Postharvest biology and technology of ornamentals

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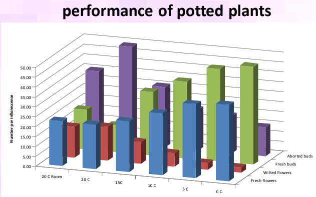
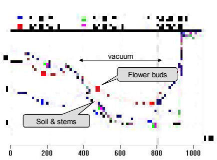
Goal

The goal of our program is to improve the postharvest life and quality of cut flowers and potted plants. Our rationale is that increased customer satisfaction will result in increased consumption and a better outcome of promotion and marketing campaigns. We are exploring physical, chemical, and molecular strategies for achieving longer lasting ornamentals.

Effect of cold-chain temperatures on postharvest performance of potted plants

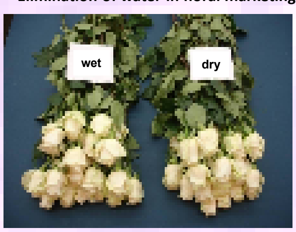


As with cut flowers, the shelf life of potted plants is dramatically affected by temperatures during marketing. This graph demonstrates the effect of temperature during simulated transportation of Campanula plants on their quality after one week in the evaluation (20 C) room. Transportation at 0-5 C resulted in fewer aborted buds and more fresh flowers and buds.



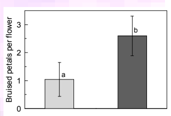
Pre-cooling potted plants is a challenge –the soil remains warm long after the plants are cool, resulting in condensation and risk of *Botrytis* infection. We are testing vacuum cooling as a strategy to provide efficient and rapid cooling of potted plants (and particularly their soil). This datalogger trace shows the rapidity of vacuum cooling.

Elimination of water in floral marketing

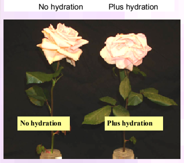


Placing cut flowers immediately in water is almost universal practice in the industry. We examined the value of this practice by harvesting 'Vendela' rose flowers and putting half in water at the farm, and holding the other half out of water throughout the postharvest chain. The photograph shows flowers after an 8-day dry shipment from Ecuador to California. Dry-handled flowers showed less opening than the flowers that were hydrated at low temperature for 24 h before being packed and shipped.

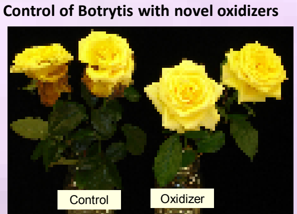
Dry handling resulted in a substantial reduction in petal bruising, both in terms of severity, and in terms of the number of petals per flower showing bruising.



The effect of dry handling on vase life of the flowers depended on the cultivar – in some cultivars the vase life was considerably extended. The photograph shows flowers of Osiana after 18 days in the vase. In other cultivars (Charlotte, Freedom) there was no significant difference in the vase life of flowers handled wet or dry.

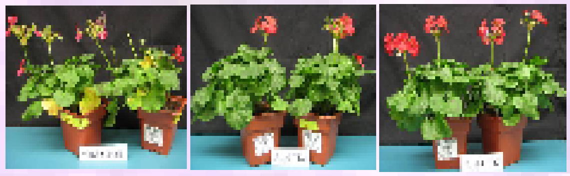


Control of Botrytis with novel oxidizers



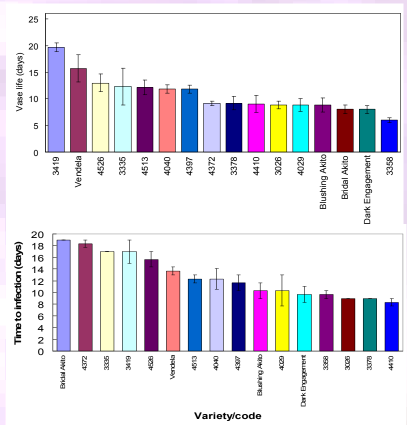
In an effort to find a 'sustainable' solution to the common problem of postharvest *Botrytis* infection in roses, we have been testing a range of GRAS and proprietary oxidizers that might be used instead of the widely-used fungicide dips. Dramatic reductions in *Botrytis* incidence have been achieved with a proprietary oxidizer.

TDZ improves postharvest performance of potted plants



Thidiazuron (TDZ), a non-metabolized cytokinin, is very effective in delaying leaf senescence in cut flowers. In addition, we have demonstrated that spraying potted plants with very low concentrations of TDZ not only prevents leaf yellowing, but extends display life, apparently by improving carbon balance, which allows the development of new buds and flowers. The photograph above shows the effects of TDZ on the display quality of flowering geranium plants (*Pelargonium hortorum* "Tango"). Plants at commercial maturity were sprayed to runoff with water (left), 5μM TDZ (center) or 10 μM TDZ (right), then, after a 3 day transport simulation were held in the display environment for 3 weeks.

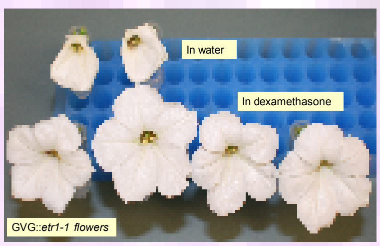
Postharvest evaluation of cut rose breeding lines



The postharvest life of ornamentals, whether they are cut flowers or potted and bedding plants, is genetically determined. Despite this, ornamental breeders have paid little attention to postharvest performance in their selection strategies. We were given the opportunity to evaluate the breeding lines of one of the major cut flower rose breeders at the 'code' stage, when selected lines are being grown out under production conditions. The graphs show the dramatic differences among different breeding lines (and even commercial cultivars that we use as 'controls'). These data indicate the importance of postharvest screening as part of a breeding program. It is clear that this would make substantial improvements possible both in vase life, and in resistance to Botrytis.

Molecular tools for improving postharvest life of ornamentals

For some years our laboratory has been identifying and exploring the function of genes associated with flower senescence. We are now using that knowledge to test strategies for engineering flowers with longer life. In preliminary studies we are using petunia flowers as a model system. We are using an inducible promoter system to induce up-regulation or silencing of genes of interest. It has been known for some years that *etr1-1*, a mutant ethylene receptor is a dominant mutation that inhibits ethylene responses when up-regulated in transgenic plants. However, inhibiting all ethylene responses has unintended consequences in normal growth and development. The petunia flowers below are from a plant engineered to express *etr1-1* when exposed to very low concentrations of an inducing chemical (dexamethasone). All of the flowers are from the same plant, but before exposure to ethylene they were placed either in water (upper two flowers) or in desamethasone (lower flowers).

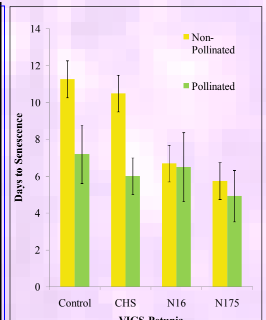


In a strategy to enhance the longevity of ethylene-insensitive flowers, we have been testing inhibition of protein turnover. The graph above shows the effect of silencing one of the components of the 26S proteasome on the life of petunia flowers.

Remodelling flowers with MADS-box genes

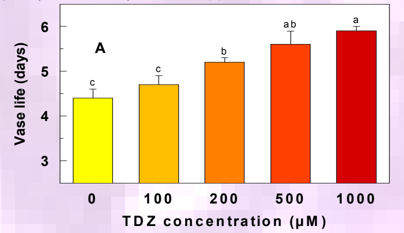
The MADS-box transcription factors are known to be central players in controlling flower morphogenesis. In the course of studying their possible effects on flower senescence (some appear to be involved in that process too), we found that silencing MADS box genes could dramatically change organ identity and floral display. The photograph shows a control purple petunia alongside a petunia silenced for a MADS-box gene, and for our reporter gene, chalcone synthase. Silencing is confirmed by the loss of anthocyanin, and generates a beautiful double rose flower by conversion of anthers to petals.

Other transcription factors appear to be important in delaying senescence. Silencing two NAM transcription factors (N16, N175) stimulated senescence (graph at right). The possible benefits of over-expressing these TFs have not yet been explored.,



TDZ improves postharvest performance of iris

The benefits of TDZ in preventing leaf yellowing and improving postharvest performance of cut flowers and potted plants are seen at concentrations between 2 and 5 μM. We tested higher concentrations with a range of spike-type flowers to see if they might improve opening, and found a substantial increase in the opening and vase life of iris flowers (A). In addition, pretreatment with TDZ resulted in equal vase life and opening of iris that had been stored for two weeks, while controls failed to open fully and/or had a very short vase life (B).



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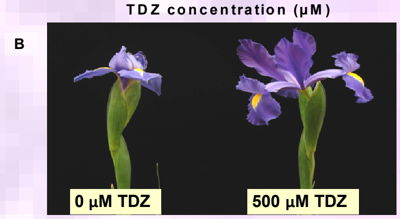
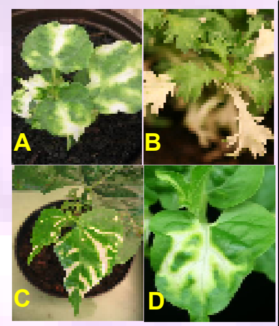


S-ABA treatments enhance display life of potted plants

Early wilting due to water loss is a major problem during the marketing of potted plants. ABA has long been known to control stomatal aperture, and we first showed its benefits as a treatment for reducing water loss from potted plants in 1984. The availability of inexpensive synthetic ABA makes this a very promising treatment for commercial use.

Application of VIGS in ornamentals

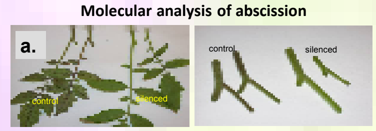
Virus-induced gene silencing (VIGS) is a powerful tool for testing gene function and even modifying phenotypes. Its use has largely been restricted to tobacco (where it was first demonstrated) and close relatives (petunia, tomato). Silencing requires a highly homologous fragment of the gene of interest. For testing VIGS in new species, we typically use a fragment of the phytoene desaturase gene (PDS), whose silencing results in photobleaching. We have designed a universal set of PCR primers for PDS that enable us to isolate a fragment from many species, and demonstrate VIGS efficacy in them. Shown here are symptoms in pansy (A), chrysanthemum (B), bean (C), and four o'clock (D). Achieving silencing in four-o'clock also required us to silence an endogenous anti-viral protein.

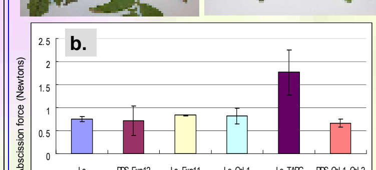


Molecular approaches to height control

Growers of potted and bedding plants frequently use chemical growth regulators to prevent stretching. These chemicals (inhibitors of gibberellin synthesis) have lasting effects that result in poor postharvest performance. We are testing molecular strategies that may allow growers to control height during production without incurring postharvest problems. In the petunia plants below (the control plant on the right), we used VIGS to silence GID, one of the key genes in the GA signaling pathway. By inducing this silencing with an inducible promoter (like alcohol), we hope to provide and effective alternative for height control.

Molecular analysis of abscission





Silencing a polygalacturonase inhibits abscission in tomato petioles. Purple tomato plants were infected with viral constructs containing fragments of different genes that aresuggested to be important in abscission. The force required to remove the petioles was measured after 2 days exposure of the purple (control) and green (silenced) explants (a.) to ethylene. Only silencing a polygalacturonase (TAPG) resulted in higher break strength (b.) than the control (Lc)

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