Extending the vase life of *Solidago canadensis* cut flowers by using different chemical treatments

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Summary: In order to increase the vase life as well as quality of leaves of goldenrod *(Solidago canadesis)*, the effect of 8-hydroxyquinoline sulphate (8-HQS), silver thiosulphate (STS) and 1-methylcyclopropene (1-MCP) were investigated. 8-HQS was used as a continuous treatment at 400 ppm with or without sucrose at 50 g/l. The treatment of STS was used by putting the flower bases at 0.4 mM for 6h with or without sucrose at 50 g/l. 1-MCP was used at 0.5 g/m^3 for 6h dry or in water. Except the treatment of 1-MCP in water, the chemical treatments, which were used, led to the increase vase of life of leaves as well as to the inflorescence of cut solidago spikes compared to the control. The best treatment in this concern was 8-HQS at 400 ppm without sucrose, which resulted in longest vase life of leaves as well as inflorescences and lowest percent loss of fresh weight of initial.

Key words: vase life, Solidago, cut flowers

Introduction

To refer to solidago as a useful plant 5 years ago would bring chuckles at best or outright derision. However, goldenrod is a handsome cut flower, exhibiting ease of culture and excellent vase life, market resistance to goldenrod is declining, albeit slowly and sales potential is strengthening. And hence, it needs more attention from researchers in this field *(Armitage,* 1993). There are about 120 species of solidago, all of which are summer or autumn flowering perennials. They can be found growing wild throughout North America, Europe and parts of Asia. Solidago has been popular as garden flower for many years and is commonly known as Golden Rod, which is descriptive. The main reason for solidago's success is that it makes an excellent filler. It is a good marketable color and it has a good vase life *(Pertwee,* 2000).

The single shoots of goldenrod (*Solidago canadensis*) bearing leaves and yellow inflorescences, are in demand as cut flowers. Flowering branches of goldenrod tend to show rapid leaf yellowing when placed in water, even when kept in the light. This early leaf yellowing is the primary factor contributing to the loss of postharvest longevity of this cut flower. Leaf yellowing symptoms appear after 2–3 days of vase life, while the longevity of inflorescence varies between 5 and 9 days *(Hadas* et al, 1996).

Patil et al (1997) reported that the vase life of *Solidago canadensis* ranged from 7.13 days with no sucrose + no HQS to 12.75 days with 2% sucrose + 1.0 mM HQS. *Ruagi* et al (1996) treated uniform *Solidago canadensis* flower stems with different chemical preservatives containing $AgNO_3$ solution (0.02 or 0.03%) and aluminium sulphate solution (0.2 or 0.4%). They found that all the solutions increased vase life compared with tap water. The longest vase life was obtained with 0.4% aluminium sulphate (9.27 days, compared with 5.47 days in tap water). *Hadas* et al (1996) pulsed the flowering shoots of *Solidago canadensis* with an aqueous solution of STS for 19h and they concluded, that STS considerably delayed leaf yellowing as well as increased the vase life of cut spikes. *Patil & Reddy* (1997) mentioned that water uptake by cut flower stems of *Solidago canadensis* was highest in a solution contained 0.5 mM cobalt sulphate + 2% sucrose. Vase life was the longest (13.75 days) also in a solution containing 0.5 mM cobalt sulphate + 2% sucrose.

In spite of increase volume of literature on vase life, little is known about practical ways to increase the vase life as well as quality of leaves of solidago cut flowers. Therefore, the present study examines the efficacy of 8-hydroxyquinoline sulphate (8-HQS), silver thiosulphate (STS) and 1-methylcyclopropene (1-MCP) in extending the vase life as well as retarding leaf yellowing of *Solidago canadensis* cut spikes.

Material and method

Plant material

Solidago canadesis spikes, which were used in this experiment were freshly cut in a local nursery at the normal commercial harvest stage. Spikes were brought to the laboratory of ornamental plants department, Szent István University Faculty of Horticultural Sciences, Budapest as

soon as possible. Lower leaves were removed and the flowering stems were trimmed to a uniform length of 60 cm.

Chemical treatments

8-HQS treatments

8-hydroxyquinoline sulphfate (8-HQS) was applied as a continuous treatments at concentration of 400 ppm with or without sucrose at 50 g/l. The spikes were placed in glass vials contained 500 ml 8-HQS of each treatments during the whole period of the experiment.

STS treatment

Silver thiosulfate was prepared as described by *Gorin* et al (1985). Cut spikes were put at 0.4 mM for 6h with or without sucrose at 50 g/l. After the treatments the spikes were placed in glasses contained tap water till the end of experiment.

1-MCP treatment

1-MCP (as EthylBloc) was obtained from AgroFresh Inc. Rohm & Haas Company. The spikes of solidago were treated dry or in water. The dry spikes, which were treated with EthylBloc, were put horizontal inside a box, which was 118x28x44cm. The box was sealed well with plastic cover and the concentrations of 1-MCP were calculated as g/m^3 (EthylBloc per cubic meters). Soon, the EthylBloc powder was weighed and placed in a test tube taped to the inside wall of the box. Since a significant percentage of 1-MCP is released immediately after addition of hot water, the box was first sealed and then hot water was injected into the test tube (just enough to cover the powder for each treatment). 1-MCP was used at 0.5 g/m^3 for 6h whether the spikes were dry or in water. The treatment of 1-MCP was conducted at 19 °C. After the treatment the flowers were aerated and then were placed into glass vials containing 500 ml tap water.

The control spikes were put into glasses contained 500 ml tap water during the whole period of the experiment. Three replications of five spikes were used per treatment. Statistical analyses were performed by using SPSS program. Differences between means were compared by using Post Hoc test and LSD values were calculated at 0.05 level.

Longevity determination

The longevity of cut spikes was determined in a vase life evaluation room at 19±1°C. Visual rating of leaf senescence was evaluated periodically during the vase life of spikes. Evaluation was based on a scale ranging from 1 to 4 when: 1=entirely green leaves, 2=initiation of wilting in 25% of leaves, 3=wilting in 25–50% of leaves, 4=wilting in 50–100% of leaves. The longevity of leaves was defined as the number of days in vase life required for 50% of the leaves to reach stage 2 or advanced stages.

Visual rating of inflorescence was evaluated on a scale from 1 to 5 when: 1=entirely green, 2=yellow closed, 3=yellow open, 4=browning of 25%, 5=browning of up to 25%. This visual rating was applied at 4 places of the inflorescence, i.e. 1=top of the inflorescence, 2=bottom of the inflorescence top, 3=top of the inflorescence end, 4=bottom of the inflorescence end *(Figure 1)*. The longevity of inflorescence was defined as the number of days in vase life required for the inflorescences to reach stage 5.

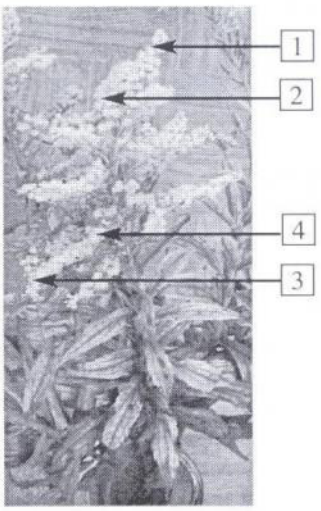

Figure 1 The four places of inflorescence of solidago

Fresh weight measurements

Fresh weight determinations of the spikes were made just before the immersion of the spikes into the glasses of water and were repeated on the day, when the vase life of control spikes was terminated. The spikes were taken out of water for as short from time as possible (20–30s). The fresh weight of each spike was expressed relative to the initial weight to represent the percent of weight loss.

Results

Longevity of leaves as well as inflorescence

The results of *(Table 1)* show that the treatments led to the increase of vase life of leaves compared to the control. The best treatment in this concern was 8-HQS at 400 ppm without sucrose which gave 11.7 days compared to 5.7 days for the control *(Figure 3)*. Otherwise, the treatments of 8-HQS and STS without sucrose gave more longevity than the others with sucrose.

The vase life of cut solidago spikes was increased by using any chemical treatment compared to the control except the treatment of 1-MCP in water which decreased it at the four places of inflorescence. The treatment of 8-HQS at 400 ppm without sucrose gave the best results in this respect. The vase life was 10.7, 11.3, 12 and 12.3 days at the four places of the inflorescence, respectively under this treatment. It could be noticed that the treatments without

Table 1 Effect of different chemical treatments on vase life of leaves as well as inflorescence of *Solidago canadensis* cut spikes

Treatments	Vase life of leaves (Days)	Vase life of inflorescences (Days)			
		place 1	place 2	place 3	place 4
Control	5.7	5.7	6	6.7	6.7
8-HQS 400 ppm + 100 g/l sucrose	8.3	9.3	9.7	9.7	9.7
8-HQS 400 ppm without sucrose	11.7	10.7	11.3	12	12.3
STS 0.4 mM + 100 g/l sucrose	7.7	7.3	8	8.7	8.7
STS 0.4 mM without sucrose	9.7	10	10.7	11	11.3
1-MCP 0.5g/m^3 6h dry	6.7	9	9.3	9	9.7
1-MCP 0.5g/m^3 6h in water	4.3	5	5.3	6	6
LSD at 0.05%	1.7	1.33	1.11	1.6	1.63

Place 1: Top of the inflorescence
Place 2: Bottom of inflorescence top
Place 3: Top of the inflorescence end
Place 4: Bottom of the inflorescence end

sucrose resulted in longer vase life than the treatments with sucrose. Otherwise, the longevity at the end of inflorescence was higher than at the top of it *(Table 1)*.

Percent loss of initial weight

The results in Table 2 indicate that the percent loss of initial weight of cut solidago spikes was lower by using the chemical treatments compared to the control. The minimum percent loss of fresh weight (3.2 %) was obtained by using 8-HQS at 400 ppm without sucrose. Meanwhile, the control and the treatment of 1-MCP in water gave the highest percent loss of fresh weight which gave 21.3% and 32.3% respectively. In addition, the treatments without sucrose resulted in lower percent loss of fresh weight than the treatments with sucrose.

Figure 2 General photo of all the treatments

Table 2 Effect of different chemical treatments on percent loss of initial weight of *Solidago canadensis* cut spikes

Treatments	Percent loss of initial weight
Control	21.3
8-HQS 400 ppm + 100 g/l sucrose	10.7
8-HQS 400 ppm without sucrose	3.2
STS 0.4 mM + 100 g/l sucrose	12.9
STS 0.4 mM without sucrose	9.2
1-MCP 0.5g/m^3 6h dry	17.1
1-MCP 0.5g/m^3 6h in water	32.3
LSD at 0.05%	7.8

Figure 3 Effect of 8-HQS without sucrose in increasing the vase life of solidago spikes comparing to the control

Discussion

A major cause of deterioration in cut flowers is blockage of xylem vessels by microorganisms that accumulate in the vase solution or in the vessels themselves. When the stem is blocked, continuing transpiration by the leaves results in net loss of water by flower and stem tissues *(Knee,* 2000).

The obtained results show the importance of 8-HQS in increasing the vase life of solidago spikes. These results may be due to the role of 8-HQS as anti-microbial agent and hence, reduce stem plugging. In addition, these results could be attributed to the role of 8-HQS in increasing the level of absorption than the control and this was clearly appeared when the pigment of toluidine blue was added *(Figure 4).*

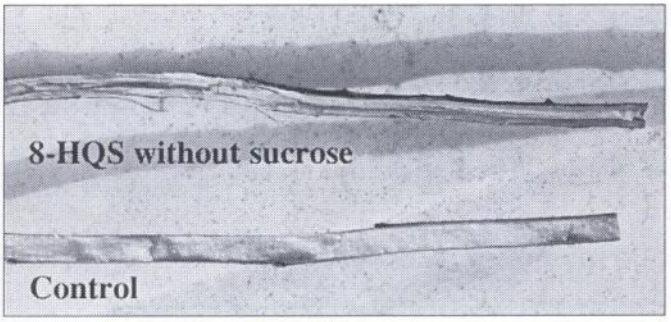

Figure 4 Longitudinal section of the base of solidago spikes indicate the level of absorption as a result of 8-HQS without sucrose comparing to the control

Also under this treatment the highest vase life of leaves was obtained and hence the vase life of inflorescence was increased. These results are in agreement with the finding of *Hussein* (1994) on chrysanthemum and calendula cut flowers. Also *Knee* (2000) mentioned that the blockage of xylem elements by microorganisms was prevented by using HQC and the vase life of carnation cut flowers was increased. Silver thiosulphfate (STS) is a very potent inhibitor of ethylene action in plant tissues. It also provides some antimicrobial activity inside the plant tissues, thus it is beneficial for ethylene-sensitive flowers *(Nawak & Rudnicki,* 1990). Consequently, the vase life of solidago cut spikes was increased. Otherwise, it is well known that flower opening is promoted by sugars applied through the stem, but vase life may not be extended because the sugar encourages multiplication of bacteria, which eventually block the xylem *(Knee,* 2000). Extending the vase life of solidago cut spikes by using 1-MCP could be attributed to the role of 1-MCP as an inhibitor of ethylene biosynthesis as well as ethylene binding and consequently preventing the undesirable postharvest effects of ethylene as reported by *Serek* et al 1995. Also *Serek* et al (1996) illustrated that 1-MCP had dramatic effects in inhibiting the ethylene stimulated abscission of buds, leaves and flowers when applied to miniature rose plants at concentrations of 100 nl/l for 6 hours. Similar results were obtained by *Cameron & Reid* (2001) on *Pelargonium peltatum* and *Skog* et al (2001), who found that at room temperature, EthylBloc performed well on all four cut flower species tested (Snapdragon, Alstromeria, Gypsophila and Delphinium) at concentration of 0.5 g/m^3.

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