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Using Gibberellins to Prevent Leaf Yellowing in Cut Lilies

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Introduction

Hybrid lilies are excellent cut flowers due to the availability of flowers with various colors and shapes. Extensive inter-species hybridization has resulted in numerous cultivars, and many new cultivars are introduced to the market each year. While the vigor and reliability of the crop has improved over the years, what has not changed is that the postharvest quality of the cut stem is an important aspect that determines the successful use of this crop as a cut flower.

The postharvest performance of cut lilies is dependent on many factors such as the cultivar, preharvest conditions, stage of harvest, and postharvest environment and handling. Generally, the vase life of cut lilies varies between 5 to 14 days depending on the cultivar. The vase life of the cut stem ends when flower petals wilt or turn brown. Leaf quality is another important postharvest aspect in cut lilies. In many, if not most, hybrid lily cultivars, leaves start to turn yellow well before the end of the inflorescence life, making the stems less attractive. This is especially true if the stems have been cold-stored for any length of time prior to marketing.

The potential use of growth regulators, especially gibberellins and cytokinins has not been studied adequately in cut lilies. Our previous studies have shown that spray treatments with GA_{4+7} alone or in combination with BA (i.e., Fascination, Valent USA) remarkably reduce cold-induced leaf yellowing in pot hybrid lilies, and gradual leaf yellowing in Easter lilies. We have also seen positive effects on flower longevity in these hormone-treated plants. These observations warranted the investigation of potential use of these chemicals in cut lilies.

This research was carried out to investigate the potential use of gibberellins and benzyladenine (BA) to improve postharvest quality of cut hybrid lilies. Experiments were conducted using various cultivars from different groups of hybrid lilies to test different aspects of the treatment such as the concentration, method of application and time of application. We emphasize that the results reported here represent non-label uses of the compounds, and especially of Fascination.

Approaches

Experiments were conducted with a range of commercially important cultivars of Oriental, Asiatic and LA-hybrid lilies. Cultivars tested included 'Amarone', 'Colosseo', 'Marseille', 'Orandiso', 'Vermeer', 'Vivaldi' (Asiatics), 'Berlin', 'Helvetia', 'Muscadet', 'Tom Pouce', 'Star Gazer' and 'Sissi' (Orientals), 'Cebeco Dazzle', 'Fangio', 'Royal Parade', 'Royal Perfume', 'Samor' (LA-hybrids). Plants were grown in bulb crates with MetroMix 360 in Cornell University greenhouses according to standard cultural practices. Stems were cut at the commercially acceptable maturity for experiments from May-July.

In most cases, growth regulator treatments were done immediately after harvest. Compounds used included: ProGibb (GA_3), Provide (GA_{4+7}), BAP-10 (benzyladenine, BA), Fascination (contains an equal, 1:1 ratio of GA_{4+7} and BA).

Several experiments were conducted to investigate factors such as compound, concentration, method and duration of application (pulse, foliar spray, or inclusion in vase solution).

After the treatments, stems were either transferred directly to a postharvest evaluation room (20°C, with typical "indoor" fluorescent light (12 hr per day) or stored (dark, on water) at 2-3°C for up to 2 weeks prior to the transfer to the postharvest evaluation room. The standard vase solution in the postharvest room contained 3% sucrose and 200 ppm 8-hydroxyquinoline citrate.

Data on leaf quality (percentage yellow or necrotic leaves) and inflorescence longevity (time of wilting of the last open flower of the inflorescence) were recorded at regular intervals in the postharvest room, up to 3 weeks.

Results

Cultivar differences

Cut lily stems of most of the cultivars started showing symptoms of leaf yellowing around one week after the placement in the postharvest room (well before the end of inflorescence life). This leaf yellowing was accelerated when stems were stored at 2-3°C for up to 2 weeks after the cut. Oriental, Asiatic and LA-hybrid cultivars varied greatly in their potential for leaf yellowing during postharvest evaluation (Table 1). Overall, oriental cultivars tended to show more yellowing after 2 weeks evaluation. Even so, the oriental 'Tom Pouce', asiatic 'Vivaldi' and the LA's 'Cebeco Dazzle' showed less than 20% yellowing, even if the cut stems had been stressed by holding dark for 2 weeks on water, at 2-3°C prior to evaluation.

Method of application: pulse, leaf spray, vase solution

GA_{4+7} was effective whether applied as a stem uptake (pulse) treatment, as a leaf/stem spray after harvest, or as a vase solution component (Table 2, Figure 2). For example, after two weeks in the postharvest room, the three cultivars used had 16-41% dead or yellow leaves whereas plants with any treatment had less than 5% yellow leaves. Another general effect of gibberellin

on lilies is an increase in flower longevity (see Figure 1). For example, with 'Star Gazer', one can see flower life increasing from 12 days to 14 days with gibberellin treatment.

Active compound

GA_{4+7} can also be seen to be the active component of the treatment, as GA_{4+7} applied individually was at least as effective as the combination of GA_{4+7} and BA (Table 3). This is the same finding as we have seen in Easter lily and in potted oriental hybrid lilies. Table 4 gives a further comparison of GA_{4+7} and GA_3 in the LA-hybrid cultivar 'Cebeco Dazzle'. While both GA's are effective in increasing flower life, only the GA_{4+7} is active in preventing leaf yellowing.

Pulse duration and temperature

There appears to be wide latitude regarding concentrations, temperature and duration for GA_{4+7} pulses. Table 5 shows that a 6-hour pulse at 3°C was as effective as an 18-hour pulse at 20°C. In this preliminary experiment, we did not measure solution uptake, but assume that much more uptake occurred with the longer and warmer treatment.

GA_{4+7} concentration

In another experiment with the Asiatic cultivar 'Orandiso', GA_{4+7} pulses at 25 ppm were equally effective as at 100 ppm. There are upper limits to GA_{4+7} use, however, as seen in Figure 3. In this experiment, the Asiatic cultivar 'Marseille' was subjected to water or long pulses of GA_3 or GA_{4+7} at 100 or 500 ppm. The higher concentration of GA_{4+7} was phytotoxic to the plants and caused complete death. While this appears to be an extreme example, additional experiments need to be conducted to further define these parameters as they relate to commercial situations.

Gibberellins also prevented leaf yellowing in cut lily stems when included as a component in the vase solution. Effective concentrations of GA_{4+7} were 5 to 25 ppm. These treatments were effective in the case of cold-stored stems too.

Disclaimer

The data presented here are for informational purposes only. There are no commercial gibberellin products currently labeled for these uses.

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Basic critical steps to success for postharvest handling of cut-lily crops

- Harvest at the correct time. This generally means when the oldest buds are fully colored, but not yet open
- Refrigerate as soon as possible to remove field (greenhouse) heat
- Grade and sort into bunches, and again refrigerate as soon as possible
- Minimize storage time as much as possible. If stems must be stored, store at 35-40F (35F is better)
- Use only clean water buckets in the packing house
- Use a floral preservative recommended for cut lilies

Table 1. Cultivar variability to postharvest leaf yellowing as cut stems. Stems were harvested, treated by immersing in 100 ppm GA_{4+7} solution or water (control) for 18 hours at 20°C. Stems were then held on water for 2 weeks in darkness at 2-3°C. Data are the percent yellow or necrotic leaves on stems after 14 days in the postharvest environment

Cultivar	Control	100 ppm GA_{4+7} pulse
	Oriental hybrids	
'Star Gazer'	93	1
'Berlin'	81	3
'Muscadet'	67	0
'Tom Pouce'	14	4
'Sissi'	77	0
	Asiatic hybrids	
'Orandiso'	41	3
'Vermeer'	20	0
'Vivaldi'	16	0
	LA hybrids	
'Cebeco Dazzle'	16	0
'Royal Perfume'	29	0
'Royal Parade '	32	0

Table 2. Effects of the application method of gibberellin on leaf quality and inflorescence longevity on three cut Oriental hybrid lily cultivars. Cut stems were treated with GA_{4+7} as a pulse (18 hr at 20°C), as a foliar spray to the harvested stem (100 ppm each GA_{4+7} and BA) or as a component in the vase solution (10 ppm GA_{4+7}). Stems were transferred to a postharvest evaluation room (20°C) just after pulse or spray treatments. Data are percentage yellow or dead leaves at weekly intervals during the postharvest evaluation.

Treatment	% Yellow or necrotic leaves after			Inflorescence longevity
week	2 weeks	3 weeks	(days)	
	‘Star Gazer’			
Control (no treatment)	3	41	100	11.8
GA_{4+7} pulse	0	0	6	14.3
GA_{4+7} and BA spray	0	3	46	13.7
Vase solution	0	0	0	14.0
	‘Berlin’			
Control (no treatment)	7	33	99	12.5
100 ppm GA_{4+7} pulse	0	0	16	13.0
GA_{4+7} and BA spray	0	5	32	13.0
Vase solution	0	0	1	14.3
	‘Muscadet’			
Control (no treatment)	0	16	84	14.3
100 ppm GA_{4+7} pulse	0	0	2	15.0
GA_{4+7} and BA spray	0	0	26	16.2
Vase solution	0	0	0	13.2

Table 3. Effects of the application method of GA_{4+7} or a combination of GA_{4+7} and BA on leaf quality and inflorescence longevity of cut Oriental hybrid lily 'Sissi'. Cut stems were treated with GA_{4+7} or a combination of GA_{4+7} and BA as a pulse (18 hr at 20°C), foliar spray or as a component in the vase solution. Stems were placed in distilled water and kept at 2-3°C in darkness for 2 weeks before transferring to a postharvest evaluation room (20°C). Pulse and spray treatments were done just before cold storage.

Treatment	% Yellow or necrotic leaves after			Inflorescence longevity (days)
	1 week	2 weeks	3 weeks	
Control (no treatment)	53	77	96	16.5
Pulse (100 ppm GA_{4+7})	0	0	5	19.0
Pulse (100 ppm each GA_{4+7} and BA)	0	0	1	17.8
Spray (100 ppm GA_{4+7})	0	2	18	18.2
Spray (100 ppm each GA_{4+7} and BA)	0	4	25	17.7
Vase solution (10 ppm GA_{4+7})	0	0	0	19.7
Vase solution (10 ppm each GA_{4+7} and BA)	0	0	0	16.7

Table 4. Comparison of the effectiveness of GA_{4+7} or GA_3 on leaf quality and inflorescence longevity of cut LA-hybrid lily 'Cebeco Dazzle'. Cut stems were treated with gibberellins as a pulse(18 hr at 20C), then held on water at 2-3°C in darkness for 2 weeks before transferring to a postharvest evaluation room (20°C). Treatments were done just before cold storage.

Treatment	% Yellow or necrotic leaves after		Inflorescence longevity
week	2 weeks	3 weeks	(days)
Control (water pulse, 18 hr at 20°C)	0	16	58	14.5
100 ppm GA_{4+7} pulse (18 hr at 20°C)	0	0	1	18.8
100 ppm GA_3 pulse (18 hr at 20°C)	0	10	40	16.5

Table 5. Effects of the duration and temperature of gibberellin pre-treatment on leaf quality and inflorescence longevity of cut LA-hybrid lily 'Royal Perfume'. Cut stems were treated by immersing in water or GA_{4+7} solutions for the indicated durations and temperatures. After treatment, stems were held in darkness on water at 2-3°C for 2 weeks prior to postharvest evaluation at 20°C.

Gibberellin Pre-Treatment	% Yellow or necrotic leaves after			Inflorescence longevity
week	2 weeks	3 weeks	(days)	
Water (18 hr at 20°C)	8	29	50	14.5
100 ppm GA_{4+7} (18 hr at 20°C)	0	0	0	18.3
100 ppm GA_{4+7} (18 hr at 3°C)	0	0	1	20.5
100 ppm GA_{4+7} (6 hr at 20°C)	0	0	1	19.2
100 ppm GA_{4+7} (6 hr at 3°C)	0	1	1	18.0

Figure 1. The effects of gibberellin $_{4+7}$ on flower longevity of oriental hybrid lily 'Sissi'. Left, control (no gibberellin); Right, pre-treatment (pulse with 100 ppm GA_{4+7} for 18 hrs). Photo was taken after 10 days in postharvest evaluation room (20°C).

Figure 2. The effects of gibberellin $_{4+7}$ on postharvest quality of oriental hybrid lily 'Sissi'. Left to right: control (no gibberellin), pre-treatment (pulse) with 100 ppm GA_{4+7} for 18 hrs, spray treatment with 100 ppm GA_{4+7} solution, inclusion in vase solution (10 ppm GA_{4+7}). Photo was taken after 10 days in postharvest evaluation room (20°C).

Figure 3. The effects of the type and concentration of gibberellin pre-treatment on cut flower quality of Asiatic hybrid lily "Marseille'. Left to right: No gibberellin (water), 100 ppm GA_3 pulse, 500 ppm GA_3 pulse, 100 ppm GA_{4+7} pulse, 500 ppm GA_{4+7} pulse, and 100 ppm GA_{4+7} spray. All pulse treatments were for 20 hours at 20C. Note the toxic effects of 500 ppm GA_{4+7} treatment.