herb dry weight of golden rod was significantly affected by spraying with the different alar concentrations. Alar at zero ppm was more effective than other treatments and significantly produced the highest herb dry weight values in both seasons (3.40 and 3.76 g in the first and second seasons, respectively). Alar at 1500 ppm shared alar at zero ppm without significant differences in between and recorded the second highest values in the second season as recorded 3.65 g.

In case of leaf area there were insignificant differences between alar concentration in the first season as registered in Table (3). Alar at 1500 ppm was more effective than other treatments and insignificantly produced the highest leaf area in the first season as recorded 7.64 cm² when compared with all other treatments. On the other hand, alar at zero ppm recorded the highest significant leaf area in the second season (8.05 cm²) when compared with alar at 1000, 500 and 1500 ppm as recorded 6.46,

6.53, 6.88 in the second seasons, respectively.

d. Effect of interaction between pinching and fertilization treatments:

Data presented in Table (4) reveal the effect of interaction between pinching and fertilization treatments on vegetative growth characteristics of goldenrod plants. Left plants without pinching in addition to fertilizing with NPK at 1.5 g/pot produced the highest values of plant height in both seasons and recorded 59.80 and 65.10 cm in the first and second seasons, respectively. In this concern, biofertilization produced the shortest plants when combined with pinching procedure as recorded 33.69 cm, in the first season, while in the second one control plants (without fertilization) produced the lowest value (31.57 cm) when combined with pinching procedure.

There were significant differences of interaction between pinching and fertilization treatments on stem diameter, left plants without pinching in addition to fertilizing with NPK at 1.5 g/pot produced the highest values in both seasons and recorded 4.83 and 5.09 mm in the first and

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

Pinching Treatments	1 st season											
	Plant height (cm)		Stem diameter (mm)		Herb fresh weight (g)		Herb dry weight (g)		Leaf area (cm ²)			
	Non pinching	Pinching	Non pinching	Pinching	Non pinching	Pinching	Non pinching	Pinching	Non pinching	Pinching		
Control	41.10 f	27.69 h	2.81 e	2.45 f	3.66 e	7.11 c	1.42 d	1.11 e	5.13 d	4.96 d		
NPK at 1.5 g/pot	59.80 a	52.19 de	4.83 a	4.25 bc	18.28 b	20.44 a	4.05 b	3.95 bc	10.31 a	7.65 c		
NPK at 3 g/pot	54.08 b-d	54.61 b-d	4.17 c	4.23 bc	18.30 b	20.29 a	3.80 c	4.62 a	9.02 b	9.29 ab		
Bio.	35.33 g	33.69 g	2.77 e	1.67 g	3.16 e	4.65 d	1.29 d	1.39 d	4.41 de	3.77 e		
Bio.+ NPK at 1.5 g/pot	55.08 bc	52.46 cd	4.08 c	4.08 c	18.12 b	20.57 a	3.92 bc	4.45 a	9.15 b	7.83 c		
Bio.+ NPK at 3 g/pot	56.69 b	49.56 e	4.46 b	3.49 d	18.26 b	20.77 a	3.98 bc	3.93 bc	8.72 bc	8.39 bc		
	2nd season											
Control	39.90 e	31.57 g	2.77 g	2.15 h	7.18 e	5.30 f	1.82 e	1.24 f	4.56 e	4.49 ef		
NPK at 1.5 g/pot	65.10 a	58.89 bc	5.09 a	4.26 de	19.48 bc	18.86 b-d	4.76 ab	4.86 a	10.44 a	7.81 b-d		
NPK at 3 g/pot	57.85 c	57.86 c	4.40 cd	4.40 cd	17.27 d	20.13 ab	4.29 d	4.93 a	9.09 a-c	6.83 d		
Bio.	33.90 fg	35.32 f	2.59 g	1.95 h	7.25 e	6.30 ef	1.51 f	1.33 f	3.92 ef	2.96 f		
Bio.+ NPK at 1.5 g/pot	61.71 ab	55.60 cd	4.65 bc	4.08 e	18.36 cd	21.18 a	4.58 bc	4.77 ab	9.94 a	6.85 d		
Bio.+ NPK at 3 g/pot	62.14 ab	53.40 d	4.71 b	3.74 f	18.43 cd	19.40 bc	4.20 d	4.41 cd	9.29 ab	7.55 cd		

Bio. = Phosphorein + Nitroben.

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

second seasons, respectively. In this concern, bio-fertilization produced the lowest stem diameter when combined with pinching procedure as recorded 1.67 and 1.95 in the first and second seasons, respectively.

In term of herb fresh weight, pinching in addition to bio-fertilization + NPK at 3 or 1.5 g/pot and chemical fertilization with NPK only at 1.5 or 3 g/pot significantly produced the highest herb fresh weight values in the first season as recorded 20.77, 20.57 g and 20.44, 20.29 g for these four treatments, respectively when compared with bio-fertilization and control without pinching which recorded only 3.16 and 3.66 g in the first season. However, pinching in addition bio-fertilization + NPK at 3 g/pot and chemical fertilization with NPK at 3 g/pot significantly produced the highest herb fresh weight values in the second season as recorded 21.18 and 20.13 g for these two treatments, respectively when compared with control and bio-fertilization combined with pinching which recorded 5.30 g and 6.30 in the second season without significant differences.

Pinching in addition to chemical fertilization with NPK at 3 g/pot and bio-fertilization + NPK at 1.5 g/pot significantly produced the highest herb dry weight values in the first and second seasons respectively as recorded 4.62, 4.45 g and 4.93, 4.77 g when compared with control with pinching which recorded 1.11 and 1.24 g in the first and second season, respectively.

Regarding leaf area, left plants without pinching in addition to fertilizing with NPK at 1.5 g/pot produced the highest leaf area values in both seasons and recorded 10.31 and 10.44 cm² in the first and second seasons, respectively. In this concern, bio fertilization produced the lowest values when combined with pinching procedure as recorded 3.77 and 2.96 cm² in the first and second seasons, respectively.

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

Table (5) show the effect of the interaction between pinching and alar concentrations on vegetative growth of goldenrod plants. Non-pinched goldenrod plants significantly produced the highest values of plant height when combined with alar concentration at 1000 ppm in both seasons (55.69 and 57.27 cm in the first and second seasons, respectively). Pinching procedure, on the other hand, produced the lowest plant height value when combined with alar at 1000 ppm as recorded 39.62 cm in the first season and 42.45 cm in the second one.

In the same manner it can be observed that non-pinched goldenrod plants significantly produced the highest values of stem diameter when combined with alar concentration at 1000 ppm in both seasons (4.12 and 4.19 mm in the first and second seasons, respectively). Pinching procedure, on the other hand, produced the lowest stem diameter value when combined with alar at 500 ppm and alar at 1000 ppm as recorded 3.27 and 3.27 mm in the first season and 3.32 mm and 3.15 mm in the second one for the first and second treatments, respectively.

For of herb fresh weight it could be noticed that pinched goldenrod plants significantly produced the highest values of herb fresh weight when combined with alar concentration at zero ppm in the first season (16.85 g), while non-pinching, on the other hand, produced the lowest herb fresh weight value when combined with alar at 1500, zero, 500 and 1000 ppm as recorded 13.12, 13.30, 13.35 and 13.41 g in the first season for each treatment, respectively. In the second season pinched goldenrod plants significantly produced the highest values of herb fresh weight when combined with alar concentration at 500 ppm (17.41 g). Non-Pinching, on the other hand, produced the lowest herb fresh weight value when combined with alar at 500 ppm as recorded 13.26 g in the same season.

Concerning herb dry weight, it could be observed from the recorded data that pinched goldenrod plants significantly produced the

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

Pinching Treatments	1 st season												
	Plant height (cm)		Stem diameter (mm)		Herb fresh weight (g)		Herb dry weight (g)		Leaf area (cm ²)				
	Non pinching	Pinching	Non pinching	Pinching	Non pinching	Pinching	Non pinching	Pinching	Non pinching	Pinching			
Fertilization treatments													
Zero	45.26 d	46.61 cd	3.96 ab	3.36 cd	13.30 e	16.85 a	3.17 bc	3.63 a	8.58 a	6.35 c			
500 ppm	47.74 c	46.45 cd	3.45 cd	3.27 d	13.35 e	15.99 b	2.87 d	3.27 b	7.33 b	7.18 bc			
1000 ppm	55.69 a	39.62 e	4.12 a	3.27 d	13.41 e	15.21 c	3.17 bc	2.89 d	7.50 b	6.88 bc			
1500 ppm	52.71 b	47.45 c	3.87 b	3.56 c	13.12 e	14.51 d	3.09 c	3.17 bc	7.76 ab	7.53 b			
	2nd season												
Zero	50.06 cd	51.59 c	4.11 a	3.56 b	15.72 b	15.49 b	3.63 bc	3.89 a	9.36 a	6.73 bc			
500 ppm	51.11 cd	48.46 d	3.74 b	3.32 c	13.26 c	17.41 a	3.22 d	3.49 c	7.53 b	5.53 c			
1000 ppm	57.27 a	42.45 e	4.19 a	3.15 c	15.21 b	13.53 c	3.78 ab	3.14 d	7.44 b	5.47 c			
1500 ppm	55.30 ab	52.58 bc	4.11 a	3.70 b	14.44 bc	14.35 bc	3.48 c	3.83 ab	7.17 b	6.60 bc			

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

highest values of herb dry weight when combined with alar concentration at zero ppm in the first and second seasons as recorded (3.63 and 3.89 g) respectively. Non-pinching, on the other hand, produced the lowest herb dry weight value when combined with alar at 500 ppm as recorded 2.87 g in the first season. Pinching procedure, on the other hand, produced the lowest herb dry weight value when combined with alar at 1000 ppm as recorded 3.14 g in the second season.

It can be observed from registered data that non-pinched goldenrod plants significantly produced the highest values of leaf area when combined with alar concentration at zero ppm in both seasons (8.58 and 9.36 cm² in the first and second seasons, respectively). On the other hand, pinching procedure produced the lowest leaf area value when combined with alar at zero ppm as recorded 6.35 cm² in the first season, while Pinching procedure produced the lowest leaf area value when combined with alar at 1000 ppm as recorded 5.47 cm² in the second season.

f. Effect of the interaction between fertilization treatments and alar concentration:

The effect of the interaction between fertilization treatments and alar concentration are shown in Table (6). The combined treatment between chemical fertilization (NPK) at 3 g/pot and alar concentration at 1000 ppm produced the highest significant value of plant height in the first season (62.83 cm). NPK at 1.5 g/pot in addition to alar concentration at 1500 ppm shared the previous combined treatment in its effect but came in the second position without significant difference as recorded 60.11 cm in the first season. On the other hand, NPK at 1.5 g/pot in addition to alar at 1500 ppm shared many other combined treatments and produced the highest insignificant value (65.42 cm) in the second season. Biofertilization in addition to alar at 1500 ppm produced the lowest values in

both seasons (28.39 and 25.28 cm in the first and second seasons, respectively).

Combined treatment between chemical fertilization (NPK) at 3 g/pot and alar concentration at 1000 ppm produced the highest significant value of stem diameter in both seasons as recorded 4.70 mm and 4.83 mm in the first and second seasons, respectively. On the other hand, NPK at 1.5 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 4.67 mm and 4.81 mm in the first and second seasons, respectively), while chemical fertilization (zero) and alar concentration at 500 ppm produced the lowest significant value of stem diameter in the first season (2.02 mm). However NPK (zero) and alar concentration at 1000 ppm produced the lowest significant value of stem diameter in the second season (1.89 mm).

Interaction treatment between bio-fertilization + (NPK) at 3 g/pot and alar concentration at 500 ppm produced the highest significant value of herb fresh weight in the first and second seasons, respectively (20.91 and 21.07 g). Bio-fertilization in addition to alar at 500, 1500, 1000 ppm and control (zero NPK) in addition to Alar at 500 and 1500 ppm produced the lowest values (3.60, 3.62, 4.02, 3.82 and 4.18 g in the first season). Bio-fertilization in addition to alar at 1500 ppm and control (zero NPK) in addition to alar at 500 ppm produced the lowest values (2.79 g and 3.23g) in the second season.

Bio-fertilization + (NPK) at 3 g/pot in addition to spraying with alar at 1500 ppm produced the highest significant value of herb dry weight (5.16 and 5.46 g in the first and second seasons, respectively). Bio-fertilization in addition to alar at 1500 ppm produced the lowest values (0.84 and 0.79 g in the first and second seasons, respectively).

Combined treatment between chemical fertilization (NPK) at 1.5 g/pot and alar concentration at 1500 ppm produced the

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

Fertilization treatments	Alar concentrations		Plant height (cm)							
			1 st season				2 nd season			
	Zero	500 ppm	1000 ppm	1500 ppm	Zero	500 ppm	1000 ppm	1500 ppm		
Control	31.39 kl	32.58 jk	29.18 kl	44.42 i	35.25 gh	30.14 h-j	26.86 ij	50.69 e		
NPK at 1.5 g/pot	50.50 gh	58.89 bc	54.50 d-f	60.11 ab	60.33 a-c	61.92 ab	60.31 a-c	65.42 a		
NPK at 3 g/pot	50.83 f-h	49.00 h	62.83 a	54.72 de	54.03 de	55.42 c-e	63.22 ab	58.75 b-d		
Bio.	41.17 i	36.28 j	32.22 k	28.39 l	41.83 f	39.58 fg	31.75 hi	25.28 j		
Bio.+ NPK at 1.5 g/pot	53.39 e-g	52.00 e-h	51.92 e-h	57.78 b-d	58.14 b-d	56.22 cd	58.36 b-d	61.89 ab		
Bio.+ NPK at 3 g/pot	48.33 h	53.83 e-g	55.25 c-e	55.08 de	55.36 c-e	55.44 c-e	58.67 b-d	61.61 ab		
Stem diameter (mm)										
Control	2.83 fg	2.02 i	2.53 gh	3.14 f	2.62 i	2.14 jk	1.89 k	3.19 h		
NPK at 1.5 g/pot	4.69 a	4.25 bc	4.56 ab	4.67 a	4.78 ab	4.61 a-c	4.51 a-d	4.81 a		
NPK at 3 g/pot	3.83 de	4.19 b-d	4.70 a	4.08 c-e	4.20 d-g	4.19 d-g	4.83 a	4.40 b-f		
Bio.	2.17 hi	2.03 i	2.42 h	2.25 hi	2.40 ij	2.20 jk	2.41 ij	2.09 jk		
Bio.+ NPK at 1.5 g/pot	4.06 c-e	3.81 e	4.14 c-e	4.33 a-c	4.53 a-d	4.08 e-g	4.33 c-g	4.53 a-d		
Bio.+ NPK at 3 g/pot	4.39 a-c	3.86 de	3.83 de	3.81 e	4.47 a-e	3.99 g	4.03 fg	4.40 b-g		
Herb fresh weight (g)										
Control	8.84 h	3.82 jk	4.70 i	4.18 i-k	6.79 ef	3.23 g	6.58 f	8.37 ef		
NPK at 1.5 g/pot	19.26 c-f	20.03 b	19.16 d-g	18.99 d-g	20.12 ab	19.74 a-c	17.46 cd	19.36 a-c		
NPK at 3 g/pot	19.14 d-g	19.94 bc	19.63 b-e	18.47 g	19.97 ab	18.58 b-d	19.80 a-c	16.46 d		
Bio.	4.38 ij	3.60 k	4.02 i-k	3.62 jk	9.16 e	8.14 ef	7.01 ef	2.79 g		
Bio.+ NPK at 1.5 g/pot	19.46 b-f	19.71 b-d	19.41 b-f	18.80 fg	18.95 a-c	21.27 a	18.96 a-c	19.90 ab		
Bio.+ NPK at 3 g/pot	19.38 b-f	20.91 a	18.93 e-g	18.85 fg	18.64 b-d	21.07 a	16.44 d	19.49 a-c		
Herb dry weight (g)										
Control	1.18 kl	0.69 m	1.42 k	1.77 j	1.47 j	0.89 k	1.74 ij	2.01 i		
NPK at 1.5 g/pot	4.45 c	4.87 b	4.13 d	2.53 h	4.88 cd	5.34 ab	4.67 de	4.35 ef		
NPK at 3 g/pot	5.15 a	3.81 e	4.18 d	3.71 ef	5.29 ab	3.78 g	5.08 a-c	4.30 ef		
Bio.	1.27 kl	1.14 l	2.12 i	0.84 m	1.43 j	1.52 j	1.93 i	0.79 k		
Bio.+ NPK at 1.5 g/pot	4.17 d	4.27 cd	3.53 f	4.78 b	4.83 cd	4.75 cd	4.10 fg	5.02 b-d		
Bio.+ NPK at 3 g/pot	4.21 cd	3.65 ef	2.82 g	5.16 a	4.65 de	3.88 g	3.23 h	5.46 a		
Leaf area (cm²)										
Control	4.81 jk	4.77 jk	4.92 jk	5.68 ij	5.84 c-e	3.75 ef	3.64 f	4.88 d-f		
NPK at 1.5 g/pot	7.60 gh	9.69 a-d	8.06 e-h	10.58 a	9.52 a	8.77 ab	8.74 ab	9.48 ab		
NPK at 3 g/pot	9.16 a-g	9.60 a-e	10.09 ab	7.79 f-h	8.97 ab	6.16 cd	9.40 ab	7.33 bc		
Bio.	3.81 k	4.18 jk	4.38 jk	3.99 k	4.59 d-f	3.07 f	3.20 f	2.91 f		
Bio.+ NPK at 1.5 g/pot	9.96 a-c	8.15 d-h	7.27 h	8.58 b-h	9.71 a	8.74 ab	5.97 cd	9.18 ab		
Bio.+ NPK at 3 g/pot	9.45 a-e	7.12 hi	8.41 c-h	9.24 a-f	9.66 a	8.70 ab	7.81 a-c	7.53 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.

highest significant value of leaf area in the first season (10.58 cm²). NPK at 3 g/pot in addition to alar concentration at 1000 ppm shared the previous combined treatment in its effect but came in the second position without significant difference as recorded 10.09 cm². In the second season, bio-fertilization +NPK at 1.5 g/pot in addition to alar at zero ppm shared many other combined treatments (without significant differences between them) and produced the highest significant values when compared with other treatments, the values ranged from 7.53 to 9.71 cm². Bio fertilization in addition to alar at zero ppm produced the lowest values as recorded 3.81 cm² in the first season. Bio-fertilization in addition to alar at 1500 ppm produced the lowest values as recorded 2.91cm² in the second season.

g. Effect of interaction between pinching, fertilization treatments and alar concentration:

Concerning plant height, non-pinched plants produced the tallest plants (65.44 cm) when combined with NPK at 1.5 g/pot and alar at 500 ppm, such result was significant with some treatments and insignificant with other ones in the first season. In the second season both combined treatment between non-pinching + bio-fertilization plus NPK at 3 g/pot + alar at 1000 ppm and non-pinching + NPK at 1.5 g/pot + alar at 500 ppm produced the tallest plants without significant differences between them (68.66 and 67.89 cm, respectively). Pinched plants without fertilization and with alar at 1000 ppm produced the lowest plant height as recorded 11.80 and 13.95 cm in the first and second seasons, respectively (Table, 7).

Effect of interaction between pinching, fertilization treatments and alar concentration was significant on stem diameter (Table, 8). In the first season non-pinched plants produced the highest stem diameter (4.95 mm) when combined with bio-fertilization plus NPK at 3 g/pot and alar at 1500 ppm, such result was significant with some treatments and insignificant with other ones. In the second season combined

treatment between non-pinching + NPK at 1.5 g/pot + alar at 500 ppm produced the highest value (5.38 mm). Pinched plants with bio-fertilization and with alar at 1000 ppm produced the lowest stem diameter as recorded 1.11 mm in the first season but pinched plants without fertilization and with alar at 1000 ppm produced the lowest stem diameter as recorded 1.23 mm in the second season

In the first season, pinched plants produced the highest herb fresh weight when combined with bio-fertilization + NPK at 3 g/pot and alar at 500 ppm as recorded 23.06 and 25.96 g in the first and second seasons, respectively (Table, 9). Non- pinched plants with bio-fertilization and with alar at 500 ppm produced the lowest herb fresh weight as recorded 2.89 g in the first season, while pinched plants with control (without fertilization) and with alar at 500 ppm produced the lowest herb fresh weight as recorded 1.47 g in the second season.

Effect of interaction between pinching, fertilization treatments and alar concentration was significant on herb dry weight (Table, 10). Pinched plants produced the highest herb dry weight when combined with bio-fertilization + NPK at 3 g/pot and alar at 1500 ppm (5.51 and 5.76 g in the first and second seasons, respectively). pinched plants in addition to bio-fertilization and with alar at 1500 ppm produced the lowest herb dry weight as recorded 0.34 g in the first season, while pinched plants with control (without fertilization) and with alar at 500 ppm produced the lowest herb dry weight as recorded 0.35 g in the second season.

Regarding leaf area, data presented in Table (11) show that in the first season non-pinched plants produced the highest leaf area (11.87 cm²) when combined with NPK at 3 g/pot and alar at zero ppm, such treatment was significant with some treatments and insignificant with other ones. In the second season, the two combined treatment between non-pinching + bio-fertilization plus NPK at 1.5 g/pot + alar at zero ppm and non-

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

		Plant height (cm)							
		1 st season				2 nd season			
Pinching	Fertilization	Alar concentrations				Alar concentrations			
		Zero	500 ppm	1000 ppm	1500 ppm	Zero	500 ppm	1000 ppm	1500 ppm
Non pinching	Control	24.44 s	44.56 op	46.56 l-o	48.83 i-o	29.61 p	38.28 o	39.78 o	51.94 i-n
	NPK at 1.5 g/pot	55.55 c-g	65.44 a	58.22 c-e	60.00 bc	61.55 a-f	67.89 a	65.72 ab	65.22 ab
	NPK at 3 g/pot	52.34 f-k	47.67 k-o	65.22 ab	51.11 g-l	57.50 c-j	54.50 f-m	64.11 a-d	55.28 e-m
	Bio.	33.34 r	23.56 st	46.22 l-o	38.22 qr	30.44 p	29.22 pq	45.06 no	30.89 p
	Bio.+ NPK at 1.5 g/pot	58.78 cd	50.89 g-m	53.17 e-j	57.50 c-f	64.67 a-c	59.67 b-h	60.28 b-g	62.22 a-e
	Bio.+ NPK at 3 g/pot	47.11 k-o	54.33 d-h	64.72 ab	60.61 a-c	56.55 e-l	57.11 d-k	68.66 a	66.22 ab
Pinching	Control	38.33 qr	20.61 s-u	11.80 v	40.00 pq	40.89 o	22.00 qr	13.95 s	49.44 l-n
	NPK at 1.5 g/pot	45.44 no	52.33 f-k	50.78 g-m	60.22 a-c	59.11 b-i	55.94 e-m	54.89 f-m	65.61 ab
	NPK at 3 g/pot	49.33 h-o	50.33 g-n	60.44 a-c	58.33 c-e	50.56 j-n	56.33 e-l	62.33 a-e	62.22 a-e
	Bio.	49.00 i-o	49.00 i-o	18.22 u	18.55 tu	53.22 g-m	49.94 k-n	18.45 rs	19.67 rs
	Bio.+ NPK at 1.5 g/pot	48.00 j-o	53.11 e-j	50.67 g-n	58.06 c-e	51.61 j-n	52.78 h-m	56.44 e-l	61.56 a-f
	Bio.+ NPK at 3 g/pot	49.56 h-o	53.33 e-i	45.78 m-o	49.56 h-o	54.16 g-m	53.78 g-m	48.67 mn	57.00 d-k

Bio. = Phosphorein + Nitrobenin.

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 stem diameter (mm) of goldenrod (*Solidago hybrida*, "Tara") plants during 2015 and 2016 seasons.

		Stem diameter (mm)							
		1 st season				2 nd season			
Pinching	Fertilization	Alar concentrations				Alar concentrations			
		Zero	500 ppm	1000 ppm	1500 ppm	Zero	500 ppm	1000 ppm	1500 ppm
Non pinching	Control	3.00 lm	2.55 m-o	2.94 lm	2.72 mn	2.78 r-u	2.40 u-w	2.55 t-v	3.35 n-r
	NPK at 1.5 g/pot	4.89 ab	4.94 a	4.89 ab	4.61 a-d	5.06 a-d	5.38 a	5.16 ab	4.78 b-g
	NPK at 3 g/pot	4.28 c-f	4.11 d-h	4.56 a-d	3.72 g-k	4.87 a-f	4.24 g-l	4.72 b-g	3.78 l-o
	Bio.	2.50 m-o	1.83 pq	3.72 g-k	3.00 lm	2.27 u-w	2.15 vw	3.29 o-r	2.68 s-v
	Bio.+ NPK at 1.5 g/pot	4.22 c-g	4.00 e-i	3.89 f-j	4.22 c-g	4.65 b-h	4.43 e-j	4.55 c-h	4.98 a-e
	Bio.+ NPK at 3 g/pot	4.89 ab	3.28 kl	4.72 a-c	4.95 a	5.01 a-d	3.87 j-n	4.87 a-f	5.09 a-c
Pinching	Control	2.65 mn	1.49 qr	2.11 op	3.56 i-k	2.45 uv	1.88 wx	1.23 y	3.03 q-t
	NPK at 1.5 g/pot	4.50 a-e	3.55 i-k	4.22 c-g	4.72 a-c	4.50 d-i	3.83 k-o	3.87 j-n	4.83 a-f
	NPK at 3 g/pot	3.39 j-l	4.27 c-f	4.83 ab	4.44 a-e	3.53 m-q	4.13 h-l	4.93 a-f	5.01 a-d
	Bio.	1.83 pq	2.22 n-p	1.11 r	1.50 qr	2.53 t-v	2.24 u-w	1.54 xy	1.50 xy
	Bio.+ NPK at 1.5 g/pot	3.89 f-j	3.61 h-k	4.39 b-f	4.44 a-e	4.40 f-k	3.73 l-p	4.11 h-l	4.09 h-m
	Bio.+ NPK at 3 g/pot	3.89 f-j	4.44 a-e	2.94 lm	2.67 mn	3.93 i-m	4.11 h-l	3.20 p-s	3.70 l-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 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.

		Herb fresh weight (g)							
		1 st season				2 nd season			
Pinching	Fertilization	Alar concentrations				Alar concentrations			
		Zero	500 ppm	1000 ppm	1500 ppm	Zero	500 ppm	1000 ppm	1500 ppm
Non pinching	Control	3.52 q-t	3.40 r-t	4.23 p-s	3.47 q-t	7.13 p-r	4.98 rs	6.45 qr	10.15 op
	NPK at 1.5 g/pot	18.22 k-m	18.91 i-k	18.19 k-m	17.81 lm	19.49 c-g	19.73 c-f	20.00 c-f	18.69 d-h
	NPK at 3 g/pot	17.50 m	18.54 j-m	19.39 f-j	17.76 lm	19.67 c-f	15.13 i-l	19.77 c-f	14.51 k-n
	Bio.	3.20 st	2.89 t	3.51 q-t	3.05 t	11.40 no	4.64 r-t	9.01 o-q	3.95 r-t
	Bio.+ NPK at 1.5 g/pot	18.99 i-k	17.59 m	17.67 m	18.23 k-m	19.67 c-f	18.90 d-g	15.47 h-l	19.38 c-g
	Bio.+ NPK at 3 g/pot	18.38 j-m	18.75 j-l	17.48 m	18.42 j-m	16.98 f-k	16.17 g-k	20.57 b-e	19.99 c-f
Pinching	Control	14.16 n	4.24 p-s	5.17 op	4.89 op	6.46 qr	1.47 t	6.70 qr	6.58 qr
	NPK at 1.5 g/pot	20.29 c-g	21.16 b-d	20.12 d-h	20.18 d-h	20.74 b-e	19.75 c-f	14.92 j-m	20.03 c-f
	NPK at 3 g/pot	20.78 b-e	21.33 bc	19.88 e-i	19.18 h-k	20.27 c-f	22.02 b-d	19.82 c-f	18.42 e-i
	Bio.	5.55 o	4.30 p-r	4.53 o-q	4.20 p-s	6.92 p-r	11.64 m-o	5.00 rs	1.63 st
	Bio.+ NPK at 1.5 g/pot	19.92 e-i	21.83 b	21.15 b-d	19.36 f-j	18.23 e-j	23.64 ab	22.44 bc	20.42 b-e
	Bio.+ NPK at 3 g/pot	20.38 c-f	23.06 a	20.38 c-f	19.27 g-k	20.30 b-f	25.96 a	12.31 l-o	19.00 d-g

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

		Herb dry weight (g)							
		1 st season				2 nd season			
Pinching	Fertilization	Alar concentrations				Alar concentrations			
		Zero	500 ppm	1000 ppm	1500 ppm	Zero	500 ppm	1000 ppm	1500 ppm
Non pinching	Control	1.23 q-t	1.00 s-u	1.36 q-s	2.09 o	1.51 u	1.42 u	1.76 s-u	2.58 r
	NPK at 1.5 g/pot	4.10 h-k	4.51 e-g	4.38 f-h	3.19 mn	4.64 f-k	5.07 c-g	5.55 a-c	3.77 o-q
	NPK at 3 g/pot	4.95 b-d	3.44 lm	3.75 kl	3.06 n	4.96 e-h	3.49 q	5.00 d-g	3.73 pq
	Bio.	0.98 tu	0.76 u	2.09 o	1.35 q-s	1.22 u	1.35 u	2.24 rs	1.22 u
	Bio.+ NPK at 1.5 g/pot	4.35 f-i	4.05 h-k	3.20 mn	4.08 h-k	5.52 a-d	4.58 g-l	3.81 n-q	4.42 h-m
	Bio.+ NPK at 3 g/pot	3.43 lm	3.43 lm	4.24 g-i	4.81 c-e	3.91 m-q	3.42 q	4.31 k-o	5.15 b-f
Pinching	Control	1.12 r-u	0.39 v	1.48 qr	1.45 qr	1.43 u	0.35 v	1.72 s-u	1.44 u
	NPK at 1.5 g/pot	4.80 c-e	5.22 ab	3.88 jk	1.88 op	5.12 b-f	5.60 a-c	3.79 n-q	4.92 e-i
	NPK at 3 g/pot	5.35 a	4.18 g-j	4.61 d-f	4.35 f-h	5.62 ab	4.06 l-p	5.15 b-f	4.86 e-j
	Bio.	1.56 pq	1.52 pq	2.14 o	0.34 v	1.64 tu	1.69 tu	1.62 tu	0.37 v
	Bio.+ NPK at 1.5 g/pot	3.99 i-k	4.48 e-g	3.86 jk	5.49 a	4.14 k-p	4.91 e-i	4.39 i-m	5.61 ab
	Bio.+ NPK at 3 g/pot	4.98 bc	3.86 jk	1.39 qr	5.51 a	5.39 a-e	4.33 j-n	2.14 r-t	5.76 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.

Table 11. Effect of the interaction between pinching, fertilization treatments and alar concentrations on leaf area (cm²) of goldenrod (*Solidago hybrida*, "Tara") plants during 2015 and 2016 seasons.

		Leaf area (cm ²)							
		1 st season				2 nd season			
Pinching	Fertilization	Alar concentration				Alar concentration			
		Zero	500 ppm	1000 ppm	1500 ppm	Zero	500 ppm	1000 ppm	1500 ppm
Non pinching	Control	5.84 m-u	4.23 r-v	4.33 q-v	6.12 l-s	5.71 i-r	3.80 o-s	4.15 n-s	4.60 l-s
	NPK at 1.5 g/pot	8.73 e-j	11.57 a-c	9.60 b-h	11.35 a-d	10.16 a-e	11.02 a-c	10.20 a-e	10.38 a-d
	NPK at 3 g/pot	11.87 a	9.25 d-i	9.41 c-i	5.57 n-v	12.66 ab	7.02 f-n	10.45 a-d	6.22 h-p
	Bio.	3.83 t-v	5.00 p-v	4.57 q-v	4.22 r-v	4.90 l-s	3.31 p-s	4.14 n-s	3.35 p-s
	Bio.+ NPK at 1.5 g/pot	11.70 ab	7.89 f-m	7.59 h-n	9.43 c-i	13.16 a	10.19 a-e	6.22 h-p	10.19 a-e
	Bio.+ NPK at 3 g/pot	9.50 b-i	6.02 l-t	9.48 b-i	9.88 a-g	9.57 c-g	9.83 b-f	9.50 c-g	8.28 c-j
Pinching	Control	3.78 uv	5.31 o-v	5.51 n-v	5.25 o-v	5.96 h-q	3.70 o-s	3.13 q-s	5.16 k-s
	NPK at 1.5 g/pot	6.47 k-q	7.81 f-m	6.52 j-q	9.81 a-h	8.89 c-h	6.52 g-o	7.27 e-m	8.58 c-i
	NPK at 3 g/pot	6.45 k-r	9.95 a-g	10.77 a-e	10.01 a-f	5.27 j-s	5.29 j-s	8.34 c-j	8.43 c-i
	Bio.	3.79 uv	3.35 v	4.19 s-v	3.76 uv	4.29 m-s	2.82 rs	2.26 s	2.47 s
	Bio.+ NPK at 1.5 g/pot	8.22 f-l	8.42 f-k	6.95 j-p	7.73 g-n	6.25 h-p	7.28 e-m	5.71 i-r	8.16 c-k
	Bio.+ NPK at 3 g/pot	9.40 c-i	8.21 f-l	7.33 i-o	8.61 e-k	9.75 b-f	7.56 d-l	6.13 h-q	6.78 f-o

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.

pinching + NPK at 3 g/pot + alar at zero ppm produced the highest values without significant differences between them (13.16 and 12.66 cm² for both treatments, respectively). Pinched plants with bio-fertilization and with alar at 500 ppm produced the lowest leaf area as recorded 3.35 cm² in the first season, while pinched plants with bio-fertilization and with alar at 1000 ppm produced the lowest leaf area as recorded 2.26 cm² in the second season.

The above mentioned results were in harmony with findings of Khobragade *et al.* (2012) who found that pinching reduced the plant height and delayed flowering of China aster (*Callistephus chinensis*) cv. Poornima; Badole *et al.* (2015) observed that the individual increase in application of nitrogen (up to 200 kg N ha) and phosphorus (up to 100 kg P ha) on China-aster significantly improved the plant height, number of branches flowering at 50 per cent; Abd El-Malik (2004) reported that microbein as a bio-fertilizer augmented greatly the vegetative growth characters of *Tagetes minuta* plants i.e. plant height, stem diameter, branch number/plant, leaves fresh and dry weight per plant and / fed as well as, fresh and dry weights of stem branches / plant compared with untreated plants; Gautam (2006) treated *Chrysanthemum morifolium* Ram plants with B-nine [daminozide] at (1000, 1500, 2000 and 2500 ppm). They found that B-nine at all concentrations retarded plant height, number of nodes and internodal length over control. It could interpret the positive effects of pinching, fertilization and alar on vegetative growth as follow: 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 mean 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 antiauxin, 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).

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 (a mixture of nitroben and phosphorein biofertilizers) plus NPK at 3 g/pot + spraying with alar at 1500 ppm to produce high quality goldenrod plants appropriate to be used as pot plants.

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تأثير التطويش، بعض معاملات التسميد والرش بالالار على نباتات السوليداجو أ. صفات النمو الخضري

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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 الخضري لنبات السوليداجو وذلك بهدف إنتاجه كنباتات اصص ذات جودة عالية.

أظهرت النتائج أن عدم اجراء التطويش قد أدى إلى زيادة في ارتفاع النبات، قطر الساق و مساحة الورقة بينما أدى التطويش الى الحصول على أعلى القيم من الوزن الطازج والوزن الجاف. التسميد الكيماوي بالـ NPK بمعدل ١,٥ جرام/اصيص و ٣ جرام /اصيص مع استخدام التسميد الحيوي أو بدونه أعطي أعلى القيم بالمقارنة بالتسميد الحيوي منفرداً ومعاملة المقارنة. استخدام الالار بتركيز ١٥٠٠ جزء في المليون انتج اعلي القيم من حيث ارتفاع النبات، قطر الساق ومساحة الورقة (الموسم الاول فقط)، بينما استخدام الالار بتركيز صفر أعطي أكثر النباتات وزناً طازجاً وجافاً وأعلى مساحة للورقة (الموسم الثاني فقط). عدم تطويش النباتات أدى الى الحصول على أعلى القيم فيما يتعلق بارتفاع النبات، قطر الساق و مساحة الورقة وذلك عند التداخل مع التسميد بالـ NPK بمعدل ١,٥ جرام / اصيص، بينما معاملة التطويش بالإضافة إلى كل معاملات التسميد (عدا المعاملة بالتسميد الحيوي منفرداً ومعاملة المقارنة) اعطت اعلي وزن طازج وجاف للنباتات. عدم اجراء عملية التطويش مع استخدام الالار بتركيز ١٠٠٠ جزء في المليون اعطي اعلي ارتفاع وقطر ساق، بينما عدم إجراء التطويش مع الالار بتركيز ٥٠٠ جزء في المليون أدى إلى الحصول على أعلى مساحة ورقة. تطويش نبات السوليداجو مع الرش بالالار بتركيز صفر و ٥٠٠ جزء في المليون ادي الي زيادة الوزن الطازج والجاف للنبات. التسميد بالـ NPK منفرداً بتركيز ١,٥ جرام / اصيص بالإضافة الى الالار ١٠٠٠ و ١٥٠٠ جزء في المليون اعطي اعلي ارتفاع نبات وقطر ساق. في هذا الاطار فان اعلي وزن طازج وجاف تم الحصول عليه بالتسميد الحيوي مع التسميد الكيماوي الـ NPK بمعدل ٣ جرام / اصيص مع الالار ٥٠٠ و ١٥٠٠ جزء في المليون. التسميد بالـ NPK بمعدل ١,٥ جرام / اصيص مع الالار بتركيز ١٥٠٠ جزء في المليون أدى إلى الحصول على أعلى مساحة اوراق في الموسم الاول بينما في الموسم الثاني فان التسميد الحيوي مع التسميد الكيماوي بالـ NPK ١,٥ جرام /اصيص مع الالار بتركيز صفر جزء في المليون كان أكثر تأثيراً. أظهرت معاملات التداخل الثلاثي تبايناً كبيراً في التأثير علي صفات النمو الخضري، علي وجه العموم عدم اجراء عملية التطويش بالتداخل مع كل معاملات التسميد (باستثناء معاملة التسميد الحيوي فقط) وجميع تركيزات الالار زادت من طول النبات، قطر الساق ومساحة الورقة مقارنة بالكنترول. بينما إجراء التطويش + التسميد الحيوي مع استخدام السماد الكيماوي الـ NPK بمعدل ٣ جرام /اصيص + الالار بتركيز ٥٠٠ أو ١٥٠٠ جزء في المليون اعطي اعلي وزن طازج وجاف علي التوالي.

وفقاً للنتائج السابقة ومن الناحية الجمالية فإنه ينصح بمعاملة نباتات السوليداجو النامية في أصص ذات قطر ١٤ سم بالتطويش + إضافة السماد الحيوي مع الكيماوي الـ NPK بمعدل ٣ جرام /اصيص + الرش بالالار بتركيز ٥٠٠ جزء في المليون لإنتاج نباتات أصص من السوليداجو ذات جودة عالية.

