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LOW PRESSURE STORAGE OF ROOTED AND UNROOTED GERANIUMS

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Abstract. Unrooted and rooted geranium (*Pelargonium* × *hortorum* L.H. Bailey.) cuttings were stored for 2, 4 and 6 weeks utilizing a low pressure (LP) storage system maintained at 2.2°C. Unrooted cuttings stored at 1/30 atm were of acceptable quality after 2, 4 or 6 weeks of storage and rooted equaled cuttings directly rooted without storage. Rooted cuttings removed after 2 and 4 weeks of LP storage were acceptable while similar material removed from common cold (CC) storage were unacceptable. In all cases LP storage extended the life of rooted and unrooted geraniums when compared to CC storage.

Many rooted and unrooted cuttings stored for extended periods show reduced rooting and deterioration of foliage. A new storage system termed hypobaric, sub-atmospheric or low pressure storage (LPS) offers a means for long-term commodity storage while preventing post-storage breakdown.

Reasons to implement LPS will vary from operation to operation; however, the ability to store rooted and unrooted cuttings for long periods could be advantageous to a producer in numerous ways. First, since more cuttings can be stored in a smaller area, it allows for increased bench space. Secondly, successful LPS would allow a grower to store cuttings taken prior to a peak season and when sales increase, remove the cuttings stored under the LP system and sell them along with additional cutting material obtained from his stock plants. Thirdly, if a producer has propagation material at the optimum condition and is not prepared to propagate it, he could store it until facilities or conditions improve.

Research involving storage of rooted and unrooted cuttings is limited. Pryor and Stewart (2) successfully stored unrooted softwood azalea cuttings for 10 weeks at -0.5°, 1.7°, and 3.9°C (31°, 35°, and 39°F) with the rooting response equal to non-stored control cuttings. Flint and McGuire (1) stored 31 species of rooted cuttings for 6 months at 1° and 4°C (32° and 40°F). Eighteen of the 31 species tested had a survival rate of 75% or greater. Snyder and Hess (3) were unsuccessful in obtaining adequate growth from *Juniperus communis* 'Hibernica', *Thuja occidentalis* 'Pyramidalis' and *Thuja occidentalis* 'Globosa' after 139 days of storage at -0.5°, 1.7° or 3.9°C. *Taxus cupidata* at 3.8°C were in excellent condition upon removal from storage and subsequent growth was equal to the controls.

Low pressure storage has not been used for commercial storage of woody cuttings as the system is relatively new and untested for this purpose. Studies have shown that the storage life of chrysanthemum, carnation, and geranium can be extended 66, 210, and 23 days respectively, using LP as compared to CC storage.[1] Rooted cuttings of chrysanthemums were successfully stored 90 days using LP as compared to 14 days with CC storage.[1]

Rooted and unrooted geraniums have a limited storage life in CC storage. Thus studies were initiated to determine if the storage life of unrooted and unrooted geranium cuttings could be extended using LP storage. In addition, pre and post harvest handling procedures were investigated.

MATERIALS AND METHODS

All plant materials were stored in 38.0 liter stainless steel milkcans lined with 1.9 × 1.9 cm/steel mesh. Low pressure chambers were sealed so that lids were air tight. Air was removed with a vaccum pump and the pressure was maintained

[1] Personal communication from S.P. Burg, 1976.

with Matheson 49 pressure regulators. Chambers were maintained at 1/30 atm with 1 air exchange per hr. Relative humidity was maintained between 95-98% by passing the air at reduced pressure entering the chamber through a water bath. Common cold storage cuttings were placed in milkcans with 95-98% relative humidity at atmospheric pressure. In all experiments, temperature was maintained at 2.2°C (36°F) and plants were stored in the dark.

Unrooted geranium cuttings were taken from stock plants immediately prior to being placed into storage. Cuttings were submerged for 30 sec in a 1 tbs/gal Daconil mixture and allowed to dry before placing in loosely sealed polyethylene bags and stored for 2, 4 or 6 weeks. Upon removal from storage, cuttings were rooted in 1:1:1 (v:v:v) peat, perlite, sand medium under a 6 sec/6 min mist cycle for 25 days. Parameters measured were foliage condition at removal and foliage and roots after rooting.

Rooted geranium cuttings received a thorough Daconil spray (1tbs/gal), allowed to dry, then placed directly into storage chambers for 2, 4 or 6 weeks. Plants were either stored under CC and LP storage. Upon removal from the storage systems, plants were placed under mist for 2 days, then removed from mist and placed in a 28°C greenhouse for 12 days. The experiment was terminated at that time and final foliage characteristics were recorded.

Scales used for evaluation of foliage and roots were as follows:

Foliage Evaluation
0 - dead
1 - all leaves yellow and deteriorating
2 - all leaves yellow
3 - majority of leaves yellow
4 - 1 or 2 leaves yellow
5 - all leaves green

Rooting Response
0 - dead
1 - callus
2 - callus with few roots
3 - light
4 - medium
5 - heavy

RESULTS

Unrooted cuttings. Unrooted cuttings of geraniums from LP storage were of acceptable quality at removal from the chambers and following 25 days in the mist bed (Table 1). Only cuttings of material stored for 2 weeks in the CC system were of acceptable quality while cuttings stored 4 and 6 weeks showed terminal dieback, basal rot and yellowing. Material stored in the LP system showed some marginal yellowing on cuttings removed after 4 and 6 weeks storage, but the yellowing did not further develop.

Rooting of cuttings stored in the LP system at all removal

dates was acceptable. Cuttings removed from CC storage after 2 weeks rooted, however, material stored 4 or 6 weeks either died in the mist bed or showed poor root development (Table 1).

Table 1. Visual evaluation of unrooted geraniums at removal and 25 days following removal from LP or CC storage.

	Low Pressure Storage[1]			Common Cold Storage		
Weeks	Foliage at removal	Foliage 25 days after rooting	Rooting response	Foliage at removal	Foliage 25 days after rooting	Rooting response
2	4.9	4.6	4.5	3.3	4.3	4.3
4	4.6	3.9	3.8	1.6	2.0	1.7
6	3.9	4.0	4.2	0.3	0.0	0.0

[1] See text for explanation of rating scales.

Rooted cuttings. Rooted geranium cuttings stored for 2, 4 and 6 weeks in a LP storage system were of acceptable quality at removal, but quality decreased at each date. Material from the 6 week LP storage treatments, however, were not acceptable when evaluated 14 days later and exhibited severely chlorotic and/or necrotic areas on the stems and leaves (Table 2). Rooted geraniums from the 4 week LP storage treatment yellowed following removal fromt e chambers but new growth was acceptable. Cuttings stored in conventional CC storage units were of acceptable condition after 2 weeks of storage, while similar material stored for 4 and 6 weeks were either completely yellow or diseased.

Table 2. Visual foliar evaluation of rooted geraniums at removal and 14 days following removal from LP or CC storage.

	Foliar Evaluation[1]			
	Low Pressure Storage		Common Cold Storage	
Weeks	At removal	14 days following removal	At removal	14 days following removal
2	5.0	3.8	3.5	3.0
4	4.2	2.4	1.4	1.8
6	4.0	1.4	0.0	0.0

[1] See text for explanation of rating scales.

DISCUSSION

As a result of these experiments, 4 week storage of rooted and unrooted geraniums appears possible utilizing a LP system. Although in the experiment reported here we achieved acceptable results with unrooted cuttings stored 6 weeks under LPS, some difficulty has been experienced in reproducing similar results.

Due to lack of research involving storage of cuttings under LP storage conditions, symptoms such as marginal yellowing, dieback of older foliage and wilting can not be completely explained. Marginal yellowing which occurred on rooted and unrooted cuttings can be limited by placing cuttings under mist promptly after their removal from the LP chambers. In addition, increasing the mist cycle for the first 2 days after removing unrooted cuttings from the LP chambers appears beneficial in preventing wilting.

The better quality of cuttings noted when intermittent mist is applied promptly after the storage period, may be related to vapor pressure deficit (VPD). When cuttings are in the LP chambers, temperature is reduced and relative humidity is maintained at approximately 95-98%. Following removal from the LP system, the cuttings are placed at room temperature (27°C) where the relative humidity is not controlled. Research has shown that if one maintains the temperature at 2.2°C and only readjusts the relative humidity from 90 to 50%, water vapor will escape from the plant 5 times faster (4). If temperature is increased to 21°C with a relative humidity of 70%, water vapor escapes 10 times as fast from foliage as compared to 2.2°C at 90% relative humidity. As a result increasing the mist cycle immediately after removing the cuttings from the LP chambers has resulted in preventing the excessive wilting noted in preliminary experiments.

Cuttings stored under CC consistently showed diseased foliage and basal rot even though they received a fungicide treatment prior to storage. Yellowing caused by chlorophyll breakdown proved to be another limiting factor in CC storage. The low oxygen levels in LP storage may prevent symptoms of this nature from occurring (5). In addition, the removal of ethylene and other volatile gases when using a LP system may also aid in extending the storage life of rooted and unrooted geraniums.

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