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Genotypic differences in vase life of *Anthurium andraeanum* (Hort.) cut-flowers are associated with differences in spathe chlorophyll content

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Highlights

- The vase life of ten anthurium cultivars was compared under high and low light.
- Blooms that contained more chlorophyll survived longer in the vase.
- Longer-lived cultivars had an ability to re-green- accumulating chlorophyll over time.
- Re-greening was associated with longer vase life, especially under high light.

Abstract

Anthurium (Anthurium andraeanum (Hort.)) is an important crop in the worldwide cut-flower industry, valued in particular for its showy colors and long vase life, which varies from a few days to several weeks depending on the cultivar. Previous work suggested that long vase life is associated with the chlorophyll content of the spathe, especially when more light is available. Here we compare the vase life of ten anthurium cultivars covering a range of chlorophyll contents, using two light intensities: low light (40μmolm^{-2} s^{-1}) and high light (400μmolm^{-2} s^{-1}). The experiment was arranged in a factorial design with six replicate cut-flowers per cultivar per light intensity, and measurements were recorded weekly for cut-flower degradation, water uptake, spathe chlorophyll content and spathe hyperspectral reflectance. Cultivar differences in vase life were positively associated with differences in the initial spathe chlorophyll content (accounting for > 60 % of the variation). The use of high light also significantly increased vase life in three of the high chlorophyll cultivars. Chlorophyll content increased over time in some cultivars, and this increase was associated with extended vase life under high light (accounting for 69 % of the variation). In both cases chlorophyll content provided a better indicator of vase life than the red dip index (R800nm – R685nm) derived from hyperspectral reflectance. The results show that cultivars with a high initial chlorophyll content often have an ability to 're-green' by increasing chlorophyll content while in the vase. Both high initial chlorophyll content and the ability to perform re-greening are associated with a longer vase life suggesting that chlorophyll activity in the spathe helps to maintain the cut-flowers.

Introduction

Anthurium (*Anthurium andraeanum* Hort.) is an important ornamental crop in the cut-flower industry. The cut-flower comprises a spathe (modified leaf), spadix (inflorescence) and peduncle (stalk) (Dufour and Guérin, 2003). Its appeal is partly due to the exceptionally long vase life which can vary from 14 d to greater than 40 d (Elibox and Umaharan, 2010).

Anthurium spathes may contain one or more pigment types. The anthocyanin, pelargonidin 3-rutinoside is responsible for orange to coral spathe colors, whereas both pelargonidin 3-rutinoside and cyanidin 3-rutinoside (another anthocyanin) are found in red and pink spathes (Iwata, 1980). Coral and pink spathes have lower concentrations of anthocyanins relative to their orange and red counterparts (Iwata et al., 1985). White-spathed cultivars lack both

anthocyanins but contain colorless flavone C-glycosides (Williams et al., 1981). Green spathes contain chlorophyll (Collette et al., 2004, Elibox and Umaharan, 2008), and some spathes are variegated (obake types) (Elibox and Umaharan, 2008) with chlorophyll and anthocyanin/flavone C-glycosides.

Evelyn et al., (2020) showed that the dark red cultivar 'Honduras' was able to extend its vase life under high light intensity (i.e., 400µmolm^{-2} s^{-1}), likely because its spathes contain chlorophyll in addition to anthocyanins (Elibox and Umaharan, 2008). In that study, hyperspectral reflectance analysis revealed a dip in reflectance at the red region and this dip increased in depth over time. As absorption in the red region has been linked to chlorophyll content (Rundquist et al., 1996, Sims and Gamon, 2002), the increased absorption over time also indicated increased chlorophyll content over time (Evelyn et al., 2020). This phenomenon, referred to as 'greening' or 're-greening' (redifferentiation of chloroplasts from chromoplasts), has been observed in anthurium spathes of some cultivars left intact on the plant (Ehrenberger et al., 2003) and investigated in other arum species: Calla Lily (Chen et al., 2012, Chen et al., 2015) and Peace Lily (Pavlovic et al., 2019). Evelyn et al., (2020) showed that higher light intensity extended the vase life of the long-lived cultivar, 'Honduras', but had no effect on a light pink, short-lived cultivar, 'Spirit', suggesting an association between spathe pigmentation and vase life. This raised the possibility that chlorophyll content and chlorophyll turnover in the spathe may be important in regulating genotypic variation in vase life.

Previous studies have linked variation in vase life in anthurium to water relations (Evelyn et al., 2020, Farrell et al., 2012, Elibox and Umaharan, 2014). Transpiration has been observed to influence genotypic variation in vase life (Sankat and Mujaffar, 1993, Mujaffar and Sankat, 2003, Elibox and Umaharan, 2010) with short vase life being associated with imbalances in water relations, even where vascular occlusion was absent (Hettiarachchi and Balas, 2005, Elibox and Umaharan, 2008). Generally, short-lived cultivars have high rates of water uptake coupled with high rates of water loss, whereas long-lived cultivars maintain a steady rate of water uptake and are better able to retain water in their bulk tissue (Farrell et al., 2012, Elibox and Umaharan, 2014). It may be that both water relations and chlorophyll content independently influence vase life or it may be that the two factors interact to regulate vase life.

Here we examined changes in chlorophyll content and water uptake over time in cut-flowers of ten anthurium cultivars covering a range of chlorophyll contents (and spathe colors) and

vase lives. The comparison was repeated under low and high light to further assess the role of re-greening in determining vase life.

Section snippets

Material

Twelve cut-flowers of each of the 10 anthurium cultivars were collected from Kairi Blooms Limited, Arima, Trinidad and Tobago. The 10 cultivars were selected based on differences in color (white- W-‘Vidya’; pink - P-‘Dusty Pink’, P-‘Local Pink’, P-‘Spirit’, P-‘Kiaso’; green - G-‘Malotte’ and G-‘Green’; and red - R-‘Success’, R-‘Honduras’ and R-‘Debe’) and vase life. Cut-flowers were selected with the criteria of having no deformities, straight peduncles and a spadix at three quarters maturity (…

Results

Bloom Degradation Index (BDI) increased over time for all cultivars (Fig. 1), however, the rate of increase varied among cultivars. Most cultivars experienced end of vase life before 40 d (Table 1). There were significant differences in days to end of vase life between cultivars ($P<0.001$), between light intensities ($P<0.01$), and in the interaction of cultivar x light intensity ($P<0.05$). All the green and red-spathed cultivars showed increases in vase life at the higher light intensity,…

Discussion

Anthurium cultivars with a longer vase life had higher initial spathe chlorophyll content and these cultivars also lasted longer when held under a high light intensity. Generally, cultivars

with a spathe chlorophyll content < 10 atLeaf units had a vase life of less than one month, while those with more chlorophyll lasted beyond one month and survived even longer under the high light intensity. Chlorophyll content values < 10 atLeaf units based on light transmission are negligible, while values…

Conclusion

This study highlighted the potential of chlorophyll content as a powerful tool for rapidly determining the potential vase life of new cultivars, with a strong significant association between initial spathe chlorophyll content and vase life. Anthurium cultivars with chlorophyll-rich spathes also have an ability to synthesize more chlorophyll in the vase, which in combination with high light further extends vase life.…

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.…

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Author Statement

No part of this work has been submitted to any other publication.…

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