“Effect of postharvest preservatives on vase life of cut rose (*Rosa hybrida* L.) cv. Top Secret”

THESIS

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Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya

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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 postharvest preservatives on vase life of cut rose (*Rosa hybrida* L.) cv. Top Secret"** submitted in partial fulfillment of the requirement for the Degree of **MASTER OF SCIENCE (AGRICULTURE)** in **HORTICULTURE** (**Floriculture and Landscape Architecture**) of Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior(M.P.) is a record of the bona-fide research work carried out by **Miss Shiwani Kshirsagar** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instruction.

No part of 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.

(Dr. Anuj Kumar)
Chairman of the Advisory Committee

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CERTIFICATE – II

This is to certify that the thesis entitled **"Effect of postharvest preservatives on vase life of cut rose (*Rosa hybrida* L.) cv. Top Secret"** Submitted by **Miss SHIWANI KSHIRSAGAR** to the Rajmata Vijayaraje Scindia Krishi Vishwavidyalaya, Gwalior in partial fulfillment of the requirements for the degree of **Master of Science (Agriculture)** in **HORTICULTURE** in the department of **Floriculture and Landscape Architecture** has been accepted 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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List of Symbol

Symbol	:	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
cv.	:	Cultivar
^{o}B	:	Degree Brix
et al.	:	et-alai
Fig.	:	Figure
g	:	Gram (s)
ha	:	Hectare
i.e.	:	That is
Kg	:	Kilogram (s)
m	:	Meter
M. S. S.	:	Mean Sum of Square
m^2	:	Meter square
Max.	:	Maximum
Min.	:	Minimum
Ml	:	Milliliter
Min.	:	Minimum
No.	:	Number
NS	:	Non Significant
RH	:	Relative Humidity
RVSKVV	:	Rajmata Vijayaraje Scindia Krishi Vishwavidyalaya
S.Em	:	Standard error of mean
Sig.	:	Significant
Viz.	:	(Videlicet) Namely
Spp.	:	Species
TSS	:	Total Soluble solid
MFHD	:	Maximum flower head diameter
RFW	:	Relative fresh weight

Chapter - I
Introduction

The rose (*Rosa hybrida* L.) is a woody perennial flowering plant and most popular flower of all gardens throughout the world.It is an indication of love, perfection, elegance and romance. It was called “The Queen of Flowers” firstly by Greek poetess in her “Ode to the Rose” (Muhummad *et al*., 1996). Rose is belonging to family Rosaceae and genus Rosa. A numbers of species are found in the northern temperate climate zone, tropical and subtropical parts of the world (Zlesak, 2006). It is hard to imagine a garden without roses (Farahat *et al.*, 2014). Apart from being admired for its beauty, rose is used in worship, garlands, bouquets, cut flowers preservers and decorations etc. because of variation in growth habit, shape, size, form, colour, fragrance and so many varieties, rose have wide suitability.Roses are acknowledged extremely beneficial for economical benefits being the good source of unprocessed material for cosmetics, perfumery and other agro-based industries. Gulkand is a value added product of rose petals used as a good digestive tonic and blood purifiers. Fruits are applied on wound, sprain, injuries and foul ulcer. Rose hips are used to make rose syrup which is rich in vitamin ‘C’ and used for different purpose.

It secures 1st position in world floriculture trade. Rose is one of the important cut flower, which have great demand in the national as well as international market. Major rose growing countries are France, Spain, USA, Italy, South Africa, and India. Rose is one of the potentially valuable cut flower and is an important commercial flower crop of our country. In India cut roses are grown in different parts of the country in which, Karnataka and Maharastra are major rose growing state of the country followed by Tamil Nadu, West Bengal and Himachal Pradesh.

Post harvest life is an important criteria for evaluation of cut flower quality,for both domestic and international markets.It has been established that the post harvest behavior of rose is an outcome of the physiological processes occurring in the leaves, stem, flower bud, the leafless peduncle connecting the bud to the stem and other related thing. Mineral nutrition, foliar feeding, irrigation and growth regulator sprays were found to influence vase life and post harvest quality of cut rose. Vase life is the period during which cut flower or cut foliage maintain its appearance in a vase. Vase life refers to the duration of time cut flowers retains their appearance and aesthetic value, especially when sitting vase water.

The vase life of cut flower with its keeping quality is most important and economic for rose growing farmers. Improvement of the keeping quality and enhancement of vase life of cut rose is an important area of research. Although various techniques have been developed to extend the vase life, however, there is a need to develop a simple method, which may be followed right at the producer end.

Vase life of cut rose is depends on different factors like air, water, and microorganisms like bacteria, fungus etc. Stem end blockage and the imbalance between water uptake and water loss from cut flowers are another factors which affects vase life of cut roses. Water balance is a factor determining quality and longevity of cut flowers. Vase life of cut rose flowers is usually short, and it related to wilting, ethylene production and vascular blockage by air and microorganisms (Elgimabi, 2011).

The senescence is the last stage of development processes that lead to death of flower, the reason behind this phenomenon is the reduction of energy during growth and development (Figueroa *et al*., 2005). It seems that supply of exogenous carbohydrate should be sufficient to delay the vase life (Kaltaler & Steponkus, 1976) and supply a cellular respiration (Cho *et al*., 2001). The vase life of flowers a large number of preservatives are available in the market in which sucrose, $AgNo_3$ and Boric acid are important chemical preservatives, which are mostly used to enhance the vase life of different flower crops. Addition of different preservative solution is recommended to enhance the vase life of cut flowers (Ichimura *et al*., 2006).

In flower, respiration is an important process for growth and flowering, in which sugar plays key role for respiration, growth and supply all essential components to flower buds (Sarkka 2005). Sugars are good source of food that provides carbohydrates energy to flower stem to regulate the metabolic process. The counter effect of defoliation in petal colour and bud blasting can be overcome by addition of sugars in form of sucrose. Carbohydrate is a major source of food and energy, reduction of carbohydrates may be resulted in form of vase life reduction of cut flowers.

Silver salts like, Silver nitrate ($AgNO_3$) is an important floral preservatives and act as ethylene inhibitor and as a germicide for extending vase life. (Singh and Tiwari, 2002).

Boric acid is another compound which delays senescence on vase life of cut flowers (Serrano *et al.,* 2001). It inhibits ethylene production through reducing ACC synthase and ACC oxidase activities. (Serrano *et al.,* 2001).

Therefore, keeping in view these facts, the present investigation entitled **"Effect of postharvest preservatives on vase life of cut rose (*Rosa hybrida* L.) cv. Top Secret"** aims to achieve the following objectives.

1. To see the effect of different post harvest preservatives on vase life of cut roses.
2. To find out the best post harvest preservatives on vase life of cut roses.
3. To study the biochemical changes associated with post harvest life and quality of cut roses.

Chapter – II

REVIEW OF LITERATURE

An experiment entitled "Effect of postharvest preservatives on vase life of cut rose (*Rosa hybrida* L.) cv.Top Secret**"** was conducted at the Department of Floriculture and Landscape Architecture., College of Horticulture, Mandsaur during October, 2019-20.

In this chapter an attempt has been made to review the researches an effect of different concentration of post harvest preservative on vase life of cut rose.

2.1: Effect of post harvest preservatives on vase life of cut roses

Dias (1994) conducted an experiment in rose 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 Raktgandha cut rose was studied and the highest gain in fresh weight on 3rd day in vase was recorded by $AgNO_3$ at 1mM pulsing for 15 minutes.

Singh and Tiwari (2000) studied that effect of pulsing with $AgNO_{3,}$ SADH, NAA and STS along with 6% sucrose for increasing vase life and quality of rose cv. 'Happiness'. All these chemicals conspicuously influenced weight loss, diameter of fully open flower and total solution uptake and vase life expect STS.

Knee (2002) conducted an experiment to see the effects of concentrations of various biocides, in a solution containing 0.2 g l^{-1} citric acid and 10g l^{-1} glucose on cut roses (*Rosa hybrida* L., 'Classy'), *Alstroemeria pelegrina* L. and carnations (*Dianthus caryophyllus* L.). At this concentration, bromopropanediol, dantogard and thiabendazole did not prevent a rise in stem resistance to water flow, or solution absorbance. Tests with carnation and *Alstroemeria* indicated that HQC, Isocil and Physan most consistently promoted fresh weight increase and maintenance.

Chamani *et al.* (2005) conducted an experiment to see the effects of ethylene and anti-ethylene treatments on postharvest life of cut rose cv. First

Red. Ethylene production measurements suggested that 'First Red' rose is climacteric during senescence. Maximum vase life in both ethylene-treated and non-ethylene-treated 'First Red' rose flowers was obtained with 0.5 mM STS.

Butt (2005) carried out an experiment to see the effect of sucrose and $AgNo_3$ at different cultivar of rose and they found that different treatments had significant effect on each cultivar. Among the treatment silver nitrate gave better performance than the sucrose with respect of shelf life of cut flowers of both the cultivars. The concentration of sucrose @25 g l^{-1} superseded over the other sucrose concentrations.

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

Bayleyegn *et al.*(2011) conducted an experiment to see four pulsing solutions (s*ilver thiosulfate* + Chrysal clear solution (RVB), s*ilver thiosulfate* + *8-hydroxyquinoline sulphate*, *silver thiosulfate* + Chrysal clear solution + *hydroxyquinolinesulphate*and H_2O), two packaging types (cardboard box and box with polyethylene bag) and four storage period intervals (0, 2, 3 and 4 weeks) on flower quality passive refrigeration system. Passive refrigeration system and pulsed with mixtures of *silver thiosulfate*, Chrysal clear solution and *8-hydroxyquinoline sulphate*were maintained a fresh-like quality of flowers.

Elgimabi (2011) observed that the flower vase life was prolonged by $AgNO_3$ treatments. The best concentration was 30 ppm. The effect was further improved when $AgNO_3$ combined with 3% sucrose, which was recorded the best vase life compared to other concentrations of sucrose. $AgNO_3$ at 30 PPM retarded the chlorophyll as well as carbohydrate degradation during the postharvest life.

Tsegaw *et al*. (2011) carried out an experiment to develop the possibilities of extending vase life of cut rose. The experiment consist three verities of rose (Red Calipso, Akito, and Viva) and different pulsing solutions comprising biocides (1g $Al_2(SO4)_3l^{-1}$, 0.4 ml $HQSl^{-1}$, 0.6 ml $NaOCll^{-1}$, 0.6g Ca $(ClO)_2l^{-1}$, 10 g l^{-1} long life, distilled water and tap water as control. Data indicate that $NaOCLl^{-1}$ and HQS extend the vase life of cut flowers and these preservatives could be considered as alternatives to Al_2 $(SO_4)_3$ currently on use in most of the cut flower industry in Ethiopia.

Seyf *et al.* (2012) conducted an experiment to see the effect of different concentration of aluminum sulfate (150 and 300 mgl^{-1}) on vase life of rose. Data revealed that Al_2 $(SO_4)_3$ showed the better performance with respect of most of the parameters studied under the investigation i.e. water uptake, bud opening, flower diameter etc.

Hajizadeh *et al.* (2012) conducted an experiment to see the effect of some effective chemical holding treatments on the vase life of rose (*Rosa hybrida*L.) cv. Black Magic. The result showed that ethanol and aluminum sulfate treatments had the most important role in the extending longevity as well as water uptake.

Elgimabi *et al*. (2013) carried out an experiment to see the effect of exogenous 8-hydroxyquniline sulfate (8-HQS) and sucrose on vase life of Taifrose cut flowers. The pulsing treatment was given for, 10 or 24 hours, and further transferred to distill water as control.The cut flowers selected in three stages of maturity (bud, half opening or complete opening). Experiment was conducted at room temperature (23±1°C), normal day light and natural ventilation. Data indicate that 8-HQS treatment showed the best results with respect of vase life of cut flowers.

Raj *et al*. (2013) conducted an experiment to see the effect of various chemical combinations on vase life and other quality parameters of cut rose flower cv. "Grand Gala". Different chemical combinations consisted of silver nitrate, citric acid, salicylic acid, aluminium sulphate and sucrose. All the treatments shows significant increase in vase life over control (distilled water). Among all the treatments, treatment T_2 (4% sucrose + silver nitrate 100 ppm pulsed for 24 hrs) was found most effective in enhancing the vase life (10 days) and maximum flower diameter of cut rose. However,maximum water uptake was recorded with the pulsing treatment T_{11} (4 % sucrose + $Al_2(SO_4)_3$ 100 ppm for 24 hrs) at senescence.

Gebremedhin *et al*. (2013). The experiment was carried out to asses the influence of five preservative solutions (aluminium + ethanol, aluminium + sucrose, ethnol + sucrose, aluminium + ethanol + sucrose and water) on two rose cultivars (‘Red Sky’ and ‘Blizzard’). The study was to identify the best combination of preservative solutions on rose cultivars. Aluminium + ethanol + sucrose preservative solution treated cut flowers had shown longest vase life, flower opening, solution uptake, petal fresh weight and TSS in both cultivars; while the values were significantly higher in ‘Red Sky’ cultivar. The findings provide an alternative for extending the vase life of cut roses and thereby ensure the satisfaction of flower users and sustainability of cut rose flower production.

Hashemabad *et al.* (2014) recorded that the effect of nano-silver and boric acid as either solitary or in combination with each other were significant (p≤0.01) on vase life, ethylene production and β-carotene pigment. The highest cut flower -Longevity (9.69 day) was obtained in pulse-treated flowers with 100 mg ^{1}boric acid. The least ethylene production was observed in cut rose treated with 100 mg ^{l} boric acid along with 5 mg l nano-silver.

Farahat *et al*. (2014) Studies were conducted a studyto determine the effects of preservative solutions of potassium chloride, aluminium sulfate ($Al_2(SO4)_3$) and 8- hydroxyl quinoline sulfate (8-HQS) on rose cut flowers. Potassium chloride at 100, 200 or 300 ppm, aluminium sulfate at 50, 100 or 200 ppm and 8- hydroxyquinoline sulfate at 125, 250 or 500 ppm as well as control (tap water) were investigated. Sucrose 5% was added with all chemical treatments. Data indicate that Al_2 $(SO_4)_3$ 50 ppm + Sucrose 5% showed best results with respect of leaf water content as compared to other treatments.

Khan *et al.* (2015) conducted an experiment to see the response of chemical preservatives on vase life of cut rose. Treatment Combined application of sugar and salicylic acid (Sugar + Salicylic Acid (50-ppm));shows the best results with respect of most of the parameters i.e. maximum stem diameter, period for first petal spreading petal water content and vase life. On the other hand, minimum flower head diameter, petal discoloration score, and flower freshness score were also found from T_7 Combined application of sugar and salicylic acid was the best among the chemicals used for extending vase life of cut rose cv. Red pearl.

Tatte *et al.* (2016) conducted an experiment to study the effect of different polyamines and natural growth substances as a pre harvest foliar spray on greenhouse rose cv. Samurai. The study involved pre-harvest foliar spraying with polyamines like spermine (10 ppm) and spermidine (10 ppm); natural growth substances like enriched banana pseudostem sap (1 per cent) and cow urine%. All the treatments improved the vegetative and flowering characters over control. The treatment of foliar spray with spermine and spermidine almost doubled the flower production and improved the flower quality in terms of bud size and vase life as compared to control.

Lee (2017) investigated the antimicrobial effect of chlorine dioxide (ClO_2) on the vase life of cut rose (*Rosa hybrida* L. 'Beast'), which were maintained in a standard holding solution containing 2% sugar. The relative fresh weight and water uptake of the cut flowers were dramatically decreased in the sucrose solution without ClO_2. These results indicate an antimicrobial activity of ClO_2 that is useful for extending the postharvest life of cut rose flowers in a vase solution that contains sucrose.

Kinfe *et al*. (2018) conducted an experiment to assess the vase life of rose cut flowers in Eritrea through the use of preservative solutions. The treatments were water (control), sucrose (5%), citric acid (CA) (300 ppm), combination of sucrose (5%) + citric acid (CA) (300 PPM); combination of sucrose (5%)+citric acid (CA) (300 PPM) with various concentrations (100, 200, 300 ppm) of 8-hydroxyquinoline (8-HQ) and Aluminum sulphate. The results demonstrated that the flowers which were treated with 8-hydroxyquinoline of 200 ppm combined with 5% of sucrose and 300 ppm of citric acid experienced the highest vase life of cut flowers (25 days) which was found to be significantly superior as compared to the control by acting as an antimicrobial agent, increasing water uptake, lowering pH and improving the carbohydrate supply.

2.2 Effect of postharvest preservatives on vase life of other flowers

ORCHID

Thwala *et al.* (2013) conducted an experiment to determine the effect of different floral preservative on the vase life of orchids. Four floral preservative solutions viz.Chrysal (commercial floral preservative) and different homemade floral preservatives: vinegar, apple juice and laundry bleach JIK; lemon juice, Sprite and Ritebr and bleach; and lime juice, sugar, Listerine mouth wash (homemade floral preservatives) were used. Homemade floral preservative combinations of Lemon,Sprite and Ritebrand bleach and lime, sugar and Listerine could, therefore be recommended for pre-treatment of Epidendrum orchid cut flowers for best results.

Uthairatanakij *et al*, (2013) carried out a study to investigate the effect of food additives on quality and vase life of *Dendrobium*cv 'Red Sonia' .Inflorescence were put into vase solutions of potassium carbonate at 1.75 and 2% sodium carbonate at 1.50, 1.75 and 2%, distilled water and a commercial flower preservative solution served as the control. The commercial solution increased fresh weight significantly. Inflorescences placed in distilled water had the longest vase life due to decreased flower dropping. The vase life of inflorescences placed in the commercial solution, potassium carbonate, and sodium carbonate were 14.5, 9-10 and 6-7 days, respectively.

Tuberose

Asil *et al.* (2011) carried out an experiment to see the effect of different chemical treatments on quantitative characteristics of Polianthes tuberosa L. (cv. Goldorosht Mahallat). The results showed that, the maximum vase life of cut flower was recorded with BA at 100 ppm.

Gladiolus

Kumar *et al.* (2010) conducted an experiment to see the response of floral preservatives on vase life of gladiolus cv. White Prosperity. Result showed that the treatment of 4% sucrose +250 ppm 8-hydroxy quinoline citrate tended to increase the days to basal floret opening (4.72 days), floral size (12.76 and 14.58 cm) of fifth and second floret, respectively Length of spike (9.84 cm), vase life (10.07 days), vase solution uptake (31.30 ml) and longevity of first five florets was registered to be the highest in spikes treated with 4 % sucrose + 300 ppm $Al_2(SO_4)_3$. The minimum values for these traits were recorded in untreated control.

Kumar (2014) an experiment conducted to prolong the post-harvest life of tuberose using single or combined holding solutions. Twelve holding solutions, viz. T_1 : 5% Sucrose+ 50 ppm $AgNO_3$, T_2 : 5% Sucrose + 100 ppm $AgNO_3$, T_3 : 5% Sucrose+ 200 ppm $Al_2(SO_4)_3$, T_4 : 5% Sucrose+ 400 ppm $Al_2(SO_4)_3$, T_5 : 5% Sucrose + 200 ppm Citric Acid, T_6 : 5% Sucrose + 400 ppm Citric Acid, T_7 : 5% Sucrose+ 200 ppm 8HQC and T_8 : 5% Sucrose + 50 ppm Calcium hypochlorite, T_9 : Control (Deionized water) were used. The results showed that the maximum vase life, floret size, number of florets open at senescence of basal floret and floret opening percentage were obtained under the treatment T_7 when spikes were held in the solutions of 5%Sucrose +300 ppm 8 HQC.

Manzoor *et al*. (2018) conducted with an objective to investigate the effect of four preservative solutions [distilled water, Sucrose (3%), $AgNO_3$ (250ppm)+Sucrose (3%),$AgNO_3$ (250ppm),] and packaging material on post harvest quality of three gladiolus varieties viz.Tissue,White Prosperity and Alexandra.Result showed that preservative solution having combination of $AgNO_3$ (250ppm)+Sucrose (3%) significantly improves days to open basal floret ,floret opening percentage ,bloom spread ,floret length ,floret diameter ,fresh spike weight dry spike ,fresh weight loss and vase life Moreover,this treatment was also effective in reducing the wilting (%) in all gladiolus varieties. However,for solution uptake (ml/spike) and solution balance (ml/spike) , $AgNO_3$ (250ppm), alone give best result.

Lily

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 intensity of petal colour.

Kim *et al*. (2005). Studied on effects of pre-treatment substances on vase life and physiological character of cut *Lilium* Oriental hybrid 'Siberia' and *Lilium* Asiatic hybrid 'Dream Land.When florets of 'Siberia' were treated with Promalin (GA_{4+7}+BA), the vase life was increased as compared to other treatments. The amount of ethylene produced continuously decreased and respiration rate showed a climacteric type rise on the 5th day. When florets of 'Dream Land' were treated with GA_{4+7} and Promalin, the vase life increased. The amount of ethylene production and respiration rate showed peak points on the 1st day. Also, the sugar contents showed the same results as with 'Siberia'.

Wani *et al.* (2010) conducted the experiment to study the effect of different holding solutions on post harvest quality of cut Asiatic lilium cv. Novecento. Uniform sized spikes of lilium at first bud colour break stage were harvested and kept in 8 different holding solutions comprised of Sucrose 2%, AS 100 ppm and STS 0.5 mM alone and in combinations. Data indicate that holding of spikes in Sucrose 2% plus STS 0.5 mM resulted in greatest water balance and flower size with maximum vase life of 16.93 days as compared with 11.21 days in control.

Chaudhary *et al.* (2016) carried out an experiment to study the effect of post harvest treatments and harvesting stage on vase life and flower quality of cut Oriental lily cv. Avocado. Based on the results it was concluded that 5-SSA could be an inexpensive and potential chemical for delaying senescence and for extending the keeping quality of cut liliums commercially.

Gerbera

Acharyya *et al*. (2013) evaluated three cultivars of gerbera viz., 'Dana Ellen', 'Rosalin' and 'Sun Way' were to twelve different treatment combinations, six of which were used as pulse treatment and the rest as holding solution. Pulsing treatment with $AgNO_3$ (1000 ppm) + Sucrose 4% in distilled water as holding showed significant beneficial effect in extending the vase life of all the three cultivars. Treatment combination $AgNO_3$ (100 ppm) + sucrose 4% + distilled water as holding solution was envisaged as the second best in extending the vase life of cut flowers.

Geshnizjany *et al*. (2014) evaluated the effects of Nano-silver (NS), calcium chloride ($CaCl_2$) and their combinations on *Gerbera jamesonii* 'Carambole' cut flowers. Treatments consisted of 5 mg L^{-1}NS, 1% and 2% $CaCl_2$5 mg L^{-1} NS+ 1% $CaCl_2$, 5 mg L^{-1} NS + 2% $CaCl_2$, 0.1% and 0.2% $CaCl_2$, 5 mg L^{-1} NS + 0.1% $CaCl_2$, 5 mg L^{-1} NS + 0.2% $CaCl_2$ and a control. It was revealed that $CaCl_2$ postharvest spray, NS in a vase solution, as well as their combinations could significantly increase the vase life of gerbera flowers. The longest postharvest life of treated flowers was obtained from 5 mg L^{-1} NS and 5 mg L^{-1} NS + 1% $CaCl_2$ treatments.

Jafarpour *et al.* (2015) aimed to investigated the effects of chemical, hormonal and essential oil substances in preservative solutions to improve its postharvest qualitative characteristics. Two pulse treatments including distilled water (pulse1) and 4% CaCl2 + 3% sucrose (pulse2) for 24 hour were applied before long-time treatments. Among all treatments, 8-HQS treatment showed the best effects on preventing stem bending, increasing capitulum diameter and also on prolonging of vase-life.

Mehraj *et al.* (2016) evaluated that the postharvest life of cut gerbera cultivars under the different preservative solutions. Three type yellow, Magenta and Orange) cut gerbera cultivars were placed on nine different preservative solutions .Yellow gerbera maximum petals water content when placed in T_9 and also showed 8.0 days more vase life compared to the control. For Magenta and Orange gerbera, maximum petals water content in T_8 and same treatment was also resulted higher vase life (6.9 days) compare to control.

Daisy

Patil (2009) conducted an experiment to study the effect of chemical preservatives on post harvest quality of Daisy. The maximum fresh weight of flowers was noticed in treatments 8-HQS 0.4 percent (116.7) followed by 0.2 per cent (116.00%) on sixth day which were significantly superior over all other treatments. Among all the treatments, the flowers kept in vase solution containing chemicals like 8-HQS at 0.4 per cent, had high amount of water uptake. Flower stalks which absorbed the maximum amount of water were the ones which also lost the maximum amount of water of

244.33 (8-HQS at 0.4%). The flower stalks held in solutions having 8-HQS at 0.4 per cent and 0.2 per cent had significantly enhanced the vase.

Chrysanthemum

Jain *et al*. (2009) evaluated five spray type cultivars of Chrysanthemum viz. Kanchil, Shyamal, Flirt, Ravikiran and Kargil or carrying out post harvest studies. Different floral preservative treatments consisted of citric acid,aluminiumsulphate, sucrose and their combination were used. Maximum vase life and solution was observed in cv. Shyamal while maximum flower diameter (6.99 cm) was recorded in cv. Ravikiran.

Amin (2017) conducted an experiment to see the effect of some preservative solutions at different concentrations on three cultivars of cut chrysanthemum. Results indicated that many aspects of postharvest quality such as longevity, loss of water, uptake rates, relative fresh weight and flower head diameters were significantly influenced by different types of preservative combinations. In the first experiment, salicylic acid influenced post harvest characteristics, suggesting a potential application of salicylic acid as a substitute for chemicals commonly used in preservative solutions. In the second experiment, the best treatment was ethanol at 3% as it increased vase life, decreased water loss, enhanced relative fresh weight and diameter of flower heads.

Bird of paradise

Motaghayer (2009). Effect of different concentrations of 4 presrvatives,8-HQS, citric acid, silver nitrate and sucrose in water (Hamedan city tap water, Hamedancookled boiled water and Doubkle distilled water) on vase life of tuberose (*Polianthestuberosa*L.)was studied. The best preservative solution for tuberose cut flower was 2% sucrose in double distilled water, which performed significantly better than other treatments.

Gendy and Mahmoud (2012) studied the effects of some preservatives materials treatments viz. {Silver thiosulphate (STS), 8-hydroxy quinolenesulphate (8-HQS), sucrose (S), ethanol extracts from sweet basil (*Ocimumbasilicum*L., Labiatae) and German chamomile

(*Matricariachamomilla*L., Compositae)} as pulsing solutions and {sucrose (S), 8-hydroxy quinolenesulphate (8-HQS) and citric acid}as holding solutions as well as their combination ones on the postharvest characters, water relation characters, bacterial counts and some chemical constituents of *Strelitziareginae*cut flower.

Carnation

Thorat *et al.*(2008) reported that the vase solution of sucrose (4%)+ 8-HQC(400ppm)+$AgNO_3$ (50ppm) increased the weight of carnation cut flower by promoting solution uptake at 3^{rd} ,6^{th} ,9^{th} and 12^{th}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.

Terék *et al.*(2010) carried out an experiment to see the effect of 1-MCP combined with Clorox and sucrose on flowers of *Dianthus caryophyllus* ‘Gioko’. Results showed that 1-MCP gave the better results with respect of vase life and other parameters studied under this investigation.

Basiri *et al.* (2011) conducted to see theefficacy of nanosilver (NS) as an anti-bactericidal agent in extending the vase life of cut flowers of carnation (*Dianthus caryophyllus*L.). Results showed that all NS treatments were combined with sugar extended the vase life of carnation flowers significantly compared with control. Observations indicated that NS treatments inhibited the growth of microorganisms in vase solution and considerably extend the vase life of cut flowers of carnation.

Roodbaraky *et al.* (2012) studied, the effect of salicylic acid on vase life and postharvest quality of cut carnation (*Dianthus caryophyllus* L. 'Liberty Abgr') . The experiment was conducted based on completely randomized design with salicylic acid in 4 concentrations (0, 50, 100 and 150 mgl^{-1}) and 3 replications. Analysis of variance revealed that the effect of salicylic acid on vase life and water absorption ($p\leq0.05$) and bacterial colonies population in vase solution and dry matter percentage ($p\leq0.01$

Sweet Pea

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

Elhindi (2012) conducted an experiment to study the effects on keeping quality and vase-life of the cut spikes of sweet pea (*Lathyrus odoratus* L.) kept in 2% sucrose, 200 ppm 8-hydroxyquinoline sulfate (8-HQS), pulsing treatment with 200 ppm 8-HQS in combination with 2% sucrose for 12 h, pulsing the spikes.The results showed that all treatments had improved the keeping quality and vase-life of the cut flowers comparing to control ones.

El.Shewaikh *et al*. (2018) conducted an experiment to see the effect of GA_3, BA, 8-HQC, CA and Sugar on shelf life of sweet pea. The results showed that, the treatment of the solution containing T_{14}: GA3 at 50 ppm + BA at 20 ppm + 8-HQC at 300 ppm + CA at 300 ppm + Sugar at 2%, followed by the solution containing the GA_3 at 50 ppm + BA at 20 ppm + CA at 300 ppm + Sugar at 2% significantly increased the water uptake, water balance, general appearance, vase life, concentration of chlorophyll a, b, carotenoids and total carbohydrates.

Anthurium

Agampodiand Jayawardena (2007) conducted an experiment to see the effect of coconut water on vase life of anthurium cut flowers. The fresh flowers were treated with 40%, 50% and 60% fresh coconut water solutions. Distilled water and 5% sucrose was used as control and standard. All treatments inclusive of standard and control contained 0.23% NaOcl as a biocide. Flowers treated with 50% of coconut water with 0.23% NaOcl recorded the longest vase life compared control and other treatments.

CHAPTER-III
MATERIALS AND METHODS

The experimental material used for different treatment during the experiment is being presented in this chapter. The experiment entitled **"Effect of postharvest preservatives on vase life of cut rose (*Rosa hybrid L.*) cv. Top Secret"** was done during October, 2019. Details of the method and techniques used in the course of the investigation are given below:

3.1: Experimental Site

The experiment was conducted at the Department of Floriculture and Landscape Architechture, K.N.K. College of Horticulture, Mandsaur, Rajmata Vijayaraje Scindia Krishi Vishwavidyalaya, Gwalior. (MP) during October, 2019. Mandsaur is situated in Malwa plateau in Western part of Madhya Pradesh. This Region comes under Agro Climatic Zone No. 10 of the state.

3.2: Climate of the Region

Mandsaur belongs to sub-tropical climate having a mean temperature range of minimum 5°C and maximum 44^{0}C in winter and summer, respectively. South-west monsoon is responsible for major part of annual precipitation. The average annual rainfall is 544.05 mm. In this area most of the rainfall is received during early July to August with occasional shower in winter. 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: Daily meteorological observations during the study period (October - 2019)

S.No.	Date	Minimum ^0C	Maximum ^0C	Relative Humidity %
1.	1-Oct-19	21	31	90
2.	2-Oct-19	20	29	95
3.	3-Oct-19	21	30	90
4.	4-Oct-19	22	32	88
5.	5-Oct-19	22	33	86
6.	6-Oct-19	23	33	88
7.	7-Oct-19	22	32	80
8.	8-Oct-19	21	32	60
9.	9-Oct-19	22	33	58
10.	10-Oct-19	23	33	55
11.	11-Oct-19	22	33	45
12.	12-Oct-19	22	34	52
13.	13-Oct-19	21	32	67
14.	14-Oct-19	22	33	65
15.	15-Oct-19	21	33	66
16.	16-Oct-19	21	34	62
17.	17-Oct-19	20	33	65
18.	18-Oct-19	20	33	66
19.	19-Oct-19	19	33	62
20.	20-Oct-19	20	32	68
21.	21-Oct-19	21	31	70
22.	22-Oct-19	19	30	71
23.	23-Oct-19	18	30	75
24.	24-Oct-19	17	30	77
25.	25-Oct-19	17	31	72
26.	26-Oct-19	17	30	74
27.	27-Oct-19	17	29	73
28.	28-Oct-19	19	28	72
29.	29-Oct-19	20	29	75
30.	30-Oct-19	19	31	79
31.	31-Oct-19	19	29	68

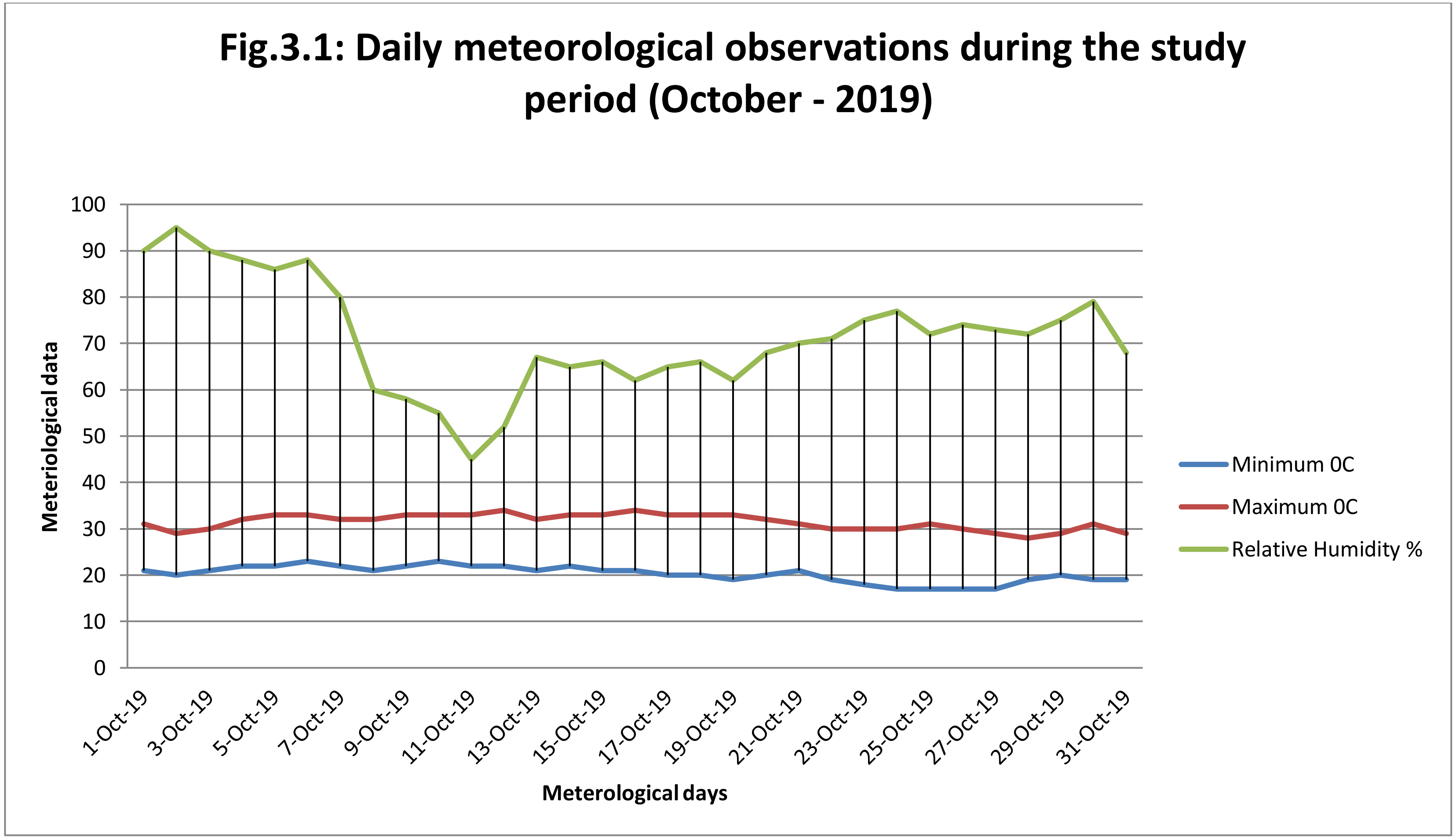


Fig.3.1: Daily meteorological observations during the study period (October - 2019)
100
90
80
70
60
50
40
30
20
10
0
Meteriological data
1-Oct-19
3-Oct-19
5-Oct-19
7-Oct-19
9-Oct-19
11-Oct-19
13-Oct-19
15-Oct-19
17-Oct-19
19-Oct-19
21-Oct-19
23-Oct-19
25-Oct-19
27-Oct-19
29-Oct-19
31-Oct-19
Meterological days
Minimum 0C
Maximum 0C
Relative Humidity %

Table 3.2: Experimental Details

Location Name of crop	: :	K.N.K. College of Horticulture, Mandsaur (M.P.) Rose (*Rosa hybrida* L.)
Name of variety	:	Top Secret
Number of cultivars	:	01
Number of replications	:	03
Number of treatments	:	14 (14 Postharvest preservative solution)
Number of flower stems per treatment per replication	:	05
Total number of flower stems	:	210

3.3: Details of Treatment

A. Postharvest preservatives

Co - Control (Distilled Water)

S_1 - Sucrose 2%

Ag_1 - $AgNO_3$ 30 ppm

Ag_2 - $AgNO_3$ 60 ppm

BO_1 - 75 mg/l

BO_2 - 100 mg/l

B. Variety:

1. Top Secret

Table - 3.3 Treatment Combinations

Treatment	Combinations
T_1	Control (Distilled Water)
T_2	S_1
T_3	Ag_1
T_4	Ag_2
T_5	BO_1
T_6	BO_2
T_7	S_1+Ag_1
T_8	S_1+Ag_2
T_9	S_1+BO_1
T_{10}	S_1+BO_2
T_{11}	$S_1+Ag_1+BO_1$
T_{12}	$S_1+Ag_1+BO_2$
T_{13}	$S_1+Ag_2+BO_1$
T_{14}	$S_1+Ag_2+BO_2$

Fig.3.2 Experimental design and layout:

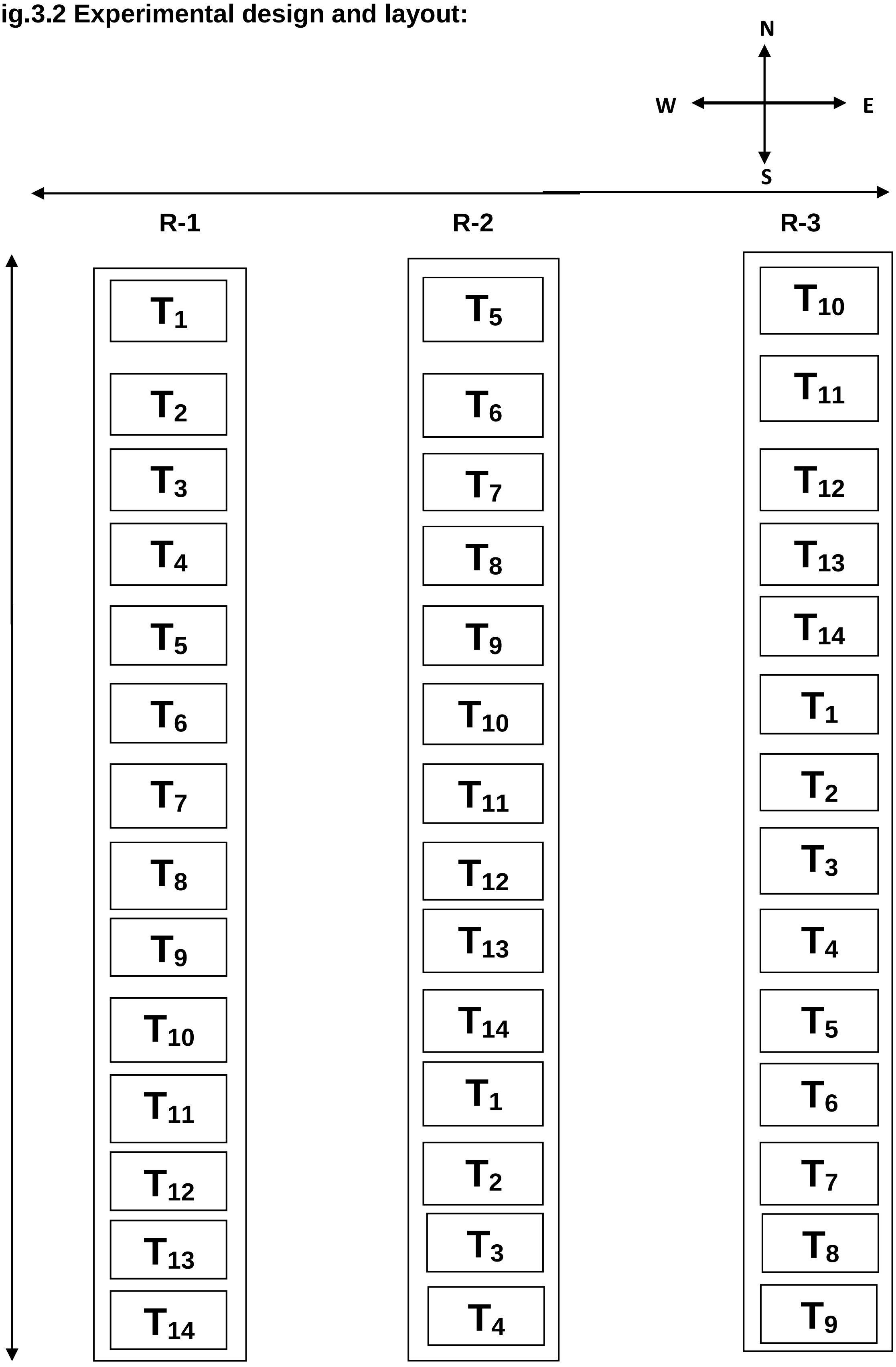


Plate 1:- A view of expriment

Cut flowers of roses were obtained from a commercial grower in Ratlam (M.P.). The variety used in the experiment was Top Secret. The flowers of uniform size and colour, free from pests and disease were selected for the experiment. After harvesting at tight bud stage the flowers were placed immediately in clean water. Harvested flowers were kept under shade and transported within 5 hours to the laboratory. Then flowers were brought to the laboratory for the vase life study.

3.5: Observations recorded:

1. Days taken for 1st petal spreading
2. Solution uptake at 3rdday (ml)
3. Solution uptake at 5thday (ml)
4. Solution uptake at senescence (ml)
5. Change in weight of flower at 3rdday (g)
6. Change in weight of flower at 5thday (g)
7. Change in weight of flower at senescence (g)
8. Relative fresh weight at 3rd day of vase
9. Relative fresh weight at 5th day of vase
10. Relative fresh weight at senescence
11. Flower Freshness Score
12. Maximum flower head diameter (cm)
13. Petal discoloration score
14. Change in total soluble solid (^{0}B)
15. Change in Chlorophyll content
16. Change in Anthocyanin content (mg/100 g)
17. Vase life (days)

3.5.1: Days taken for 1st petal spreading

Observations are recorded when 1st petal of flower was spread.

3.5.2: Solution uptake (ml) on the 3rdday

Initially the volume of vase solution was taken 200 ml uniformly for all the treatments. The volume of vase solution was measured by using a measuring cylinder on the 3rd day. The difference between the initial volume (on 1st day) and final volume (on 3rd day of vase life) was expressed as the solution uptake.

3.5.3: Solution uptake (ml) on the 5th day

The difference between the initial volume (on the 1st day) and final volume (on 5th day of vase life) was e9xpressed as the solution uptake on 6th day of vase life.

3.5.4: Solution uptake (ml) at senescence/Total uptake of solution (ml)

The difference between the initial volume (on the 1st day) and final volume (at senescence) was expressed as the total solution uptake.

3.5.5: Change in weight of flowers (g) on 3rd day in the vase

Change in fresh weight was calculated through below formula

change in weight of flower = weight of flower at 1st day – weight of flower at 3rd day.

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

3.5.6: Change in weight of flower (g) on 5th day in the vase

Flowers were removed from the vase solution on 5th day in the vase and again weighed with the help of electronic balance.

3.5.7: Change in weight of flower (%) at senescence

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

3.5.8: Relative fresh weight at 3rd day of vase

Relative fresh weight at 3rd day was calculated through below formula

Relative Fresh weight at 3rd day = Weight of flower at 3rd day / Initial weight x 100

3.5.9: Relative fresh weight at 5th day of vase

Relative fresh weight at 5th day was calculated through below formula

Relative Fresh weight at 5th day = Weight of flower at 5th day / Initial weight x 100

3.5.10: Relative fresh weight at senescence

Relative fresh weight at senescence was calculated through below formula

Relative Fresh weight at Senescence = Weight of flower at senescence / Initial weight x 100

3.5.11: Flower freshness score

Freshness of flower was observed on 5th day of vase. Freshness of flower was scored on 1-5 scale (1 = fresh flower, 2 = very slight petal enrolling, 3 = noticeable in-rolling, 4 = petal shriveling and 5 = maximum petal shriveling), (Macnish *et al.,* 1999).

3.5.12: Maximum flower head diameter (MFHD)

Flower bud diameter was measured daily with Vernier-caliper. The MFHD of five cut flowers in each replication were recorded using the procedure of Van Doorn *et al.,* (1991).

3.5.13: Petal discolouration score

Flower petal color change or discoloration (fading) was assessed according to the procedures described by Macnish *et al.,* (1999) with rating scale of 1 = none/slight fading, 2 = moderate fading and 3 = advanced fading.

3.5.14: Change in total soluble solid (TSS)

Tissue sap was extracted from ten petals and TSS was determined using digital Refractrometer (model: RFM 840, Japan) by placing two drops of clear juice on the prism surface and reading was taken as described by Lacey *et al* (2001). Data were taken at first day of vase and 3rd day of vase and difference between these two reading is known as change in TSS and expressed in ^{o}Brix.

3.5.15: Change in chlorophyll content

Chlorophyll content was estimated in leaf from the top (fully expended leaf) with the help of chlorophyll meter (SPAD-502 plus) in flower stem. Chlorophyll content is expressed in terms of SPAD units. Data were taken at first day of vase and 5th day of vase. The difference between the initial value (on 1st day) and final value (on 5th day of vase) was expressed as the change in chlorophyll content.

3.5.16: Change in Anthocynin content (mg/100 g)

Anthocyanin are the most important and groups of colouring matters in plants. These intensely coloured water-soluble pigments are responsible for all colours in leaves petals and fruits of higher plants. They are based chemically on a single aromatic structure, that of cyaniding and all are derived from this pigment by addition or by substraction of hydroxyl groups or by methylation or by glycosylation. There are six common anthocyninidin and the position of attachment of sugar (usually to the 3-hydroxyl or to the 3 and hydroxy).

Principle

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

Reagents

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

Method:

a. Grind a known weight of fresh flower petals in alcohol.
b. Filter or centrifuge and collect the extract
c. Pipette 1ml of the alcohol extract into the test tube and add 3ml or HCL in aqueous methanol.
d. Add 1ml of Anthocyanin reagent to the samples.
e. Prepare the blank in the same manner by adding 1ml of methanol instead of anthocyanin reagent.
f. After 15 min of incubation in dark, measures the asorbance at 525nm against the blank.
g. Calculate the amount of anthocynins present in the sample from a standard curve prepared with cyanin hydrochloride.

Notes

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

The difference between the initial value (on 1st day) and final value (on 5th day of vase) was expressed as the change in anthocynin content.

3.5.17: Vase life in Days

Vase life was recorded as the number of days on vase until the flowers showed symptoms of bent neck or advanced signs of fading on all petals.

3.6: Statistical analysis:

Experimental data of the study entitled "Effect of postharvest preservatives on vase life of cut rose (*Rosa hybrid L.*) cv. Top Secret" were recorded and stastically analyzed using the method of analysis of variance as described by fisher, (1960) in his book : the design of Experiment."

The analysis of variance has been given in appendix and the skeleton of analysis of variance is presented in table (3.4).

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 (3.4).

Table 3.4: the skeleton of analysis of variance:

Source of variance	**DF**	**SS**	**MSS**	**Fc**	**Ft%**
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. ±For T $= \frac{\sqrt{2\ \text{EMS}}}{R}$

CD for T = S.Em.± x √2 x $t_{5\%\ (edf)}$

Where:-

EMS : Error mean sum of squares

R : Replications

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

S.Em. ± : Standard error of mean

CD : Critical difference

Chapter - IV

Result

The finding of the study entitled "**Effect of postharvest preservatives on vase life of cut rose (*Rosa hybrida* L.) cv. Top Secret**" have been presented in this chapter. The data pertaining to various parameters were subjected to statistical analysis by using Completely Randomized Design (CRD). In support of the tabular representation of data, graphical representation has also been presented in this chapter to provide better comprehension of the different parameters.

4.1. Days taken for 1^{st} petal spreading

The data pertaining to days taken for 1^{st} petal spreading was presented in Table 4.1 and illustrated in fig 4.1.

It can be observed from Table 4.1 and fig. 4.1 that the effects of postharvest preservatives on days taken for 1st petal spreading are statistically significant.

The day's taken to 1^{st} petal spreading was varied from 1.60 to 2.93 days. The maximum days taken to 1^{st} petal spreading (2.93days) was recorded with T_1(Control). While the minimum days taken to 1^{st} petal spreading (1.60 days) was recorded with T_{11}(Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 75 mg/l of water).

Table-4.1: Effect of post harvest preservatives on days taken for 1st petal spreading

Treatments	Symbol	Days taken for 1st petal spreading
Control	T_1	2.93
Sucrose (2.0 %)	T_2	2.33
$AgNo_3$ (30 ppm)	T_3	2.00
$AgNo_3$ (60 ppm)	T_4	2.00
Boric Acid (75 mg/l of water)	T_5	2.13
Boric Acid (100 mg/l of water)	T_6	2.27
Sucrose (2.0 %) + $AgNo_3$ (30 ppm)	T_7	2.07
Sucrose (2.0 %) + $AgNo_3$ (60 ppm)	T_8	2.13
Sucrose 2.0 %) + Boric Acid (75 mg/l of water)	T_9	1.80
Sucrose (2.0 %) + Boric Acid (100 mg/l of water)	T_{10}	1.87
Sucrose (2.0 %) + $AgNo_3$ (30 ppm) + Boric Acid (75mg/l of water)	T_{11}	1.60
Sucrose (2.0 %) + $AgNo_3$ (30 ppm) + Boric Acid (100 mg/l of water)	T_{12}	1.73
Sucrose (2.0 %) + $AgNo_3$ (60 ppm) + Boric Acid (75 mg/l of water)	T_{13}	1.93
Sucrose (2.0 %) + $AgNo_3$ (60 ppm) + Boric Acid (100 mg/l of water)	T_{14}	1.93
S.E.m±		0.16
CD at 5%		0.46

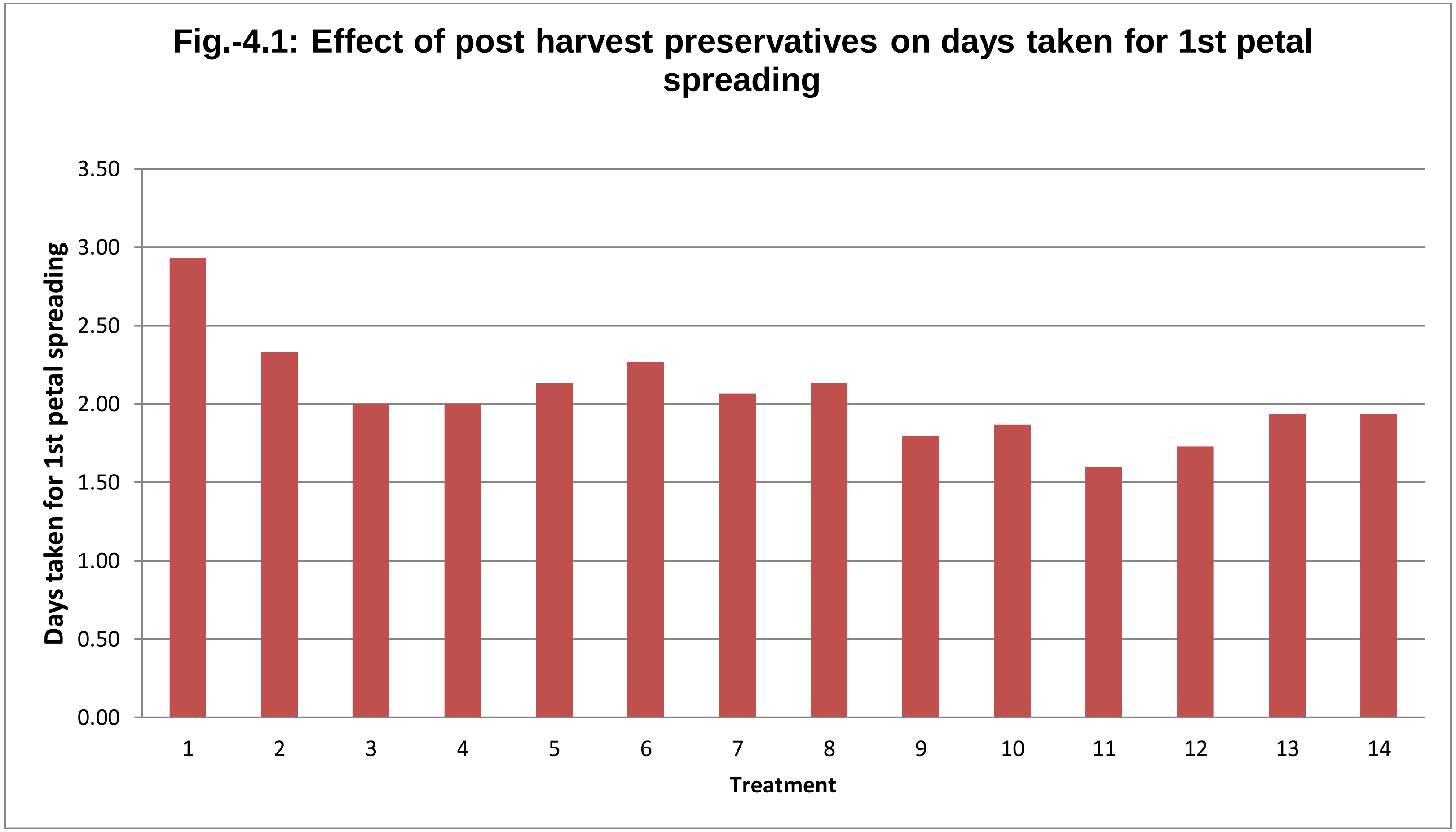


Fig.-4.1: Effect of post harvest preservatives on days taken for 1st petal spreading
Days taken for 1st petal spreading
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Treatment

4.2. Solution uptake at 3rd day (ml)

It can be observed from Table 4.2 and fig 4.2 that the effect of preservatives on solution uptake (ml) on 3rd day in vase was statistically significant.

Solution uptake (ml) on 3rd day in vase was varied from 16.50 to 49.73 ml. The maximum solution uptake at 3rd day (49.73 ml) was recorded with T_4 ($AgNo_3$ 60 ppm) followed by 48.93 ml with T_6 (Boric Acid 100 mg/l of water), 38.27 ml with T_3 ($AgNo_3$ 30 ppm).T_4 shows statistically better than other treatments. The minimum solution uptake on 3rd day was (16.50 ml) with T_2 (Sucrose 2.0 %) followed by 19.27 ml recorded with T_1 (control).

4.3. Solution uptake at 5th day (ml)

The data pertaining to solution uptake at 5th day of vase were presented in Table 4.2 and illustrated in fig 4.3.

It is evident from the table 4.2 that effect of preservatives on solution uptake at 5th day was statistically significant.

Solution uptake at 5th day varied from 27.13 to 75.87 ml. The maximum solution uptake at 5th day (75.87 ml) was recorded with treatment T_4 ($AgNo_3$ 60 ppm) followed by 58.67 ml with T_3 ($AgNo_3$ 30 ppm), 57.67 ml with T_6 (Boric Acid 100 mg/ l of water). The minimum solution uptake at 5th day (27.13 ml) was recorded with T_2 (Sucrose 2%) followed by 33.93 ml with T_1 (Control).

4.4. Solution uptake at senescence (ml)

The data pertaining to solution uptake at senescence were presented in Table 4.2 and illustrated in fig 4.2.

It is evident from the table 4.2 that effect of preservatives on solution uptake at senescence was statistically significant.

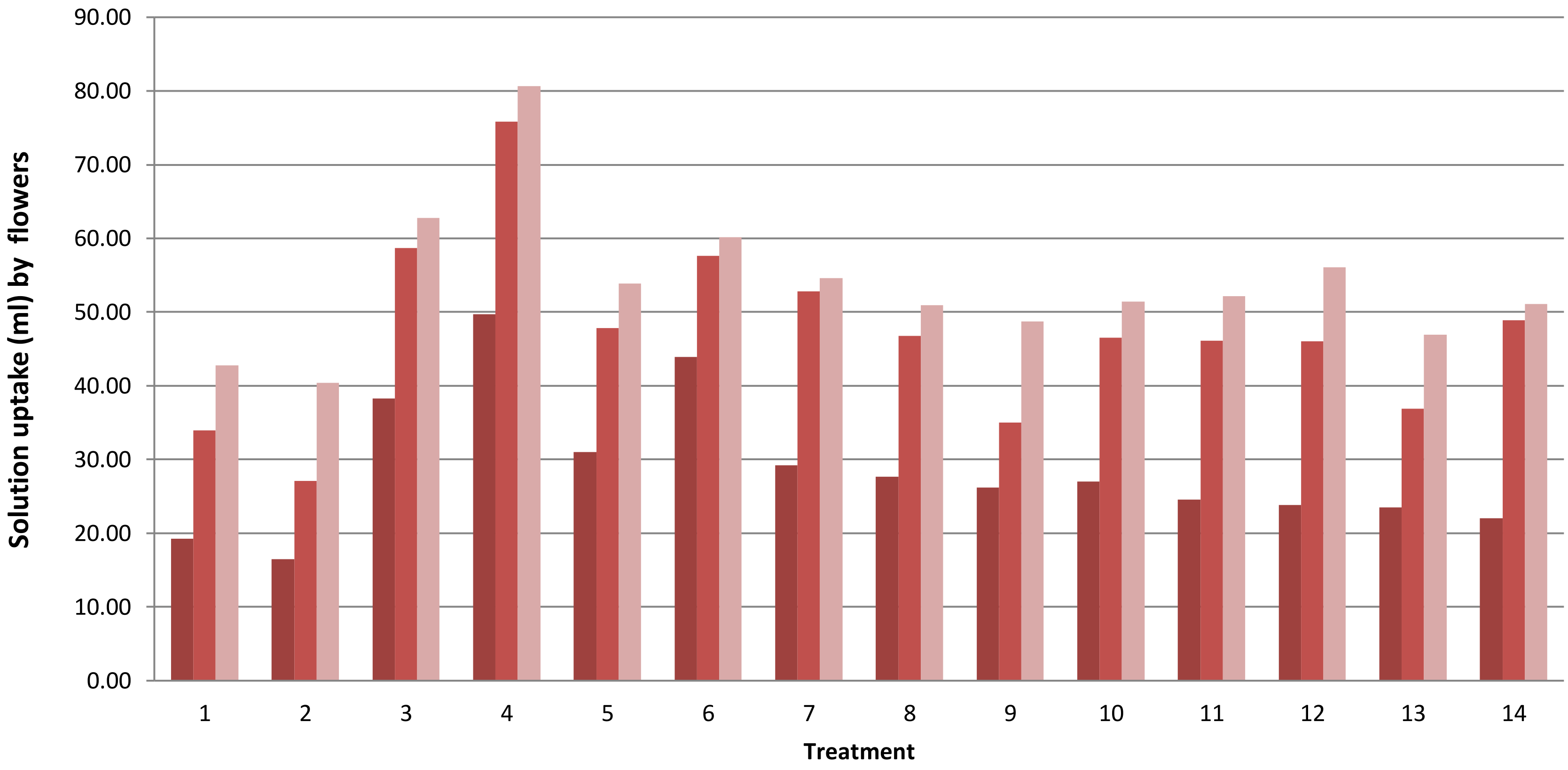
Solution uptake at senescence varied from 40.40 to 80.67.

The maximum solution uptake at senescence (80.67 ml) was recorded with T_4 ($AgNo_3$ 60 ppm) followed by was 62.80 ml with T_3 ($AgNo_3$ 30 ppm), 60.20 ml with T_6 (Boric Acid 100 mg/ l of water) and minimum solution uptake at senescence (40.40 ml) recorded with T_2(Sucrose 2.0 %) followed by 42.8 ml with T_1 (Control).

Table-4.2: Effect of post harvest preservatives on Solution uptake (ml) by flowers

Treatments	Solution uptake at 3rd day (ml)	Solution uptake at 5th day (ml)	Solution uptake at senescence day (ml)
T_1	19.27	33.93	42.80
T_2	16.50	27.13	40.40
T_3	38.27	58.67	62.80
T_4	49.73	75.87	80.67
T_5	31.00	47.87	53.87
T_6	43.93	57.67	60.20
T_7	29.20	52.80	54.60
T_8	27.67	46.73	50.97
T_9	26.20	35.00	48.73
T_{10}	27.00	46.53	51.40
T_{11}	24.53	46.13	52.20
T_{12}	23.87	46.07	56.07
T_{13}	23.47	36.93	46.93
T_{14}	22.07	48.93	51.07
S.E.m±	2.50	3.60	2.69
CD at 5%	7.25	10.43	7.80

Fig.-4.2: Effect of post harvest preservatives on Solution uptake (ml) by flowers



4.5. Change in weight of flower on 3rdday of vase (g)

The data pertaining to change in fresh weight on 3rd day in vase with different treatments are presented in Table 4.3 and illustrated in fig 4.3.

It can be observed from Table 4.3 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.

The maximum increase in fresh weight of flower (3.41 g) on 3rd day was observed in T_4(AgNo$_3$ 60 ppm) followed by 2.57 g recorded with T_7 (Sucrose 2%+ AgNo$_3$ 30 ppm) both of these are statistically at par to each other. The minimum increase in fresh weight of flowerat 3rd day of vase life (0.82 g) was recorded with T_2 (Sucrose 2%) followed by 0.93 g with T_1 (Control) and both of these are statistically smilar to each other.

4.6. Change in weight of flower on 5thday of vase (g)

Change in fresh weight on 5thday in vase can be observed from Table 4.3 and fig 4.3. The effect of post harvest preservatives on 5th day of vase was statistically significant.

The maximum change in fresh weight on 5th day of vase (4.22 g) was observed with T_4(AgNo$_3$ 60 ppm) followed by T_7 (Sucrose 2.0 % + AgNo$_3$ 30 ppm) and T_3 (AgNo$_3$ 30 ppm) which recorded the value 4.19 and 3.63 g respectively.The minimum change in fresh weight (2.71 g) was recorded with T_1(Control).

4.7. Change in weight of flower at senescence

Change in fresh weight at senescence can be observed from Table 4.3 and in fig 4.4. The effect of postharvest preservatives on change in fresh weight at senescence was statistically significant.

The perusal of data revealed that minimum change in fresh weight at senescence (-1.25 g) was recorded withT_{11} (Sucrose 2.0 % + AgNo3 30 ppm+ Boric Acid 75 mg/l of water) followed by -1.35 g with T_{12} (Sucrose 2.0 % + AgNo$_3$ 30 ppm + Boric Acid 100 mg/l of water), -1.69 g with T_7, -1.67 g with T_8 and all of these treatments are statistically at par to each other. The maximum change in weight at senescence (-4.39 g) was recorded with T_4 (AgNo$_3$ 60 ppm) followed by T_3 ,T_1,T_2, and T_5 which recorded the value of 4.28, 4.14,3.12 and 3.12 respectively. All of these treatments are at par to each other.

Table-4.3: Effect of post harvest preservatives on change in weight of flower

Treatment	Change in weight of flower 3rd day of vase	Change in weight of flower 5th day of vase	Change in weight of flower senescence day of vase
T_1	0.93	2.71	-4.14
T_2	0.82	3.61	-3.12
T_3	1.05	3.63	-4.28
T_4	3.41	4.22	-4.39
T_5	1.01	3.39	-3.12
T_6	1.63	2.95	-2.97
T_7	2.57	4.19	-1.69
T_8	2.07	2.80	-1.67
T_9	0.96	2.37	-1.85
T_{10}	1.34	3.07	-1.94
T_{11}	2.10	3.17	-1.25
T_{12}	1.94	3.16	-1.35
T_{13}	1.75	2.74	-1.80
T_{14}	1.91	2.76	-1.76
S.E.m±	**0.41**	**0.43**	**0.37**
CD at 5%	**1.18**	**1.23**	**1.90**

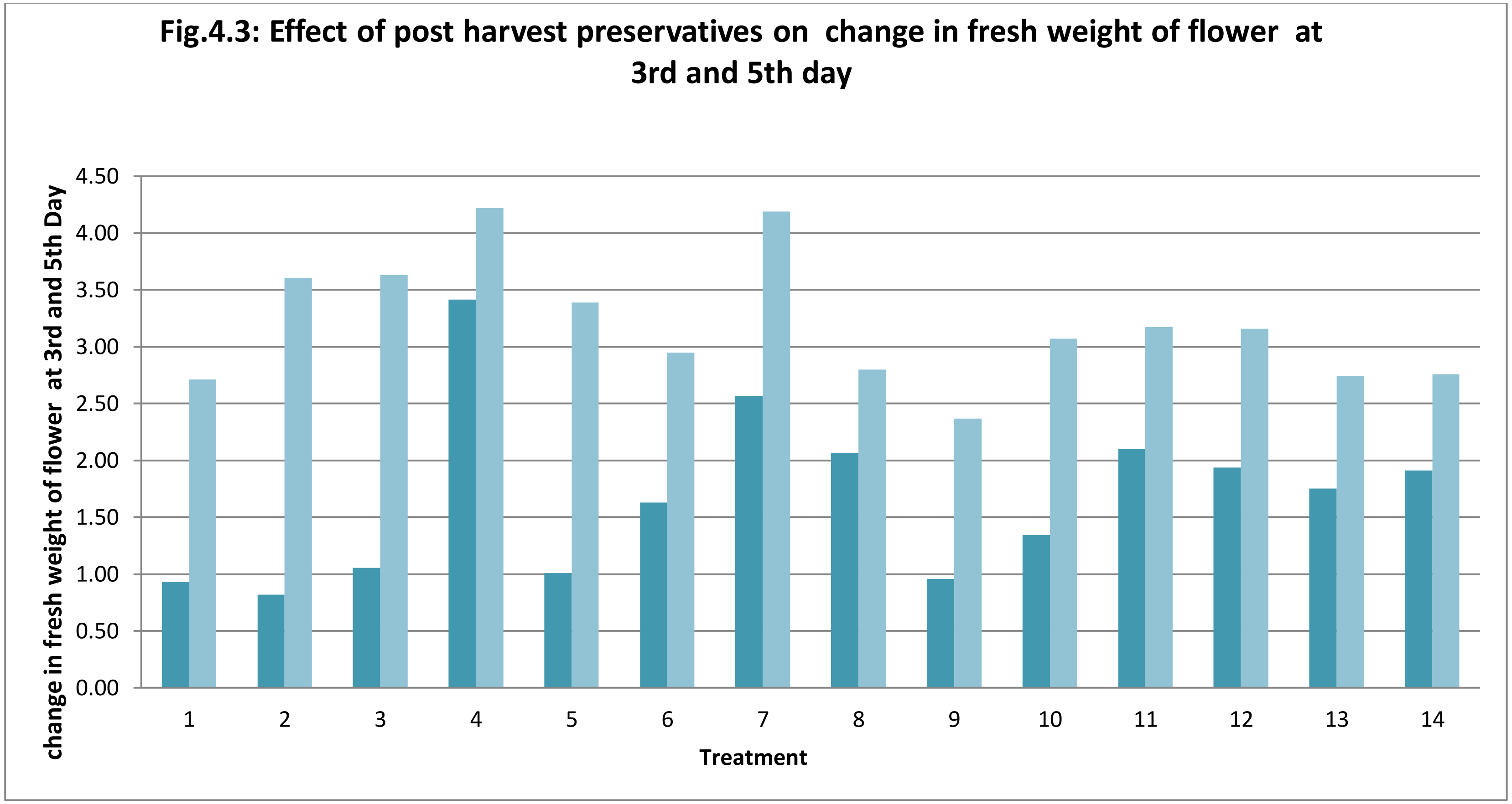


Fig.4.3: Effect of post harvest preservatives on change in fresh weight of flower at 3rd and 5th day
change in fresh weight of flower at 3rd and 5th Day
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Treatment

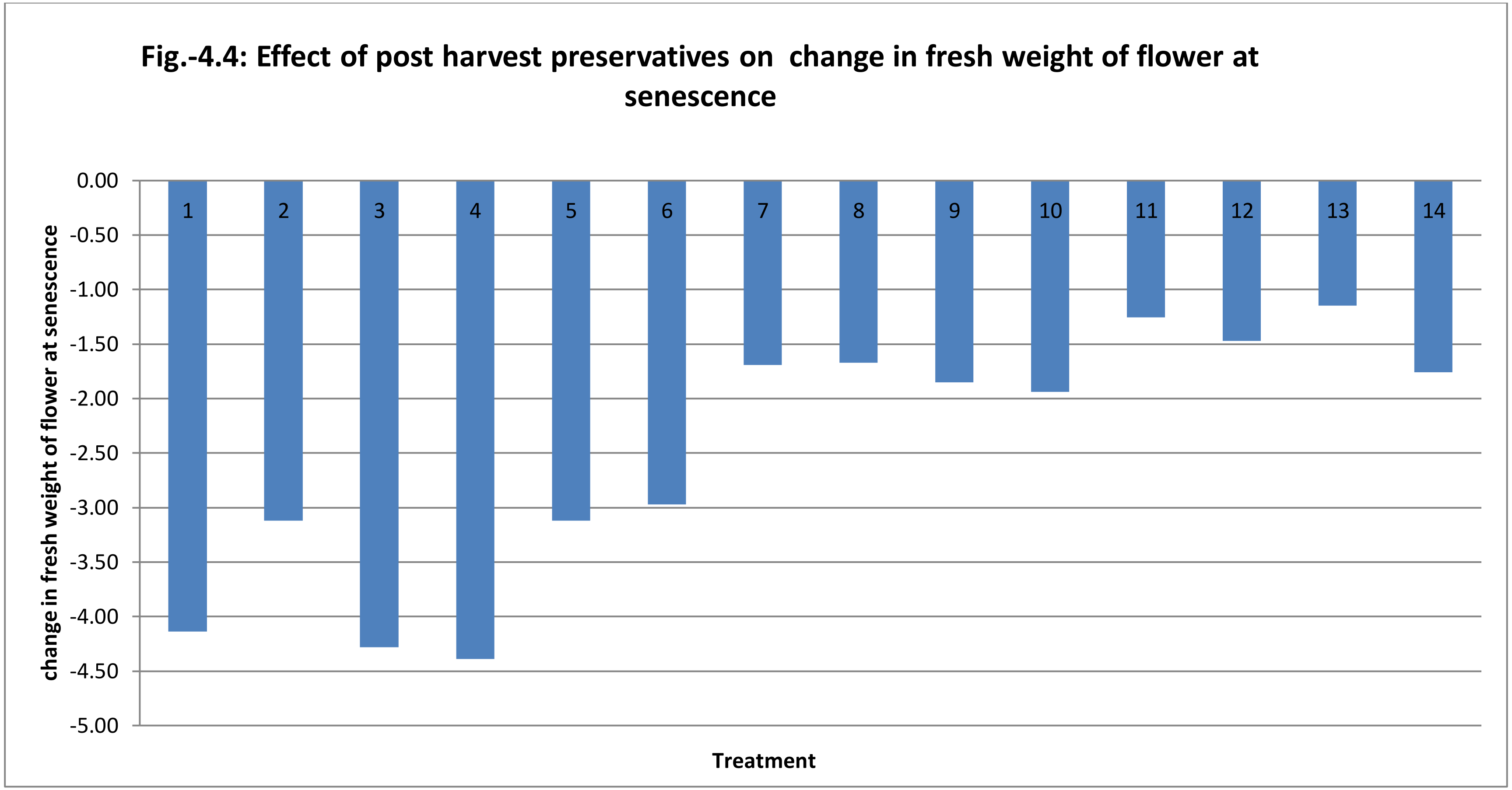


Fig.-4.4: Effect of post harvest preservatives on change in fresh weight of flower at senescence
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
-3.00
-3.50
-4.00
-4.50
-5.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
change in fresh weight of flower at senescence
Treatment

4.8. Relative fresh weight at 3rd day of vase (%)

The data pertaining relative fresh weight at 3rd day of vase have been presented in Table 4.4 and illustrated in figure 4.5. It is evident that the effects of preservatives on relative fresh weight at 3rd day of vase are statistically significant.

The data of relative fresh weight at 3rd day of vase was varied from 106.04 to 128.44 %.The maximum relative fresh weight at 3rd day (128.44 %.) was recorded with T_4 ($AgNo_3$60 ppm) and followed by T_7(Sucrose 2% + $AgNo_3$ 30 ppm) which recorded 123.22 % and both are statistically similar to each other. The minimum relative fresh weight at 3rdday (106.04%) was recorded with T_2 (Sucrose 2.0 %).

4.9. Relative fresh weight at 5th day of vase (%)

The data pertaining to relative fresh weight at 5th day of vase (%) with different treatments are presented in Table 4.4 and fig 4..5

It can be observed from Table 4.9 and fig 4.9 that the effect of post harvest preservative on relative fresh weight at 5th day of vase (%) was statistically non-significant.

Relative fresh weight at 5th day of vase was varied from 120.65 to 137.83 %.The maximum relative fresh weight at 5thday (137.83%) was recorded with T_7(Sucrose 2% + $AgNo_3$ 30 ppm) followed by T_4($AgNo_3$ 60 ppm) which recorded 135.17% and all of these treatments are statistically at par to each other. The minimum relative fresh weight at 5thday (120.65%) was recorded with T_8 (Sucrose 2.0 % +Boric Acid 75 mg/l).

4.10. Relative fresh weight at senescence (%)

The data pertaining to relative fresh weight at senescence (%) with different treatments are presented in Table 4.4 and fig 4.5. It is evident that the effect of post harvest preservative on relative fresh weight at senescence (%) was statistically significant.

Relative fresh weight at senescence is varied from 63.42 % to 87.87%. The maximum relative fresh weight at senescence (87.87%) was recorded by T_{12} (Sucrose 2% +$AgNo_3$ 30 ppm + Boric Acid 100mg/l of water) followed by 87.69 % with T_{11} (Sucrose 2% +$AgNo_3$ 30 ppm + Boric Acid 75 mg/l of water, 84.73 % with T_7, 83.88% with T_9 and all of these treatments are statistically at par to each other. The minimum relative fresh weight at senescence (63.42%) was recorded with T_4($AgNo_3$ 60 ppm).

Table-4.4: Effect of post harvest preservatives on relative fresh weight of flower

Treatments	Relative fresh weight at 3rd day	Relative fresh weight at 5th day	Relative fresh weight at senescence
T_1	107.53	121.87	66.59
T_2	106.04	126.55	77.03
T_3	107.31	125.18	70.31
T_4	128.35	135.17	63.42
T_5	109.55	132.15	70.41
T_6	117.08	130.94	68.81
T_7	123.22	137.83	84.73
T_8	120.80	128.19	83.16
T_9	108.34	120.65	83.88
T_{10}	113.97	131.46	80.12
T_{11}	120.51	130.99	87.69
T_{12}	110.74	128.40	87.87
T_{13}	124.57	130.50	79.96
T_{14}	119.09	127.58	82.41
S.E.m±	2.15	7.00	3.24
CD at 5%	6.22	20.28	9.39

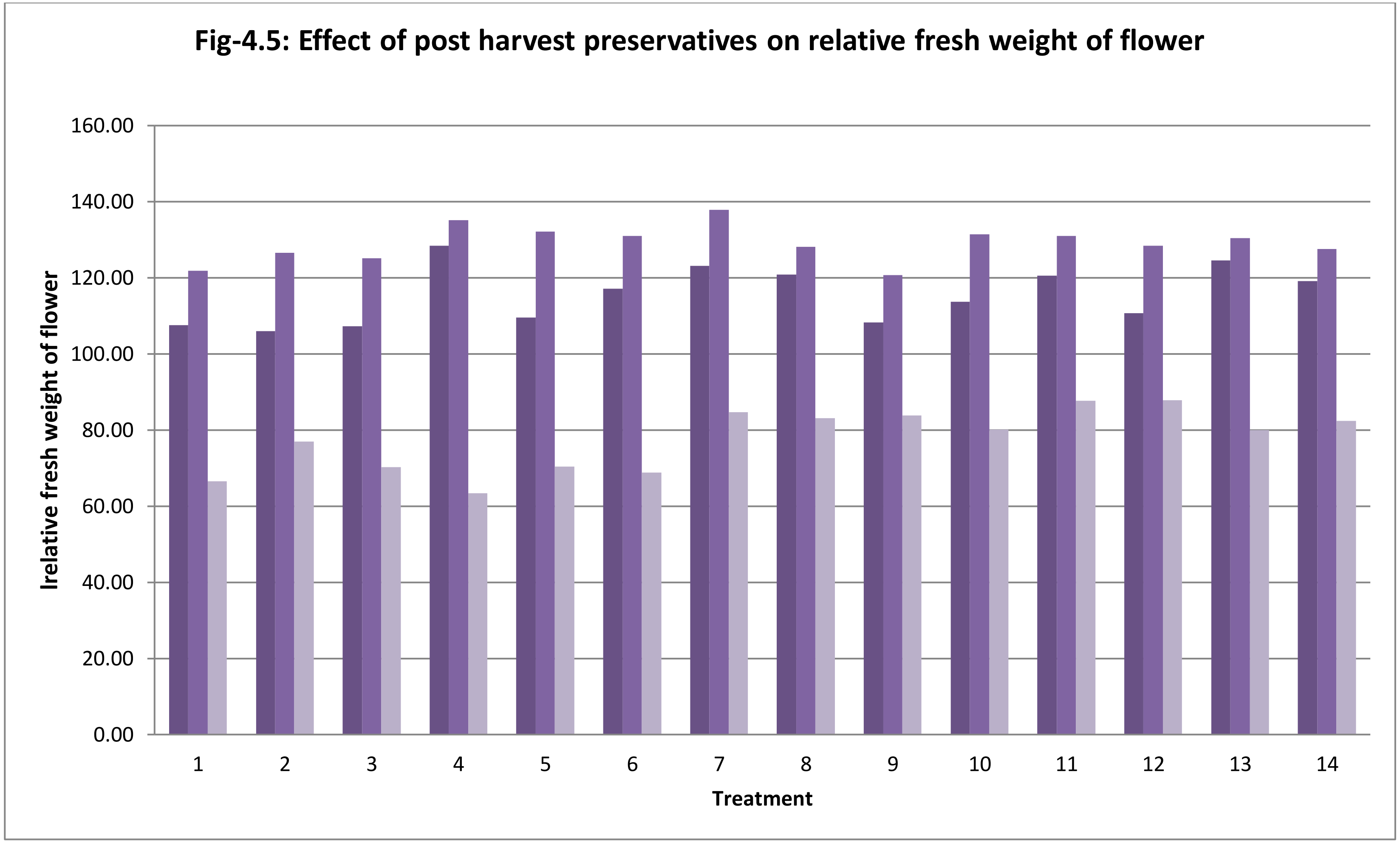


Fig-4.5: Effect of post harvest preservatives on relative fresh weight of flower
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Irelative fresh weight of flower
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Treatment

4.11. Flower freshness score

The data pertaining to flower freshness score with different treatments are presented in Table 4.5 and illustrated in fig 4.6.

It can be observed from Table 4.5 and fig 4.6 that effects of post harvest preservatives on flower freshness score are statistically significant.

Flower freshness score was varied from 1.67 to 3.00.The best result with respect of flower freshness score (1.67) was recorded with T_{11} (Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 75mg/l of water) followed by 2.00 with T_{12} (Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 100mg/l of water) and both of these are statistically at par to each other. The maximum flower freshness score (3.00) was observed with T_1(Control) followed by 2.87 with T_9(Sucrose 2.% +Boric Acid 75mg/l of water). 2.80, 2.73, recorded with T_{10} (Sucrose 2.0 % + Boric Acid 100mg/l of water) and T_2 (Sucrose 2%) respectively and all of these treatments are at par to each other.

4.12. Maximum flower head diameter (MFHD)

The data pertaining to maximum flower head diameter with different treatments was presented in Table 4.5 and illustrated in fig 4.7.

It can be observed from Table 4.5 and fig 4.7 that effect of post harvest preservatives on maximum flower head diameter are statistically significant.

Maximum flower head diameter (MFHD) was varied from 5.24 to 7.67cm.The maximum flower head diameter (7.67cm) was recorded with T_{11} (Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 75 mg/l of water) followed by 7.34 cm and 7.24 cm recorded with T_{12} (Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 100 mg/l of water) and T_{10} (Sucrose 2.0 % + Boric Acid 100mg/l of water) respectively, all of these treatments are statistically at par to each other. The minimum Flower head diameter (5.24 cm) was observed in T_1 (Control).

4.13. Petal discoloration score

The data pertaining to petal discolouration score with different treatments was presented in Table 4.5 and illustrated in fig 4.8 and it can be observed from Table 4.5 and fig 4.8 that effect of post harvest preservatives on petal discoloration score are statistically significant. The petal discoloration was varied from 3.07 to 5.00.

The best result with respect of petal discolouration score (3.07) was recorded with T_{11} (Sucrose 2.0 %+$AgNo_3$ 30 ppm + Boric Acid 75mg/l of water) and T_{12}(Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 100mg/l of water).The maximum petal discoloration score (5.00) was recorded with T_1(Control) followed by 4.87 with T_9 (Sucrose 2%+Boric Acid 75mg/l of water),T_{10}(Sucrose 2%+Boric Acid 100mg/l of water) and T_2,(Sucrose 2%) all of these treatments are statistically at par to each other.

Table-4.5: Effect of post harvest preservatives on flower freshness score, Maximum flower head diameter and Petal discoloration Score

Treatment	Flower freshness score	Maximum flower head diameter	Petal discoloration score
T_1	3.00	5.24	5.00
T_2	2.73	6.74	4.87
T_3	2.47	6.78	4.67
T_4	2.40	6.55	4.07
T_5	2.60	6.67	4.73
T_6	2.47	6.74	4.67
T_7	2.40	6.18	3.73
T_8	2.60	6.93	4.53
T_9	2.87	6.90	4.87
T_{10}	2.80	7.24	4.87
T_{11}	1.67	7.67	3.07
T_{12}	2.00	7.34	3.07
T_{13}	2.20	7.33	4.87
T_{14}	2.40	7.30	4.40
S.E.m±	0.10	0.18	0.21
CD at 5%	0.30	0.51	0.60

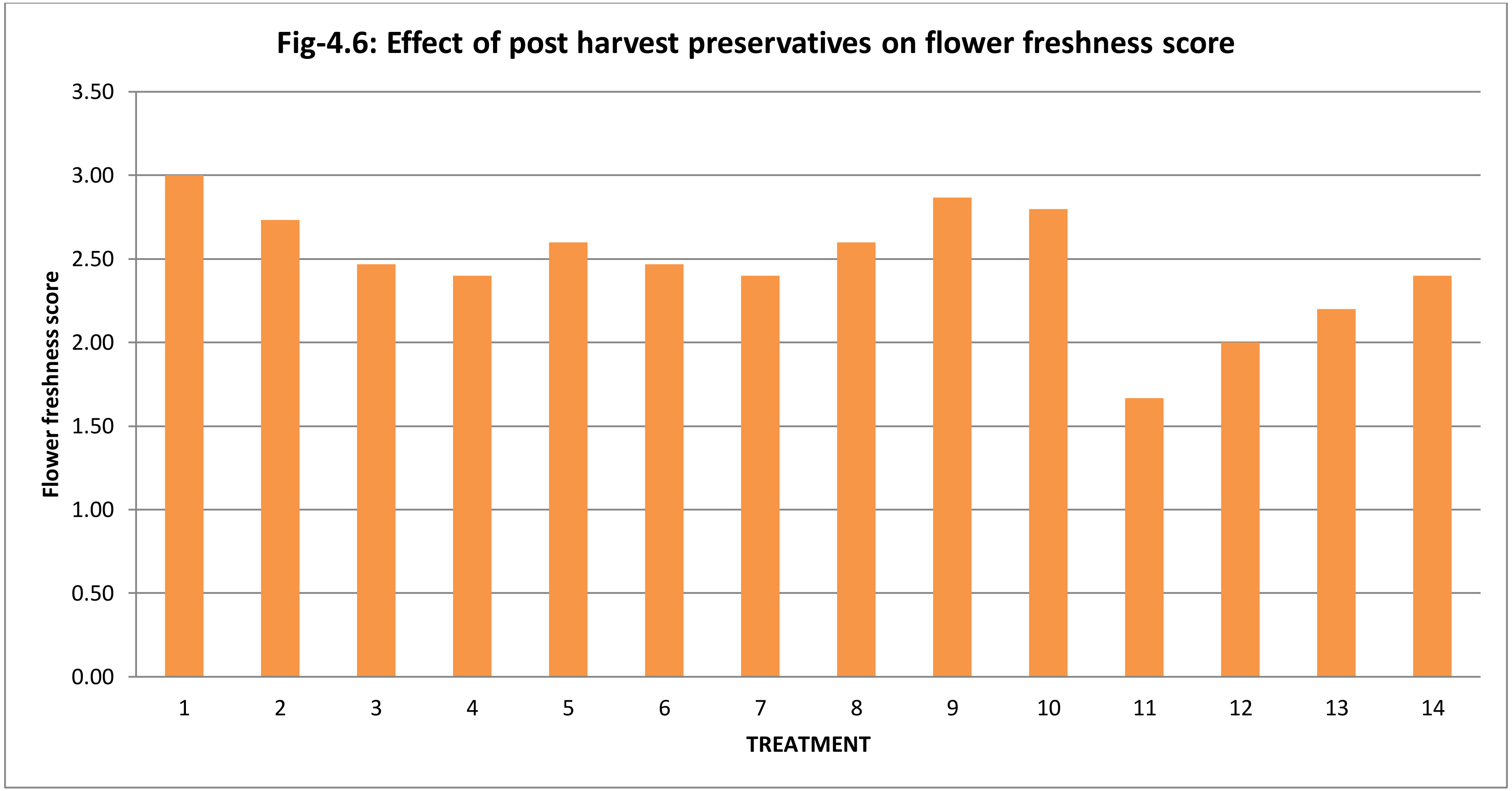
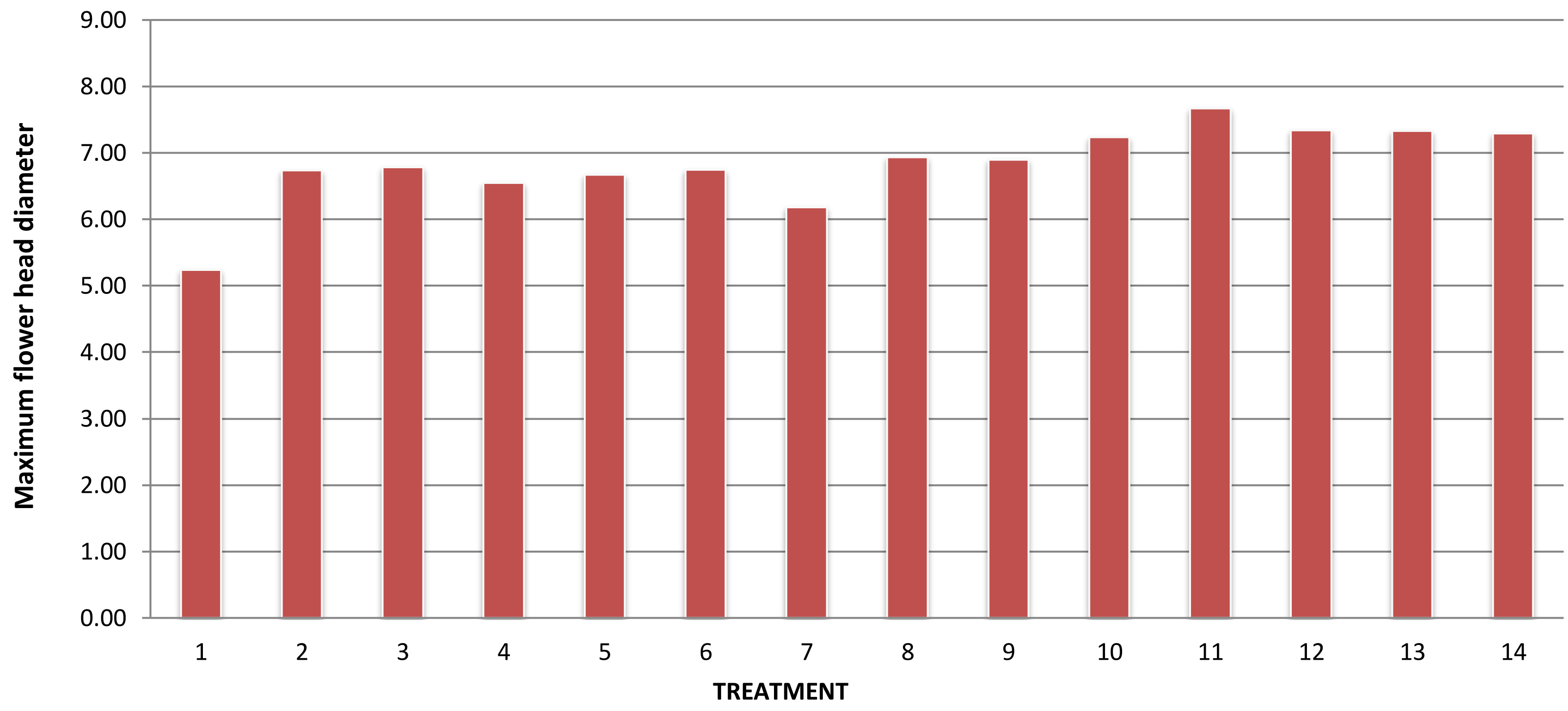


Fig-4.6: Effect of post harvest preservatives on flower freshness score
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Flower freshness score
1
2
3
4
5
6
7
8
9
10
11
12
13
14
TREATMENT

Fig.-4.7: Effect of Post harvest preservatives on Maximum flower head diameter



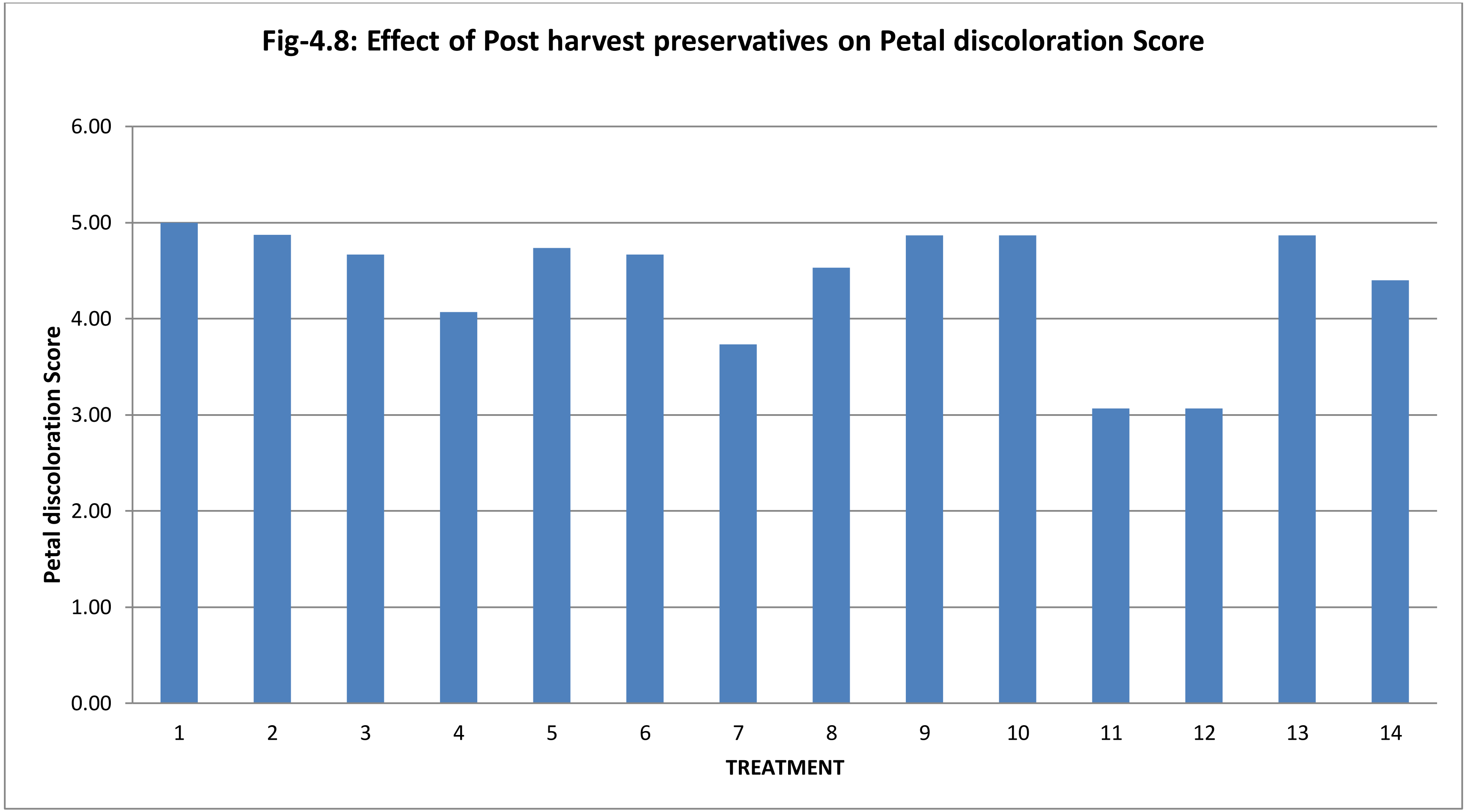


Fig-4.8: Effect of Post harvest preservatives on Petal discoloration Score
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Petal discoloration Score
1
2
3
4
5
6
7
8
9
10
11
12
13
14
TREATMENT

4.14. Change in total soluble solid TSS (^{0}B)

The data pertaining to change in total soluble solid was presented in Table 4.6 and illustrated in fig 4.9.

It can be observed from Table 4.6 and fig. 4.9 that effect of post harvest preservatives on change in total soluble solid are statistically significant.

The change in total soluble solid was varied from 1.02 to 1.51 ^{0}B.The maximum change in total soluble solid TSS (1.51^{0}B) was recorded with T_{14} (Sucrose 2.0 % + $AgNo_3$ 60 ppm + Boric Acid 100 mg/l of water) followed by 1.41^{0}B with T_{12}(Sucrose 2.0 % + $AgNo_3$30 ppm + Boric Acid 100 mg/l of water), 1.39^{0}B with T_{11}(Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 75 mg/l of water).The minimum change in total soluble solid (1.02^{0}B) was recorded with T_2 (Sucrose 2.0 %).

4.15 Change in chlorophyll content (mg/100g)

The data pertaining to change in chlorophyll content was presented in Table 4.6 and illustrated in fig 4.10.

It can be observed from Table 4.16 and fig. 4.10 that effects of post harvest preservatives on change in chlorophyll content are statistically significant.

The change in chlorophyll content was varied from 0.72 to 1.60. The maximum change in chlorophyll content (1.60) was recorded with T_1 (control) followed by1.34 with T_8(Sucrose 2.0 % + $AgNo_3$ 60 ppm) and 1.39 with T_4($AgNo_3$ 60 ppm). The minimum chlorophyll content(0.72) was recorded with T_{11}(Sucrose 2.0 % + $AgNo_3$30 ppm +Boric Acid 75mg/l of water)and T_{12}.(Sucrose 2.0 % + $AgNo_3$30 ppm +Boric Acid 100 mg/l of water).

4.16. Change in anthocyanin content (mg/100g)

The data pertaining to change in anthocyanin content are presented in Table 4.6 and illustrated in fig 4.11.

It can be observed from Table 4.6 and fig. 4.11 that effect of post harvest preservatives on change in anthocyanin content are statistically non significant.

The change in change in anthocyanin content was varied from 170.21 to 210.15 mg. The maximum change in anthocyanin content recorded with (210.15mg/100 g) with T_1(Control)followed by 190.13 with T_2(Sucrose 2%) and both are at par to each other. The minimum change in anthocyanin content (170.21mg) recorded with T_3($AgNo_3$ 30 ppm).

Table-4.6: Effect of post harvest preservatives on change in total soluble solid, chlorophyll content and anthocyanin content.

Treatment	Change in Total Soluble Solid	Change in Chlorophyll content	Change in Anthocyanin content
T_1	1.02	1.60	210.15
T_2	1.15	1.30	190.13
T_3	1.09	1.51	170.21
T_4	1.10	1.39	180.28
T_5	1.23	0.90	200.15
T_6	1.21	0.95	200.18
T_7	1.08	1.01	200.07
T_8	1.24	1.34	190.21
T_9	1.27	0.89	190.19
T_{10}	1.29	0.77	185.33
T_{11}	1.39	0.72	170.40
T_{12}	1.41	0.72	175.22
T_{13}	1.36	0.97	180.21
T_{14}	1.51	0.99	180.18
S.E.m±	0.10	0.07	4.71
CD at 5%	0.29	0.19	13.71

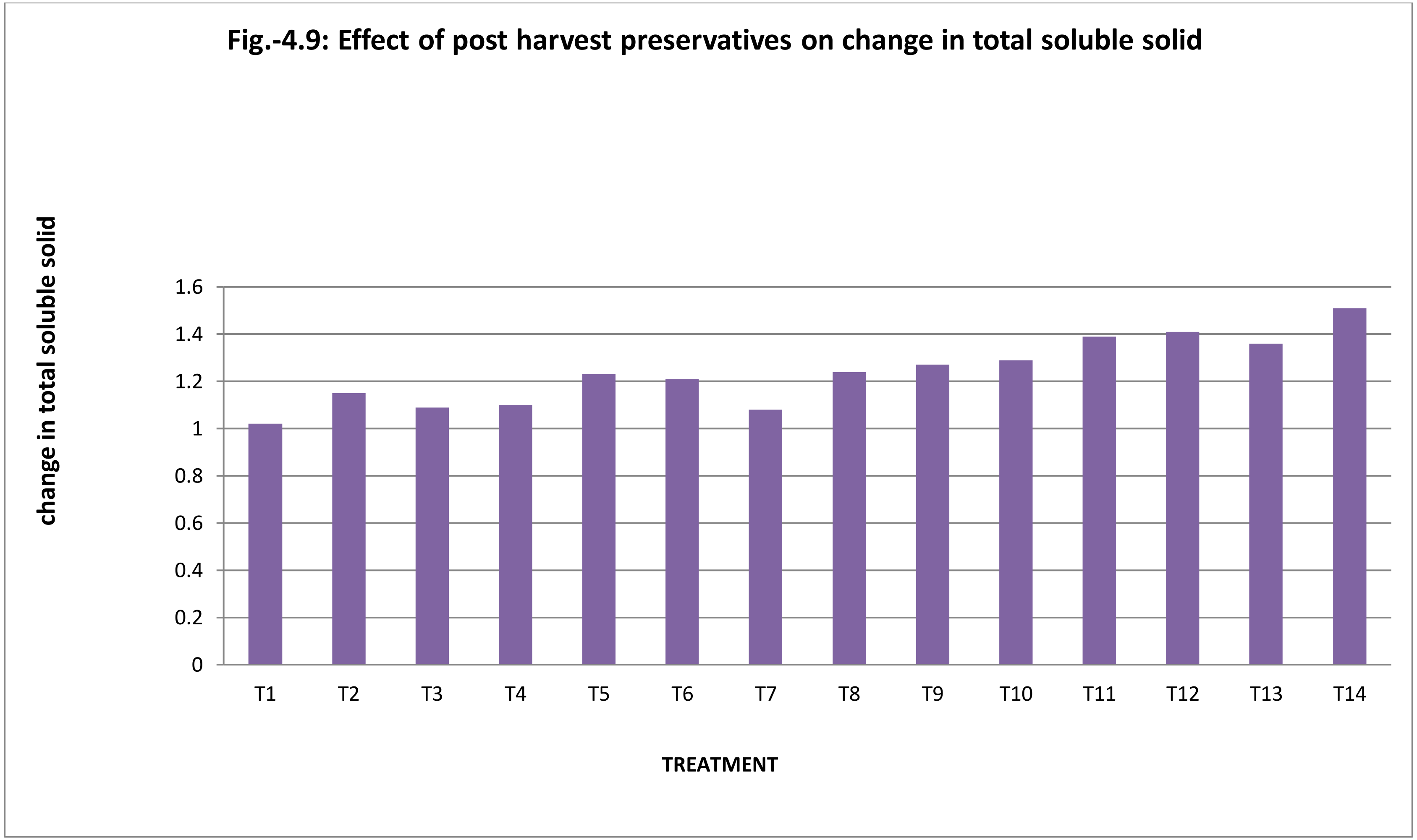
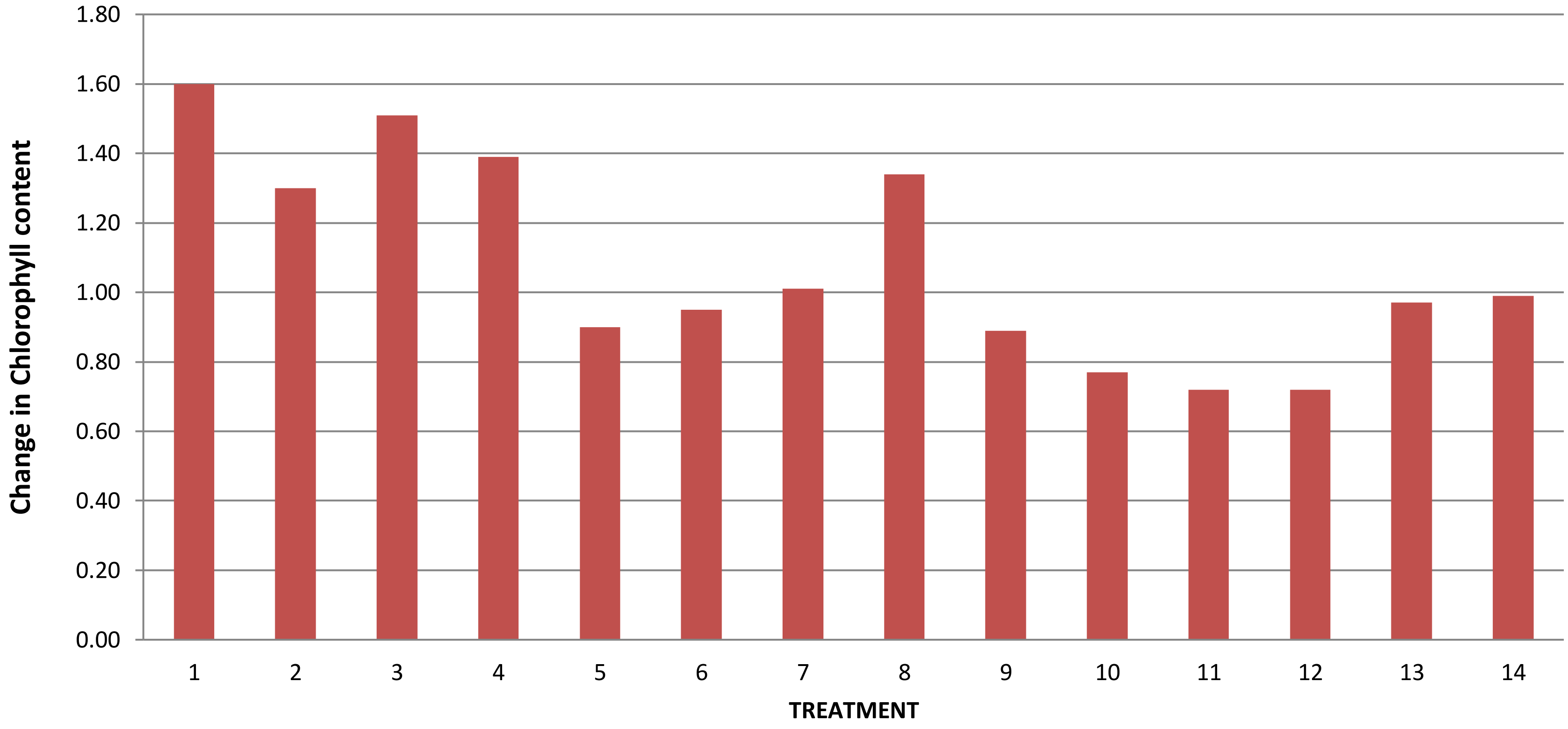


Fig.-4.9: Effect of post harvest preservatives on change in total soluble solid
change in total soluble solid
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
T13
T14
TREATMENT

Fig.-4.10: Effect of Post harvest preservatives on Change in Chlorophyll content



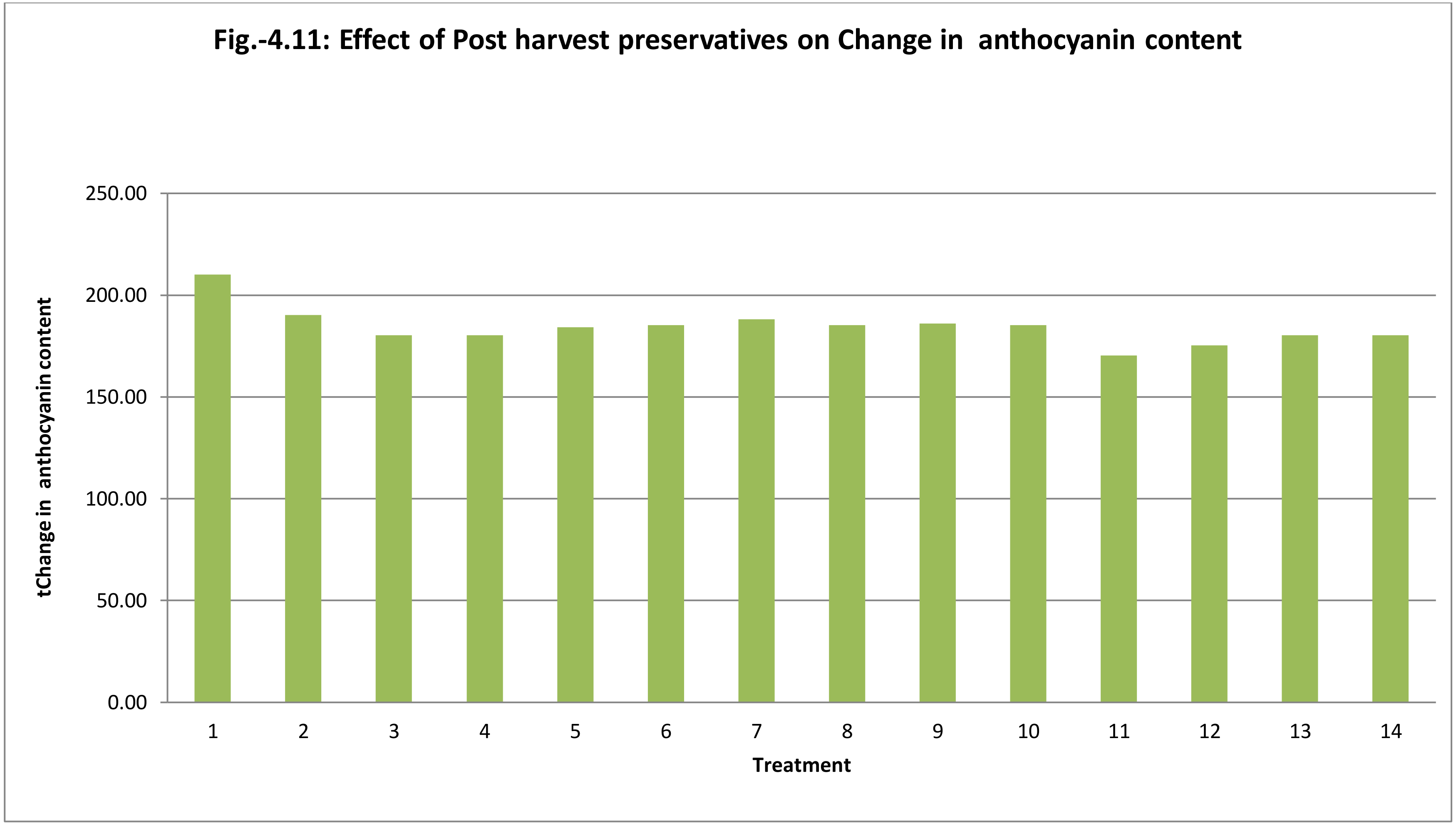


Fig.-4.11: Effect of Post harvest preservatives on Change in anthocyanin content
250.00
200.00
150.00
100.00
50.00
0.00
tChange in anthocyanin content
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Treatment

4.17. Vase life (days)

The data pertaining to vase life was presented in Table 4.7 and illustrated in fig 4.12 and it can be observed from Table 4.7 and fig. 4.12 that effect of post harvest preservatives on vase life was statistically significant.

The vase life was varied from 5.40 to 9.0 days. The maximum vase life (9.0 days) was recorded with T_{11} (Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 75mg/l of water) followed by 8.95 days with T_{12} (Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 100 mg/l of water), 8.40 days with T_{13}(Sucrose 2.0 % + $AgNo_3$ 60 ppm + Boric Acid 75 mg/l of water), 8.23 days with T_{14} (Sucrose 2.0 % + $AgNo_3$ 60 ppm + Boric Acid 100 mg/l of water).The minimum vase life (5.40 days) was observed in T_1(Control) followed by 5.47 day with T_2 (Sucrose), 6.53 days with T_5(Boric Acid 75 mg/l), 6.67 days with T_6 (Boric Acid 100 mg/l of water).

Table-4.7: Effect of post harvest preservatives on vase life

Treatment	Vase life (days)
T_1	5.40
T_2	5.47
T_3	7.33
T_4	7.53
T_5	6.53
T_6	6.67
T_7	6.93
T_8	7.33
T_9	7.00
T_{10}	6.67
T_{11}	9.00
T_{12}	8.95
T_{13}	8.40
T_{14}	8.23
S.E.m±	0.27
CD at 5%	0.78

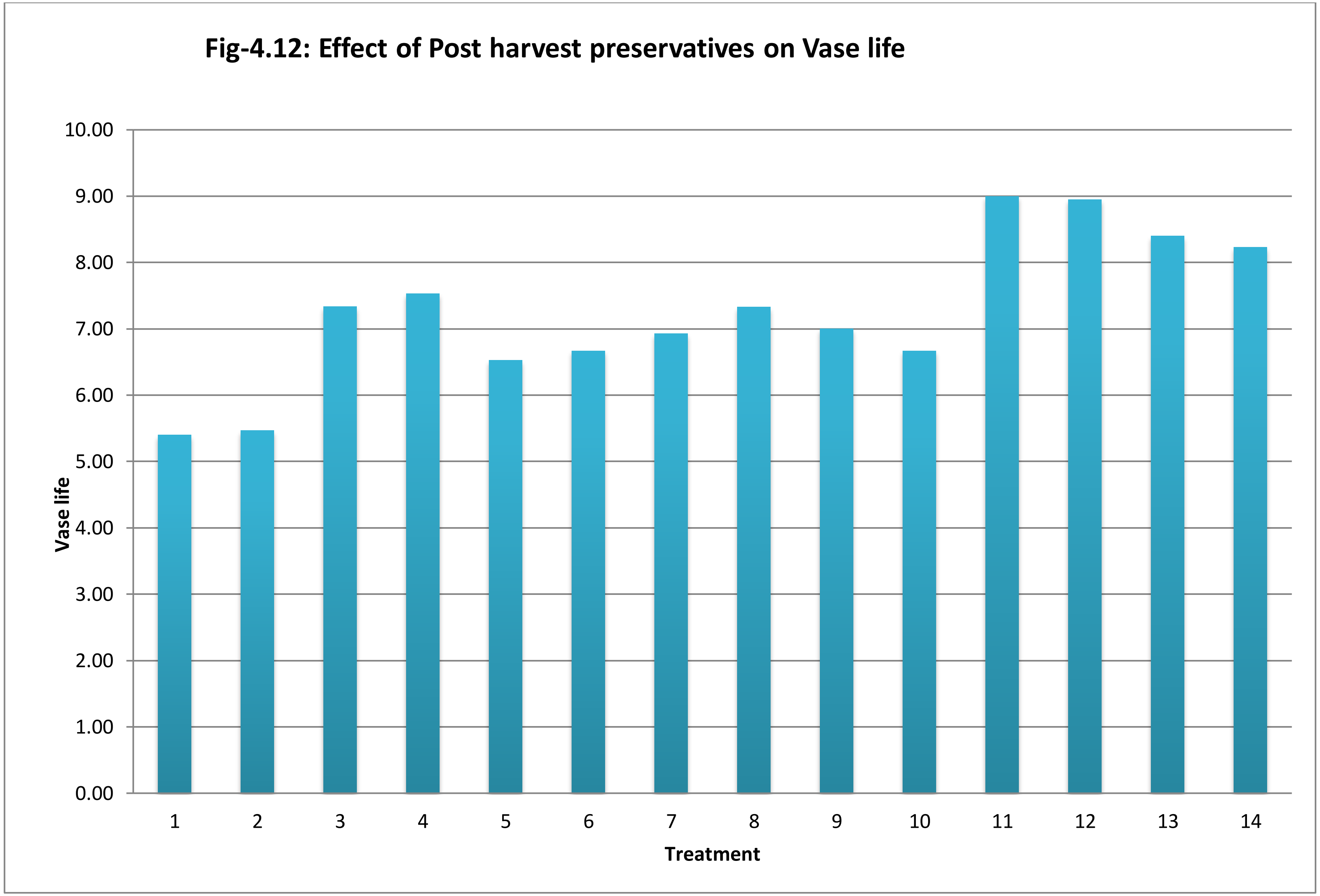


Fig-4.12: Effect of Post harvest preservatives on Vase life
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Vase life
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Treatment

Chapter- V
Discussion

In this chapter, an attempt has been made to discuss the possible reason of the variability obtained due to the different treatments in the present investigation entitled **"Effect of postharvest preservatives on vase life of cut rose (*Rosa hybrida* L.) cv. Top Secret."** The results obtained from the investigations described in the preceding chapter attempts have been made to collaborate the findings reported by the present investigations with those of various workers in the past.

Days taken for 1st petal spreading

It can be observed from Table 4.1 and the effect of preservatives on days taken to 1st petal spreading was statistically non-significant.

The maximum days taken to 1st petal spreading was recorded with T_1 (Control), while the minimum days taken to 1st petal spreading was recorded with T_{11} (Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 75 mg/l of water).

Solution uptake (ml) of flowers

It can be observed from Table 4.2 and the effect of preservatives on solution uptake (ml) by the cut rose cv. Top Secret on 3rd day, 5th day and at senescence (total solution uptake) was statistically significant.

The maximum solution uptake at 3rd day was recorded with T_4 ($AgNo_3$ 60 ppm) followed by with T_6 (Boric Acid 100 mg/l of water) and the minimum solution uptake on 3rd day was with T_2 (Sucrose 2.0 %). The maximum solution uptake at 5th day was recorded with treatment T_4 ($AgNo_3$ 60 ppm), followed by with T_3 ($AgNo_3$ 30 ppm), 57.67 ml with T_6 (Boric Acid 100 mg/ l of water). The minimum solution uptake at 5th day was recorded with T_2 (Sucrose 2%) followed by with T_1 (Control). The maximum solution uptake at senescence was recorded with T_4 ($AgNo_3$ 60 ppm) followed by with T_3 ($AgNo_3$ 30 ppm) with T_6 (Boric Acid 100 mg/ l of water) and minimum solution uptake at senescence was recorded with T_2(Sucrose 2.0 % + $AgNo_3$ 60 ppm + Boric Acid 75 mg/l of water) followed by with T_1 (Control).

Solution uptake of cut flowers were depends on the type of preservative solutions. This solution 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. The results are in close conformity with the findings observed by Kesta *et al*., (1995).

Change in weight of flower (g)

The effect of post harvest preservatives on change in fresh weight of flower on 3rd day and at senescence was statistically significant.

Among the preservatives solution the maximum increase in fresh weight of flower on 3rd day was observed in T_4 ($AgNo_3$ 60 ppm),while the minimum increase in fresh weight of flower on 3rd day of vase life was recorded with T_2(Sucrose2%). The maximum change in fresh weight on 5th day of vase was observed with T_4 ($AgNo_3$ 60 ppm) ,while the minimum change in fresh weight was recorded with T_1 (Control).The minimum change in fresh weight at senescence was recorded in T_{11} (Sucrose 2.0 % + $AgNo_3$ 30 ppm+ Boric Acid 75 mg/l of water) T_{12} (Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 100mg/l of water)while The maximum change in weight at senescence was recorded with ($AgNo_3$ 60 ppm).

The similar results were also reported by Amariutei *et al.*, (1986) in gerbera who revealed that the dry weight of flowers was greater in pulsed inflorescences than those in water only Similar results were observed by 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.

Relative fresh weight of flowers (%)

The effects of preservatives on relative fresh weight of flowers are statistically significant.

The maximum relative fresh weight at 3rd day was recorded with T_4 ($AgNo_3$ 60 ppm) followed by T_{13}(Sucrose 2.0 %+ $AgNo_3$60 ppm+ Boric Acid 75 mg/l) which recorded while the minimum relative fresh weight at 3rd day was recorded with T_2(Sucrose 2.0 %). The maximum relative fresh weight at 5th was recorded with T_7 (Sucrose 2% + $AgNo_3$ 30 ppm).The minimum relative fresh weight at 5th day was recorded with T_8 (Sucrose 2.0 % + Boric Acid 75 mg/l).The maximum relative fresh weight at senescence was recorded with T_{12}(Sucrose 2% + $AgNo_3$ 30 ppm) while the minimum relative fresh weight at senescence was recorded with T_4($AgNo_3$ 60 ppm).

Similar results were observed by 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.

Flower freshness score

The flower freshness score with different treatments was presented. The effects of post harvest preservatives on flower freshness score are statistically significant.

The best result with respect of flower freshness score was recorded with T_{11} (Sucrose 2.0 % + AgNo3 30 ppm + Boric Acid 75mg/l of water), while maximum flower freshness score was recorded with T_1 (Control).

Post harvest preservatives contain anti ethylene compounds, which is beneficial for maintenance of flowers as fresh as possible for a longer period. These results are in close conformity with the findings observed by Mehraj *et al.* (2013).

Maximum flower head diameter (MFHD)

The data pertaining to maximum flower head diameter (MFHD) with different treatments was presented in Table 4.12.The effects of post harvest preservatives are statistically significant.

The maximum flower head diameter was recorded with T_{11} (Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 75mg/l of water), while the minimum flower head diameter was observed in T_1 (Control).These results are confirmed by Ichimura *et al*. (2005, 2006).

Petal Discoloration score

The data pertaining to petal discoloration score with different treatments was presented in Table 4.13 and the effects of post harvest preservatives on petal discoloration score are statistically significant.

The best result with respect of petal discoloration score was recorded with T_{11} (Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 75 mg/l of water) and T_{11} (Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 75mg/l of water). The maximum petal discoloration recorded with T_1 (Control).

In this case sucrose may act as the CHO supplier and $AgNo_3$ and Boric acid acted as the germicides. Addition of sugar to the vase solution counteracted the adverse effects of defoliation on petal color and overcome the increased bud blasting (Susan, 2003). These results are advocated by Mehraj *et al.* (2013).

Change in total soluble solid TSS (^{0}B)

The data pertaining to change in total soluble solid was presented in Table 4.14 and the effect of post harvest preservatives on change in total soluble solid are statistically non significant.

The maximum change in total soluble solid TSS was with T_{14} (Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 75mg/l of water) .The minimum change in total soluble solid was recorded with T_{10} (Sucrose 2.0%).

Change in chlorophyll content

The data pertaining to Change in chlorophyll content was presented in Table 4.17 and illustrated fig 4.17 and the effect of post harvest preservatives are statistically significant.

The maximum change in chlorophyll content recorded with T_1 (Control) recorded with followed by T_8 (Sucrose 2.0 % + $AgNo_3$ 60 ppm) and (T_4 $AgNo_3$ 60 ppm) respectively. The minimum change in chlorophyll content was recorded with T_{11} (Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 75mg/l of water) and T_{12} (Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 100 mg/l of water).

All of the preservatives used in this experiment such as $AgNO_{3,}$ boric acid with or without sucrose and sucrose individually show the positive effect on preserving the leaves in good condition by let down the %of wilting and inhibiting the chlorophyll and carbohydrate degradation. Similar results were obtained by Serek *et al*. (1996), Singh and Tiwari (2002); Harode *et al*. (1993) and Reddy *et al*. (1988).

Change in Anthocyanin content

The data pertaining to Change in Anthocyanin content was presented in Table 4.17 and illustrated fig 4.17 and the effect of post harvest preservatives are statistically non significant.

The Maximum Change in Anthocyanin content recorded with with T_1 (Control) followed by with T_2(Sucrose 2%). The minimum change in anthocyanin content which is T_3 ($AgNo_3$ 30 ppm).

Vase life (days)

The data pertaining to vase life was presented in Table 4.17 and the effect of post harvest preservatives on vase life was statistically significant.

The maximum vase life was recorded with T_{11} (Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 75 mg/l of water) followed by with T_{12} (Sucrose 2.0 % +

AgNo3 30 ppm + Boric Acid 100 mg/l of water). The minimum vase life was observed in T_1 (Control).

The vase life of cut rose flowers is primarily influenced by water balance, which is determined by water loss and water uptake (Fanourakis *et al.*, 2013). Silver nitrate ($AgNO_3$) and Boric Acid are very potent inhibitors of ethylene action in plant tissues. The treatment of Sucrose + $AgNo_3$ + Boric Acid may be decreased the ethylene production and helpful to increase the vase life of rose as comparison to control. It is also provides some antimicrobial activity inside the plant tissues, thus its beneficial for rose flowers. These results are confirmed by Bartoli *et al*. (1997) and WeiMing *et al*. (1997).

Chapter- VI

Summary, Conclusion and Suggestions for Further Work

The present laboratory experiment entitled "**Effect of postharvest preservatives on vase life of cut rose (*Rosa hybrida* L.) cv. Top Secret"** at Department of Floriculture and Landscape Architecture, College of Horticulture, Mandsaur (M.P.) during the winter season of 2019. The research experiment was laid out in completely randomized design.

The results of the present study regarding the influence of different post harvest preservatives on different post-harvest parameters have been summarized in this chapter.

Summary:-

1. The maximum days taken to 1^{st} petal spreading was recorded with T_{11}(Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 75 mg/l of water) while the minimum days taken to 1^{st} petal spreading was recorded with T_1 (Control).

2. The maximum solution uptake at 3^{rd} day was recorded with T_4 ($AgNo_3$ 60 ppm) and minimum solution uptake on 3^{rd} day was with T_2 (Sucrose 2.0 %).

3. The maximum solution uptake at 5^{th} day was recorded with treatment T_4 ($AgNo_3$ 60 ppm) and minimum solution uptake at 5^{th} day was recorded with T_2 (Sucrose 2%).

4. The maximum solution uptake at senescence was recorded with T_4 ($AgNo_3$ 60 ppm) and minimum solution uptake at senescence recorded with T_2 (Sucrose 2.0 %).

5. The maximum increase in fresh weight of flower on 3^{rd} day was observed in T_4 ($AgNo_3$ 60 ppm). The minimum increase in fresh weight of flower at 3^{rd} day of vase life was recorded with T_2(Sucrose 2%).

6. The maximum change in fresh weight on 5th day of vase was observed with T_4 ($AgNo_3$ 60 ppm). The minimum change in fresh weight was recorded with T_1 (Control).

7.The perusal of data revealed that minimum change in fresh weight at senescence was recorded with T_{11} (Sucrose 2.0 % + AgNo3 30 ppm+ Boric Acid 75 mg/l of water). The maximum change in weight at senescence was recorded with T_4 ($AgNo_3$ 60 ppm).

8. The maximum relative fresh weight at 3rd day was recorded with T_4 ($AgNo_3$ 60 ppm) and minimum relative fresh weight at 3rd day was recorded with T_2 (Sucrose 2.0 %).

9. The maximum relative fresh weight at 5th day was recorded with T_7 (Sucrose 2% + $AgNo_3$ 30 ppm) and minimum relative fresh weight at 5thday was recorded with T_8 (Sucrose 2.0 % + Boric Acid 75 mg/l).

10. The maximum relative fresh weight at senescence was recorded by T_{12} (Sucrose 2% + $AgNo_3$ 30 ppm + Boric Acid 100mg/l of water). The minimum relative fresh weight at senescence was recorded with T_4($AgNo_3$ 60 ppm).

11. The best result with respect of flower freshness score was recorded with T_{11} (Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 75mg/l of water) and maximum flower freshness score was observed with T_1 (Control).

12.The maximum flower head diameter was recorded with T_{11} (Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 75 mg/l of water). The minimum flower head diameter was observed in T_1 (Control).

13.The maximum petal discoloration score was recorded with T_1 (Control) and minimum wit T_{11} (Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 75mg/l of water).

14. The maximum change in total soluble solid was recorded with T_{14} (Sucrose 2.0 % + $AgNo_3$ 60 ppm + Boric Acid 100 mg/l of water).The minimum change in total soluble solid was recorded with T_2 (Sucrose 2.0 %).

15. The maximum change in chlorophyll content was recorded with T_1 (control) and minimum change in chlorophyll content was recorded with T_{11} (Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 75mg/l of water).

16. The maximum change in anthocyanin content was recorded with T_1 (Control). The minimum change in anthocyanin content recorded with T_3 ($AgNo_3$ 30 ppm).

17. The maximum vase life (9.0 days) was recorded with T_{11} (Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 75 mg/l of water). The minimum vase life was observed in T_1 (control).

CONCLUSION

Among the preservatives evaluated in this experiment, different preservatives show the best result with respect of different parameters. T_{11} Sucrose 2.0 % + $AgNo_3$ 30 ppm + Boric Acid 75 mg/l of water) recorded the best performance with respect of days taken to 1st petal spreading, change in weight of flowers at senescence, flower freshness score, maximum flower head diameter, petal discoloration score, change in TSS, change in chlorophyll content, change in anthocyanin content and vase life. While T_4($AgNo_3$ 60 ppm) showed the best result with respect of solution uptake at 3rd day, 5th day and at senescence , change in weight of flowers at 3rd day of vase, at 5th day of vase and relative fresh weight at 3rd day of vase.

T_{12} (Sucrose 2% + $AgNo_3$ 30 ppm + Boric Acid 100mg/l of water) shows excellent result with respect to relative fresh weight at senescence and petal discolouration score while T_7(Sucrose 2% + $AgNo_3$ 30 ppm) shows the best performance in respect of relative fresh weight at 5th day of vase.

6.3 Suggestions for future work

Following future line of work is suggested for obtaining improved post harvest life of rose for benefit to growers.

1. Since it was the first year of the trial it is suggested that, findings of the present study must be tested coming years for confirmation.
2. More number of rose cultivars and preservatives should be tried for finding best results.

Chapter-VII

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APPENDICES

Appendix- I: Analysis of variance for the Days taken for 1st petal spreading

Source of variation	D.F.	Mean sum of squares Days taken for 1st petal spreading
Treatment	13	0.44
Error	28	0.27
Total	41	

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

Source of variation	D.F.	Mean sum of squares Solution uptake by flowers		
		On 3rd day	On 5th day	At senescence
Treatment	13	261.11	446.22	289.44
Error	28	56.48	116.60	65.31
Total	41			

Appendix- III: Analysis of variance for the Change in weight of flower.

Source of variation	D.F.	Mean sum of squares		
		Change in weight of flower		
		On 3rd day	On 5th day	At senescence
Treatment	13	1.62	0.932	3.78
Error	28	01.50	1.63	1.06
Total	41			

Appendix- IV: Analysis of variance for the flower freshness score

Source of variation	D.F.	Mean sum of squares
		Flower freshness score
Treatment	13	0.37
Error	28	0.10
Total	41	

Appendix-V: Analysis of variance for the Maximum flower head diameter

Source of variation	D.F.	Mean sum of squares
		Maximum flower head diameter
Treatment	13	0.44
Error	28	0.27
Total	41	

Appendix-VI: Analysis of variance for the Petal dicolouration score

Source of variation	D.F.	Mean sum of squares
		Petal dicolouration score
Treatment	13	1.30
Error	28	0.38
Total	41	

Appendix-VII: Analysis of variance for the biochemical parameters of flower

Source of variation	D.F.	Mean sum of squares		
		Change in TSS	Change in Chlorophyll	Change in Anthocyanin
Treatment	13	.0.15	0.54	190.00
Error	28	0.12	0.26	200.00
Total	41			

Appendix-VIII: Analysis of variance for the Vase life of Flowers (days)

Source of variation	D.F.	Mean sum of squares
		Vase life of Flowers (days)
Treatment	13	3.67
Error	28	0.65
Total	41	

VITA

The author of this thesis **Shiwani Kshirsagar d/o. Premchand Kshirsagar,** was born on 18^{th} march 1996 at Balod (C.G.). She passed High School and Senior Secondary Examination from C.G. Board, Raipur from Saraswati Shishu Mandir High School Balod, District Balod (C.G.) with 84.67 % in 2011 and 78% in 2013 respectively. She joined Danteshwari College of Horticulture, Raipur (C.G.) in 2014 and completed B.Sc.-Horticulture (Hons.) in the year 2018 with 1_{st} division securing an CGPA of 7.48 on 10 point scale.

After graduation, she joined M.Sc. (Ag-Horticulture) in College of Horticulture, Mandsaur specialization in Floriculture and Landscape Architecture. She has completed the entire course requirement for the above said Master Degree in the year 2019-20 with an OGPA of 8.07 on a 10 point scale. She was allotted an interesting research problem entitled **''Effect of postharvest preservatives on vase life of cut Rose (*Rosa hybrida* L.) cv. Top Secret ''** of his choice for thesis work, which has been duly completed by her and presented in the form of this thesis.

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