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Effect of low temperature storage on conservation varieties of Chrysanthemum cutting

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The objective of this research was to evaluate postharvest quality of 'Lona' and 'Garfield' varieties chrysanthemums, stored at different temperatures. The experiment was carried out in a plastic greenhouse at Pouso Alegre, Minas Gerais State, Brazil (22° 13'48" S, 45° 56'11" W and 832 m in height). The inflorescences were kept at 1.5, 2.5 and 5.0°C. The evaluated parameters were senescent flowers and necrosed ligules. The evaluations were performed in the open storage room at 4, 8, and 12 days, at room temperature. It was observed that chrysanthemum 'Lona' flower senescence was accelerated at 2.5 and 5.0°C; while for 'Garfield', the senescence was larger at 1.5°C. For 'Lona' and 'Garfield' chrysanthemums, the temperature of 1.5°C favored the development of necrosis.

Key words: *Dendranthema grandiflora* Tzvelev, varieties, pompom, conservation.

INTRODUCTION

The cultivation of flowers and ornamental plants in Brazil is an important activity because it generates employment opportunities and improves income levels in several states. The main species include: rose, kalanchoe, violet, begonia, gerbera, ficus, fern and chrysanthemum (Mitsueda et al., 2011). Chrysanthemum is ranked as one of the cut flowers that feature a variety of colors and inflorescences. However, the lack of specific care during harvesting, transport and storage causes a lot of damage which impairs the quality of flowers and increased post-harvest losses. The use of low temperature during storage is important for conservation of the flowers, because in addition to inhibiting bacterial and fungal infections, it reduces degradation of certain enzymes and ethylene production, decreases perspiration, respiration, and delays related to the different processes of growth and senescence (Nowak and Rudnicki, 1990; ASHRAE, 1994). The temperature in the preservation of chrysanthemum varies with the variety and the shelf. Nowak (1991) recommend 1°C as the best temperature for storage, however, Sacalis (1993) and Vieira and Souza (2009) recommend a wider temperature of 0-5°C. Some authors have used temperatures recommended above, for several species (Ichimura et al., 1989; Hastenreiter et al., 2006; Vieira and Lima, 2009; Vieira et al., 2010).

The aim of this study is to evaluate the effect of different storage temperatures on the postharvest quality of cut chrysanthemums.

MATERIALS AND METHODS

The experiment was conducted in a greenhouse in Pouso Alegre /

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MG (22° 13'48" S, 45° 56'11" W) and 832 m in height. Two varieties of cut chrysanthemum (*Dendranthema grandiflora* Tzvelev), 'Lona' (inflorescence type pompom, globular, formed by small ligules with purple coloring and reaction time of seven and a half weeks) and 'Garfield' (with identical phenotypic characteristics, but with ligules orange staining) were used. The experimental design was completely randomized with six replications and three stems experimental. The flowers were harvested when they had nearly 50% of ligules expanded, which corresponds to the commercial harvest. Thereupon, the stems were standardized to a length of 75 and 15 cm defoliation of the base of the stem.

The following were placed in plastic containers containing 1 L of water and stored at temperatures of 1.5, 2.5 and 5.0°C and relative humidity (RH) of 90%. After 7 days of storage, the inflorescences were transferred into plastic containers containing 300 ml of water not distilled (renewed every 48 h). The evaluations were carried out in the chambers and after 4, 8 and 12 days of exposure at room temperature with an average of 25.2 °C, where they were assessed with the following parameters:

Senescent flowers: those who had more than 50% of the disk flowers with anthers mature and attenuation of dark purple to light purple to chrysanthemum 'Lona' and attenuation of dark orange to light orange to chrysanthemum ' Garfield '.
Ligules darkened: were considered those that had blackened necrotic spots on the edges or in the center. The calculations were subjected to analysis of variance, and means were compared by Duncan test at 5% probability of error.

RESULTS AND DISCUSSION

In evaluating the data senescent flowers of chrysanthemum 'Lona', it was observed that during storage there was no difference between the temperatures (Table 1). However, for evaluation at 4, 8 and 12 days flowers that remained in temperature of 1.5°C, this process developed more slowly compared with those stored at 2.5 and 5.0°C. The stems to come out of cold storage had a rate of 5 to 7% of senescing flowers, but to those stored for 12 days at room temperature, this index remained below 50% at a temperature of 1.5°C; while those stored at 2.5 and 5.0°C rose to 49 and 56% respectively.

These results are explained by the retardation of physiological processes (Taiz and Zeiger, 2004), as reported by Brackmann et al. (2000) in chrysanthemum 'Red refocus', who noted that the percentage of senescent flowers was lower in stems stored at low temperature.

This fact was also investigated by Vieira and Souza (2009) in chrysanthemum Yoko Ono, which reported that storage above 1.5°C had accelerated senescence process. Vieira and Lima (2009) studied the postharvest chrysanthemum Faroe, and observed an increase in the percentage of senescent flowers during storage at 10°C. According to Ferguson et al. (1990), elevated temperatures may directly or indirectly injure plant protein by inactivation of enzymes, changes in the conformation of peptides or disruption of complexes in the membrane.
Chrysanthemum 'Garfield "(Table 2) showed no difference between the temperatures during storage.

Metabolic activity observed in flowers during the period, demonstrated that the sensitivity grows at low temperatures, which requires the use of temperatures less than 5.0°C during storage. These results are comparable with the data reported by Vieira and Souza (2009), who observed greater symptoms of senescence in chrysanthemum Statesman stored at 1.5°C. However, these results are not in accordance with other studies by these authors, which reported a higher percentage of senescent flowers above 1.5°C in chrysanthemum Yoko Ono.

According to Nowak and Rudnicki (1990), the post-harvest treatment is related to the genetic, physiological and anatomical differences in species and varieties, confirming the results observed in this study. When assessing the darkening of ligule (Tables 3 and 4), results showed that it was higher in temperature of 1.5°C for both cultivars of chrysanthemum cutting. The flowers removed from cold storage had on average, 2 to 4% of ligules with darkened spots for chrysanthemum 'Lona' and 'Garfield' respectively, a value that has evolved to 8 and 10% in the first 4 days at room temperature and 18 and 23% at last review. Similar results were observed by Brackmann et al. (2000) for chrysanthemum during storage of 'Red refocus', where the percentage of darkened ligules were observed at -0.5°C compared with the temperature of 2.5°C.

In evaluating the ligules of chrysanthemum Yoko Ono and Statesman, Vieira and Souza (2009) observed the temperature of 1.5°C favored the development of browning of ligules. In other species Joyce and Shorter (2000) found the temperature range of security for the storage of flowers Anigozanthos spp., Cvs. H1 and Bush Dawn is between 2 and 5°C; for when kept at 0°C showed chilling injury whose symptoms were wilting and discoloration of the petals.

There was a reduction in the life of the flowers of potted Campanula medium stored at 2°C in that the storage time increased from 1 to 3 weeks (Bosma and Dole, 2002). In *Curcuma alismatifolia* (curcuma, Tulip and Tulip siam) Bunya-Atichart et al. (2004) observed dryness and change in color of the bracts of pink to dark violet.

According to Kays (1991), the sensitivity of a plant or part thereof to chilling (chilling injury) varies depending on the species, cultivar of the plant and the time of exposure to low temperature.

However the mechanisms of tolerance to chilling injury are complex. It may occur along with other biochemical and physiological mechanisms to maintain normal physiological functions under stressful conditions, or it may be promoted by chilling injury (Pennycooke et al., 2005). Overall, these results suggest that low temperature storage can activate more intensely, degradative enzymes cell wall tissue of ligules. According to Buchanan et al. (2000), these enzymes are responsible for the first signs of senescence by altering metabolism. This shows that temperature is the most

Table 1. Percentage of senescent flowers at three different temperatures and times of evaluation of chrysanthemum (*Dedranthema grandiflora Tzvelev*) 'Lona'. Pouso, MG. 2011.

Seasons	**Senescent flowers**		
	1.5°C	**2.5°C**	**5.0°C**
Output Storage	5.13 ^{dA}	5.42 ^{dA}	7.17 ^{dA}
4 days in room °C	11.46 ^{cC}	17.11 ^{cB}	23.25 ^{cA}
8 days in room °C	23.17 ^{bC}	32.48 ^{bB}	38.39 ^{bA}
12 days in room °C	36.58 ^{aC}	53.05 ^{aB}	59.27 ^{aA}
CV%	4.38%	6.52%	6.26%

¹ Means not followed by the same lowercase letters on the line and letters in the same column differ by Duncan test (α=0.05).

Table 2. Percentage of senescent flowers at three different temperatures and times of evaluation of chrysanthemum (*Dedranthema grandiflora* Tzvelev) 'Garfield'. Pouso Alegre, MG. 2011.

Seasons	**Senescent flowers**		
	1.5°C	**2.5°C**	**5.0°C**
Output Storage	10.47 ^{dA}	11.79 ^{dA}	4.85 ^{dB}
4 days in room °C	25.83 ^{cA}	28.42 ^{cB}	17.64 ^{cC}
8 days in room °C	44.63 b^{A}	37.71 ^{bB}	33.84 ^{bC}
12 days in room °C	64.73 ^{aA}	53.65 ^{aB}	46.19 ^{aC}
CV%	7.84%	6.71%	6.92%

¹ Means not followed by the same lowercase letters on the line and letters in the same column differ by Duncan test (α=0.05).

Table 3. Percentage of ligules darkened at three temperatures and different times of evaluation of chrysanthemum (*Dedranthema grandiflora* Tzvelev) 'Lona' Pouso Alegre, MG. 2011.

Seasons	**Ligules darkened**		
	1.5°C	**2.5°C**	**5.0°C**
Output Storage	2.29 ^{dA}	1.71 ^{cA}	1.24 ^{cA}
4 days in room °C	8.53 ^{cA}	1.59 ^{cB}	1.63 ^{cB}
8 days in room °C	12.58 ^{bA}	2.83 ^{bB}	5.27 ^{bB}
12 days in room °C	18.05 ^{aA}	10.63 a^{B}	9.89 ^{aB}
CV%	5.52%	4.50%	5.83%

¹ Means not followed by the same lowercase letters on the line and letters in the same column differ by Duncan test (α=0.05).

Table 4. Percentage of ligules darkened at three temperatures and different times of evaluation of chrysanthemum (*Dedranthema grandiflora* Tzvelev) 'Garfield'. Pouso Alegre, MG. 2011.

Seasons	**Ligules darkened**		
	1.5°C	**2.5°C**	**5.0°C**
Output Storage	4.48 ^{dA}	2.83 ^{cA}	2.54 ^{cA}
4 days in room °C	10.41 ^{cA}	4.74 ^{cB}	3.25 ^{cB}
8 days in room °C	16.22 ^{bA}	8.06 ^{bB}	8.23 ^{bB}
12 days in room °C	23.64 ^{aA}	14.52 ^{aB}	12.88 ^{aB}
CV%	6.19%	4.53%	6.84%

¹ Means not followed by the same lowercase letters on the line and letters in the same column differ by Duncan test (α=0.05).

important environmental factor in the conservation of vegetables because it directly affects the natural processes of respiration, perspiration and other biochemical and physiological aspects of growth.

Conclusion

Under the conditions of the test, the temperature of 1.5°C slows senescence for Chrysanthemum 'Lona', but decreases the shelf life for chrysanthemum 'Garfield'. At a temperature of 2.5 to 5.0°C there was found to be decrease in the percentage of darkened ligules for both genotypes.

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