

A LONG TERM STORAGE EXPERIMENT YEAR 5

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For images please visit the website.



As part of our ongoing quest for a long-term stored peony of good quality, here are the results of our ULO-storage experiments, year 5 already.

For those readers that are only now learning about these long term Ultra Low Oxygen (ULO) treatments: we use large plastic boxes which can be closed airtight. Those boxes have several membranes that can be closed so as to let more or less fresh oxygen in. As the peonies inside use the oxygen to breathe, inside the box the oxygen proportion of the air steadily decreases from about 21% to some 5% (the ULO condition) at which point the peonies slow down their breathing rate and hence their 'ageing'. It is a treatment which is commonly used for hard fruits like apples and pears to store them longtime and have produce available outside of the harvesting season. Unfortunately the procedure with peonies is not as straightforward as with those fruits and previous years have mostly resulted in disappointments as for example last year.

This year was a terrible year when we look at peony diseases. A very late deep frost in Spring and then rain and drizzle for weeks upon weeks resulted in a very high proportion of botrytis infected stems. Never before have we experienced such large numbers of bad stems, flowers and leaflets. This obviously made our testing much more difficult because we could be sure that at least some botrytis was going to be present when filling up the boxes. Therefore, and because we still hadn't found a perfect protocol, we only used two boxes in our trial.

Peonies were cut May 26th and placed into the boxes, without putting them in water first. We mainly used Coral Charm as we thought it would be a better candidate for long term storage than the usual 'The Fawn' from former trials. Coral Charm is a variety that can be cut tighter than most others and will always open well. Also it was noted that Coral Charm showed no signs of botrytis on the flowers whilst in the lactifloras it was omnipresent. A few stems of other varieties were also added just to give a fast impression of what could be possible with them. We didn't have too many stems available this year so they were only half full with some 250-300 stems in them and one set of Calcium Chloride (1kg in total) laid above them. The boxes were closed June 2nd and opened July 31st (after 9 weeks) and September 15th (just over 15 weeks).

The first weeks we left open all 6 membranes of each box to let oxygen levels decrease slowly. This was opposite to last year where we closed them all at the onset with the aim of going towards 5% oxygen in the air as fast as possible. Because we had some 'grey flecks' in the flowers last year we reasoned the fast decrease may have been a possible reason and thus wanted to avoid this.

We have reported on our experiments before and you can read it all here:

<https://www.peonysociety.eu/ultra-low-oxygen-ulo-storage-of-peonies>

<https://www.peonysociety.eu/a-long-term-storage-experiment-year-2>

<https://www.peonysociety.eu/a-long-term-storage-experiment-year-3>

<https://www.peonysociety.eu/a-long-term-storage-experiment-year-4>

The research institute we cooperated with has not received any further funding from the European Union, which is unfortunate as now we have to go it all alone, but they sure did help us along the way. Their results were published this year.

https://www.actahort.org/books/1368/1368_4.htm

Herbaceous cut peony (*Paeonia lactiflora* Pall.) has a limited marketable period due to seasonal production. A qualitative storage period can extend the sales period. For three consecutive years, the effects of storage and subsequent vase life of the cultivars 'Sarah Bernhardt' (SB) and 'The Fawn' (TF) were monitored. Vase life after dry storage at 2°C for 6 and 10 weeks under a normal atmosphere and a controlled atmosphere was compared to vase life immediately after harvest. The atmosphere was modified using a commercial pallet box (Janny MT module) which resulted in an average concentration of oxygen and carbon dioxide of approximately 3%. During storage ethylene accumulated in the pallet box, while under normal atmosphere ethylene levels remained low. Disease incidence (*Botrytis cinerea*) increased during storage and was higher in 2021 (a cold and wet spring) compared to 2020 (a warm and dry spring). After 10 weeks of storage, disease incidence on the flowers was significantly less under controlled atmosphere compared to normal atmosphere. A postharvest treatment before storage in 2021 with 30% pyrimethanil as fumigant significantly decreased *Botrytis* incidence. However, the treatment was phytotoxic. Even though the maximum efficiency of photosystem II (Fv/Fm) decreased significantly during storage and was significantly lower under controlled atmosphere, flower opening, and vase life were not equally affected. Vase life of SB was shorter after storage. However, flower opening of SB was improved after 6 weeks of storage in 2020 compared to non-stored flowers. Flower opening of TF was not different after 6 weeks and poorer after 10 weeks of storage compared to non-stored flowers. The storage atmosphere had no significant effect on flower opening and vase life in 2019 and 2020. In 2021 vase life was shorter for flowers stored under a normal atmosphere due to supplemental *Botrytis* infestation during vase life.

With so few peony stems in the boxes and with all membranes open the oxygen level went down very slowly, so from June 15th we gradually closed some membranes until all were closed June 20th and the boxes were completely airtight. Oxygen levels then further decreased towards 5% and July 31st a first box was opened.

The second box had one membrane open again from August 5th after we saw the oxygen level decreasing towards 4% and we aimed at 5% (the black line in the graph). As can be seen from the graph, temperature was rather constant and low, we didn't make the mistake to raise it halfway the experiment. Oxygen levels decreased towards 5% and then increased again after August 5th. CO2 levels went rather high when the box was fully airtight, but this lowered again with a membrane newly open. Relative humidity (right Y-axis) was rather constant although it slowly raised somewhat over time.

As to the results. July 31st was mostly fine as you can see from the images. My notes for each tested variety (only Coral Charm had several hundred stems, others are 10 stems on average):

-Coral Charm: perfect; petals undamaged; sometimes some rot on the foliage; sepals were already damaged from hail during the growing season; flowers open perfectly, although slightly faster than during the normal growing season; fragrance the same, though slightly less intense

-OFF-4 (Old Faithful x Coral Charm): ok; opens faster than Coral Charm

-Bowl of Cream: ok; two out of ten with botrytis on the buds, probably already present when cutting them; others perfect; opens very well; excellent

-Canary Brilliants: ok

-(The Fawn x open) 001 flat pink: bad; nearly all of the botrytis; some with the 'grey flecks' again

-The Fawn: 2 different treatments; first one left to dry very much (>1 week) before closing the box, leaflets of these don't revitalize again and remain dried up; second treatment better, with leaflets becoming fresh again; some 'open buds' have some botrytis in the inner petals; 'closed' buds are mostly free from botrytis; buds free from botrytis open well

So we can conclude that they can be stored well for 9 weeks. Conclusions at this stage:

-Letting them 'dry' somewhat before the boxes are closed is good, but they shouldn't be dried out to the point where they will not rehydrate again, a few days (2-3) is thus more than enough. The damage from too much dehydration shows most in the leaflets that are attached to the bud and are thus most visible when placing in a vase.

-1 set of calcium chloride is sufficient here, at least for these 300 stems. The box had no condensation inside. Some 1,6 litres of water was soaked up from the air by it. When fully filled we may assume that 2 sets will be needed.

-There were no 'grey flecks' on the petals (except for that one seedling variety). We cannot be sure but we assume they resulted from decreasing the oxygen content too fast last year, whilst this year we opted for doing that more slowly.

We sold some of the stems at the auction beginning of August. Now we must note that a few years ago there were no peonies to be sold at the Brussels auction at that time of the year. How this has changed in only a couple of years, each and every week they were auctioned by the thousands, right up until halfway August. Not the numbers of the full season of course, but usually hovering around 10-20% in comparison. There are more and more peonies being grown each year and growers try to sell them over a longer period. Which is fine but, how to say it?, I wasn't exactly impressed with the quality of what was being sold. I've taken some images from peonies sold by other growers. As can be seen below, the petals are often dried up and don't seem able to rehydrate again, they are sure not to open very well whilst some other varieties that are known to open well tend to have damaged outer petals. I would not be happy to have such flowers in a vase and I suppose I wasn't alone as the prices fetched for them were not higher than during peak season. Given the storage costs and waste it also involves, that can hardly be called a success for the growers concerned. It will be quite a challenge to overcome the bad reputation that 'stored peonies' now have unfortunately.

September 15 then... We intended to open the second box end of August, beginning of September, but an unexpected very late heat wave then struck Belgium and we drowned in work with our other flowers so opening this test box was postponed until this later day. When opening we immediately noticed condensation in the box and on the flowers above. A bit unexpected as the graph shows that relative humidity never reached 100%, although it did increase over time. It could be that the increase of oxygen above 5% again made the peonies inside respire some more, resulting in more vaporization perhaps. The calcium chloride had been insufficient to absorb excess humidity, so for such longer storage more sets need to be included. Due to the humidity there was quite some botrytis. Bowl of Cream, The Fawn, Canary Brilliants and the Coral Charm on top were all lost. Some Coral Charm which was dried out too much also didn't recover, but the great majority of this variety was actually still fine it seemed. I write 'seemed' because although they looked good, it turned out that the petals, which felt 'wet', had experienced some unexpected damage. They were no longer well attached to the stem actually. You could easily take all petals and pull them off without any trouble at all. On the vase this resulted in the petals suddenly falling down. I had decided not to sell any at the auction because I didn't fully trust it after such a long time storage so I gave them away to several florists to try out. While initially they all found them good looking, the end conclusion was the same everywhere: several of them had their petals falling down after one or two days. So, this was a failure. The few good ones were ok, thus if the excess humidity can be avoided they would probably be fine. Next year we will repeat this very long storage with more calcium chloride, the set present in the box had absorbed some 2 litres of water which is only slightly more than 45 days before and we may thus assume that it was fully saturated at this temperature. Given that the box was half full, we expect 3 or perhaps even 4 sets will be necessary for such a long term storage. We hope this way we can keep the box totally free from condensation and if the petals can be protected from becoming too wet we think in our 6th year we may finally be able to show good results after very long storage, which is about time I would think...

As a small side-note: OFF-4 (Old Faithful x Coral Charm, a Hans Maschke seedling) was fine even after this long storage, the petals seem better able to cope with the humidity. This probably comes from its mother Old Faithful which, despite its 'open' buds', are able to withstand the humidity. Unfortunately OFF-4 is currently only a few dozen plants.

The current best procedure to the best of our knowledge is as follows:

- harvest good quality stems that have preferably been sprayed against botrytis (fluopyram is a good protectant)
- use varieties that open well and can be cut tight, use varieties with 'closed' buds (good tested ones are Old Faithful, Bowl of Cream, Coral Charm, Rozella, OFF-4. I don't know about the more common standard varieties, but it could be expected that Duchesse de Nemours will be good (cut tight it opens well) and Sarah Bernhardt will be better than The Fawn as it has closed buds)
- place something on the bottom of the box so the peonies are 'floating' in the box and don't touch the sides or bottom
- lay the flowers in the box without placing them in water first and leave them in cold storage for 2-3 days so they can dry out somewhat
- add calcium chloride, 600 stems will need 2 kg for about 45 days, for longer storage adjust proportionately
- close the box, leave open all lids so oxygen levels decrease only gradually

- keep temperature constant and close to zero so that there will not be much condensation and the buds will not develop further
- check oxygen levels and open lids or close again to keep it around 5%
- open the box when needed, leave the flowers for half a day in the box so they can adjust to ambient conditions
- prepare the flowers, recut the stems, place in a solution of 15 ppm nano-silver for a few hours so the stems are protected from bacteria in the water and will be more resistant to ethylene, after some 12 hours they should be rehydrated again and be ready to be sold