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RESEARCH NEWSLETTER

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Using Florel to Control Upper Leaf Necrosis and Reduce Height in Pot Oriental Hybrid Lilies

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Background

In issues 5 and 6 of the Research Newsletter (April 2005) we reported on our extensive work on "leaf scorch" or more accurately, 'Upper Leaf Necrosis" (ULN) in oriental hybrid lilies. The disorder is characterized by necrosed (dead) upper leaves and by leaf curling, distortion and/or leaf tip burn (Fig. 1). The disorder is commonly found in greenhouse grown oriental hybrid lilies worldwide and may occur on both pot and cut crops. In 2000, we initiated a research program to investigate this problem. Dr. Yao-Chien Alex Chang, now Professor of Floriculture at the National Taiwan University, did this work for his Ph.D. degree at Cornell. The details of those studies, and the many findings related to the ULN problem itself can be found in the April 2005 Research Newsletter (available online at www.flowerbulbs.cornell.edu). Briefly, we found that ULN is due to calcium deficiency in the upper leaves. We found that the bulb scales and the young embryonic leaves have very little calcium when harvested. Also, since larger (more ULN sensitive) bulbs have more leaves on the stem, their leaves overlap each other and reduce water loss and calcium movement into the expanding leaf. A key realization of this work was that the cause of the injury happens much earlier than the symptoms of the injury. We were able to see the earliest symptoms of ULN at least 3 weeks before the massive necrosis seen in commercial crops. Management techniques to control ULN must therefore begin when plants are fairly small, about 12-14 inches tall.

From Calcium Deficiency to Height Control

Air movement on the leaves is the classic way to increase calcium uptake into leaves or fruit. Thus, an effective method to reduce ULN is to use fans and blow air on the plants, with enough force and volume that the leaves move slightly. Another way to increase calcium in the leaves was to expose the leaves to air. In one experiment, we artificially unfolded leaves from the stem (when plants were about 12" tall) as a way to increase transpiration (water loss) from the leaf and therefore increase the amount of calcium moved into the leaf. When leaves were gently bent back from the stem (Fig. 2) once per day the ULN at crop maturity almost completely disappeared, and if it was done twice per day, no ULN was seen, even on 16/18 cm bulbs which are normally very sensitive to ULN (Figure 3). Interestingly, the plants that had unfolded leaves were shorter than the controls (Fig. 3). Probably, this was due to the mechanical stress caused by the unfolding. In many plants, such mechanical stress produces small amounts of ethylene and causes shorter, thicker and stronger stems.

Obviously, it is not possible to manually unfold leaves on lilies in a commercial greenhouse! But, we realized that plants naturally "unfold" leaves in response to ethylene, in a phenomenon called "epinasty". As we thought about this result, we imagined that it might be possible to use the ethylene-generating chemical, ethephon (sold as Florel or Ethrel) as a way of artificially unfolding leaves. The ethylene might also cause the plants to stay shorter, as we saw in the "artificial leaf unfolding" experiments.

In North America, it is common to give 'Star Gazer' and many oriental hybrid lilies a pre-plant dip into Sumagic (uniconazole) or other growth regulator to reduce stem growth. To this end, the Flowerbulb Research Program has invested a lot of time and energy into growth regulator research in the last several years. While Sumagic, Bonzi and other PGRs are effective, if a chemical treatment is necessary, growers would prefer to be able to spray crops due to chemical and labor cost considerations.

Therefore, we set up a series of experiments to test whether ethylene might be useful in oriental hybrid lilies to 1) reduce ULN by inducing upper leaf unfolding and 2) give some degree of height control.

What We Did

In these experiments, we used ‘Star Gazer’ lily grown as pot plants. One bulb was planted per 15 cm pot with a soil-containing planting medium. Plants were grown in a glass greenhouse under a range of climate conditions from mid spring to fall. The basic night temperature was set at 21°c. Florel was applied as a foliar spray to the point solution ran off the leaves. A spreader/sticker was also used. In these studies, we looked at Florel concentration, timing and number of foliar sprays.

Our Findings

Florel, leaf unfolding and ULN
As we predicted, Florel sprays caused the upper leaves to “bend back” from the central stem, and this caused an “opening” of the leaves on the top of the stem (Fig. 4). While Florel was effective at concentrations between 500-2,000 ppm (note: 1 ppm, part per million, is equal to 1 milligram per liter, or mg/L), a greater effect was seen with 1,000 or 2,000 ppm. The severity of upper leaf necrosis was also generally reduced by Florel treatments.

Florel and height control
Florel foliar sprays in the range of 500 to 2,000 ppm were effective in reducing stem length (Fig. 5). In this experiment, Florel was applied twice, on days 24 and 34 after planting (plants were about 10” tall at the time of the first spray). Florel sprays also increased stem thickness, resulting in stronger plants. Control plants averaged 7.7 mm in diameter, while Florel treated plants (500 to 2,000 ppm) averaged 9.1 mm.

Optimum Timing of Florel Sprays
If sprayed too early, there is not enough leaf surface area to absorb the spray solution, and there is little response. When sprayed too late, flower abortion can occur. Figure 6 shows a comparison of “optimally treated” and “late treated” plants. In this experiment, we sprayed plants with 1,000 ppm Florel on days 24 and 34 after planting (the optimum treatment), or a “late spray” of the same concentration at 50 and 60 days after planting. The late treated plants are taller (they were nearly full grown when sprayed), and have aborted flower buds! Spraying the plants at 24 and 34 days after planting provided a good combination of height control, reduction of upper leaf necrosis and no flower abortion.

The Bottom line: Trial Use Guidelines

For preliminary trials with Florel on potted ‘Star Gazer’, we suggest two 1,000 ppm sprays at 20 and 30 days after planting (assuming the crop is grown at normal temperatures). This treatment has proven effective in reducing Upper Leaf Necrosis, reducing stem growth, and thickening stems to produce an excellent pot lily (Fig. 7). We have only worked on ‘Star Gazer’, and have not tried other Oriental hybrid cultivars. Do not apply Florel to LA or Asiatic hybrid lilies!

Possible Problems

Florel-induced bud abortion. When sprayed onto plants, Florel releases ethylene, and ethylene can abort lily buds. Therefore, the key to our suggested use is proper timing! **Spraying Florel late in the crop will cause serious levels of flower abortion and a total crop loss!** Our suggested spray times (20 and 30 days after planting) are early enough to avoid this problem, yet allow control of ULN and give a degree of height control. **Do not apply Florel later than 35 days (5 weeks) after planting.**
Inadequate height control. It is possible tha our suggestions for Florel will not cause all of the needed

height control. We have not tried combinations of Sumagic dips and Florel sprays, but we suspect the typical pre-plant Sumagic bulb dip PLUS Florel would make the crop way too short. If necessary, mid-crop Sumagic foliar sprays at 5 ppm can be used to control upper stem elongation prior to bud development.

Non-labeled use of Florel. This is a non-labeled use of Florel. We are only expressing the results of our trials with this use. At such time that this treatment would become labeled, growers will need to be precise and careful when administering this treatment.

Acknowledgments

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Fig. 1. Overall view of Upper Leaf Necrosis (ULN) on 'Star Gazer' lily.

Fig. 2. Side view of 'Star Gazer' lilies, with the plant on the right showing the result of "artificial leaf unfolding" to open up the smallest leaves to increase their transpiration and calcium uptake. Plant on the left is a normal, untreated plant.

Fig. 3. 'Star Gazer' plants grown from 16/18 cm bulbs. Left: control, middle: plants with leaves unfolded artificially once per day, right: plant with leaves unfolded twice per day. Note that plants with artificial leaf unfolding have very little ULN and are shorter and stockier.

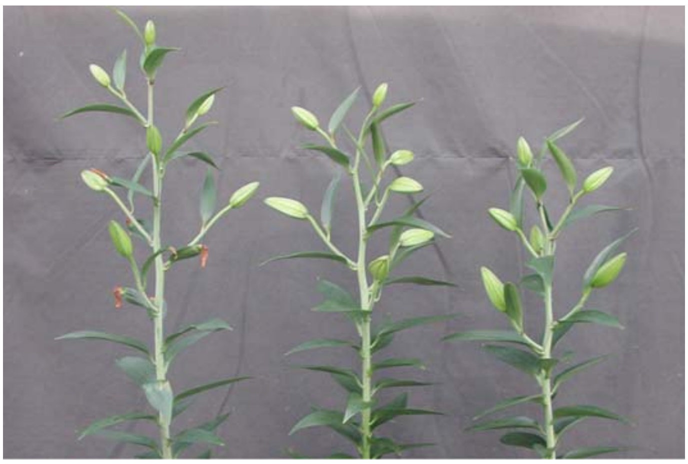

Fig.4. Effect of Florel (ethephon) on leaf upper leaf unfolding in 'Star Gazer' lilies. Plants were sprayed twice at the concentrations shown, at 24 and 34 days after planting. Notice in the controls (sprayed with water, on the left), the leaves are very upright and "closed" at the top, and that plants sprayed with Florel have upper leave that are bent away from the center.

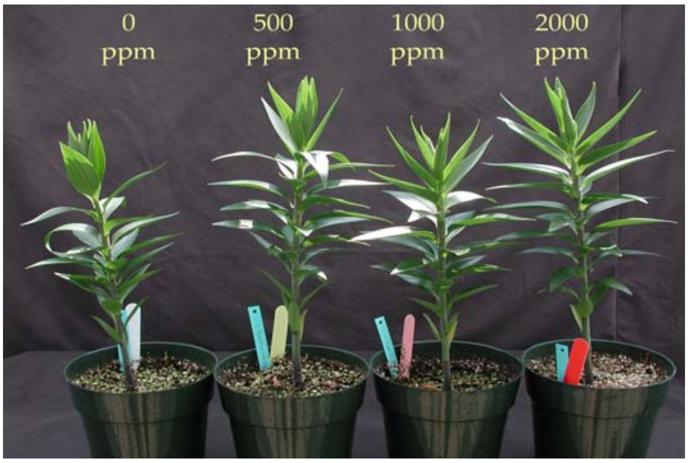

Fig. 5. Effect of Florel sprays on 'Star Gazer' lilies. Plants were sprayed to runoff 24 and 34 days after planting. Left to right: control (water), 500, 1,000, 2,000 ppm. Note more ULN on controls, and shorter plants, with less ULN on the Florel-treated plants.

Fig. 6. 'Star Gazer' plants grown with Florel as the only growth retardant. Left to right: Control, 1,000 ppm Florel applied on days 24 and 34, 1,000 ppm Florel applied on days 50 and 60. Note bud abortion and less height control from the late Florel application (on the right)!

Fig. 7. 'Star Gazer' lilies grown without (left) and with Florel (right). Plant on the right was sprayed two times with 1,000 ppm Florel at 24 and 34 days after planting, when it was about 12" tall. Note the Florel-treated plant does not have upper leaf necrosis and is a shorter, stockier plant more suitable for-pot production.

Florel Costs

The chemical cost for the proposed Florel treatment are low. Assuming Florel is obtained at $30per liter, an application rate of 1,000 ppm, coverage of approximately 2 liters per 100 sq. ft. and a 6" crop spaced pot-to-pot (that is, 400 pots/100 sq. ft.), it can be calculated that the material cost for a 6" pot is on the order of 0.38 cents per pot. Thus, the labor cost of doing such a treatment is almost certainly greater than the chemical cost.

With more difficulty, one can also compare the Florel spray with pre-plant dips into paclobutrazol (Bonzi or Piccolo) or unicolazole (Sumagic), the most common form of height control in most hybrid lilies today. Depending on the material used (paclobutrazol is more expensive per bulb than uniconazole), and concentration, a per bulb cost of 1 to 6 cents for the dip solution is reasonable. Thus, the material cost of the Florel spray is less than the pre-plant dip, plus the ease of spray application gives additional savings over the labor of pre-plant bulb dips. Also, there is no control of ULN by the anti-gibberellin pre-plant dips.

Drying out of perennials is the most important factor in quality loss in the chain

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In a joint project, financed by the Dutch Product Board for Horticulture, PPO and Cornell University investigated the role of temperature and drying out in the loss in quality of perennials during storage and shipping. The research was carried out with the genera *Echinacea*, *Helleborus*, *Papaver*, *Phlox*, *Achillea*, *Aster* and *Geranium*.

In one experiment storage at +2 and -2 °C (28 and 36 F) was compared. Regrowth of the genera *Achillea*, *Aster*, *Echinacea* and *Phlox* was not affected by the different storage temperatures. *Hellborus* showed a better regrowth when stored at -2 °C. The regrowth of *Geranium* and *Papaver* was better after storage at +2 °C.

In another experiment the effects of a temporary rise in temperature during shipping (as in the case of a failure of the cooling unit) were studied by storing the plants at -2 °C, followed by 4 days at +2 °C or 2 days at +9 °C and placing them back at -2°C again. Within 3 hours after increasing the temperature to +9 a rise in temperature from - 2 to + 2 °C was measured inside the boxes between the plants. The temporary rise in temperature was especially harmful to *Geranium* and resulted in a much lower percentage of regrowth. In *Phlox* a moderately harmful effect was observed and, remarkably, a positive effect on regrowth of *Papaver* was observed. In the other species the treatment had no effect.

Drying out can occur in all stages during the chain and can lead to great losses. In an experiment different degrees of water loss were achieved by placing the washed perennials for 0 to 24 h in a 9 °C storage room at a relative humidity of 50 % with an air movement (speed) of 15 meters/minute (a slight draft). The species *Achillea*, *Echinacea* and *Phlox* were highly sensitive to drying out. An exposure of 4 to 8 h to the above mentioned drying conditions already resulted in a partial regrowth failure (after planting). *Achillea* and *Phlox* were completely unable to regrow after 24 h of drying out. Regrowth of *Echinacea* was inhibited by 50 % in that case. In *Helleborus* a reduction in regrowth was found after 8 and 24 h. *Aster*, *Geranium* and *Papaver* were less sensitive to drying out, possibly because of the amount and structure of the roots.

Plants that were dried out showed a more severe infestation by molds. The presence of molds after shipping therefore may be an indication of drying out in an earlier stage. The drying conditions as used in the experiment are likely to occur in practice, especially in the top layer of plants in the boxes.

Conclusions

- Regrowth of washed perennials is negatively affected by too high storage temperatures and drying out during the chain.
- Drying out must be prevented during all stages in the chain. Plants cannot recover from a too severe water loss.

- The period in the barn between harvest and washing and between washing and packing should be as short as possible in order to prevent drying out. In the meantime plants should be covered with plastic.

Species tested	Optimal storage temperature
Achillea millefolium 'Paprika'	Between -2°C and +2°C (28 and 36 F)
Aster novae-angliae 'Andenken an Alma Pötschke'	Between -2°C and +2°C
Echinacea purpurea 'Art's Pride'	Between -2°C and +2°C
Geranium cinereum 'Ballerina'	+0,5°C or +2°C
Helleborus niger 'Buis'	-2°C or -0,5°C
Papaver orientale 'Forncett Summer'	+0,5 °C or +2°C
Phlox paniculata 'Amethyst'	Between -2°C and +2°C

Echinacea after washing

Achillea and Phlox are extremely sensitive to drying out. An exposure to drying conditions for 5 h (Achillea) or 10 h (Phlox) already reduced the percentage of regrowth.

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