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INFLUENCE OF GROWTH REGULATORS ON THE GROWTH AND FLOWERING OF *Solidago* x *hybrida*

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SUMMARY

Influence of different concentrations of daminozide (Alar 85) on the growth and flowering of *Solidago x hybrida* cv. Goldwedel, grown from terminal and subterminal cuttings, was investigated during two years. Plant height and the number of inflorescences per plant were the variables measured in order to assess the potentials of its cultivation as a pot plant. Different daminozide concentrations were shown to have the strongest influence on flowering. Plants grown from subterminal cuttings were by 22% shorter than plants grown from terminal cuttings. Application of Alar 85 as growth retardant had no significant effect on plant height reduction, and it even produced an adverse effect in the case of subterminal cuttings. A 0.4% concentration of Alar 85 had a positive effect on plant diameter. These results point to the possibility of growing *Solidago x hybrida* cv. Goldwedel as a pot plant without daminozide application.

Key words: daminozide, terminal cuttings, sub-terminal cuttings, pot plant

INTRODUCTION

The research was done on the species *Solidago x hybrida* cv. Goldwedel, a perennial from the family *Asteraceae*, created by crossing the North American species *Solidago canadensis* and *Solidago gigantea*.

Solidago varieties flower abundantly in diverse shades of yellow on every sun-exposed garden soil. Many *Solidago* varieties are now grown for flowerbeds and as cut flowers.

Very few papers have been published on the flowering of *Solidago* species. One of the first appeared in 1940, when A l l a r d and G a r d n e r

investigated the relation between the flowering and length of day in nine North American *Solidago* species, including *Solidago canadensis*, for which they established to be a short-day plant. S i e b e r (1987, 1988) described several varieties of *Solidago x hybrida*. P o r s (1989) investigated the time of flowering of *Solidago canadensis* in a three-year field trial. He established that the differences in flowering time between the clones within a population were to a larger extent due to genetic variability than to environmental influence.

In the last few years, great interest in increasing the assortment of flowering pot plants has been recorded in horticultural production, which instigated research into the possibilities of growing different kinds of perennials for this purpose. The requirements for their production include: high productivity per unit area, low nutrient and pesticide requirements and a short growing period. The main quality demands that a flowering pot plant should satisfy are compact growth and abundant flowering. *Solidago x hybrida* cv. Goldwedel satisfies completely these demands and is beginning to be grown as a pot plant.

MATERIALS AND METHODS

The effect of foliar application of daminozide (Alar 85) in 0.0% (A0), 0.2% (A1) and 0.4% (A2) concentrations on the perennial *Solidago x hybrida* grown from cuttings, was investigated during the summers of 1992 and 1993.

Terminal and subterminal cuttings, 8 cm long, were taken on 15.06.1992 from plants grown in the garden of the Department of Ornamental Plants and Landscape Architecture of the Faculty of Agriculture in Zagreb. Cuttings were rooted in a garden frame, in a multi-plot Styrofoam plate filled with sand. Throughout the 14 days of rooting, the garden frame was covered and shaded with frame windows and the cuttings were every day bedewed with water.

After rooting, the cuttings were planted in 500-ml pots filled with substrate (a mixture of loamy garden soil and sand, 2:1) with neutral reaction, 2% humus, 39.0 mg P_2O_5/100g of soil, 12.0 mg K_2O/100g of soil and 1.08 mg B/kg of soil.

The pots with cuttings were then placed on an asbestos board in the sunny part of the garden, according to the randomized block scheme in 5 replications with 6 combinations. Each combination had 10 terminal (T) and 10 subterminal (S) cuttings. Foliar application of daminozide Alar 85 was carried out three weeks after planting, using a hand sprayer.

In the first half of September, when the plants had reached the market size, their following characteristics were measured: plant height, plant diameter, and the number of inflorescences. The height of all rooted plants was measured just before the application of daminozide and at the end of the trial.

The research goal was to investigate the differences between some interesting properties (compactness and the number of inflorescences) of plants grown from terminal and subterminal cuttings, along with the influence of different Alar 85 concentrations. The results were statistically processed by means of the ANOVA test.

RESULTS AND DISCUSSION

Results of the analysis of variance for the studied properties, per factors and combinations, are given in Table 1.

Table 1. Results of the analysis of variance for the studied properties, per factors and combinations, in 1992 and 1993

Tablica 1. Rezultati analize varijance za proučavana svojstva, po faktorima i kombinacijama, 1992. i 1993. godine

	1992			1993		
	Height Visina	Inflorescence number Broj cvatova	Plant diameter Promjer biljke	Height Visina	Inflorescence number Broj cvatova	Plant diameter Promjer biljke
A0T	24.78	2.66	14.00	24.44	2.46	13.98
A0S	18.00	3.96	14.16	16.88	3.48	14.60
A1T	24.58	4.16	14.30	24.86	3.70	15.68
A1S	18.32	4.22	15.02	19.22	4.64	14.68
A2T	24.24	4.18	15.20	23.94	4.02	14.48
A2S	20.94	3.42	16.60	21.14	2.88	15.26
Daminozide						
$LSD_{P=5\%}$	2.91	1.31	1.17	3.77	1.58	2.14
$LSD_{p=1\%}$	3.97	1.78	1.61	5.15	2.16	2.92

A0T=0% daminozide, terminal cuttings/0% daminozida, terminalna reznica

A1T=0.2% daminozide, terminal cuttings/0.2% daminozida, terminalna reznica

A2T=0.4% daminozide, terminal cuttings/0.4% daminozida, terminalna reznica

A0S=0% daminozide, subterminal cuttings/0% daminozida, subterminalna reznica

A1S=0.2% daminozide, subterminal cuttings/0.2% daminozida, subterminalna reznica

A2S=0.4 % daminozide, subterminal cuttings/0.4% daminozida, subterminalna reznica

Plant height

The effect of daminozide (Alar 85) on plant growth, estimated on the basis of plant height, largely depended on the cutting position on the stock plant. Significantly higher plants (P=1%) were obtained from terminal than from subterminal cuttings. Further, the daminozide rate did not have a significant influence on the height of terminal and subterminal cuttings.

Contrary to expectations, increased daminozide concentrations did not inhibit the growth of plants grown from subterminal cuttings. More intensive plant growth after the application of growth retardants was recorded by Z e e n

w a a r t (1963) in his research into the influence of Cycocel on the flowering and growth of *Pharbitis nil*.

In general, the plants grown from terminal cuttings were significantly higher than those from subterminal cuttings in both research years, which is logical because of the naturally more intensive growth of terminal cuttings (chart 1 and 2). It is interesting to note that the growth of terminal cuttings was decreased by the application of a 0.4% concentration of daminozide, but the differences were not significant compared to the height of plants grown without daminozide. These results are in agreement with the reports of G r a n t z a u et. al. (1987), who also obtained satisfactory results with untreated *Solydago x hybrida* plants.

Chart 1. Height of Solidago x hybrida cv. Goldwedel plants in dependence on the daminozide rate

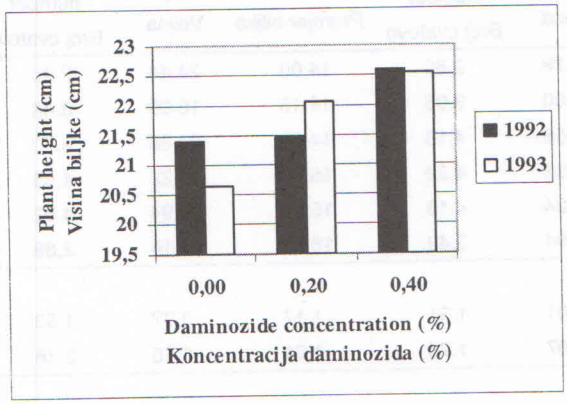
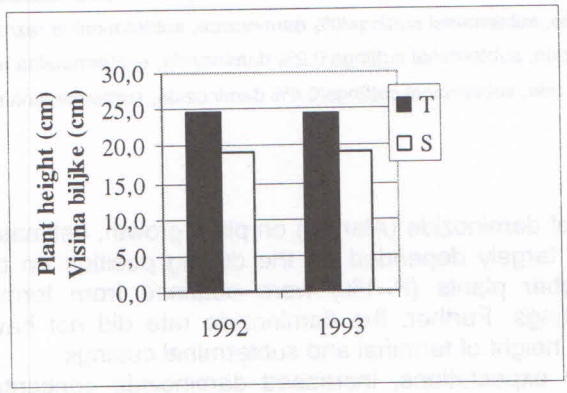


Chart 2. Height of the Solidago x hybrida cv. Goldwedel plants in dependence on the type of cuttings



T= terminal cuttings/ terminalne reznice
S= subterminal cuttings/ subterminalne reznice

The latest researches on different daminozide rates and the number of its applications point to a positive plant response in terms of shoot length reduction. Growth retardants have a physiological role as inhibitors of cell division and enlargement, thus reducing elongation of the aboveground plant organs (D u b r a v e c and R e g u l a, 1995)

Spraying with an Alar concentration of 2500 mg/l applied two times after pinching, between week 2 and week 4 of the growing, has been shown to be efficient for height control of two chrysanthemum cultivars grown as pot plants (S t a r m a n, 1990) Treatment of chrysanthemums grown as pot plants with a daminozide concentration of 4800 ppm, first at the beginning of flower stem elongation, and then a week later, resulted in a 30% growth reduction (N a m et al.,1995).

In a chrysanthemum trial, spraying with 1000 ppm of daminozide reduced the plant height by 4% (E l - K e l t a w i et al. 1996).

T a y a m a (1992) investigated the duration of daminozide action in potted chrysanthemums and determined the biggest difference between the control plant and plants sprayed with 5000 mg/l daminozide in the third week after application.

W i l f r e d (1991), however, failed to achieve satisfactory results, even after two sprayings with a 0.25% solution of Alar 85 in some high varieties of *Solidago sp.*

Accordingly, it seems obvious that the growth regulator daminozide, in the applied concentration, did not cause the desired effect of height reduction. This raises the question of the concentration and the number of applications of daminozide, which should be the subject of further research.

Plant diameter

In the second research year, there were no significant differences in the plant diameter between plants grown from terminal and subterminal cuttings, and the concentration of daminozide had no significant influence on the plant height either.

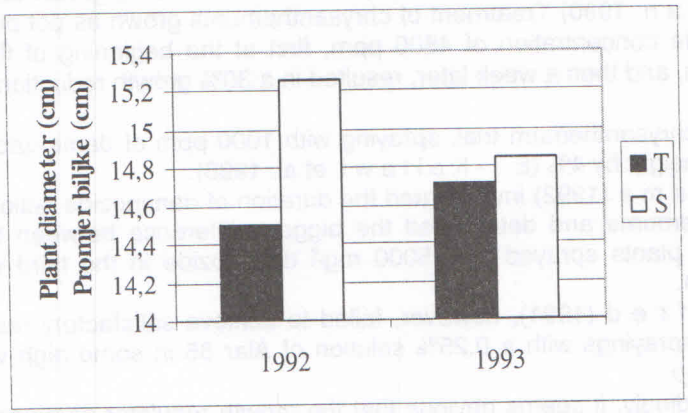
In the first research year, however, only the application of a 0.4% daminozide concentration led to a significant increase of the plant diameter. Further, a significantly larger plant diameter was recorded in plants grown from subterminal cuttings (chart 3 and 4).

Number of inflorescences

The effect of the growth regulator daminozide on the number of inflorescences is intensified by the interaction of its concentration with the cutting type. Thus, an increase of daminozide concentration led to a proportional increase in the number of inflorescences of terminal cuttings. This effect, however, was not consistent in the case of subterminal cuttings.

Application of a 0.2% daminozide concentration increased the inflorescence number whereas its 0.4% concentration influenced a rapid decrease in the number of inflorescences. Besides, in both research years, the largest number of inflorescences was recorded with the application of the 0.2% daminozide concentration (Chart 5 and 6).

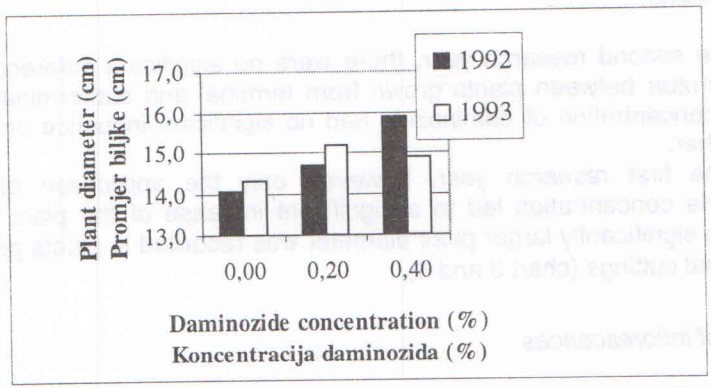
Chart 3. Plant diameter of Solidago x hybrida cv. Goldwedel in dependence on the type of cuttings



T= terminal cuttings/terminalna reznica

S= subterminal cuttings/subterminalna reznica

Chart 4. Plant diameter of Solidagox hybrida cv. Goldwedel in dependence on the daminozide rate



However, regardless of the year or cutting type, no significant effect of daminozide on the inflorescence number was recorded in either research year.

A similar conclusion was reached by C a t h e y and S t u a r t (1961), who studied the influence of growth retardants Phosphon and Cycocel on 55

herbaceous species and failed to determine their influence on flower formation. But, the same authors report that the application of growth retardants led to intensified flower formation in the subsequent year.

Chart 5. Number of inflorescences of Solidago x hybrida cv. Goldwedel in dependence on the daminozide rate

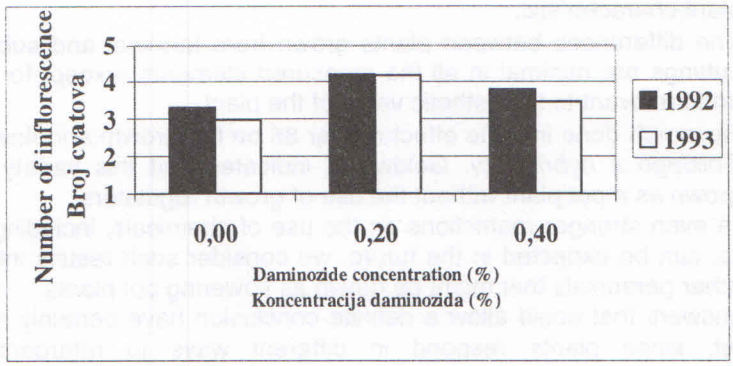
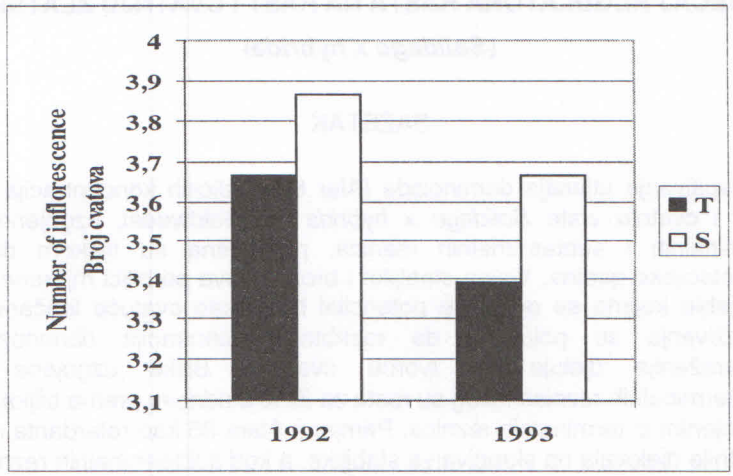


Chart 6. Number of inflorescences of Solidago x hybrida cv. Goldwedel in dependence on the type of the cuttings



T= terminal cuttings/terminalna reznica

S= subterminal cuttings/subterminalna reznica

In contrast, a positive effect of Alar on reduced shoot growth and more intensive flower formation in Idared apples was reported by D u b r a v e c et al. (1983).

CONCLUSIONS

The two-year research results on the effect of Alar 85 upon the growth and flowering of *Solidago x hybrida* cv. Goldwedel point to the following conclusions:

- The application of Alar 85 was justified in that it increased the number of inflorescences, which, along with compactness, is the most important plant characteristic.
- The differences between plants grown from terminal and subterminal cuttings are minimal in all the measured elements (except for height), and irrelevant to the esthetic value of the plant.
- Research done into the effect of Alar 85 on the growth and flowering of *Solidago x hybrida* cv. Goldwedel indicates that this variety can be grown as a pot plant without the use of growth regulators.

Since even stronger restrictions on the use of chemicals, including growth regulators, can be expected in the future, we consider such results interesting also for other perennials that might be grown as flowering pot plants.

All answers that could allow a definite conclusion have certainly not been found yet, since plants respond in different ways to retardants, their concentrations and methods, and the time of application.

UTJECAJ REGULATORA RASTA NA RAST I CVATNJU ZLATNICE (*Solidago x hybrida*)

SAŽETAK

Ispitivanje utjecaja daminozida (Alar 85) različitih koncentracija na rast i cvatnju vrste *Solidago x hybrida* cv. Goldwedel, uzgojene iz terminalnih i subterminalnih reznica, provedena su tijekom dvije vegetacijske godine. Visina stabljike i broj cvatova po biljci mjerene su varijable kojima se ocjenjuje potencijal biljke kao cvatuće lončanice. Istraživanja su pokazala da različita koncentracija daminozida najizraženije djeluje na tvorbu cvatova. Biljke uzgojene iz subterminalnih reznica nižeg su rasta za 22% u odnosu prema biljkama uzgojenim iz terminalnih reznica. Primjena Alara 85 kao retardanta nije znatnije djelovala na skraćivanja stabljike, a kod subterminalnih reznica izazvano je i negativno djelovanje. Pozitivan utjecaj Alara na povećanje promjera krošnje utvrđen je pri primjeni 0,4%-tne koncentracije.

Rezultati ukazuju na mogućnost uzgoja trajnice *Solidago x hybrida* cv. Goldwedel kao lončanice i bez upotrebe daminozida.

Ključne riječi: daminozid, terminalne reznice, subterminalne reznice, lončanica

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