EFFECTS OF COLD STORAGE ON VASE LIFE OF CUT EUCALYPTUS PARVIFOLIA CAMBAGE BRANCHES

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ABSTRACT – The effect of dry and wet storage on vase life of cut Eucalyptus parvifolia Cambage branches was investigated. Cut Eucalyptus parvifolia branches were stored in a refrigerated chamber (at 5 °C, relative humidity 70-80% and light intensity of 3-5 μmol m⁻² s⁻¹ PPFD) for 2, 3 and 4 weeks. After storage, physiological behaviour was assessed by measuring water uptake, water potential, weight variation, relative weight change percentage, chlorophyll content, ethylene production and vase life. Weight variations were the same in all treatments. Water uptake declined at the end of vase life of cut foliage stored for 4 weeks. Ethylene production increased with storage time. Chlorophyll content showed differences after storage but reached the same values in all treatments towards the end of vase life. There was no significant difference in vase life among the treatments. Results obtained suggested that water potential, water uptake, ethylene production and relative weight change percentage can be used as indicators of quality and stress status during vase life of cut Eucalyptus parvifolia branches. In conclusion the longest practical storage time for Eucalyptus parvifolia was 3 weeks without losing ornamental value.

Key words: cut foliage, dry and wet storage, ethylene, water potentials, chlorophyll.

1. INTRODUCTION

Cut Eucalyptus foliage is important in floral decorations. Over the last few years the cultivated area of foliage in Italy has been increasing. Several Eucalyptus species have been evaluated for cut foliage production (Rumine and Bellandi, 1989). Interest is growing concerning optimal postharvest technology for cut Eucalyptus foliage, but few recommendations are available in the literature. Companies and growers usually use the same vase solution for flowers and foliage. However the physiological behaviour is different between these two types of commodities. It is not advisable to use the same treatments for all cut floral perishable products.

Cold storage can be used as an alternative to chemical treatments to preserve perishable commodities (Rudnicki, et al., 1991). Low temperatures reduce physiological processes and maintain keeping quality (Reid, 1991) so that storage temperature and storage time are negatively correlated. Each species seems to have an optimal storage temperature and a maximum storage time before damage is seen or reduction of the shelf life is necessary. At 5°C, Eucalyptus gunnii can be stored for 4 weeks without reducing vase life (Forrest, 1991). Wet and dry storage were compared in E. gunnii and E. crenulata. Vase life after treatment was not differentially affected in either species (Jones, et al., 1993). Among Eucalyptus foliage sold in Tuscany, cut Eucalyptus parvifolia Cambage, has many problems after harvest. Specifically, it has the shortest vase life (about 7 days) and the highest ethylene production (6 nl g⁻¹ h⁻¹) in the first few days after harvest of all the Eucalyptus species studied (Ferrante et al., 1998).

The aim of the present study was to evaluate the effect of cold storage on the physiological behaviour of cut E. parvifolia and to determine how long cut Eucalyptus parvifolia branches could be stored at low temperatures without losing commercial quality.
2. MATERIALS AND METHODS

2.1 Plant material

Cut branches of *Eucalyptus parvifolia* Cambage were harvested early in the morning from a commercial producer (Solarì floriculture grower, Massarosa, Lucca, Italy) and transported to the laboratory within 2 hours of harvest. Cut branches (150) were selected for length and weight to obtain homogenous samples. Stem ends were cut under water to give branches with a stem length of 60 cm and an initial fresh weight of 19.73 g ± 1.54.

2.2 Storage treatments

Branches of cut *Eucalyptus* foliage were placed in tanks with their bases in distilled water (wet storage) and stored in a refrigerated chamber at 5 °C, relative humidity 70-80% and light intensity of 3-5 μmol m⁻² s⁻¹ PPFD for 12 hours per day. Non-stored cut branches were taken for vase life assessment immediately after harvest. Ten branches were removed from storage at 2, 3 and 4 weeks. Cut branches were placed in individual bottles and were transferred to the vase life room. Evaporation in the growth chamber was 0.36 ± 0.06 g per day, measured from vases containing no stems.

2.3 Measurements

Vase life, water uptake, water balance, weight variation, relative weight change percentage, chlorophyll content and ethylene production were measured in all the experiments. After cold storage the cut branches were placed in a ventilated controlled temperature room at 20 °C, where relative humidity ranged between 60-70%. The light period was 12 h per day and photon flux density at branch level was about 10 μmol m⁻² s⁻¹. Vase life was determined by daily observation and was considered terminated at the first signs of wilting or of yellowing on the upper surface of the leaves.

2.4 Chlorophyll determination

Chlorophyll a and b were extracted using 99.9% methanol as a solvent to extract chlorophyll from leaf samples kept in the dark in a cold room at 4 °C for 24 hours. Quantitative chlorophyll determinations were carried out immediately after extraction. Absorbance was measured spectrophotometrically and chlorophyll contents were calculated by Lichtenthaler’s (1987) formula. Chlorophyll contents were measured at 4 and 14 days after storage, three samples for each treatment.

2.5 Water potential

Total water potential was determined by the pressure chamber (Scholander et al., 1965). Three apical portions (10 cm) of branches were used as sample. Osmotic potential was determined on frozen/thawed leaf tissue using a freezing-point depression osmometer (Roebling, Berlin, Germany) calibrated with standard sodium chloride solutions. Turgor was calculated as the difference between total water potential and osmotic potential.

2.6 Ethylene production

Ethylene production was immediately determined after cut branches were removed from the cold room. Ethylene response to cold storage was evaluated measuring the hormone produced at 1, 2, 3 and 4 hours from cut branches that were stored for 2 weeks. After 2, 3 and 4 weeks of storage cut branches were transferred from cold chamber to vase life room and ethylene production was measured, in order to evaluate the effect of cold storage on the hormone biosynthesis. Ethylene production was measured
by enclosing three apical portions (ca. 10 cm long) of experimental branches in airtight containers (250 mL). Two milliliters gas samples were taken from the headspace of the containers with a hypodermic syringe after 1 h incubation at room temperature. Ethylene concentration in the sample was measured by gas chromatography (HP5890, Hewlett-Packard, Menlo Park, CA) using a flame ionization detector (FID) and a stainless steel column (150 x 0.4 cm packed with Hysep T); column and detector temperatures were 70 °C and 350 °C, respectively, and nitrogen carrier gas had a flow rate of 40 mL min⁻¹. Quantification was carried out using a standard and results were expressed on a fresh weight basis (mL h⁻¹ g⁻¹ F.W.).

2.7 Statistical analysis

Means and standard errors were calculated for water uptake, water potentials and chlorophyll contents. Vase life and ethylene production data were analysed by ANOVA. Mean separations were calculated by Tukey’s test at P < 0.05. Each treatment was composed of 10 replicate stems.

3. RESULTS

3.1 Dry and wet storage in cut foliage

Cut branches dry stored died within two days in the cold room, while branches stored in distilled water survived for much longer. In fact, the wet storage was prolonged for 4 weeks. After three weeks of storage, cut branches did not really show ornamental quality reduction, but the first symptoms of senescence were visible and the mortality of cut branches was about 1-2%. Unfortunately only one week more (4 weeks) dramatically increased the mortality to 50%.

3.2 Effect of cold storage

Vase life

Every week 10 cut branches were taken out from the cold room and transferred to the vase life room for postharvest evaluations. The vase life of cut branches was not affected by the storage and was the same in all the treatments, i.e. about 13 days (Tab. 1).

Water status and weight variation

There was no statistical difference in water uptake among the treatments, except at the end of the vase life. Cut branches stored for 4 weeks showed a decline of water uptake and reached the lowest value (Fig. 1). Absolute weight variations among treatments were not significantly different during vase life (data not shown). However the stored branches started to lose weight from the beginning of post-storage life and did not show the typical initial weight increment that was seen in cut foliage placed in water immediately after harvest. The total water

<table>
<thead>
<tr>
<th>Storage time (weeks)</th>
<th>Mean</th>
<th>Err.st.</th>
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<tbody>
<tr>
<td>0</td>
<td>14.55</td>
<td>± 0.89</td>
</tr>
<tr>
<td>2</td>
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<td>± 0.76</td>
</tr>
<tr>
<td>3</td>
<td>13.00</td>
<td>± 1.73</td>
</tr>
<tr>
<td>4</td>
<td>12.50</td>
<td>± 1.62</td>
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Tab. 1 - Vase life (days) of cut E. parvifolia branches after cold storage at 5 °C. Data were analysed by one-way ANOVA (P < 0.05).

![Fig. 1 - Water uptake during vase life of cut foliage previously stored for 0, 2, 3 and 4 weeks. Vertical bars represent the standard error of the mean (n = 10).](image)
potential, osmotic potential and turgor were measured after the branches had been taken out from the cold storage. The total water potential and turgor decreased after 2 weeks of cold storage (Fig. 2), while the osmotic potential did not change at any time during storage.

Chlorophyll content
Chlorophyll content decreased after two weeks of storage in all treatments, but increased again during vase life up to the initial contents (Fig. 3). The pigments a and b had the same rate of degradation and recovery.

Ethylene production
Ethylene production was measured weekly by cut branches taken out from the cold room. Low temperatures inhibited ethylene production; recovery time was also studied. Cut branches coming immediately out of the cold room did not produce ethylene. The hormone was detectable 1 hour after cut branches were placed in the vase life room. The peak of ethylene production was reached after 2 hours, then decreased and became stable (Fig. 4).

The level of ethylene evolved from cut branches increased with storage time; therefore the highest values were obtained from cut branches stored for 4 weeks that produced up to 6 nl h⁻¹ g⁻¹ FW (Fig. 5).

4. DISCUSSION

Cold storage is the most used strategy to reduce weight losses for all horticultural crops.
During storage, the total water and turgor decreased in cut branches, while osmotic potential did not decline during vase life (Fig. 2). This result might be due to a lack of the osmotic adjustment that should prevent the drop of turgor as reported for cut flower species under moderate water stress (van Doorn, 1997). The negative pressure observed in cut branches after the third week of storage did not induce a visible wilting symptom. Since leaves do not change colour, chlorophyll degradation cannot be used as indicator of leaf senescence in cut E. parvifolia. Degradation decreased after the first signs of wilting occurred. Chlorophyll analysis showed that chlorophyll b was degraded faster than chlorophyll a. However, more investigations are being carried out in order to determine whether chlorophyll b is converted to a.

Cut E. parvifolia branches were successfully stored for 3 weeks without affecting the post-storage life. Longer storage caused mortality, suggesting that this species is more fragile than other Eucalyptus species such as E. gunnii (Forrest, 1991).

During storage, ethylene production time was inhibited, but increased when cut foliage was taken out from the cold storage room and reached its highest value after 2 hours. Various plants show reduction of ethylene evolution during exposure to low temperatures, and this is attributed to impairment of the conversion of 1-aminocyclopropane-1-carboxylic acid (ACC) to ethylene (Wang, 1989). ACC accumulation occurs during cold storage in some cut flowers such as roses and, in these plants, transfer to warmer temperatures causes considerable ethylene evolution (Barrowclough, et al., 1991; Serrano, et al., 1995).

Ethylene production after storage was therefore measured four hours after cut branches were transferred from cold chamber to postharvest evaluation room. Ethylene biosynthesis is known to be temperature dependent. For example, maximum activity of ACC oxidase has been found in the range 30-37.5 °C (Muñoz, et al., 1999). The clima-
teric peak of ethylene production, characteristic of many cut flowers, was not observed in cut E. parvifolia branches although ethylene biosynthesis did increase at the end of vase life (Ferrante et al., 1998).

Temperature-induced change in ethylene production may have significant impact on the postharvest behaviour of foliage branches or may damage adjacent cut flowers in mixed bouquets.

In conclusion water potential, water uptake, absolute weight variation and ethylene production could be used as indicators of postharvest decline and stress level in E. parvifolia. Low temperatures extend postharvest life without loss of ornamental quality. Cold storage is therefore one of the most effective methods for holding and maintaining quality of cut Eucalyptus parvifolia foliage. The maximum storage time at 5 °C was three weeks. Longer storage adversely affects foliage quality through reduction of chlorophyll content and increasing water stress.

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REFERENCES


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