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EFFECT OF CALCIUM FOR PRODUCING HIGH QUALITY FLOWERS IN *Gerbera jamesonii* TO EXTEND THE VASE LIFE

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ABSTRACT

Gerbera (*Gerbera jamesonii)* is an ornamental cut flower which possesses high demand on commercial scale in Sri Lanka. But bent neck due to low stem thickness is a major issue associated with gerbera in floral decorations. Therefore present study was aimed to find out the best calcium concentration to produce of high quality stem of *Gerbera jamesonii* as a pre-harvest treatment. The Experiment was conducted at the Gerbera plant house located at Botanic Gardens, Henarathgoda, Gampaha by using potted (pot mixture consists of 1:1:1 sand: coir dust and half burned paddy husk) tissue cultured Gerbera plants, i.e. Variety Fredi. The experiment was arranged as a Completely Randomized Design (CRD) with six treatments randomized in three replicates. Treatments were the six different calcium concentrations (g), i.e. 0 (control), 0.25, 0.15, 0.1, 0.2 and 0.3 applied to the plants in every three weeks. All cultural practices were done similar to other plants. Once a week measurements were taken on height of the stem, stem thickness, number of leaves per plant as well as the head diameter. The data obtained were tabulated and analyzed subjected to the Analysis of Variance (ANOVA) procedure of Statistical Analysis System (SAS). Duncan's New Multiple Range Test (DNMRT) was performed to compare the differences among treatment means at p=0.05.Stem thickness (mm) had significant differences ($p<0.05$) among different calcium concentrations tested. The highest stem thickness was recorded from the highest calcium concentration applied treatment, i.e. 0.3g whiniest the lowest from no calcium applied treatment, i.e. control. Head diameter was not significantly different ($p>0.05$) within calcium levels of 0.15 and 0.2. Furthermore the highest stem height, head diameter as well as number of leaves per plant recorded from the highest calcium concentration applied plants. However, number of leaves per plant was not significant different ($p<0.05$) among high calcium concentrations, i.e. 0.3, 0.2 and 0.1. Overall results showed that

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the application of 0.3g of calcium was the most effective treatment to produce of high quality stem of *Gerbera jamesonii*. Overall results showed that the application of 0.3g of calcium was the most effective treatment to produce of high quality stem for prolonging the vase-life and improving the postharvest quality of *Gerbera jamesonii*.

Keywords: Gerbera jamesonii, calcium concentrations, stem thickness, quality flowers

INTRODUCTION

Gerbera daisies (*Gerbera jamesonii*) is the fifth-most used cut flower worldwide belonging to family Asteraceae (Choudhary and Prasad 2000). Gerbera has numerous number of hybrids with different shades of attractive colours. It flowers year-round in warm and humid conditions (Aderson et. al., 2011). Good plant growth, maximum number of flowers coupled with good stalk length and flower size are some of the global criteria for cut flower trade (Nair et al., 2002; Gaurav et al., 2005). Gerbera production under protected environment is highly recommended to achieve better productivity and quality of flowers as it protects against rain, wind and reduces the attack of pests and diseases (Guiselini et al. 2010). Keeping quality is an important parameter for evaluation of cut flowers for both domestic and export markets. Stalk bending is one of the major problems in gerbera cut flowers (Dissanayake et al., 2009). Although the gerbera plant is an ornamental cut flower. Cut flower needs strong stems for commercial purposes. Flower stalks are long, thin and leaf-less. The thickness of stem in gerbera plant is law. This is the biggest problem in cut flower industry. There is no evidence to improvement of gerbera stem thickness. It is mostly found inhabit evaluation of cut flower quality, for both domestic and temperate and mountainous regions. Gerberas are grown export markets and local market. One of the problems when doing floral decorations by using these cut flowers is bent neck due to law thickness. Therefore it is important to find out a suitable fertilizer mixture to produce of high quality stem of *Gerbera jamesonii* as pre-harvest treatment. Calcium is considered to be the key element in the primary walls of plant cells (Pilbeam and Morely 2007). Cell wall strength and thickness are increased by calcium addition. Calcium is a critical part of the cell wall that produces strong structural rigidity by forming cross-links within the pectin polysaccharide matrix. Research in postharvest physiology suggests that Ca may be involved in control of membrane stability and senescence of plant cells (Leshem, 1992; Paliyath and Droilldard, 1992; Torre et al., 1999; Rubinstein, 2000). Alterations of the intercellular and/or cytosolic concentrations of Ca may trigger either catabolism or remodeling and the turnover process of the cell membrane components. Calcium can be transported in and out of cytosol through proton pumps, depending on the electrical gradient across membranes (Ferguson, 1984; Leshem, 1992). In the cytosol, Ca is maintained at very low concentrations by intracellular binding or uptake into organelles (Ferguson, 1984; Leshem, 1992). It has been hypothesized that extracellular concentrations of Ca

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may have inhibitory effects on senescence (Ferguson, 1984; Leshem, 1992). Therefore, close regulation of Ca concentration in the cytosol, the external surface of the plasma membrane and cell wall may be required to delay senescence (Ferguson, 1984). These postharvest responses were most probably due to Ca accumulation in scrapes and hormone-like activity of Humic acid. Cold storage facilitates the preservation of commodities and aims at maintenance of the harvested cut flower in 'fresh' condition, markedly affecting the consumer acceptability thus, rendering storage as an important procedure in supply and demand regulation (Singh et al.,2001). In the light of this situation it is important to find out suitable vase life solution for Gerbera flowers. Therefore, the work embodied in this paper aimed to find out a solution to improve a quality flower production by using different concentrations of calcium and other related characters of cut gerbera flowers.

MATERIALS AND METHODS

Experiment I

Experimental design and treatments

The experiment was arranged as a Completely Randomized Design (CRD) with six treatments randomized in three replicates. Treatments were the six different calcium concentrations (g), i.e. 0 (control), 0.25, 0.15, 0.1, 0.2 and 0.3 applied to the plants in every three weeks as given below.

Treatments	Composition
T1	Control + pot mixture no paddy husk
T2	0.25g of Calcium Nitrate + pot mixture
T3	0.15g of Calcium Nitrate + pot mixture
T4	0.1g of Calcium Nitrate + pot mixture
T5	0.2g of Calcium Nitrate + pot mixture
T6	0.3g of Calcium Nitrate + pot mixture

Planting materials and handling

The Experiment was conducted at the Gerbera plant house located at Botanic Gardens, Henarathgoda, Gampaha by using potted (pot mixture consists of 1:1:1 sand: coir dust and half burned paddy husk) tissue cultured Gerbera plants, i.e. Variety Fredi. Plants were allowed to grow under normal conditions, which are similar to other plants. All cultural practices were done similar to other plants.

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Measurements

Once a week measurements were taken on height of the stem, stem thickness, number of leaves per plant as well as the head diameter.

Experiment II

The Gerbera flowers were harvested early in the morning and covered with plastic package and immediately transported to the laboratory. Same size flowers were selected for the experiment and the stems were re –cut leaving about 36 cm from the flower head prior to placing them in the treatment solution. The flowers were kept in at room temperature of 30° C. Same size glass bottles were used to fill different treatment solutions in the experiment as given below.

Treatment	Solution
T1	Glucose 15g + 200ml distill water
T2	Glucose 15g + 200ml distill water + 5g calcium nitrate
T3	Glucose 15g + 200ml distill water + 7g calcium nitrate
T4	Glucose 15g + 200ml distill water + 9g calcium nitrate
T5	Glucose 15g + 200ml distill water + 11g calcium nitrate
T6	Glucose 15g + 200ml distill water + 13g calcium nitrate

Measurements

During the vase life of Gerbera flowers measurements were taken on thickness of the stem, flower (head) diameter, fresh weight of the stem, neck bending date as well as ending date of the vase life. Following scale was used to evaluate the quality of Gerbera flowers during the vase life.

1- Wilted flower with discolored petals.
2- High level of petal discoloration with moderate wilting
3- Slight petal discoloration with moderate wilting
4- Full bloom with no petal discoloration and slight wilting
5- Full bloom with no petal discoloration and wilting (De Silva et al., 2013).

Statistical Analysis

The data obtained were tabulated and analyzed subjected to the Analysis of Variance (ANOVA) procedure of Statistical Analysis System (SAS). Duncan's New Multiple Range Test (DNMRT) was performed to compare the differences among treatment means at p=0.05. Correlation

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analysis was used to determine the strength of the relationships between measured parameters during the vase life.

RESULTS AND DISCUSSION

Qualitative characteristics of Gerbera

The highest stem thickness was recorded from the highest calcium concentration applied treatment, i.e. 0.3g whilst the lowest from no calcium applied treatment, i.e. control. Calcium considered to be the key element in the primary walls of plant cells (Zhong, 2002). Gerbera flower quality parameters such as stalk length, head diameter, etc can be changed by growing seasons, cultivars and production techniques such as in soil or soilless culture systems (Moltay *et. al*., 1998). Raese (1987) also reported that calcium treatments increased the growth of apple and pear stems. Among different treatments testes the highest stem height was recorded from T6, i.e. 0.3g of Calcium Nitrate and the lowest was from 0.1g of Calcium Nitrate applied treatment. The application of calcium raises plant height (Wilkins, 2005).

Smolen and Sady (2008) reported that the Ca application caused an increase in the concentration of N-total in storage roots in comparison with control plants. Similar results were obtained in present study where total Ca in stem height increased when sprayed with higher level of Ca. Auxin causes an increase in plant height due to stimulation of cell extension and softens the cell wall by increasing plasticity (Davies, 1995).

The head diameter is very important parameter as it is desirable to produce the biggest flowers for floral arrangements. Head diameter was not significantly different ($p>0.05$) within calcium levels of 0.15 and 0.2. On the other hand the results clearly showed that the greatest flower diameter was obtained from the highest Calcium Nitrate concentration applied treatment whist the lowest was from control (Table 1).

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Table 1: Effect of different concentrations of calcium nitrate on qualitative characteristics of Gerbera

Treatment	Stem thickness (mm)	Number of leaves	stem height (cm)	Head Diameter (cm)
T1	3.20^{d}	4.73^{b}	23.65^{b}	7.20^{d}
T2	4.51^{b}	7.38^{ab}	23.51^{b}	9.43^{b}
T3	4.10^{c}	7.18^{ab}	22.25^{bc}	8.66^{c}
T4	4.08^{c}	7.68^{a}	21.40^{c}	8.50^{c}
T5	4.35^{b}	9.16^{a}	23.99^{b}	9.50^{b}
T6	4.78^{a}	7.95^{a}	26.53^{a}	10.20^{a}

Note: *Means with same letters along the columns are not significantly different at $p < 0.05$. Measurements are the means of two replicates.*

The increase in flower diameter reflected the range of flowers opening during the displaying time. These results are coincided with the studies of El-Saka 2002. The overall observations showed that the calcium treatments caused faster growth and development of buds on Gerbera plants.

Effect of different concentrations of calcium nitrate on Vase life of Gerbera

According to the study findings the calcium nitrate cause to enhance the vase life of cut Gerbera flowers when compared to the control (non calcium nitrate) of the experiment. With extending the postharvest longevity similar results obtained from Sunflowers, Dianthus (Mayak et al., 1978), Gerbera (Gerasopoulos and Chebli, 1999), and Roses (Michalczuck et al., 1989; Torre et al., 1999). Vase life ending date was not significantly different ($p<0.05$) within calcium levels of 7 and 9. Vase life ending date had significant differences ($p<0.05$) among different calcium concentrations applied treatments. T6 showed much higher vase life when compared to other treatments. On the other hand, non calcium nitrate applied treatment, i.e control showed a shorter vase life of 4 days (Table 2).

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Table 2: Effect of different concentrations of calcium nitrate during vase life of Gerbera

Treatments	Stem thickness	Vase life ending date	Fresh weight of the head	Fresh weight of the stem	Head diameter during vase life
T1	3.14^{c}	4^{e}	2.25^{a}	4.93^{a}	9.37^{a}
T2	3.92^{b}	6^{d}	2.27^{a}	4.99^{a}	9.38^{a}
T3	3.72^{b}	7^{c}	1.92^{a}	5.18^{a}	8.87^{a}
T4	4.87^{a}	8^{c}	2.60^{a}	5.11^{a}	8.87^{a}
T5	4.45^{a}	11^{b}	2.69^{a}	7.11^{a}	9.85^{a}
T6	4.65^{a}	13^{a}	3.56^{a}	7.98^{a}	9.60^{a}

Note: *Means with same letters along the columns are not significantly different at $p < 0.05$. Measurements are the means of two replicates*

Preharvest application plus all postharvest treatments increased the vase life of Gerbera when compared to Ca pretreatment in both seasons. These results are in harmony with the studies of Bolivar et al., 1999 on cut roses. That study indicated that the longest vase life was obtained with the treatments of 13g Calcium Nitrate + 15g glucose + 200ml distilled water with 13 days. It was considered as the most effective treatment for increasing vase life

Results clearly indicated the high calcium application cause to enhance fresh weight of the Gerbera stem. Therefore application of 13g of calcium nitrate for commercial usage can be recommended to obtain high fresh weight of stem in vase life. This is also due to the reason for low neck bending in vase life. The increase in flower diameter reflected the range of flowers opening during the displaying time. These results are coincided with the studies of El-Saka, 2002. Large differences were found in flower diameter among different cultivars (Hossain et al., 2015; Mehraj et al., 2014; Jamal Uddin et al., 2014; Gotz, 1983).

Correlation Analysis

When linear correlation analysis was performed for the overall data set, there was a highly significant ($p<0.0001$) positive correlation between thickness of the stem and fresh weight of the Gerbera flower (head). On the other hand there was a significant ($p=0.05$) positive correlation between head diameter and fresh weight of the stem. Furthermore, fresh weight of the stem positively correlated with the vase-life of Gerbera flowers (Table 3).

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Table 3: Linear correlation coefficients between Head Fresh Weight (HFW), Stem Fresh Weight (SFW), Stem Thickness (ST), Head Diameter (HD), Neck Bending (NEB) and Vase Life (VL) of *Gerbera jamesonii*

	HFW	SFW	ST	HD	NB	VL
HFW	-					
SFW	0.02211^{ns}	-				
ST	0.88005***	-0.00013ns	-			
HD	-0.38367ns	0.72936*	-0.44773ns	-		
NB	-0.28967ns	-0.21823ns	-0.22759ns	-0.17579ns	-	
VL	0.03223ns	0.64474*	0.21352ns	0.35483ns	-0.09622ns	-

Note: ns- non significant at p=0.05;* significant at p<0.05;** significant at; p<0.01;*** significant at p<0.0001

It has been cited that "bent neck is caused by insufficient flower stem hardening, maturation of the stem tissue below the harvest flower or level of dry matters and water content of flowers" (Danaee, et al., 2011). The short vase life of cut flowers was caused by poor water relations in association with a lower water uptake (probably due to growth of microbes and vascular blockage), high rate of transpiration and water loss. Senesce of ornamentals caused by ethylene action, Carbohydrate depletion microorganism like factors. Calcium Nitrate can be used to extend the postharvest life. Calcium Nitrate can extend the vas life by reducing oxygen free radicals, this has been successfully tested with Family Asteraceae (Kazemi et al, 2012). Vase life termination for many cut flowers is characterized by wilting (He et al., 2006). The water balance is a major factor determining the quality and longevity of cut flowers (Acharya et. al, 2010). It is influenced by water uptake and transpiration and balance between two mentioned processes (De Silva, 2013).

CONCLUSION

The highest stem thickness was recorded from the highest calcium concentration applied treatment, i.e. 0.3g within the lowest from no calcium applied treatment, i.e. control. Head diameter was not significantly different (p<0.05) within calcium levels of 0.15 and 0.2. Furthermore the highest stem height, head diameter as well as number of leaves per plant recorded from the highest calcium concentration applied plants. However, number of leaves per plant was not significant different (p<0.05) among high calcium concentrations, i.e. 0.3, 0.2 and 0.1. It can be concluded that among all preservatives application of calcium nitrate successfully

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has improved qualitative characteristics of cut gerbera flowers. Keeping quality (vase life) of Gerbera cut flowers have been improved noticeably with high concentration of calcium nitrate. Overall results showed that the application of 0.3g of calcium was the most effective treatment to produce of high quality stem for prolonging the vase-life and improving the postharvest quality of *Gerbera jamesonii*.

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