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Effect of different sucrose concentrations on the vase life of different protea cultivars (*Protea leucadendron and leucospermum*)

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Abstract

Many researchers have recommended carbohydrates supply as a remedy to improve vase life, however the actual application rates are seldom known. An experiment was laid out as a 4 x 4 factorial Structure in a randomized complete block design (RCBD); at Midlands State University Agricultural Laboratory to determine the most effective sucrose concentration in delaying leaf blackening in different protea varieties. Procedures were developed for the pulsing of protea varieties using different sucrose concentrations. Four protea varieties (High Gold, Tango, Scarlett Ribbon, and Safari Sunset) were treated with four different sucrose concentrations (0ppm, 30ppm, 40ppm, 50ppm) with the aim of determining the most effective sucrose concentrations in extension of vase life and delaying leaf blackening. Number of days taken to onset of leaf desiccation and leaf blackening were recorded. The results showed that, there was a significant interaction ($p<0.05$) on the effect of different sucrose concentrations and protea varieties on vase life. There were significant differences on the effectiveness of different sucrose concentration in extension of vase life of different protea varieties. It was concluded that 40ppm was the most effective sucrose concentration in almost all the varieties and Safari Sunset had the longest vase life of all the varieties.

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Introduction

Proteas are native to southern Africa and belong to the same family of plants (proteaceae) as the Australlian *bamksias*, *grevilleas* and *warathas*. *Protea leucospermum* include tango, high gold and scarlett ribbon and from *protea leucadendron* include safari sunset. Protease are commercially grown as cut flowers and also known as holiday flowering plants (Corr and Eistenberg, 1982). Protease can be used for many days in a fresh arrangement and can be redone for a dry look. Protease suits any occasion and can be used as cooperate gifts, hotel lobby decoration and holiday gifts (Rodney, 2001).

Among horticultural crops, cut flowers and other ornamentals have high respiration rates; hence they are susceptible to high deterioration. High respiration rate and rapid development of buds indicate the need for substantial carbon dioxide supply to the flower after harvesting (Terril, 1993). Starch and sugar stored in plants provide much needed food for the cut flower opening and maintenance. When a flower is cut, cell elongation will not continue long enough to achieve full opening of the buds and petals due to insufficient quantities of carbohydrates.

Vase life is one of the most important characteristics determining the commercial value of ornamental plants. It is the time taken by a flower in a vase before it starts to deteriorate, that is having droopy heads, leaf desiccation and premature wilting. Vase life is vital in cut flower production as it determines the market price of many flowers (Prasad and Kumah, 2003). The use of pulsing solutions can be exploited to extend the vase life of most flowers. Despite being grown as a cut flower, vase life of flower bearing stems of protease is limited by its susceptibility to leaf blackening. Hence the length of vase life differs with each variety depending on how susceptible the variety is to leaf blackening (Jones, 2005).

Vase life of flower bearing stems of protease is limited by its susceptibility to leaf blackening. Much has been debated on the possible effects of leaf blackening in protease and how this disorder can be prevented or controlled. According to Jones (2005), leaf blackening is a serious postharvest disorder which occurs within 3 to 5 days after harvest and dramatically reduces vase life of stems. It has a great effect on the marketability of the product. The cause of this blackening is not well understood, but researchers have established the link between carbohydrate stress and the onset of blackening.

The main reason for this leaf blackening is believed to be a low level of carbohydrates in the leaf cells. Recent researches have attempted to further elucidate the biochemistry of blackening and to find practical treatments to prevent the problem. According to Van Doom (2000), addition of sucrose in pulse solutions delays this blackening after harvest since it is due to carbohydrate demand by the flower head, however the concentration levels are seldom known. Hence this trial seeks to identify the most effective sucrose concentrations in extension of vase life and delaying leaf blackening in different protea varieties.

Methodology

The experiment was conducted at Midlands State University in the Agricultural Laboratory. Midlands State University is located in Gweru about 8,6km out of Gweru town, at an altitude of 1400m. Gweru town lies in the Midlands Province of Zimbabwe at a latitude of 19°26`60 East and longitude of 29°49`60s South with an average temperatures of 20-25°C.

The experiment was laid out as a 4 X 4 factorial structure in a randomized complete block design (RCBD).Factor A was sucrose concentration with four levels (0ppm, 30ppm, 40ppm and 50ppm). Factor B was protea varieties (High gold, Tango, Scarlet ribbon and Safari sunset). Blocking factor was natural light .

Treatments

T1-2ml/litre alcohol (1%) + 1 ml/ litre sodium hypo chloride + 0ppm sucrose

T1-2ml/litre alcohol (1%) + 1 ml/ litre sodium hypo chloride + 30ppm sucrose

T1-2ml/litre alcohol (1%) + 1 ml/ litre sodium hypo chloride + 40ppm sucrose

T1-2ml/litre alcohol (1%) + 1 ml/ litre sodium hypo chloride + 50ppm sucrose.

Flowers were picked using a sharp secateurs and sterilization of the secateurs was done between each plant using a sterilant (spore kill) to prevent spread of pathogens between plants. Harvesting was done in the morning and picked blooms were placed in buckets with fresh water and a bactericide. The buckets were placed in a shaded trailer to avoid direct sunlight and delivered to cool pack house.

Grading of flowers was done by clearing stems off dust and dirt, graded, stripped and bunched. Damaged leaves and suckers were removed from the stems. Stems were removed from the field buckets and placed in fresh clean buckets. They were then placed in a cold room at 4^{o}c in buckets containing bactericide which reduces bacterial growth.

Pulsing was done using the following solutions:
Alcohol 1% as a preservant applied at a rate of 2ml/litre in each treatment. Sodium hypo chloride as a biocide was applied at a rate of 1ml/litre in each treatment to reduce bacterial growth and also inhibiting stem clogging. Sucrose as an energy source at a rate of 30ppm, 40ppm, 50ppm was prepared using the following conversion ratio: 1000ppm = 1g/litre.0.03g/litre, 0.04 g/litre and 0.05 g/litre of sucrose (sugar) respectively were dissolved in borehole water and the mixture was prepared in 8 litre buckets for all the treatments. An electronic digital scale was used to measure the amount of sucrose in grams for each treatment. The respective amount of alcohol and sodium hypo chloride was measured using 10ml syringes. Stirring was done using a glass tube to allow even distribution of the pulse components.

Four (one bucket for each variety), 8 litre buckets were filled with borehole water for easy uptake of water by the flowers. 8mls of alcohol 1% and 4mls of sodium hypo chloride were added in each bucket. Sucrose was added as per treatment except for the control treatment. The solution was stirred using a glass tube and the solution was placed in 600ml bottles as per treatment. Before placement of pulse solution, the bottles were rinsed with liquid soap or bleach to remove bacteria. Flower stems were cut 2cm from the bottom to remove the hard coat on the stems and for the stems to have a fresh cut. Stems were placed in bottles as per treatment and the bottles were randomly placed on the table in the laboratory, the random number method was used to randomize treatments.

Vase life days of the different protea varieties were then recorded. Vase life is defined as the time taken by a flower in a vase before it starts deteriorating, which is leaf blackening, leaf desiccation and droopy heads. Average number of days taken by each variety and treatment was calculated to show the response on vase life of different protea varieties to different sucrose concentrations. Calculations of blackening rate and desiccation rate were used to determine vase life. For leaf blackening rate, number of affected stems per variety per treatment was calculated and mean number of affected stems showed the rate of affection. Leaf desiccation rate, number of affected stems per variety per treatment was calculated and mean number of affected stems showed the rate of desiccation per variety.

Data was analyzed using Genstat Discovery version. Separation of means where there was significant difference was done using Fischer's Least Significant Difference (LSD) method. The data was presented graphically.

Results and discussion.

Effects of different sucrose concentrations and variety on the vase life of protease

There was a significant interaction between the different sucrose concentrations and protea varieties on their effect on vase life ($p>0.001$). In all varieties there was a general increase in vase life as the sucrose concentrations increased. Tango, Scarlet ribbon and High gold varieties recorded their greatest vase life days in 40ppm sucrose concentration with averages of 18.25, 19.97 and 13.6 days respectively. Safari

sunset recorded its greatest vase life days of an average of 21.22 days in a sucrose concentration of 50ppm. The lowest vase life in all the varieties was recorded in the control with 0ppm sucrose concentration.

The different protea varieties had different vase life durations in all the four sucrose concentrations possibly due t their differences in their genetic makeup resulting in their different deterioration rates. According to Armitage, 1991, the overall quality and post-harvest performance of fresh cut protease depend on variety and conditions in the field. Corr and Eisenberg 1982 reported that, protea cut stems are living organs and continue living after harvest, with their vase life depending on the rate of respiration and rate of water loss. At harvest, the levels of carbohydrates drops rapidly due to this continued respiration, thus reducing the ability of the flower to absorb sufficient quantities of water hence drying the leaf cells. Addition of sugars in pulse solutions can supplement carbohydrates to cut stems and increase their vase life, though they might have negative effects to some varieties especially those that are susceptible to fungi and bacteria attack (Hammer, 1980).

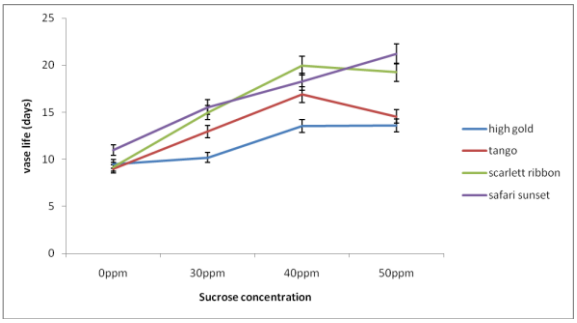

Fig. 1. interaction effect of different sucrose concentrations and protea varieties on vase life.
Grand Mean= 14.344, CV% = 3.7 ,LSD (0.05)= 1.1242.

In the current experiment, the supply of sugars to cut protea stems promoted flower opening and retarded flower senescence as noted by reduced leaf desiccation and leaf blackening in Safari sunset and Scarlett ribbon pincushions which were stored for 20 days. However sucrose vase solutions did not improve vase life of high gold pincushion as it was stored only for 9.75 days. This was probably due to the morphological structure of the variety, which is woody as compared to others. Stevens (2002) described high gold as a woody variety, this can contribute to restriction of absorption of water thus leading to the drying of the leaf cells, hence reduced vase life.

Also the vascular bundles of this variety are thick, inflexible and prone to blockage and bacterial attack (Halevy and Mayak, 1979); hence the stems were unable to draw water due to air or bacterial growth which reduces water uptake and this blocks xylem vessels leading to water stress. According to Hardenburg (1968), this was expressed in the form of early wilting of leaves or flowers as a result of premature loss of cell turgidity and this might appear when water uptake and transpiration are out of balance during a lasting period of time. This finally leads to an unrecoverable situation and the premature end of flower vase life (Wouter, 2003). Also the *High gold* variety had an increased transpiration surface of the petals on open flowers. Addition of high sucrose concentrations to this variety accelerated petal desiccation, resulting in decreased inflorescence life of the flowers (Downs, 1988).

In cut flowers bearing florets that develop sequentially after harvest, there is competition among florets for the available carbohydrate. Immature flower buds fail to develop without an additional carbohydrate supply. In *Safari sunset* pincushion, harvesting of the flower resulted in cessation of flower bud opening and applying sucrose was essential to continued bud opening. This was shown by the ability of the variety to store for 20 days and bud opening during the long run. Sucrose treatment also increased the longevity of individual florets, perhaps by increasing the pool of respiratory substrate and lowering the osmotic potential of the petals (Kofranek and Halevy, 1976).

The longevity of cut inflorescences treated with 30ppm sucrose was 13.5 days and those treated with 40 ppm sucrose was nearly twice as long. This shows that the pulse treatment of 30ppm was not as effective as continuous application but certainly provided a commercially useful increase in vase life. Presumably, the total amount of sucrose absorbed by inflorescences during the post-harvest period was greater when sucrose was continuously applied at low concentration that when it was provided as a high-concentration of 50ppm pulse. The intermediate vase life (18 days) of flowers that were pulsed with 50ppm sucrose indicates that this pulse treatment could be useful (Hackett and Sachs, 1985). In cut proteas, the beneficial effects of sucrose include reduced petal sensitivity to ethylene, which delays the onset of climacteric ethylene production and senescence (Woltering, 2002).

The 50ppm sucrose solution would potentially supply sugar at two times the rate required, and the oversupply could explain why leaf blackening was noted. Blackening is absent when the oversupply of carbohydrates arises from endogenous production. Possibly, the different sources lead to carbohydrate accumulation in different cell compartments or tissues. Features of carbohydrate pattern itself in Protea are the relatively low levels of sucrose and starch, as well as the high concentration of polgalaton and its complete unavailability for re-metabolism (Pun, Shimuzu, Tanase and Ichimura, 2005). Had it been accessible, it could have doubled the survival time. Because the polyol fraction was not used, osmotic changes in the cell due to carbohydrate oversupply of exogenous sucrose, are unlikely to be the cause of loss of membrane function, in that the osmotic behavior should be dominated by the polyol in situations. Indeed, this osmotic buffering by inert polyol may be part of the adaptation of many of the protea species to a dry habitat (Bieleski, 1992). While the polyol would thus protect against rapid desiccation under natural growth conditions, its unavailability as a carbohydrate supply appears to contribute to the rapid death of the leaves of harvested protea flower stems.

The control showed the least number of days in all treatments with an average of 10.75 days this could possibly be due to the absence of supplementary food on all varieties. Generally, pulse solutions should have a source of food, biocide, and a bactericide; however it is important to note that some food sources promotes growth of microbes and this might be devastating among varieties (Sacalis, 1993).

Conclusion

The findings of this study would normally indicate the need for vase life solutions containing carbohydrates to prevent leaf blackening in proteas. Sugar-containing vase solutions sometimes do alleviate the disorder, but it is apparent that proteas are also sensitive to sugar concentrations higher than 40ppm which may lead to accelerated leaf blackening. This was shown on the findings of this study when a sucrose concentration of 50ppm reduced vase life of proteas to an average of 15 days in all varieties. Hence a concentration of 40ppm is beneficial to most varieties and was best on Scarlett ribbon and safari sunset showing an average of 20 days.

The practical implications of this study for producers of proteas that are sensitive to leaf blackening are several. Flowers should be cooled as rapidly as possible after harvest to reduce respiration and development of the inflorescence. Protea growers are therefore recommended to use pulse solutions containing 40ppm sucrose as it increased vase life of *Scarlett ribbon* and *Safari sunset* with an average of 17.5 days.

The fact that blackening is substantially accelerated in the dark and under high sucrose concentrations indicates a means by which growers or breeders could select cultivars of species such as *P. eximia* and P. *neriifolla* that are less affected by the problem.

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References

Armitage AM. 1991. The Georgia Report - Stage of flower development at harvest. The Cut Flower Quarterly **3(1),** 13

Bieleski RL. 1992. Sugar alcohols in: A. Loewus and W. Tanner (eds.). Plant carbohydrates I. Intracellular carbohydrates. Encyclopedia of Plant Physiology, NS vol. 13A. Springer-Verlag, Berlin.

Corr B, Eisenberg. 1982. Improving the post-harvest handling of holiday flowering plants. St. Flor. Assoc. Bul.

Downs CG, Reihana M, Dick H. 1988. Bud opening treatments to improve gypsophilla quality after transport. Scientia Hort 34.

Halevy AH, Mayak S. 1979. Senescence and postharvest physiology of cut flowers Part 1. Hort Review 1, Janick, J. ed. AV1, Westport.

Hammer PA. 1980. Other Flowering Pot Plants. R. A. Larson.ed. Introduction to Floriculture. New York. Academic Press Inc.

Hardenburg RE, Watada AE, Wang CY. 1986. The commercial Stage of Fruits, Vegetables and Florist and Nursery Stocks.

Kofranek T and Halevy B. 1976. Sucrose pulsing or Gladiolus stems before storage to increase spike quality. Hort Science **11,** 572- 573.

Prasad A, Kumah V. 2003. Commercial Floriculture, Agribios.

Pun UK, Shimuzu H, Tanase K, Ichimura K . 2005. Effect of sucrose on ethylene biosynthesis in cut spray carnation flowers. Acta Hort (ISHS), 669 .

Sacalis JN . 1993. Cut Flower Prolonging Freshness – Post production Care and Handling 2nd ed, Ball Publishing, Batavia. IL – USA.

Stevens IA. 2002. Sucrose pulsing on cut flowers.

Terril A. Nell. 1993. Flowering Potted Plants Prolonging Shelf Performance, Ball Publishing, Batavia, USA.

Van Doom WG. 2000. http;//www.actahort.org.

Woltering EJ. 2002. Effects of ethylene on ornamental pot plants; a classification. Scientia Hort

Wouter G. 2003. Senescence and postharvest physiology of cut flowers Part 2. Hort Review 1, Janick, J. ed. AV1, Westport.