“Effect of post harvest preservatives on vase life of chrysanthemum (*Dendranthema grandiflora*) cv. Hybrid-1”

THESIS

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In

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FLORICULTURE AND LANDSCAPE ARCHITECTURE

by

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CERTIFICATE- I

This is to certify that the thesis entitled **"Effect of post harvest preservatives on vase life of chrysanthemum (*Dendranthema grandiflora*) cv. Hybrid-1"** submitted in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** in **HORTICULTURE (Floriculture and Landscape Architecture)** of Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya Gwalior (M.P.) is a record of the bona-side research work carried out by **Mr. ANIL KUMAR AJNERIYA** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and Director of Instruction.

No part the thesis has been submitted for any other degree or diploma or has been published. All the assistance and help received during the course of this investigation has been acknowledged by the scholar.

Signature

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CERTIFICATE - II

This is to certify that the thesis entitled **"Effect of post harvest preservatives on vase life of chrysanthemum (*Dendranthema grandiflora*) cv. Hybrid-1"** submitted by **Mr. ANIL KUMAR AJNERIYA** to the Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, in partial fulfillment of the requirements for the degree of **Master of Science** in **Horticulture** in the **Department of Floriculture and Landscape Architecture,** has been, after evaluation by the External Examiner and approved by the Student's Advisory Committee after an oral examination on the same.

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Dean of the college (signature) ……

Director Instruction (signature) ……

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Place: Mandsaur
Date: …/…/……

(Anil Kumar Ajneriya)

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List of Symbol

Symbol	Abbreviation	Stands for
%	-	Percentage
&	-	And
/	-	Per
@	-	At the rate of
^{o}C	-	Degree Celsius
-	ANOVA	Analysis of Variance
-	C.D.	Critical Difference
-	Cm	Centimeter
-	cv.	Cultivar
-	d. f.	Degree of Freedom
-	*et al.*	et-alai
-	Fig.	Figure
-	G	Gram
-	*i.e.*	That is
-	Kg	Kilogram
-	M. S. S.	Mean Sum of Square
-	Max.	Maximum
-	Mg	Milli Gram
-	Min.	Minimum
-	ml	Milliliter
-	No.	Number
-	NS	Non Significant
-	RH	Relative Humidity
-	RVSKVV	Rajmata Vijyaraje Scindia Krishi Vishwa Vidhyalaya
-	S.Em	Standard error of mean
-	Sig.	Significant
-	spp.	Species
-	TSS	Total Soluble Solids
-	Var.	Variety
-	*Viz.*	(Videlicet) Namely

Chapter-I

INTRODUCTION

Chrysanthemum (*Dendranthema grandiflorum*) is one of the popular and commercial cut flowers that grown on a large scale in the world (Anjum *et.al.* 2007). It is one of the most common cut flowers and of the highest economic importance in the floriculture industry for decoration and adornment (Kafi and Ghahsareh, 2009).

Chrysanthemum is a leading commercial crop grown for cut and loose flowers and also as a pot plant. It is a native of China and belongs to the family Asteraceae. It is commonly known as Autumn Queen. Chrysanthemum is highly attractive and charming short day plant, which behaves both as an annual as well as perennial flowering herb (Arora, 1990). Cut flowers of chrysanthemum are widely used in two types namely, standard (one flower on the stem) and spray (multiple flowers on the stem) and that is commercially propagated by rooted cuttings and it has a shallow but fibrous root system which is sensitive to water logging and prone to attack by diseases. In general, it requires high light intensity and plants grown under reduced light become taller have strong stem and larger leaves. Nowadays, cut flowers occupy an important position in the local and foreign markets because of their importance as a source of national income that is very popular in floral bouquets and flower arrangement. Cut flowers are previous products of horticulture, maintaining good quality of cut flowers and extending the vase life, are considered important and practical for having acceptable products for the markets. For this reason, a considerable number of studies have been undertaken for this purpose (Redman, *et al*, 2002; Macnish *et al*, 2008 and Solgi *et al*, 2009, Zencirkiran, 2005; Zencirkiran, 2010).

Vase life is an important parameter for evaluation of cut flower quality, for both domestic and export markets. The techniques of prolonging the vase life of flowers will be a great asset to the growers and users (Nair *et al.* 2003).

The vase life is differing among various species and cultivars of chrysanthemum, which is one of the most valuable characteristics determining its quality, satisfying consumer preferences and the commercial value. Short post harvest life is one of the most important problems of the cut flowers. Using vase preservatives in vase solutions is one of the most common methods for prolonging cut flowers' vase life.

Vase life of cut flowers is mainly affected by two main factors, namely ethylene which accelerates the senescence of many flowers and microorganisms which cause vascular blockage and thus reduce the vase life of cut flowers (Van Doorn and Witte, 1997; Van Doorn, 1994, Zencirkiran, 2005; Zencirkiran, 2010). The internal factors which are responsible for the keeping quality of cut blooms are the rate of water absorption and transpiration. Respiration is another internal factor that affects the life of cut flower. Some environmental factors such as temperature, relative humidity and wind velocity also affect cut flower life (Meman and Dabhi, 2006). A floral preservative usually is a complex mixture of sucrose (sugar), acidifier, an inhibitor of microorganisms and also an ethylene action or synthesis inhibitor like STS and SA. Addition of chemical preservatives to the holding solution is recommended to prolong the vase-life of cut flowers. All holding solutions must essentially contain two components viz., sugar and germicides. The sugars provide a respiratory substrate, while the germicides control harmful bacteria and prevent plugging of the conducting tissues. Silver nitrate ($AgNo_3$) is a well known germicide which generally used for control of germs that present in xylem of the plants, so after $Agno_3$ application in holding solutions block then result xylem vessels will be clean and then plants easily uptake the solution.

Sucrose alone has not been usually used because sucrose treatment without germicides promotes bacterial proliferation, leading to shortening of vase life. However, if treatment with sucrose alone extends vase life of a cut flowers, shortage of carbohydrates is considered to be involved in short vase life. Besides citric acid may kill bacteria of a solution, for an acidifier, citric acid is readily available and cheap. Citric acid content of commercially available lemonade and other juice products varies widely, ranging from 0.03 to 0.22 g/oz (Penniston *et. al.*, 2008).

In recent years scientist have given due attention to the idea of post harvest management most important factors in improving the vase life and flower quality with the application of different holding solution in various ways.

The holding solutions generally modify the physiological processes of flower and ultimately affect the vase life and quality of blooms. Several holding solutions have been widely used in many flower crops. The uses of citric acid, sucrose, $GA_{3,}$ kinetin and silver nitrate have been reported to be remarkably successful in improving vase life and quality of several flower and ornamental crops.

Keeping in view the above facts and the paucity of research on these aspects in the Malwa region of Madhya Pradesh, the present study is proposed to be conducted with the following objectives.

1. To study the effect of different preservatives on vase life of chrysanthemum.
2. To study the effect of different preservatives on post harvest quality of chrysanthemum.
3. To study the effect of different preservatives on biochemical changes.

Chapter-II

REVIEW OF LITERATURE

Chrysanthemum is second important cut flower in the world after rose. One of the most important problems is short life after harvest. Producers need to increase longevity of these flowers with using post harvest preservatives. With the aim of achieving the best chemical treatments to increase flower vase life of chrysanthemum as well as other flowers. Research work done so for in India and abroad has been reviewed in this chapter.

Effect of post harvest preservatives on vase life and quality of Chrysanthemum

Singh and Arora (1995) reported that cut stems of chrysanthemums maintained very high water potential of flowers and leaves when held in solutions of 8-HQC, $AgNO_3$ and chrysal which improved the vase life of flowers.

Hayashi and Todoriki (1996) observed that aqueous solution (2%) of sucrose, glucose, fructose or maltose delayed bloom wilting and foliage yellowing of cut chrysanthemums (cv. Seishu) caused by gamma irradiation at 750 Gy. Holding chrysanthemum cut flowers in a sucrose solution before and during irradiation did not influence vase life, but holding the cut flowers in a sucrose solution following irradiation prolonged vase life. The results suggest that sugars reduce radiation-induced physiological deterioration of chrysanthemums.

Lee JongSuk *et al.* (1996) conducted an experiment to see the effects of pretreating cut chrysanthemum (cultivars Kyungsubang and Chunkwang) flowers with silver thiosulfate (STS; 2 mM for 30 min) or Chrysal RVB (0.2% for 16 h) on the vase life of flowers in various holding solutions were investigated. A solution containing 3% sucrose + 150 p.p.m. hydroxyquinoline sulfate (HQS) + 50 p.p.m. AgNO3 solution also improved the quality (FW and flower diameter) of flowers. In all treatments, ethylene production was low. Pretreatment of Chunkwang flowers with STS or Chrysal RVB extended vaselife, particularly for flowers held in the sucrose + HQS + $AgNO_3$; carbonated water (20 or 30%) was also a good holding solution for promoting vase life.

Yakimova *et al.* (1996) conducted an experiment with open chrysanthemum flowers, cv. Westland, cold stored buds of cv. Walusa and cut roses, cv. Sonia. The treatments were provided by holding solutions where sucrose, Glean-75 and their combinations were used. Treatment Glean-75 + sucrose on cut roses cv. Sonia result with respect of longer vase life and good quality of the flowers. The dynamics of α-amylase and invertase were associated with the phases of development. Decrease of the activities in controls during the phase of senescence was shown both for chrysanthemums and roses.

Bhat *et al.* (1999) conducted an experiment to see the effects of various holding, pulsing (16 h) and packaging treatments on the vase life of cut Chrysanthemum var. Mountaineer and Kundan observed that among holding solutions 8- hydroxyquinoline (250 ppm) + sucrose (1.5%) show the best result with respect of vase life, flower diameter and fresh weight loss, while the best pulsing solution was benzyladenine (0.025 mM) + silver thiosulfate (0.4 mM) + 8-hydroxyquinoline (250 ppm) + sucrose (5%) and the best packaging treatment was cold storage (4 ± 1^0 C) for 24 h after wrapping in cellophane.

Brackmann *et al.* (2000) conducted an experiment to see the effects of preservative solutions, distilled water (control), 2% sucrose, 200 ppm 8-hydroxyquinoline (8-HQ), 100 ppm aminoethoxyvinylglycine (AVG), 2% sucrose + 200 ppm 8-HQ, 2% sucrose + 100 ppm AVG and 2% sucrose + 200 ppm 8-HQ + 100 ppm AVG, on postharvest quality of cut chrysanthemums, *D. grandiflora* [*Dendranthema morifolium*] cv. Snowdon were evaluated. Data revealed that most of the solutions increased flower weight during storage. The postharvest quality of *D. grandiflora* was best in 8-HQ and sucrose + 8-HQ.

Talukdar *et al.* (2004) studied that the effects of holding solution on the vase life and conductivity of chrysanthemum (*Dendranthema grandiflorum* [*D. morifolium*]) cultivars Golden Giant, Diamond Jubilee and Snow Ball were used. The chemicals used were $AgNO_3$ (25, 30 and 35 ppm) and $Al_2(SO_4)_3$ (0.1, 0.2 and 0.3%) and it was observed that $AgNO_3$ at 25 ppm, $Al_2(SO_4)_3$ at 0.1%, and $AgNO_3$ at 30 and 35 ppm were beneficial for improving the postharvest life of cut chrysanthemum flowers.

Singh *et al.* (2005) conducted a trial to evaluate the keeping quality of *Chrysanthemum morifolium* flowers taken from potted plants subjected to different nitrogen (0, 10, 20 and 30 g/pot) and potash levels (0, 8, 16 and 24 g/pot) as well as pinching treatments (0, 10, 20 and 30 days after repotting). The effects of holding solution, i.e. water (control), sucrose (0.5%) and sodium benzoate (0.5%), on cut flower quality were also studied. Maximum vase life (12.15-12.50 days) was recorded with 0.5% sucrose, followed by water and sodium benzoate, when flowers were taken from potted plants that received 20 g N/pot. Application of 16 g K/pot was equally effective in improving the vase life of flowers dipped in 0.5% sucrose solution. However, dipping flowers in sodium benzoate failed to enhance vase life significantly.

Verma *et al.* (2007) conducted an investigation to study the influence of nitrogen (0, 20, 40, 60 g/m2) and potassium levels (0, 10, 20, 30 g/m2) on postharvest quality of cut flowers of chrysanthemum (Dendranthema grandiflora [Chrysanthemum morifolium]) cv. Snow Ball, evaluated in holding solutions (2% sucrose in combination with 200 ppm 8-HQC, 1500 ppm aluminium sulfate, a combination of both and in distilled water). Maximum vase life (19.27 days) and amount of solution consumed (263.8 ml) was recorded with 0 g N and 20 g K/m2 treatment in 2% sucrose in combination with 200 ppm 8-HQC, whereas, minimum were recorded with 60 g N and 0 g K/m2 treatment in distilled water (control). But, maximum flower size was recorded (13.03 mm) in 40 g N and 20 g K/m2 treatment in same holding solution. Maximum percent physiological loss in weight was noticed in 60 g N and 0 g K/m2 in distilled water.

Jain Ritu *et al.* (2009) reported that five spray type cultivars of Chrysanthemum viz. Kanchil, Shyamal, Flirt, Ravikiran and Kargil were chosen for carrying out post harvest studies. Different floral preservative treatments consisted of citric acid, aluminium sulphate, sucrose and their combination were used. All the chemical treatments significantly increased the vase life over control (distilled water). Amongst the cultivars, maximum percentage of floret opening (97.85) was recorded in cv. Kargil. Minimum weight loss (10.92%) was observed in cv. Kanchil. Maximum vase life (27.03

days) and volume of solution consumed (55.85 ml) was observed in cv. Shyamal while maximum flower diameter (6.99 cm) was recorded in cv. Ravikiran.

Zamani *et al.* (2011) carried out an experiment to investigate the effect of different concentrations of salicylic acid (SA), malic acid (MA), citric acid (CA) and sucrose (Suc) on keeping quality and vase life of chrysanthemum cut flowers. The results showed that maximum flower vase life was recorded in 150 mg/l MA +1.5 mM SA + 3% Sucrose treatments.

Abou El-Ghait *et al*. (2012) conducted an experiment to evaluate the effects of five preservative solutions as pulsing applications, four cold storage periods and three holding solution treatments as well as their interactions on vase life and quality of chrysanthemum (*Dendranthema grandiflorum* Kitam.) cv. "White Zambla" cut flowers. All pulsing solutions significantly increased vase life, florets opening % and change percentage in fresh weight of cut flowers, decreased contamination in vase solution, improved water balance for cut flowers and increased total sugars content in florets. Pulsing treatment of STS at 0.4 mM for 30 minutes then pulsed in BA at 10 ppm + GA_3 at 20 ppm + AOA at 4 mM for 24 hours had the most favorable effect in this respect. All holding solution treatments also increased vase life, florets opening % and change percentage in fresh weight of cut flower spike, decreased contamination in vase solution, improved water balance for cut flower spikes and increased total sugars content in florets, with superiority for the treatment of sucrose at 2% + 8-hydroxyquinoline sulphate at 100 ppm + citric acid at 100 ppm. As the cold storage period was increased from zero-time to 21-days, the above mentioned characters of cut flower longevity and quality were decreased. When pulsing applications interacted with cold storage periods then subjected to holding solution treatments, the highest quality and the longest vase life of chrysanthemum cut flowers were obtained under the interaction treatments of pulsing in STS at 0.4 mM for 30 minutes then pulsed in BA at 10 ppm + GA_3 at 20 ppm + AOA at 4 mM for 24 hours without cold storage or with storage for 7-days at 2±1°C and treated with holding solution containing sucrose at 2% + 8-hydroxy quinoline sulphate at 100 ppm + citric acid at 100 ppm as compared to control and the other interaction treatments in both seasons of this study.

Mashhadian *et al.* (2012) conducted an experiment to see the effect of salicylic acid (SA) and citric acid (CA) on vase life of chrysanthemum flowers. Four concentration of SA at (0, 100, 200, 300 ppm) and three concentration of CA at (0, 100, 200 ppm) were used as a treatment and replicate 3 times . Data indicate that SA and CA increased vase life, petal water content (%), initial fresh weight (%) and marketability, significantly. The highest vase life (21.77 days) was observed for the treatments of SA (300 ppm). The significant increase (300%) in vase life is considered to be due to plant regulating and anti-stress properties of SA and CA.

Mehraj *et al.* (2013) conducted an experiment to extend the vase life of cut White Snowball chrysanthemum. Five treatments were used in experiment, i.e., tap water (Control, C_0); distilled water (C_1); 100-ppm sucrose solution (C_2); 100-ppm lemon juice solution (C_3) and 100-ppm sucrose + lemon juice solution (C_4). 100-ppm of sucrose + lemon juice solution (C_4) provided fresh weight loss (7.0 g), days taken for first petal fall (5.0 days), days taken for petal discoloration (8.7 days) and longevity (13.0 days) whereas maximum flower head diameter (92.2 mm) was found in 100-ppm lemon juice solution (C_3) which was statistically similar with C_4 (90.8 mm).

Effect of chemical solutions on vase life and quality of other flowers

Carnation

Thorat *et al.* (2008) reported that the vase solution of sucrose (4%) + 8-HQC (400 ppm) + $AgNO_3$ (50 ppm) increased the weight of carnation cut flower by promoting solution uptake at 3rd, 6th, 9th and 12th day. This treatment was also found beneficial for enhancing the vase life of 15.27 days and diameter 7.63 cm of carnation cut flower.

China aster

Mantur and Nalawadi (1989) reported that in China aster maximum vase life was obtained with 0.2 per cent $Al_2 (SO_4)_3$ and 2 per cent sucrose.

Dendrobium

Ketsa *et al.* (1995) studied the effect of $AgNO_3$ on the vase life of cut flowers of *Dendrobium* 'Pompadour' and it was observed that $AgNO_3$ must be present continuously together with 8 -hydroxyquinoline sulfate (HQS) and glucose in order to maximize water uptake and vase life. $AgNO_3$ was more effective than silver thiosulfate (STS) in controlling microbial growth and vase life. *Bacillus* sp. was found in vase water from all treatments except that containing $AgNO_3$, HQS and glucose. This suggests that $AgNO_3$ in the holding solution may act as an antimicrobial agent, and not as an inhibitor of ethylene synthesis.

Chandran *et al.* (2006) treated pollinated *Dendrobium* (Heang Beauty) flowers with solutions containing different concentrations of sucrose or glucose, Aminooxyacetic acid (AOA) and a combination of sugars and AOA. Results showed that the best treatment was 4% sucrose + 0.5mM AOA with respect of longenvity of the flowers and AOA also beneficial for better water uptake and delayed turgor loss in flowers.

Gerbera

Amariutei *et al.* (1986) reported that inflorescences of the gerbera cultivars Richard and Symphonie had higher sugar content in the petals and higher respiration rate than Richard when treated with 20% sucrose + 0.02% 8-hydroxyquinoline sulphate + 0.0025% $AgNO_3$.

Gladiolus

Anserwadekar and Patil (1986) studied the effects of sucrose and GA_3 on gladiolus spikes and reported that 6% sucrose was found to be a good medium for prolonging the vase-life of gladiolus spikes.

De *et al.* (1996) studied that post harvest life of pulsed gladiolus spikes was affected by different chemicals in cv. Highstyle and reported that sucrose 4% + 8 – HQC (250 ppm) was found most beneficial for improving vase life of gladiolus.

Singh *et al.* (2008) conducted an experiment to see the effect of gibberellic acid (GA_3) and benzyl adenine (BA) with sucrose in the vase solution on cell membrane stability and vase life of gladiolus. Data showed that vase solution treatment combinations of GA_3 and BA with sucrose significantly increased the membrane stability index and enhanced the vase life as compared to the sucrose alone treatments or the controls. Vase solution treatment of GA_3 (50 mg l^{-1}), followed by BA (50 mg l^{-1}) with sucrose (50 g l^{-1}) significantly increased solution uptake, fresh weight and dry weight of cut spikes. These results suggest that post-harvest application of GA_3 (50 mg l^{-1}) with sucrose (50 g l^{-1}) maintains higher spike fresh and dry weight, improves anti-oxidative defence, stabilizes membrane integrity leading to a delay in petal cell death.

Khan *et al.* (2009) conducted a study to determine the optimum level of sucrose concentration and pH to extend the vase life of gladiolus flower. The highest percentage (88.8%) of florets was opened in 4.5% sucrose solution which was statistically similar to 1.5% and 3.0% sucrose solutions. Lowest infection percentage (1.91%) was observed in 4.5% sucrose solution.

Lilly

Han (2003) conducted an experiment on oriental Lily cv. Stargazer to see the effect of sucrose on vase life. Data indicate that sucrose 2% show the significant effect with respect of anthocyanin content and the intensity of petal colour.

Rose

Dias (1994) conducted an experiment in roses cv. Arjun for vase life study and observed that maximum vase life was recorded with aluminium sulphate followed by citric acid.

Effect of pulsing with $AgNO_3$, STS and DMSO (Dimethyl Sulphoxide) on Raktagandha cut rose was studied and the highest gain in fresh weight on 3rd day in the vase was recorded by $AgNO_3$ at 1mM pulsing for 15 minutes **(Anonymous, 2000).**

Singh and Tiwari (2000) studied the effect of pulsing with $AgNO_3$, SADH, NAA and STS along with 6% sucrose for increasing vase life and quality of rose flower cv. 'Happiness'. All these chemicals conspicuously influenced weight gain, weight loss, diameter of fully open flower and total solution uptake and vase life except STS.

Butt (2005) reported significant influence of sucrose ($C_{12}H_{22}O_{11}$) and silver nitrate ($AgNO_3$) at different concentrations on the vase life of two roses *(Rosa hybrida)*, namely Trika and Whisky Mac. It was found that different treatments had significant effect on each cultivar. Further more silver nitrate, in most of the cases, gave better performance than sucrose in enhancing the vase life of cut flowers of both the cultivars. In all the treatments containing sucrose and silver nitrate, the concentration of 150 ppm of $AgNO_3$ prolonged the maximum number of days in both the cultivars, which were 4.3 and 3.2 days more in Whisky Mac and Trika, respectively as compared to control.

Younis *et al.* (2006) conducted an experiment to study the effect of different doses of certain preservative solutions, i.e. Glucose, Sodium Benzoate and Silver Nitrate on cut rose flowers (cv. Kardinal and Whisky Mac.). Data obtained on longevity of the flowers of cv. " Kardinal" and Whisky Mac showed that silver nitrate 250mg/L gave maximum longevity in both the varieties.

Elgimabi (2011) conducted a study to see the effect of silver nitrate ($AgNO_3$) and sucrose at different concentration on rose cut flowers longevity. The results showed that flower vase life was prolonged by all $AgNO_3$ treatments. The best concentration was 30 ppm. The effect was further improved when $AgNO_3$ was combined with 3% sucrose, which recorded the best vase life compared to other concentrations of sucrose. Also $AgNO_3$ at 30 ppm retarded the chlorophyll as well as carbohydrate degradation during the postharvest life.

Strelitzia

Hassan (2009) carried out an investigation to study the effect of 100, 200 and 300 ppm 8-hydroxyquinoline sulphate (8-HQS) and 5 and 10% sucrose treatments on the vase life and post-harvest quality of cut flowers of *Strelitzia reginae* and *Hippeastrum vittatum* Herb. cv. Apple Blossom. All the treatments significantly increased the vase life and number of open florets of *Strelitzia reginae* cut flowers compared to the control. In addition, the percentage of fresh weight gain from the initial weight were also enhanced in both cut flower crops.

Sweet pea

Ichimura and Hiraya (1999) reported that treatment with STS followed by sucrose was the most effective in promoting floret opening as well as extending longevity of cut sweet pea (cv. Diana) flowers. Ethylene production was inhibited by all treatments, particularly in the presence of sucrose.

Tuberose

Saini *et al.* (1994) conducted an experiment to study the effect of sugar and $AgNO_3$ on the vase life of tuberose. It was observed that these chemicals increased the vase life of cut tuberose spikes in lower concentration.

Reddy and Singh (1996) conducted an experiment for post harvest study in tuberose and observed that due to sucrose treatment water uptake was increased in tuberose spike might be increased the osmotic potential and improved the ability of spikes to absorb water.

Kumar and Singh (2004) reported that sucrose at 2 and 4% concentrations had significant effect on vase life of tuberose cv. Pearl Double cut spikes. Sucrose and GA_3 influenced water uptake, vase life, fresh weight and flower opening. Overall observations reveal an increase in vase life with sucrose and plant growth regulator treatments.

Calendula, Zinnia, Antirrhinum and Sweet pea

Awad *et al.* (1986) reported that the longevity of Calendula, Zinnia and Antirrhinum was increased after dipping in 1000 ppm $AgNO_3$ up to 40 minutes. Lower

concentrations down to 20 ppm were also effective. Placing flowers in sucrose solution up to 10% after $AgNO_3$ dipping enhanced the longevity of Calendula and Zinnia. Using sucrose up to 7% combined with silver thiosulphate or silver nitrate enhanced the longevity of Sweet Pea.

Ruscus and Nephrolepis

Nooh *et al.* (1986) studied the effects of various concentrations of sucrose and 8-HQC, either individually or in combination, on the keeping quality of cut green stems and leaves of *Ruscus hypoglossum* and *Nephrolepis exaltata*. Adding 8-HQC and sucrose (150 ppm + 2 ¼% or 300 ppm + 2¼%, respectively) to the holding solution of *Ruscus* or *Nephrolepis* was most effective in improving the vase life compared with the controls (tap water).

Effect of chemical solutions on biochemical Parameters

Chrysanthemum

Su *et al.* (1991) reported that when cut chrysanthemum blooms were treated with 5 per cent sucrose + 0.3 mM STS or 5 per cent sucrose + 50ppm $AgNO_3$ + 150 ppm citric acid for 16 hours and then stored at 0^oC for 5 weeks. The treatment increased the soluble sugar content in the petals.

Abou El-Ghait *et al*. (2012) conducted an experiment to evaluate the effects of five preservative solutions as pulsing applications, four cold storage periods and three holding solution treatments as well as their interactions on vase life and quality of chrysanthemum (*Dendranthema grandiflorum* Kitam.) cv. "White Zambla" cut flowers. All pulsing solutions significantly increased total sugars content in florets. Pulsing treatment of STS at 0.4 mM for 30 minutes then pulsed in BA at 10 ppm + GA_3 at 20 ppm + AOA at 4 mM for 24 hours had the most favorable effect in this respect. All holding solution treatments also increased total sugars content in florets, with superiority

for the treatment of sucrose at 2% + 8-hydroxyquinoline sulphate at 100 ppm + citric acid at 100 ppm.

Dahlia

Abdel-Kader *et al.* (2004) carried out a postharvest study on dahlia. They reported that sucrose 1.5% was the best holding solution. It resulted in highest reducing sugars content in the petals and also increased the anthocyanin content.

Gerbera

Amariutei *et al.* (1986) reported that inflorescences of the gerbera cultivars Richard and Symphonie had higher sugar content in the petals and higher respiration rate than Richard when treated with 20% sucrose + 0.02% 8-hydroxyquinoline sulphate + 0.00

Strelitzia

Hassan (2009) carried out an investigation to study the effect of 100, 200 and 300 ppm 8-hydroxyquinoline sulphate (8-HQS) and 5 and 10% sucrose treatments on the vase life and post-harvest quality of cut flowers of *Strelitzia reginae* Ait. and *Hippeastrum vittatum* Herb. cv. Apple Blossom. All the treatments significantly increased the carbohydrate content compared to the control in both cut flower crops.

Sweet pea

Ichimura and Hiraya (1999) reported that anthocyanin concentrations were increased by treatments with sucrose alone or STS followed by sucrose in flowers of Sweet pea.

Chapter-III

MATERIALS AND METHODS

The experimental materials and criteria used for treatment evaluation during the course of investigation are being presented in this chapter. The experiment entitled **"Effect of post harvest preservatives on vase life of chrysanthemum (*Dendranthema grandiflora*) cv. Hybrid-1"** was conducted during the period from September 2014 to March 2015. Details of the method and techniques utilized in the experiment are given below.

3.1: Experimental Site

The experiment was laid out at the K.N.K. College of Horticulture, Mandsaur (M.P.) during September 2014 to March 2015. Mandsaur is situated in Malwa plateau in Western part of Madhya Pradesh at North latitude of 23.45^0 to 24.13^0 and 74.44^0 to 75.18^0 East longitudes and an altitude of 435.02 meters above mean sea level. This region falls under Agro climatic zone no.10 of the state.

3.2: Climate of the Region

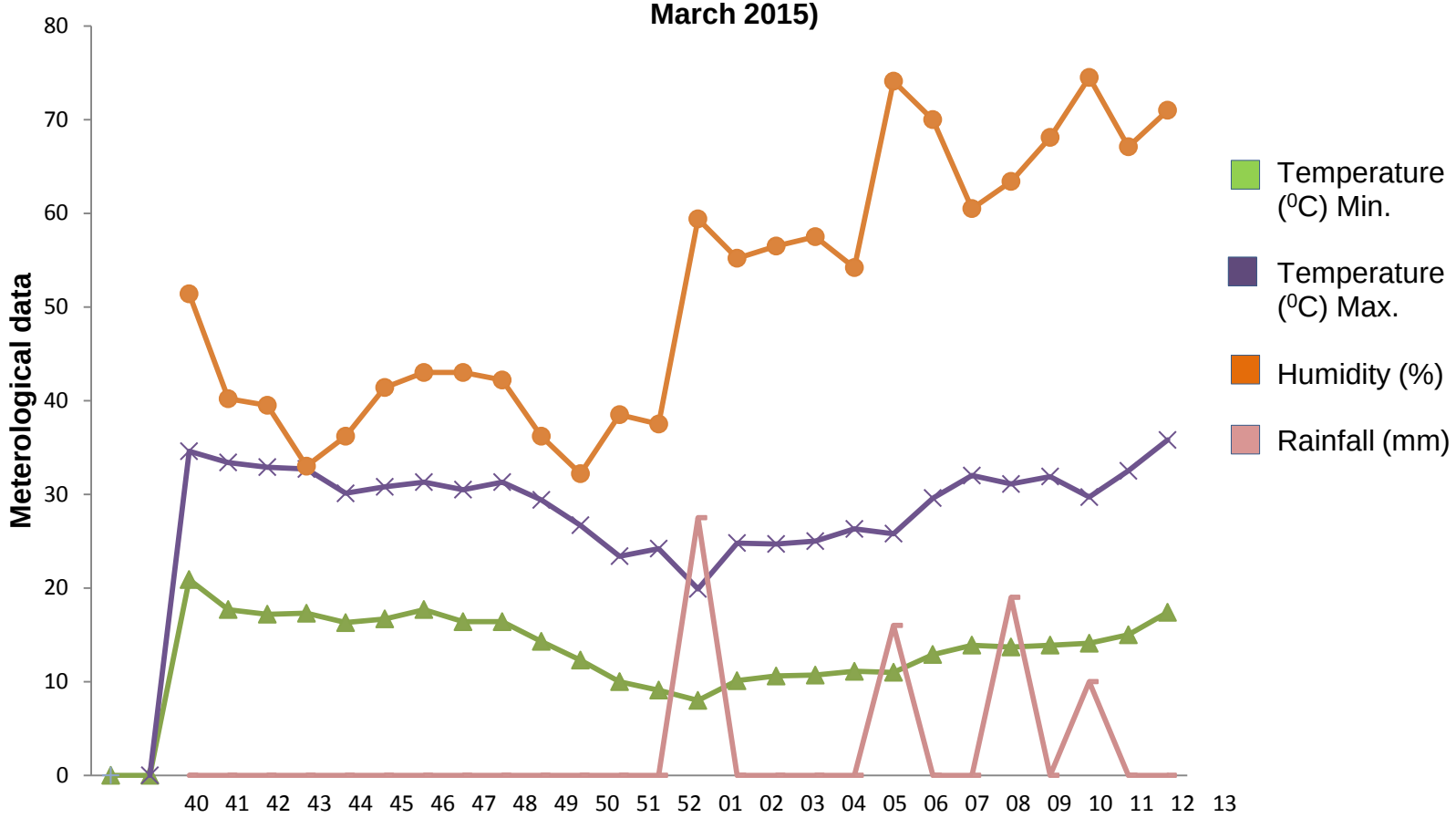
Mandsaur belongs to sub-tropical climate having a temperature range of minimum 5^0C and maximum 44^0C in winter and summer, respectively. In this area, most of the rainfall is received during mid June to mid September with occasional showers in winter. South-west monsoon is responsible for major portion of annual precipitation. The average rainfall is 544.05 mm. Meteorological data recorded during the period of investigation are presented in (table 3.1) and are graphically shown in (fig 3.1).

Table- 3.1: Weekly meteorological observations during the study period (September-2014 to March-2015)

Week No.	Duration	Average weekly Temperature		Relative Humidity (%)	Weekly Rainfall (mm)
		Min. (^{0}C)	Max. (^{0}C)		
37	11/9/14 to 17/9/14	22.5	29.8	81.4	68.7
38	18/9/14 to 24/9/14	21.6	32.3	62.1	-
39	25/9/14 to 1/10/14	19.5	33.8	58.0	-
40	2/10/14 to 8/10/14	20.9	34.6	51.4	-
41	9/10/14 to 15/10/14	17.7	33.4	40.2	-
42	16/10/14 to 22/10/14	17.2	32.9	39.5	-
43	23/10/14 to 29/10/14	17.3	32.7	33.0	-
44	30/10/14 to 5/11/14	16.3	30.1	36.2	-
45	6/11/14 to 12/11/14	16.7	30.8	41.4	-
46	13/11/14 to 19/11/14	17.7	31.3	43.0	-

47	20/11/14 to 26/11/14	16.4	30.5	43.0	-
48	27/11/14 to 3/12/14	16.4	31.3	42.2	-
49	4/12/14 to 10/12/14	14.3	29.4	36.2	-
50	11/12/14 to 17/12/14	12.3	26.7	32.2	-
51	18/12/14 to 24/12/14	10.0	23.4	38.5	-
52	25/12/14 to 31/12/14	9.1	24.2	37.5	-
01	1/1/15 to 7/1/15	8.0	19.9	59.4	27.5
02	8/1/15 to 14/1/15	10.1	24.8	55.2	-
03	15/1/15 to 21/1/15	10.6	24.7	56.5	-
04	22/1/15 to 28/1/15	10.7	25.0	57.5	-
05	29/1/15 to 4/2/15	11.1	26.3	54.2	-
06	5/2/15 to 11/2/15	11.0	25.8	74.1	16.0
07	12/2/15 to18/2/15	12.9	29.6	70.0	-
08	19/2/15 to 25/2/15	13.9	32.0	60.5	-
09	26/2/15 to 4/3/15	13.7	31.1	63.4	19.0
10	5/3/15 to 11/3/15	13.9	31.9	68.1	-
11	12/3/15 to 18/3/15	14.1	29.7	74.5	10.0
12	19/3/15 to 25/3/15	15.0	32.5	67.1	-
13	26/3/15 to 1/4/15	17.4	35.8	71.0	

Fig. 3.1: Weekly meterological observations during the study period (October-2014 to March 2015)



3.3: Experimental Details

Location	K. N. K. College of Horticulture Mandsaur (M.P.)
Name of crop	Chrysanthemum
Variety	Hybrid-1
Season	September 2014 - March 2015
No. of Treatments	09 (09 preservative solutions)
Design	CRD
Number of Cultivar	01
Number of Replications	03
Potting medium	Soil, Sand and FYM (1:1:1)

3.4: Treatment details

A. Preservatives:

C_0 - Control (Distilled water)

S_1 - 2% Sucrose

S_2 - 4% Sucrose

Ag_1 - 20 ppm $AgNO_3$

Ag_2 - 40 ppm $AgNO_3$

C_1 - 50 ppm Citric acid

C_2 - 100 ppm Citric acid

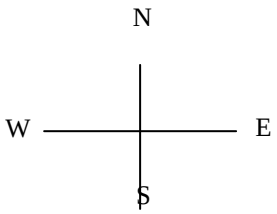
B. Variety:

1. Hybrid-1

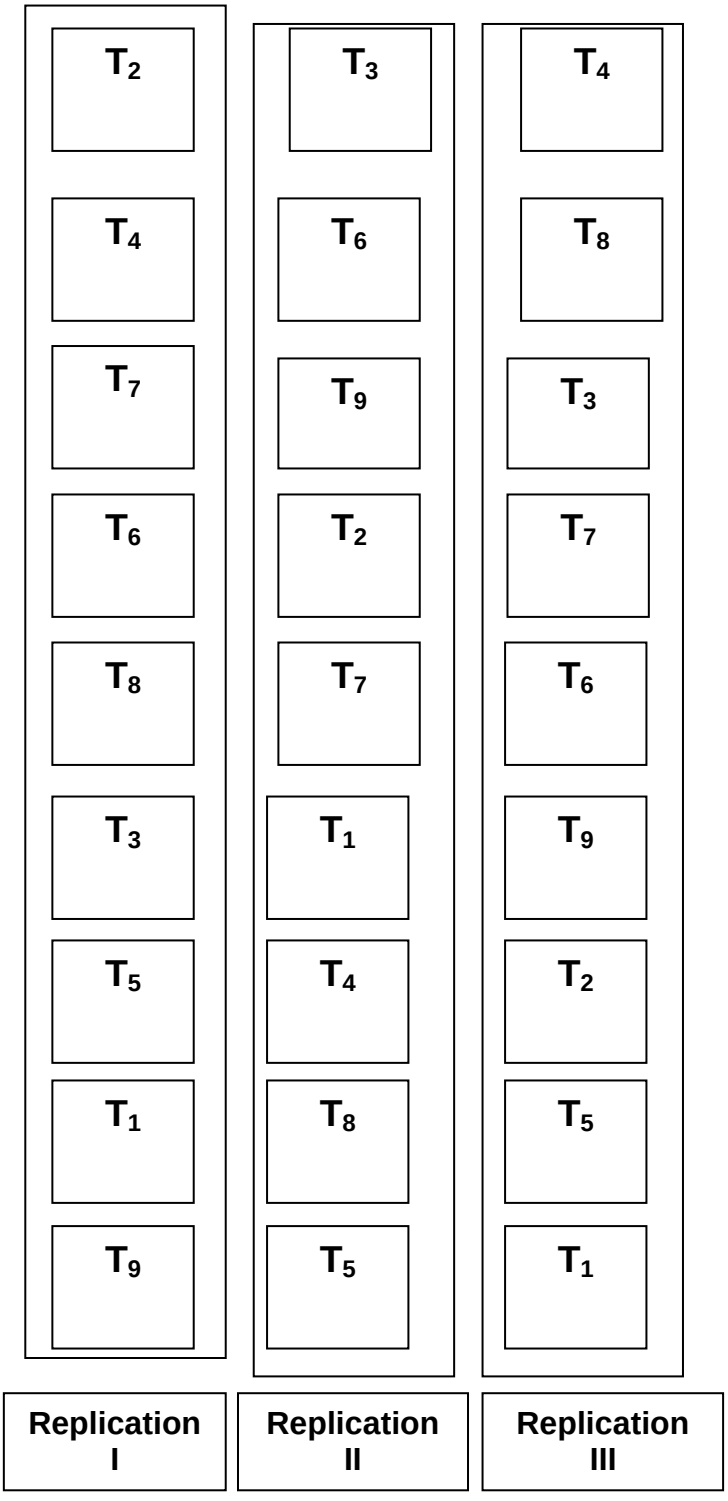
Table- 3.2: Treatment Combinations

Treatment	combinations
T_1	$S_1 + C_1 + Ag_1$
T_2	$S_1 + C_1 + Ag_2$
T_3	$S_1 + C_2 + Ag_1$
T_4	$S_1 + C_2 + Ag_2$
T_5	$S_2 + C_1 + Ag_1$
T_6	$S_2 + C_1 + Ag_2$
T_7	$S_2 + C_2 + Ag_1$
T_8	$S_2 + C_2 + Ag_2$
T_9 (Control)	Distilled water

3.5: Experimental design and layout



The description of design and layout is as follows



Flowers utilized for this study were obtained from plants raised in pots inside the shade net house of the Department of Floriculture and Landscape Architecture, K.N.K College of Horticulture, Mandsaur**.**

3.6: Pot Operations

3.6.1 Preparation of pots

Proper drainage system was maintained in pots. The drainage hole at the bottom of pots was loosely covered with small bricks and stones before filling media.

3.6.2: Pot filling

The pots were filled by the medium (Soil : Sand : FYM - 1:1:1) @ 7 kg/ pot.

3.6.3: Planting

A healthy rooted cutting was planted in each pot. Before planting the rooted cuttings were dipped in bavistin 3g/litre of water, for 15 minutes. The rooted cuttings were planted at the centre of the pots. Immediately after planting, watering was done and pots were kept in shade net house.

3.6.4: Care and Management of the plants

Recommended dose of manures and fertilizers were applied. The plants were irrigated once a week during the period from September to February and once in two days during March-April. Weeding, hoeing etc were also carried out from time to time.

3.6.5: Plant protection

The medium was drenched with chlorpyriphos 3ml/l of water at 15 days after planting for termite control. At 30 days after planting the medium was drenched with carbendazim 3g/l of water for protection from fungi.

3.6.6: Harvesting

Flowers were harvested when the outer ray florets were completely elongated and two rows of disc florets were completely developed. They were harvested with the help of secateurs and kept in fresh water immediately after harvesting. A uniform stalk length of 30 cm was maintained for the experiment.

3.7: Experimental material

The variety used in the investigation was Hybrid-1. The desired flowers of uniform size and colour, free from pests and diseases were selected and harvested. The flowers were harvested when the ray florets were completely elongated. Immediately after harvest the cut ends of the stalk were placed in clean water the flowers were brought to the laboratory for the vase life study.

3.8: Observations

1. Flower head diameter (cm).
2. Change in fresh weight on 3rd day in vase.
3. Change in fresh weight on 6th day in vase.
4. Change in fresh weight on 9th day in vase.
5. Change in fresh weight at senescence.
6. Solution uptake (ml) on 3rd day in vase.
7. Solution uptake (ml) on 6th day in vase.
8. Solution uptake (ml) on 9th day in vase.
9. Solution uptake (ml) at senescence.
10. Pigment content in petal (mg/100 g).
11. Petal T.S.S.(mg/g).
12. Soluble sugar content in petals (mg/g).
13. Reducing sugar content in petals (mg/g).
14. Vase life (Days).

1. Flower head diameter (cm)

The diameter of the flower was measured by using a centimeter scale.

2. Change in fresh weight of flowers (%) on 3rd day in the vase

Change in fresh weight were calculated through below formula Change in fresh weight = (Fresh weight on 3rd day in the vase / fresh weight at the time of harvesting X 100) - 100. Flowers were removed from the vase

solution on the 3rd day in the vase and weighed with the help of electronic balance.

3. Change in fresh weight of flowers (%) on 6th day in the vase

Flowers were removed from the vase solution on 6th day in the vase and again weighed with the help of electronic balance.

4. Change in fresh weight of flowers (%) on 9th day in the vase

Flowers were removed from the vase solution on 9th day in the vase and again weighed with the help of electronic balance.

5. Change in fresh weight of flowers (%) at senescence

Flowers were removed from the vase solution at senescence and weighed with the help of electronic balance.

6. Solution uptake (ml) on the 3rd day

Initially the volume of vase solution/water was kept 300ml uniformly for all the treatments. The volume of vase solution/water was measured by using a measuring cylinder on the 3rd day. The difference between the initial volume (on the first day) and final volume (on 3rd day of vase life) was expressed as the water/ solution uptake.

7. Solution uptake (ml) on the 6th day

The difference between the initial volume (on the first day) and final volume (on 6th day of vase life) was expressed as the water/ solution uptake on the 6th day of vase.

8. Solution uptake (ml) on the 9th day

The difference between the initial volume (on the first day) and final volume (on 9th day of vase life) was expressed as the water/ solution uptake on the 9th day of vase.

9. Solution uptake (ml) at senescence / Total uptake of solution (ml)

The difference between the initial volume (on the first day) and final volume (on last day of vase life) was expressed as the total water/ solution uptake

10. Pigment content (anthocyanin) in petals (mg/100g)

Estimation of anthocyanin

Anthocyanins are the most important and widespread groups of colouring matters in plants. These intensely coloured water-soluble pigments are responsible for nearly all colours in leaves, petals and fruits of higher plants. They are,based chemically on a single aromatic structure, that of cyanidin and all are derived from this pigment by addition or by subtraction of hydroxyl groups or by methylation or by glycosylation. There are six common anthocyanidins (anthocyanin aglycones, formed when anthocyanins are hydrolyzed with acid) which differ in the nature of the sugar (often glucose, but may also be galactose, rhamnose, xylose or arabinose), the number of sugar units (mono-, di- or tri-glycosides) and the position of attachment of sugar (usually to the 3'-hydroxyl or to the 3'- and 5' -hydroxyl).

Principle

The alcohol extract of the sample is treated with HCI in aqueous methanol followed by anthocyanin reagent. The colour intensity is measured colorimetrically at 525nm.

Reagents

1. Alcohol
2. 0.5N HCl in 80-85% methanol (HCI in aqueous methanol).
3. Anthocyanin reagent: Mix 1 ml of 30% H_2O_2 with 9ml of methanolic HCI (5:1, 3N).

Method

1. Grind a known weight of fresh flower petals in alcohol.
2. Filter or centrifuge and collect the extract.

3. Pipette 1 ml of the alcohol extract into the test tube and add 3ml or HCI in aqueous methanol.
4. Add 1 ml of anthocyanin reagents to the samples.
5. Prepare the blank in the same manner by adding 1ml of methanol- HQ instead of anthocyanin reagent.
6. After 15 min of incubation in the dark, measure the absorbance at 525nm against the blank.
7. Calculate the amount of anthocyanins present in the sample from a standard curve prepared with cyanin hydrochloride.

Notes

1. 10 µ of cyanin hydrochloride/ml in methanol-HCI = absorbance or 0.405 in a 1.0 cm cell at A_{525}.
2. Alternatively, the anthocyanin content may be expressed as A_{525} values.

11. Petal T.S.S.

All the flowers of each plant were crushed to form a homogenized sample and than the juice (flower extract) were extracted through muslin cloth. The extract was used for determination of T.S.S. in ^{0}Brix by hand refractometer. Few drops of juice were placed on the surface of prism. The hinged part was placed back. The refractometer was then placed against the sun. The reading was noted by revolving the eyepiece at room temperature.

12. Soluble sugar content in petals (mg/g)

(a) Preparation of solution: A homogenous sample of flower extract was prepared after crushing two grams of flower petals in 20 ml of ethanol and filtering by muslin cloth. 20 ml of extract sample was diluted to 100 ml by distilled water and this solution was used for estimation of sugars.

(b) Preparation of Fehling's solution:

(i) Fehling's solution "A": Weighed 34.63 g of copper sulphate (A.R.) crystals on an analytical balance and transferred it to a clean and dry 50 ml volumetric flask. Added 0.5 ml of concentrated sulphuric acid and some distilled water. Shaken well to dissolve and added distilled water to make the volume up to mark (500ml).

(ii) Fehling's solution "B": Dissolved 173.0 g of pure sodium potassium tartarate (Rochelle salt) and 50 g of sodium hydroxide in distilled water and made the volume (500 ml) in volumetric flask by adding distilled water.

(C) Glucose solution (0.5%): Dissolved 2.5 g of glucose (A.R. anhydrous) in distilled water and made the volume to 500 ml by adding distilled water.

12.1. Soluble sugar content in petals (mg/g):

For the estimation of total sugars, 20 ml of flower extract solution was taken in a beaker and 5 ml of concentrated HCl was added and then the solution was boiled on water bath for five minutes for the hydrolysis to convert the non-reducing sugar in to reducing sugars. After cooling, the excess of acid was neutralized by sodium carbonate solution. The solution was transferred in a 100 ml volumetric flask and volume was made up to mark by adding distilled water. This solution was taken in a burette and titrated with the Fehling's solution A and B similar as was done in reducing sugars. The total sugars in percentage were calculated with the help of following formula.

Total sugars (%) = (0.25/Burette reading) x100

13. Reducing sugar content in petals (mg/g)

Reducing sugar in flower extract was estimated by the method as suggested by Nelson (1944). 5 ml each of Fehling's "A" and "B" solution were taken in a 300 ml conical flask and diluted with 40 ml of distilled water. The flower extract taken in a burette was added slowly in hot (boiling) Fehling's solution till the appearance of slight red colour. Now three drops of methylene blue indicator were added and titration

Plate- 1: A view of vase life study in the laboratory of floriculture and landscape architecture.

was continued till a brick red precipitate appeared by destroying the blue colouration. The reducing sugar in percentage was calculated with the help of following formula:

Reducing sugar (%) = (0.25/Burette reading) x100

14. Vase life of flowers (days)

The cut flowers were discarded when one-third of the petals were brown or wilted, the number of days taken for this was recorded as vase life of the cut flowers.

3.9: Statistical Analysis:

Experimental data of the study entitled “Effect of post harvest preservatives on vase life of chrysanthemum (*Dendranthema grandiflora*) cv. Hybrid-1” were recorded and statistically analyzed using the method of Analysis of variance as described by Fisher, (1960) in his book “ The Design of Experiments.”

The analysis of variance has been given in appendix and the skeleton of analysis of variance is presented in table (3.3).

The ‘F’ test was applied to judge the overall significance of various treatments in general and comparison of individual treatment was made with

the help of critical difference at 5% level of significance, which was calculated as given in the table (3.2).

Table 3.3: The skeleton of analysis of variance

Source of variance	DF	SS	MSS	Fc	Ft 5%
Treatment	8	SS(t)	SS(t)/8	SS(V)/ {SS(E)/18}	
Error	18	SS(E)	SS(E)/18		
Total	26	SS(T)			

$$S.Em. \pm = \sqrt{\frac{2\ EMS}{R}}$$

$$CD = S.Em. \pm \times \sqrt{2} \times t_{5\%\ (edf)}$$

Where

EMS : Error mean sum of squares

R : Replications

$t_{5\%}$: Table value at error degree of freedom

S.Em. ± : Standard error of mean

CD : Critical difference

CHAPTER – IV

RESULTS

The results of the experiment entitled **"Effect of post harvest preservatives on vase life of chrysanthemum (*Dendranthema grandiflora*) cv. Hybrid-1"** have been presented in this chapter. The data pertaining to various characters were subjected to statistical analysis by using CRD. In support of the tabular representation of data, graphical representation has also been presented in this chapter to provide better comprehension of the characters.

4.1. Flower head diameter (cm)

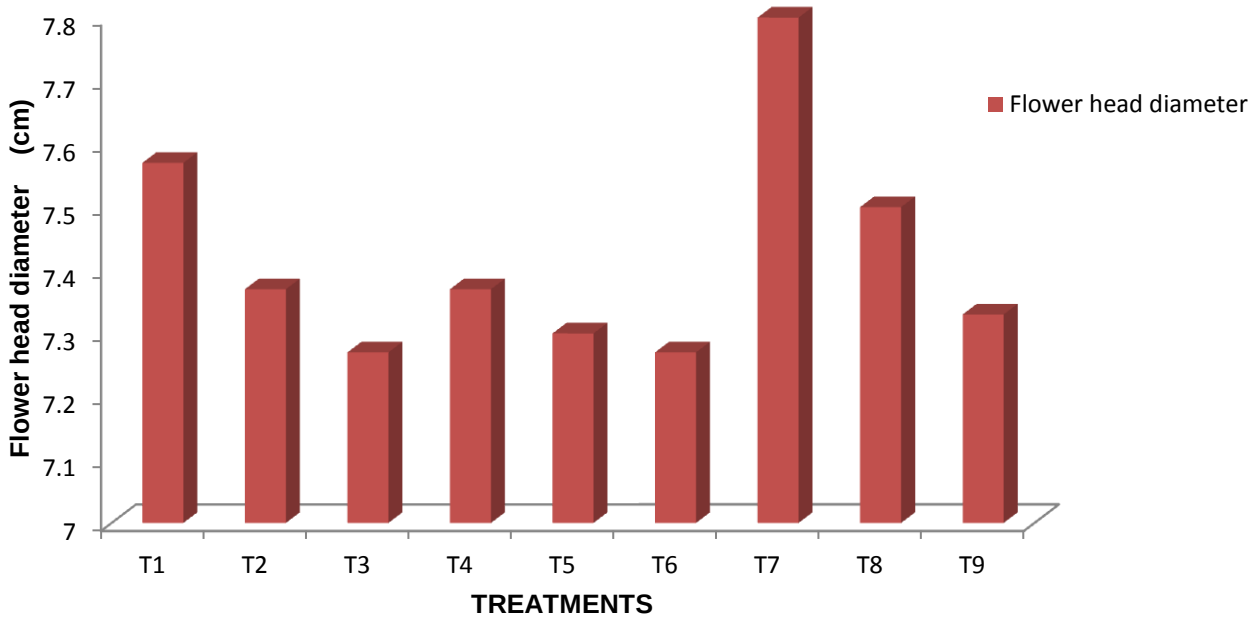
The data pertaining to flower head diameter (cm) with different treatments are presented in Table 4.1 and Fig. 4.1 and it can be observed from Table 4.1 and Fig. 4.1 that the effect of post harvest preservatives on flower head diameter was statistically significant.

Data showed that the flower head diameter was increased in vase in all the treatments among the preservatives solutions. The maximum flower head diameter 7.80 cm was recorded with T_7 (4% Sucrose + 100 ppm Citric acid + 20 ppm $AgNO_3$), which was statistically superior to control (7.33 cm) followed by T_1 (2% Sucrose + 50 ppm Citric acid + 20 ppm $AgNO_3$), T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$), T4 (2% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$) and T2 (2% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$) which recorded 7.57 cm, 7.50 cm and 7.37 cm respectively, while the smallest head diameter of flower (7.27 cm) was recorded in T_3 (2% Sucrose + 100 ppm Citric acid + 20 ppm $AgNO_3$) and T_6 (4% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$).

Table- 4.1: Effect of Post harvest preservatives on flower head diameter (cm)

Treatment	Symbol	Flower head diameter (cm)
2% Sucrose +50 ppm Citric acid + 20 ppm $AgNO_3$	T_1	7.57
2% Sucrose +50 ppm Citric acid + 40 ppm $AgNO_3$	T_2	7.37
2% Sucrose +100 ppm Citric acid + 20 ppm $AgNO_3$	T_3	7.27
2% Sucrose +100 ppm Citric acid + 40 ppm $AgNO_3$	T_4	7.37
4% Sucrose +50 ppm Citric acid + 20 ppm $AgNO_3$	T_5	7.30
4% Sucrose +50 ppm Citric acid + 40 ppm $AgNO_3$	T_6	7.27
4% Sucrose +100 ppm Citric acid + 20 ppm $AgNO_3$	T_7	7.80
4% Sucrose +100 ppm Citric acid + 40 ppm $AgNO_3$	T_8	7.50
Control (Distilled water)	T_9	7.33
S.Em.±		0.105
CD at 5%		0.313

Fig. - 4.1: Effect of Post harvest preservatives on flower head diameter (cm)



4.2. Change in fresh weight (%) on 3rd day in vase

The data pertaining to change in fresh weight (%) on 3rd day in vase with different treatments are presented in Table 4.2 and Fig. 4.2 and it can be observed from Table 4.2 and Fig. 4.3 that the effect of post harvest preservatives on change in fresh weight of flower on 3rd day in vase was statistically significant.

Data showed that the fresh weight of flower increased on 3rd day in vase in all the treatments. Among the preservatives solutions the maximum increase in fresh weight of flower (5.21%) on 3rd day was observed in T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$) followed by (5.17%) T_6 (4% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$), 4.97% with T_5 (4% Sucrose + 50 ppm Citric acid + 20 ppm $AgNO_3$), 4.71% with T_4 (2% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$) and 4.58% with T_3 (2% Sucrose + 100 ppm Citric acid + 20 ppm $AgNO_3$) all of these treatments were statistically superior to control. The minimum increase in fresh weight of flower (2.64%) on 3rd day was recorded in control *i.e.* T_9 (Distilled water).

4.3. Change in fresh weight (%) on 6th day in the vase

The data pertaining to change in fresh weight (%) of flower on 6th day in vase with different treatments are presented in Table 4.2 and illustrated Fig. 4.2.

The perusal of data from Table 4.2 revealed that change in fresh weight (%) of flowers varied from 8.73% to 13.89%. Among the preservatives solutions the maximum increase in fresh weight of flower (13.89%) on 6th day was recorded in T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$), which is statistically superior to control, however rest all treatment show statistically similarity during the experiment. The minimum increase in fresh weight of flower (8.73%) on 6th day was recorded in T_9 (Distilled water).

4.4. Change in fresh weight (%) on 9th day in the vase

The data pertaining to change in fresh weight (%) on 9th day in vase with different treatments were presented in Table 4.2 and Fig. 4.2 and it can be

observed from Table 4.2 and Fig. 4.8 that the effect of post harvest preservatives on change in fresh weight of flowers on 9^{th} day in vase was statistically significant.

The perusal of data revealed that change in fresh weight (%) of flowers varied from 9.33% to 17.37%. Various treatments showed pronounced difference on change in fresh weight on 9^{th} day of observation. Maximum fresh weight (17.37%) was recorded with treatment T_5 (4% Sucrose + 50 ppm Citric acid + 20 ppm $AgNO_3$) which was failed to show significant difference with treatments T_8, T_2, T_3, T_6 and T_7, whereas it was found statistically significant to treatments T_1 and T_9 (control).

The minimum increase in fresh weight of flowers (9.33%) on 9^{th} day was recorded in T_9 (Distilled water).

4.5. Change in fresh weight (%) at senescence

The effect of preservatives solutions on change in fresh weight (%) at senescence were statistically significant.

It can be observed from Table 4.2 and fig. 4.3 that the maximum change in weight of flowers at senescence (-5.07%) was recorded with T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$) followed by -5.53% with T_5 (4% Sucrose + 50 ppm Citric acid + 20 ppm $AgNO_3$), -6.15% with T_1 (2% Sucrose + 50 ppm Citric acid + 20 ppm $AgNO_3$). Treatment T_8 found statistically at par with all treatments, except T_7 (4% Sucrose + 100 ppm Citric acid + 20 ppm $AgNO_3$) which recorded minimum weight of flowers at senescence (-12.45%).

Table- 4.2: Effect of post harvest preservatives on change in fresh weight (%) of flowers

Treatment	Change in fresh weight (%)			
	On 3rd day in the vase	On 6th day in the vase	On 9th day in the vase	At senescence
T_1	3.88	8.98	11.65	-6.15
T_2	3.39	10.47	15.23	-12.22
T_3	4.58	11.47	14.61	-9.08
T_4	4.71	10.10	14.13	-11.03
T_5	4.97	12.07	17.37	-5.53
T_6	5.17	11.65	15.09	-7.98
T_7	4.07	9.52	13.53	-12.45
T_8	5.21	13.89	17.13	-5.07
T_9	2.64	8.73	9.33	-11.43
S.Em.±	0.524	1.70	1.50	2.42
CD at 5%	1.56	5.06	4.44	7.19

Fig. - 4.2: Effect of post harvest preservatives on change in fresh weight (%) of flowers

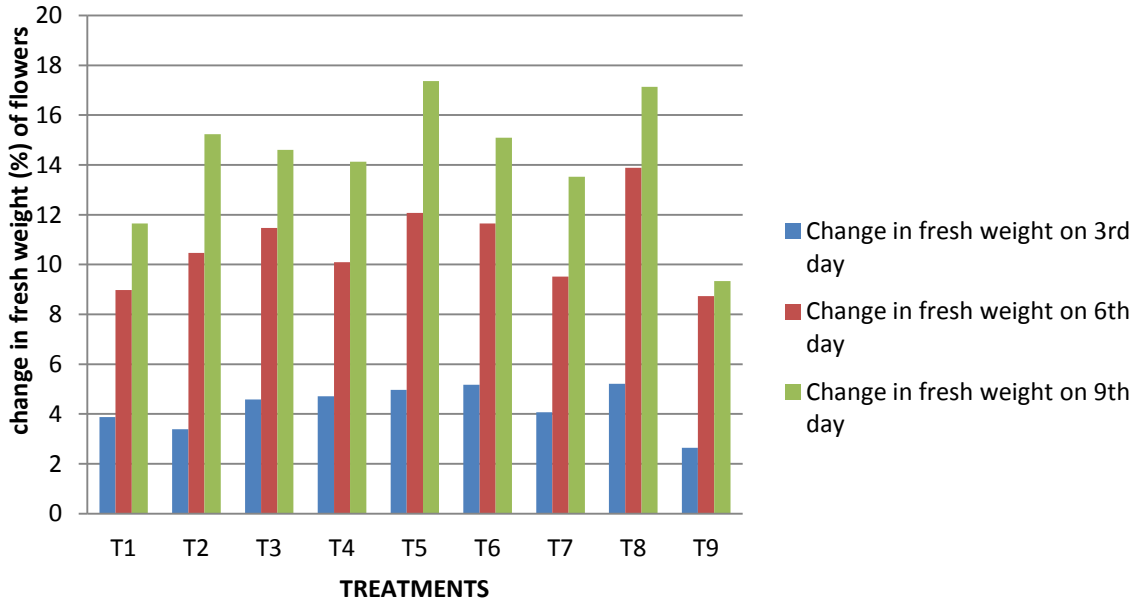
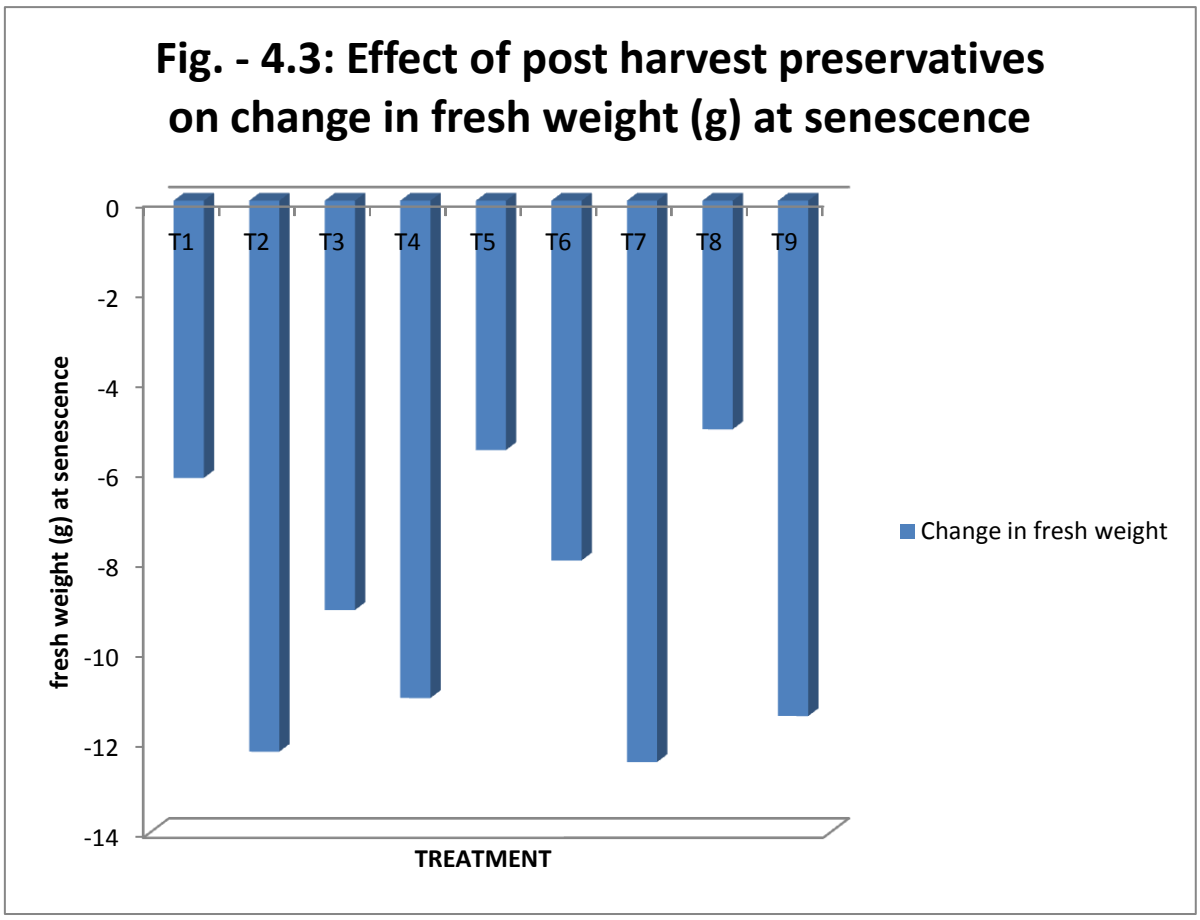


Fig. - 4.3: Effect of post harvest preservatives on change in fresh weight (g) at senescence



4.6. Solution uptake (ml) on 3rd day in vase

It can be observed from Table 4.3 and Fig. 4.4 that the effect of post harvest preservatives on solution uptake (ml) on 3rd day in vase was statistically significant.

Data indicate that the treatment 2% sucrose + 50 ppm citric acid + 40 ppm $AgNo_3$ (T_2) exerted maximum (4.00 ml) solution uptake on 3rd day followed by treatment 4% Sucrose + 100 ppm Citric acid +40 ppm $AgNO_3$ (T_8) which recorded a value of 3.67 ml. It is imperative to mention here that treatment T_2 showed significance difference to treatment T_5 and treatment T_9 (control) and failed to show statistical difference to other treatments i.e. T_8, T_1, T_3, T_4, T_6 and T_7. The minimum solution uptake on 3rd day in vase (3.00 ml) was recorded in T_9 (Distilled water).

4.7. Solution uptake on 6th day

Significant difference due to various treatments was also recorded on solution uptake on 6th day of observation and the maximum solution uptake on 6th day (9.67 ml) was recorded in T_2 (2% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$) followed by T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$). Treatment T_2 found statistically at par with treatments T_8, T_6, T_4 and T_1, whereas it was significantly superior to treatments T_3, T_5, T_7 and T_9 (control). The minimum solution uptake on 6th day (5.67 ml) was recorded in T_9 (Distilled water).

4.8. Solution uptake on 9th day

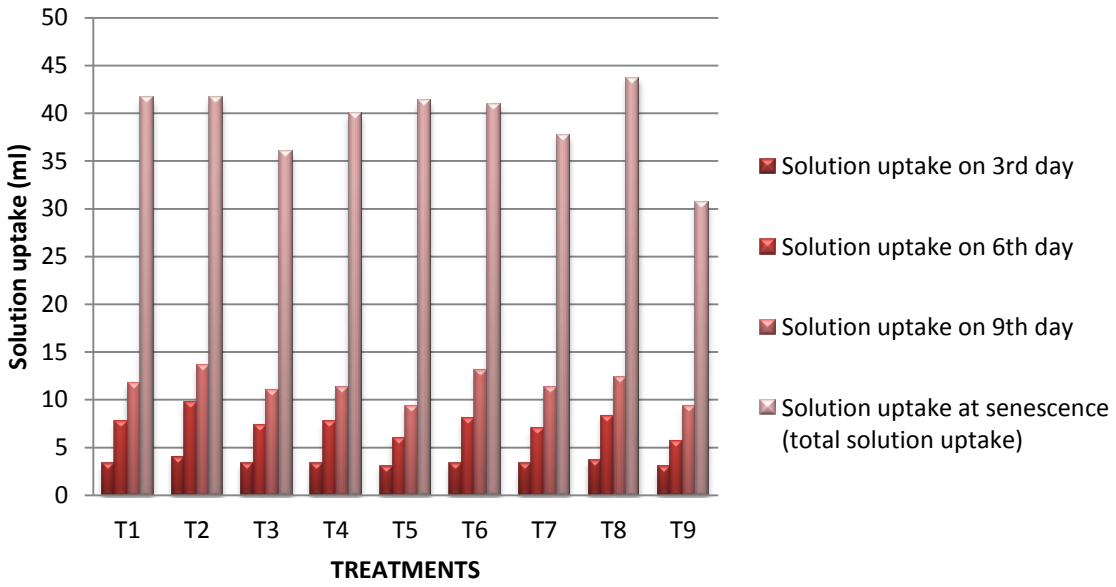
The data pertaining to solution uptake on 9th day of vase were presented in Table 4.3 and illustrated Fig. 4.4. Solution uptake on 9th day varied from 9.33 to 13.67 ml.

Treatments T_2 (2% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$) exhibited maximum solution uptake (13.67 ml) which was statistically at par with treatments T_6, T_8,T_1, T_4 and T_7 however these treatments was found significantly similler to treatments control (T_7), T_5 and T_3. The minimum solution uptake on 9th day (9.33 ml) was recorded in T_9 (Distilled water).

Table- 4.3: Effect of post harvest preservatives on solution uptake (ml) by flowers

Treatment	Solution uptake (ml)			
	On 3rd day in the vase	On 6th day in the vase	On 9th day in the vase	At senescence
T_1	3.33	7.67	11.67	41.67
T_2	4.00	9.67	13.67	41.67
T_3	3.33	7.33	11.00	36.00
T_4	3.33	7.67	11.33	40.00
T_5	3.00	6.00	9.33	41.33
T_6	3.33	8.00	13.00	41.00
T_7	3.33	7.00	11.33	37.67
T_8	3.67	8.33	12.33	43.67
T_9	3.00	5.67	9.33	30.67
S.Em.±	0.272	0.745	0.85	1.61
CD at 5%	0.81	2.22	2.51	4.78

Table- 4.4: Effect of post harvest preservatives on solution uptake (ml) by flowers



4.9. Solution uptake (ml) at senescence (Total uptake of solution)

The data pertaining to solution uptake on at senescence is presented in Table 4.3 and illustrated Fig. 4.4. Solution uptake varied from 30.67 to 43.67 ml. The maximum solution uptake on at senescence (43.67 ml) was recorded in T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$), followed by 41.67 ml with T_2 (2% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$) & T_1 (2% Sucrose + 50 ppm Citric acid + 20 ppm $AgNO_3$), 41.33 ml with T_5 (4% Sucrose + 50 ppm Citric acid + 20 ppm $AgNO_3$), 41.00 ml with T_6 (4% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$) and 40.00 ml with T_4 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$), all of these being statistically at par to each other and superior to control. The minimum solution uptake by the flowers at senescence (30.67 ml) was recorded in T_9 (Distilled water).

The effect of preservatives on solution uptake (ml) at senescence was statistically significant.

4.10. Pigment content (Anthocyanin) in petals (mg/100g)

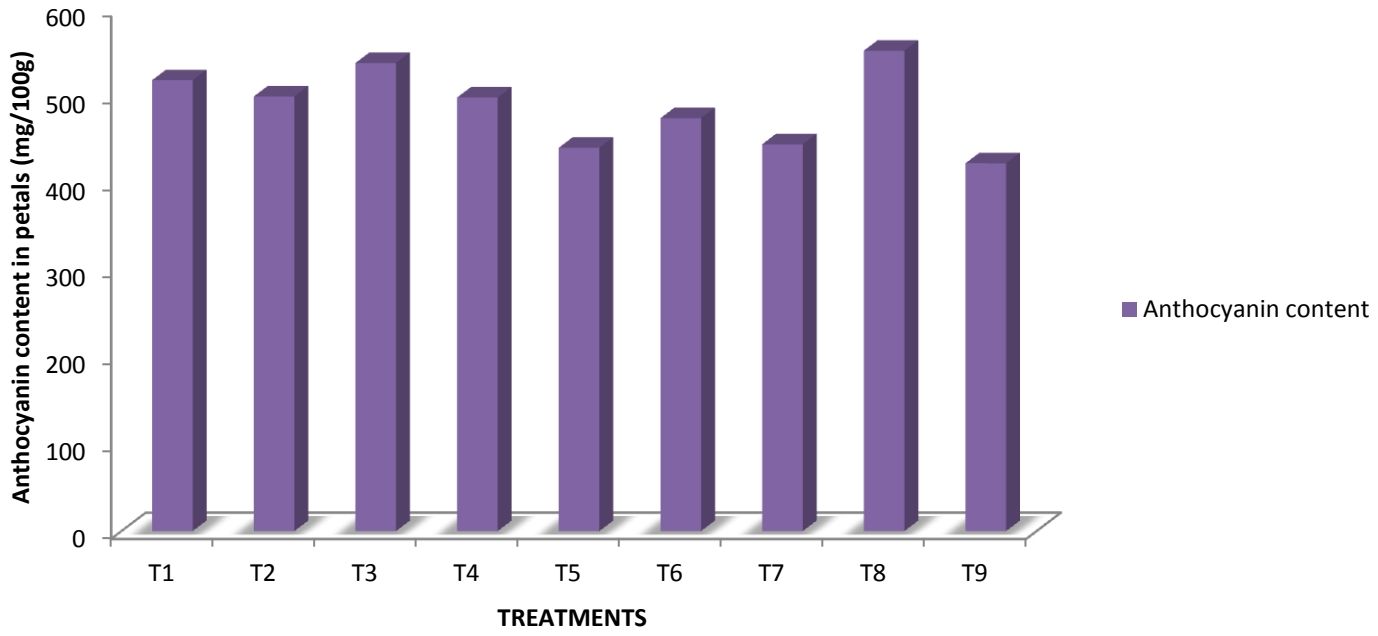
The effect of preservatives solutions on anthocyanin content in petals was statistically significant.

It can be observed from Table 4.4 and Fig. 4.5 that the maximum anthocyanin content in petals (551.51mg/100g) was recorded in T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$) followed by 537.36 mg/100g with T_3 (2% Sucrose + 100 ppm Citric acid + 20 ppm $AgNO_3$) however all the treatments show significant difference. The minimum anthocyanin content in petals (422.24 mg/100g) was recorded in T_9 (Distilled water).

Table- 4.4: Effect of post harvest preservatives on pigment content (anthocyanin) in petals (mg/100g)

Treatment	Symbol	Pigment content (anthocyanin) in petals (mg/100g)
2% Sucrose +50 ppm Citric acid + 20 ppm $AgNO_3$	T_1	517.60
2% Sucrose +50 ppm Citric acid + 40 ppm $AgNO_3$	T_2	498.90
2% Sucrose +100 ppm Citric acid + 20 ppm $AgNO_3$	T_3	537.36
2% Sucrose +100 ppm Citric acid + 40 ppm $AgNO_3$	T_4	497.77
4% Sucrose +50 ppm Citric acid + 20 ppm $AgNO_3$	T_5	440.07
4% Sucrose +50 ppm Citric acid + 40 ppm $AgNO_3$	T_6	474.01
4% Sucrose +100 ppm Citric acid + 20 ppm $AgNO_3$	T_7	444.03
4% Sucrose +100 ppm Citric acid + 40 ppm $AgNO_3$	T_8	551.51
Control (Distilled water)	T_9	422.24
S.Em.±		2.128
CD at 5%		6.322

Fig. - 4.5: Effect of post harvest preservatives on pigment content (anthocyanin) in petals (mg/100g)



4.11. Petal T.S.S. (mg/g) /Total soluble solids (^{0}Brix)

The data pertaining to T.S.S. in petals with different treatments were presented in Table 4.5 and Fig. 4.6 and it can be observed from Table 4.5 and Fig. 4.6 that the effect of post harvest preservatives on T.S.S. in petals was statistically significant.

The perusal of data from Table 4.5 revealed that T.S.S. in petals of flowers varied from 11.20 ^{0}Brix to 13.20^0 Brix. Among the preservatives solutions the maximum T.S.S. in petals 13.20^0 Brix was recorded in T_1 (2% Sucrose + 50 ppm Citric acid + 20 ppm $AgNO_3$) followed by 12.47^0 Brix with T_4 (2% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$), 12.40^0 Brix with T_2 (2% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$), 11.60^0 Brix with T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$) and T_6 (4% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$) all of these are statistically superior to control and the minimum T.S.S. in petals (11.20 ^{0}Brix) was recorded in T_9 (Distilled water).

4.12. Soluble sugar content in petals (mg/g)

The data pertaining to soluble sugar content in petals were presented in Table 4.5 and illustrated Fig. 4.7. Variation was in soluble sugar content in petals (mg/g), among various treatments of preservatives solutions. Soluble sugar content in petals varied from 2.60 to 3.72 (mg/g). The maximum soluble sugar content in petals (3.72 mg/g) was recorded with T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$) followed by 3.71 mg/g with T_6 (4% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$), 3.70 mg/g with T_2 (2% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$), 3.65 mg/g with T_1 (2% Sucrose + 50 ppm Citric acid + 20 ppm $AgNO_3$) and 3.25 mg/g with T_5 (4% Sucrose + 50 ppm Citric acid + 20 ppm $AgNO_3$) & T_3 (2% Sucrose + 100 ppm Citric acid + 20 ppm $AgNO_3$) all of these are statistically superior to control. The minimum soluble sugar content in petals (2.60 mg/g) was recorded in T_9 (Distilled water).

The effect of preservatives solutions on soluble sugar content in petals (mg/g) was statistically significant.

Table- 4.5: Effect of post harvest preservatives on petal T.S.S. / Total soluble solids (^{0}Brix) and soluble sugar content in petals (mg/g)

Treatment	Symbol	Petal T.S.S. (^{0}Brix)	Soluble sugar content in petals (mg/g)
2% Sucrose +50 ppm Citric acid + 20 ppm $AgNO_3$	T_1	13.20	3.65
2% Sucrose +50 ppm Citric acid + 40 ppm $AgNO_3$	T_2	12.40	3.70
2% Sucrose +100 ppm Citric acid + 20 ppm $AgNO_3$	T_3	11.40	3.25
2% Sucrose +100 ppm Citric acid + 40 ppm $AgNO_3$	T_4	12.47	2.88
4% Sucrose +50 ppm Citric acid + 20 ppm $AgNO_3$	T_5	11.27	3.25
4% Sucrose +50 ppm Citric acid + 40 ppm $AgNO_3$	T_6	11.60	3.71
4% Sucrose +100 ppm Citric acid + 20 ppm $AgNO_3$	T_7	11.40	2.88
4% Sucrose +100 ppm Citric acid + 40 ppm $AgNO_3$	T_8	11.60	3.72
Control (Distilled water)	T_9	11.20	2.60
S.Em.±		0.107	0.05
CD at 5%		0.317	0.15

Fig. - 4.6: Effect of post harvest preservatives on petal T.S.S. / Total soluble solids ($_0$Brix)

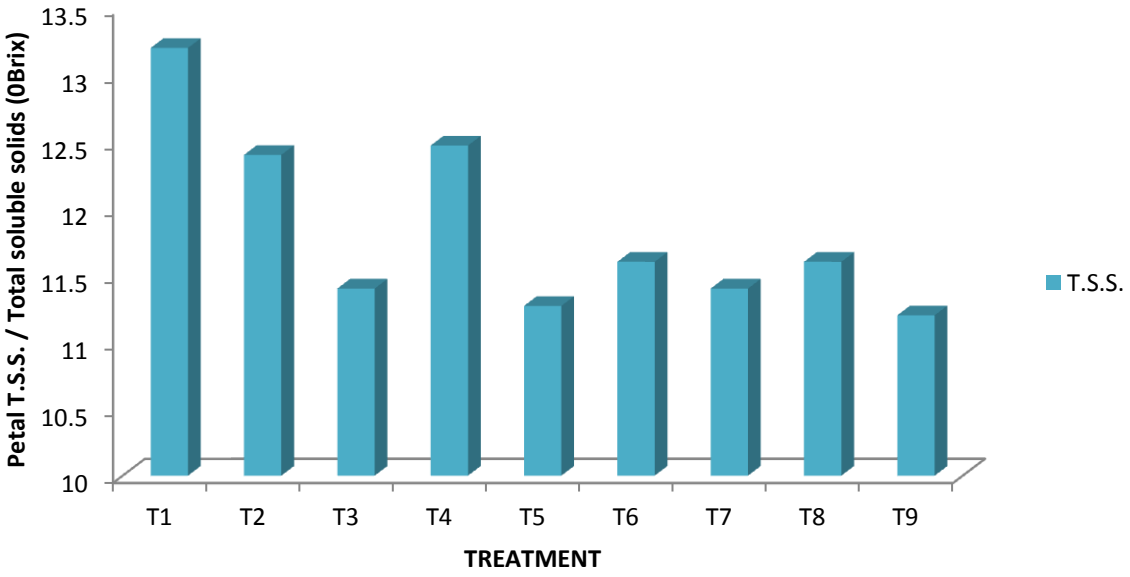
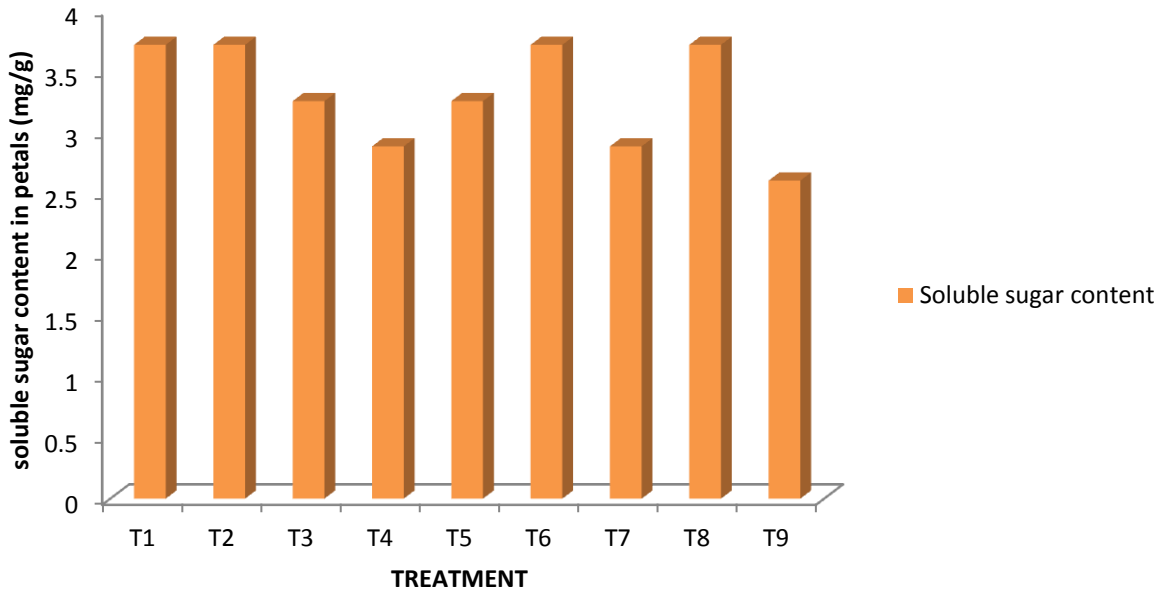


Fig. - 4.7: Effect of post harvest preservatives on soluble sugar content in petals (mg/g)



4.13. Reducing sugar content in petals (mg/g)

The data pertaining to reducing sugar content in petals were presented in Table 4.6 and illustrated Fig. 4.8. Variation was in reducing sugar content in petals (mg/g), among various treatments of preservatives solutions. Reducing sugar content in petals varied from 2.16 to 3.35 (mg/g). The maximum reducing sugar content in petals (3.35 mg/g) was recorded with T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$) followed by 3.25 mg/g with T_6 (4% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$) and T_2 (2% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$). The minimum soluble sugar content in petals (2.16 mg/g) was recorded in T_9 (Distilled water).

The effect of preservatives solutions on reducing sugar content in petals (mg/g) was statistically significant. All the treatments show significant result compare to control (T_9).

4.14. Vase life of flowers (days)

The data pertaining to vase life of flowers (days) were presented in Table 4.6 and illustrated Fig. 4.9. Variation was in vase life of flowers (days), among various treatments of preservatives solutions. Vase life of flowers varied from 27.67 to 35.00 days.

It is intresting to note that maximum vase life (35.00 days) recorded with 2% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$ (T_2) which was statisticlly at par (34.00 days) with treatment 4% sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$ (T_8), T_7, T_6 and T_1 but significantly superior over treatments T_3, T_4 and T_9. The minimum vase life (27.67 days) was recorded in T_9 (Distilled water).

Table- 4.6: Effect of post harvest preservatives on reducing sugar content in petals (mg/g) and vase life (days)

Treatment	Symbol	Reducing sugar content in petals (mg/g)	Vase life (days)
2% Sucrose +50 ppm Citric acid + 20 ppm $AgNO_3$	T_1	2.88	31
2% Sucrose +50 ppm Citric acid + 40 ppm $AgNO_3$	T_2	3.25	35
2% Sucrose +100 ppm Citric acid + 20 ppm $AgNO_3$	T_3	2.88	29.67
2% Sucrose +100 ppm Citric acid + 40 ppm $AgNO_3$	T_4	2.52	30.00
4% Sucrose +50 ppm Citric acid + 20 ppm $AgNO_3$	T_5	2.84	23.67
4% Sucrose +50 ppm Citric acid + 40 ppm $AgNO_3$	T_6	3.25	30.67
4% Sucrose +100 ppm Citric acid + 20 ppm $AgNO_3$	T_7	2.52	31.00
4% Sucrose +100 ppm Citric acid + 40 ppm $AgNO_3$	T_8	3.35	34.00
Control (Distilled water)	T_9	2.16	27.67
S.Em.±		0.076	1.48
CD at 5%		0.23	4.40

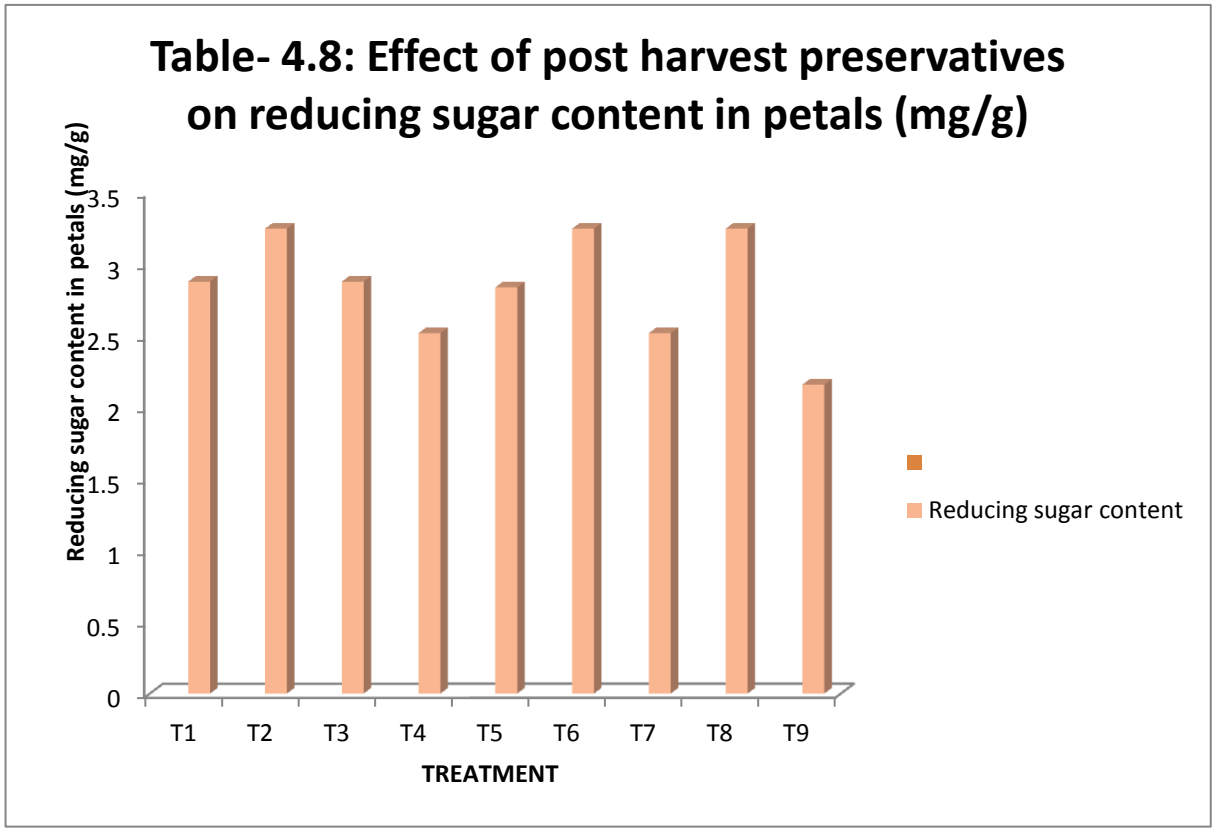
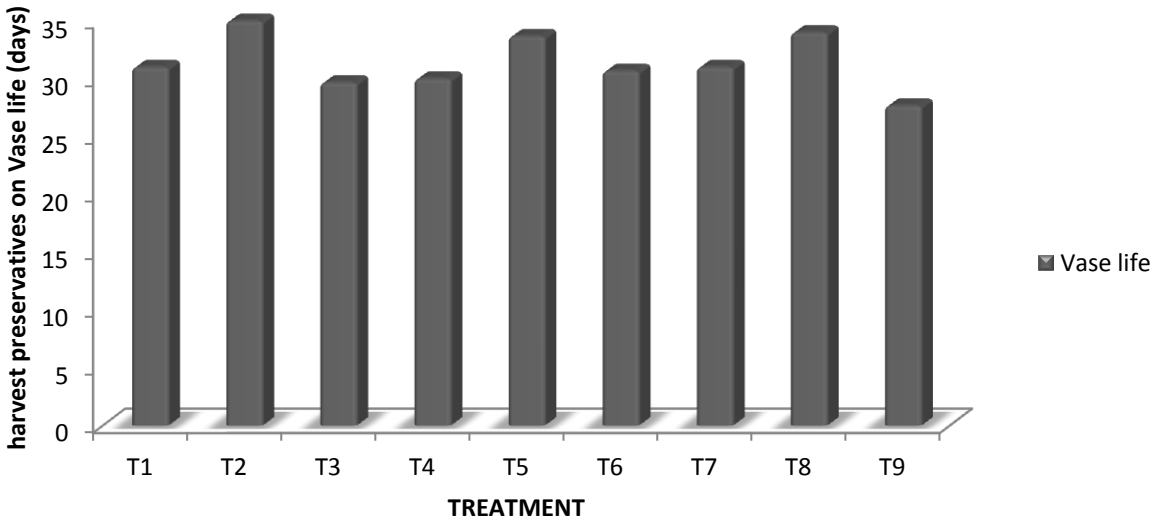


Table- 4.8: Effect of post harvest preservatives on reducing sugar content in petals (mg/g)
Reducing sugar content in petals (mg/g)
3.5
3
2.5
2
1.5
1
0.5
0
T1
T2
T3
T4
T5
T6
T7
T8
T9
TREATMENT
Reducing sugar content

Fig. - 4.9: Effect of post harvest preservatives on Vase life (days)



DISCUSSION

In this chapter an attempt has been made to evaluate the possible reasons of the variability obtained due to the different treatments in the present investigation entitled **"Effect of post harvest preservatives on vase life of chrysanthemum (*Dendranthema grandiflora*) cv. Hybrid-1".** The findings described in the preceding chapter have been critically discussed here in detail.

Flower head diameter (cm)

The flower head diameter of flowers was significantly influenced by the post harvest preservative solutions. The maximum flower head diameter was recorded with T_7 (4% Sucrose + 100 ppm Citric acid + 20 ppm $AgNO_3$), while the minimum flower head diameter was recorded with T_3 (2% Sucrose + 100 ppm Citric acid + 20 ppm $AgNO_3$) and T_6 (4% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$).

Keeping flower head diameter near at constant before harvesting it requires the influx of water and osmolytes such as glucose and amino and organic acids (Van Meeteren *et. al*., 2000). Van Doorn *et. al*. (1997) described that the decrease in water potential was correlated with inhibition of corolla growth and flower opening. Such likely, Bhat, *et. al.,* (1999) reported that chrysanthemum cut flower when kept on holding solution containing 250 ppm 8-HQS and sucrose at 1.5% had the greatest flower diameter.

Change in fresh weight (%) of flowers

The effect of preservative solutions on change in fresh weight of flowers on 3^{rd} day, 6^{th}, 9^{th} day and at senescence was statistically significant. Among the preservatives solutions the maximum increase in fresh weight of flowers on 3^{rd} day was observed in T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$) followed by T_6 (4% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$). The maximum increase in fresh weight of flowers on 6^{th} day was recorded in T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$). The maximum increase in fresh weight of flowers on 9^{th} day was recorded in T_5 (4% Sucrose + 50 ppm Citric acid + 20 ppm $AgNO_3$) followed by T_8 (4% Sucrose + 100 ppm Citric acid +

40 ppm $AgNO_3$). Among the preservatives solutions the maximum weight of flowers at senescence was recorded with T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$). The minimum weight of flowers on 3rd day, 6th day and 9th day was recorded under control, while at senescence was recorded in T_7 (4% Sucrose + 100 ppm Citric acid + 20 ppm $AgNO_3$). The similar results were obtained by Amariutei *et al.*, (1986) on gerbera who demonstrated that the dry weight of flowers was greater in pulsed inflorescences than those in water only. Similar results were observed by the Das *et al.,* (2008). They reported that the flower preservatives maintain higher fresh weight due to reduction in respiration and transpiration rate and check deterioration of cell ultra structure. Soad *et al.* (2011) reported that the decrease of increasing flower fresh weight may be due to increase of transpiration about of water uptake during the self life period.

Solution uptake (ml) by the flowers

The effect of preservative solutions on solution uptake by the cut flowers of chrysanthemum cv. Hybrid-1 on 3rd day, 6th day, 9th day and at senescence (total solution uptake) was statistically significant. The maximum solution uptake by the flowers on 3rd day was recorded in T_2 (2% Sucrose + 50 ppm Citric acid +40 ppm $AgNO_3$), followed by T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$), while the minimum solution uptake (ml) on 3rd day of vase was recorded under control. The maximum solution uptake on 6th day and 9th day was recorded in T_2 (2% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$) while at senescence maximum solution uptake was recorded with T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$). The minimum solution uptake on 3rd day, 6th day, 9th day and at senescence was recorded in the T_9 (Only distilled water). Similar results were observed by Kesta *et al*., (1995). They observed that $AgNO_3$ must be present continuously together with 8-hydroxyquinoline sulphate (HQS) and glucose in order to maximize water uptake. Reddy and Singh (1996) reported that increase in water uptake by sucrose pulsing treated tuberose spikes might be due to translocated sugars accumulated in flowers which increased the osmotic potential and improved the ability of spikes to absorb water. This solution/water uptake by flower might be due to the fact that the $AgNO_3$ present

in the holding solution acted as a biocide inhibiting microbial population that might have resulted in blockage of the vascular tissues. Sucrose helps in maintaining the water balance and turgidity. Hence, addition of sucrose to the holding solution might have led to increased uptake of the holding solution (Nair *et al.* 2003).

Pigment content (Anthocyanin) in petals (mg/100g)

The effect of preservative solutions on anthocyanin content in petals was statistically significant. The maximum anthocyanin content in petals was recorded in T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$) followed by T_3 (2% Sucrose + 100 ppm Citric acid + 20 ppm $AgNO_3$), while the minimum anthocyanin content in petals was recorded in the T_9 (Only DW). Similar results were obtained by Soad *et al.* (2011) on gerbera and demonstrated that the anthocyanin content of flower was higher in different preservative solutions as compared to distilled water

. **Petal T.S.S. (mg/g) /Total soluble solids (^{0}Brix)**

The maximum T.S.S. in petals (^{0}Brix) was recorded in T_1 (2% Sucrose + 50 ppm Citric acid + 20 ppm $AgNO_3$) followed by T_4 (2% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$), while the minimum T.S.S. in petals (11.20 ^{0}Brix) was recorded in the T_9 (Only distilled water). Similar results were recorded by Abou El-Ghait E.M. *et al.* (2012) and observed that TSS was increased up to eight vase life days and then decreased which confirmed of Elgimabi and Sliai (2013) who reported that sugar content of roses increased at the beginning of the experiment, and then decreased towards the end. An increase in TSS at the early stage may be due to substitution of the required substrate for respiration by rapid solution uptake whereas the reduction in TSS after the 8th day of vase life may be due to the utilization of the stored food as substrate and inability to substitute it by the low solution uptake as the storage time increased.

Soluble sugar content in petals (mg/g)

The maximum soluble sugar content in petals was recorded with T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$) followed by T_6 (4% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$), T_2 (2% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$) and the minimum soluble sugar content in petals was recorded in T_9 (distilled water).

Similar results were observed by Bhattacharjee and De (1998) who reported that $Agno_3$ increased the soluble sugar content in flower petals and increased the vase life of cut flowers of rose.

Reducing sugar content in petals (mg/g)

The maximum reducing sugar content in petals was recorded with T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$) followed by T_6 (4% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$) and T_2 (2% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$) while the minimum reducing sugar content in petals was recorded in T_9 (distilled water) similar results were recorded by Nichols (1973) who revealed that absorbed sucrose was rapidly converted in petals to reducing sugars, which accumulated in the corolla. Abdel-Kadar *et al.* (2004) reported that using sucrose or citric acid as holding solution significantly maximized percentage of reducing sugars.

Vase life of flowers (days)

The maximum vase life of flowers was recorded in T_2 (2% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$) followed by T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$) and T_5 (4% Sucrose + 50 ppm Citric acid + 20 ppm $AgNO_3$), while the minimum vase life of flowers was recorded in the T_9 (Only DW). Sucrose in the vase solution might have provided additional respirable substrate to the cut flower thus resulting in longer vase life. Sucrose alone, however, tends to promote microbial growth. Hence, the combination of sugars and biocides might have extended the vase life of cut flowers and improved the quality of flowers. Similar results were obtained by Awad *et al.* (1986). They reported the beneficial effect of $AgNO_3$ in the vase-solution to the production of

Ag^+ ions, which might inhibit the rise of ethylene precursor, thereby enhancing the longevity of cut flowers. Ketsa *et al.* (1995) reported that the improvement in vase life of flowers and quality parameters in $AgNO_3$ solution might be due to the fact that it is a very effective biocide, which completely inhibits microbial growth. $AgNO_3$ is an effective bactericide, which is often added in vase solution for the extension of vase life (Anjum, 2001).

Chapter – VI

SUMMARY, CONCLUSIONS AND SUGGESTIONS FOR FURTHER WORK

6.1: Summary:

The present investigation entitled **"Effect of post harvest preservatives on vase life of chrysanthemum (*Dendranthema grandiflora* L.) cv. Hybrid-1"** was conducted during the period of September 2014 to March 2015 at the Department of Floriculture and Landscape Architecture, K.N.K. College of Horticulture, Mandsaur, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.).

The experiment was carried out in Completely Randomized Design with three replications. Nine post harvest preservative solutions were used to see the effect of post harvest preservatives on vase life of chrysanthemum cv. Hybrid-1. The findings of this experiment are summarized in the following heads below:

6.1.1: Flower head diameter

The effect of post harvest preservatives on flower head diameter was statistically significant. The maximum flower head diameter were recorded with T_7 treatment (4% Sucrose + 100 ppm Citric acid + 20 ppm $AgNO_3$), while the smallest head diameter of flowers was recorded in T_3 (2% Sucrose + 100 ppm Citric acid + 20 ppm $AgNO_3$) and T_6 (4% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$).

6.1.2: Change in fresh weight of flowers

The effect of preservative solutions on change in fresh weight of flower on 3rd day, 6th day, 9th day and at senescence was statistically significant.

The maximum increase in fresh weight of flowers on 3rd day and 6th day was observed in T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$). The

maximum increase in fresh weight of flowers on 9th day was recorded in T_5 (4% Sucrose + 50 ppm Citric acid + 20 ppm $AgNO_3$). The minimum increase in fresh weight of flowers on 3rd day, 6th day, 9th day was recorded in the control *i.e.* T_9 (Distilled water).

A decrease in fresh weight (%) of cut flowers from 9th day to senescence in vase was also observed. Among the preservative solutions the maximum weight of flowers at senescence was recorded with T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$), while the minimum weight of flowers at senescence was recorded in T_7 (4% Sucrose + 100 ppm Citric acid + 20 ppm $AgNO_3$).

6.1.3: Solution uptake by the flowers

The effect of preservative solutions on solution uptake by the flowers on 3rd day, 6th day, 9th day and at senescence (total solution uptake) was statistically significant.

Among the solutions the maximum solution uptake by the flowers on 3rd day, 6th day, and 9th day was recorded with T_2 (2% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$) and at senescence (total solution uptake) withT_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$) while the minimum solution uptake by the flowers on 3rd day, 6th day, 9th day and at senescence (total solution uptake) was recorded in under control.

6.1.4: Biochemical parameters of flowers

The effect of preservative solutions on anthocyanin content, petal T.S.S., soluble sugar content and reducing sugar content was statistically significant.

The maximum anthocyanin content in petals was recorded in T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$) and the minimum anthocyanin content in petals was recorded in the T_9 (Distilled water).

The maximum T.S.S. in petals (^{0}Brix) was recorded in T_1 (2% Sucrose + 50 ppm Citric acid + 20 ppm $AgNO_3$) and the minimum T.S.S. in petals was recorded in T_9 (Distilled water).

The maximum soluble sugar content in petals was recorded with T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$) and the minimum soluble sugar content in petals was recorded in the T_9 (Distilled water).

The maximum reducing sugar content in petals was recorded with T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$) and the minimum soluble sugar content in petals was recorded in T_9 (Distilled water).

6.1.5: Vase life of flowers

The vase life of flowers was significantly influenced by the post harvest preservative solutions. The maximum vase life of flowers was recorded in T_2 (2% Sucrose + 50 ppm Citric acid + 40 ppm $AgNO_3$), followed by T_8 (4% Sucrose + 100 ppm Citric acid + 40 ppm $AgNO_3$) while the minimum vase life of flowers was recorded in T_9 (Distilled water).

6.2 CONCLUSIONS

It is concluded from the present study that the role of post harvest preservative solutions is vital for the vase life, quality parameters and biochemical parameters of chrysanthemum.

In the present study the T_8 (4% Sucrose + 100 ppm + 40 ppm $AgNO_3$) was observed to be best in term of vase life, quality parameters and biochemical parameters of flowers *i.e.* solution uptake, change in fresh weight, pigment content, soluble sugar content and reducing sugar content, however T_2 (2% Sucrose + 50 ppm citric acid + 40 ppm $AgNO_3$) was found to be the best in terms of vase life and statistically similar to T_8 (4% Sucrose + 100 ppm citric acid + 40 ppm $AgNO_3$). While the T_1 (2% Sucrose + 50 ppm citric acid + 20 ppm $AgNO_3$) was found to be best in term of petal T.S.S. and maximum flower head diameter was recorded with T_7 (4% Sucrose + 100 ppm Citric acid + 20 ppm $AgNO_3$).

6.3 SUGGESTIONS FOR FURTHER WORK

Based on the results obtained in the present investigation, the following future line of work is suggested:

1. The findings of present study must be tested for confirmation.
2. The present study may be repeated with other varieties.
3. More number of preservative solutions may be tested for vase life, quality and biochemical parameters of the flowers.
4. Effect of natural preservatives may be tested on vase life, quality and biochemical parameters of the flowers.

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APPENDICES

Appendix- I: Analysis of variance for the flower head diameter (cm)

Source of Variation	D.F.	MSS
		Flower head diameter (cm.)
Treatment	8	0.092593
Error	18	0.033333
Total	26	

Appendix- III: Analysis of variance for the change in fresh weight (%) of flowers

Source of Variation	D.F.	MSS			
		Change in fresh weight of flowers (%)			
		On 3rd day	**On 6th day**	**On 9th day**	**At senescence**
Treatment	8	2.292362	8.314	26.329	25.841
Error	18	0.825993	8.711	6.704	17.577
Total	26				

Appendix- II: Analysis of variance for the solution uptake by flowers

Source of Variation	D.F.	MSS			
		Solution uptake by the flowers (ml)			
		On 3rd day	**On 6th day**	**On 9th day**	**At senescence**
Treatment	8	0.287	4.342593	12.204	47.204
Error	18	0.222	1.666667	2.148	7.778
Total	26				

Appendix- V: Analysis of variance for the biochemical parameters of flowers

Source of Variance	D.F.	MSS			
		Anthocyanin (mg/100g)	Petal T.S.S. (^{0}Brix)	Total soluble sugar (mg/g)	Reducing sugar (mg/g)
Treatment	8	6113.644	1.423704	0.570075	0.442118
Error	18	13.58382	0.034074	0.009422	0.018267
Total	26				

Appendix- IV: Analysis of variance for the vase life of flowers (days)

Source of Variation	D.F.	MSS
		Vase life of flowers (days)
Treatment	8	16.531
Error	18	6.593
Total	26	

VITA

The author of this thesis **Anil Kumar Ajneriya** was born on 02nd May 1990 at Sehore District (M.P.). He passed his Secondary Examination in the year 2006 from M.P. Board, Bhopal from Government Boys H. S. School Ashta, District Sehore (M.P) and Senior Secondary Examination in the year 2008 from M.P. Board, Bhopal from Excellence Higher Secondary School, Ashta, District Sehore (M.P). With 63.3% and 56 % marks respectively.

He joined College of Horticulture, Mandsaur in 2009 and completed B.Sc. (Horti.) in the year 2013 with 1st division securing an OGPA of 6.83 on 10 point scale.

After graduation, he joined M.Sc. (Horticulture) in College of Horticulture, Mandsaur specialization in Floriculture and Landscape Architecture. He has completed the entire course requirement for the above said Master Degree in the year 2015-16 with an OGPA of 7.32 on a 10 point scale.

He was allotted an interesting research problem entitled **"Effect of post harvest preservatives on vase life of chrysanthemum (*Dendranthema grandiflora*) cv. Hybrid-1"** of his choice for thesis work, which has been duly completed by him and presented in the form of this thesis.

(Anil Kumar Ajneriya)