

**“POST HARVEST STUDY ON GERBERA (*Gerbera jamesonii*)
CV. STANZA”**

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GUJARAT STATE

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**“POST HARVEST STUDY ON GERBERA (*Gerbera jamesonii*)
CV. STANZA”**

A

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IN

**FLORICULTURE AND LANDSCAPE ARCHITECTURE
BY**

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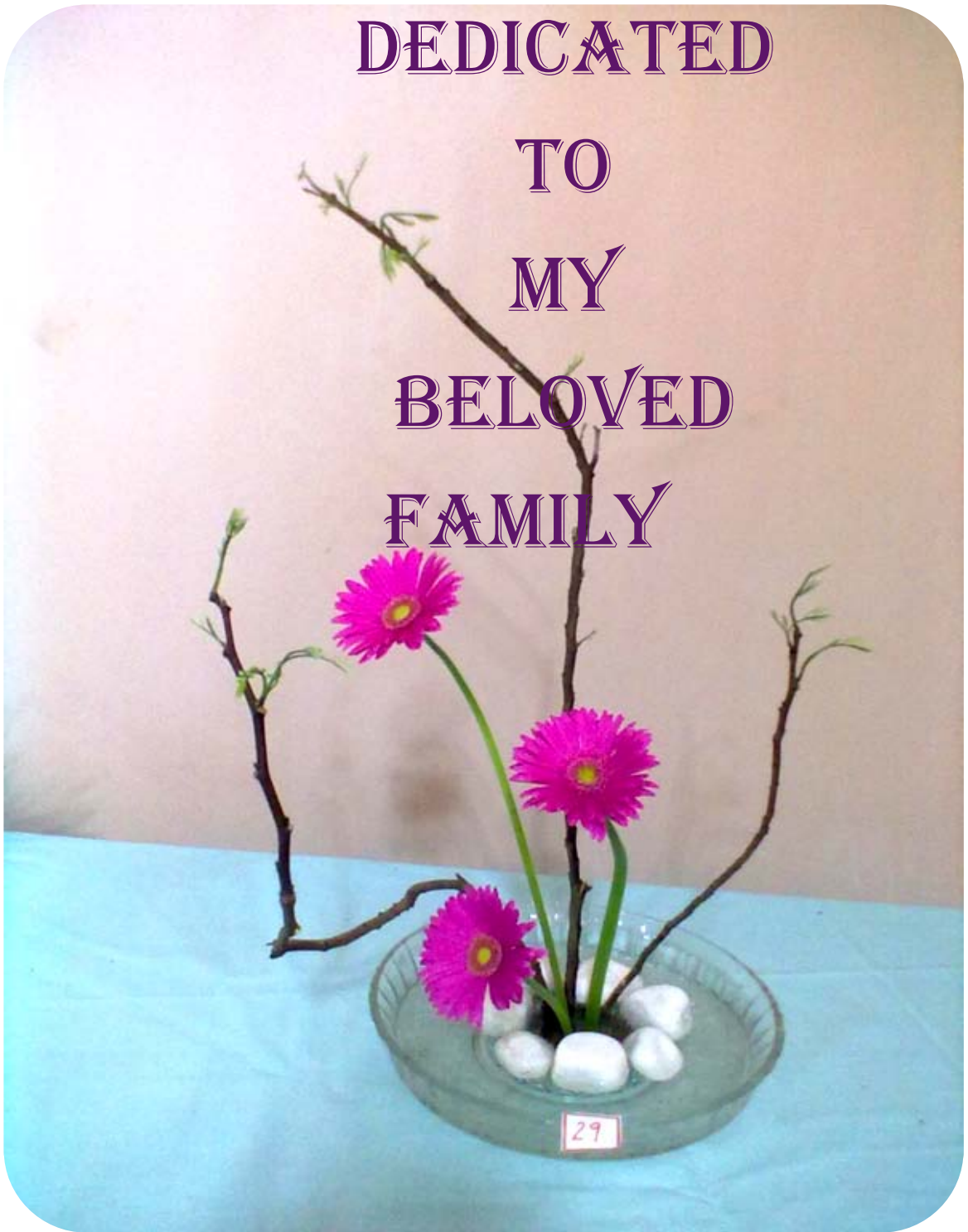
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**“POST HARVEST STUDY ON GERBERA
(*Gerbera jamesonii*) CV. STANZA”**

Name of Student	Major Advisor
Joshi Aditi Chandrakant	Dr. B.K. Dhaduk

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A B S T R A C T

Research entitled “Post harvest study on gerbera (*Gerbera jamesonii*) cv. Stanza” was conducted with a view to improve the post harvest flower quality and vase life. The research work was carried out at Laboratory of Floriculture, Department of Floriculture and Landscape Architecture, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari in the year 2010 to 2012. Five experiments were conducted viz., Experiment : I Standardization of harvest stage and stalk length of gerbera cv. Stanza. Experiment : II Effect of pulsing solutions on post harvest life of gerbera cv. Stanza. Experiment : III Effect of holding solutions on post harvest life of gerbera cv. Stanza. Experiment : IV Effect of storage techniques on post harvest life of gerbera cv. Stanza and Experiment : V Effect of storage durations on post harvest life of gerbera cv. Stanza for improving post harvest life of gerbera cut flower.

In experiment first, harvest stage and stalk length significantly influence all parameter in terms of post harvest quality and vase life in gerbera cv. Stanza. Fully open ray florets, unopen disc florets (S₁) with stalk length 60 cm (L₃) was found to be the most appropriate having highest overall quality score with vase life of 8.90 days.

In experiment second, the study was conducted to find out the effect of 3 hours pulsing with different pulsing solutions *viz.*, Sucrose 5%, Sucrose 10%, Ascorbic acid 250 mg/l + Sucrose 10%, 8 HQC 250 mg/l + Sucrose 10% and Control (water) on gerbera cv. Stanza. Pulsing of 8 HQC 250 mg/l + Sucrose 10% solution treatment showed highly promising results with maintained flower size and flower quality at 2nd, 4th, 6th, 8th and 10th days in vase life of gerbera cv. Stanza. Further, the same chemical treated cut flowers showed significantly, decreased physiological loss in weight, higher water uptake and retention of fresh weight also maintained qualitative parameters like flower size, pigment content and decreased scape bending with increased quantitative parameters like MSI, TDS, anthocyanin content in petals and dry weight as compared to other pulsed in gerbera cv. Stanza.

In experiment third, holding solution significantly influenced post harvest quality and vase life of gerbera cut flowers with respect to all parameters. Holding solution containing Citric acid 300 mg/l + Sucrose 2%, Citric acid 500 mg/l + Sucrose 2%, GA₃ 100 mg/l + Sucrose 2%, GA₃ 200 mg/l + Sucrose 2%, Spermine 50 mg/l + Sucrose 2%, Spermine 100 mg/l +

Sucrose 2%, 8 HQ 100 mg/l + Sucrose 2%, 8 HQ 200 mg/l + Sucrose 2% and Control. Among the holding solutions, the Citric acid 300 mg/l + Sucrose 2% significantly maintained quantitative parameters like, increase in water uptake, change in fresh weight, minimum physiological change in weight, total dissolved solutes in petal and reduce electrolyte leakage in petal tissue, along with qualitative parameters like influence on flower size, minimum scape bending curvature and pigment retention (anthocyanin) in petal, excellent overall quality with increase in vase life by 13.10 days as compared to control (8.87 days) in gerbera cv. Stanza.

In experiment fourth, the study was carried out to find the effect of different storage techniques at 6°C for 7 days *viz.*, dry storage with packaging of PP (polypropylene) and CFB box and wet storage methods of holding cut stems in AgNO₃ 10 mg/l + Sucrose 2%, AgNO₃ 20 mg/l + Sucrose 2%, Sodium benzoate 100 mg/l + Sucrose 2%, Sodium benzoate 200 mg/l + Sucrose 2% and Control (In RO water) solutions on flower quality and vase life of gerbera. As compared to different storage techniques, dry storage with wrapping PP material at 6°C flowers showed promising results with maintained flower quality by the end of the storage period for 7 days. Cut flowers packed with PP packaging maintained significantly negligible physiological loss in weight, absence of scape bending after storage, maintained higher water uptake and retention of fresh weight with improved flower size during vase life as compared to other storage techniques in gerbera. Membrane stability index (MSI) of the petal tissue, dry weight and total dissolved solutes (TDS) of petals were also

significantly higher in PP packaged stored at 6°C on 2nd DAS, 4th DAS and 6th DAS, which delayed the petal senescence and enhanced the vase life as compared to all other treatments. Overall flower quality with regard to turgidity, colour & freshness were also maintained higher in PP packaging.

Experiment five was conducted to find out the effect of storage durations *viz.*, 8, 12, 16 and 20 days on gerbera flowers harvested at fully open ray florets, unopen disc florets with 60 cm stalk length, pulsed with 8 HQC 250 mg/l + Sucrose 10% and packaged PP stored at 6°C. After removing from storage gerbera flowers were kept in Citric acid 300 mg/l + Sucrose 2%. With increase in the storage duration trend showed a decrease in all the qualitative and quantitative parameters however, pulsed with 8 HQC 250 mg/l + Sucrose 10% and PP packaged gerbera cut flowers, stored at 6°C temperature for durations of 8 and 12 days were show higher retention of fresh weight (*i.e.* low physiological loss in weight and higher fresh weight at 2nd, 4th and 6th DAS) and higher water up take was observed. Further it maintained higher up to 12 days of storage. Whereas, it declined in long duration of storage at 16 and 20 days. Flower stored for 8 and 12 days recorded higher membrane stability index (MSI) of the petal tissue, total dissolved solutes (TDS) of petals, petal total soluble sugar (TSS), anthocyanin content and dry weight in gerbera cv. Stanza. Maximum overall flower quality and vase life also recorded for duration of 8 days and 12 days in gerbera cv. Stanza.



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C E R T I F I C A T E

This is to certify that the thesis **“POST HARVEST STUDY ON GERBERA (*Gerbera jamesonii*) CV. STANZA”** entitled submitted by **JOSHI ADITI C.** in partial fulfillment of the requirements for the award of the degree of **DOCTOR OF PHILOSOPHY (HORTICULTURE)** in **FLORICULTURE AND LANDSCAPE ARCHITECTURE** of the Navsari Agricultural University is a record of bonafide research work carried out by her under my guidance and the thesis has not previously formed the basis for the award of any degree, diploma or other similar title.

Place: Navsari

Date: 23-07-2012

(B. K. Dhaduk)

Major Advisor

DECLARATION

This is to certify that the whole of the research work reported here in the thesis for the partial fulfillment of the requirements for the degree of **DOCTOR OF PHILOSOPHY (HORTICULTURE)** in **FLORICULTURE AND LANDSCAPE ARCHITECTURE** by the undersigned is the result of investigation done by me under direct guidance of **Dr. B. K. Dhaduk**, Professor and Head (Horticulture), ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari and no part of the work has been submitted for any other degree so far.

Place: Navsari

Date: 23-07-2012

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(Aditi C. Joshi)

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List of Abbreviations

%	Per cent
°	Degree
°B	Degree brix
°C	Degree centigrade
8-HQ	8-Hydroxyquinoline
8-HQC	8-Hydroxyquinoline citrate
AgNO ₃	Silver Nitrate
Anon.	Anonymous
C. D.	Critical difference
C. V.	Coefficient of variance
CFB box	Corrugated Fibre Board Box
cm	Centimetre
CO ₂	Carbon dioxide
CRD	Completely randomized design
cv.	Cultivar
cvs.	Cultivars
DAS	Days after storage
<i>et al.</i>	et alii and others
etc.	Etcetera
Ex.	Experiment
FCRD	Completely randomized design with factorial concept
Fig.	Figure
GA ₃	Gibberellic acid
gm	Gram
h	Hour
<i>i.e.</i>	That is
mg	Millie gram
mg/gm	Milli gram per gram

mg/l	Millie gram per litre
ml	Milli litre
ml/l	Millie litre per litre
MSI	Membrane stability index
N.S	Non-significant
No.	Number
O ₂	Oxygen
PP	Polypropylene
S. Em.	Standard Error of Mean
Sig.	Significant
TDS	Total dissolved solutes
TSS	Total soluble sugar
Var.	Variety
<i>viz.</i>	Namely



INTRODUCTION

I. INTRODUCTION

“Flowers have spoken to me more than I can tell in written words. They are the hieroglyphics of angels, loved by all men for the beauty of their character, though few can decipher even fragment of their meaning” [Lydia]. Flowers are heart, soul and ornamentation of nature; it is really hard to explain the beauty and essence of flower, which is adored by everyone, even the God himself. Flowers convey us the feeling of truthfulness, simplicity, purity and pioussness. Flowers seem to be intended for the solace of ordinary humanity and mankind.

Floriculture, the art and knowledge of growing flowers, is today a good viable agro-based industry with a high export potential in our county. It is gaining impetus with the growing demand and consumption of flowers in the world. It has become a fast emerging lucrative industry as a major venture worldwide now-a-days. It is becoming increasingly popular not only as an essential part of good living but also as a commercial enterprise with considerable potential for export, earning a good amount of foreign exchange. The scope of floriculture has increased tremendously in India, which is evident by exponential increase in area from 53,000 ha (1993-94) to 1,91,600 ha area in India is under floriculture producing 10,31,000 metric tonnes (MT) of loose flowers and 69,027 lakh numbers of cut flowers during 2010-11. The overall exports of floricultural produce from India had touched Rs. 294.4 crore by the end of 2009-10. In India major flower

growing states are West Bengal, Maharashtra, Karnataka, Tamil Nadu, Sikkim, Uttranchal, Andhra Pradesh, Delhi, Gujarat, Uttar Pradesh and Haryana. A number of export oriented units have been set up in the floriculture segment in the last decade (Anon., 2012).

Gujarat, endowed with varied agro-climatic condition, has immense scope for cultivation of various flower crops and is advancing rapidly in the lucrative flora business. Within last 4-5 years, area under flower cultivation has been doubled and shifted from mere cultivation in the state of traditional flowers to modern hi-tech greenhouse projects producing high quality cut flowers. The important flower crops in the state are rose, gerbera, chrysanthemum, marigold, jasmine, tuberose, gaillardia, and spider lily. The flowers are mostly cultivated around Navsari, Surat, Vadodara, Anand, Ahmadabad, Sabarkantha and Rajkot.

In Gujarat, area under floriculture is around 12,500 ha producing around 49,500 MT of loose flowers and 5,063 lakh cut flowers (Anon., 2010). An increase in area under protected cultivation from 30 acre to 150 acre has been reported in Gujarat. Generally, rose and gerbera are the two major crops flourishing well under protected cultivation. However, these crops need high input and management due to high disease and pest incidence in South Gujarat region.

One of these flowers, out valuing all utilities of the world through its magnificent beauty, varying hues and colours is the pride of nature- '*Gerbera*'.

Introduction

Gerbera (*Gerbera jamesonii* Hook.) came into the dictionary of floriculture after it was discovered by Pre-Linnean botanist, Gronovious but it received its fortunate name in honour of German naturalist, 'Traugott Gerber'. Gerbera is an internationally important cut flower grown for its colourful, showy and long lasting daisy like flowers. It is one of nature's beautiful creation having beautiful flowers, exquisite shape, size and bewitching colour. It is commonly known as "Transvaal daisy", "Barbeton daisy", "African daisy" or "Hitlon Daisy".

Gerbera belongs to the family Asteraceae and is considered to be the native of South African and Asiatic regions. The genus consists of forty species of semi hardy and perennial flowering plants. Out of these only *Gerbera jamesonii* is under cultivation. Some other important species are *G.aspleifolia*, *G.aurantiaca*, *G. kunzeana*, *G.viridifolia* etc.

Gerberas are widely used as cut flower because the flower are available in numerous colours like pink, white, yellow, orange, crimson, purple and in many combinations and shades. The flowers are well suited for vase decoration and other floral arrangements on account of its lengthy robust pedicel. This hardy upright leafless stem facilitates long distance transport. Apart from this gerbera is an ideal crop for beds, borders, pot and rock garden, etc.

Gerbera occupies 4th position in top ten cut flowers of export. Good quality cut flowers of gerbera can be produced under protected cultivation. Gerbera has good demand both in domestic

and international markets. The annual consumption of gerbera as cut flower in the world is worth 121.2 million Euros (Anon., 2006).

Post harvest management is one of the important aspect in cut flower marketing. Lack of proper post harvest handling causes nearly 30-50 per cent losses of cut flowers during entire market chain (Singh and Tiwari, 2002). Post harvest losses in flowers are observed mainly due to faulty harvest and improper techniques of handling, packaging, storing, transport and marketing.

There are frequent price gluts and fluctuations in the Indian flower market. Physiological, ultra structural and biochemical changes occurring during the post harvest life will influence the quality of cut flowers (Faragher *et. al.*, 1986). Keeping quality of flowers is influenced by internal factors (hormonal balance, CHO status, age, genetic makeup, water balance etc.) and external factors (environmental and mechanical). Post harvest metabolic activities like respiration and transpiration are known to influence the vase life of cut flowers (Halevy and Mayak, 1981; Randhawa and Mukhopadhyay, 1986). Water balance in flowers also plays an important role in maintaining flower turgidity, freshness, petal orientation and proper bud opening.

Gerbera flowers are most vulnerable to damage owing to their delicacy and tenderness. Further, cut stems of gerbera are highly prone to water stress due to hollow stem. Blockage of xylem due to bacterial plugging causes stem break, which adversely affects the flower vase life (Balestra *et al.*, 2005).

Few scientists have worked on the improvement of postharvest life of gerbera (Prashanth and Chandrashekar, 2007; Nair *et al.*, 2000; Deambrogia *et al.*, 1991; Marousky, 1986). Vase solution and pulsing treatments are known to improve post harvest life in various flowers (Singh *et al.*, 2008a; Sankar *et al.*, 2007; Singh *et al.*, 2007; Bhaskar *et al.*, 2005; Bhasker *et al.*, 2000; Bhat *et al.*, 1999; Salunkhe *et al.*, 1990 and Marousky, 1986). Sucrose replaces the depleted endogenous carbohydrates utilized during post harvest life of flowers as well as controls scape bending in gerbera (Prashanth and Chandrashekar, 2007; Andra, 1994 and Salunkhe *et al.*, 1990). Citric acid extends vase life of cut flowers by reduced stem plugging, improved water balance and arresting microbial population in vase solution (Singh and Bhattacharjee, 1993; Marousky, 1971). Few reports of use of anti oxidants like α -lipoic acid, sodium benzoate, *etc.* are known to improve vase life of cut flowers (Singh *et al.*, 2007). 8-HQC acidifies holding solution which can retard the microbial growth (Larsen and Schole, 1965). Vascular blockage and water absorption is greatly influenced by 8-HQC.

Some reports on storage of gerbera have been published (Halevy and Mayak, 1981). Yet, appropriate storage technology has not been standardized for gerbera. The major constrains in export of cut flowers from our country are poor packaging, inadequate facilities of storage and transport. Storage technology like Wet storage (Jain *et al.*, 2007; Palanikumar and Bhattacharjee, 2001) and dry storage are used. Pulsing of flowers before storage helps to improve post storage life of the flowers (Arora and Singh, 2002).

Although, post harvest research in gerbera is being conducted worldwide yet feasibility of appropriate post harvest technology is lacking. From the above elaboration, it is clear that cut flowers life can be prolonged by adapting improved production technology, harvesting at proper stage with appropriate spike length and keeping in vase with different chemicals. Information on storage technology and duration of storage and specific preservatives at effective concentrations, are still lacking for gerbera cut flowers. The present experiment was therefore, taken up during 2010-2011 and 2011-12 with the following objectives.

Objectives:

1. To standardize harvest stage and stalk length for gerbera cv. Stanza
2. To find out best pulsing and holding solutions for gerbera cv. Stanza
3. To evaluate and standardize packaging and storage technology with pre storage pulsing and post holding solutions for gerbera cv. Stanza
4. To standardize storage duration for gerbera cv. Stanza



REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

Appropriate post harvest management of any cut flowers is of utmost importance to ensure the long-lasting quality. Although, Indian flowers are now being recognized and gained acceptance in international market yet, its share is negligible (less than 2%). Standardization of post harvest technology of different cut flowers is a must to meet high quality standards at world trade. The appropriate technique of storage and packaging are of considerable utility to fetch more prices and to avoid frequent gluts in marketing systems in our country. The technology of packaging, pulsing and storage of cut flowers is a new era of research and has recently gained attention with the expansion of floriculture as an industry. Thus, the evaluation of appropriate technology for storage of flowers is vital in development of market strategy and accessibility at international level.

Research comprising of role of various chemicals consisting of PGRs, germicides, antiethylene agents and sugar for different flowers have been conducted by various scientists (Bala *et al.* 2008, Singh *et al.* 2005, etc.). Further, some reports on role of packaging films, storage temperature and methods as well as pre and post storage treatments have been published for various flowers. Relevant literatures available on these aspects have been reviewed for rose and some important ornamental crops under following headings.

- 2.1 Effect of harvest stage and stalk length on post harvest life.**
- 2.2 Effect of pulsing and Holding solutions on post harvest life.**
- 2.3 Effect of storage technology on post harvest life.**
- 2.4 Pre and post storage treatment and storage duration on post harvest life.**
- 2.1 Effect of harvest stage and stalk length on post harvest life.**

In case of gerbera, research with regard to post harvest aspect is meager. Very few scientists have worked on standardization of harvest stage and stalk length for improving post harvest quality in gerbera.

Bhattacharjee and Das (2008) and Ketsa and Kosonmethakul (2001) with regard to harvest stage, suggested advanced stage for harvesting (75-90%) of *Dendrobium* cut spikes.

Brahmankar *et al.*, (2005) studied the different harvesting stages *viz.*, unopened stage with fully matured buds, 25% opened stage and 50% opened stage and chemical preservatives with three levels of concentrations *viz.*, Sucrose (1%, 2% and 3%), Sucrose 2% + $Al_2(SO_4)_3$ (0.03%, 0.06% and 0.09%), Sucrose 2% $AgNO_3$ (0.015%, 0.03% and 0.045%) and Sucrose 2% + 8-HQ (0.01%, 0.02% and 0.03%) was studied to enhance the postharvest life and quality of golden rod panicles. It was observed that less advanced stages, both unopened stage and

25% open stage along with Sucrose 2% + 8-HQ 0.03% significantly enhanced floret opening, higher panicle weight with excellent flower colour, turgidity, freshness and enhanced vase life of golden rod.

Singh *et al.* (2003) studied the effect of sucrose on vase life of cut roses cv. First Red at different stages. Among four stages for experiment i.e. tight bud stage, buds half open, buds three-fourth open and fully open, the buds harvested at three-fourth opening with Sucrose 2% + $\text{Al}_2(\text{SO}_4)_3$ 300 ppm showed maximum vase life.

Satpute and Patel (2002) reported greatest vase life (11.00 days) with 100 cm spike length as compared to 80, 60 and 40 cm in gladiolus cv. White Prosperity.

De and Barman (1998) studied the effect of stalk lengths (30, 45, 60, 75 and 100 cm), stage of harvest and different concentration of sucrose (0, 2, 4, 6, 8, 10 and 12 per cent) on cut spike of tuberose. They found that spike having 75 cm floral stalk length, creamy white buds and one floret opened stage was beneficial for increasing the vase life and improving diameter of florets.

A successive increase in petal area, decreased loss of weight and increased vase life was observed with the increase in stem length. Short-stemmed flowers lasted for a shorter duration (Gothmare, 1993).

Mukhopandhyay (1990) reported that blooms with long stems are accepted in export market. In the United States of America, grading of flowers is followed according to stem length. The minimum length of cut rose starts from 25 cm and then the grade increased by 5 cm increment.

Halevy (1976) reported that the translocation of sugar from stem accumulates in the flower, which increases the water uptake and helps to maintain turgidity in the stem thus, extending the vase life of the flowers. The stem possesses high sucrose inversion capacity, which helps to prolong the shelf life (Chin and Sacalis, 1977).

Rogers (1973) observed that the role of water status in the cut flowers helps in extending the vase life of the flower and depends on the maturity of the stem.

2.2 Effect of pulsing and holding solutions on post harvest life

Pulsing is a short duration treatment given to cut flowers in the form of high concentration of sucrose. In a principle, sugar works as an antidesiccant for microbial growth. Fresh cut flowers are pulsed by placing lower portion of flower stems in solutions containing sugar and germicides for a period ranging from few hours to 2 days, depending upon the flower species (Grover *et al.*, 2005). Hence, the antimicrobial agents i.e. 8-HQ, 8-HQS, 8-HQC, Silver salts, Citric acid, *etc.* are also incorporated to enhance better solution uptake that would suffice maximum effects of the supplied sugar to improve flower opening,

flower size, shape, colour and longevity of cut flowers (Singh *et al.*, 2007).

Holding solution, preservative or vase solution refers to a solution consisting of sucrose, anti-microbial agent and or growth regulator in which cut flowers can be continuously held. Basically, the concentration is much lower than pulse solution. The anti-microbial agents like 8-HQC, 8-HQS, Aluminium sulphate, anti-ethylene agents like STS, AgNO₃ and acidifying agents like citric acid are widely used as vase solution. Even plant growth regulators like gibberellic acid; Bezyladenine, *etc.* are also reported to improve vase life and quality of gladiolus and chrysanthemum. Growth retardants like CCC, SADH and MH have also been reported to improve vase life of some cut flowers. Besides, some chemicals (anti-oxidants and mineral salts) like Sodium Benzoate, Calcium Chloride, Ammonium Sulphate, Zinc Sulphate, α -Lipoic Acid are also used for prolonging life and quality (Singh and Jegadheesan, 2003; Namita *et al.*, 2006 and Gerasopoulos and Chebli, 1998).

2.2.1 Gerbera

Javad *et al.* (2011) evaluated that gerbera cut flower pulse with 8 HQS 600 ppm + Citric acid 300 ppm + sucrose 4% maximum vase life (days), water up take (ml) and minimum scape bending curvature (⁰) in different cultivars.

Patel *et al.* (2008) reported that the gerbera flowers in vase solution of 8 HQC (0.02%) + Sucrose (3%) recorded higher

gain in fresh weight, enhanced vase life with improved cut flower quality as compared to control.

Madhavi (2007) study the effect of different preservatives to extend the vase life of gerbera and revealed that citric acid (200 ppm and 400 ppm) and AgNO₃ (500 ppm) selected best preservative with respect to water up take, transpirational water loss, water balance, fresh weight and vase life.

Prashanth and Chandrashekhar (2007a) studied biocides in vase solution which influenced the bio-chemical changes associated with senescence, decreased the leakage of ions and improved the post harvest life in gerbera (*Gerbera jamesonii* Bolus ex. Hook) cv. Yanara. Cut gerbera held in 200 ppm 8-HQS registered longest vase life (8.28 days) with lowest electrolyte leakage, higher water potential and higher level of proteins and phenols in flower scapes compared to other treatments.

Prasanth and Chandrashekhar (2007b) studied the influence of sucrose at different concentrations on post harvest life of cut gerbera cv. Yanara. Highest water uptake (10.299 g/f), maximum vase life (8.06 day) and lowest scape bending (13.444 degrees) were recorded at 5 % Sucrose compared to other treatments. The lower concentrations of Sucrose (2 % and 3 %) and control were ineffective in controlling scape bending due to disturbed water relations and higher peroxidase activity.

Chauhan (2004) studied the effect of preservative chemicals at different concentrations on vase life gerbera cv. Scilla and reported that Citric acid at 200ppm showed maximum

vase life (11.48 days) followed by silver nitrate at 400 ppm (10.9 days).

Nair *et al.*, (2003) conducted an experiment to prolong the vase life of cut gerbera (*Gerbera jamesonii*) flowers using floral preservatives. There were 25 treatments of holding solutions containing AgNO₃ (10, 20 and 30 ppm), Sucrose (2, 4 and 6 %), Ascorbic acid (1, 2 and 3 %), Potassium metabisulphite (250, 500 and 750 ppm), 8-hydroxyquinoline (100, 200 and 300 ppm), and their combinations. The maximum number of days taken for flower head drooping was recorded in 20 ppm AgNO₃+ 4% Sucrose (16.12), followed by 20 ppm AgNO₃+ 6% Sucrose (14.80). The control (distilled water) recorded the minimum number of days (6.93) for flower head drooping. The maximum quantity (24.63 ml) of holding solution was absorbed in 20 ppm AgNO₃+6% Sucrose treatment, which was at par with 20 ppm AgNO₃+ 2% Sucrose (24.09 ml) and 20 ppm AgNO₃+ 4% Sucrose (22.98 ml); the minimum quantity (7.55 ml) was recorded in the control.

Deambrogia *et al.* (1991) revealed that the mixture of 8-HQS + NaB + Aminoacetic acid 2, 4, 5, T + Sucrose enhanced the vase life of gerbera cv. Rebecca.

2.2.2 Chrysanthemum

Mashhadian *et al.* (2012) observed that citric acid increased vase life, petal water content (%), fresh weight (%) and marketability in chrysanthemum.

Gupta *et al.* (2006) recommended 2 % sucrose + 25 ppm AgNO₃ + 75 ppm Citric acid and 2 % Sucrose + 500 ppm 8-HQC

as best holding solution for bud opening and extending vase life in chrysanthemum.

The cut flower of chrysanthemum cv. Mountaineer and Kundan kept in holding solution 8-HQ (250 ppm) and Sucrose (1.0%) had maximum vase life, maximum diameter and minimum weight loss as compared to other holding solutions (Bhat *et al.*, 1999).

Serini and Banfi (1974) attributed antibacterial property of 8-HQ compound in enhancing the vase life of chrysanthemum.

2.2.3 China Aster

The maximum vase life (8.0 and 8.3 days) in China aster flowers were observed when kept in vase solution containing 2 % sucrose during *kharif* and *rabi* seasons (Mantur and Nalawadi, 1989).

Gowda (1986) in the flower of china aster cv. Ostrich Plume recorded longest vase life when given (0.4%) $Al_2(SO_4)_3$ and 2% Sucrose treatment in both monsoon and winter season.

2.2.4 Rose

Jain *et al.* (2007) investigated the effects of pulsing in the cut flowers of rose cv. First Red Rose cut flowers pulsed in 200 ppm 8-HQC + 3 % Sucrose and stored at 2°C for five duration *i.e.* 0, 3, 6, 9 or 12 day, showed maximum flower diameter (8.50 cm), vase life (19.28 day), volume of solution consumed (53.31 ml) and protein (17.87 %).

Dixit *et al.* (2005) studied the effect of different preservative chemicals in vase solution on the vase life of rose cv. 'Kiss of Fire'. Sucrose (5.5-5.7 %), Cobalt chloride (66-234 mg/l) and Citric acid (116-284 mg/l) were used in vase solution. Roses pulsed with Silver nitrate at 1000 ppm for 15 min. showed increase vase life by three days due to use of preservative solution and pulsing. Rose buds opened fully in 2-3 days. The maximum weight gain was during 2nd and 3rd days.

De and Bhattacharjee (1999) in rose cv. Super Star observed longest vase life along with improvement of flower diameter, flower opening and solution uptake with the treatment of STS (0.2 mm) + 8-HQC (300 ppm) + Sucrose (2%).

Patil and Singh (1995) studied the effect of various vase solutions (different combinations of the 5% Sucrose, 300 ppm Aluminium sulphate, 200 ppm 8-HQC and 300 ppm Citric acid) under ambient conditions on cut rose cv. Gladiator and they obtained longest vase life with Sucrose 5 % + Aluminium sulphate 300 ppm + Citric acid 300 ppm.

Bhattacharjee (1993) reported that 8-HQC at 250 ppm concentration was best among all the five treatments namely, 8-HQC 250 ppm, Aluminium sulphate at 50 ppm, Sucrose at 10,000 ppm, Silver nitrate at 25 ppm and Citric acid at 200 ppm for prolonging the post harvest life of cut rose cv. Priyadarshini. He also reported maximum beneficial effect the mixture of all the five chemicals. Further he observed more water uptake, maximum flower diameter and highest longevity of the cut rose when 40 cm

flower stem length was used.

Doorn and Perik (1990) also studied the bacteriostatic effect of 8-HQC in cut rose flowers cv. Sonia, Ilona, Polka and Frisco and marked that hydraulic conductance of stems held in this solution for 2 days was increased in stems of freshly harvested flowers.

Michalczuk *et al.* (1989) reported that vase life and bud opening of rose cv. Sonia, Celica, Samantha and Mercedes were improved with Ca alone or together with 2% Sucrose and 8-HQC.

Marousky (1971) investigated inhibition of vascular blockage and increased moisture retention in cut roses induced by pH, 8-HQC and Sucrose. Sucrose treated roses absorbed less solution but still they gained more weight than roses held in water due to stomatal closure and showed increased moisture retention. 8-HQC reduced the incidence of vascular blockage and increased water absorption and flower longevity.

2.2.5 Gladiolus

Dantuluri *et al.* (2008) studied the effect of certain polyamines in vase solution on postharvest life of gladiolus cut spikes. Polyamines 100 ppm Spermine + 4 % Sucrose, 500 ppm Spermine + 4 % Sucrose and 500 ppm Spermidine + 4 % Sucrose significantly improved fresh weight, uptake of vase solution, flower opening and vase life over control and also delayed senescence by improving membrane stability.

Singh *et al.* (2007) reported that pulse treatment of 300 ppm 8-HQ with 5 % Sucrose significantly enhanced the per cent gain in fresh and dry weight of cut spikes and maintain higher reducing, non-reducing sugar content in petals and carotenes and anthocyanin pigments in the petal of the cut spikes on 4th day after treatment (DAT) in gladiolus. This treatment also maintained higher activities of antioxidant enzymes and higher MSI on 5th DAT.

Namita *et al.* (2006) studied the effect of pulsing treatments on storage life and quality of gladiolus cv. Jacksonville Gold cut spikes. Pulsing of gladiolus spikes with Sucrose (20 %) + $\text{Al}_2(\text{SO}_4)_3 \cdot 16 \text{H}_2\text{O}$ (400 ppm) and GA_3 (100 and 200 ppm) showed increase in vase life, floret longevity, floret diameter, per cent floret opening and per cent increase in fresh weight. The pulsed gladiolus spikes could be wet stored at 4 ± 0.5 °C for 12 days without much reduction in vase life.

Singh *et al.* (2005) reported that 8-HQ pulse treatment before the sucrose treatment eliminated the microbial growth and improved the uptake of sucrose pulse treatment in gladiolus cv. 'Peter Pears'. The double pulsing treatment, comprising of 300 ppm 8-HQ for a duration of 1 h, followed by 20 % sucrose for a duration of 12 h (double pulsing), revealed significantly enhanced water uptake and per cent gain in fresh weight as compared to control and single (sucrose) pulsed spikes and also improved the membrane stability and keeping quality of gladiolus flowers accompanied with enhanced per cent bud opening (98.6 %) and

floret width.

Hussain *et al.* (2001) recorded that the amount of soluble carbohydrate present in a single floret of cut gladiolus increased with floret opening and decreased with senescence. Soluble proteins were found to be higher in bud stage and at fully opened stage. Pulsing with 20 % Sucrose significantly increased the amount of soluble carbohydrate and soluble protein.

Singh *et al.* (2000) reported that different biocides in vase solution effectively controlled bacterial growth but did not increase vase life appreciably in gladiolus cv. Har Majesty. The efficiency of biocides increased only when used along with 2 % Sucrose solution. Pulsing treatments with 20 % Sucrose along with 250 mg/l 8-HQC for 20 h at 23 ± 2 °C was found to be more effective than at 5 ± 1 °C.

De *et al.* (1996) studied the effects of sucrose, salts and organic acids on the post harvest life and quality of pulsed gladiolus spikes cv. High Style. 4 % Sucrose + 250 mg/l 8-HQC were found most beneficial for improving the post harvest life and quality of cut gladiolus spikes over control.

Lal *et al.* (1990) found longer vase life of cut flowers of gladiolus cv. Silver Horn in the solution 8-HQS 200 ppm along with larger floret size as well as turgid and shining petals. While, 8-HQC at 150 ppm was the next better chemical, which prolonged the vase life and quality of cut flower as compared to control.

Rameshwar (1974) concluded that maximum floret size

diameter (12cm), per cent of florets open (92%) and vase life (13 days) can be attained when the spikes of gladiolus were treated with Al_2SO_4 (0.1%) + Sucrose (4%).

Marousky (1972) suggested role of sucrose in floral preservatives as an “anti-desiccant”. He also reported that sucrose caused decrease in stomatal opening and thereby maintained fresh weight.

2.2.4 Tuberose

Kumar and Singh (2004) reported that Sucrose at 2 % and 4 % concentration 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 floret opening. Over all observations suggest an increase in vase life with sucrose and plant growth regulators treatments.

Kumar *et al.* (2004) reported that 0.5 % Citric acid as vase solution was most effective in promoting water uptake, vase life, floret opening, increasing diameter and length of first, third and last fully opened pair of florets, while 0.1 % Citric acid was most effective in influencing the fresh weight and length of rachis in tuberose cv. Double.

Anjum *et al.* (2001) study that different concentration of Ascorbic acid (50 ppm, 100 ppm, 150 ppm and 200 ppm) maximum vase life, water uptake and fragrance observed with Ascorbic acid at 200 ppm in tuberose.

Bhaskar *et al.* (2000) studied the effect of certain

chemicals on the post harvest life of cut tuberose cv. Double. Preservative solution 3 % Sucrose + 250 ppm Citric acid + 0.01 % Calcium nitrate combination as vase solution proved to be best for recording maximum vase life of 14.67 days.

Saini *et al.* (1994) reported significantly higher vase life, solution uptake and opening of florets with 2% Sucrose + (0.005%) $\text{Al}_2(\text{SO}_4)_3$ + (0.005%) AgNO_3 vase solution, respectively.

Mukhopadhyay (1982) reported that longevity of tuberose flower spikes and floral development was due to 1-5 % Sucrose treatment as it served as a source of energy and good respiratory substrate for the maintenance of osmotic potentiality in tuberose cv. Single.

2.2.5 Anthurium

Maximum post harvest longevity (28.17 day) was found in the flowers of Anthurium cv. Nitta when treated with 400 ppm 8-HQS + 5 % Sucrose as holding solutions as compared to control (13.33 day) (Maitra and Roychowdhury, 2005).

2.2.6 Carnation

Mayak and Dilley (1976) observed that when Carnation flowers supplemented with Sucrose (5%) senesced less rapidly when treated with ethylene or abscisic acid than those not treated with Sucrose.

2.2.7 Orchid

Jomy *et al.* (2003) studied the post-harvest treatments

like pulsing, conditioning and holding solution in freshly cut *Dendrobium* varieties viz. Walter Oumae, Mary Trowse and Candy Stripe. In cv. 'Candy Stripe' conditioning with tap water altered to pH 3.0 + pulsing (4% Sucrose + 400 ppm 8 HQ) + holding solution (6% Sucrose + 300 ppm 8 HQ + 20 ppm AgNO₃) gave enhanced vase life of 13 days.

Babu *et al.* (2001) revealed that holding solution of 100 ppm 8 HQC + 3 % Sucrose extended vase life up to 31.33 days and also reported lowest rate of respiration and no colour fading of flowers in orchid.

2.2.10 Others

An experiment to study the effect of chemical preservative on vase life of Daisy flowers at dharwad and observed that maximum fresh weight, high amount of water up take (239.09) and longest vase life (10.53 days) in 8-HQC 0.4% (Patil., 2009)

Valsalakumari *et al.* (2003) recorded that pulsing treatment significantly influenced the post harvest longevity of flowers. Vase life could be extended from 15 days (control) to 32 days by holding solution 300 ppm 8 HQC + 6 % Sucrose.

2.3 Effect of storage technology on post harvest life

The flowers growers and wholesalers face considerable problems in marketing of cut flowers especially during glut period when production is surplus and demand is low. In order to regulate flower market and price stability, storage of cut flowers is a better

option. Generally two methods viz. dry storage and wet storage.

Singh *et al.* (2008b) studied the effect of different polymeric films on modified atmosphere storage of gladiolus cut spikes and recorded maximum vase life in PP (100 gauge) polymeric film packaged cold stored flowers. Moreover, there was no significant effect of polymeric film sleeves on floret size during storage though the size tends to decrease slightly with increase in the duration.

Singh *et al.* (2007) investigated the effects of different type of packaging films viz. cellophane, polypropylene, newspaper, butter-paper, brown-paper, plastic coated paper for modified atmosphere storage at low temperature (6-10°C) on the factors influencing petal senescence and vase life of gladiolus cut spikes, cv. 'Peter Pears'. Polypropylene packaged cut spikes delayed the petal senescence and extended the vase life of gladiolus cut spikes. Polypropylene was found to be an effective packaging film for modified atmosphere (MA) storage at low temperature (6-10°C) for storage of gladiolus cut spikes up to 10 days.

Jain *et al.* (2007) studied effect of wet storage on postharvest quality of rose cv. First Red and recorded maximum flower diameter (8.50 cm), vase life (19.28 days), volume of solution consumed (53.31 ml) and proteins (17.87 %) when cut spikes were stored for zero days in 50 ppm 8-HQC + 1.5 per cent Sucrose, 200 ppm 8-HQC + 3 per cent Sucrose and chlorinated water (200 ppm). However, maximum reducing sugar content

(445.50 mg/g) was recorded in flowers stored for 9 day in 50 ppm 8-HQC + 1.5 per cent Sucrose.

Jain *et al.* (2006) observed that cut flowers of rose cv. First Red wrapped in cellophane paper and stored at 2⁰C for 3 days resulted in increased vase life, volume of solution consumed and appearance as well as showed minimum weight loss.

Verma *et al.* (2006) studied three packaging materials *viz.*, newspaper, cello paper, cellophane wax paper and polyethylene for packaging and storage of the chrysanthemum flowers for 24, 48 and 72 h at ambient storage, zero energy cool chamber and cold storage. The maximum vase life (19.20 days), volume of solution consumed (259.30 ml), flower size (10.90 cm), total sugars (41.81 mg/g) and minimum weight loss (5.16%), was observed in cut flowers packed in wax paper for 24 h in cold storage, however, minimum vase life, flower size, volume of solution consumed and total sugar were recorded in flower wrapped in newspaper and stored for 72 h at ambient conditions.

The cut spikes of gladiolus cv. Her Majesty was kept in various wrapping materials such as polyethylene, cellophane, butter paper, news paper and packed in CFB boxes. Boxes were stored at 4⁰C, 10⁰C and in ambient condition for 2, 4 and 6 days. After storage, the spikes were held in solution of 4 % Sucrose + 100 ppm Al₂ (SO₄)₃ + 200 ppm 8-HQC solution in vase. Found that flower stored at 4⁰C and packed in butter paper for 6 days and flowers packaged in cellophane for 2 days proved to be the best for increasing the post harvest life of gladiolus (Beura and Singh,

2003).

Redman *et al.* (2002) noted that one to two weeks of 2⁰C cold storage was useful in extending storage life of *Buddleia davidii*, *Cercis canadensis* L., *Cosmos bipinnatus* 'Sensation', and *Penstemon digitalis* Nutt. 4 or 7⁰C storage temperature was also effective for *Cercis* and *Penstemon*. *Achillea filipendulina* 'Coronation Gold', *Celosia*, *Echinacea purpurea* Moench, *Helianthus maximiliani* and *Weigela* did not tolerate 1 week or more storage at 2⁰C temperature and should be marketed immediately after harvest.

Palanikumar and Bhattacharjee (2001) studied the effect of wet storage on post harvest life and flower quality of cut Roses cvs. Golden Giant, Raktagandha and Queen Elizabeth for 3, 4, 5 and 6 days after 4⁰C and 1, 2, 3 and 4 days under 8⁰C. Under 4⁰C the cut roses can be stored maximum of five days and under 8⁰C the roses can be stored maximum of two days without affecting their ultimate keeping quality in the vase at ambient temperature.

Serrana *et al.* (1992) studied the physiological alterations in cold stored rose flowers (*Rosa hybrida*, M. cultivar 'Visa') and found that during the storage of rose flowers cultivar 'Visa' at 4⁰C, the rate of ethylene production was maintained at very low levels and was unaffected by the time of cold storage whereas, respiration was decreased during storage. They also observed that the ACC (1-aminocyclopropane-1-carboxylic acid) levels increased with senescence, both in the free and conjugate forms, and were higher in the roses which had previously been in

cold storage.

Cushman *et al.* (1998) conducted an experiment on the effects of shipping temperature (4⁰C, 16⁰C or 28⁰C) and duration (2, 4 or 6 days) on flower longevity and leaf abscission of pot rose cvs. 'Meijikatar' and 'Meirutral'. Higher floral longevity, flower quality and the least leaf abscission was observed in plants stored at 4⁰C for up to 6 days either cultivar.

Ranwala and Miller (1998) revealed that cold storage of puffy bud stage of liliun sp. 'Stargazer' plants at 4, 7 or 10⁰C in dark for 2 weeks induced leaf chlorosis within 4 days in a simulated consumer environment and resulted in 60% leaf chlorosis and 40% leaf abscission after 20 days of storage. Cold storage also reduced the duration to flower bud opening (days from the end of cold storage till the last flower bud opened), inflorescence and flower longevity and increased flower bud abortion.

Belynskaya and Kondrat'-eva (1990) reported that the dry storage at 2⁰C to 4⁰C with 6% Sucrose solution for 24 h was better for the quality of tulip flower 'Prad' and cut flowers was preserved for 3-4 weeks. They also noted that cut daffodil flowers (cv. Agathan) resulted the best visual characteristics stored in a solution of 0.02% Citric acid and 4% Sucrose for 21 days at 2-4⁰C and 85% RH.

Swart (1989) observed that low temperature storage (2 days at 2⁰C compared with 9⁰C) improved subsequent vase life after cold storage at 20⁰C without affecting flower quality in

dahlia.

Faragher *et al.* (1984) studied the effects of cold storage and water loss on opening and vase life of 'Mercedes' roses and observed that dry storage for 10 days did not significantly reduce the water content of the petals, but did reduce the subsequent vase life at 22⁰C compared with freshly cut flowers. Further, they reported that dry storage also caused decreases in flower diameter and the number of reflexed petals after transfer to 22⁰C but had longer vase life than wet stored flowers.

Jiang *et al.* (1989) stored cut flowers at 0⁰C, 2⁰C or 4⁰C for one week with or without sucrose treatment. The highest quality flowers were those stored at 0⁰C. Treatment with sucrose also improved quality. The quality of flowers stored for 2 weeks at 0⁰C with Sucrose treatment was as high as that of fresh flowers and suggested that sugar content could provide an indication of keeping quality.

Mor *et al.* (1989) studied the long term storage of roses. They observed that the senescence process of cut roses continue during the cold storage and hence ultimately vase life declines with the increase in the storage period.

Nowak and Rudnicki (1984) conducted an experiment on cold storage of the gladiolus spikes cv. Dukat (yellow flowers) and reported that cut spikes could be dry-stored in sealed polyethylene sleeves at 4⁰C for up to 4 weeks without any reduction in vase life.

Faragher *et al.* (1982) observed that spray carnations cv. Pink Royale held at 2⁰C for 6 to 17 days reduced the time for petal-inrolling (sleepiness) to occur at 22⁰C by 1 to 2.5 day. They found that flowers kept at 2⁰C for 6 days showed increase in fresh weight, sucrose uptake, ATP-ase activity membrane protein and phospholipids contents.

2.4 Effect of pre and post storage treatment and storage duration on post harvest life.

Appropriate packaging of cut flowers together with pulsing and holding offers potential advantages of extending their storage period, vase life and mentioning flowers quality.

Singh *et al.* (2007) investigated the role of pre-storage pulsing and vase solution in improving the flower quality and vase life of low temperature stored gladiolus cut spike cv. Peter Pears and revealed that the polypropylene packaged gladiolus spikes with refrigerated storage at 6⁰-10⁰C can be stored up to 10 days with extended vase life (7 to 7.7 days) and improved flower quality as compared to unpacked i.e. control (2.2 to 2 days).

Namita *et al.* (2006) studied the effect of pulsing treatments on storage life and quality of gladiolus cv. Jacksonville Gold cut spikes. The pulsed gladiolus spikes wet stored under refrigerated conditions showed decline in vase life, floret longevity, floret diameter, percent floret opening and percent increase in fresh weight with increasing storage duration. The pulsed gladiolus spikes could be wet stored at 4±0.5⁰C for 12 days without much reduction in vase life.

Srivastava *et al.* (2005) carried out an experiment on the effect of pulsing solution, packaging material and storage duration on the post-harvest life of gladiolus cv. Novalux. Among all the pulsing treatments, 20% Sucrose + 200 ppm $\text{Al}_2(\text{SO}_4)_3$ was found better for most of the floral traits. Whereas among all packaging and storage treatments, spikes wrapped in brown paper and stored for 72 h at 4°C was found suitable for enhancing the longevity of cut spikes.

Kumar *et al.* (2003 a) studied the effect of pulsing with 10% Sucrose + 250 ppm $\text{Al}_2(\text{SO}_4)_3$ followed by dry cool storage (4-5 °C) for 3, 4, 5 and 6 days of tuberose spike cvs. Suvasini and Double. They reported that spike can be dry cold stored for 5 days, without affecting vase life over the control.

Kumar *et al.* (2003 b) observed that the pulsing with 10% Sucrose + 250 ppm $\text{Al}_2(\text{SO}_4)_3$ for 12 h and cold storage of cut tuberose spikes for 4 days improved the postharvest life and flower quality as evident from higher rachis length, delay in wilting of first, third and last opened floret pair.

Mwangi and Bhattacharjee (2003) carried out an experiment on the influence of pulsing and dry cool storage at 4°C for 0, 4, 5, 6 and 7 days on the post harvest life and quality of 'Noblesse' cut roses. The cut flowers pulsed with BA (25 ppm) for 45 minutes and dry stored for 6 days at 4°C showed highest vase life without affecting their keeping quality.

Pal *et al.* (2003) studied the influence of storage environment, 8-HQC and Sucrose on post harvest quality of 'First

Red' cut rose, which were stored at ambient conditions ($20 \pm 5^{\circ}\text{C}$, 40-70% RH) and in cool chamber ($15 \pm 2^{\circ}\text{C}$, 90-95% RH) in holding solution containing distilled water, HQC and Sucrose + HQC for a period of 4 days. Angle of neck bending was significantly reduced in high humidity storage which increased flower diameter and marketability. The high humidity cool chamber also showed better retention of petal anthocyanin with low respiration and ethylene evolution by the whole stalk. The senescence of flowers was rapid at ambient with high rate of ion leakage from petals and high respiration rates at ambient. Addition of sucrose and HQC in holding solution further helped in maintaining the overall quality of cut flowers in humid storage condition.

Katwate *et al.* (1995) studied the influence of low storage temperature on longevity of cut spikes of 'Single' tuberose. The flower spikes were wrapped in single layer of cellophane paper and kept at low temperature of 4°C for 24, 48 and 72 h and then spikes were held in a vase solution of 2% sucrose + 8 HQC 200 ppm. Highest total post harvest life (hours of storage + vase life) of 14.2 days was noted in 72 h treatment at 4°C while highest vase life was observed in flowers held at 48 h.

Patil *et al.* (1994) studied the influence of low temperature storage on longevity of cut-spikes of gladiolus cv. Suchitra. Spikes were packed in the cellophane paper and were stored at low temperature at 4.0 to 4.5°C for 24, 48, 72 and 168 h with zero hr as a control. The spikes held in the vase solution after

storage for 24 h and 48 h containing a mixture of 5% Sucrose and 200 ppm 8-HQC at room temperature, recorded effective increase in longevity.

Song *et al.* (1992) studied the physiological responses of cut *Gladiolus gandavensis* 'Spic and Span' flowers pretreated with Sucrose (10%), Sucrose + 4 mM Silver thiosulphate (STS) or a hot water dip (80⁰C for 2 seconds) and subjected to simulated shipping for 6, 12 and 24 h at room temperature or stored for 1 or 2 weeks at 8⁰C. The pretreatment with sucrose + STS extended vase life by 2 days over the control and improved flower quality by increasing floret number while flower quality declined with storage but less so when flowers were pretreated with Sucrose + STS.



MATERIALS AND METHODS

III. MATERIALS AND METHODS

The experiment on “Post harvest study on gerbera (*Gerbera jamesonii*) cv. Stanza” was carried out in the year 2010-2012. During the course of investigation the material used and the techniques adopted are explained topics wise.

3.1 Location

The experiment was conducted at the Laboratory of Floriculture, Department of Floriculture and Landscape architecture, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari in the year 2010 to 2012. The N.A.U. Campus is situated near the coast of the Arabian Sea at 75° 95' E longitudes, 20° 95' North latitude with an altitude of 10-12 meters above sea level. It is 13 km away from the historical place Dandi Seashore.

3.2 Climate

Climate of this area is typically tropical, characterized by fairly hot and humid summer, warm and humid monsoon and moderately cold winter. The summer commences from February and reaches the maximum by May with temperature range varying from 29.6°C to 37.8°C. Relative humidity during summer varies from 80% to 89%. By the second week of June, monsoon starts with heavy rainfall during July, August and ends by October. Annual precipitation varies from 1117.3 to 2207.3 mm. Relative humidity during monsoon varies from 85 to 90% being highly humid. The

winter season sets in by the end of October and continues till February, with December and January being the coldest months. Temperature range during winter varies from 10°C to 23.8°C.

3.3 Weather condition during period of experiment

The meteorological data on maximum and minimum temperature and relative humidity during the course of investigation was recorded at Meteorological Observatory, Navsari Agricultural University, Navsari, have been presented in Appendix-I.

3.4 Site of experiment

Experiment was carried out in Floriculture Research Laboratory, Department of Floriculture and Landscaping, ASPEE College of Horticulture and Forestry, Navsari Agricultural University and cold storage facilities was provided by Fruit Processing Unit, Navsari Agricultural University, Navsari.

3.5 Experimental material

The cut flowers of gerbera cv. Stanza used in this study was obtained from commercial green house complex, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari in the year 2010-2011. The flowers were harvested at uniform flower size and fresh weight as per require in experiment in the early morning, and brought to the Floricultural Laboratory, ASPEE College of Horticulture and Forestry, N.A.U., Navsari. General view of green house depicted in plate - I.



Plate-I : General view of green house

3.6 Experiment design

The experiment was laid out in Completely Randomized Design (CRD) and Completely Randomized Design with Factorial concept (FCRD) and the treatments were replicated three times in Exp. I, III, IV and four times in Exp. II and V.

3.7 Experimental details

Experiment: I Standardization of harvest stage and stalk length of gerbera cv. Stanza

Location : Floriculture Laboratory

ASPEE College of Horticulture and Forestry,
N.A.U., Navsari

Season and Year : 2010-11 and 2011-12

Crop Variety : Gerbera cv. Stanza

No. of treatments : Harvest stage (S) : 3,

Stalk length (L) : 3

Total treatment combinations : 9

No. of repetitions : 3

Experimental Design: FCRD (Completely Randomized Design with Factorial concept)

Factor 1: Harvest stage: (S)

S₁: Fully open ray florets, unopen disc florets.

S₂: 30 % open disc florets.

S₃: 50 % open disc florets.

Factor 2: Stalk length: (L)

L₁: 40 cm

L₂: 50 cm

L₃: 60 cm

Treatment combinations :

1) S₁L₁

4) S₂L₁

7) S₃L₁

2) S₁L₂

5) S₂L₂

8) S₃L₂

3) S₁ L₃

6) S₃L₃

9) S₃L₃

Experiment: II Effect of pulsing solutions on post harvest life of gerbera cv. Stanza

Location : Floriculture Laboratory

ASPEE College of Horticulture and Forestry,

N.A.U., Navsari

Season and Year : 2010-11 and 2011-12

Crop Variety : Gerbera cv. Stanza

Total treatments : Pulsing solutions: 5

Time of pulsing : 3 h

Pulsing solutions :

P₁ : Sucrose 5%

P₂ : Sucrose 10%

P₃ : Ascorbic acid 250 mg/l + Sucrose 10%

P₄ : 8 HQC 250 mg/l + Sucrose 10%

P₅ : Control (In RO water)

No. of repetitions : 4

Experimental Design : CRD (Completely Randomized Design)

S_x L_x: The best harvest stage and stalk length derived from Experiment 1 and taken in the experiment to standardize pulsing solution.

Experiment: III Effect of holding solutions on post harvest life of gerbera cv. Stanza

Location : Floriculture Laboratory

ASPEE College of Horticulture and Forestry,

N.A.U., Navsari

Season and Year : 2010-11 and 2011-12

Crop Variety : Gerbera cv. Stanza

Total treatments : Holding solution: 9

Holding solution- (H)

H₁ : Citric acid 300 mg/l + Sucrose 2%

H₂ : Citric acid 500 mg/l + Sucrose 2%

H₃ : GA₃ 10 mg/l + Sucrose 2%

H₄ : GA₃ 20 mg/l + Sucrose 2%

H₅ : Spermine 50 mg/l + Sucrose 2%

H₆ : Spermine 100 mg/l + Sucrose 2%

H₇ : 8 HQ 100 mg/l + Sucrose 2%

H₈ : 8 HQ 200 mg/l + Sucrose 2%

H₉ : Control (In RO water)

No. of repetitions : 3

Experimental Design: CRD (Completely Randomized Design)

S_x L_x and P_x: The best harvest stage and stalk length derived from Experiment 1 and kept in best pulsing solution from Experiment 2 then taken in the experiment to standardize holding solution.

Experiment: IV Effect of storage techniques on post harvest life of gerbera cv. Stanza

Location : Floriculture Laboratory
ASPEE College of
Horticulture and Forestry,
N.A.U., Navsari

Season and Year : 2010-11 and 2011-12

Crop Variety : Gerbera cv. Stanza

Total treatments : Storage technology: 7

Storage temperature (T) : 6 °C

Storage duration : 7 days

Storage techniques- (Q)

Q₁- Dry storage with wrapping material: PP

Q₂- Dry storage with wrapping material: CFB box

Q₃- Wet storage + AgNO₃ 10 mg/l + Sucrose 2%

Q₄- Wet storage + AgNO₃ 20 mg/l + Sucrose 2%

Q₅- Wet storage + Sodium benzoate 100 mg/l + Sucrose 2%

Q₆- Wet storage + Sodium benzoate 200 mg/l + Sucrose 2%

Q₇- Wet storage + Control (In RO water)

No. of repetitions : 3

Experimental Design : CRD (Completely Randomized Design)

S_x L_x and P_x: The best harvest stage, stalk length and best pulsing solution will be derived from Experiment 1 and 2 will be taken in the experiment to standardize storage technique. After storage it will be kept in best holding solution (H_x) as a vase solution from derived from Experiment 3.

Experiment: V Effect of storage durations on post harvest life of gerbera cv. Stanza

Location : Floriculture Laboratory

ASPEE College of Horticulture and Forestry,

N.A.U., Navsari

Season and Year : 2010-11 and 2011-12

Crop Variety : Gerbera cv. Stanza

Total treatments : Storage durations: 4

Storage temperature (T): 6 °C

Storage durations: (D)

D₁: 8 days

D₂: 12 days

D₃: 16 days

D₄: 20 days

No. of repetitions : 4

Experimental Design: CRD (Completely Randomized Design)

S_x L_x, P_x and Q_x: The best harvest stage, stalk length, best pulsing solution and best storage technique will be derived from Experiment 1, 2 and 4 will be taken in the experiment to standardize storage duration. After storage duration it will be kept in best holding solution (H_x) as a vase solution from Experiment 3.

3.8. Methodology adopted for preparation of treatments

Experiment I

The experiment was conducted to standardize harvest stage and stalk length in gerbera cv. Stanza. Gerbera cut flowers were harvested with three different stages viz., (fully open ray florets, unopen disc florets, 30 % open disc florets and 50 % open disc florets) and transferred to floricultural laboratory. All the stages

were divided in to three divisions (A, B and C). Each division were divided in to three bunches each containing 15 flowers. Division of A, were cut at 40 cm stalk length, of B were cut at 50 cm of stalk length and of C were cut at 60 cm of stalk length and kept in RO water in for taking observations and recording data.

Experiment II

Gerbera flowers were harvested at uniform stage (best harvest stage derived from Ex. I) and cut at stalk length best resulted in Ex. I and transferred to floricultural laboratory. Cut flowers were divided in to 5 divisions each group containing 15 flowers (Division A to E) and dipped in different pulsing solution for 3 hours. Division of A were dipped in solution containing Sucrose 5%, of B were dipped in Sucrose 10%, of C were dipped in Ascorbic acid 250 mg/l + Sucrose 10%, of D were dipped in 8-HQC 250 mg/l + Sucrose 10% and of E were held in RO water for duration of 3 hours. After that all the divisions were held in to RO water for taking observations and recording data.

Experiment III

Gerbera flowers were harvested at uniform stage and stock length (best harvest stage and stock length derived from Experiment I transferred to floriculture laboratory; best pulsing solution (cut flowers) derived from experiment II taken for experiment III. Cut flowers were divided into 9 divisions, each group containing 15 flowers (Division A to I) and kept in different holding solution up to end of vase life. Division of A were kept in a Citric acid 300 mg/l +

Sucrose 2% solution, of B were kept in a Citric acid 500 mg/l + Sucrose 2%, of C were kept in a GA₃ 10 mg/l + Sucrose 2%, of D were kept in a GA₃ 20 mg/l + Sucrose 2%, of E were kept in a Spermine 50 mg/l + Sucrose 2%, of F were kept in a Spermine 100 mg/l + Sucrose 2%, of G were kept in a 8-HQ 100 mg/l + Sucrose 2%, of H were kept in a 8-HQ 200 mg/l + Sucrose 2% and of I were kept in a RO water. Afterwards, observations were recorded from the given divisions.

Experiment IV

Gerbera flowers were harvested at uniform stage and stock length (best harvest stage and stock length derived from Experiment I transferred to floriculture laboratory; best pulsing solution (cut flowers) derived from experiment II. It was conducted to standardize storage technology comprising of dry and wet storage in gerbera. Flower stems were divided into 7 divisions (A to G) and each division was again divided in to bunch with 15 flowers in each bunch. Bunches of division 'A' were seal packaged with polypropylene (PP), bunches of B were kept in CFB box, of C were dipped in AgNO₃ 10 mg/l + Sucrose 2%, of D were dipped in AgNO₃ 20 mg/l + Sucrose 2%, of E were dipped in Sodium benzoate 100 mg/l + Sucrose 2%, of F were dipped in Sodium benzoate 200 mg/l + Sucrose 2% and G were dipped in a RO water for seven day at 6^o C in cold storage. After seven days stored flowers were removed from the storage and brought to the floriculture laboratory and kept in a

best holding solution derived from experiment III. Further, observations were recorded

Experiment V

Gerbera flowers were harvested at uniform stage and stock length (best harvest stage and stock length derived from Experiment I transferred to floriculture laboratory; best pulsing solutions (cut flowers) derived from experiment II. Cut flowers (gerbera) which are qualified as best under storage techniques derived from experiment IV were further stored for the duration of 8, 12, 16 and 20 days at 6⁰ C. It was conducted to standardize storage duration in gerbera. Flower stems were divided into 4 divisions (A to D) and each division was again divided in to bunch with 15 flowers each. Bunches of division A were stored for 8 days, of B were stored for 12 days, and of C were stored for 16 days and division D were stored for 20 days. Flowers were removed from the storage and brought to the floriculture laboratory and kept in a best holding solution derived from experiment III. Subsequently observations were recorded.

3.8.1 Storage Technologies

Basically two storage technologies were used *viz.*, dry storage and wet storage. For dry storage, cut flowers were seal packaged with polypropylene and CFB box. For wet storage cut flowers were held in AgNO₃ 10 mg/l + Sucrose 2%, AgNO₃ 20 mg/l + Sucrose 2%, Sodium benzoate 100 mg/l + Sucrose 2%, Sodium benzoate 200 mg/l + Sucrose 2% and water (RO water).

3.8.2 Cold storage temperature

Both dry and wet stored cut flowers were kept in cold storage at 6°C temperature.

3.8.3 Cold storage duration (days)

Cut flowers were kept in cold storage at different durations of 8, 12, 16 and 20 days.

3.8.4 Pulsing solution

For pulsing treatment, different pulsing solutions solution was prepared by using distilled water.

3.8.4.1 Sucrose solution

Sucrose solution of 2 %, 5 % and 10 % concentrations were prepared by dissolving 20 gm, 50 gm and 100 gm Sucrose in one liter of distilled water.

3.8.4.2 Ascorbic acid

Ascorbic acid solution of 250 mg/l concentration was prepared by dissolving the 250 mg in one liter of distilled water.

3.8.4.3 Hydroxyquinoline citrate solution

8-hydroxyquinoline citrate solution of 200 mg/l concentration was prepared by dissolving the 200 mg 8 HQC in one liter of distilled water and boiling until the powder was completely dissolved.

3.8.5. Holding solution

3.8.5.1 Citric Acid

Citric acid solution of 300 mg/l and 500 mg/l concentration was prepared by dissolving the 300 mg and 500 mg citric acid in one liter of distilled water.

3.8.5.2 Gibberellic Acid (GA₃) solution

Gibberellic Acid solution of 10 mg/l and 20 mg/l concentration was prepared by dissolving the 10 mg and 20 mg Gibberellic Acid in small quantity of 0.1N NaOH and make final volume one liter by adding distilled water.

3.8.5.3 Spermine solution

Spermine solution of 50 mg/l and 100 mg/l concentration was prepared by dissolving the 50 mg and 100 mg spermine in one liter of distilled water.

3.8.5.4 8-Hydroxyquinoline solution

8-Hydroxyquinoline solution of 100 mg/l and 200mg/l concentration was prepared by dissolving the 100 mg and 200 mg 8-HQ in one liter of distilled water and boiling until the powder was completely dissolved.

3.8.6 Wet storage solution

3.8.6.1 AgNO₃ solution

AgNO₃ solution of 10 mg/l and 20 mg/l concentration was prepared by dissolving the 10 mg and 20 mg of AgNO₃ in small amount of alcohol and final volume made to 1 liter by adding distilled water.

3.8.6.2 Sodium benzoate solution

Sodium benzoate solution of 100 mg/l and 200 mg/l concentration was prepared by dissolving the 100 mg and 200 mg Sodium benzoate in one liter of distilled water.

3.9 Observations recorded

3.9.1 Quantitative Parameters:

3.9.1.1 Change in fresh weight (FW) (gm) every alternate day

Formula,

$FW = \text{Flower weight on particular day (gm)}$

3.9.1.2 Physiological change in weight (%)

Physiological change in weight was measured at just after the cold storage. It was measured in percentage.

Formula,

$PLW = \frac{\text{Initial weight} - \text{Final Weight}}{\text{Initial weight}} \times 100$

3.9.1.3 Water uptake at alternate day (ml)

This observation was measured after removing cut flowers from the water at alternate day *viz.*, 2nd, 4th, 6th, 8th and 10th day. The remaining water was measured in ml.

Formula,

$\text{Uptake of water (ml)} = \text{Initial water (ml)} - \text{Remaining water (ml)}$

3.9.1.4 MSI (Membrane Stability Index) in petals

MSI was calculated on the basis of electrolyte leakage (ion leakage) of petals.

The electrolyte leakage was measured by taking five petal discs (1cm²) of flower at 4th DAT. The petal discs were rinsed well in deionized water prior to incubation in 5 ml of deionized water for 3 h at room temperature. After incubation, conductivity of the bathing solution was measured with the conductivity meter (value A). The petal discs were boiled with bathing solution for 10 minutes to kill tissue. After cooling to room temperature, the conductivity of bathing solution was again measured (value B).

$$\text{Ion leakage (\%)} = (\text{value A} / \text{value B}) \times 100$$

$$\text{MSI (\%)} = [1 - (\text{value A} / \text{value B})] \times 100$$

3.9.1.5 Total Dissolved Solutes (TDS) (°B)

TDS was measured with the help of digital refractometer in °Brix.

3.9.1.6 Total Soluble Sugar (TSS) (mg/gm fresh weight)

One ml of water used to measure the TSS of the petals from the solution prepared to measure MSI (membrane stability index). In one ml of solution 4 ml of 0.2 % anthrone reagent (200 mg in 100 ml H₂SO₄) was added in each test tube and placed in ice cold water. Reagent blank was prepared by adding 1 ml of distilled water and 4 ml of anthrone reagent. The intensity of colour was read at

600nm on spectrophotometer. A standard curve was prepared using 10 mg glucose per 100 ml distilled water.

Total soluble sugar (mg/gm) = sample O.D. x Standard O.D. x dilution factor

3.9.1.7 Dry weight (%)

To measure Dry matter content in the fresh flowers, after taking fresh weight of 10 flowers, they were covered with a single layer of paper where placed in oven for drying and the weight was measured every day until the difference between two successive readings became zero and the final weight was taken as the dry weight of fresh flowers. Percentage dry weight of fresh flowers was measure with following formula,

$$\begin{aligned} & \text{Dry weight percentage of fresh flower} \\ & = \text{Dry weight/initial fresh weight} \times 100 \\ & = A \% \end{aligned}$$

At the end of vase life of treated cut flowers, flowers were covered with single layer of paper and placed in oven at 50⁰C temperature. Weight of flower was measured before and after oven drying every day until the difference between two successive readings became zero. This final weight was considered as dry weight of the flowers.

$$\begin{aligned} & \text{Dry weight percentage} \\ & = \text{dry weight/initial fresh weight} \times 100 \\ & = B \% \end{aligned}$$

Change in dry weight percentage

= A % - B %

3.9.1.8 Disease incidence.

The disease incidence was recorded during the investigation on visual basis.

3.9.2 Qualitative parameters:

3.9.2.1 Flower size (cm)

Individual flower size (diameter) (cm) was measured with the use of vernier calipers.

3.9.2.2 Scape bending curvature (°)

Cut flower scape bending curvature was measured as angle of the scape by using protractor and expressed as the angle (degree).

3.9.2.3 Pigment content (Anthocyanin)

Procedure followed for chemical analysis of anthocyanin pigment from gerbera flowers is given below.

A sample of known weight (1 to 5 gm) of the flowers of gerbera was taken and macerated nicely with the help of a mortar and pestle. It was mixed with 20 ml of mixture 95% ethanol: 1.5 N HCL (In the proportion of 85:15). This mixture was transferred into another beaker, covered with Para film and stored for overnight at 4°C. Next day; the mixture was filtered through No.1 Whatman filter paper in a funnel and the filtrate was collected in a flask. After the

filtration was over, the macerate (left in the filter paper) was again mixed with 10 ml of extracting solvent and filtered through another no.1 Whatman filter paper into the flask containing earlier filtrate. The final volume was made to 30 ml by the addition of extraction solvent. From that solution, 10 ml was taken into another beaker and made to 20 ml by the addition of extracting solvent. This solution, was then stored in dark for two hrs at room temperature and the spectrophotometer reading was recorded at 535 nm wavelength and the anthocyanin pigment was estimated according the formula:

$$\begin{aligned} \text{Anthocyanin content: (mg/gm)} \\ &= D_{535} \times \text{Dilution factor} \times 10 / \text{Avg} E_{535}^{1\%} \\ &= (D_{535} \times \text{Dilution factor}) / 98.2 \end{aligned}$$

Where,

$$D_{535} = \text{O.D. at 535 nm wavelength}$$

$$\begin{aligned} \text{Dilution factor} &= (\text{original extract} \times \text{dilution amount}) / \text{extract taken} \\ &\quad \text{for dilution} \\ &= (30 \times 20) / 10 \\ &= 60 \end{aligned}$$

3.9.3 Vase life and Overall quality

3.9.3.1 Vase life (days)

Vase life was measured in days at the time of keeping the flowers in vase until the first sign of wilting or fading to the death of the 50 % flower petals.

3.9.3.2 Quality assessments: (on visual basis, 5 point scale)

These parameters were measured visually by seeing the petal colour, petal freshness, and turgidity of cut flowers.

Parameters were graded with five categories as below.

- 1 Dull/Flaccid
- 2 Poor
- 3 Fair
- 4 Very good
- 5 Excellent

3.10 Statistical Analysis

The data recorded during the course of investigation were subjected to the statistical analysis. The design of analysis used was Completely Randomized Design with Factorial concept as described by Panse and Sukhatme (1967). The significance of treatment differences was tested by 'F' test on the basis of null hypothesis. The appropriate standard error (S.Em \pm) was computed in each case. Coefficient of variance per cent was also worked out for all the characters. At some stage vase life was completed then mean data was presented in respected table.

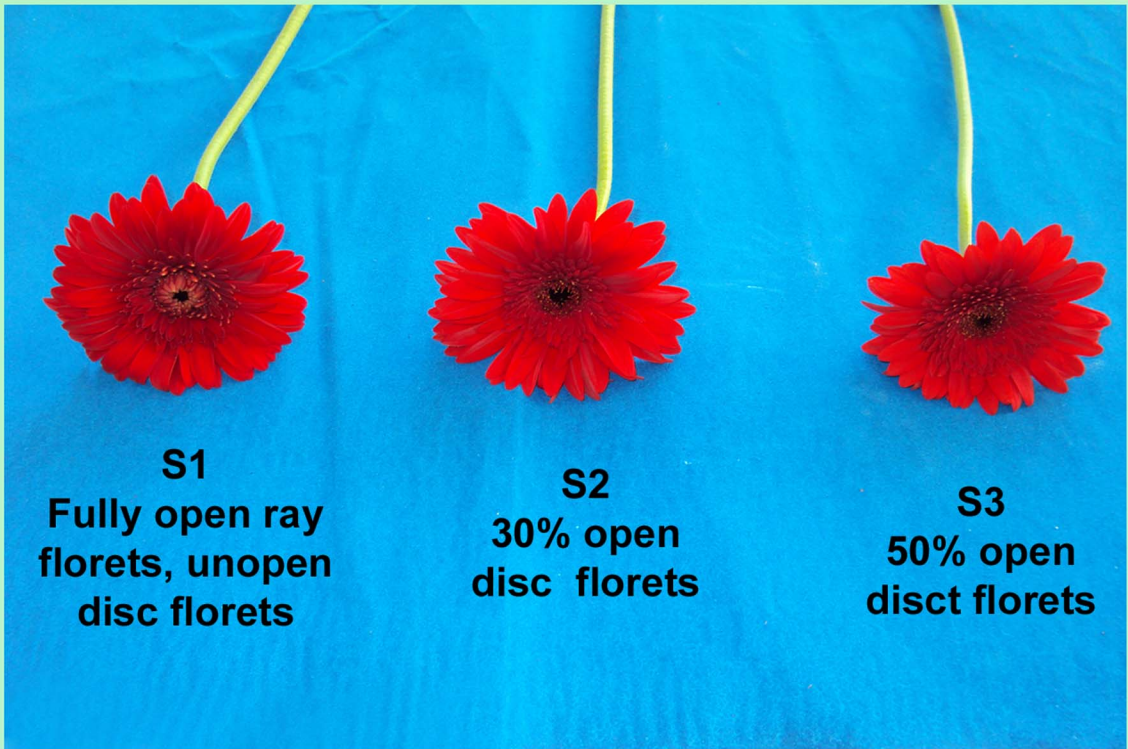


Plate-II : Different harvest stage

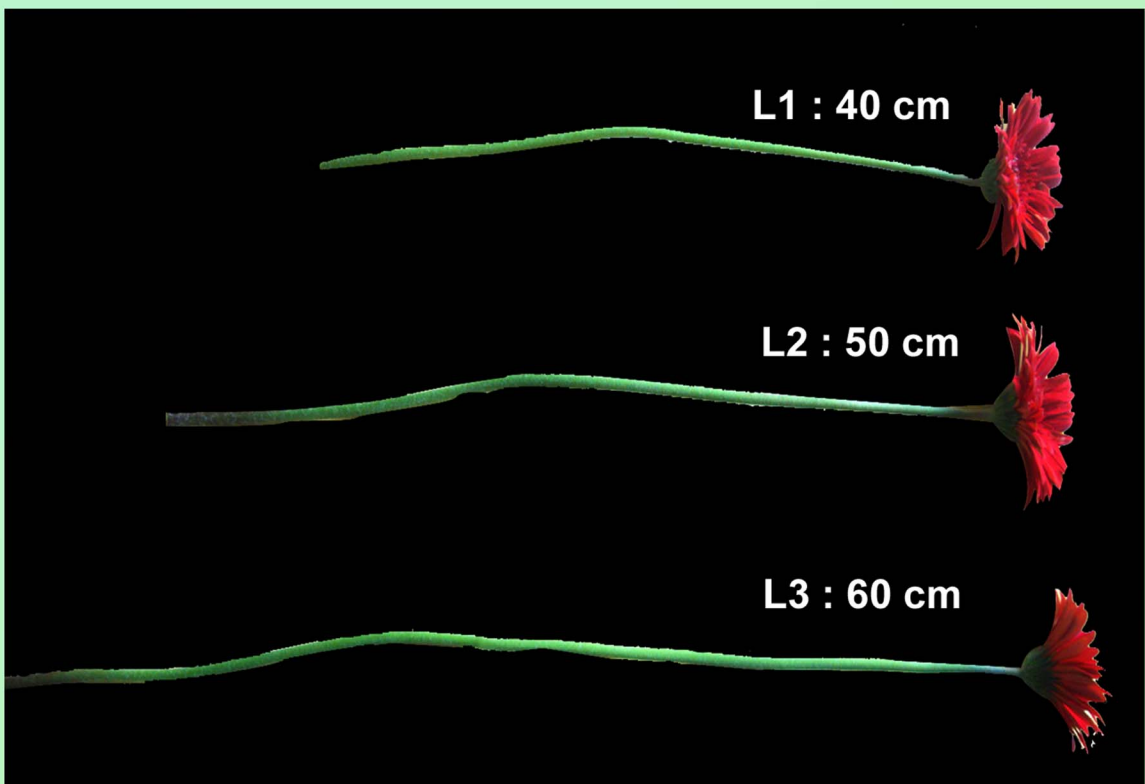


Plate-III : Different stalk length



EXPERIMENTAL RESULTS

IV. EXPERIMENTAL RESULTS

The present investigation on “Post harvest study on gerbera (*Gerbera jamesonii*) cv. Stanza” was conducted in the year, 2010-11 and 2011-12 in the Laboratory of Floriculture, Department of Floriculture and Landscape architecture, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari. Post harvest management is one of the major important aspects in cut flower marketing. Nearly, 30-50 percent losses of cut flowers occur due to improper post harvest handling during entire market chain (Singh *et al.*, 2002). Although, post harvest research is being conducted on gerbera worldwide yet appropriate standardization techniques of harvest stage, stalk length, pulsing, holding solution, packaging, storage technique and storage duration is required with regard to gerbera flowers. Hence, this experiment based on the post harvest study in gerbera has been planned.

The results of each parameter are presented in this chapter, as five experiments were conducted *viz.*, experiment I, experiment II, experiment III, experiment IV and experiment V are this chapter has been divided accordingly:

Experiment: I Standardization of harvest stage and stalk length of gerbera (*Gerbera jamesonii*) cv. Stanza

Experiment: II Effect of pulsing solutions on post harvest life of gerbera (*Gerbera jamesonii*) cv. Stanza

Experiment: III Effect of holding solutions on post harvest life of gerbera (*Gerbera jamesonii*) cv. Stanza

Experiment: IV Effect of storage techniques on post harvest life of gerbera (*Gerbera jamesonii*) cv. Stanza

Experiment : V Effect of storage duration on post harvest life of gerbera (*Gerbera jamesonii*) cv. Stanza

4.1 Experiment :

I Standardization of harvest stage and stalk length of gerbera (*Gerbera jamesonii*) cv. Stanza

4.1.1 Quantitative Parameters:

4.1.1.1 Changes in Fresh Weight (gm) at Every Alternate Day

The data pertaining regarding to change in fresh weight (gm) at initial, 2nd, 4th, 6th and 8th day in gerbera cv. Stanza during 2010-11, 2011-12 and pooled analysis was significantly influence by different harvest stage (S) and stalk length (L) are presented in Table 1 and in graphical form in Figure 1, respectively.

Effect of Harvest Stage

The data presented in Table 1 clearly indicated that the fresh weight of gerbera cv. Stanza had given non- significant effect during initial (0th) day and in 2nd day. At 4th and 6th day clearly showed significant difference among different harvest stages (S) in gerbera cv. Stanza. Significantly higher flower weight (gm) at 4th day was observed in fully open ray florets, unopen disc florets (S₁; 95.83 g) which were at par with 30 % open disc florets. On 6th day

Table : 1 Effect of different harvest stages (S) and stalk lengths (L) on change in fresh weight (gm) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Change in fresh weight (gm)														
	Fresh weight at initial (0 th) day			Fresh weight at 2 nd day			Fresh weight at 4 th day			Fresh weight at 6 th day			Fresh weight at 8 th day*		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Mean data
Harvest stage (S)															
S ₁	93.77	93.60	93.68	100.02	99.65	99.83	95.98	95.68	95.83	77.33	77.02	77.17	57.57	57.43	57.49
S ₂	94.27	94.39	94.33	100.09	100.05	100.06	94.93	94.91	94.92	71.97	71.58	71.77	51.92	52.61	52.26
S ₃	95.47	94.86	95.16	100.01	99.18	99.69	90.34	89.80	90.07	62.12	61.77	61.94	****	****	****
S.Em.±	0.896	0.667	0.789	0.744	0.776	0.760	0.777	0.787	0.781	1.140	1.093	1.117	****	****	****
C.D.at5%	NS	NS	NS	NS	NS	NS	2.30	2.33	2.24	3.39	3.25	3.20	****	****	****
Stalk length (L)															
L ₁	88.20	86.94	87.57	92.54	91.20	91.87	84.44	83.23	83.84	58.24	57.42	57.82	****	****	****
L ₂	95.49	95.53	95.50	101.57	101.07	101.31	95.72	95.18	95.45	73.16	72.67	72.91	54.28	53.45	53.87
L ₃	99.83	100.37	100.10	106.00	106.62	106.30	101.09	101.98	101.54	80.02	80.28	80.15	56.39	57.00	56.70
S.Em.±	0.896	0.667	0.789	0.744	0.776	0.760	0.777	0.787	0.781	1.140	1.093	1.117	****	****	****
C.D.at5%	2.66	1.98	2.27	2.20	2.30	2.18	2.30	2.33	2.24	3.39	3.25	3.20	****	****	****
Interaction (S × L)															
S.Em.±	1.552	1.154	0.967	1.288	1.345	0.931	1.345	1.362	0.957	1.974	1.893	1.368	****	****	****
C.D.at5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	****	****	****
C.V. %	2.84	2.12	2.51	2.23	2.34	2.28	2.49	2.53	2.51	4.85	4.68	4.77	****	****	****

Note : * Not included in statistical analysis

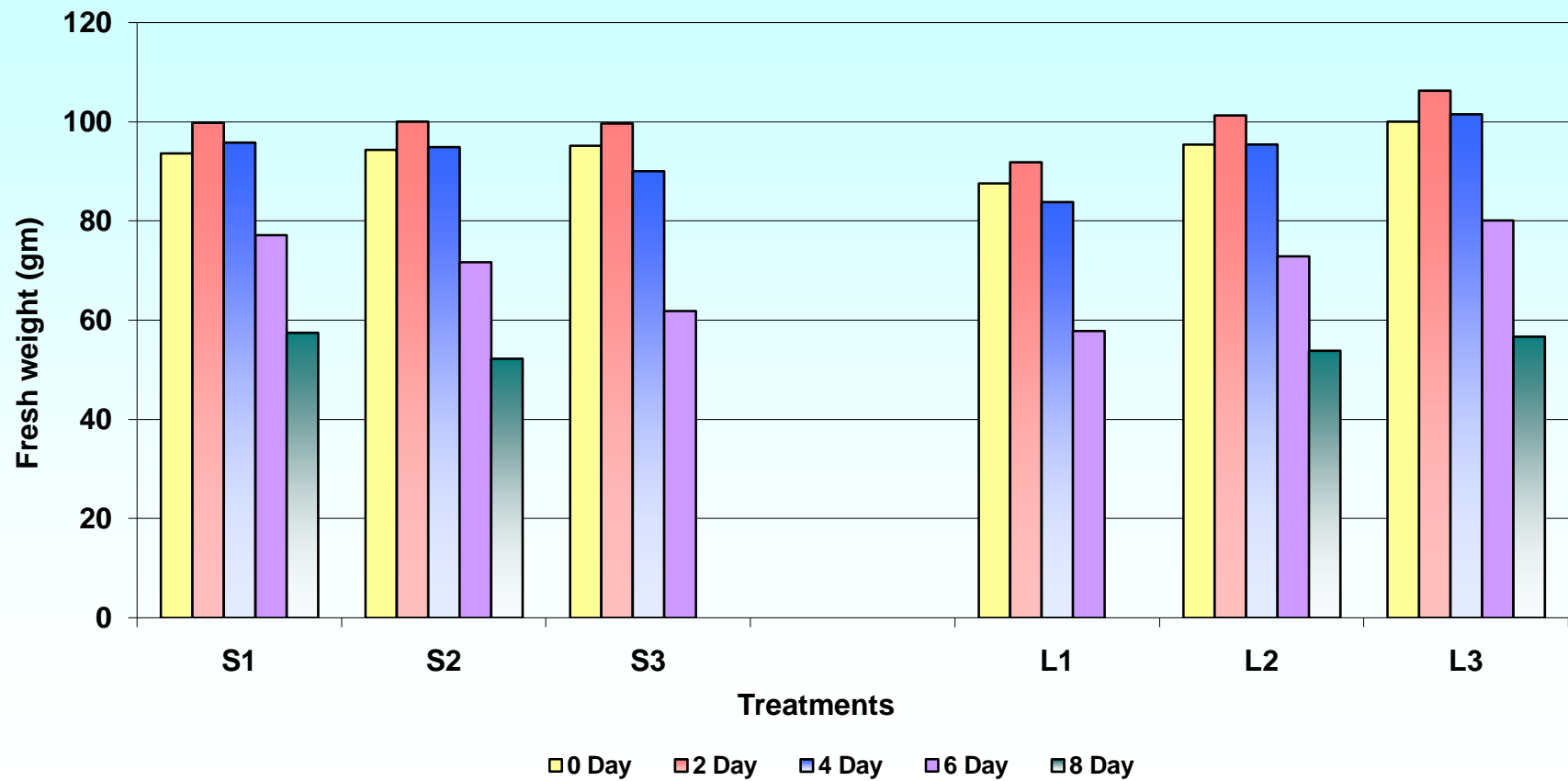
Harvest stage (S) S₁: Fully open ray florets, unopen disc florets S₂: 30 % open disc florets S₃: 50 % open disc florets

Stalk length (L) L₁: 40 cm

L₂: 50 cm

L₃: 60 cm

Fig-1 : Effect of different harvest stages (S) and stalk lengths (L) on change in fresh weight (gm) of gerbera (*Gerbera jamesonii*) cv. Stanza (in pooled analysis)



Experimental Results

significantly higher flower weight (gm) was observed in S₁ (77.17 gm) which was followed by S₂ (71.77 gm) in pooled analysis. At 8th day mean data was presented due to some treatments was completed their vase life. At 8th day maximum flower weight was observed in S₁ (57.49 gm) in mean data. Similar result was observed in 2010-2011 and 2011-12.

Effect of Stalk Length

The significant difference was noted for change in fresh weight (gm) due to effect of stalk length. Among all stalk lengths, 60 cm stalk length give significantly higher fresh weight (100.10 gm, 106.30 gm, 101.54 gm, 80.15 gm and 56.70 gm) which was followed by 50 cm stalk length (90.50 gm, 101.37 gm, 95.45 gm, 72.91 gm and 53.87 gm) in pooled analysis at initial, 2nd, 4th, 6th and 8th day, respectively in gerbera cv. Stanza. Minimum fresh weight (gm) was recorded with smaller stalk length (40 cm). Similar trend was observed in both the years of experiment.

Interaction effect

The combination of harvest stage (S) and stalk length (L) was found non-significant for change in fresh weight (gm) initial (0), 2nd, 4th and 6th day.

The line of similarity in result was obtained for both the year of investigation.

4.1.1.2 Physiological Change in Weight (%)

The data in respect to percent of physiological change in weight by harvest stage (S) and stalk length (L) of gerbera cv. Stanza are presented in Table 2.

Table : 2 Effect of different harvest stages (S) and stalk lengths (L) on physiological change in weight (%) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Physiological Change in weight (%)											
	Physiological Change at 2 nd day			Physiological Change at 4 th day			Physiological Change at 6 th day			Physiological Change at 8 th day*		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Mean data
Harvest stage (S)												
S ₁	6.37	6.45	6.41	- 4.13	- 4.11	- 4.12	- 20.17	- 20.04	- 20.11	- 31.94	- 31.77	- 31.85
S ₂	5.99	5.99	5.99	- 5.25	- 5.24	- 5.25	- 24.14	- 24.87	- 24.51	- 35.49	- 35.13	- 35.30
S ₃	4.50	4.51	4.50	- 9.89	- 9.92	- 9.90	- 31.50	- 31.52	- 31.51	****	****	****
S.E.m.±	0.110	0.108	0.077	0.107	0.106	0.106	0.415	0.460	0.439	****	****	****
C. D. at 5%	0.32	0.32	0.22	0.32	0.31	0.30	1.24	1.37	1.26	****	****	****
Stalk length (L)												
L ₁	4.91	4.92	4.91	- 8.82	- 8.78	- 8.80	- 31.10	- 31.08	- 31.09	****	****	****
L ₂	5.80	5.83	5.82	-5.81	- 5.85	- 5.83	- 23.74	- 23.95	- 23.85	- 33.16	- 33.06	- 33.11
L ₃	6.16	6.19	6.17	- 4.65	- 4.65	- 4.65	- 20.97	- 21.40	- 21.19	- 33.09	- 32.81	- 32.195
S.E.m.±	0.110	0.108	0.077	0.107	0.106	0.106	0.415	0.460	0.439	****	****	****
C. D. at 5%	0.32	0.32	0.22	0.32	0.31	0.30	1.24	1.37	1.26	****	****	****
Interaction (S × L)												
S.E.m.±	0.191	0.187	0.134	0.184	0.108	0.130	0.721	0.796	0.538	****	****	****
C. D. at 5%	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	****	****	****
C.V. %	5.89	5.75	5.82	4.98	4.95	4.96	4.95	5.42	5.19	****	****	****

Note: Figures with negative (-ve) denote decrease in fresh weight (%)

Note : * Not included in statistical analysis

Harvest stage (S) S₁: Fully open ray florets, unopen disc florets S₂: 30 % open disc florets S₃: 50 % open disc florets
 Stalk length (L) L₁: 40 cm L₂: 50 cm L₃: 60 cm

Effect of Harvest Stage

The trend of data in Table 2 clearly shows higher retention of flower weight up to 2nd day. After that, trend was in decreasing trend up to 8th day. At 8th day mean data was presented.

At 2nd day higher retention was observed in S₁ (6.37%) which was followed by S₂ (5.99 %) while minimum weight loss was observed at 4th, 6th and 8th day in S₁ (-4.13 %, -20.17 % and -31.94 %, respectively) which was followed by S₂ (-5.25 %, -24.14 % and -35.49 %, respectively) during 2010-11. Maximum weight loss recorded with S₃ (50 % open disc florets).

Effect of Stalk Length

In case of stalk length significantly higher weight retention was observed with 60 cm stalk length at 2nd day (6.16%) which was followed by 50 cm stalk length (5.80 %). While minimum physiological loss in weight was noted with 60 cm stalk length (-4.65 %, -20.97 % and -33.09 %) which was followed by 50 cm stalk length (-5.81 %, -23.74 % and -33.16 %) at 4th, 6th and 8th day, respectively during 2010-11.

Interaction Effect

The physiological change in weight (%) was showed non-significant with harvest stage (S) and stalk length (L) at 2nd, 4th and 6th day.

Parallel trend was repeated for year 2011-12 and in pooled analysis.

4.1.1.3 Water Uptake (ml)

The effect of harvest stage and stalk length for water up take at alternate days (ml) and total water up take (ml) during vase life was recorded at alternate days up to end of vase life in gerbera cv. Stanza during 2010-11, 2011-12 and in pooled analysis were give in Table 3, Table 4, Table 5 and Table 6 and graphically depicted in Figure 2.

Effect of harvest stage

The mean data presented in Table 3, 4, 5 and 6 indicated that harvest stage significantly influence the water up take at 2nd, 4th, 6th, 8th and total water up take in gerbera cv. Stanza during both the years and in pooled analysis.

In pooled analysis, significantly higher water up take at 2nd day was observed in fully open ray florets, unopen disc florets (S₁; 35.62 ml) which was at par with 30 % ring disc florets (S₂; 34.44 ml), however at 4th, 6th and total water up take was significantly higher observed in (S₁; 32.90 ml, 27.82 ml and 106.40 ml, respectively) which was followed by (S₂, 30.45 ml, 24.30 ml and 92.98 ml, respectively). At 8th day maximum water up take was observed with (S₁, 15.05 ml), while minimum water up take observed with S₃. More or less similar trend was observed in water up take at 2nd, 4th, 6th, 8th and total water up take during both the years of investigation. At 8th day some treatment was completed their vase life that's why they are not included in statistical analysis.

Table : 3 Effect of different harvest stages (S) and stalk lengths (L) on water uptake (ml) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Water up take (ml)														
	Water uptake at 2 nd day			Water uptake at 4 th day			Water uptake at 6 th day			Water uptake at 8 th day*			Total water uptake (ml)		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Mean data	2010-11	2011-12	Pooled
Harvest stage (S)															
S ₁	35.79	35.49	35.62	32.79	33.02	32.90	27.79	27.85	27.82	14.95	15.15	15.05	106.33	106.47	106.40
S ₂	34.39	34.48	34.44	30.39	30.51	30.45	24.67	23.94	24.30	11.50	11.22	11.36	93.29	92.67	92.98
S ₃	32.30	32.49	32.40	26.45	25.90	26.18	19.58	19.12	19.35	****	****	****	78.33	77.51	77.92
S.E.m.±	0.700	0.627	0.664	0.500	0.490	0.95	0.387	0.321	0.356	****	****	****	1.350	1.503	1.428
C.D.at5%	2.08	1.86	1.90	1.48	1.46	1.42	1.15	0.95	0.02	****	****	****	4.01	4.47	4.09
Stalk length (L)															
L ₁	29.48	29.55	29.51	26.24	26.31	26.27	22.08	21.57	21.82	****	****	****	77.79	77.42	77.61
L ₂	35.35	35.35	35.35	30.24	29.89	30.06	24.04	23.66	23.84	12.74	12.81	12.77	93.87	93.17	93.52
L ₃	37.66	37.56	37.61	33.15	33.24	33.19	25.92	25.69	25.80	14.33	14.36	14.34	106.28	106.06	106.17
S.E.m.±	0.700	0.627	0.664	0.500	0.490	0.95	0.387	0.321	0.356	****	****	****	1.350	1.503	1.428
C.D.at5%	2.08	1.86	1.90	1.48	1.46	1.42	1.15	0.95	0.02	****	****	****	4.01	4.47	4.09
Interaction (S × L)															
S.E.m.±	1.21	1.085	0.813	0.866	0.849	0.606	0.669	0.556	0.435	****	****	****	2.338	2.603	1.749
C.D.at5%	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	****	****	****	6.95	7.74	5.01
C.V. %	6.15	5.50	5.83	5.02	4.93	4.99	4.83	4.08	4.48	****	****	****	4.37	4.89	4.64

Note : * Not included in statistical analysis

Harvest stage (S) S₁: Fully open ray florets, unopen disc florets S₂: 30 % open disc florets S₃: 50 % open disc florets
 Stalk length (L) L₁: 40 cm L₂: 50 cm L₃: 60 cm

Table : 4 Effect of different harvest stages (S) and stalk lengths (L) on total water up take (ml) of gerbera (*Gerbera jamesonii*) cv. Stanza in year 2010-11

Treatments	Total water up take (ml)			
	L ₁ : 40 cm	L ₂ : 50 cm	L ₃ : 60 cm	Mean
S₁: Fully open ray florets, unopen disc florets	83.10	112.74	123.16	106.33
S₂: 30 % open disc florets	81.71	89.56	108.60	93.29
S₃: 50 % open disc florets	68.58	79.32	87.10	78.33
Mean	77.79	93.87	106.28	
S. Em ±	2.338			
C. D. at 5 %	6.95			
C.V. %	4.37			

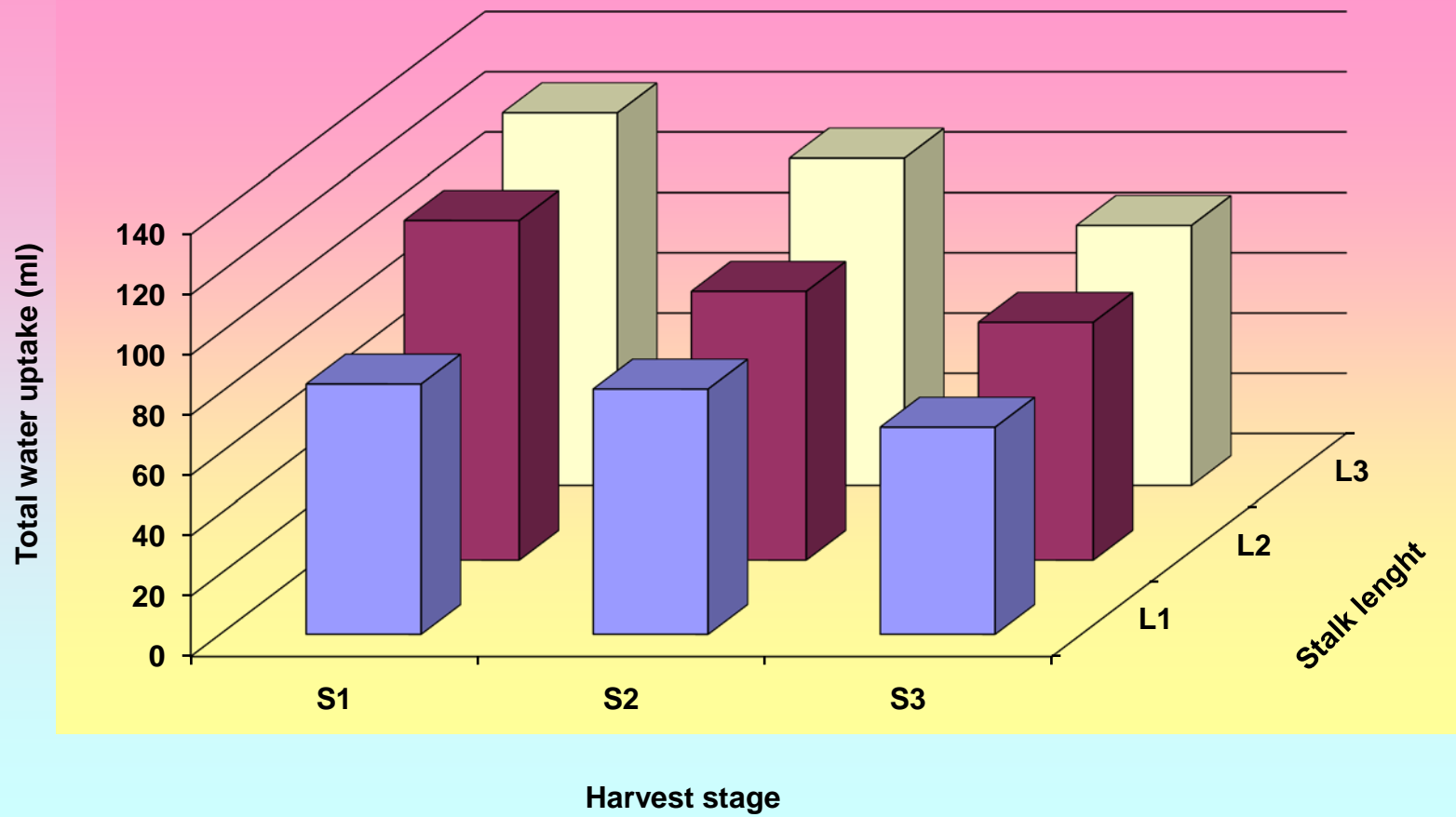
Table : 5 Effect of different harvest stages (S) and stalk lengths (L) on total water up take (ml) of gerbera (*Gerbera jamesonii*) cv. Stanza in the year 2011-12

Treatments	Total water up take (ml)			
	L ₁ : 40 cm	L ₂ : 50 cm	L ₃ : 60 cm	Mean
S₁: Fully open ray florets, unopen disc florets	82.78	112.54	124.08	106.47
S₂: 30 % open disc florets	80.86	88.65	108.50	92.67
S₃: 50 % open disc florets	68.63	78.31	85.61	77.51
Mean	77.42	93.17	106.06	
S. Em ±	2.603			
C. D. at 5 %	7.74			
C.V. %	4.89			

Table : 6 Effect of different harvest stages (S) and stalk lengths (L) on total water up take (ml) of gerbera (*Gerbera jamesonii*) cv. Stanza in pooled analysis

Treatments	Total water up take (ml)			
	L ₁ : 40 cm	L ₂ : 50 cm	L ₃ : 60 cm	Mean
S₁: Fully open ray florets, unopen disc florets	82.94	112.64	123.62	106.40
S₂: 30 % open disc florets	81.28	89.11	108.55	92.98
S₃: 50 % open disc florets	68.60	78.82	86.35	77.92
Mean	77.61	93.52	106.17	
S. Em ±	1.749			
C. D. at 5 %	5.01			
C.V. %	4.64			

Fig -2 : Effect of different harvest stages (S) and stalk lengths (L) on total water up take (ml) of gerbera (*Gerbera jamesonii*) cv. Stanza (in pooled analysis)



Effect of Stalk Length

The significant difference was recorded for water up take with different stalk lengths (40 cm, 50 cm and 60 cm) at 2nd, 4th, 6th, 8th and total water up take during 2010-11, 2011-12 and in pooled analysis.

Among different stalk length maximum water up take (37.61 ml, 33.24 ml, 25.80 ml, 14.34 ml and 106.17 ml) was observed with 60 cm stalk length, which was followed by 50 cm stalk length at 2nd, 4th, 6th, 8th and total water up take, respectively in pooled analysis. More or less similar trend was observed in both the years of investigation at 2nd, 4th, 6th, 8th and total water up take.

Interactions Effect

The interaction effect of harvest stage and stalk length was found non-significant for water up take at 2nd, 4th and 6th day while, on total water up take it was significant. Significantly higher total water up take was recorded in S₁L₃ (123.62 ml) which was followed by S₁L₂ (112.64 ml) in pooled analysis. Similar trend of results were obtained for both the years of investigation and in pooled analysis.

4.1.1.4 Membrane Stability Index (%) in Petals

MSI in petal displays the moderate range of variation under this investigation. The mean data pertaining to MSI in different harvest stage and stalk length are illustrated in Table 7.

Table : 7 Effect of different harvest stages (S) and stalk lengths (L) on membrane stability index (%) in petals of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Membrane Stability Index (MSI) in petals (%)					
	MSI at 4 th day			MSI at 8 th day*		
	2010-11	2011-12	Pooled	2010-11	2011-12	Mean data
Harvest stage (S)						
S₁: Fully open ray florets, unopen disc florets	21.63	21.97	21.80	13.92	14.02	13.97
S₂: 30 % open disc florets	19.90	20.03	19.97	10.07	10.02	10.04
S₃: 50 % open disc florets	13.17	13.08	13.12	****	****	****
S.E.m.±	0.273	0.290	0.281	****	****	****
C. D. at 5%	0.81	0.87	0.80	****	****	****
Stalk length (L)						
L₁: 40 cm	13.96	14.04	14.00	****	****	****
L₂: 50 cm	19.90	20.03	19.97	12.47	12.64	12.55
L₃: 60 cm	20.84	21.02	20.93	12.72	12.71	12.72
S.E.m.±	0.273	0.290	0.281	****	****	****
C. D. at 5%	0.81	0.87	0.80	****	****	****
Interaction (S × L)						
S.E.m.±	0.473	0.502	0.345	****	****	****
C. D. at 5%	N.S	N.S	N.S	****	****	****
C.V. %	4.50	4.74	4.62	****	****	****

Note : * Not included in statistical analysis

Harvest Stage

The data relevant to MSI in petals of gerbera was significantly affected by harvest stage. Significantly higher MSI in petal at 4th day was observed with fully open ray florets, unopen disc florets (S₁; 21.80 %) which was followed by 30 % open disc florets (S₂; 19.97%) in pooled analysis.

At 8th day maximum MSI was observed with fully open ray florets, unopen disc florets (S₁; 21.80%) which was followed by 30 % open disc florets (S₂; 10.04%) in mean data.

Stalk Length

Among different stalk length (L₃; 60 cm stalk length) give maximum MSI in petal at 4th and 8th day (20.93 % and 12.72 %, respectively) which was followed by (L₂) 50 cm stalk length in pooled analysis.

Interaction Effect

The combination of harvest stage and stalk length give non-significant effect.

Parallel result was observed in incorporated both the years of experiment.

4.1.1.5 Total Dissolved Solutes (TDS) (°B)

The data concerned with TDS (°B) in petal affected due to different harvest stages and stalk lengths in gerbera cv. Stanza are furnished in Table 8.

Table : 8 Effect of different harvest stages (S) and stalk lengths (L) on total dissolved solutes (TDS) (°B) in petals of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	TDS (°B) at 4 th day		
	2010-11	2011-12	Pooled
Harvest stage (s)			
S₁: Fully open ray florets, unopen disc florets	11.24	11.44	11.34
S₂: 30 % open ring disc florets	10.67	10.64	10.66
S₃: 50 % open ring disc florets	9.00	8.91	8.96
S.E.m.±	0.150	0.157	0.154
C. D. at 5%	0.45	0.47	0.44
Stalk length (L)			
L₁: 40 cm	9.80	9.76	9.78
L₂: 50 cm	10.47	10.46	10.46
L₃: 60 cm	10.67	10.78	10.71
S.E.m.±	0.150	0.157	0.154
C. D. at 5%	0.45	0.47	0.44
Interaction (S × L)			
S.E.m.±	0.259	0.271	0.188
C. D. at 5%	N.S	N.S	N.S
C.V. %	4.37	4.56	4.46

Effect of Harvest Stage

The data presented in Table 8 indicated that, the harvest stages significantly influenced TDS ($^{\circ}\text{B}$) in gerbera cut flower during both the years and in pooled analysis. Among different harvest stages; S_1 , recorded maximum TDS (11.24°B , 11.44°B and 11.34°B) in petals of gerbera cut flowers, which was followed by S_2 (10.67°B , 10.64°B and 10.66°B), minimum TDS ($^{\circ}\text{B}$) was recorded with S_3 (9.00°B , 8.91°B and 8.96°B) during 2010-11, 2011-12 and in pooled analysis, respectively.

Effect of Stalk Length

A perusal of data revealed that different stalk lengths significantly influenced TDS ($^{\circ}\text{B}$) of gerbera during both the years of study. Among different stalk lengths L_3 recorded maximum TDS (10.67°B , 10.78°B and 10.71°B) which was at par with L_2 (10.47°B , 10.46°B and 10.46°B) during 2010-11, 2011-12 and in pooled analysis, respectively.

Effect of Interactions

The interaction effect of harvest stage and stalk length was non-significant.

4.1.1.6 Dry Weight (%)

The data regarded with dry weight (%) affected with harvest stage and stalk length in gerbera cv. Stanza are presented in Table 9.

Table : 9 Effect of different harvest stages (S) and stalk lengths (L) on dry weight (%) in petals of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatment	Dry weight (%)		
	2010-11	2011-12	Pooled
Harvest stage (S)			
S₁: Fully open ray florets, unopen disc florets	7.30	7.30	7.30
S₂: 30 % open disc florets	6.84	6.93	6.8
S₃: 50 % open disc florets	5.55	5.48	5.52
S.E.m.±	0.116	0.118	0.117
C. D. at 5%	0.34	0.35	0.34
Stalk length (L)			
L₁: 40 cm	6.15	6.07	6.11
L₂: 50 cm	6.52	6.58	6.55
L₃: 60 cm	7.02	7.05	7.03
S.E.m.±	0.116	0.118	0.117
C. D. at 5%	0.34	0.35	0.34
Interaction (S × L)			
S.E.m.±	0.202	0.204	0.203
C. D. at 5%	N.S	N.S	N.S
C.V. %	5.33	5.39	5.36

Effect of Harvest Stage

Looking to the data, it was clearly indicated that different harvest stages significantly influenced dry weight (%) in gerbera cv. Stanza. Among different harvest stages fully open ray florets, unopen disc florets give significantly higher dry weight (7.30 %) which was followed by 30% open disc florets (6.84 %) during 2010-11.

Effect of Stalk Length

In case of different stalk lengths, maximum dry weight (%) was observed with 60 cm stalk length (7.20 %) which was followed by 50 cm stalk length (6.32 %) during 2010-11.

Interaction Effect

The interaction effect of harvest stage and stalk length (S×L) was non-significant on dry weight (%).

Similar trend was observed in the 2011-12 and in pooled analysis.

4.1.2 Qualitative Parameter

4.1.2.1 Flower Size (cm)

The mean data for flower size (cm) are presented in Table 10 and graphically portrayed in Figure 3.

Harvest Stage

The harvest stages were given non-significant results at initial and 2nd day. While, at 4th, 6th and 8th day gives significant results. Significantly maximum flower size (cm) was observed in fully open ray florets, unopen disc florets (S₁; 9.71 cm, 8.50 cm and

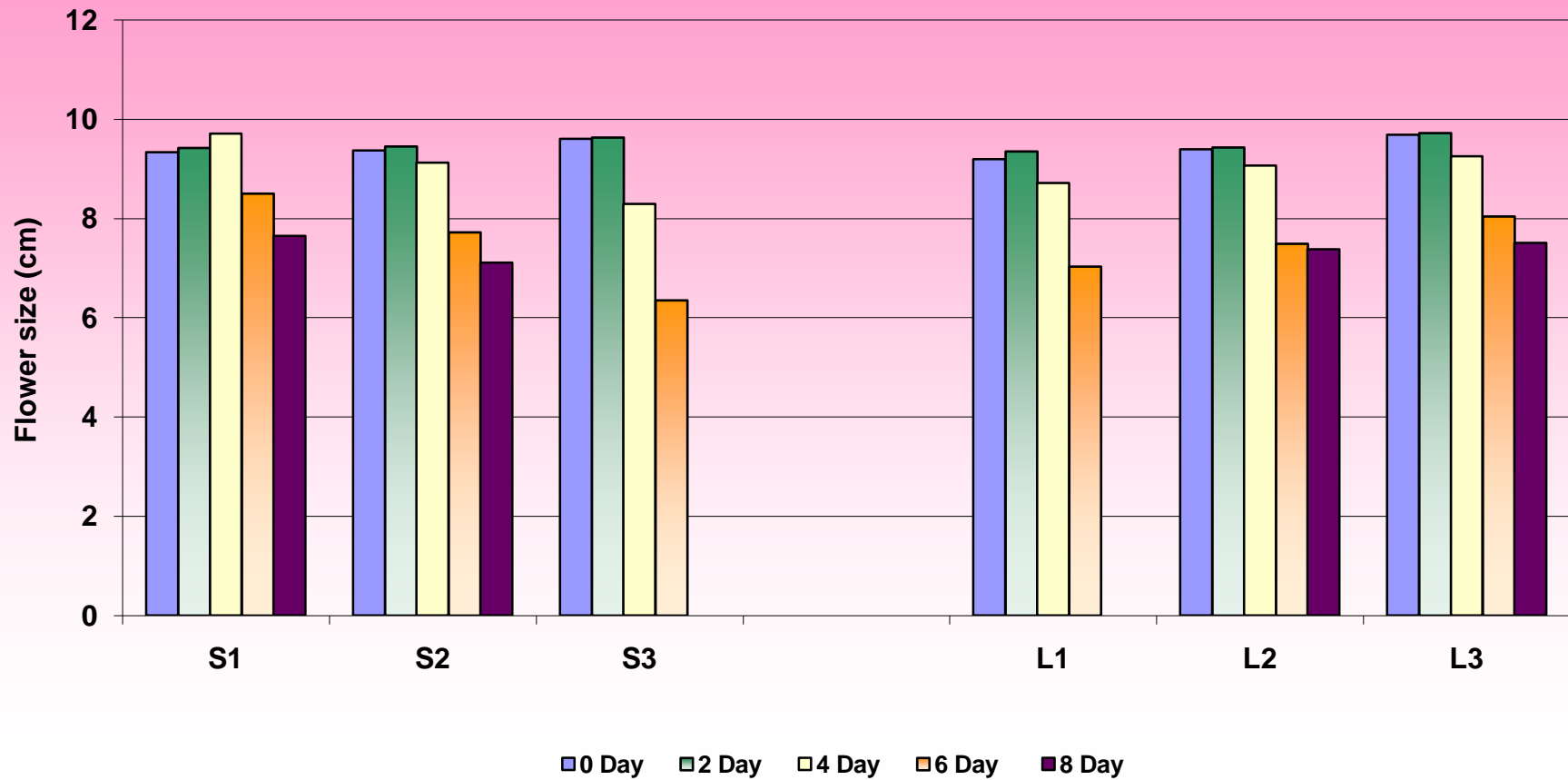
Table : 10 Effect of different harvest stages (S) and stalk lengths (L) on flower size (cm) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatment	Flower size (cm)														
	Flower size at initial (0 th)day			Flower size at 2 nd day			Flower size at 4 th day			Flower size at 6 th day			Flower size at 8 th day*		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Mean data
Harvest stage (S)															
S ₁	9.32	9.33	9.33	9.42	9.44	9.42	9.67	9.76	9.71	8.47	8.53	8.50	7.64	7.63	7.64
S ₂	9.35	9.36	9.36	9.45	9.46	9.45	9.11	9.14	9.12	7.74	7.71	7.72	7.15	7.06	7.11
S ₃	9.55	9.64	9.60	9.63	99.64	9.63	8.25	8.33	8.29	6.35	6.34	6.35	****	****	****
S.E.m.±	0.133	0.100	0.118	0.093	0.097	0.095	0.122	0.148	0.136	0.128	0.120	0.124	****	****	****
C.D.at5%	N.S	N.S	N.S	N.S	N.S	N.S	0.36	0.44	0.39	0.38	0.35	0.35	****	****	****
Stalk length (L)															
L ₁	9.15	9.24	9.19	9.35	9.37	9.35	8.71	8.72	8.71	7.03	7.03	7.03	****	****	****
L ₂	9.40	9.39	9.39	9.45	9.43	9.43	9.02	9.10	9.06	7.51	7.48	7.49	7.42	0.33	7.38
L ₃	9.66	9.69	9.68	9.70	9.74	9.72	9.03	9.41	9.25	8.02	8.08	8.04	7.51	0.53	7.50
S.E.m.±	0.133	0.100	0.118	0.093	0.097	0.095	0.122	0.148	0.136	0.128	0.120	0.124	****	****	****
C.D.at5%	0.39	0.30	0.41	0.27	0.29	0.27	0.36	0.44	0.39	0.38	0.35	0.35	****	****	****
Interaction (S × L)															
S.E.m.±	0.230	0.166	0.142	0.161	0.167	0.116	0.211	0.257	0.166	0.222	0.207	0.152	****	****	****
C.D.at5%	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	****	****	****
C.V. %	4.25	3.05	3.70	2.95	3.05	3	4.07	4.99	4.52	5.12	4.78	4.95	****	****	****

Note : * Not included in statistical analysis

Harvest stage (S) S₁: Fully open ray florets, unopen disc florets S₂: 30 % open disc florets S₃: 50 % open disc florets
Stalk length (L) L₁: 40 cm L₂: 50 cm L₃: 60 cm

Fig-3 : Effect of different harvest stages (S) and stalk lengths (L) on flower size (cm) of gerbera (*Gerbera jamesonii*) cv. Stanza (In pooled analysis)



Experimental Results

7.64 cm) which were followed by (S_2 ; 9.12 cm, 7.72 cm and 7.11 cm) at 4th, 6th and 8th day, respectively in pooled analysis. Due to complication of vase life of S_3 (50% open disc florets), the mean data was presented at 8th day.

Stalk Length

A study of the data presented for flower size (cm) indicated that all the three stalk lengths affect the flower size (cm) significantly in both the years and in pooled analysis.

Significantly largest flower size at initial, 2nd and 4th day of vase life was observed with 60 cm stalk length (L_3 ; 9.68 cm, 9.72 cm and 9.25 cm, respectively) which was at par with 50 cm stalk length (L_2 ; 9.39 cm, 9.43 cm and 9.06 cm, respectively). In case of 6th day and 8th day largest flower size was observed with L_3 (8.04 cm and 7.50 cm, respectively) which was followed by L_2 (7.49 cm and 7.38 cm, respectively) in pooled analysis and in mean data.

Interaction Effect

Interaction effect of harvest stage and stalk length was found non-significant.

Similar trend of results was reported for both the years for flower size.

4.1.2.2 Scape Bending Curvature ($^{\circ}$)

The data concerning scape bending ($^{\circ}$) as influenced by harvesting stage and stalk length are presented in Table 11.

Table : 11 Effect of different harvest stages (S) and stalk lengths (L) on scape bending curvature ($^{\circ}$) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Scape bending curvature ($^{\circ}$) at 4 th day			Scape bending curvature ($^{\circ}$) at 8 th day*		
	2010-11	2011-12	Pooled	2010-11	2011-12	Mean data
Harvest stage (S)						
S₁: Fully open ray florets, unopen disc florets	21.31	21.25	21.28	68.30	67.87	68.08
S₂: 30 % open disc florets	23.34	23.52	23.43	83.38	84.43	83.90
S₃: 50 % open disc florets	28.00	28.42	28.21	****	****	****
S.E.m. ±	0.360	0.430	0.382	****	****	****
C. D. at 5%	1.07	1.19	1.09	****	****	****
Stalk length (L)						
L₁: 40 cm	25.52	25.76	25.64	****	****	****
L₂: 50 cm	24.48	24.35	24.51	74.46	74.54	74.50
L₃: 60 cm	22.65	23.08	22.81	72.76	72.81	72.76
S.E.m. ±	0.360	0.430	0.382	****	****	****
C. D. at 5%	1.07	1.19	1.09	****	****	****
Interaction (S × L)						
S.E.m. ±	0.623	0.698	0.468	****	****	****
C. D. at 5%	N.S	N.S	N.S	****	****	****
C.V. %	4.46	4.96	4.72	****	****	****

Note : * Not included in statistical analysis

Effect of Harvest Stage

It was evident from the data presented in Table 11 that the least scape bending curvature ($^{\circ}$) was noted clearly significant difference at different harvest stages. Significantly minimum scape bending curvature observed in fully open ray florets, unopen disc florets (21.31° , 21.25° and 21.28°) during year 2010-11, 2011-12 and in pooled analysis, respectively which was followed by with 30 % open disc florets. Maximum scape bending curvature ($^{\circ}$) was noted with 50 % open disc florets. Similar result was observed in 8th day and in both the years.

Effect of stalk length

In case of stalk length, with longest stalk length scape bending curvature was minimized (22.81° and 72.76°) with 60 cm stalk length which was followed by (24.51° and 74.50°) with 50 cm stalk length in 4th and 8th day, respectively in pooled analysis.

Interaction effect

The interaction effect of harvest stage and stalk length was recorded non-significant.

4.1.2.3 Pigment Content (Anthocyanin)

The significant effect of harvest stage and stalk length on pigment content (anthocyanin) was presented in Table 12, Table 13 and Table 14 and graphically rendered Figure 4.

Harvest Stage

From the Table 12, Table 13 and Table 14, revealed, that minimum anthocyanin content was recorded in S₁ (0.33 mg/gm, 0.32 mg/gm and 0.32 mg/gm), which was followed by S₂ (0.41 mg/gm,

Table : 12 Effect of different harvest stages (S) and stalk lengths (L) on pigment content (mg/g) at 4th day of gerbera (*Gerbera jamesonii*) cv. Stanza in the year 2010-11

Treatments	Pigment content (mg/g) at 4 th day			
	L ₁ : 40 cm	L ₂ : 50 cm	L ₃ : 60 cm	Mean
S₁: Fully open ray florets, unopen disc florets	0.40	0.30	0.28	0.33
S₂: 30 % open disc florets	0.44	0.40	0.39	0.41
S₃: 50 % open disc florets	0.61	0.50	0.49	0.53
Mean	0.48	0.40	0.39	
S.V.	S. Em ±	C. D. at 5 %	C. V. %	
S	0.004	0.01	2.84	
L	0.004	0.01		
S × L	0.007	0.20		

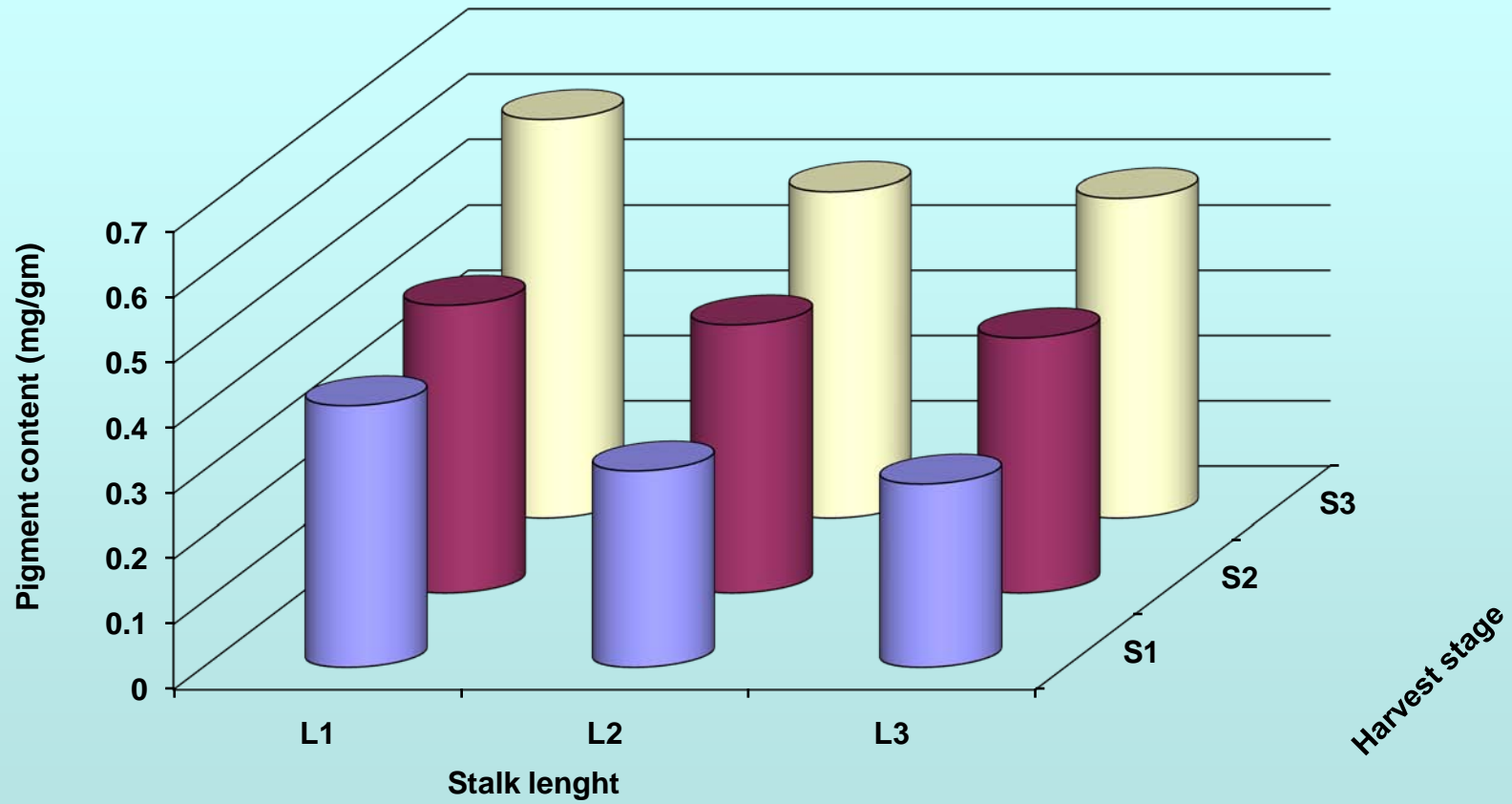
Table : 13 Effect of different harvest stages (S) and stalk lengths (L) on pigment content (mg/g) at 4th day of gerbera (*Gerbera jamesonii*) cv. Stanza in the year 2011-12

Treatments	Pigment content (mg/g) at 4 th day			
	L ₁ : 40 cm	L ₂ : 50 cm	L ₃ : 60 cm	Mean
S₁: Fully open ray florets, unopen disc florets	0.39	0.30	0.27	0.32
S₂: 30 % open disc florets	0.44	0.43	0.38	0.41
S₃: 50 % open disc florets	0.61	0.50	0.49	0.54
Mean	0.48	0.41	0.38	
S.V.	S. Em ±	C. D. at 5 %	C. V. %	
S	0.052	0.02	3.71	
L	0.052	0.02		
S × L	0.009	0.03		

Table : 14 Effect of different harvest stages (S) and stalk lengths (L) on pigment content (mg/g) at 4th day of gerbera (*Gerbera jamesonii*) cv. Stanza in pooled analysis

Treatments	Pigment content (mg/g) at 4 th day			
	L ₁ : 40 cm	L ₂ : 50 cm	L ₃ : 60 cm	Mean
S₁: Fully open ray florets, unopen disc florets	0.40	0.30	0.28	0.32
S₂: 30 % open disc florets	0.44	0.41	0.39	0.41
S₃: 50 % open disc florets	0.61	0.50	0.49	0.53
Mean	0.48	0.40	0.38	
S.V.	S. Em ±	C. D. at 5 %	C. V. %	
S	0.005	0.01	3.30	
L	0.005	0.01		
S × L	0.006	0.02		

Fig-4 : Effect of different harvest stages (S) and stalk lengths (L) on pigment content (mg/gm) at 4th day of gerbera (*Gerbera jamesonii*) cv. Stanza (in pooled analysis)



Experimental Results

0.41 mg/gm and 0.41 mg/gm) as recorded on 4th day during both the years and in pooled, analysis respectively in gerbera cv. Stanza.

Stalk Length

Among different stalk lengths of gerbera cv. Stanza, minimum anthocyanin content was recorded in L₃ (0.39 mg/gm, 0.38 mg/gm and 0.38 mg/gm) on 4th day in both the years and in pooled analysis, respectively.

Interaction Effect

Both harvest stage and stalk length significantly affect anthocyanin content in gerbera cv. Stanza. Minimum anthocyanin content was recorded in S₁L₃ (0.28 mg/gm, 0.27 mg/gm and 0.28 mg/gm) which was followed by S₁L₂ (0.30 mg/gm, 0.30 mg/gm and 0.30 mg/gm) as recorded on 4th day in both the years and in pooled analysis, respectively.

4.1.2.4 Disease Incidence.

There was no disease incidence visually found in all harvest stage and stalk length.

4.1.3 Vase Life and Overall Quality

4.1.3.1 Vase Life (days)

The statistical data concerning with the vase life of gerbera flowers affected due to different harvest stages and stalk lengths. Data related with vase life are given in Table 15, Table 16 and Table 17 and graphically demonstrated in Figure 5.

Table : 15 Effect of different harvest stages (S) and stalk lengths (L) on vase life (days) of gerbera (*Gerbera jamesonii*) cv. Stanza in the year 2010-11

Treatments	Vase life (days)			
	L ₁ : 40 cm	L ₂ : 50 cm	L ₃ : 60 cm	Mean
S₁: Fully open ray florets, unopen disc florets	7.33	8.47	9.00	8.27
S₂: 30 % open disc florets	6.87	7.73	8.07	7.56
S₃: 50 % open disc florets	6.27	6.53	6.80	6.53
Mean	6.82	7.58	7.96	
S.V.	S. Em ±	C. D. at 5 %	C. V. %	
S	0.100	0.30	4.03	
L	0.100	0.30		
S × L	0.174	0.52		

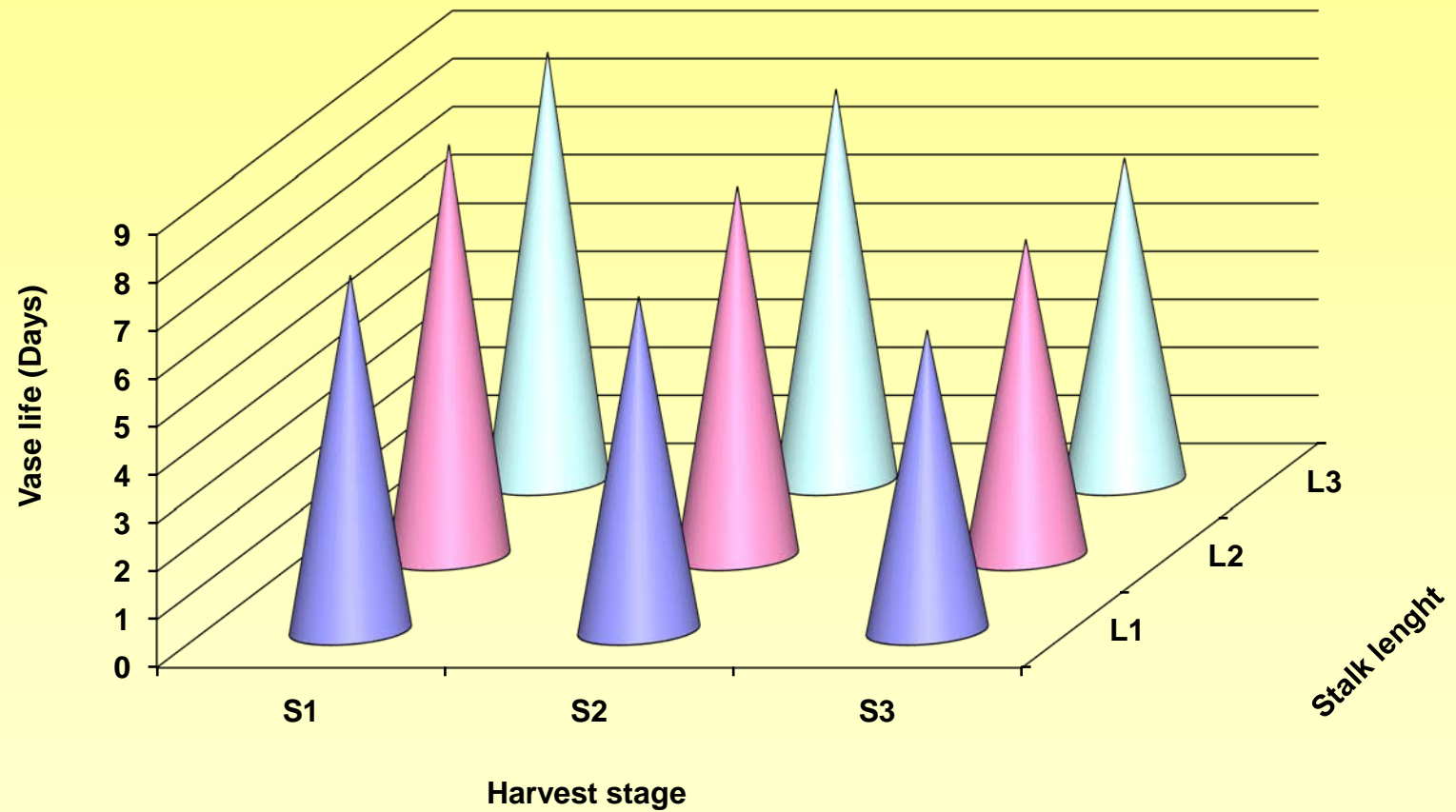
Table : 16 Effect of different harvest stage (S) and stalk length (L) on vase life (days) of gerbera (*Gerbera jamesonii*) cv. Stanza in the year 2011-12

Treatments	Vase life (days)			
	L ₁ : 40 cm	L ₂ : 50 cm	L ₃ : 60 cm	Mean
S₁: Fully open ray florets, unopen disc florets	7.40	8.60	8.80	8.27
S₂: 30 % open disc florets	7.00	7.60	8.20	7.60
S₃: 50 % open disc florets	6.20	6.60	6.60	6.47
Mean	6.87	7.60	7.87	
S.V.	S. Em ±	C. D. at 5 %	C. V. %	
S	0.091	0.27	3.69	
L	0.091	0.27		
S × L	0.158	0.47		

Table : 17 Effect of different harvest stages (S) and stalk lengths (L) on vase life (days) of gerbera (*Gerbera jamesonii*) cv. Stanza in the pooled analysis

Treatments	Vase life (days)			
	L ₁ : 40 cm	L ₂ : 50 cm	L ₃ : 60 cm	Mean
S₁: Fully open ray florets, unopen disc florets	7.37	8.53	8.90	8.27
S₂: 30 % open disc florets	6.93	7.67	8.13	7.58
S₃: 50 % open disc florets	6.23	6.57	6.70	6.50
Mean	6.84	7.59	7.91	
S.V.	S. Em ±	C. D. at 5 %	C. V. %	
S	0.096	0.28	3.87	
L	0.096	0.28		
S × L	0.118	0.34		

Fig-5 : Effect of different harvest stages (S) and stalk lengths (L) on vase life (days) of gerbera (*Gerbera jamesonii*) cv. Stanza (in pooled analysis)



Harvest Stage

Different harvest stage significantly affected the vase life of gerbera cv. Stanza in year 2010-11, 2011-12 and on collective analysis. Significantly prominent vase life observed with fully open ray florets, unopen disc florets (8.27 days) which were followed by 30% open disc florets (7.58 days) in pooled analysis.

Stalk Length

Vase life of the flower was directly affected by stalk length as apparently shown in Table 15, 16 and 17. Significantly maximum vase life perceived from longest stalk length (60 cm) with 7.91 days which was followed by medium stalk length (50 cm) with 7.59 days. Minimum vase life was shown with shortest stalk (40 cm) with 6.84 days in pooled analysis.

Interaction Effect

The gerbera cv. Stanza exhibited a supplementary variation with respect to interaction of harvest stage and stalk length for vase life. Significantly highest vase life was observed in flower harvest at fully open ray florets, unopen disc florets having 60 cm stalk length (S_1L_3) i.e. 8.90 days which was followed by 30 % open disc florets having 50 cm stalk (S_2L_3) i.e. 8.53 days in pooled analysis. Least days for vase life was observed with 50 % open disc florets having 40 cm stalk length (S_3L_1) i.e. 6.23 days in gerbera cv. Stanza in pooled analysis.

More or less similar trend was observed during both the years of investigation.

4.1.3.2 Quality Assessments: (on visual basis, 5 point scale)

The effect of different harvest stages on colour and freshness of cut flower was visually examined at 2nd, 4th, 6th and 8th day. The result with regard to qualitative parameter has been depicted in Table 18.

Harvest stage fully open ray florets, unopen disc florets with 60 cm stalk length was maintained good colour, petal turgidity and freshness. Cut flowers harvested at 50% open disc florets with 40 cm stalk length observed decreased colour and freshness.

Experiment : II Effect of pulsing solutions on post harvest life in gerbera cv. stanza

4.2.1 Quantitative Parameters:

4.2.1.1 Change in Fresh Weight (gm) at Every Alternate Day

The data pertaining to change in fresh weight recorded and being presented in Table 19 and graphically presented in Figure 6.

The statistical analysis of data revealed that the change in fresh weight was non-significant at initial day after that it was significantly, influenced with the different pulsing solutions in gerbera cv. Stanza in both the years and in pooled analysis .

The maximum fresh weight (gm) observed with the 8 HQC 250 mg/l + Sucrose 10 % solution i.e. 114.98 gm, 115.17 gm and 115.08 gm which was at par with Ascorbic acid 250 mg/l + Sucrose 10% i.e. 113.78 gm, 113.32 gm and 113.55 gm at 2nd day

Table : 18 Effect of different harvest stages (S) and stalk lengths (L) on overall quality of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	2 nd day						4 th day						6 th day						8 th day					
	2010-11			2011-12			2010-11			2011-12			2010-11			2011-12			2010-11			2011-12		
	L ₁	L ₂	L ₃	L ₁	L ₂	L ₃	L ₁	L ₂	L ₃	L ₁	L ₂	L ₃	L ₁	L ₂	L ₃	L ₁	L ₂	L ₃	L ₁	L ₂	L ₃	L ₁	L ₂	L ₃
S ₁	5	5	5	5	5	5	5	5	5	5	5	5	3	4	5	3	4	5	*	3	4	*	3	4
S ₂	5	5	5	5	5	5	4	5	5	4	5	5	2	3	4	2	3	4	*	*	2	*	*	2
S ₃	5	5	5	5	5	5	3	3	4	3	3	4	1	1	2	1	1	2	*	*	*	*	*	*

Note : * Indicate vase life was completed

Harvest stage (S) S₁: Fully open ray florets, unopen disc florets S₂: 30 % open disc florets S₃: 50 % open disc florets

Stalk length (L) L₁: 40 cm L₂: 50 cm L₃: 60 cm

Where,

1	Dull/Flaccid
2	Poor
3	Fair
4	Very good
5	Excellent

Table : 19 Effect of different pulsing solutions on change in fresh weight (gm) of gerbera (*Gerbera jamesonii*) cv. Stanza

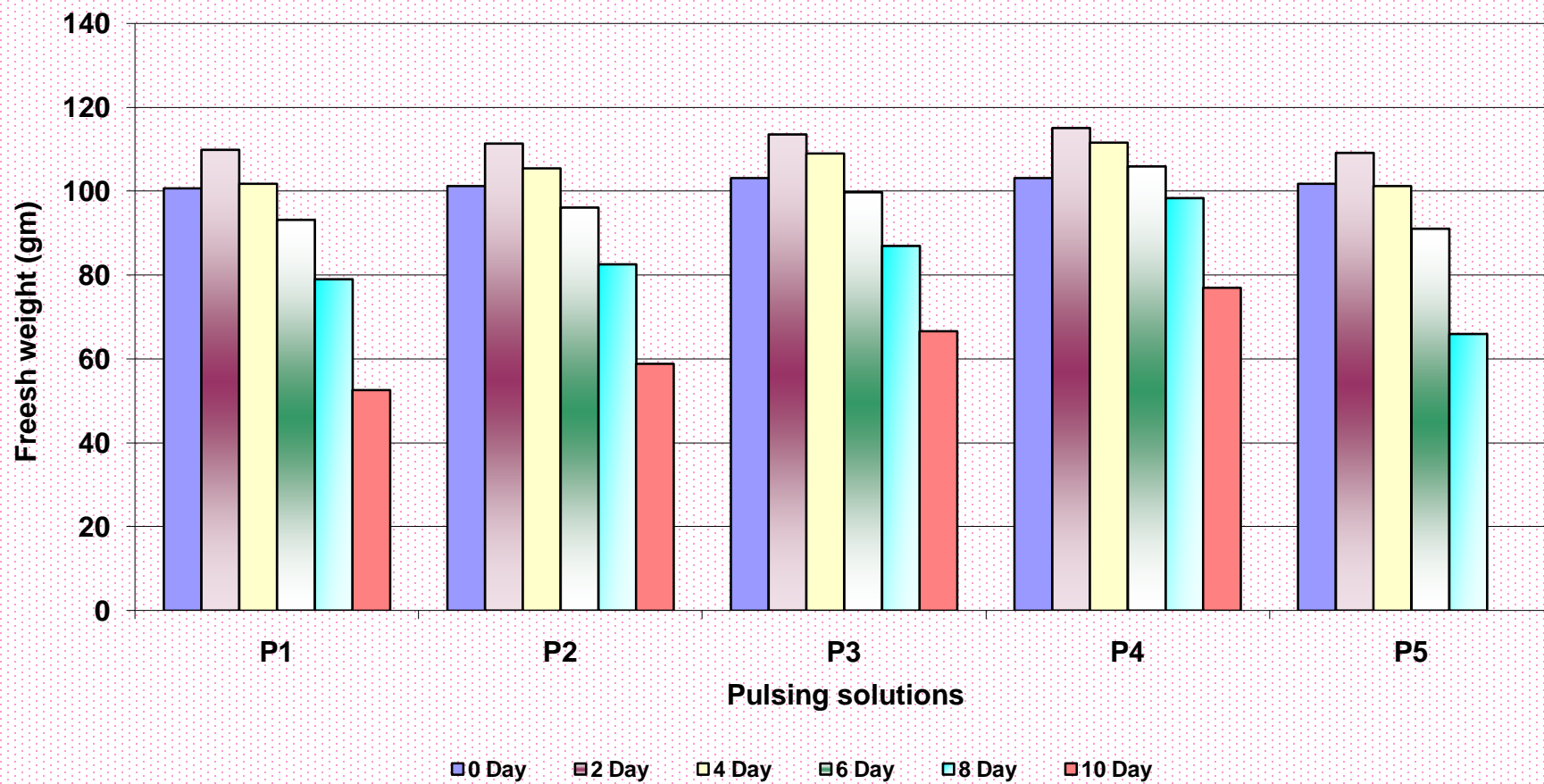
Treatments	Fresh weight (gm) at initial (0 th) day			Fresh weight (gm) at 2 nd day			Fresh weight (gm) at 4 th day		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
Pulsing solution (P)	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
P₁: Sucrose 5%	100.15	101.20	100.68	109.23	110.52	109.88	102.25	101.17	101.78
P₂: Sucrose 10%	101.23	101.40	101.32	111.24	111.49	111.37	105.76	105.19	105.48
P₃: Ascorbic acid 250 mg/l + Sucrose 10%	103.40	102.87	103.14	113.78	113.32	113.55	109.43	108.71	109.07
P₄: 8 HQC 250 mg/l + Sucrose 10%	102.98	103.32	103.15	114.98	115.17	115.08	111.25	111.99	111.62
P₅: Control	101.70	102.01	101.86	108.96	109.34	109.15	101.52	100.95	101.24
S. Em. ±	1.073	1.139	0.783	1.232	1.213	0.867	1.594	1.839	1.217
C.D. at 5%	N.S	N.S	N.S	3.71	3.66	2.50	4.81	5.54	3.51
C.V.%	2.11	2.23	2.17	2.21	2.17	2.19	3.01	3.48	3.25
Pooled	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %
Y	0.595	N.S	2.17	0.547	N.S	2.19	0.770	N.S	3.25
Y × T	1.107	N.S		1.222	N.S		1.721	N.S	

Table : 19 Effect of different pulsing solutions on change in fresh weight (gm) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Fresh weight (gm) at 6 th day			Fresh weight (gm) at 8 th day			Fresh weight (gm) at 10 th day*		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Mean data
Pulsing solution (P)	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Mean data
P₁: Sucrose 5%	92.72	93.63	93.18	78.63	79.39	79.01	52.23	53.01	52.62
P₂: Sucrose 10%	96.12	96.09	96.11	82.60	82.54	82.57	58.65	59.00	58.83
P₃: Ascorbic acid 250 mg/l + Sucrose 10%	99.82	99.69	99.76	86.91	87.00	86.96	66.78	66.52	66.65
P₄: 8 HQC 250 mg/l + Sucrose 10%	105.88	106.00	105.92	98.30	98.41	98.36	77.14	76.99	77.07
P₅: Control	90.84	91.27	91.06	65.80	66.12	65.96	****	****	****
S. Em. ±	1.627	1.467	1.095	1.366	1.429	0.988	****	****	****
C.D. at 5%	4.90	4.42	3.16	4.12	4.31	2.85	****	****	****
C.V.%	3.35	3.01	3.19	3.31	3.46	3.39	****	****	****
Pooled	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %	****	****	****
Y	0.693	N.S	3.19	0.625	N.S	3.39	****	****	****
Y×T	1.549	N.S		1.398	N.S		****	****	

Note : * Not included in statistical analysis

Fig-6 : Effect of different pulsing solutions on change in fresh weight (gm) of gerbera (*Gerbera jamesonii*) cv. Stanza (In pooled analysis)



in 2010-11, 2011-12 and in pooled analysis, respectively. At 4th, 6th and 8th day maximum fresh weight (gm) observed with 8 HQC 250 mg/l + Sucrose 10% (P₄; 111.62 gm, 105.92 gm and 98.36 gm, respectively) which was followed by Ascorbic acid 250 mg/l + Sucrose 10% in pooled analysis. At 10th day maximum flower weight observed with 8-HQC 250 mg/l + Sucrose 10 % (P₄; 77.07 gm) in mean data. Parallel consequent was surveillance in both the year of experiment.

4.2.1.2 Physiological Change in Weight (%)

The data regarding physiological change in weight (%) significantly affected by pulsing solution in gerbera cv. Stanza are furnished in Table 20 and graphically depicted in Figure 7.

There were significant differences among different pulsing solutions in relation to physiological change in weight (%). Up to 2nd day flower weight was improved then after worsen was observed. 8 HQC 250 mg/l + Sucrose 10 % gave good result in regard to physiological change in weight (11.56 %, -3.28 %, -4.82 %, -7.16 % and -21.68 %) which was followed by Ascorbic acid 250 mg/l + Sucrose 10 % (10.10 %, -3.87 %, -8.62 %, -12.83 % and -23.38 %) at 2nd, 4th, 6th, 8th and 10th day in pooled analysis. Maximum loss observed with control. At 10th day some treatments completed their vase life so, it was not included in statistical analysis. Equivalent results were seen in both the years.

4.2.1.3 Water Uptake (ml)

Data pertained to water uptake at alternate day (ml) and total water uptake (ml) affected due to different pulsing solutions in gerbera cv. Stanza at 2nd, 4th, 6th, 8th and 10th day during

Table : 20 Effect of different pulsing solutions on physiological change in weight (%) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Physiological change in weight (%) at 2 nd day			Physiological change in weight (%) at 4 th day			Physiological change in weight (%) at 6 th day		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
Pulsing solution (P)									
P₁: Sucrose 5%	9.07	9.21	9.14	- 6.39	- 6.38	- 6.38	- 9.32	- 9.51	- 9.42
P₂: Sucrose 10%	9.89	9.95	9.92	- 4.93	- 5.09	- 5.01	- 9.11	- 9.19	- 9.15
P₃: Ascorbic acid 250 mg/l + Sucrose 10%	10.04	10.16	10.10	- 3.82	- 3.89	- 3.87	- 8.78	- 8.47	- 8.62
P₄: 8 HQC 250 mg/l + Sucrose 10%	11.65	11.47	11.56	- 3.24	- 3.32	- 3.28	- 4.83	- 4.80	- 4.82
P₅: Control	7.14	7.19	7.16	- 6.83	- 6.71	- 6.77	- 10.52	- 10.51	- 10.51
S. Em. ±	0.105	0.099	0.072	0.067	0.071	0.049	0.131	0.138	0.095
C.D. at 5%	0.32	0.30	0.21	0.20	0.21	0.14	0.39	0.42	0.27
C.V.%	2.20	2.07	2.13	2.67	0.79	2.73	3.08	3.25	3.17
Pooled	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %
Y	0.046	N.S	2.13	0.031	N.S	2.73	0.060	N.S	3.17
Y×T	0.102	N.S		0.069	N.S		0.135	N.S	

Note: Figures with negative (-ve) denote decrease in fresh weight (%)

Conti.....

Table : 20 Effect of different pulsing solutions on change in physiological change in weight (%) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Physiological change in weight (%) at 8 th day			Physiological change in weight (%) at 10 th day*		
	2010-11	2011-12	Pooled	2010-11	2011-12	Mean data
Pulsing solution (P)						
P₁: Sucrose 5%	- 15.20	- 15.21	- 15.20	- 33.64	- 33.23	- 33.43
P₂: Sucrose 10%	- 14.07	- 14.10	- 14.08	- 29.06	- 28.52	- 28.79
P₃: Ascorbic acid 250 mg/l + Sucrose 10%	- 12.93	- 12.76	- 12.83	- 23.23	- 23.54	- 23.38
P₄: 8 HQC 250 mg/l + Sucrose 10%	- 7.16	- 7.16	- 7.16	- 21.59	- 21.77	- 21.68
P₅: Control	- 27.56	- 27.56	- 27.56	****	****	****
S. Em. ±	0.290	0.280	0.201	****	****	****
C.D. at 5%	0.87	0.84	0.58	****	****	****
C.V.%	3.77	3.65	3.71	****	****	****
Pooled	SEm±	C.D. at 5%	C.V. %	****	****	****
Y	0.127	N.S	3.71	****	****	****
Y×T	0.85	N.S		****	****	

Note: Figures with negative (-ve) denote decrease in fresh weight (%)

Note : * Not included in statistical analysis

Fig-7 : Effect of different pulsing solutions on change in physiological change in weight (%) of gerbera (*Gerbera jamesonii*) cv. Stanza (In pooled analysis)

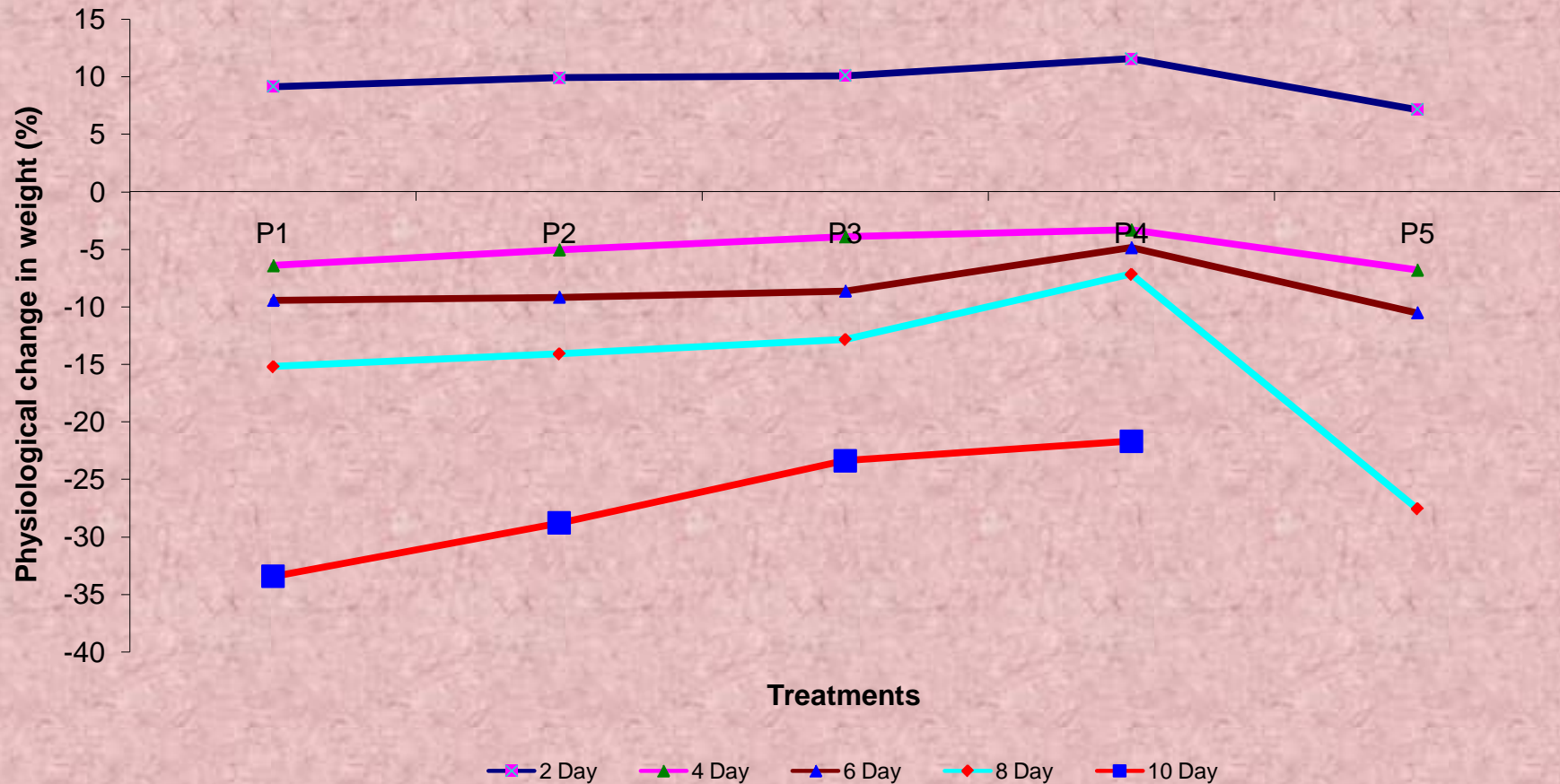


Table : 21 Effect of different pulsing solutions on water uptake (ml) of gerbera (*Gerbera jamesonii*) cv. Stanza

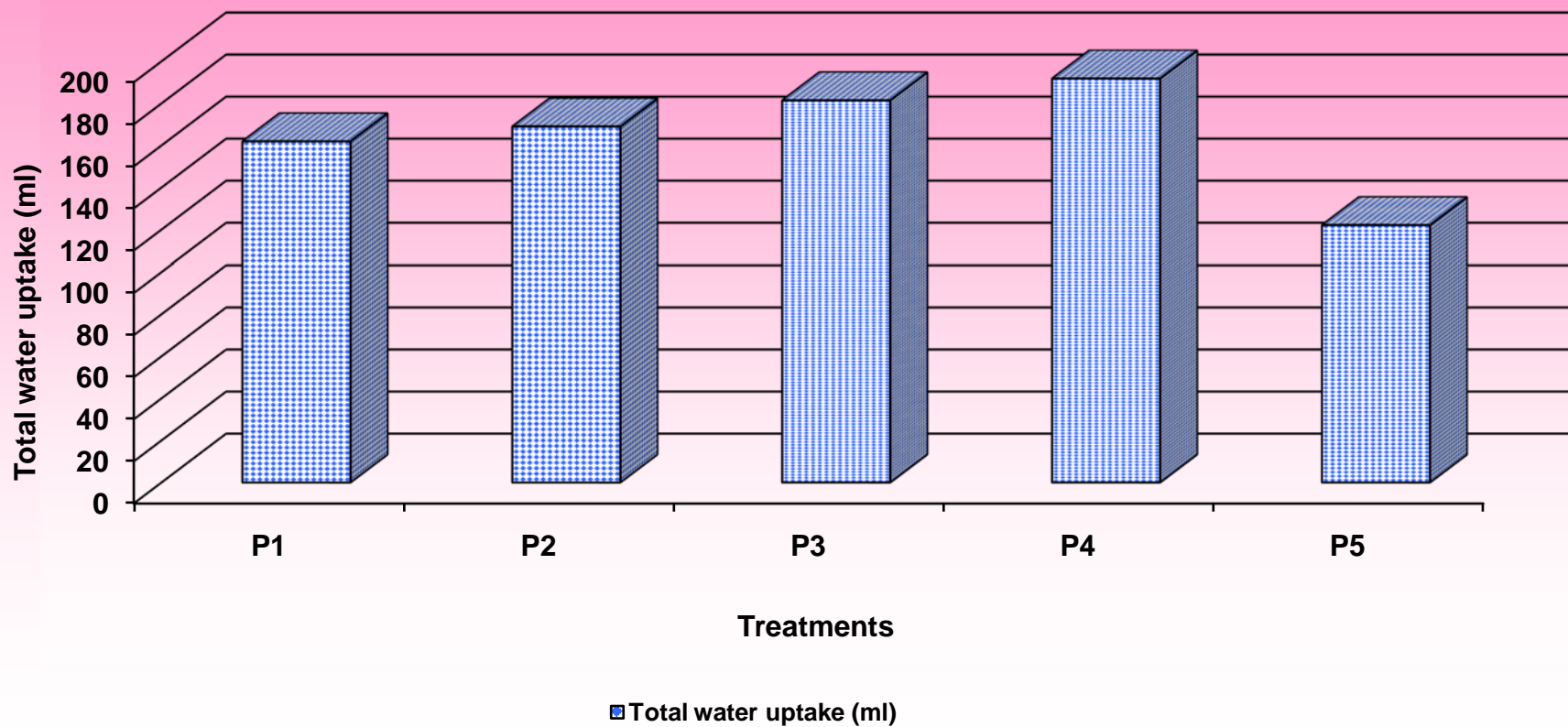
Treatments	Water uptake (ml) at 2 nd day			Water uptake (ml) at 4 th day			Water uptake (ml) at 6 th day		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
Pulsing solution (P)									
P₁: Sucrose 5%	41.76	42.00	41.88	37.55	38.00	37.77	33.36	32.26	32.81
P₂: Sucrose 10%	42.20	43.02	42.61	39.01	39.14	39.07	34.08	33.68	33.88
P₃: Ascorbic acid 250 mg/l + Sucrose 10%	43.68	44.38	44.01	41.27	43.27	41.77	36.29	37.52	36.90
P₄: 8 HQC 250 mg/l + Sucrose 10%	45.58	45.24	45.41	43.38	44.46	43.92	38.48	39.08	38.78
P₅: Control	40.00	39.82	39.91	35.31	36.54	35.92	29.49	28.98	29.23
S. Em. ±	0.756	0.736	0.528	0.766	0.726	0.528	0.639	0.566	0.427
C.D. at 5%	2.28	2.22	1.52	2.31	2.19	1.52	1.93	1.71	1.23
C.V.%	3.55	3.43	3.49	3.90	3.62	3.76	3.72	3.30	3.52
Pooled	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %
Y	0.334	N.S	3.49	0.334	N.S	3.76	0.270	N.S	3.52
Y×T	0.746	N.S		0.746	N.S		0.604	N.S	

Table : 21 Effect of different pulsing solutions on water uptake (ml) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Water uptake (ml) at 8 th day			Water uptake (ml) at 10 th day*			Total water up take (ml)		
	2010-11	2011-12	Pooled	2010-11	2011-12	Mean data	2010-11	2011-12	Pooled
Pulsing solution (P)	2010-11	2011-12	Pooled	2010-11	2011-12	Mean data	2010-11	2011-12	Pooled
P₁: Sucrose 5%	29.50	28.88	29.19	20.61	198.98	20.30	162.78	161.12	161.98
P₂: Sucrose 10%	30.28	31.46	30.87	22.86	22.30	22.58	168.43	169.60	169.01
P₃: Ascorbic acid 250 mg/l + Sucrose 10%	32.99	33.28	33.14	25.24	26.06	25.65	179.46	183.47	181.46
P₄: 8 HQC 250 mg/l + Sucrose 10%	34.50	35.00	34.75	28.90	29.02	28.96	190.84	192.80	191.82
P₅: Control	17.51	16.64	17.08	****	****	****	122.31	121.98	122.14
S. Em. ±	0.508	0.548	0.374	****	****	****	3.500	3.548	2.492
C.D. at 5%	1.53	1.65	1.08	****	****	****	10.55	10.69	7.20
C.V.%	3.51	3.77	3.65	****	****	****	4.25	4.28	4.26
Pooled	SEm±	C.D. at 5%	C.V. %	****	****	****	SEm±	C.D. at 5%	C.V. %
Y	0.236	N.S	3.65	****	****	****	1.567	N.S	4.26
Y×T	0.529	N.S		****	****		3.524	N.S	

Note : * Not included in statistical analysis

Fig-8 :Effect of different pulsing solutions on total water uptake (ml) of gerbera (*Gerbera jamesonii*) cv. Stanza



2010-11, 2011-12 and in pooled analysis are given in Table 21 and graphically drawn in Figure 8.

The data in the Table 21 clearly showed significant influence of different pulsing solutions on water uptake at 2nd, 4th, 6th, 8th, 10th and total water up take during 2010-11, 2011-12 and pooled analysis. Significantly higher water uptake (45.58 ml, 43.38 ml, 38.48 ml and 34.50 ml) was recorded in (8 HQC 250 mg/l+ Sucrose 10% solution) treatment P₄, at 2nd, 4th, 6th and 8th day, respectively. At 10th day maximum water uptake was observed in P₄ (28.96 ml) in 2010-11. Total water uptake (190.84 ml, 192.80 ml and 191.82 ml) was observed during both the years and in pooled analysis, respectively.

4.2.1.4 Membrane Stability Index (MSI) in Petals

The data pertaining to membrane stability index (MSI) in petals recorded periodically at 4nd and 8th day as influenced by different pulsing solutions are presented in Table 22 and graphically illustrated in Figure 9.

The data clearly indicated that membrane stability index was progressively decreased with advancement of flower stage at 4th and 8th day.

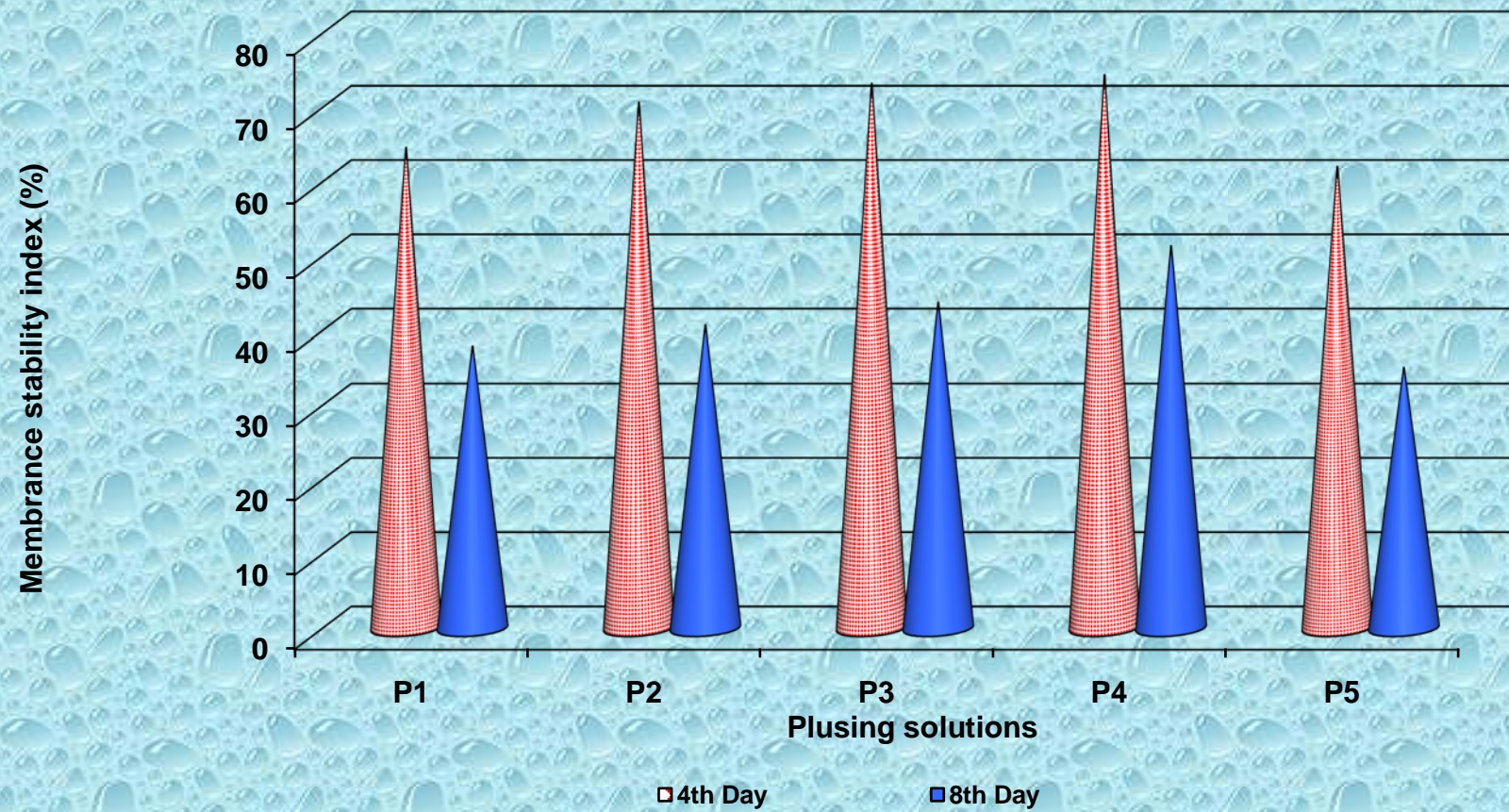
The data in the Table 22 revealed that membrane stability index was differed significantly due to different pulsing solutions.

Significantly higher MSI (74.85 %, 73.92 % and 74.38 %) was recorded in (8 HQC 250 mg/l + Sucrose 10 % solution)

Table : 22 Effect of different pulsing solutions on membrane stability index (%) in petals of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	MSI (%) at 4 th day			MSI (%) at 8 th day		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
Pulsing solution (P)						
P₁: Sucrose 5%	65.01	64.18	64.59	37.30	38.56	37.93
P₂: Sucrose 10%	70.08	71.29	70.68	41.37	40.04	40.71
P₃: Ascorbic acid 250 mg/l + Sucrose 10%	73.41	72.98	73.19	44.05	43.45	43.75
P₄: 8 HQC 250 mg/l + Sucrose 10%	74.85	73.92	74.38	50.77	51.91	51.34
P₅: Control	61.34	62.69	62.02	35.57	34.54	35.05
S. Em. ±	1.079	1.070	0.760	0.540	0.572	0.393
C.D. at 5%	3.25	3.22	2.19	1.63	1.72	1.13
C.V.%	3.13	3.10	3.12	2.58	2.74	2.66
Pooled	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %
Y	0.480	N.S	3.12	0.249	N.S	2.66
Y×T	1.074	N.S		0.556	N.S	

Fig-9 : Effect of different pulsing solutions on membrane stability index (%) in petals of gerbera (*Gerbera jamesonii*) cv. Stanza (In pooled analysis)



treatment P₄, which was at par with in (Ascorbic acid 250 mg/l + Sucrose 10 % solution) treatment P₃ (73.41 %, 72.98 % and 73.19 %) at 4th day during both the years and in pooled analysis, respectively.

At 8th day, significantly higher MSI was recorded in 8 HQC 250 mg/l + Sucrose 10 % solution (P₄; 50.77 %, 51.91 % and 51.34 %) which was at followed by in Ascorbic acid 250 mg/l + Sucrose 10% solution (P₃; 44.05 %, 43.45 % and 43.75 %) at 8th day during both the years and in pooled analysis, respectively.

4.2.1.5 Total Dissolved Solutes (⁰B)

The data pertaining to TDS of petals in different pulsing solutions are illustrated in Table 23 and graphically drawn in Figure 10.

Maximum TDS recorded in 8 HQC 250 mg/l + Sucrose 10 % (P₄; 11.23⁰B, 11.27⁰B and 11.25⁰B) which was at par with Ascorbic acid 250 mg/l + Sucrose 10 % at 4th day during 2010-11, 2011-12 and in pooled analysis, respectively.

4.2.1.6 Dry Weight (%)

The data concerned with dry weight (%) affected due to different pulsing solutions in gerbera cv. Stanza cut flowers are furnished in Table 24 and graphically visualized in Figure 10

From Table 24, dry weight (%) was significantly influenced by different pulsing solutions during both years and in pooled analysis. Significantly higher dry weight (8.76 %, 8.47 % and 8.62 %) was recorded in (8-HQC 250 mg/l + Sucrose 10 %

Table : 23 Effect of different pulsing solutions on total dissolved solutes (TDS) (°B) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	TDS (°B) at 4 th day		
	2010-11	2011-12	Pooled
Pulsing solution (P)			
P₁: Sucrose 5%	10.27	10.35	10.31
P₂: Sucrose 10%	10.56	10.38	10.47
P₃: Ascorbic acid 250 mg/l + Sucrose 10%	11.07	10.76	10.92
P₄: 8 HQC 250 mg/l + Sucrose 10%	11.23	11.27	11.25
P₅: Control	10.05	10.00	10.03
S. Em. ±	0.128	0.117	0.087
C.D. at 5%	0.38	0.35	0.25
C.V.%	2.40	2.22	2.31
Pooled	SEm±	C.D. at 5%	C.V. %
Y	0.055	N.S	2.31
YXT	0.123	N.S	

Fig-10 : Effect of different pulsing solutions on total dissolved solutes (TDS) (°B) at 4th day and dry weight (%) of gerbera (*Gerbera jamesonii*) cv. Stanza (In pooled analysis)

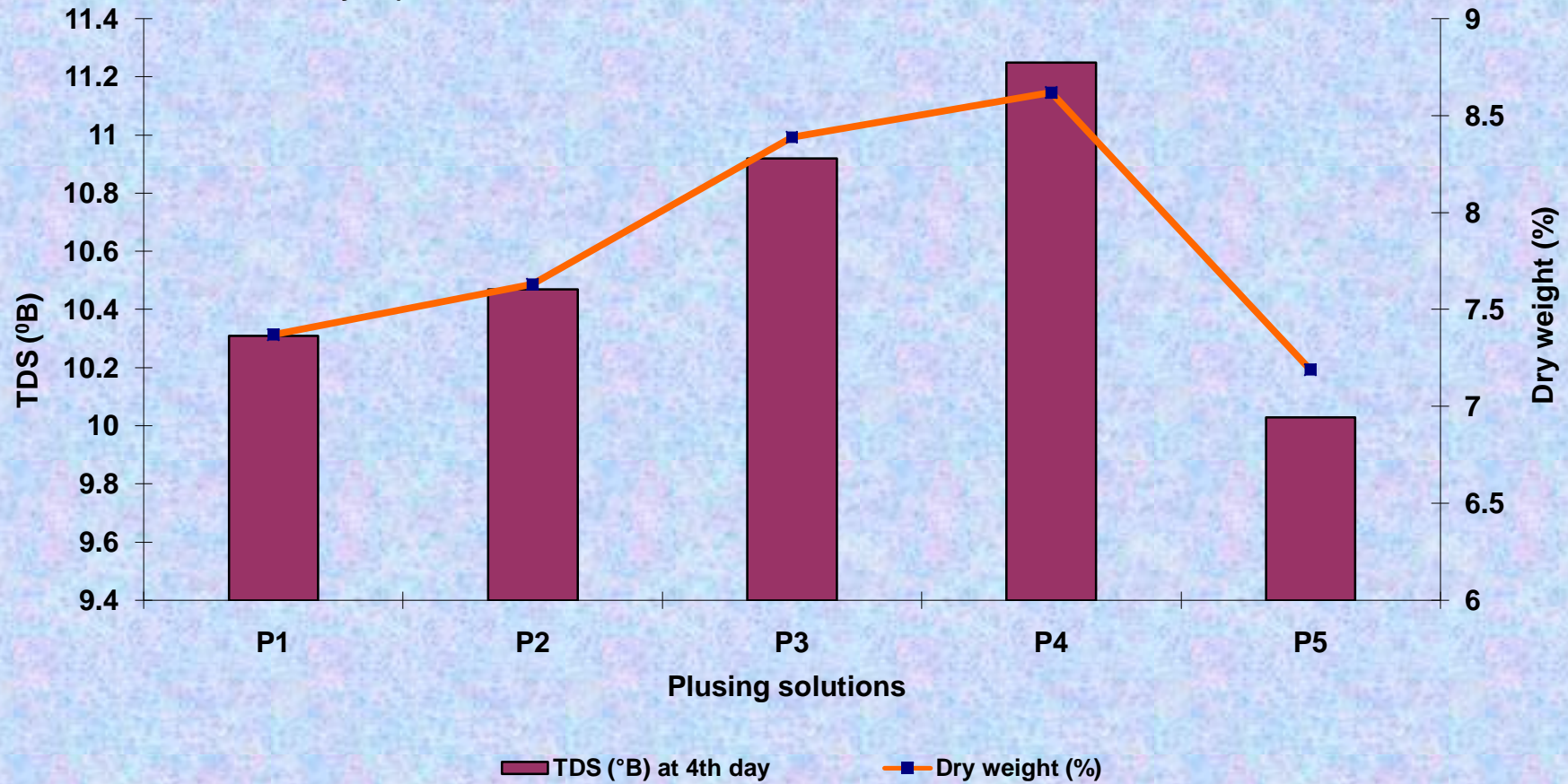


Table : 24 Effect of different pulsing solutions on dry weight (%) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Dry weight (%)		
	2010-11	2011-12	Pooled
Pulsing solution (P)			
P₁: Sucrose 5%	7.32	7.42	7.37
P₂: Sucrose 10%	7.54	7.71	7.63
P₃: Ascorbic acid 250 mg/l + Sucrose 10%	8.38	8.40	8.39
P₄: 8 HQC 250 mg/l + Sucrose 10%	8.76	8.47	8.62
P₅: Control	7.25	7.13	7.19
S. Em. ±	0.125	0.151	0.098
C.D. at 5%	0.38	0.46	0.28
C.V.%	3.19	3.86	3.54
Pooled	SEm±	C.D. at 5%	C.V. %
Y	0.062	N.S	3.54
Y×T	0.139	N.S	

solution) treatment P₄, which was at par with treatment P₃, (Ascorbic acid 250 mg/l + Sucrose 10 % solution) at 4th day during 2010-11, 2011-12 and in pooled analysis, respectively.

4.2.2 Qualitative Parameter

4.2.2.1 Flower Size (cm)

The data noted on flower size as affected by different treatments have being presented in Table 25 and depicted graphically in Figure 11.

The effect of pulsing solution was significant in influencing the flower size of gerbera cv. Stanza. All the pulsing solution significantly increased the flower size (cm) over control.

At initial day, there was non-significant in case of flower size in gerbera cv. Stanza.

At 2nd day, Maximum flower size (10.75 cm, 10.72 cm and 10.73 cm) was recorded when pulsing with 8 HQC 250 mg/l + Sucrose 10 %, which was statistically at par with Ascorbic acid 250 mg/l + Sucrose 10 % (10.54 cm, 10.63 cm and 10.58 cm) in 2010-11, 2011-12 and in pooled analysis, respectively.

More or less similar trend was observed at 4th, 6th, 8th and 10th day (mean data) during both the years of investigation and in pooled analysis.

4.2.2.2 Scape bending curvature (°) (4th and 8th day)

The data related to scape bending curvature (°) in gerbera cv. Stanza cut flowers are recorded at 4th and 8th day

Table : 25 Effect of different pulsing solutions on flower size (cm) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Flower size (cm) at initial (0 th) day			Flower size (cm) at 2 nd day			Flower size (cm) at 4 th day		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
Pulsing solution (P)	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
P₁: Sucrose 5%	9.42	9.63	9.52	10.33	10.29	10.31	10.54	10.52	10.53
P₂: Sucrose 10%	9.48	9.52	9.50	10.35	10.32	10.33	10.67	10.71	10.69
P₃: Ascorbic acid 250mg/l + Sucrose 10%	9.58	9.81	9.69	10.54	10.63	10.58	10.76	10.82	10.79
P₄: 8 HQC 250 mg/l + Sucrose 10%	9.69	9.69	9.69	10.75	10.72	10.73	10.98	10.95	10.97
P₅: Control	9.55	9.74	9.64	10.25	10.28	10.27	10.42	10.44	10.43
S. Em. ±	0.216	0.114	0.122	0.104	0.101	0.072	0.106	0.103	0.074
C.D. at 5%	N.S	N.S	N.S	0.31	0.30	0.21	0.32	0.31	0.21
C.V.%	4.53	2.36	3.60	1.99	1.93	1.96	1.98	1.92	1.96
Pooled	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %
Y	0.007	N.S	3.60	0.046	N.S	1.96	0.047	N.S	1.96
Y×T	0.173	N.S		0.102	N.S		0.104	N.S	

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Table : 25 Effect of different pulsing solutions on flower size (cm) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Flower size (cm) at 6 th day			Flower size (cm) at 8 th day			Flower size (cm) at 10 th day*		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Mean data
P₁: Sucrose 5%	9.45	9.44	9.45	8.13	8.13	8.13	6.74	6.71	6.73
P₂: Sucrose 10%	9.73	9.81	9.77	8.44	8.45	8.45	6.84	6.87	6.86
P₃: Ascorbic acid 250mg/l + Sucrose 10%	10.03	10.00	10.02	8.53	8.52	8.53	7.16	7.15	7.16
P₄: 8 HQC 250 mg/l + Sucrose 10%	10.20	10.18	10.19	9.05	9.00	9.03	7.82	7.73	7.78
P₅: Control	8.63	8.70	8.67	7.75	7.60	7.68	****	****	****
S. Em. ±	0.177	0.160	0.119	0.178	0.131	0.110	****	****	****
C.D. at 5%	0.53	0.48	0.34	0.54	0.39	0.32	****	****	****
C.V.%	3.68	3.33	3.51	4.25	3.14	3.74	****	****	****
Pooled	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %	****	****	****
Y	0.075	N.S	3.51	0.070	N.S	3.78	****	****	****
Y×T	0.169	N.S		0.156	N.S		****	****	

Note : * Not included in statistical analysis

Fgi- 11: Effect of different pulsing solutions on flower size (cm) of gerbera (*Gerbera jamesonii*) cv. Stanza

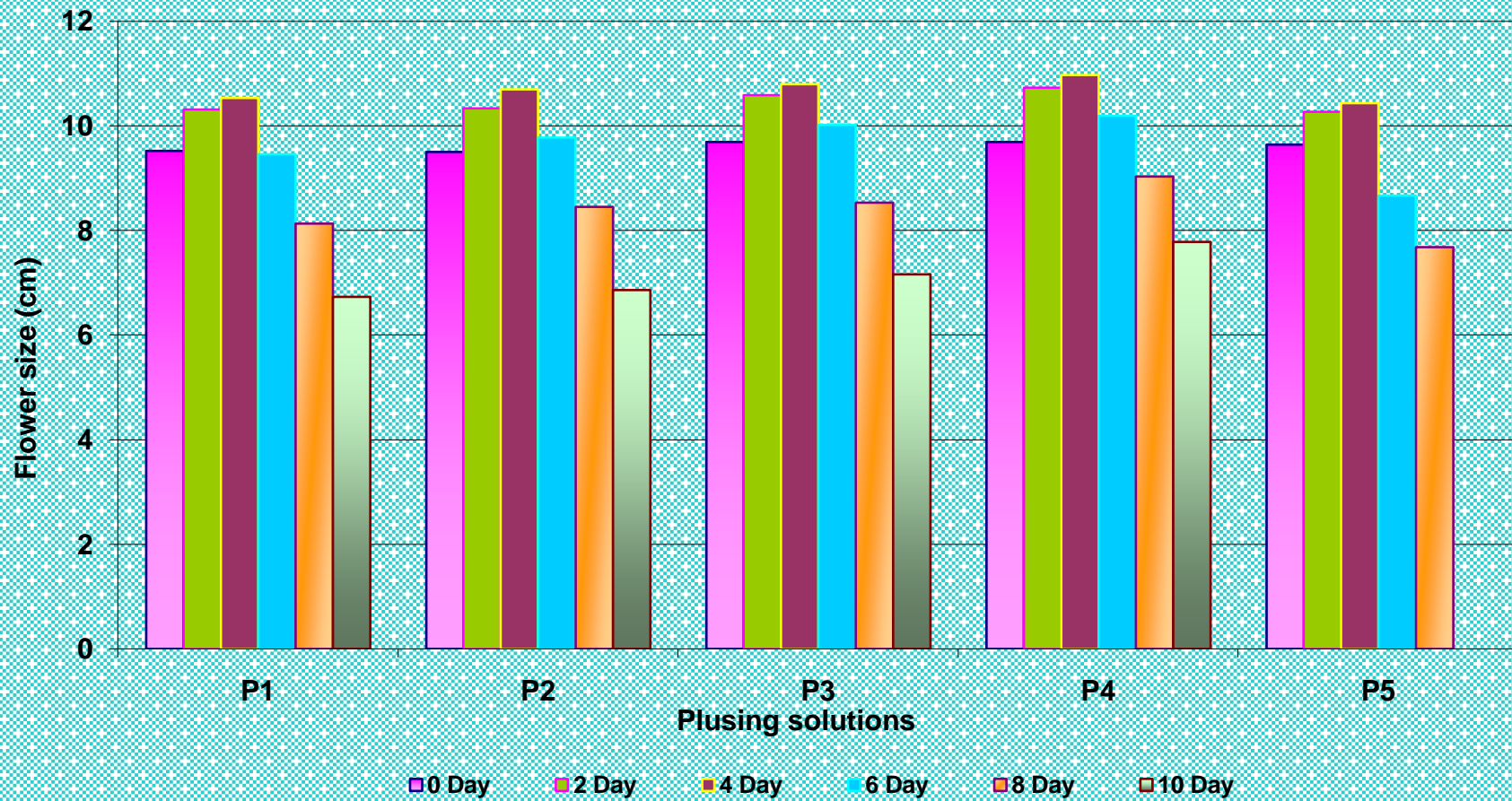


Table : 26 Effect of different pulsing solutions on scape bending curvature (⁰) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Scape bending curvature (⁰) at 4 th day			Scape bending curvature (⁰) at 8 th day		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
Pulsing solution (P)						
P₁: Sucrose 5%	27.42	28.20	27.81	50.18	51.89	51.04
P₂: Sucrose 10%	25.18	25.62	25.40	49.32	50.00	49.66
P₃: Ascorbic acid 250 mg/l + Sucrose 10%	20.46	21.02	20.74	42.27	43.78	43.03
P₄: 8 HQC 250 mg/l + Sucrose 10%	15.30	14.00	14.65	33.71	32.84	33.28
P₅: Control	30.84	31.28	31.06	85.06	86.26	85.66
S. Em. ±	0.248	0.535	0.295	0.744	0.736	0.523
C.D. at 5%	0.75	1.61	0.85	2.24	2.22	1.51
C.V.%	2.08	4.46	3.49	2.86	2.78	2.82
Pooled	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %
Y	0.187	N.S	3.49	0.331	N.S	2.82
Y×T	0.417	N.S		0.740	N.S	

during both the years and in pooled analysis are depicted in Table 26 and graphically in Figure 12.

From the data, revealed that minimum scape bending (15.30° to 33.71° , 14.00° to 32.84° and 14.65° to 33.28°), which was followed by Ascorbic acid 250 mg/l + Sucrose 10 % (20.46° to 42.27° , 21.02° to 43.78° and 20.74° to 43.03°) at 4th to 6th DAS during both the years and in pooled analysis, respectively. Whereas, gerbera cut flowers cv. Stanza without pulsing suffered maximum scape bending curvature, at 4th and 8th days during both the years and in pooled analysis.

4.2.2.3 Pigment Content (Anthocyanin)

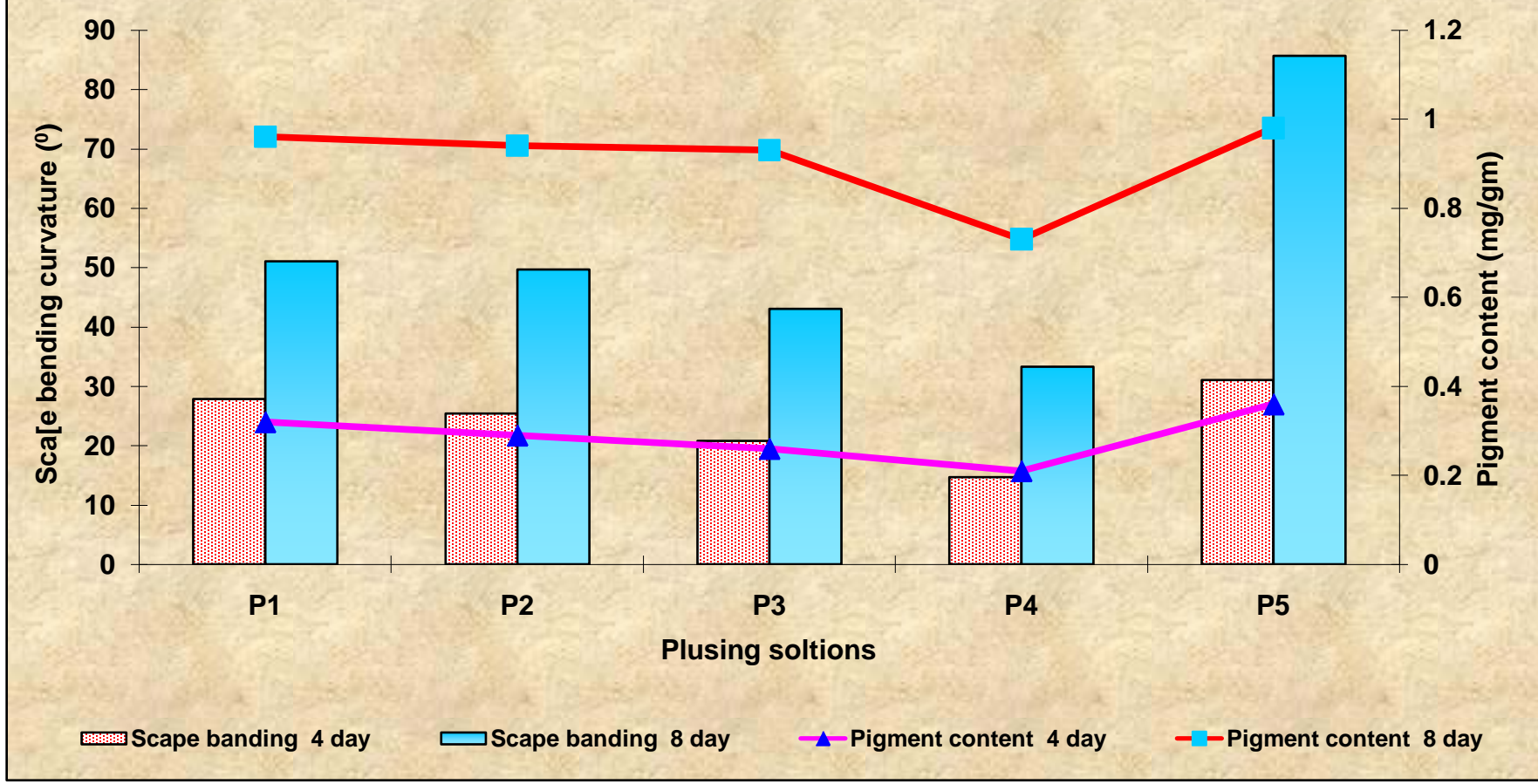
The data pertaining to anthocyanin content in gerbera cv. Stanza at 4th and 8th day during 2010-11 and 2011-12 are depicted in Table 27 and graphically in Figure 12.

The data in Table 27 clearly showed significant influence of pulsing solution on anthocyanin content in petals of gerbera cv. Stanza flowers at 4th and 8th day during both years and in pooled analysis. The maximum anthocyanin content in petals was recorded in control (0.36 mg/g and 0.98 mg/g), whereas, minimum anthocyanin content was registered in 8 HQC 250 mg/l + Sucrose 10 % (0.21 mg/g and 0.73 mg/g) which was followed by Ascorbic acid 250 mg/l + Sucrose 10 % in gerbera cv. Stanza during pooled analysis at 4th and 8th day, respectively. Similar result was shown in both the years.

Table : 27 Effect of different pulsing solutions on pigment content (anthocyanin) (mg/g) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Pigment content (mg/g) at 4 th day			Pigment content (mg/g) at 8 th day		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
Pulsing solution (P)						
P₁: Sucrose 5%	0.31	0.32	0.32	0.97	0.96	0.96
P₂: Sucrose 10%	0.30	0.29	0.29	0.94	0.94	0.94
P₃: Ascorbic acid 250 mg/l + Sucrose 10%	0.27	0.26	0.26	0.92	0.93	0.93
P₄: 8 HQC 250 mg/l + Sucrose 10%	0.20	0.21	0.21	0.72	0.74	0.73
P₅: Control	0.36	0.35	0.36	0.97	0.98	0.98
S. Em. ±	0.004	0.006	0.004	0.011	0.014	0.009
C.D. at 5%	0.01	0.02	0.01	0.03	0.04	0.03
C.V. %	2.47	4.37	3.55	2.39	3.14	2.79
Pooled	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %
Y	0.006	N.S	3.55	0.249	N.S	2.79
Y×T	0.013	N.S		0.556	N.S	

Fig- 12 : Effect of different pulsing solutions on scape bending curvature ($^{\circ}$) and pigment content (anthocyanin) (mg/gm) of gerbera (*Gerbera jamesonii*) cv. Stanza at 4th and 8th days (In pooled analysis)



4.2.2.4 Disease Incidence.

There was no disease incidence visually found in all pulsing solution.

4.2.3 Vase Life (days) and Overall Quality

4.2.3.1 Vase Life (days)

The effect of pulsing solution on vase life was recorded during 2010-11 and 2011-12 depicted in Table 28 and graphically represented in Figure 13.

Vase life of gerbera cv. Stanza was significantly influenced by different pulsing solution during 2010-11, 2011-12 and in pooled analysis. Among different pulsing solution, 8-HQC 250 mg/l + Sucrose 10 % (P₄), recorded maximum vase life 10.90 days, 10.80 days and 10.85 days, which was at par with Ascorbic acid 250 mg/l + Sucrose 10 % (P₃) 10.60 days, 10.40 days and 10.50 days during 2010-11, 2011-12 and in pooled analysis, respectively.

4.1.3.2 Quality Assessments: (on visual basis, 5 point scale)

The effect of pulsing solution on overall quality flower was visually examined at 2nd, 4th, 6th, 8th and 10th day on the basis of freshness, turgidity and overall acceptability and score was given (based on 5 point scale) accordingly. The result with regard to qualitative parameter has been mentioned in Table 29.

Flowers pulsed with 8 HQC 250 mg/l + Sucrose 10 % retains highest score as compared to other pulsing solution.

Table : 28 Effect of different pulsing solutions on vase life (days) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Vase life (days)		
	2010-11	2011-12	Pooled
Pulsing solutions (P)			
P₁: Sucrose 5%	10.00	9.80	9.90
P₂: Sucrose 10%	10.40	10.20	10.30
P₃: Ascorbic acid 250 mg/l + Sucrose 10%	10.60	10.40	10.50
P₄: 8 HQC 250 mg/l + Sucrose 10%	10.90	10.80	10.85
P₅: Control	8.20	8.40	8.30
S. Em. ±	0.224	0.175	0.142
C.D. at 5%	0.67	0.53	0.41
C.V.%	4.46	3.53	4.03
Pooled	SEm±	C.D. at 5%	C.V. %
Y	0.090	N.S	4.03
Y×T	0.201	N.S	

Fig-13 : Effect of different pulsing solutions on vase life (days) of gerbera (*Gerbera jamesonii*) cv. Stanza (In 1st and 2nd years)

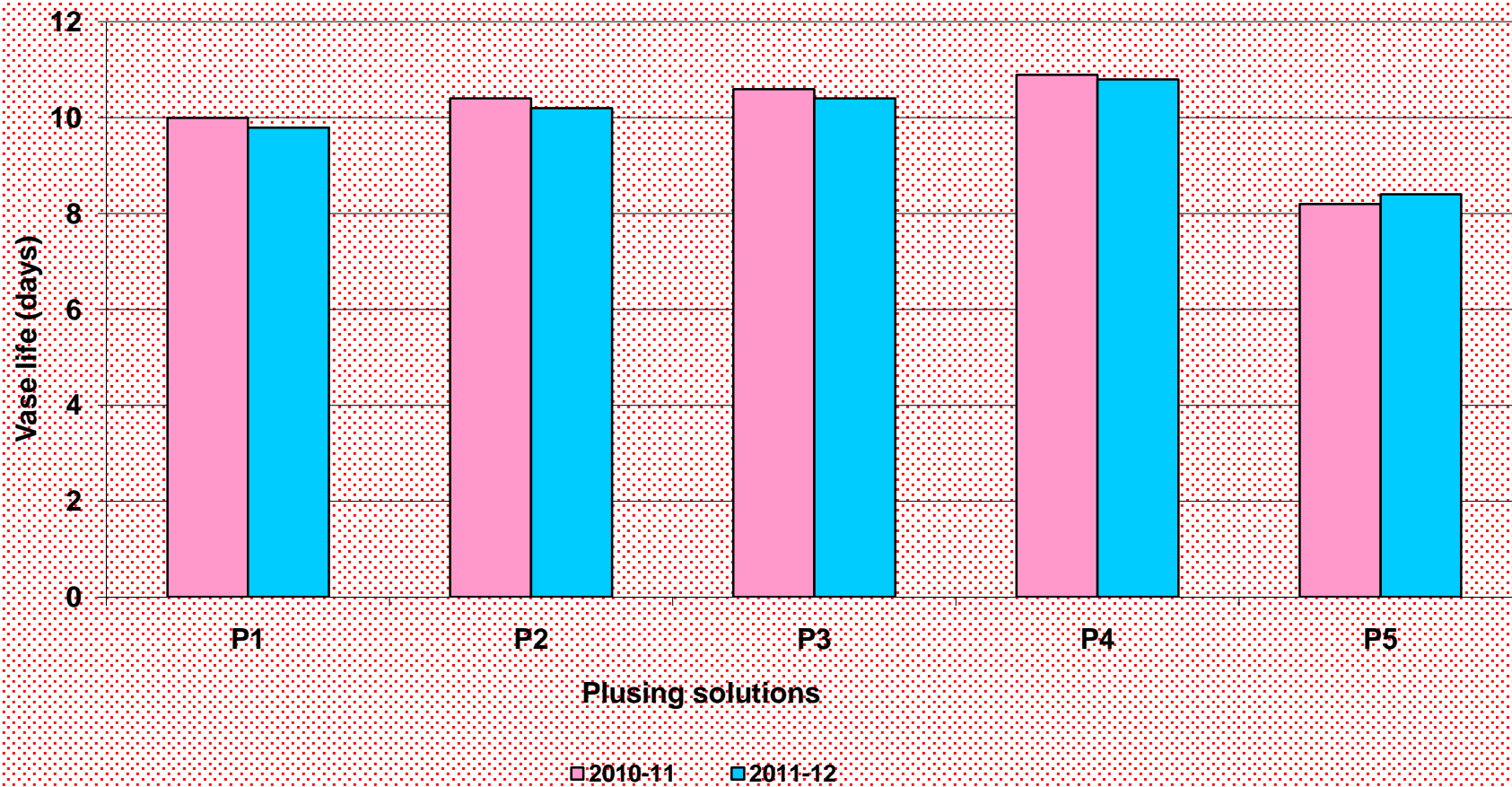


Table : 29 Effect of different pulsing solutions on overall quality of gerbera (*Gerbera jameSsonii*) cv. Stanza

Treatments	Initial (0 th) day		2 nd day		4 th day		6 th day		8 th day		10 th day	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
P₁: Sucrose 5%	5	5	5	5	5	5	4	4	2	2	1	1
P₂: Sucrose 10%	5	5	5	5	5	5	4	4	3	3	2	2
P₃: Ascorbic acid 250 mg/l + Sucrose 10%	5	5	5	5	5	5	5	5	4	4	3	3
P₄: 8 HQC 250 mg/l + Sucrose 10%	5	5	5	5	5	5	5	5	5	5	4	4
P₅: Control	5	5	5	5	4	4	2	2	1	1	*	*

Note : * Indicate vase life was completed

Where,

1	Dull/Flaccid
2	Poor
3	Fair
4	Very good
5	Excellent



Plate-IV : Effect of harvest stage and stalk length of gerbera cv. Stanza at 4th day



Plate-V : Effect of pulsing solution of gerbera cv. Stanza at 6th day



Plate-VI : Effect of holding solution of gerbera cv. Stanza 8th day

Experiment : III Effect of holding solution on post harvest life of gerbera cv. Stanza

4.3.1 Quantitative Parameter

4.3.1.1 Change in Fresh Weight (gm) at Every Alternate Day

The data on change in fresh weight as influenced by different holding solutions on initial, 2nd, 4th, 6th, 8th, 10th and 12th day are presented in Table 30.

The data presented in Table 30 clearly indicated that the fresh weight of cut gerbera had non-significant effect during initial and 2nd day.

The data clearly showed significant difference among different holding solutions on fresh weight of Gerbera (*Gerbera jamesonii*) cv. Stanza on 4th, 6th, 8th, 10th and 12th day during vase life. Significantly maximum fresh weight (gm) on 4th, 6th and 8th day was observed in cut flowers kept in solution containing Citric acid 300 mg/l + Sucrose 2 % H₁ (115.08 gm, 111.66 gm and 104.68 gm, respectively) which was at par with H₂ (112.22 gm, 108.59 gm and 101.08 gm, respectively) and H₈ (112.05 gm, 108.14 gm and 100.00 gm, respectively) in 2011-12. Mean data presented in Table 30 clearly showed that at 10th and 12th day higher fresh weight was observed with Citric acid 300 mg/l + Sucrose 2 % (87.66 gm and 67.99 gm) which was followed by Citric acid 500 mg/l + Sucrose 2 % in 2011-12. However, minimum fresh weight (gm) was observed in control. More or less similar result was observed in 2010-11 and in pooled analysis.

Table : 30 Effect of different holding solutions on change in fresh weight (gm) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Fresh weight (gm) at initial (0 th) day			Fresh weight (gm) at 2 nd day			Fresh weight (gm) at 4 th day			Fresh weight (gm) at 6 th day		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
H₁ : Citric acid 300 mg/l + Sucrose 2%	102.46	101.82	102.14	116.69	115.78	116.24	115.99	115.08	115.54	112.41	111.66	112.04
H₂ : Citric acid 500 mg/l + Sucrose 2%	101.65	100.25	100.95	115.13	113.75	114.44	113.44	112.22	112.83	109.47	108.59	109.03
H₃ : GA₃ 10 mg/l + Sucrose 2%	100.76	102.01	101.39	111.54	112.87	112.21	108.33	109.66	109.00	103.13	104.25	103.69
H₄ : GA₃ 20 mg/l + Sucrose 2%	102.23	101.13	101.68	112.23	111.36	111.80	108.60	107.7	108.15	102.85	101.78	102.32
H₅ : Spermine 50 mg/l + Sucrose 2%	101.52	101.67	101.60	110.75	110.87	110.81	106.71	106.96	106.84	100.04	100.14	100.09
H₆ : Spermine 100 mg/l + Sucrose 2%	100.84	101.44	101.14	110.51	111.04	110.78	106.70	107.18	106.94	100.39	100.93	100.66
H₇ : 8-HQ 100mg/l + Sucrose 2%	101.97	102.11	102.04	113.54	113.61	113.58	110.65	110.69	110.67	106.02	106.19	106.11
H₈ : 8-HQ 200mg/l + Sucrose 2%	102.11	102.87	102.49	114.13	114.83	114.48	111.40	112.05	111.73	107.30	108.14	107.72
H₉ : Control	101.38	100.96	101.17	109.65	109.26	109.46	102.78	102.47	102.63	93.02	92.87	92.95
S. Em. ±	1.44	1.62	1.084	2.08	2.14	1.490	1.696	1.291	1.066	1.477	1.556	1.073
C.D. at 5%	NS	NS	NS	NS	NS	NS	5.04	3.84	3.06	4.39	4.62	3.08
C.V.%	2.46	2.76	2.61	3.19	3.29	3.24	2.69	2.05	2.37	2.46	2.60	2.52
Pooled	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %
Y	0.511	N.S	2.61	0.703	N.S	3.24	0.502	N.S	2.37	0.506	N.S	2.52
Y×T	1.532	N.S		2.108	N.S		1.507	N.S		1.517	N.S	

Table : 30 Effect of different holding solutions on change in fresh weight (gm) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Fresh weight (gm) at 8 th day			Fresh weight (gm) at 10 th day*			Fresh weight (gm) at 12 th day*		
	Holding solution (H)	2010-11	2011-12	Pooled	2010-11	2011-12	Mean data	2010-11	2011-12
H ₁ : Citric acid 300 mg/l + Sucrose 2%	105.04	104.68	104.86	87.95	87.66	87.81	67.95	67.99	67.97
H ₂ : Citric acid 500 mg/l + Sucrose 2%	101.83	101.08	101.46	83.80	83.05	83.43	63.65	62.88	63.27
H ₃ : GA ₃ 10 mg/l + Sucrose 2%	93.93	95.28	94.61	71.67	72.64	72.16	****	****	****
H ₄ : GA ₃ 20 mg/l + Sucrose 2%	93.20	92.59	92.90	70.07	69.51	69.79	****	****	****
H ₅ : Spermine 50 mg/l + Sucrose 2%	90.31	90.03	90.17	65.03	64.48	64.76	****	****	****
H ₆ : Spermine 100 mg/l + Sucrose 2%	92.45	91.02	91.73	66.35	65.87	66.11	****	****	****
H ₇ : 8-HQ 100mg/l + Sucrose 2%	97.17	97.35	97.26	77.04	76.9	76.97	54.78	54.61	54.70
H ₈ : 8-HQ 200mg/l + Sucrose 2%	99.35	100	99.67	80.29	81.2	80.75	59.37	60	59.69
H ₉ : Control	86.45	79.52	82.98	****	****	****	****	****	****
S. Em. ±	1.726	2.111	1.364	****	****	****	****	****	****
C.D. at 5%	5.13	6.27	3.19	****	****	****	****	****	****
C.V.%	3.13	3.87	3.50	****	****	****	****	****	****
Pooled	SEm±	C.D. at 5%	C.V. %	****	****	****	****	****	****
Y	0.643	N.S	3.50	****	****	****	****	****	****
Y×T	1.929	N.S		****	****		****	****	

Note : * Not included in statistical analysis

4.3.1.2 Physiological Change in Weight (%)

The effect of different holding solutions on physiological change in weight (%) was recorded on 2nd, 4th, 6th, 8th, 10th and 12th day of vase life in gerbera cv. Stanza during year 2010-11, 2011-12 and pooled analysis. The data is depicted in Table 31 and in graphical form, in Figure 14.

The trend of data in Table 31 showed higher retention of fresh weight in Citric acid 300 mg/l + Sucrose 2 %, while control suffered maximum decrease in fresh weight.

During 2010-11, the data showed minimum physiological change in weight (13.89 %, -0.60 %, -3.09 %, -6.30 %, -16.50 % and -22.74 %) in cut gerbera cv. Stanza flowers kept in Citric acid 300 mg/l + Sucrose 2 % (H₁), which was followed by Citric acid 500 mg/l + Sucrose 2 % (H₂) at 2nd, 4th, 6th, 8th, 10th and 12th day, respectively.

More or less similar trend was observed during 2011-12 and in pooled analysis on physiological change in weight as influenced by different holding solutions in gerbera cv. Stanza.

4.3.1.3 Solution Uptake (ml)

Solution uptake of the gerbera flowers cv. Stanza was affected by different holding solutions is presented in Table 32 and realistically depicted in Figure 15.

In different holding solutions Citric acid 300 mg/l + Sucrose 2 % was found to be the best treatment, when compared with the other holding solutions and control, during the 2nd to 12th

Table : 31 Effect of different holding solutions on physiological change in weight (%) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Physiological change in weight (%) at 2 nd day			Physiological change in weight (%) at 4 th day			Physiological change in weight (%) at 6 th day		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
Holding solutions (H)									
H ₁ : Citric acid 300 mg/l + Sucrose 2%	13.89	13.71	13.80	- 0.60	- 0.60	- 0.60	- 3.09	- 2.97	- 3.03
H ₂ : Citric acid 500 mg/l + Sucrose 2%	13.26	13.47	13.36	- 1.47	- 1.35	- 1.41	- 3.50	- 3.23	- 3.37
H ₃ : GA ₃ 10 mg/l + Sucrose 2%	10.70	10.65	10.67	- 2.88	- 2.84	- 2.86	- 4.80	- 4.93	- 4.87
H ₄ : GA ₃ 20 mg/l + Sucrose 2%	9.78	10.12	9.95	- 3.23	- 3.29	- 3.26	- 5.29	- 5.50	- 5.40
H ₅ : Spermine 50 mg/l + Sucrose 2%	9.09	9.05	9.07	- 3.65	- 3.53	- 3.59	- 6.25	- 6.38	- 6.31
H ₆ : Spermine 100 mg/l + Sucrose 2%	9.59	9.46	9.53	- 3.45	- 3.48	- 3.46	- 5.91	- 5.83	- 5.87
H ₇ : 8-HQ 100mg/l + Sucrose 2%	11.35	11.26	11.30	- 2.55	- 2.57	- 2.56	- 4.18	- 4.07	- 4.12
H ₈ : 8-HQ 200mg/l + Sucrose 2%	11.77	11.63	11.70	- 2.39	- 2.42	- 2.41	- 3.68	- 3.49	- 3.58
H ₉ : Control	8.16	8.22	8.19	- 6.27	- 6.21	- 6.24	- 9.50	- 9.37	- 9.43
S. Em. ±	0.167	0.181	0.123	0.052	0.046	0.035	0.078	0.083	0.057
C.D. at 5%	0.50	0.54	0.35	0.15	0.14	0.10	0.23	0.25	0.16
C.V.%	2.67	2.88	2.77	3.06	2.70	2.88	2.64	2.82	2.73
Pooled	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %
Y	0.058	N.S	2.77	0.016	N.S	2.88	0.027	N.S	2.73
Y×T	0.174	N.S		0.049	N.S		0.081	N.S	

Note: Figures with negative (-ve) denote decrease in fresh weight (%)

Conti...

Table : 31 Effect of different holding solutions on physiological change in weight (%) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatment	Physiological change in weight (%) at 8 th day			Physiological change in weight (%) at 10 th day*			Physiological change in weight (%) at 12 th day*		
	2010-11	2011-12	Pooled	2010-11	2011-12	Mean data	2010-11	2011-12	Mean data
H ₁ : Citric acid 300 mg/l + Sucrose 2%	- 6.30	- 6.25	- 6.27	- 16.50	- 16.26	- 16.38	- 22.74	- 22.44	- 22.59
H ₂ : Citric acid 500 mg/l + Sucrose 2%	- 7.01	- 6.92	- 6.96	- 17.68	- 17.84	- 17.76	- 24.05	- 24.29	- 24.17
H ₃ : GA ₃ 10 mg/l + Sucrose 2%	- 8.92	- 8.60	- 8.76	- 23.70	- 23.76	- 23.73	****	****	****
H ₄ : GA ₃ 20 mg/l + Sucrose 2%	- 9.38	- 9.03	- 9.21	- 24.82	- 24.93	- 24.87	****	****	****
H ₅ : Spermine 50 mg/l + Sucrose 2%	- 10.01	- 10.10	- 10.05	- 27.77	- 28.38	- 28.07	****	****	****
H ₆ : Spermine 100 mg/l + Sucrose 2%	- 9.85	- 9.82	- 9.84	- 26.69	- 27.63	- 27.16	****	****	****
H ₇ : 8-HQ 100mg/l + Sucrose 2%	- 8.23	- 8.32	- 8.28	- 20.81	- 21.01	- 20.91	- 28.89	- 28.63	- 28.76
H ₈ : 8-HQ 200mg/l + Sucrose 2%	- 7.77	- 7.53	- 7.65	- 18.87	18.80	- 18.83	- 26.06	- 25.63	- 25.84
H ₉ : Control	- 14.21	- 14.37	- 14.29	****	****	****	****	****	****
S. Em. ±	0.113	0.125	0.084	****	****	****	****	****	****
C.D. at 5%	0.34	0.37	0.24	****	****	****	****	****	****
C.V.%	2.16	2.41	2.29	****	****	****	****	****	****
Pooled	SEm±	C.D. at 5%	C.V. %	****	****	****	****	****	****
Y	0.040	N.S	2.29	****	****	****	****	****	****
Y×T	0.119	N.S		****	****		****	****	

Note: Figures with negative (-ve) denote decrease in fresh weight (%)

Note : * Not included in statistical analysis

Fig-14: Effect of different holding solutions on physiological change in weight (%) of gerbera (*Gerbera jamsonii*) cv. Stanza (In Pooled analysis)

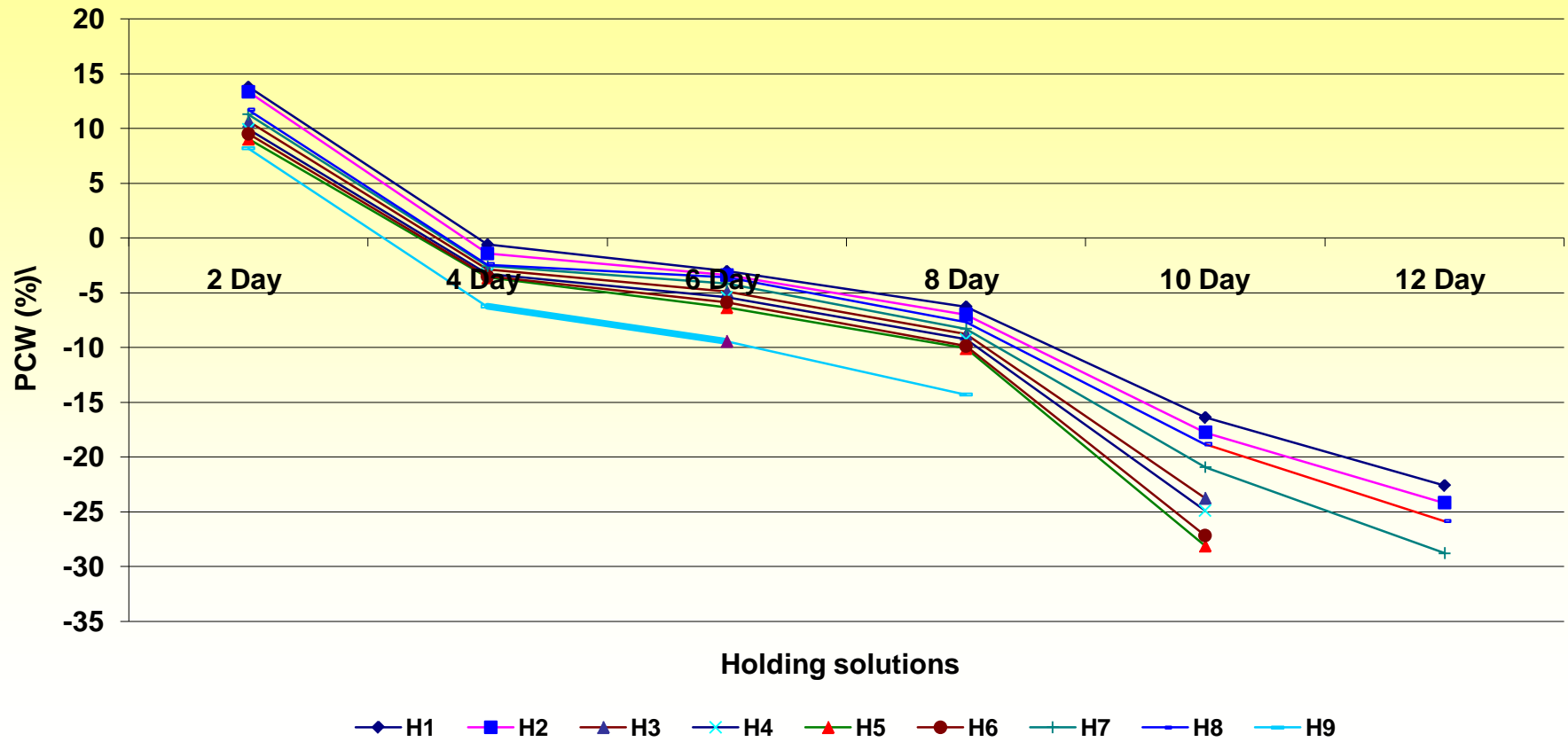


Table : 32 Effect of different holding solutions on solution uptake (ml) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Solution uptake at 2 nd day			Solution uptake at 4 th day			Solution uptake at 6 th day			Solution uptake at 8 th day		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
H₁ : Citric acid 300 mg/l + Sucrose 2%	51.19	50.97	51.08	50.65	50.55	50.60	48.32	48.27	48.30	45.25	45.44	45.35
H₂ : Citric acid 500 mg/l + Sucrose 2%	50.26	50.10	50.18	48.37	49.12	48.75	47.22	47.09	47.16	43.56	43.72	43.64
H₃ : GA₃ 10 mg/l + Sucrose 2%	45.67	46.52	46.10	44.32	45.05	44.69	43.47	44.15	43.81	38.41	37.65	38.03
H₄ : GA₃ 20 mg/l + Sucrose 2%	44.23	45.54	44.89	43.47	44.43	43.95	42.13	43.13	42.63	39.65	39.17	39.41
H₅ : Spermine 50 mg/l + Sucrose 2%	43.38	44.08	43.73	42.21	42.23	42.22	40.28	40.52	40.40	35.34	34.21	34.78
H₆ : Spermine 100 mg/l + Sucrose 2%	43.98	43.54	43.76	42.92	43.26	43.09	41.54	41.14	41.34	36.92	37.54	37.23
H₇ : 8-HQ 100mg/l + Sucrose 2%	47.45	48.19	47.82	46.54	47.87	47.21	44.42	45.56	44.99	40.41	41.22	40.82
H₈ : 8-HQ 200mg/l + Sucrose 2%	48.72	49.27	49.00	47.66	48.34	48.00	45.63	46.30	45.97	41.82	42.36	42.09
H₉ : Control	43.05	42.99	43.02	39.23	39	39.12	35.19	34.84	35.02	29.04	28.87	28.96
S. Em. ±	0.664	0.658	0.467	0.704	0.739	0.510	0.635	0.658	0.457	0.733	0.693	0.504
C.D. at 5%	1.97	1.96	1.34	2.09	2.19	1.46	1.89	1.96	1.31	2.18	2.06	1.45
C.V.%	2.48	2.44	2.46	2.71	2.81	2.56	2.55	2.62	2.58	3.26	3.08	3.17
Pooled	SEm ±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %
Y	0.220	N.S	2.46	0.241	N.S	2.56	0.216	N.S	2.58	0.238	N.S	3.17
Y×T	0.661	N.S		0.722	N.S		0.647	N.S		0.713	N.S	

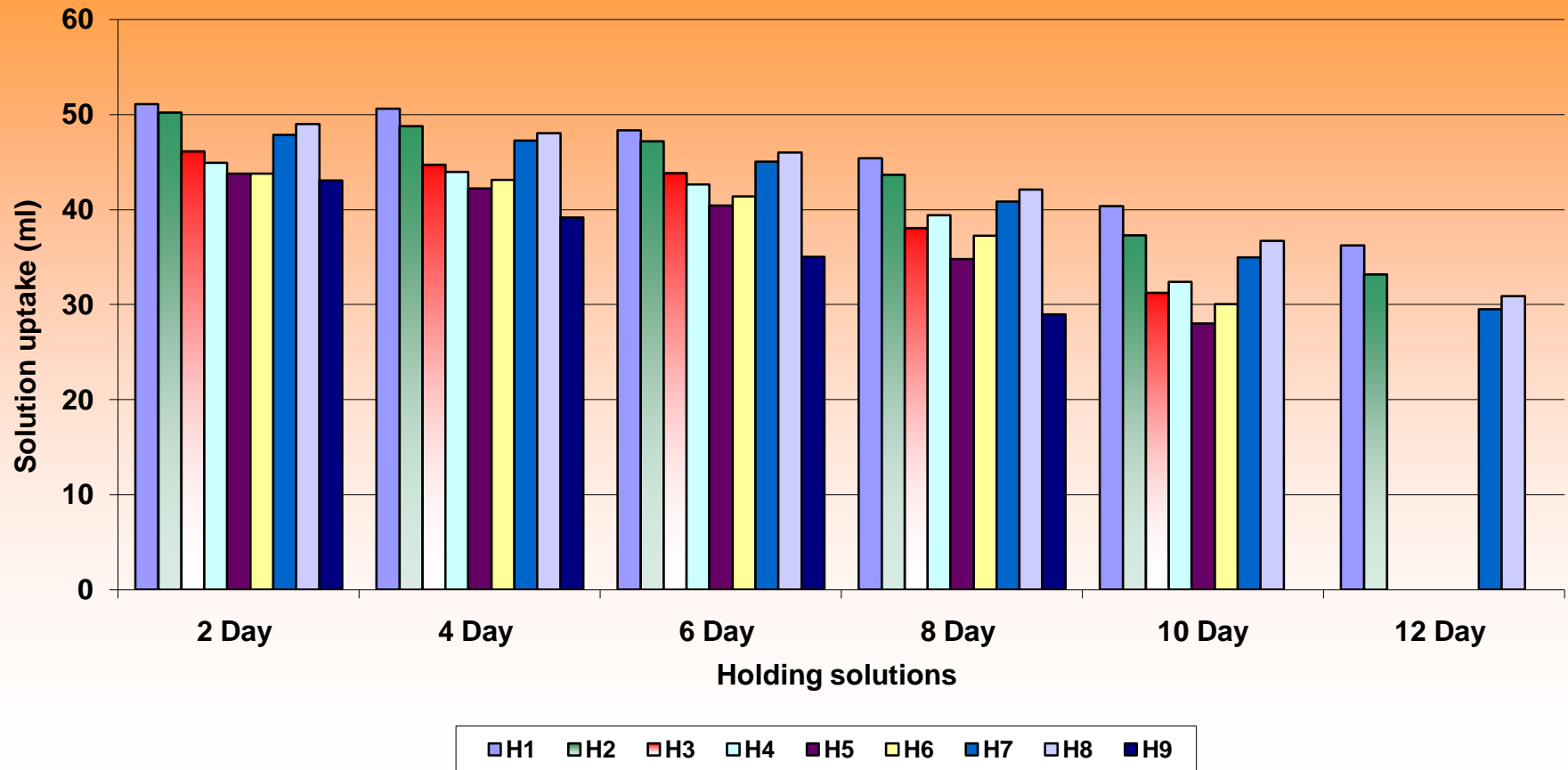
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Table : 32 Effect of different holding solutions on solution uptake (ml) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Solution uptake at 10 th day*			Solution uptake at 12 th day*			Total water up take (ml)		
	2010-11	2011-12	Mean data	2010-11	2011-12	Mean data	2010-11	2011-12	Pooled
H ₁ : Citric acid 300 mg/l + Sucrose 2%	40.26	40.37	40.32	36.27	36.18	36.23	271.94	271.73	271.84
H ₂ : Citric acid 500 mg/l + Sucrose 2%	37.34	37.19	37.27	32.98	33.34	33.16	259.73	260.56	260.15
H ₃ : GA ₃ 10 mg/l + Sucrose 2%	31.46	30.97	31.22	****	****	****	203.33	204.34	203.84
H ₄ : GA ₃ 20 mg/l + Sucrose 2%	33.28	31.45	32.37	****	****	****	202.76	203.72	203.24
H ₅ : Spermine 50 mg/l + Sucrose 2%	28.54	27.43	27.99	****	****	****	189.75	188.47	189.11
H ₆ : Spermine 100 mg/l + Sucrose 2%	30.81	29.18	30.00	****	****	****	196.17	194.66	195.42
H ₇ : 8-HQ 100mg/l + Sucrose 2%	34.64	35.27	34.96	29.82	29.14	29.48	243.28	247.25	245.27
H ₈ : 8-HQ 200mg/l + Sucrose 2%	36.32	37.09	36.71	30.26	31.45	30.86	250.41	254.81	252.61
H ₉ : Control	****	****	****	****	****	****	146.51	145.70	146.11
S. Em. ±	****	****	****	****	****	****	5.323	6.264	4.110
C.D. at 5%	****	****	****	****	****	****	15.82	18.61	11.79
C.V.%	****	****	****	****	****	****	4.23	4.95	4.59
Pooled	****	****	****	****	****	****	SEm±	C.D. at 5%	C.V. %
Y	****	****	****	****	****	****	1.938	N.S	4.59
Y×T	****	****		****	****	****	5.813	N.S	

Note : * Not included in statistical analysis

Fig-15 : Effect of different holding solutions on solution uptake (ml) of gerbera (Gerbera jamsonii) cv. Stanza (In pooled analysis)



day period of vase life. The same trend was followed throughout the vase life period.

Maximum solution up take at 2nd, 4th, 6th, 8th, 10th, 12th and total solution up take was observed with Citric acid 300 mg/l + Sucrose 2 % i.e. 51.08 ml, 50.60 ml, 48.30 ml, 45.35 ml, 40.32 ml, 36.23 ml and 271.84 ml, respectively in pooled analysis which was followed by Citric acid 500 mg/l + Sucrose 2 %. At 10th and 12th day mean data was presented. More or less similar result was observed in both the year for solution up take in gerbera cv. Stanza.

4.3.1.4 Membrane Stability Index (%) in Petals

The data pertaining to membrane stability index (MSI) in petals was recorded periodically at 4th and 8th day as influenced by different holding solutions are presented in Table 33 and graphically illustrated in Figure 16 .

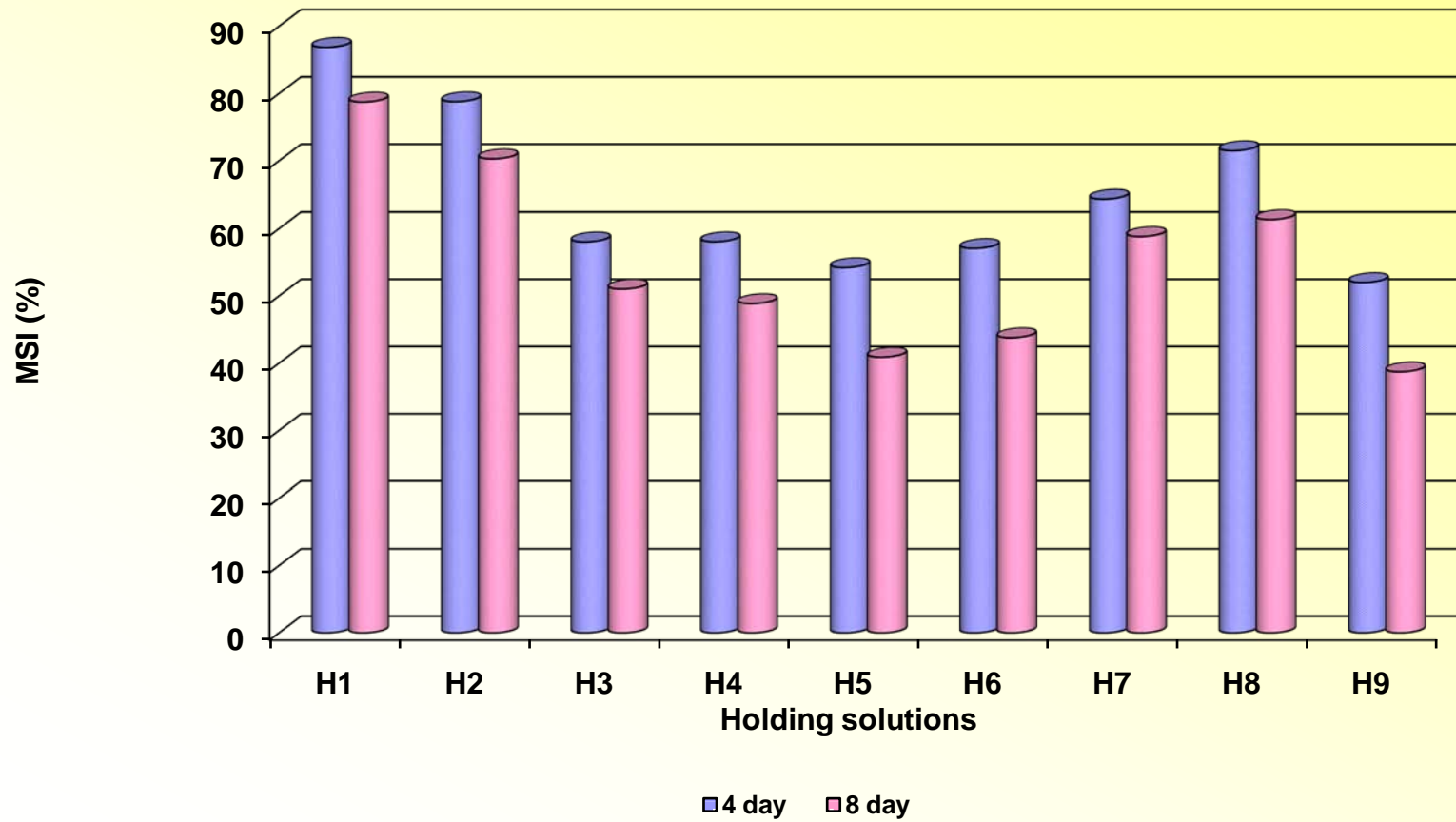
The data clearly indicated that membrane stability index was progressively decreased with advancement of flower stage at 4th and 8th day.

The data in the Table 33 revealed that membrane stability index was differed significantly due to different holding solutions in gerbera cv. Stanza cut flowers at 4th and 8th day during 2010-11, 2011-12 and in pooled analysis, significantly higher MSI was observed with Citric acid 300 mg/l + Sucrose 2 % (86.31 %, 87.42 % and 86.87 %, and 78.45 %, 79.02 % and 78.74 %) which was followed by Citric acid 500 mg/l + Sucrose 2 %, at 4th and 8th day in 2010-11, 2011-12 and in pooled analysis, respectively.

Table : 33 Effect of different holding solutions on membrane stability index (%) in petals of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	MSI (%) at 4 th day			MSI (%) at 8 th day		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
Holding solution (H)						
H₁ : Citric acid 300 mg/l + Sucrose 2%	86.31	87.42	86.87	78.45	79.02	78.74
H₂ : Citric acid 500 mg/l + Sucrose 2%	78.33	79.25	78.79	69.23	71.34	70.29
H₃ : GA₃ 10 mg/l + Sucrose 2%	58.76	57.31	58.04	50.67	51.37	51.02
H₄ : GA₃ 20 mg/l + Sucrose 2%	58.00	58.11	58.06	48.00	49.72	48.86
H₅ : Spermine 50 mg/l + Sucrose 2%	54.42	53.98	54.20	40.75	41.05	40.90
H₆ : Spermine 100 mg/l + Sucrose 2%	57.33	56.78	57.06	44.33	43.25	43.79
H₇ : 8-HQ 100mg/l + Sucrose 2%	63.23	65.54	64.39	59.33	58.33	58.83
H₈ : 8-HQ 200mg/l + Sucrose 2%	70.65	72.34	71.50	60.14	62.56	61.35
H₉ : Control	52.52	51.45	51.99	39.00	38.43	38.72
S. Em. ±	0.964	0.824	0.634	0.999	0.872	0.663
C.D. at 5%	2.86	2.45	1.82	2.97	2.59	1.90
C.V.%	2.59	2.21	2.39	3.18	2.75	3.02
Pooled	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %
Y	0.299	N.S	2.39	0.312	N.S	3.02
Y×T	0.897	N.S		0.937	N.S	

Fig-16 : Effect of different holding solutions on membrane stability index (%) in petals of gerbera (*Gerbera jamesonii*) cv. Stanza at 4th and 8th day (In pooled analysis)



4.3.1.5 Total Dissolved Solutes (TDS) (°B)

The mean data on total dissolved solutes (TDS) in petals was recorded at 4th day as influenced by different holding solutions are presented in Table 34 and graphically illustrated in Figure 17.

Total dissolved solutes (°B) were differed significantly due to different holding solutions during at 4th day in cut flowers of gerbera cv. Stanza during both years and in pooled analysis. Significantly higher TDS (14.31°B, 14.52°B and 14.42°B) was observed with Citric acid 300 mg/l + Sucrose 2 % (H₁) which was at par with Citric acid 500 mg/l + Sucrose 2 % (14.03°B, 14.14°B and 14.09°B) at 4th during both the years and in pooled analysis, respectively.

Minimum total dissolved solutes (°B) was revealed in control (6.51°B, 7.08°B and 6.80°B) at 4th day during both the years and in pooled analysis, respectively in gerbera cv. Stanza.

4.3.1.6 Dry Weight (%)

The data concerned with dry weight (%) affected due to different holding solutions in gerbera cv. Stanza are furnished in Table 35.

Looking to the data, treatment H₁ (Citric acid 300 mg/l + Sucrose 2 %) being 9.11%, 9.08% and 9.10% was significantly superior for dry weight (%) as compared to other treatments as well as control which was at par with H₂ (Citric acid 500 mg/l + Sucrose 2 %), H₈ (8 HQ 200 mg/l + Sucrose 2 %), H₇ (8 HQ 100

Table : 34 Effect of different holding solutions on total dissolved solutes (TDS) (°B) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments Holding solution (H)	TDS (°B) at 4 th day		
	2010-11	2011-12	Pooled
H ₁ : Citric acid 300 mg/l + Sucrose 2%	14.31	14.52	14.42
H ₂ : Citric acid 500 mg/l + Sucrose 2%	14.03	14.14	14.09
H ₃ : GA ₃ 10 mg/l + Sucrose 2%	12.12	12.04	12.08
H ₄ : GA ₃ 20 mg/l + Sucrose 2%	12.53	12.67	12.60
H ₅ : Spermine 50 mg/l + Sucrose 2%	10.37	10.25	10.31
H ₆ : Spermine 100 mg/l + Sucrose 2%	11.84	11.86	11.85
H ₇ : 8-HQ 100mg/l + Sucrose 2%	12.86	12.79	12.83
H ₈ : 8-HQ 200mg/l + Sucrose 2%	13.15	12.91	13.03
H ₉ : Control	6.51	7.08	6.80
S. Em. ±	0.156	0.174	0.117
C.D. at 5%	0.46	0.52	0.34
C.V. %	2.26	2.51	2.88
Pooled	SEm±	C.D. at 5%	C.V. %
Y	0.055	N.S	2.88
Y×T	0.165	N.S	

Fig-17: Effect of different holding solutions on total dissolved solutes (TDS) (°B) of gerbera (*Gerbera jamesonii*) cv. Stanza at 4th day (In pooled analysis)

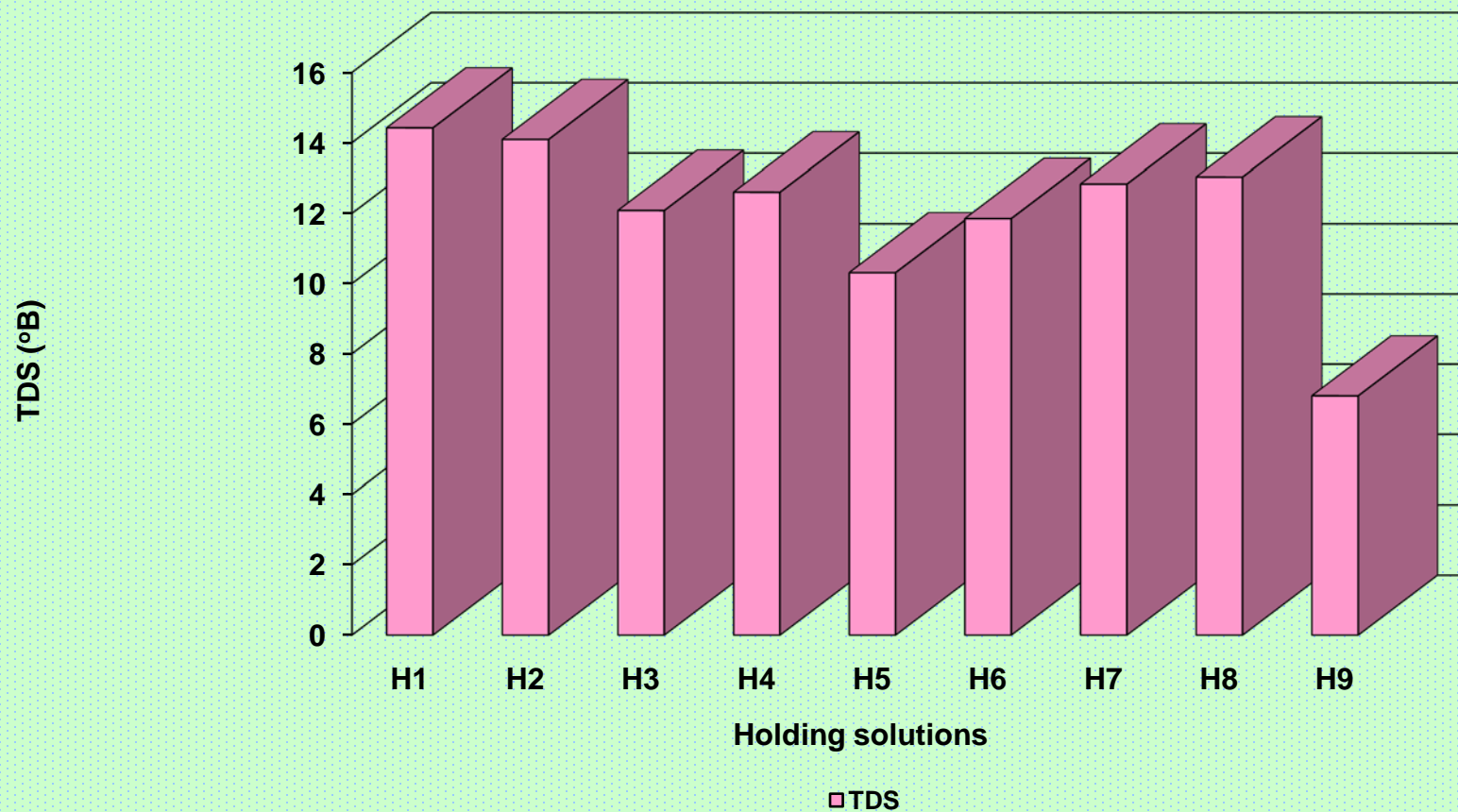


Fig-18 : Effect of different holding solutions on flower size (cm) of gerbera (*Gerbera jamesonii*) cv. Stanza (In pooled analysis)

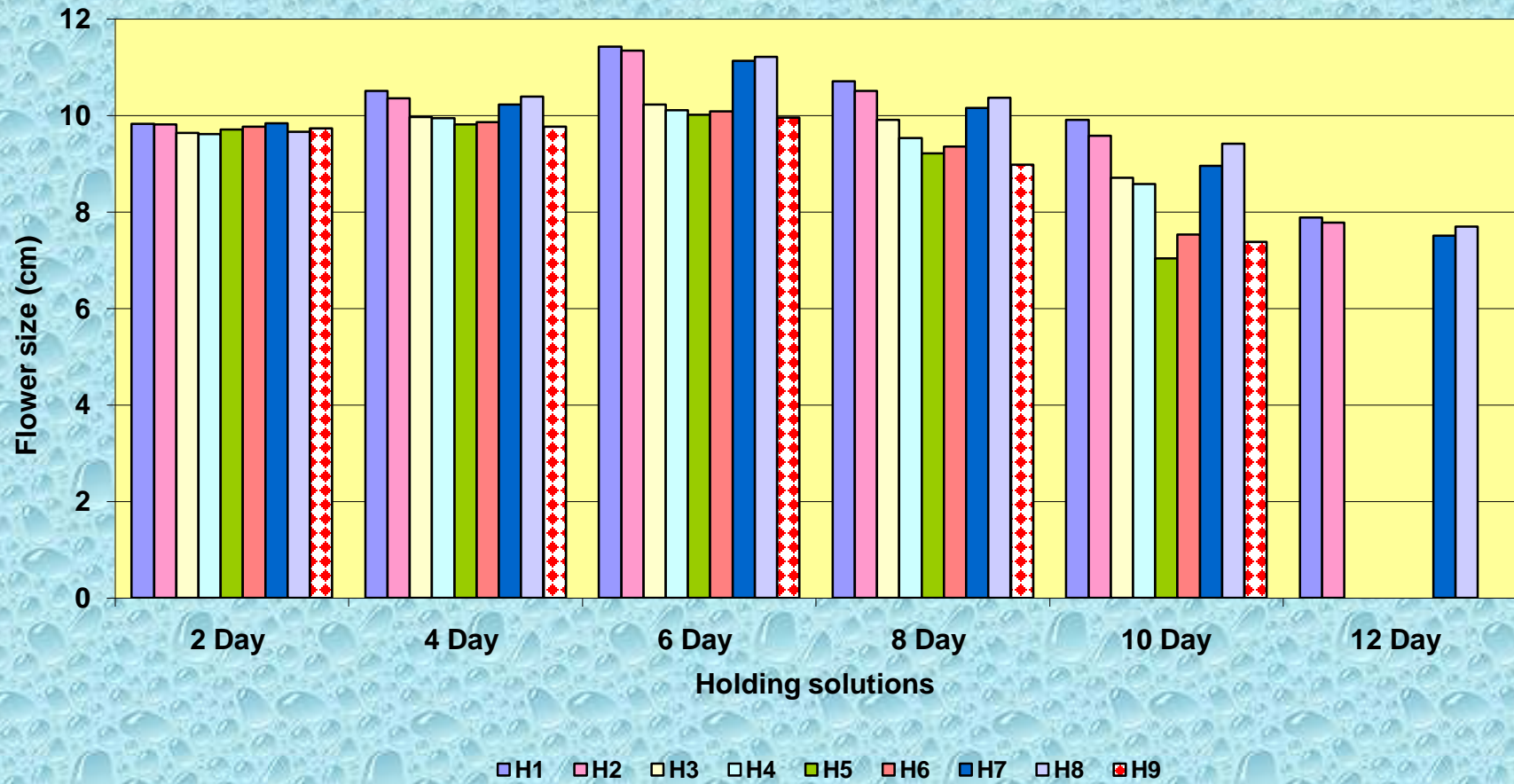


Table : 35 Effect of different holding solutions on dry weight (%) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Dry weight (%)		
	2010-11	2011-12	Pooled
Holding solution (H)			
H₁ : Citric acid 300 mg/l + Sucrose 2%	9.11	9.08	9.10
H₂ : Citric acid 500 mg/l + Sucrose 2%	9.04	9.02	9.03
H₃ : GA₃ 10 mg/l + Sucrose 2%	8.91	8.90	8.91
H₄ : GA₃ 20 mg/l + Sucrose 2%	8.76	8.82	8.79
H₅ : Spermine 50 mg/l + Sucrose 2%	8.58	8.52	8.55
H₆ : Spermine 100 mg/l + Sucrose 2%	8.68	8.61	8.65
H₇ : 8-HQ 100mg/l + Sucrose 2%	8.96	8.92	8.94
H₈ : 8-HQ 200mg/l + Sucrose 2%	9.02	8.98	9.00
H₉ : Control	7.29	7.19	7.24
S. Em. ±	0.133	0.121	0.090
C.D. at 5%	0.39	0.36	0.26
C.V. %	2.64	2.42	2.53
Pooled	SEm±	C.D. at 5%	C.V. %
Y	0.042	N.S	2.53
Y×T	0.127	N.S	

mg/l + Sucrose 2 %), H₃ (GA₃ 5 mg/l + Sucrose 2 %) at 4th day during 2010-11, 2011-12 and in pooled analysis, respectively.

4.3.2 Qualitative Parameter

4.3.2.1 Flower Size (cm)

The data given in Table 36 and graphically drawn in Figure 18 revealed that flower size (cm) was significantly influenced by different holding solutions at 2nd, 4th, 6th, 8th, 10th and 12th day during both the year and in pooled analysis.

At initial day flower size was given non-significant.

At 2nd day, flower kept in Citric acid 300 mg/l + Sucrose 2 % solution H₁, recorded maximum flower size (10.30 cm, 10.71 cm and 10.51 cm) which was at par with Citric acid 500 mg/l + Sucrose 2 %, 8-HQ 200 mg/l + Sucrose 2 % and 8-HQ 100 mg/l + Sucrose 2 % during 2010-11, 2011-12 and in pooled analysis, respectively. Similar result was observed at 4th day.

At 6th day, maximum flower size (cm) was observed with Citric acid 300 mg/l + Sucrose 2 % solution H₁, (10.66cm, 10.74cm and 10.70cm) which was at par with Citric acid 500 mg/l + Sucrose 2 % during 2010-11, 2011-12 and in pooled analysis, respectively. Similar result was observed at 8th day.

At 10th day mean data show maximum flower size was observed with Citric acid 300 mg/l + Sucrose 2 % (8.74 cm, 8.82 cm and 8.74 cm) in both the year and in mean data. Similar result was observed at 12th day.

Table : 36 Effect of different holding solutions on flower size (cm) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Flower size at initial (0 th) day			Flower size at 2 nd day			Flower size at 4 th day			Flower size at 6 th day		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
H₁ : Citric acid 300 mg/l + Sucrose 2%	9.72	9.91	9.82	10.30	10.71	10.51	11.39	11.45	11.42	10.66	10.74	10.70
H₂ : Citric acid 500 mg/l + Sucrose 2%	9.74	9.87	9.81	10.28	10.42	10.35	11.30	11.38	11.34	10.49	10.51	10.50
H₃ : GA₃ 10 mg/l + Sucrose 2%	9.52	9.76	9.64	9.91	10.01	9.96	10.28	10.15	10.22	9.91	9.89	9.90
H₄ : GA₃ 20 mg/l + Sucrose 2%	9.50	9.71	9.61	9.89	9.99	9.94	10.17	10.04	10.11	9.57	9.48	9.53
H₅ : Spermine 50 mg/l + Sucrose 2%	9.76	9.63	9.70	9.83	9.78	9.81	10.09	9.92	10.01	9.27	9.15	9.21
H₆ : Spermine 100 mg/l + Sucrose 2%	9.73	9.78	9.76	9.85	9.87	9.86	10.15	10.00	10.08	9.45	9.24	9.35
H₇ : 8-HQ 100mg/l + Sucrose 2%	9.84	9.81	9.83	10.28	10.15	10.22	11.16	11.09	11.13	10.18	10.11	10.15
H₈ : 8-HQ 200mg/l + Sucrose 2%	9.62	9.69	9.66	10.36	10.41	10.39	11.30	11.12	11.21	10.38	10.35	10.37
H₉ : Control	9.67	9.78	9.73	9.81	9.72	9.77	10.01	9.89	9.95	9.04	8.92	8.98
S. Em. ±	0.139	0.173	0.111	0.127	0.174	0.108	0.179	0.139	0.113	0.156	0.128	0.101
C.D. at 5%	NS	NS	NS	0.38	0.52	0.31	0.53	0.41	0.32	0.46	0.38	0.29
C.V.%	2.48	3.07	2.78	2.19	2.97	2.58	2.91	2.27	2.54	2.73	2.25	2.99
Pooled	SEm ±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %	SEm ±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %
Y	0.052	N.S	2.78	0.051	N.S	2.58	0.053	N.S	2.54	0.047	N.S	2.99
Y×T	0.157	N.S		0.152	N.S		0.160	N.S		0.142	N.S	

Conti...

Table : 36 Effect of different holding solutions on flower size (cm) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Flower size at 8 th day			Flower size at 10 th day*			Flower size at 12 th day*		
	Holding solution (H)	2010-11	2011-12	Pooled	2010-11	2011-12	Mean data	2010-11	2011-12
H ₁ : Citric acid 300 mg/l + Sucrose 2%	9.89	9.91	9.90	8.74	8.82	8.78	7.86	7.89	7.88
H ₂ : Citric acid 500 mg/l + Sucrose 2%	9.54	9.61	9.58	8.62	8.70	8.66	7.76	7.80	7.78
H ₃ : GA ₃ 10 mg/l + Sucrose 2%	8.74	8.65	8.70	7.87	7.67	7.77	****	****	****
H ₄ : GA ₃ 20 mg/l + Sucrose 2%	8.62	8.54	8.58	7.86	7.58	7.72	****	****	****
H ₅ : Spermine 50 mg/l + sucrose 2%	7.06	7.01	7.04	6.19	6.12	6.16	****	****	****
H ₆ : Spermine 100 mg/l + Sucrose 2%	7.62	7.44	7.53	6.66	6.53	6.60	****	****	****
H ₇ : 8-HQ 100mg/l + Sucrose 2%	8.98	8.92	8.95	8.03	7.89	7.96	7.52	7.49	7.51
H ₈ : 8-HQ 200mg/l + Sucrose 2%	9.42	9.39	9.41	8.75	8.71	8.73	7.70	7.68	7.69
H ₉ : Control	7.43	7.32	7.38	****	****	****	****	****	****
S. Em. ±	0.146	0.139	0.101	****	****	****	****	****	****
C.D. at 5%	0.43	0.41	0.29	****	****	****	****	****	****
C.V.%	2.95	2.82	2.89	****	****	****	****	****	****
Pooled	SEm±	C.D. at 5%	C.V. %	****	****	****	****	****	****
Y	0.048	N.S	2.89	****	****	****	****	****	****
Y×T	0.143	N.S		****	****		****	****	

Note : * Not included in statistical analysis

4.3.2.2 Scape Bending Curvature ($^{\circ}$) (4th and 8th day)

The data noted for scape bending curvature ($^{\circ}$) in gerbera cv. Stanza cut flowers are recorded at 4th and 8th day during both the years and in pooled analysis are depicted in Table 37 and graphically in Figure 19.

The statistical analysis of data revealed that the scape bending curvature ($^{\circ}$) was significantly, influenced with the application of different holding solution in gerbera cv. Stanza.

Treatment H₁ (Citric acid 300 mg/l + sucrose 2 % solution), recorded minimum scape bending curvature (10.41 $^{\circ}$ to 25.04 $^{\circ}$), which was at par with Treatment H₂ (10.59 $^{\circ}$ to 26.13 $^{\circ}$) and Treatment H₈ (10.90 $^{\circ}$ to 26.65 $^{\circ}$) in pooled analysis at 4th to 6th day in pooled analysis, respectively.

Maximum scape bending curvature observed in treatment H₉ (control) i.e. 28.24 $^{\circ}$ to 96.71 $^{\circ}$ in pooled analysis at 4th to 6th day in pooled analysis, respectively.

Similar result for scape bending curvature observed was shown in both the years of experiment.

4.3.2.3 Pigment Content (Anthocyanin)

The data pertaining to anthocyanin content in gerbera cv. Stanza at 4th and 8th day during 2010-11, 2011-12 and in pooled analysis are depicted in Table 38 and graphically in Figure 19.

Looking to the data, treatment H₁ (Citric acid 300 mg/l + Sucrose 2 %) being 0.21 mg/gm to 0.63 mg/gm, which was followed by H₂ (Citric acid 300 mg/l + Sucrose 2 %) being

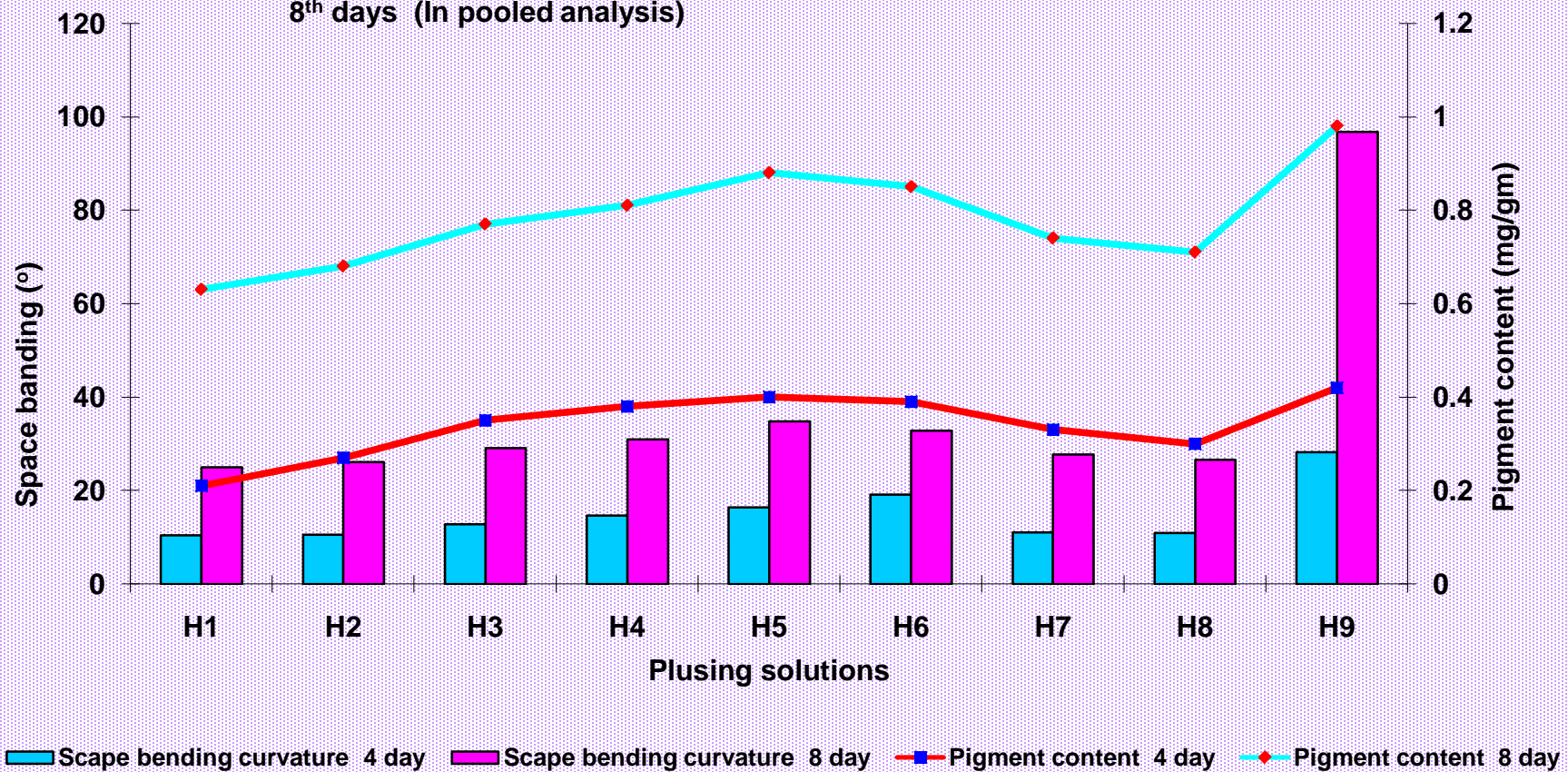
Table : 37 Effect of different holding solution on scape bending curvature ($^{\circ}$) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Scape bending curvature ($^{\circ}$) at 4 th day			Scape bending curvature ($^{\circ}$) at 8 th day		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
Holding solution (H)						
H₁ : Citric acid 300 mg/l + Sucrose 2%	10.34	10.48	10.41	24.92	25.17	25.04
H₂ : Citric acid 500 mg/l + Sucrose 2%	10.62	10.55	10.59	26.30	25.96	26.13
H₃ : GA₃ 10 mg/l + Sucrose 2%	12.44	13.07	12.76	28.45	29.87	29.16
H₄ : GA₃ 20 mg/l + Sucrose 2%	14.25	15.14	14.70	30.14	31.71	30.93
H₅ : Spermine 50 mg/l + Sucrose 2%	16.54	16.33	16.44	34.28	35.34	34.81
H₆ : Spermine 100 mg/l + Sucrose 2%	19.13	19.24	19.19	32.40	33.26	32.83
H₇ : 8-HQ 100mg/l + Sucrose 2%	10.98	11.10	11.04	27.40	28.14	27.77
H₈ : 8-HQ 200mg/l + Sucrose 2%	10.83	10.96	10.90	26.82	26.88	26.65
H₉ : Control	28.12	28.35	28.24	95.54	96.87	96.71
S. Em. \pm	0.214	0.261	0.168	0.826	0.797	0.567
C.D. at 5%	0.63	0.78	0.48	2.45	2.37	1.62
C.V.%	2.50	3.00	2.75	3.94	3.71	3.78
Pooled	SEm \pm	C.D. at 5%	C.V. %	SEm \pm	C.D. at 5%	C.V. %
Y	0.080	N.S	2.75	0.267	N.S	3.78
Y\timesT	0.239	N.S		0.800	N.S	

Table : 38 Effect of different holding solutions on pigment content (anthocyanin) (mg/gm) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Pigment content (mg/gm) at 4 th day			Pigment content (mg/gm) at 8 th day		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
H₁ : Citric acid 300 mg/l + Sucrose 2%	0.20	0.21	0.21	0.62	0.64	0.63
H₂ : Citric acid 500 mg/l + Sucrose 2%	0.28	0.26	0.27	0.68	0.69	0.68
H₃ : GA₃ 10 mg/l + Sucrose 2%	0.35	0.34	0.35	0.78	0.76	0.77
H₄ : GA₃ 20 mg/l + Sucrose 2%	0.37	0.38	0.38	0.81	0.80	0.81
H₅ : Spermine 50 mg/l + Sucrose 2%	0.40	0.40	0.40	0.86	0.89	0.88
H₆ : Spermine 100 mg/l + Sucrose 2%	0.39	0.38	0.39	0.84	0.86	0.85
H₇ : 8-HQ 100mg/l + Sucrose 2%	0.32	0.33	0.33	0.74	0.73	0.74
H₈ : 8-HQ 200mg/l + Sucrose 2%	0.30	0.29	0.30	0.71	0.70	0.71
H₉ : Control	0.42	0.41	0.42	0.97	0.98	0.98
S. Em. ±	0.005	0.006	0.004	0.013	0.013	0.009
C.D. at 5%	0.02	0.02	0.01	0.04	0.04	0.03
C.V.%	2.67	3.00	2.83	2.79	2.88	2.84
Pooled	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %
Y	0.002	N.S	2.83	0.004	N.S	2.84
Y×T	0.005	N.S		0.013	N.S	

Fig-19 : Effect of different holding solution on scape bending curvature ($^{\circ}$) and pigment content (mg/gm) of gerbera (*Gerbera jamesonii*) cv. Stanza at 4th and 8th days (In pooled analysis)



0.27 mg/gm to 0.68 mg/gm, maximum anthocyanin content showed in H₉ (control) being 0.42 mg/gm to 0.98 mg/gm as at 4th to 8th day in pooled analysis.

Similar drift was observed in both the years of experiment in gerbera cv. Stanza for anthocyanin pigment.

4.3.2.4 Disease Incidence.

There was no disease incidence on visual basis found in all holding solution.

4.3.3 Vase Life (days) and Overall Quality

4.3.3.1 Vase Life (days)

The effect of different holding solutions on vase life was recorded and mentioned in Table 39 and graphically demonstrated in Figure 20.

Different holding solutions significantly influence vase life of gerbera cv. Stanza. The maximum vase life of gerbera cv. Stanza was recorded in Citric acid 300 mg/l + Sucrose 2 % (H₁; 13.20, 13.00 and 13.10 days) which was at par with citric acid 500 mg/l + Sucrose 2 % (H₂; 12.80, 12.80 and 12.80 days). However, minimum vase life observed with control (H₉; 9.20, 8.53 and 8.87 days) in 2010-11, 2011-12 and in pooled analysis, respectively.

4.3.3.2 Quality Assessments: (on visual basis, 5 point scale)

The effect of holding solutions on overall quality of flower was visually examined on 2th, 4th, 6th, 8th, 10th and 12th day on the basis of freshness, turgidity and overall acceptability and

Table : 39 Effect of different holding solutions on vase life (days) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Vase life (days)		
	2010-11	2011-12	Pooled
Holding solution (H)			
H₁ : Citric acid 300 mg/l + Sucrose 2%	13.20	13.00	13.10
H₂ : Citric acid 500 mg/l + Sucrose 2%	12.80	12.80	12.80
H₃ : GA₃ 10 mg/l + Sucrose 2%	11.60	11.80	11.70
H₄ : GA₃ 20 mg/l + Sucrose 2%	11.20	11.20	11.20
H₅ : Spermine 50 mg/l + Sucrose 2%	10.60	10.40	10.50
H₆ : Spermine 100 mg/l + Sucrose 2%	10.80	10.60	10.70
H₇ : 8-HQ 100mg/l + Sucrose 2%	12.00	12.13	12.07
H₈ : 8-HQ 200mg/l + Sucrose 2%	12.20	12.33	12.27
H₉ : Control	9.20	8.53	8.87
S. Em. ±	0.204	0.192	0.140
C.D. at 5%	0.61	0.57	0.40
C.V.%	3.06	2.92	2.99
Pooled	SEm±	C.D. at 5%	C.V. %
Y	0.066	N.S	2.99
Y×T	0.198	N.S	

Fig-20 : Effect of different holding solutions on vase life (days) of gerbera (*Gerbera jamesonii*) cv. Stanza (In pooled analysis)

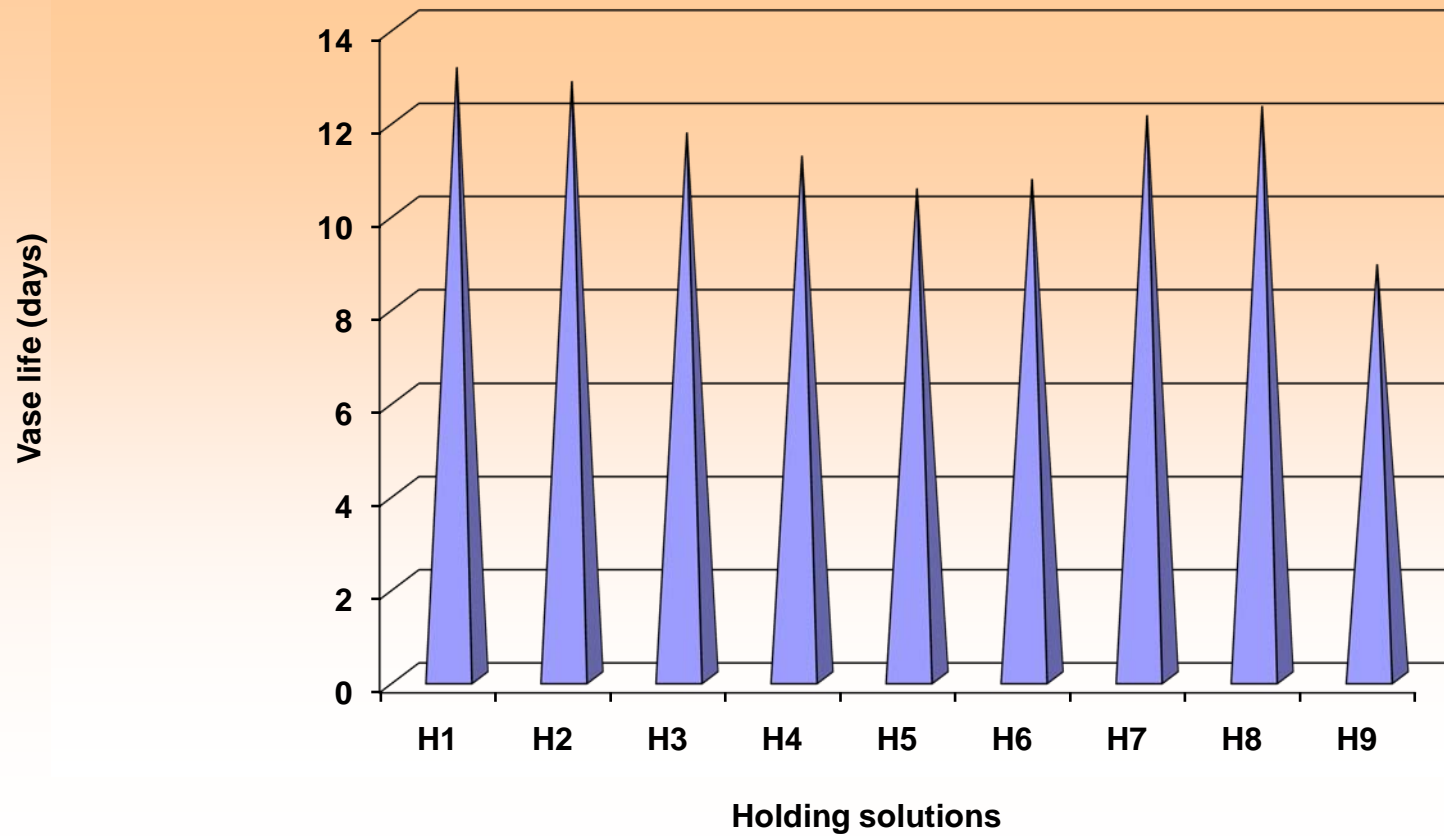


Table : 40 Effect of different holding solutions on overall quality of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	2 nd day		4 th day		6 th day		8 th day		10 th day		12 th day	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
H₁ : Citric acid 300 mg/l + Sucrose 2%	5	5	5	5	5	5	5	5	5	5	4	4
H₂ : Citric acid 500 mg/l + Sucrose 2%	5	5	5	5	5	5	5	5	4	4	3	3
H₃ : GA₃ 10 mg/l + Sucrose 2%	5	5	5	5	4	4	3	3	2	2	*	*
H₄ : GA₃ 20 mg/l + Sucrose 2%	5	5	5	5	4	4	3	3	2	2	*	*
H₅ : Spermine 50 mg/l + Sucrose 2%	5	5	4	4	3	3	2	2	1	1	*	*
H₆ : Spermine 100 mg/l + Sucrose 2%	5	5	4	4	4	4	2	2	1	1	*	*
H₇ : 8-HQ 100mg/l + Sucrose 2%	5	5	5	5	5	5	5	5	4	4	2	2
H₈ : 8-HQ 200mg/l + Sucrose 2%	5	5	5	5	5	5	5	5	4	4	3	3
H₉ : Control	5	5	3	3	1	1	*	*	*	*	*	*

Note : * Indicate vase life was completed

Where,	1	Dull/Flaccid
	2	Poor
	3	Fair
	4	Very good
	5	Excellent

accordingly score was given (based on 5 point scale). The result with regard to qualitative parameter has been depicted in Table 40.

Gerbera cv. stanza kept in Citric acid 300 mg/l + Sucrose 2 % retains highest score on colour, freshness, turgidity and overall acceptability.

Experiment: IV Effect of storage techniques on post harvest life of gerbera cv. Stanza

4.4.1 Quantitative Parameter

4.4.1.1 Change in Fresh Weight (gm) at Every Alternate Day

A perusal of data regarding with change in fresh weight percentage at initial, 0th DAS, 2nd DAS, 4th DAS and 6th DAS in gerbera cv. Stanza during 2010-11, 2011-12 and in pooled analysis as significantly influenced by different storage techniques are presented in Table 41.

At initial day flower weight was shown non-significant. At 0 DAS, 2nd DAS and 4th DAS was significant influence by different storage techniques. Maximum fresh weight was observed with dry storage with PP packaging (111.08 gm, 117.35 gm and 108.76 gm) which was followed by Q₆ (wet storage + Sodium benzoate 200 mg/l + Sucrose 2 %) at 0th DAS, 2nd DAS and 4th DAS, respectively during 2010-11. At 6th day mean data was presented maximum fresh weight (gm) observed with dry storage with wrapping material: PP. Similar result was observed in 2011-12 and in pooled analysis.

Table : 41 Effect of different storage techniques on fresh weight (gm) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Fresh weight (gm) at initial (0 th) day			Fresh weight (gm) at 0 th DAS			Fresh weight (gm) at 2 nd DAS		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
Q₁: Dry storage with wrapping material : PP	112.34	110.15	111.25	111.08	108.98	110.03	117.35	114.94	116.15
Q₂: Dry storage with wrapping material : CFB box	111.51	112.08	111.80	91.03	91.17	91.10	95.56	95.68	95.62
Q₃: Wet storage + AgNO₃ 10 mg/l + Sucrose 2%	112.22	111.31	111.77	108.15	107.15	107.65	93.17	92.16	92.67
Q₄: Wet storage + AgNO₃ 20 mg/l + Sucrose 2%	110.94	109.17	110.06	108.18	106.25	107.22	96.25	94.58	95.42
Q₅: Wet storage + Sodium benzoate 100 mg/l + Sucrose 2%	108.73	111.34	110.04	106.25	109.00	107.63	98.74	101.65	100.20
Q₆: Wet storage + Sodium benzoate 200 mg/l + Sucrose 2%	113.29	110.76	112.03	112.25	109.84	111.05	108.37	106.07	107.22
Q₇: Wet storage + RO water(control)	112.07	113.24	112.66	100.65	101.73	101.19	77.84	78.72	78.28
S. Em. ±	1.443	1.397	0.987	1.416	1.264	0.933	1.479	1.518	1.041
C.D. at 5%	NS	NS	NS	4.30	3.84	2.70	4.49	4.61	3.01
C.V.%	2.24	2.18	2.21	2.38	2.09	2.21	2.63	2.69	2.65
Pooled	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %
Y	0.528	N.S	2.21	0.499	N.S	2.22	0.557	N.S	2.65
Y×T	1.396	N.S		1.319	N.S		1.473	N.S	

Conti...

Table : 41 Effect of different storage techniques on change in fresh weight (gm) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Fresh weight (gm) at 4 th DAS			Fresh weight (gm) at 6 th DAS*		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
Storage technology (Q)						
Q₁: Dry storage with wrapping material : PP	108.76	106.59	107.68	86.54	84.72	85.63
Q₂: Dry storage with wrapping material : CFB box	75.68	76.46	76.07	****	****	****
Q₃: Wet storage + AgNO₃ 10 mg/l + Sucrose 2%	71.06	70.21	70.64	****	****	****
Q₄: Wet storage + AgNO₃ 20 mg/l + Sucrose 2%	74.21	72.87	73.54	****	****	****
Q₅: Wet storage + Sodium benzoate 100 mg/l + Sucrose 2%	79.60	81.92	80.76	****	****	****
Q₆: Wet storage + Sodium benzoate 200 mg/l + Sucrose 2%	89.87	87.88	88.88	64.32	63.15	63.74
Q₇: Wet storage + RO water(control)	50.10	52.16	51.13	****	****	****
S. Em. ±	1.634	1.529	1.100	****	****	****
C.D. at 5%	4.96	4.64	3.18	****	****	****
C.V.%	3.61	3.38	3.50	****	****	****
Pooled	SEm±	C.D. at 5%	C.V. %	****	****	****
Y	0.588	N.S	3.50	****	****	****
Y×T	1.555	N.S		****	****	

Note : * Not included in statistical analysis

4.4.1.2 Physiological Change in Weight (%)

The effect of storage techniques (wet and dry storage) on physiological change in weight (%) was recorded just after 7 days storage of gerbera cv. Stanza at 6°C in cold storage during year 2010-11, 2011-12. The data is depicted in Table 42, and in graphical form, in Figure 21.

The data in the Table 42 clearly showed significant influence of storage techniques on physiological change in weight just after storage during 2010-11, 2011-12 and pooled analysis.

At 0 DAS minimum physiological loss in weight was observed with Sodium benzoate 200 mg/l + Sucrose 2 % (0.92 %, 0.83 % and 0.87 %) which was followed by cut flowers wrapped in polypropylene (1.12 %, 1.06 % and 1.09%) in 2010-11, 2011-12 and in pooled analysis

The minimum physiological loss in weight observed in packaged in polypropylene at 4th DAS (7.29 %) which was followed by flowers kept in solution containing Sodium benzoate 200 mg/l + Sucrose 2 % (17.11 %) in pooled analysis. The maximum physiological loss in weight was observed in wet storage + RO water (34.69 %) in pooled analysis.

The minimum physiological loss in weight was observed in packaged in polypropylene at 6th DAS (-20.29%) in mean data.

More or less similar trend was observed during both the years and in pooled analysis on physiological change in weight as

Table : 42 Effect of different storage techniques on physiological change in weight (%) of gerbera (*Gerbera jamesonii*) cv. Stanza

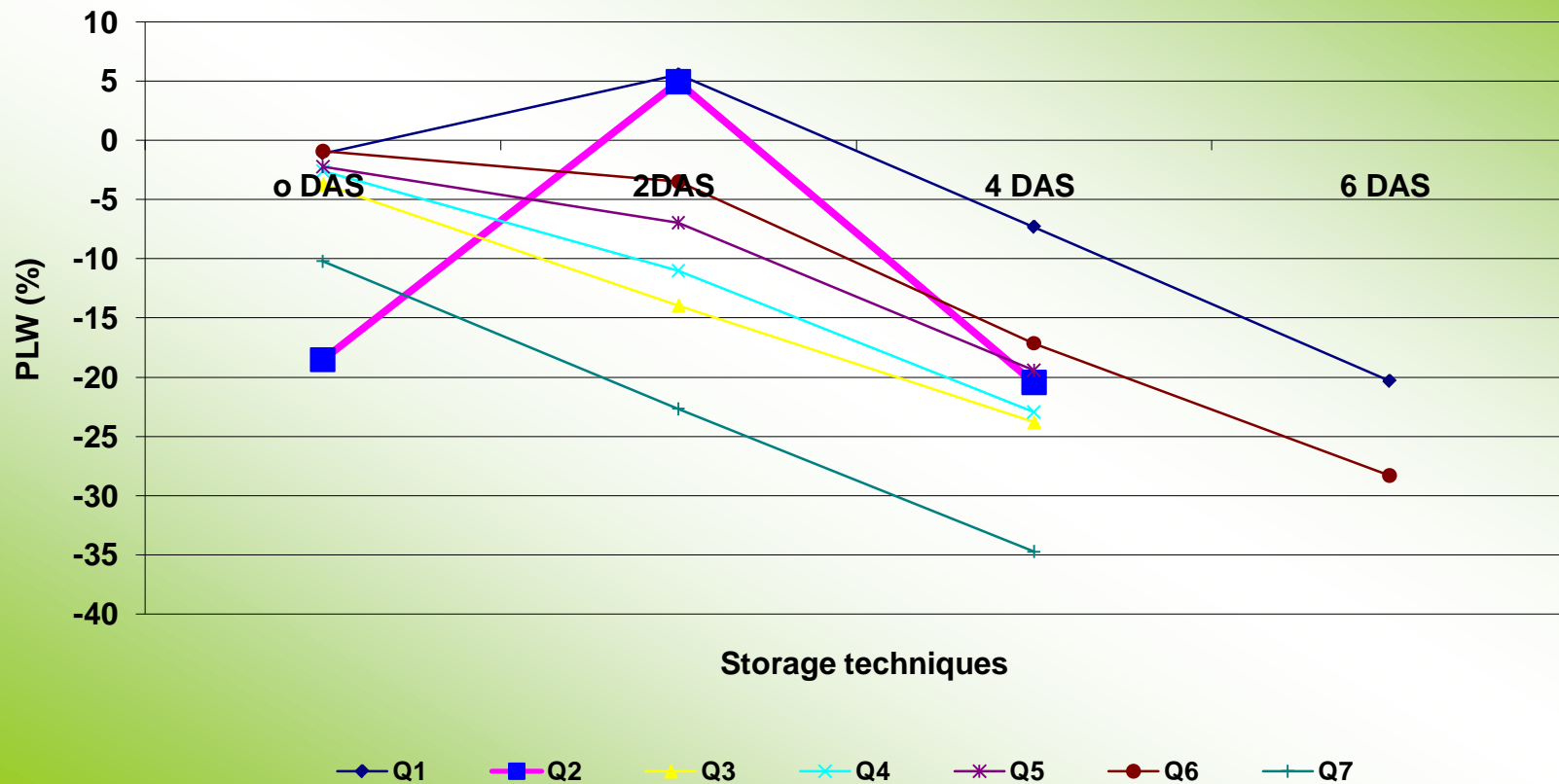
Treatments	Physiological change in weight (%) at 0 th DAS			Physiological change in weight (%) at 2 nd DAS			Physiological change in weight (%) at 4 th DAS			Physiological change in weight (%) at 6 th DAS		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
Q₁: Dry storage with wrapping material : PP	- 1.12	- 1.06	- 1.09	5.64	5.47	5.56	- 7.32	- 7.26	- 7.29	- 20.43	- 20.15	- 20.29
Q₂: Dry storage with wrapping material : CFB box	- 18.38	- 18.66	- 18.51	4.98	4.94	4.96	- 20.80	- 20.09	- 20.45	****	****	****
Q₃: Wet storage + AgNO₃ 10 mg/l + Sucrose 2%	- 3.63	- 3.74	- 3.68	- 13.85	- 13.99	-13.92	- 23.73	- 23.82	- 23.77	****	****	****
Q₄: Wet storage + AgNO₃ 20 mg/l + Sucrose 2%	- 2.49	- 2.67	- 2.58	- 11.03	- 10.98	-11.01	- 22.90	- 22.95	- 22.93	****	****	****
Q₅: Wet storage + Sodium benzoate 100 mg/l + Sucrose 2%	- 2.28	- 2.10	- 2.19	- 7.07	- 6.74	-6.91	- 19.38	- 19.41	- 19.40	****	****	****
Q₆: Wet storage + Sodium benzoate 200 mg/l + Sucrose 2%	- 0.92	- 0.83	- 0.87	- 3.46	- 3.43	-3.44	- 17.07	- 17.15	- 17.11	- 28.43	- 28.15	- 28.29
Q₇: Wet storage + RO water (control)	- 10.19	- 10.16	- 10.18	- 22.65	- 22.62	- 22.64	- 35.64	- 33.74	-34.69	****	****	****
S. Em. ±	0.127	0.156	0.099	0.165	0.150	0.109	0.352	0.387	0.257	****	****	****
C.D. at 5%	0.39	0.47	0.29	0.50	0.46	0.32	1.07	1.17	0.74	****	****	****
C.V.%	3.95	4.82	4.39	2.90	2.67	2.78	2.91	3.25	3.08	****	****	****
Pooled	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %	****	****	****
Y	0.053	N.S	4.39	0.058	N.S	2.78	0.137	N.S	3.08	****	****	****
Y×T	0.140	N.S		0.155	N.S		0.363	N.S		****	****	

Note: Figures with negative (-ve) denote decrease in fresh weight (%)

Note : * Not included in statistical analysis

Conti...

Fig-21 : Effect of different storage techniques on physiological change in weight (%) of gerbera (*Gerbera jamesonii*) cv. Stanza (In pooled analysis)



influenced by different storage techniques in 6°C cold stored gerbera cut flowers (cv. Stanza).

4.4.1.3 Solution Uptake (ml)

Data pertained for solution uptake at alternate day (ml) and total solution uptake (ml) affected due to different storage techniques in gerbera cv. Stanza during 2010-11, 2011-12 and pooled are given in Table 43.

Effect of Storage Techniques

The data indicated that storage techniques significantly influenced solution up take at 2nd and 4th DAS in gerbera cv. Stanza during both the years and in pooled analysis. In pooled analysis, significantly higher solution uptake (63.90 ml, 54.70 ml and 150.57 ml) was recorded with PP packaged gerbera at 6°C cold stored at 2nd and 4th DAS and total solution up take, respectively. At 6th DAS maximum solution uptake was observed in PP packaged (31.98 ml) in mean data. More or less similar trend was observed in solution uptake at 2nd, 4th, 6th DAS and total solution uptake during both the years of investigation.

4.4.1.4 Membrane Stability Index (MSI) (%) in Petals

The data pertaining to membrane stability index (MSI) in petals was recorded at 4th DAS as influenced by different storage techniques in Table 44 and graphically illustrated in Figure 22.

Membrane stability index was differed significantly due to different storage techniques at 4th DAS in gerbera cut flowers cv. Stanza.

Table :43 Effect of different storage techniques on solution up take (ml) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Solution uptake (ml) at 2 nd DAS			Solution uptake (ml) at 4 th DAS			Solution uptake (ml) at 6 th DAS			Total solution uptake (ml)		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
Q₁: Dry storage with wrapping material : PP	63.23	64.56	63.90	54.34	55.05	54.70	31.94	32.02	31.98	149.51	151.63	150.57
Q₂: Dry storage with wrapping material : CFB box	58.76	59.17	58.96	29.15	28.27	28.71	****	****	****	87.91	87.44	87.68
Q₃: Wet storage + AgNO₃ 10 mg/l + Sucrose 2%	46.15	45.23	45.69	23.26	22.89	23.08	****	****	****	69.41	68.12	68.77
Q₄: Wet storage + AgNO₃ 20 mg/l + Sucrose 2%	49.42	47.87	48.65	28.62	27.45	28.04	****	****	****	78.04	75.32	76.68
Q₅: Wet storage + Sodium benzoate 100 mg/l + Sucrose 2%	53.27	54.41	53.84	31.27	30.19	30.73	****	****	****	84.54	84.60	84.57
Q₆: Wet storage + Sodium benzoate 200 mg/l + Sucrose 2%	58.82	56.75	57.79	34.52	33.74	34.13	26.68	26.42	26.55	120.02	116.91	118.47
Q₇: Wet storage + RO water(control)	40.67	41.31	40.99	21.30	22.93	21.62	****	****	****	61.64	63.24	62.42
S. Em. ±	0.704	0.768	0.512	0.492	0.544	0.360	****	****	****	2.192	2.322	1.569
C.D. at 5%	2.14	2.33	1.48	1.49	1.65	1.04	****	****	****	6.65	7.04	4.54
C.V.%	2.31	2.52	2.42	2.68	3.01	2.84	****	****	****	4.08	4.35	4.22
Pooled	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %	****	****	****	SEm±	C.D. at 5%	C.V. %
Y	0.274	N.S	2.42	0.193	N.S	2.84	****	****	****	0.839	N.S	4.22
Y×T	0.724	N.S		0.510	N.S		****	****		****	2.219	

Note : * Not included in statistical analysis

Conti...

Fig-22 : Effect of different storage techniques on membrane stability index (%) in petals of gerbera (*Gerbera jamesonii*) cv. Stanza (In pooled analysis)

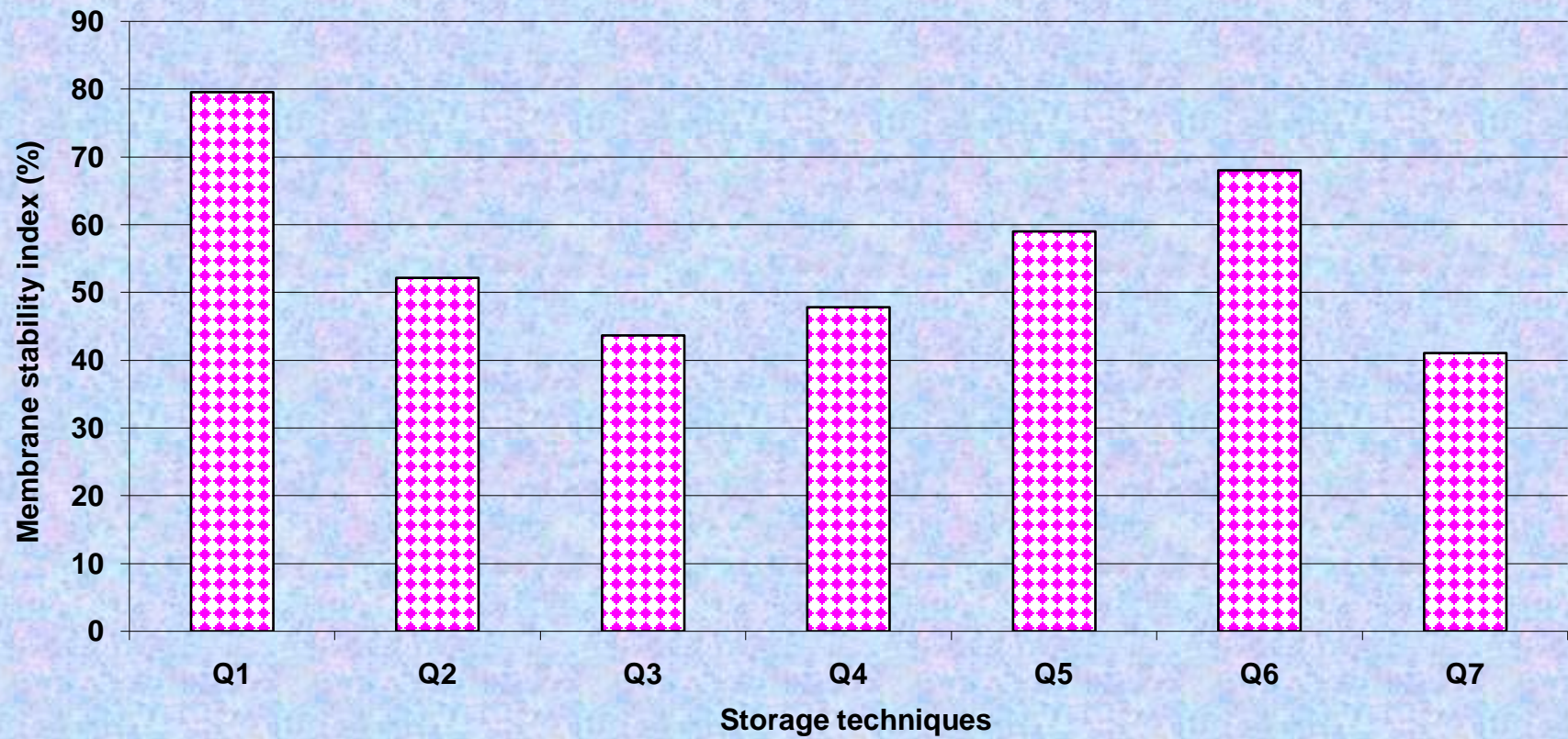


Table : 44 Effect of different storage techniques on membrane stability index (%) in petals of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	MSI (%) at 4 th DAS		
	2010-11	2011-12	Pooled
Storage technology (Q)			
Q₁: Dry storage with wrapping material : PP	79.00	80.15	79.58
Q₂: Dry storage with wrapping material : CFB box	51.15	53.14	52.15
Q₃: Wet storage + AgNO₃ 10 mg/l + Sucrose 2%	43.18	44.06	43.62
Q₄: Wet storage + AgNO₃ 20 mg/l + Sucrose 2%	48.17	47.52	47.85
Q₅: Wet storage + Sodium benzoate 100 mg/l + Sucrose 2%	59.65	58.29	58.97
Q₆: Wet storage + Sodium benzoate 200 mg/l + Sucrose 2%	68.43	67.62	68.03
Q₇: Wet storage + RO water(control)	40.67	41.37	41.02
S. Em. ±	0.652	0.739	0.484
C.D. at 5%	1.98	2.24	1.40
C.V.%	2.03	2.28	2.15
Pooled	SEm±	C.D. at 5%	C.V. %
Y	0.259	N.S	2.15
Y×T	0.685	N.S	

Experimental Results

At 4th DAS, higher MSI (79.00 %, 80.15 % and 79.58 %) was observed in PP packaged gerbera flowers which was followed by Sodium benzoate 200 mg/l + Sucrose 2 % (68.43 %, 67.62 % and 68.03 %) during 2010-11, 2011-12 and in pooled analysis, respectively.

4.4.1.5 Total Dissolved Solutes (TDS) (°B)

The effect of different storage technology on total dissolved solutes (TDS) in petals tissue during vase life of gerbera cv. Stanza was recorded at 4th DAS. The result is mention in Table 45 and graphical form in Figure 23.

The higher level of total dissolved solutes (°B) was observed on 4th DAS in treatment Q₁ (Dry storage with wrapping material : PP) being 12.68°B, 12.44°B and 12.56°B , followed by Q₆ (wet storage with Sodium benzoate 200 mg/l + Sucrose 2 %) being 11.20°B, 10.84°B and 11.02°B during 2010-11, 2011-12 and in pooled analysis, respectively.

4.4.1.6 Dry Weight (%)

The data concerned with dry weight (%) affected due to different storage techniques in gerbera cv. Stanza are furnished in Table 46 and graphically illustrated in Figure 24.

The mean data indicated storage techniques significantly influence dry weight (%) in gerbera cut flowers (cv. Stanza) during both the years and pooled analysis. Among different storage techniques, Dry storage with wrapping material : PP, recorded maximum dry weight (8.86 %, 8.79 % and 8.83 %), which was

Table : 45 Effect of different storage techniques on total dissolved solutes (TDS) (°B) in gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	TDS (°B) at 4 th DAS		
	2010-11	2011-12	Pooled
Storage technology (Q)			
Q₁: Dry storage with wrapping material : PP	12.68	12.44	12.56
Q₂: Dry storage with wrapping material : CFB box	9.06	9.15	9.11
Q₃: Wet storage + AgNO₃ 10 mg/l + Sucrose 2%	7.66	7.82	7.74
Q₄: Wet storage + AgNO₃ 20 mg/l + Sucrose 2%	8.64	8.42	8.53
Q₅: Wet storage + Sodium benzoate 100 mg/l + Sucrose 2%	10.18	9.96	10.07
Q₆: Wet storage + Sodium benzoate 200 mg/l + Sucrose 2%	11.20	10.84	11.02
Q₇: Wet storage + RO water(control)	7.26	7.32	7.29
S. Em. ±	0.127	0.122	0.087
C.D. at 5%	0.39	0.37	0.25
C.V.%	2.31	2.24	2.23
Pooled	SEm±	C.D. at 5%	C.V. %
Y	0.046	N.S	2.23
Y×T	0.122	N.S	

Fig-23 : Effect of different storage techniques on total dissolved solutes (TDS) (°B) in gerbera (*Gerbera jamesonii*) cv. Stanza (In pooled analysis)

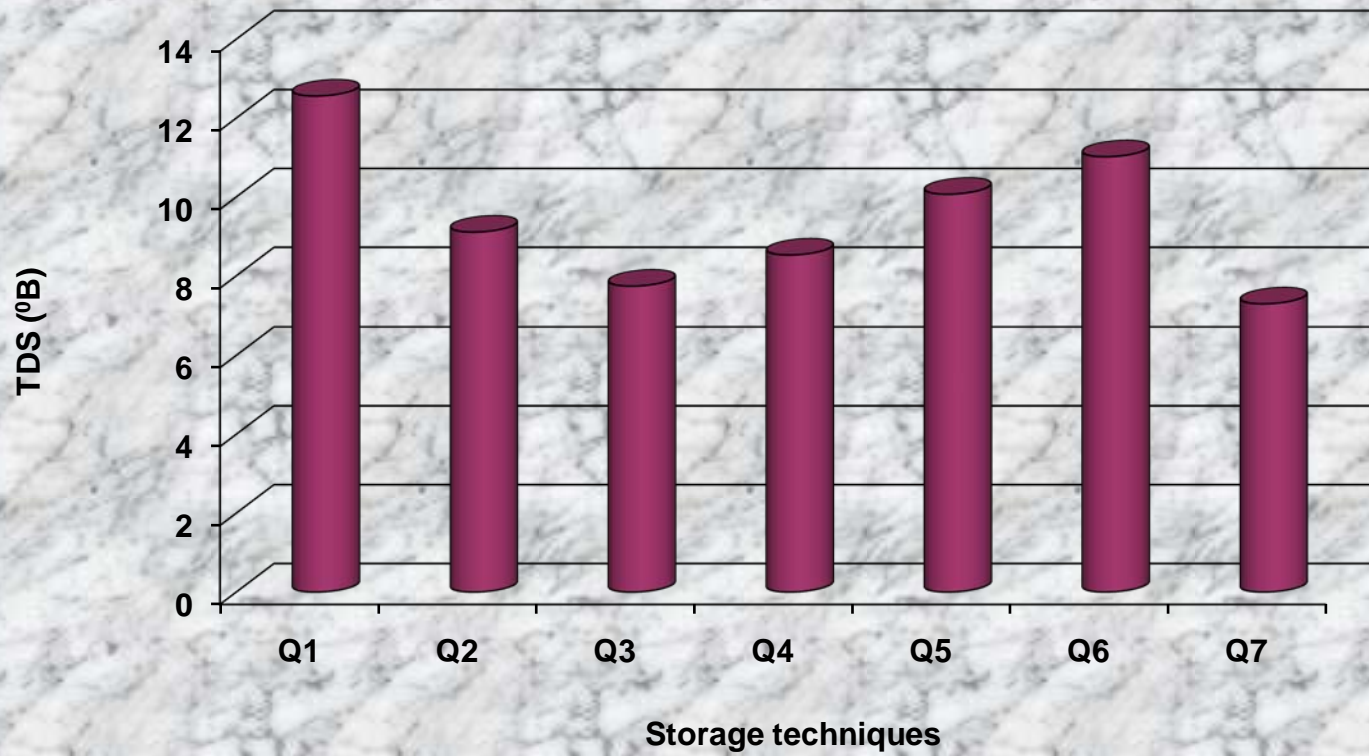
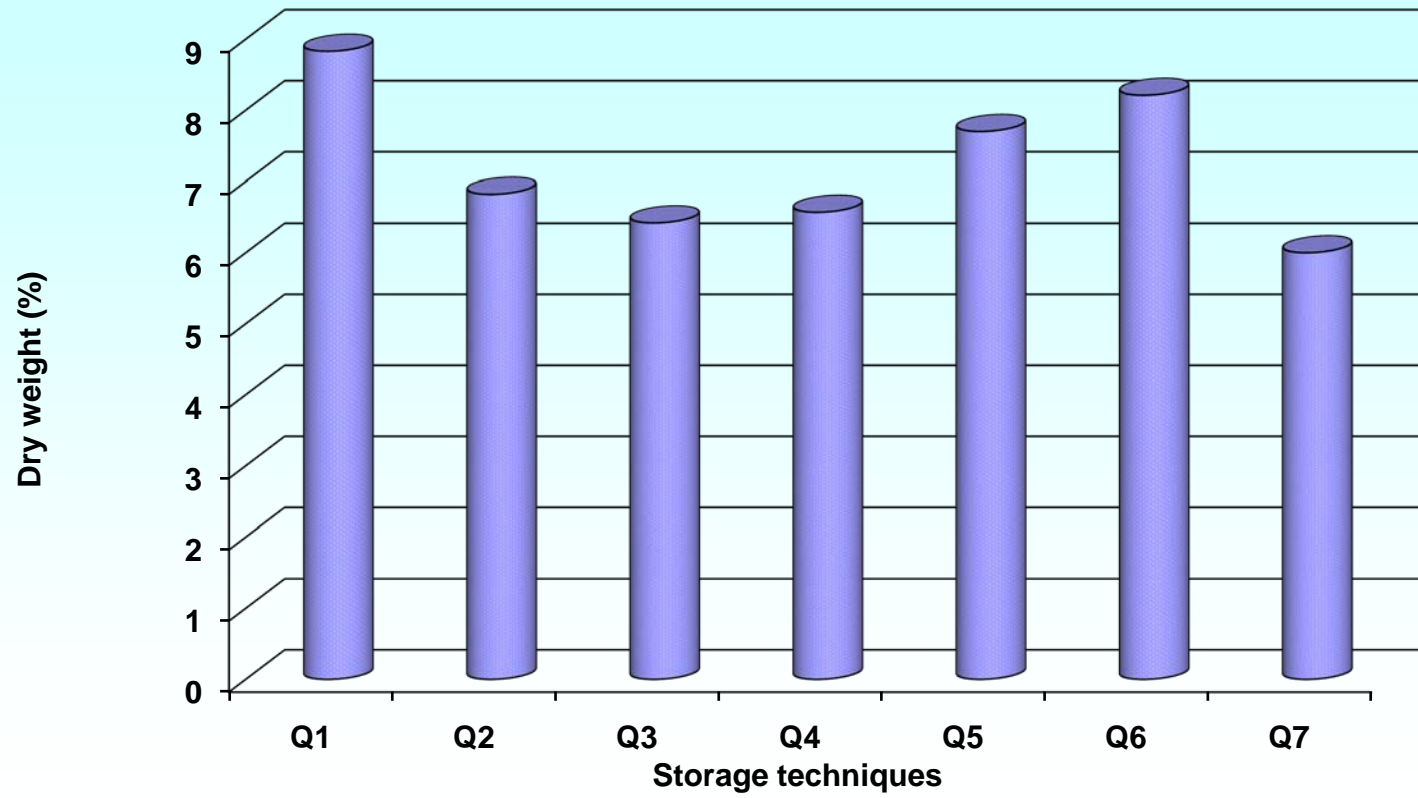


Table : 46 Effect of different storage techniques on dry weight (%) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Dry weight (%)		
	2010-11	2011-12	Pooled
Storage technology (Q)			
Q₁: Dry storage with wrapping material : PP	8.86	8.79	8.83
Q₂: Dry storage with wrapping material : CFB box	6.84	6.80	6.82
Q₃: Wet storage + AgNO₃ 10 mg/l + Sucrose 2%	6.34	6.50	6.42
Q₄: Wet storage + AgNO₃ 20 mg/l + Sucrose 2%	6.66	6.45	6.57
Q₅: Wet storage + Sodium benzoate 100 mg/l + Sucrose 2%	7.62	7.78	7.70
Q₆: Wet storage + Sodium benzoate 200 mg/l + Sucrose 2%	8.25	8.16	8.21
Q₇: Wet storage + RO water(control)	5.88	6.12	6.00
S. Em. ±	0.141	0.156	0.104
C.D. at 5%	0.43	0.47	0.30
C.V.%	3.40	3.75	3.58
Pooled	SEm±	C.D. at 5%	C.V. %
Y	0.055	N.S	3.58
Y×T	0.147	N.S	

Fig-24 : Effect of different storage techniques on dry weight (%) of gerbera (*Gerbera jamesonii*) cv. Stanza (In pooled analysis)



followed by wet storage with Sodium benzoate 200 mg/l + Sucrose 2 % (8.25 %, 8.16 % and 8.21 %) during 2010-11, 2011-12 and in pooled analysis, respectively.

4.4.2 Qualitative Parameter

4.4.2.1 Flower Size (cm)

The mean data on flower size (cm) was recorded at initial (0), 0 DAS, 2nd DAS, 4th DAS and 6th DAS and furnished in Table 47 and graphically illustrated in Figure 25.

The statistical analysis of data revealed that at initial day the size of flower size (cm) in gerbera cv. Stanza was found non-significant.

At 0 DAS significantly larger flower size was found in wet storage with Sodium benzoate 200 mg/l + Sucrose 2 % (Q₆) i.e. 10.74 cm, 10.45 cm and 10.60 cm, which was at par with Sodium benzoate 100 mg/l + Sucrose 2% (Q₅) i.e.10.51 cm, 10.07 cm and 10.29 cm during 2010-11, 2011-12 and in pooled analysis, respectively.

At 2nd DAS significantly larger flower size was found in dry storage with wrapping material : PP (Q₁) i.e.10.16 cm, 10.53 cm and 10.35 cm which was followed by wet storage with Sodium benzoate 200 mg/l + Sucrose 2 % (Q₆) i.e. 9.67 cm, 9.52 cm and 9.60 cm during 2010-11, 2011-12 and in pooled analysis, respectively. More or less similar trend was observed at 4th DAS during both the years of investigation. At 6th DAS maximum

Table : 47 Effect of different storage techniques on flower size (cm) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Flower size (cm) (0 th) initial day			Flower size (cm) 0 th DAS			Flower size (cm) 2 nd DAS		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
Storage technology (Q)									
Q₁: Dry storage with wrapping material : PP	9.73	9.75	9.74	9.68	9.70	9.69	10.16	10.53	10.35
Q₂: Dry storage with wrapping material : CFB box	9.60	9.73	9.67	8.17	8.53	8.35	8.96	8.63	8.80
Q₃: Wet storage + AgNO₃ 10 mg/l + Sucrose 2%	10.32	9.83	10.08	9.88	9.87	9.88	7.73	7.87	7.80
Q₄: Wet storage + AgNO₃ 20 mg/l + Sucrose 2%	9.28	9.62	9.45	9.92	9.93	9.93	8.96	8.63	8.80
Q₅: Wet storage + Sodium benzoate 100 mg/l + Sucrose 2%	9.67	10.03	9.85	10.51	10.07	10.29	9.45	9.48	9.47
Q₆: Wet storage + Sodium benzoate 200 mg/l + Sucrose 2%	9.83	9.65	9.74	10.74	10.45	10.60	9.67	9.52	9.60
Q₇: Wet storage + RO water(control)	9.75	9.81	9.78	9.46	9.77	9.62	7.17	7.48	7.33
S. Em. ±	0.195	0.173	0.128	0.146	0.140	0.099	0.140	0.152	0.102
C.D. at 5%	NS	NS	NS	0.44	0.42	0.29	0.43	0.46	0.29
C.V.%	3.47	3.07	3.27	2.59	2.48	2.54	2.74	2.97	2.85
Pooled	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %
Y	0.068	N.S	3.27	0.053	N.S	2.54	0.054	N.S	2.85
Y×T	0.181	N.S		0.140	N.S		0.144	N.S	

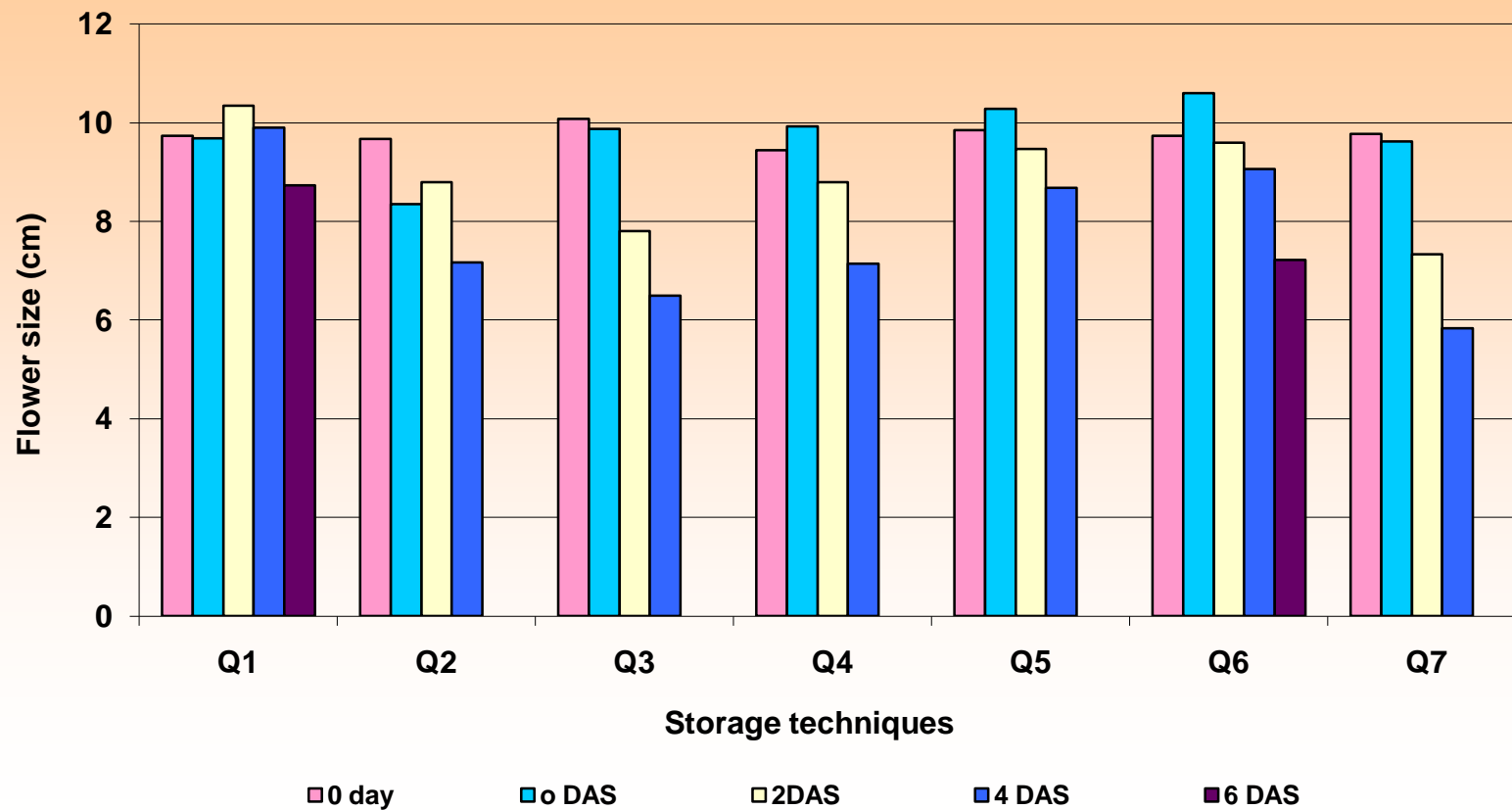
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Table :47 Effect of different storage techniques on flower size (cm) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Flower size (cm) 4 th DAS			Flower size (cm) 6 th DAS*		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
Storage technology (Q)						
Q₁: Dry storage with wrapping material : PP	9.82	9.98	9.90	8.64	8.82	8.73
Q₂: Dry storage with wrapping material : CFB box	7.15	7.18	7.17	****	****	****
Q₃: Wet storage + AgNO₃ 10 mg/l + Sucrose 2%	6.83	6.15	6.49	****	****	****
Q₄: Wet storage + AgNO₃ 20 mg/l + Sucrose 2%	7.10	7.19	7.15	****	****	****
Q₅: Wet storage + Sodium benzoate 100 mg/l + Sucrose 2%	8.62	8.74	8.68	****	****	****
Q₆: Wet storage + Sodium benzoate 200 mg/l + Sucrose 2%	9.17	8.95	9.06	7.18	7.25	7.22
Q₇: Wet storage + RO water(control)	5.65	6.00	5.83	****	****	****
S. Em. ±	0.160	0.155	0.110	****	****	****
C.D. at 5%	0.48	0.47	0.32	****	****	****
C.V.%	3.57	3.48	3.52	****	****	****
Pooled	SEm±	C.D. at 5%	C.V. %	****	****	****
Y	0.059	N.S	3.52	****	****	****
Y×T	0.155	N.S		****	****	

Note : * Not included in statistical analysis

Fig-25 : Effect of different storage techniques on flower size (cm) of gerbera (*Gerbera jamesonii*) cv. Stanza (In pooled analysis)



treatment was completed their vase life, that's why they are not included in statistical analysis.

4.4.2.2 Scape Bending Curvature ($^{\circ}$)

The data related to scape bending curvature ($^{\circ}$) in gerbera cv. Stanza are recorded 4th DAS during both the years and are depicted in Table 48 and graphically in Figure 26.

Minimum scape bending curvature ($^{\circ}$) at 4th DAS was observed with dry storage with wrapping material: PP (Q₁; 28.82⁰, 27.38⁰ and 28.10⁰) which was followed by Sodium benzoate 200 mg/l + Sucrose 2% (Q₆; 36.88⁰, 37.60⁰ and 37.24⁰) during 2010-11, 2011-12 and in pooled analysis, respectively.

4.4.2.3 Pigment Content (Anthocyanin)

The data pertaining to anthocyanin content in gerbera petals (cv. Stanza) at 4th DAS during 2010-1, 2011-12 and in pooled analysis are depicted in Table 49 and graphically in Figure 27.

The significant effect of individual storage techniques was on pigment content (anthocyanin) in gerbera cv. Stanza. Maximum anthocyanin content present in Q₇ (0.34 mg/gm, in wet storage in RO water), while minimum anthocyanin content present in Q₁ (0.16 mg/gm, in dry storage with wrapping material: PP) which was followed by Q₆ (0.18 mg/gm, Sodium benzoate 200mg/l + Sucrose 2 %) in pooled analysis.

Parallel result was observed in both the years of experiment.

Table : 48 Effect of storage techniques on scape bending curvature (⁰) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Scape bending curvature (⁰) at 4 th DAS		
	2010-11	2011-12	Pooled
Storage technology (Q)			
Q₁: Dry storage with wrapping material : PP	28.82	27.38	28.10
Q₂: Dry storage with wrapping material : CFB box	60.18	61.08	60.63
Q₃: Wet storage + AgNO₃ 10 mg/l + Sucrose 2%	85.54	87.46	86.50
Q₄: Wet storage + AgNO₃ 20 mg/l + Sucrose 2%	73.75	74.08	73.92
Q₅: Wet storage + Sodium benzoate 100 mg/l + Sucrose 2%	42.34	42.72	42.53
Q₆: Wet storage + Sodium benzoate 200 mg/l + Sucrose 2%	36.88	37.60	37.24
Q₇: Wet storage + RO water(control)	93.32	92.18	92.75
S. Em. ±	0.798	0.779	0.548
C.D. at 5%	2.42	2.36	1.59
C.V.%	2.30	2.24	2.27
Pooled	S _{Em} ±	C.D. at 5%	C.V. %
Y	0.293	N.S	2.27
Y×T	0.775	N.S	

Fig-26 : Effect of storage techniques on scape bending curvature (°) of gerbera (*Gerbera jamsonii*) cv. Stanza (In pooled analysis)

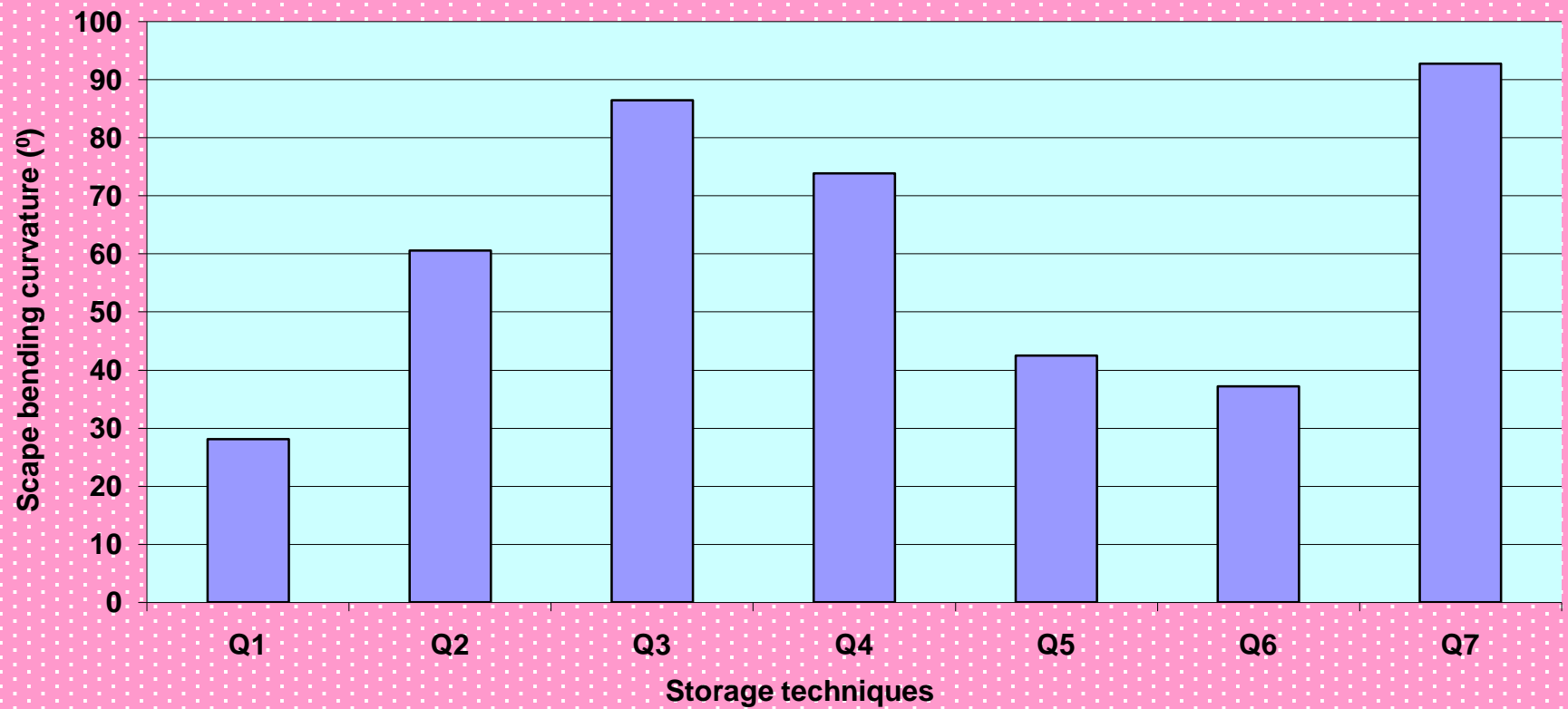


Table : 49 Effect of different storage techniques on pigment content (anthocyanin) (mg/g) in gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Pigment content (mg/g) at 4 th DAS		
	2010-11	2011-12	Pooled
Storage technology (Q)			
Q₁: Dry storage with wrapping material : PP	0.16	0.15	0.16
Q₂: Dry storage with wrapping material : CFB box	0.22	0.23	0.23
Q₃: Wet storage + AgNO₃ 10 mg/l + Sucrose 2%	0.27	0.28	0.28
Q₄: Wet storage + AgNO₃ 20 mg/l + Sucrose 2%	0.25	0.25	0.25
Q₅: Wet storage + Sodium benzoate 100 mg/l + Sucrose 2%	0.20	0.20	0.20
Q₆: Wet storage + Sodium benzoate 200 mg/l + Sucrose 2%	0.18	0.18	0.18
Q₇: Wet storage + RO water(control)	0.34	0.33	0.34
S. Em. ±	0.003	0.004	0.003
C.D. at 5%	0.01	0.01	0.01
C.V.%	2.33	3.26	2.80
Pooled	SEm±	C.D. at 5%	C.V. %
Y	0.001	N.S	2.80
Y×T	0.004	N.S	

Fig-27 : Effect of different storage techniques on pigment content (anthocyanin) (mg/gm) in gerbera (*Gerbera jamesonii*) cv. Stanza (In pooled analysis)

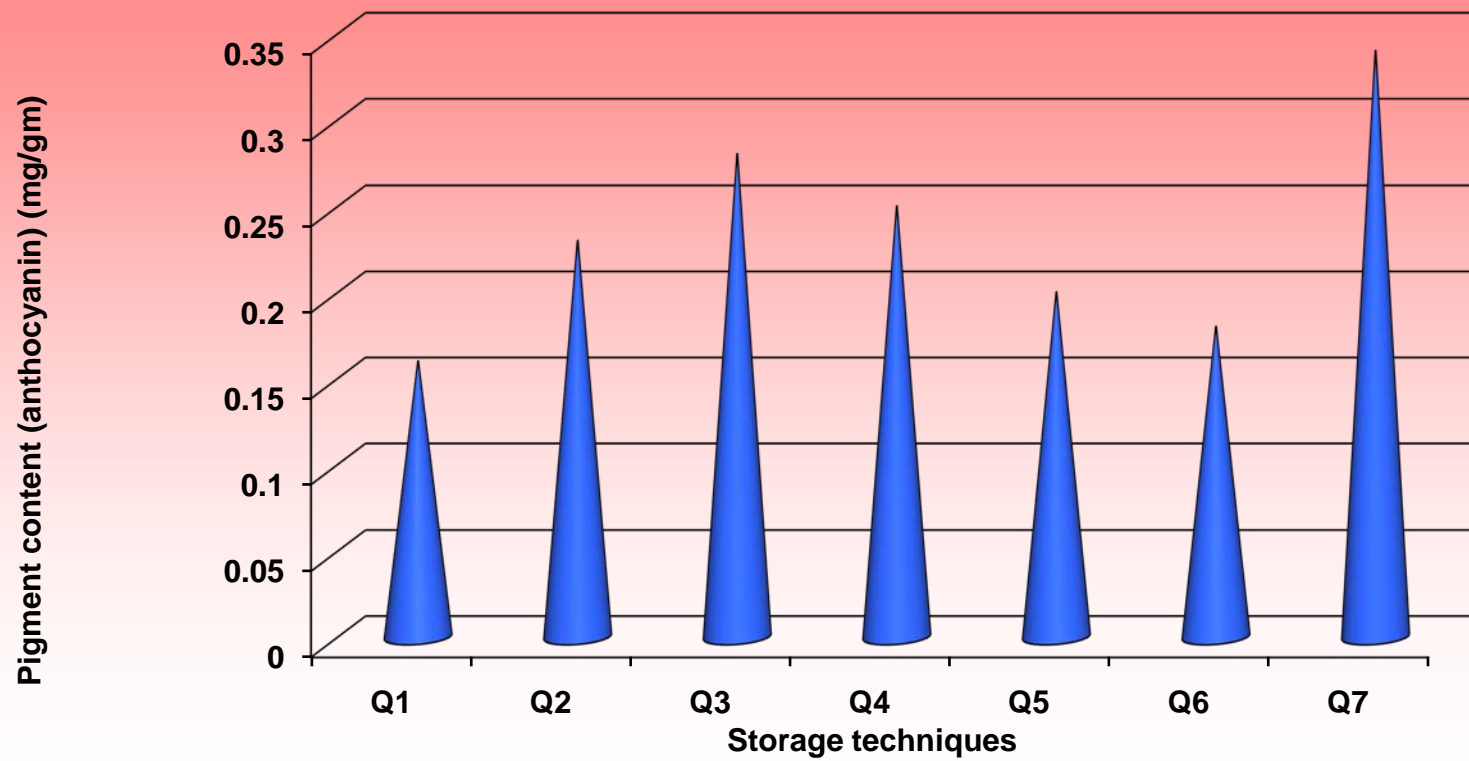
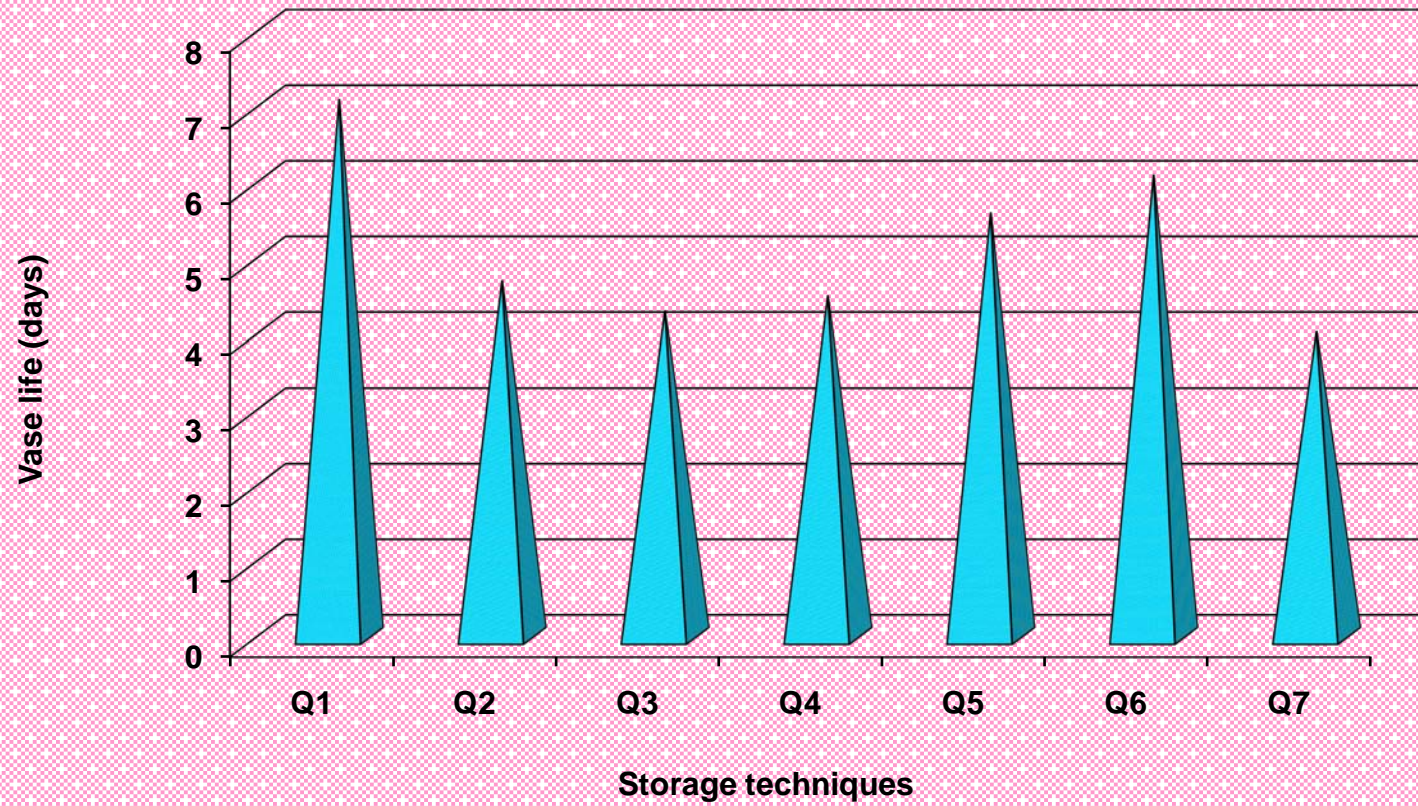


Fig-28 : Effect of different storage techniques on vase life (days) of gerbera (*Gerbera jamesonii*) cv. Stanza (In pooled analysis)



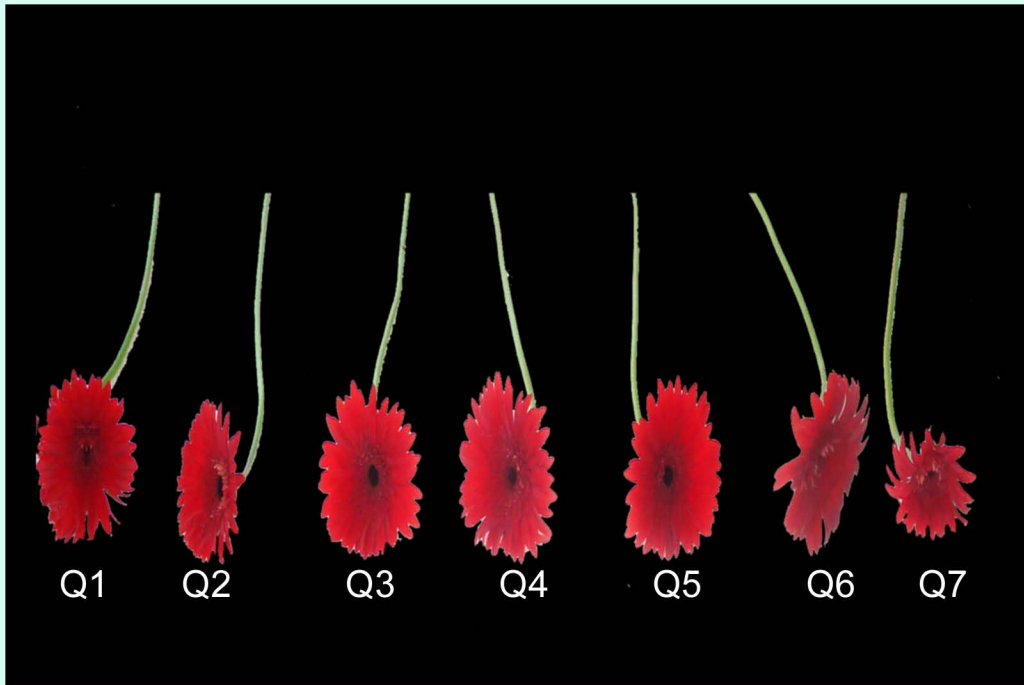


Plate-VII : Effect of different storage techniques in gerbera cv. Stanza at 0 day after storage



Plate-VIII : Effect of different storage techniques in gerbera cv. Stanza at 4th DAS

4.4.2.4 Disease Incidence

There was no disease incidence visually found in all storage techniques.

4.4.3 Vase Life (days) and Overall Quality

4.4.3.1 Vase Life (days)

The effect of storage techniques on vase life of flower was depicted in Table 50 and graphically shown in Figure 28.

Vase life of gerbera cv. Stanza was significantly influenced by different storage techniques during 2010-11, 2011-12 and in pooled analysis. Among different storage techniques, dry storage with wrapping material: PP, recorded maximum vase life i.e., 7.00 days, 7.20 days and 7.10 days, which was followed by Sodium benzoate 200 mg/l + Sucrose 2 % i.e., 6.00 days, 6.20 days and 6.10 days during 2010-11, 2011-12 and in pooled analysis, respectively.

4.4.3.2 Quality Assessments: (on visual basis, 5 point scale)

The effect of storage techniques on overall quality flower was visually examined at 0th DAS, 2nd DAS, 4th DAS and 6th DAS on the basis of freshness, turgidity and overall acceptability and score was given (based on 5 point scale) accordingly. The result with regard to qualitative parameter has been mentioned in Table 51.

Flower stored for 7 days at 6⁰C in polypropylene dry storage give better flower overall quality.

Table : 50 Effect of different storage techniques on vase life (days) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Vase life (days)		
	2010-11	2011-12	Pooled
Storage technology (Q)			
Q₁: Dry storage with wrapping material : PP	7.00	7.20	7.10
Q₂: Dry storage with wrapping material : CFB box	4.60	4.80	4.70
Q₃: Wet storage + AgNO₃ 10 mg/l + Sucrose 2%	4.20	4.40	4.30
Q₄: Wet storage + AgNO₃ 20 mg/l + Sucrose 2%	4.40	4.60	4.50
Q₅: Wet storage + Sodium benzoate 100 mg/l + Sucrose 2%	5.80	5.40	5.60
Q₆: Wet storage + Sodium benzoate 200 mg/l + Sucrose 2%	6.00	6.20	6.10
Q₇: Wet storage + RO water(control)	4.00	4.07	4.03
S. Em. ±	0.115	0.147	0.092
C.D. at 5%	0.35	0.45	0.27
C.V.%	3.89	4.86	4.37
Pooled	SEm±	C.D. at 5%	C.V. %
Y	0.049	N.S	4.37
Y×T	0.130	N.S	

Table : 51 Effect of different storage techniques on overall quality of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	0 th DAS		2 nd DAS		4 th DAS		6 th DAS	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
Q ₁ : Dry storage with wrapping material : PP	5	5	5	5	5	5	4	4
Q ₂ : Dry storage with wrapping material : CFB box	5	5	4	4	2	2	*	*
Q ₃ : Wet storage + AgNO ₃ 10 mg/l + Sucrose 2%	4	4	3	3	1	1	*	*
Q ₄ : Wet storage + AgNO ₃ 20 mg/l + Sucrose 2%	5	5	3	3	2	2	*	*
Q ₅ : Wet storage + Sodium benzoate 100 mg/l + Sucrose 2%	5	5	4	4	3	3	*	*
Q ₆ : Wet storage + Sodium benzoate 200 mg/l + Sucrose 2%	5	5	5	5	4	4	3	3
Q ₇ : Wet storage + RO water(control)	3	3	2	2	1	1	*	*

Note : * Indicate vase life was completed

Where,

1	Dull/Flaccid
2	Poor
3	Fair
4	Very good
5	Excellent

Experiment: V Effect of storage duration on post harvest life of gerbera cv. Stanza

4.5.1 Quantities Parameter

4.5.1.1 Change in Fresh Weight (gm) at Every Alternate Day

A change in fresh weight in gerbera of “Stanza” cultivar reveals a highly significant effect of storage duration presented in Table 52.

Maximum fresh weight was observed with (D₁; 8 day storage) i.e. 114.31 gm, 113.66 gm, 118.80 gm and 115.36 gm at initial day (0th) day, 0th DAS, 2nd DAS and 4th DAS, respectively, which was at par with D₂ (12 day storage). Lowest fresh weight retention was recorded in D₄ (20 day storage) as recorded on initial to 4th DAS of vase life (113.53 gm to 78.87 gm, 111.40 gm to 77.15 gm and 112.47 gm to 78.01 gm) in both years and in pooled analysis, respectively.

At 6th day and 8th day mean data was presented maximum fresh weight was observed with (8 day storage duration) (105.27 gm and 82.00 gm) and minimum fresh weight was observed with (20 day storage duration).

4.5.1.2 Physiological Change in Weight (%)

Treatment means of “stanza” cultivar of gerbera Table 53 reveal significantly highest weight loss in 20 day storage while 8 day storage retained maximum weight up to the end of vase life during both years and in pooled analysis.

Table : 52 Effect of storage durations on change in fresh weight (gm) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Fresh weight (gm) at initial (0 th) day			Fresh weight (gm) at 0 th DAS			Fresh weight (gm) at 2 nd DAS			Fresh weight (gm) at 4 th DAS		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
Storage duration (D)	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
D₁ : 8 days	114.76	113.86	114.31	114.10	113.22	113.66	119.23	118.37	118.80	115.87	114.85	115.36
D₂ : 12 days	111.19	112.52	111.86	109.96	111.26	110.61	113.17	114.48	113.83	107.14	108.72	107.93
D₃ : 16 days	110.93	113.23	112.08	108.15	110.37	109.26	108.54	110.75	109.65	100.15	102.34	101.25
D₄ : 20 days	113.53	111.40	112.47	107.87	105.98	106.93	97.87	96.03	96.95	78.87	77.15	78.01
S. Em. ±	1.263	1.287	0.901	1.245	1.321	0.908	1.284	1.341	0.928	1.269	1.243	0.888
C.D. at 5%	NS	NS	NS	3.73	3.96	2.62	3.85	4.02	2.68	3.80	3.73	2.56
C.V.%	2.51	2.55	2.53	2.53	2.68	2.61	2.62	2.73	2.67	2.82	2.76	2.79
Pooled	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %
Y	0.637	N.S	2.53	0.642	N.S	2.61	1.90	N.S	2.67	0.628	N.S	2.79
Y × T	1.275	N.S		1.283	N.S		3.79	N.S		1.256	N.S	

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Treatments	Fresh weight (gm) at 6 th DAS*			Fresh weight (gm) at 8 th DAS*		
Storage duration (D)	2010-11	2011-12	Mean data	2010-11	2011-12	Mean data
D₁ : 8 days	105.68	104.86	105.27	82.37	81.62	82.00
D₂ : 12 days	84.52	85.81	85.17	****	****	****
D₃ : 16 days	76.15	78.00	77.08	****	****	****
D₄ : 20 days	****	****	****	****	****	****

Note : * Not included in statistical analysis

Table : 53 Effect of storage durations on physiological change of weight (%) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Physiological change in weight (%) at 0 th DAS			Physiological change in weight (%) at 2 nd DAS			Physiological change in weight (%) at 4 th DAS		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
D₁ : 8 days	-0.58	-0.56	-0.57	4.51	4.55	4.53	- 2.82	- 2.97	- 2.90
D₂ : 12 days	-1.11	-1.12	-1.11	2.92	2.89	2.91	- 5.33	- 5.03	- 5.18
D₃ : 16 days	-2.51	-2.51	-2.51	0.36	0.34	0.35	- 7.73	- 7.59	- 7.66
D₄ : 20 days	-4.99	-4.87	-4.93	- 9.27	- 9.39	- 9.33	- 19.41	- 19.66	- 19.54
S. Em. ±	0.028	0.023	0.018	0.046	0.052	0.035	0.144	0.145	0.102
C.D. at 5%	0.08	0.07	0.05	0.14	0.16	0.10	0.43	0.44	0.30
C.V.%	2.71	2.28	2.51	2.41	2.73	2.58	3.65	3.68	3.66
Pooled	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %
Y	0.013	N.S	2.51	0.025	N.S	2.58	0.072	N.S	3.66
Y × T	0.026	N.S		0.049	N.S		0.144	N.S	

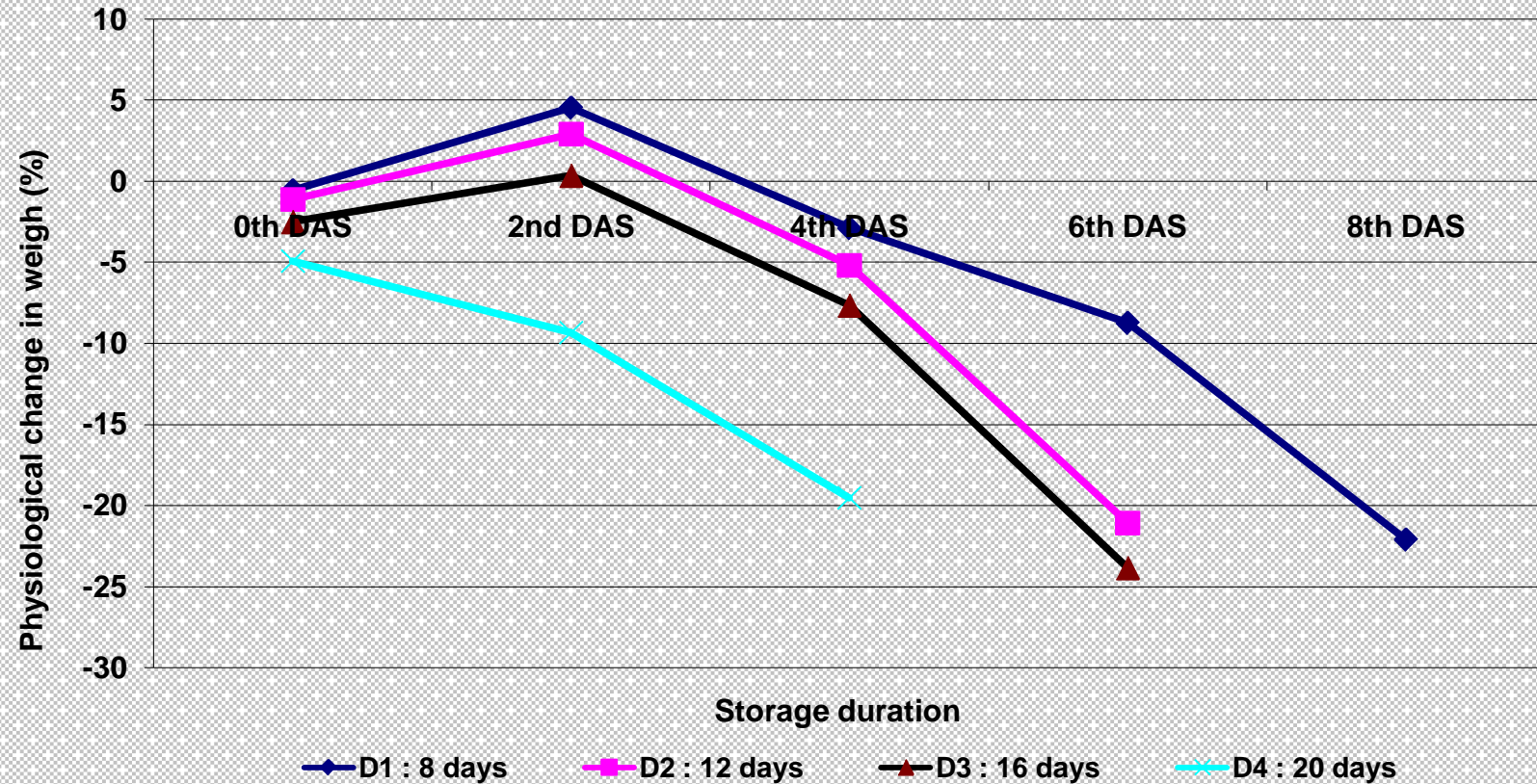
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Treatments	Physiological change in weight (%) at 6 th DAS*			Physiological change in weight (%) at 8 th DAS*		
	2010 -11	2011-12	Pooled	2010 -11	2011-12	Pooled
D₁ : 8 days	- 8.79	- 8.70	- 8.75	- 22.06	- 22.18	- 22.12
D₂ : 12 days	- 21.11	- 21.07	- 21.09	****	****	****
D₃ : 16 days	- 23.96	- 23.78	- 23.87	****	****	****
D₄ : 20 days	****	****	****	****	****	****

Note: Figures with negative (-ve) denote decrease in fresh weight (%)

Note : * Not included in statistical analysis

Fig - 29: Effect of storage duration on physiological change of weight (%) of gerbera (*Gerbera jamesonii*) cv. Stanza (In pooled analysis)



Data on physiological change in weight during different intervals shows that weight loss decreased during initial days in D₁ and D₂. But it increase continuously at each interval till the end of vase life. 8 days Storage period (D₁) was shown lowest weight loss i.e. (-2.82 %, -2.97 % and -2.90 %) which was at par with D₂ (12 day storage; -5.33 %, -5.03 % and -5.18 %) on 1st year, 2nd year and in pooled analysis during entire experiment. Significantly higher weight loss occurred in 20 days storage. (Figure 29)

4.5.1.3 Solution Uptake (ml)

Solution uptake of the gerbera flowers in cv. Stanza as affected by storage duration was presented in table 54.

Maximum total solution uptake (182.53 ml, 181.73 ml and 182.13 ml) was recorded in D₁ on 1st year, 2nd year and in pooled analysis during entire vase life which was at par with D₂ in both the years and in pooled analysis.

Least water uptake was recorded in D₄ (20 day storage) (101.31 ml, 105.14 ml and 103.23 ml) on 1st year, 2nd year and in pooled analysis. In the initial days rate of water uptake was high which decline in later days as shown in Figure 30.

4.5.1.4 Membrane Stability Index (MSI) (%) in petals

The storage period means show an overall decrease in MSI value during the entire vase life. MSI in gerbera cv. Stanza (Table 55) decreased significantly during both years as senescence appears. D₁ had higher MSI value (86.23 %, 84.67 % and 85.45 %) which was at par with D₂ (78.84 %, 79.88 % and 79.36 %) at

Table : 54 Effect of storage durations on solution up take (ml) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Solution up take (ml) at 2 nd DAS			Solution uptake (ml) at 4 th DAS			Solution uptake (ml) at 6 th DAS*		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Mean data
D₁ : 8 days	65.09	64.34	64.72	50.08	50.72	50.40	38.17	37.86	38.02
D₂ : 12 days	60.15	62.89	61.52	48.27	47.25	47.76	29.86	30.18	30.02
D₃ : 16 days	56.27	55.28	55.78	40.43	41.36	40.90	25.10	24.35	24.73
D₄ : 20 days	50.32	51.62	50.97	33.19	34.45	33.82	****	*****	****
S. Em. ±	0.701	0.778	0.524	0.526	0.569	0.388	****	*****	****
C.D. at 5%	2.10	2.33	1.51	1.58	1.71	1.12	****	*****	****
C.V.%	2.71	2.97	2.84	2.74	2.93	2.84	****	*****	****
Pooled	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %	****	*****	****
Y	0.370	N.S	2.84	0.274	N.S	2.84	****	*****	****
Y × T	0.741	N.S		0.548	N.S		****	*****	

Note : * Not included in statistical Analysis

Conti...

Table : 54 Effect of storage durations on solution up take (ml) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Solution uptake (ml) at 8 th DAS			Total Solution uptake (ml)		
	2010-11	2011-12	Mean data	2010-11	2011-12	Pooled
D₁ : 8 days	29.19	28.81	29.00	182.53	181.73	182.13
D₂ : 12 days	*****	*****	*****	138.08	140.32	139.20
D₃ : 16 days	*****	*****	*****	121.60	120.99	121.30
D₄ : 20 days	*****	*****	*****	101.31	105.14	103.23
S. Em. ±	*****	*****	*****	2.015	1.885	1.379
C.D. at 5%	*****	*****	*****	6.04	5.65	3.98
C.V.%	*****	*****	*****	3.32	3.08	3.20
Pooled	*****	*****	*****	SEm±	C.D. at 5%	C.V. %
Y	*****	*****	*****	0.975	N.S	3.20
Y × T	*****	*****		1.951	N.S	

Note : * Not included in statistical analysis

Fig-30 : Effect of storage durations on total solution up take (ml) of gerbera (*Gerbera jamesonii*) cv. Stanza (In pooled analysis)

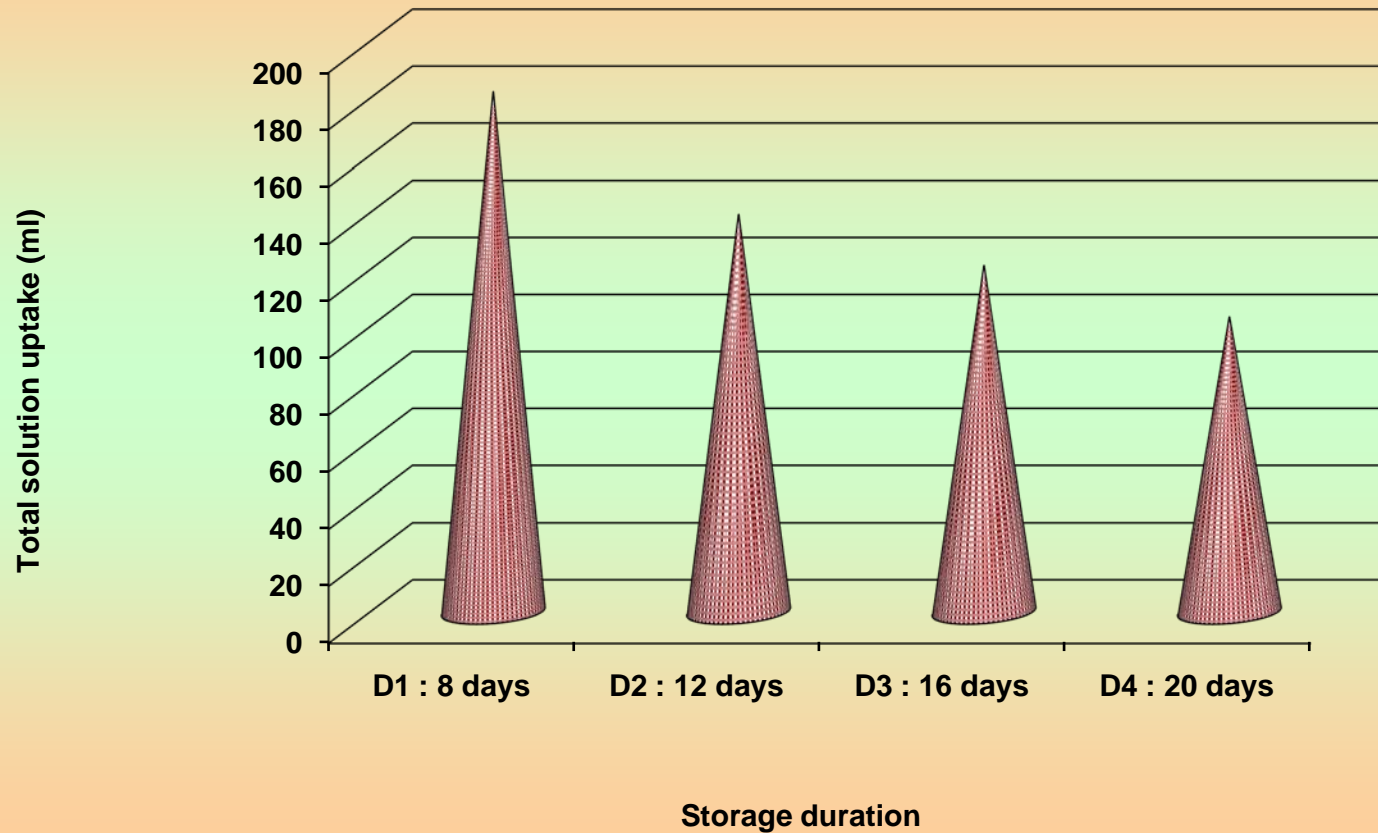


Table : 55 Effect of storage durations on membrane stability index (%) of petals of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	MSI (%) at 4 th DAS			MSI (%) at 8 th DAS*		
	2010-11	2011-12	Pooled	2010-11	2011-12	Mean data
D₁ : 8 days	86.23	84.67	85.45	61.56	60.45	61.01
D₂ : 12 days	78.84	79.88	79.36	****	****	****
D₃ : 16 days	70.17	68.22	69.20	****	****	****
D₄ : 20 days	54.00	55.98	54.99	****	****	****
S. Em. ±	0.983	0.835	0.645	****	****	****
C.D. at 5%	2.95	2.50	1.86	****	****	****
C.V.%	3.04	2.59	2.82	****	****	****
Pooled	SEm±	C.D. at 5%	C.V. %	****	****	****
Y	0.456	N.S	2.82	****	****	****
Y × T	0.912	N.S		****	****	

Note : * Not included in statistical analysis

4th DAS during both years and in pooled analysis, respectively. Lowest MSI was recorded in D₄ (54.00 %, 55.98 % and 54.99 %). At 8th day the data was not included in statistical analysis due to maximum treatment was completed their vase life.

4.5.1.5 Total Dissolved Solutes (TDS) (°B)

The significant effect of storage duration on total dissolved solutes in gerbera cv. Stanza (Table 56) shows that storage duration of 8 day retained highest levels of TDS (0.29⁰B, 0.28⁰B and 0.28⁰B) during both years and in pooled analysis, respectively which was at par with storage duration of 12 day, whereas in 20 day storage (D₄), least TDS was recorded (Figure 31).

4.5.1.6 Total Soluble Sugar (TSS) (mg/gm)

Data in Table 57 reveals significant difference in TSS as a result of storage duration.

Maximum TDS was observed in 8 day storage duration (D₁) stored flowers (17.81°B, 17.98°B and 17.90°B) which was at par with 12 day storage duration (D₂) stored flowers (14.95°B, 15.08°B and 15.02°B). Lowest TSS was recorded in 20 day (D₄) stored flowers (11.23°B, 11.45°B and 11.34°B) as recorded on 4th DAS of vase life in 1st year, 2nd year and in pooled analysis, respectively.

4.5.1.7 Dry weight (%)

The effect of storage duration on dry weight was recorded on 4th and 8th day of vase life as presented in table 58.

Table : 56 Effect of storage durations on total dissolved solutes (TDS) (°B) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	TDS (°) at 4 th DAS		
	2010-11	2011-12	Pooled
D₁ : 8 days	0.29	0.28	0.28
D₂ : 12 days	0.19	0.19	0.19
D₃ : 16 days	0.16	0.16	0.16
D₄ : 20 days	0.12	0.12	0.12
S. Em. ±	0.004	0.003	0.002
C.D. at 5%	0.01	0.01	0.01
C.V.%	4.37	3.28	4.17
Pooled	SEm±	C.D. at 5%	C.V. %
Y	0.002	N.S	4.17
Y × T	0.004	N.S	

Fig-31 : Effect of storage duration on total dissolved solutes (TDS) (°B) of gerbera (*Gerbera jamesonii*) cv. Stanza (In pooled analysis)

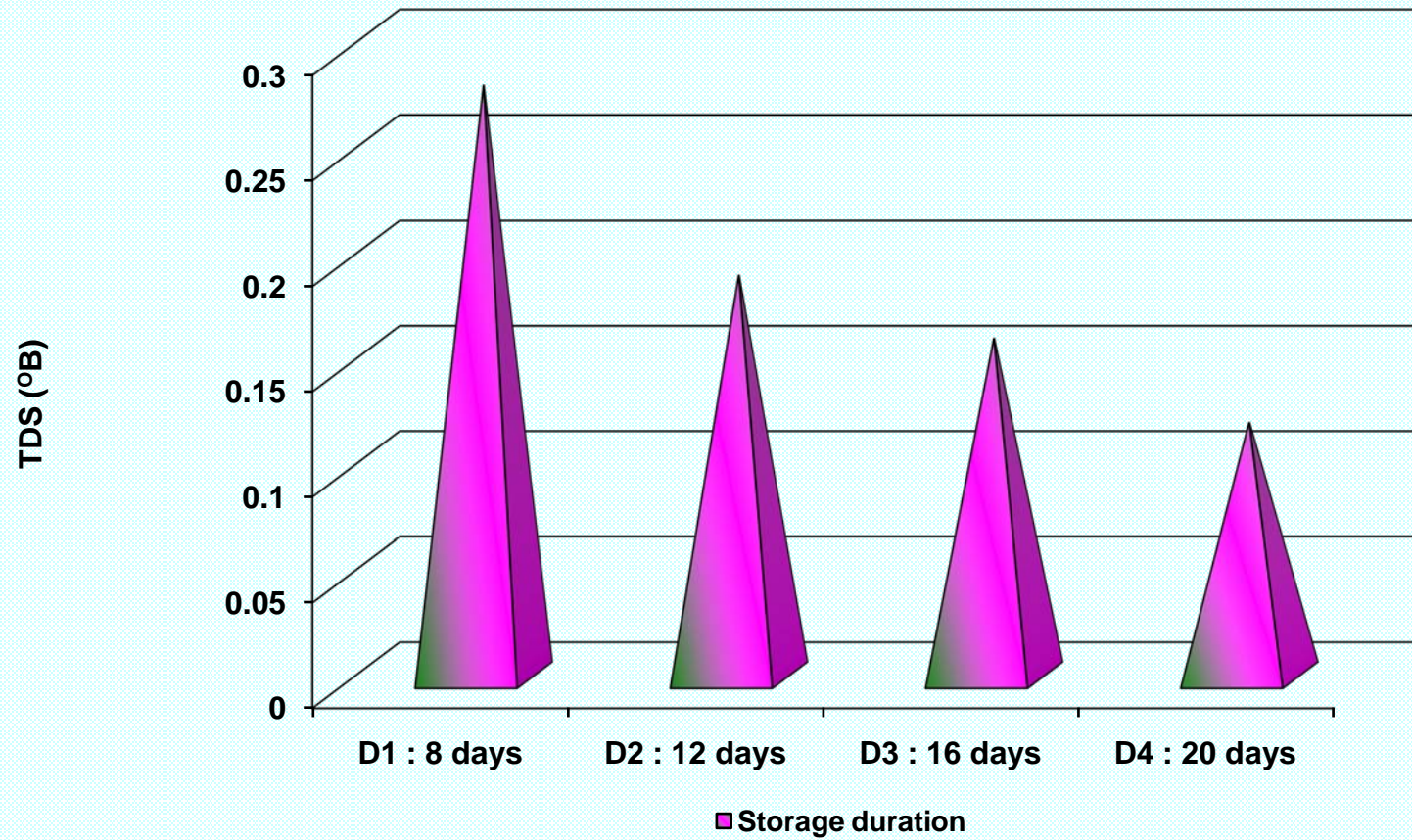


Table : 57 Effect of storage durations on total soluble sugar (TSS) (mg/gm) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	TSS (mg/gm) 4 DAS		
	2010-11	2011-12	Pooled
D₁ : 8 days	17.81	17.98	17.90
D₂ : 12 days	14.95	15.08	15.02
D₃ : 16 days	13.76	13.64	13.70
D₄ : 20 days	11.23	11.45	11.34
S. Em. ±	0.146	0.163	0.109
C.D. at 5%	0.44	0.49	0.32
C.V.%	2.26	2.51	2.39
Pooled	SEm±	C.D. at 5%	C.V. %
Y	0.077	N.S	2.39
Y × T	0.155	N.S	

Table : 58 Effect of storage durations on dry weight (%) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Dry weight (%)		
	2010-11	2011-12	Pooled
Storage duration (D)			
D₁ : 8 days	9.00	8.90	8.95
D₂ : 12 days	8.13	8.34	8.24
D₃ : 16 days	7.92	8.02	7.97
D₄ : 20 days	7.03	6.98	7.01
S. Em. ±	0.119	0.118	0.084
C.D. at 5%	0.36	0.35	0.24
C.V.%	3.32	3.28	3.30
Pooled	SEm±	C.D. at 5%	C.V. %
Y	0.059	N.S	3.30
Y × T	0.119	N.S	

Experimental Results

The data showed that different durations was significantly influence dry weight. Maximum dry weight was observed in 8 day storage (D₁, 9.00 %, 8.90 % and 8.95 %) which was statistically at par with 12 day storage (D₂, 8.13 %, 8.34 % and 8.24 %) on both the years of study and in pooled analysis, respectively. D₄, (20 day storage) recorded minimum dry weight (7.03 %, 6.98 % and 7.01 %) in 1st year, 2nd year and in pooled analysis.

4.5.2 Qualitative parameter

4.5.2.1 Flower Size (cm)

Flower size attributes in gerbera flower of “Stanza” cultivar resulting from storage period was shown in Table 59 and Figure 32.

Storage period means show that flower size increased significantly during the 2nd DAS in all the treatments after which it starts decreasing in D₃ and D₄, and from 6th DAS it decreased in all the treatments in 1st year, 2nd year and in pooled analysis.

Lowest change in flower size was recorded in D₁ (9.69 cm to 7.27 cm, 9.73 cm to 7.24 cm and 9.71 cm to 7.26 cm) on initial and 8th DAS in 1st year, 2nd year and in pooled analysis, respectively which was at par with D₂ (12 day storage duration).

4.5.2.2 Scape Bending Curvature (°)

Gerbera cv. Stanza recorded significant effect of storage duration on scape bending curvature increased with the

Table : 59 Effect of storage durations on flower size (cm) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Flower size (cm) at initial (0 th) day			Flower size (cm) at 0 th DAS			Flower size (cm) at 2 nd DAS			Flower size (cm) at 4 th DAS		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
D₁ : 8 days	9.69	9.73	9.71	9.64	9.68	9.66	10.81	10.91	10.86	9.51	9.63	9.57
D₂ : 12 days	9.63	9.69	9.66	9.53	9.60	9.57	9.98	10.03	10.01	8.62	8.78	8.70
D₃ : 16 days	9.51	9.48	9.50	8.40	8.33	8.37	8.62	9.12	8.87	7.25	6.84	7.05
D₄ : 20 days	9.77	9.55	9.66	8.13	7.84	7.99	8.24	8.15	8.20	5.58	5.42	5.50
S. Em. ±	0.129	0.143	0.096	0.093	0.120	0.076	0.142	0.121	0.093	0.119	0.123	0.085
C.D. at 5%	NS	NS	NS	0.28	0.36	0.22	0.42	0.36	0.27	0.36	0.37	0.25
C.V.%	2.99	3.34	3.17	2.32	3.02	2.69	3.36	2.84	3.11	3.43	3.59	3.51
Pooled	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %	SEm±	C.D. at 5%	C.V. %
Y	0.068	N.S	3.17	0.054	N.S	2.69	0.066	N.S	3.11	0.060	N.S	3.15
Y × T	0.136	N.S		0.107	N.S		0.132	N.S				

Treatments	Flower size (cm) at 6 th DAS*			Flower size (cm) at 8 th DAS*		
	2010-11	2011-12	Mean data	2010-11	2011-12	Mean data
D₁ : 8 days	8.08	7.96	8.02	7.27	7.24	7.26
D₂ : 12 days	7.61	7.72	7.67	****	****	****
D₃ : 16 days	6.98	6.64	6.81	****	****	****
D₄ : 20 days	****	****	****	****	****	****

Note : * Not included in statistical analysis

Fig-32 : Effect of storage duration on flower size (cm) of gerbera (*Gerbera jamesonii*) cv. Stanza (In pooled analysis)

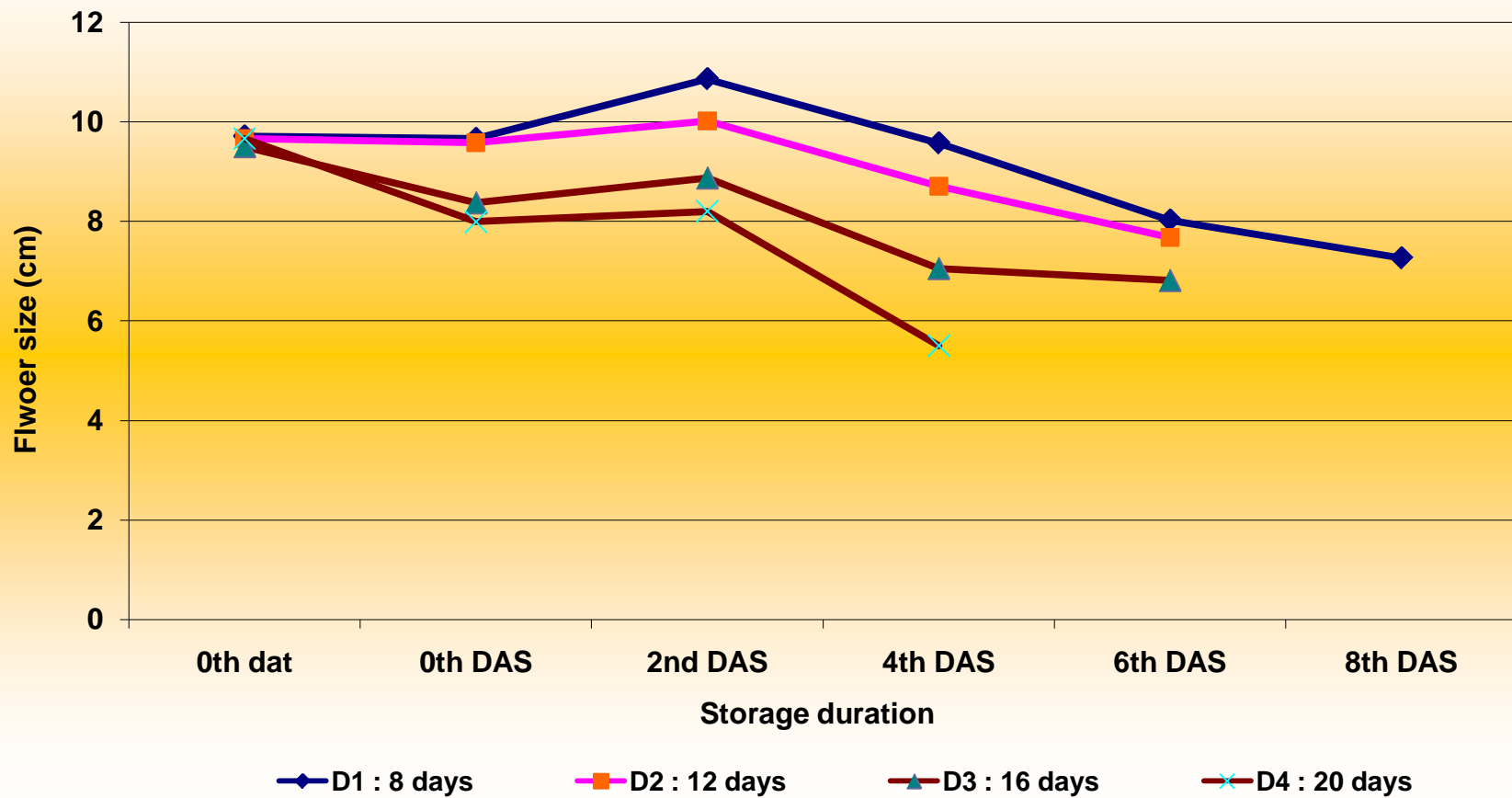


Table : 60 Effect of storage durations on scape bending curvature ($^{\circ}$) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Scape bending curvature ($^{\circ}$) at 4 th DAS			Scape bending curvature ($^{\circ}$) at 8 th DAS*		
	2010-11	2011-12	Pooled	2010-11	2011-12	Mean data
D₁ : 8 days	9.32	9.18	9.25	61.54	60.37	60.96
D₂ : 12 days	17.20	18.06	17.63	****	****	****
D₃ : 16 days	28.64	28.45	28.55	****	****	****
D₄ : 20 days	34.18	33.89	34.04	****	****	****
S. Em. \pm	0.229	0.256	0.172	****	****	****
C.D. at 5%	0.69	0.77	0.50	****	****	****
C.V.%	2.29	2.56	2.43	****	****	****
Pooled	SEm \pm	C.D. at 5%	C.V. %	****	****	****
Y	0.121	N.S	2.43	****	****	****
Y \times T	0.243	N.S		****	****	

Note : * Not included in statistical analysis

passage of time in all treatments as depicted in Table 60 and graphically drawn in Figure 33.

Minimum scape bending curvature was recorded in D₁ (8 day storage) (9.32⁰, 9.18⁰ and 9.25⁰) which was at par with D₂ (12 day storage) on 4th DAS of vase life during both years and in pooled analysis, respectively.

Maximum scape bending curvature was recorded in D₄ (20 day storage) (34.18⁰, 33.89⁰ and 34.04⁰) on 4th DAS of vase life in both the years and in pooled analysis.

4.5.2.3 Pigment Content (Anthocyanin)

The anthocyanin content at 4th and 8th days after storage was found significant in both the years and in pooled analysis in gerbera cv. stanza in Table 61 and drawn in Figure 33.

Minimum anthocyanin content in cv. stanza was recorded in the 8th day storage (D₁, 0.51 mg/gm, 0.52 mg/gm and 0.51 mg/gm) followed by D₂ (12 day storage) on 4th DAS of vase life (0.61 mg/gm, 0.62 mg/gm and 0.62 mg/gm) in 1st year, 2nd year and in pooled analysis, respectively.

However, maximum anthocyanin content was recorded in 20 day stored flowers (D₄, 0.78 mg/gm, 0.75 mg/gm and 0.77 mg/gm) on 4th day in both the year of study and in pooled analysis, respectively. At 8th day mean data was presented.

4.5.2.4 Disease Incidence

There was no disease incidence found on visual basis all storage duration.

Table : 61 Effect of storage durations on pigment content (anthocyanin) (mg/g) of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Pigment content (mg/g) at 4 DAS			Pigment content (mg/g) at 8 DAS		
	2010-11	2011-12	Pooled	2010-11	2011-12	Mean data
D₁ : 8 days	0.51	0.52	0.51	0.72	0.73	0.72
D₂ : 12 days	0.61	0.62	0.62	****	****	****
D₃ : 16 days	0.67	0.65	0.66	****	****	****
D₄ : 20 days	0.78	0.75	0.77	****	****	****
S. Em. ±	0.008	0.009	0.006	****	****	****
C.D. at 5%	0.02	0.03	0.02	****	****	****
C.V.%	2.74	3.11	2.93	****	****	****
Pooled	SEm±	C.D. at 5%	C.V. %	****	****	****
Y	0.004	N.S	2.93	****	****	****
Y × T	0.008	N.S		****	****	

Note : * Not included in statistical analysis

Fig-33 : Effect of storage duration on scape bending curvature ($^{\circ}$) and pigment content (mg/gm) of gerbera (*Gerbera jamesonii*) cv. Stanza (In pooled analysis)

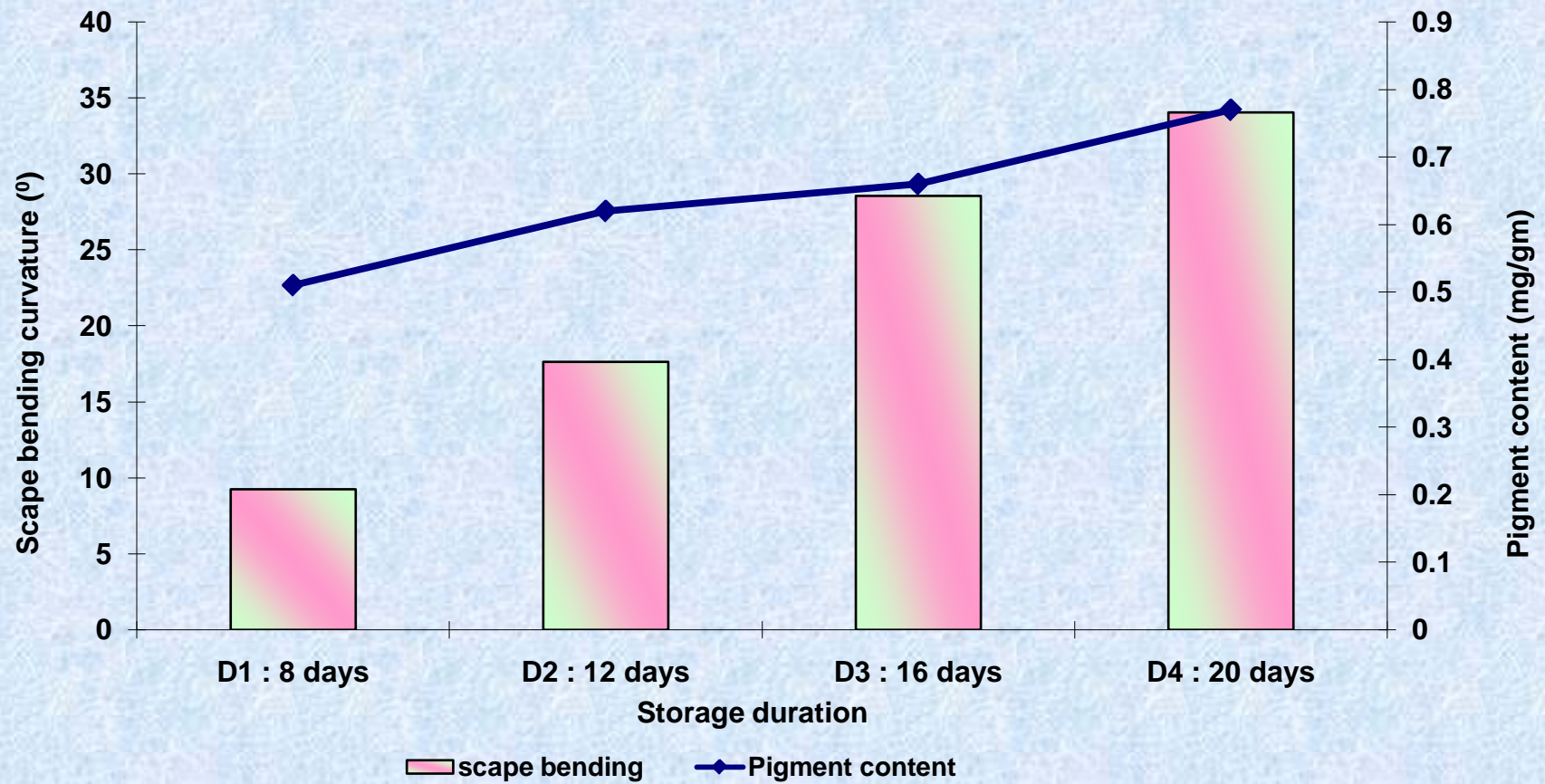


Table : 62 Effect of storage durations on vase life (days) in gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	Vase life (days)		
	2010-11	2011-12	Pooled
D₁ : 8 days	8.20	8.10	8.15
D₂ : 12 days	7.20	7.00	7.10
D₃ : 16 days	6.60	6.20	6.40
D₄ : 20 days	4.30	4.40	4.35
S. Em. ±	0.114	0.140	0.090
C.D. at 5%	0.34	0.42	0.26
C.V.%	3.88	4.86	4.39
Pooled	SEm±	C.D. at 5%	C.V. %
Y	0.064	N.S	4.39
Y × T	0.127	N.S	

Fig-34: Effect of storage duration on vase life (days) in gerbera (*Gerbera jamesonii*) cv. Stanza (In pooled analysis)

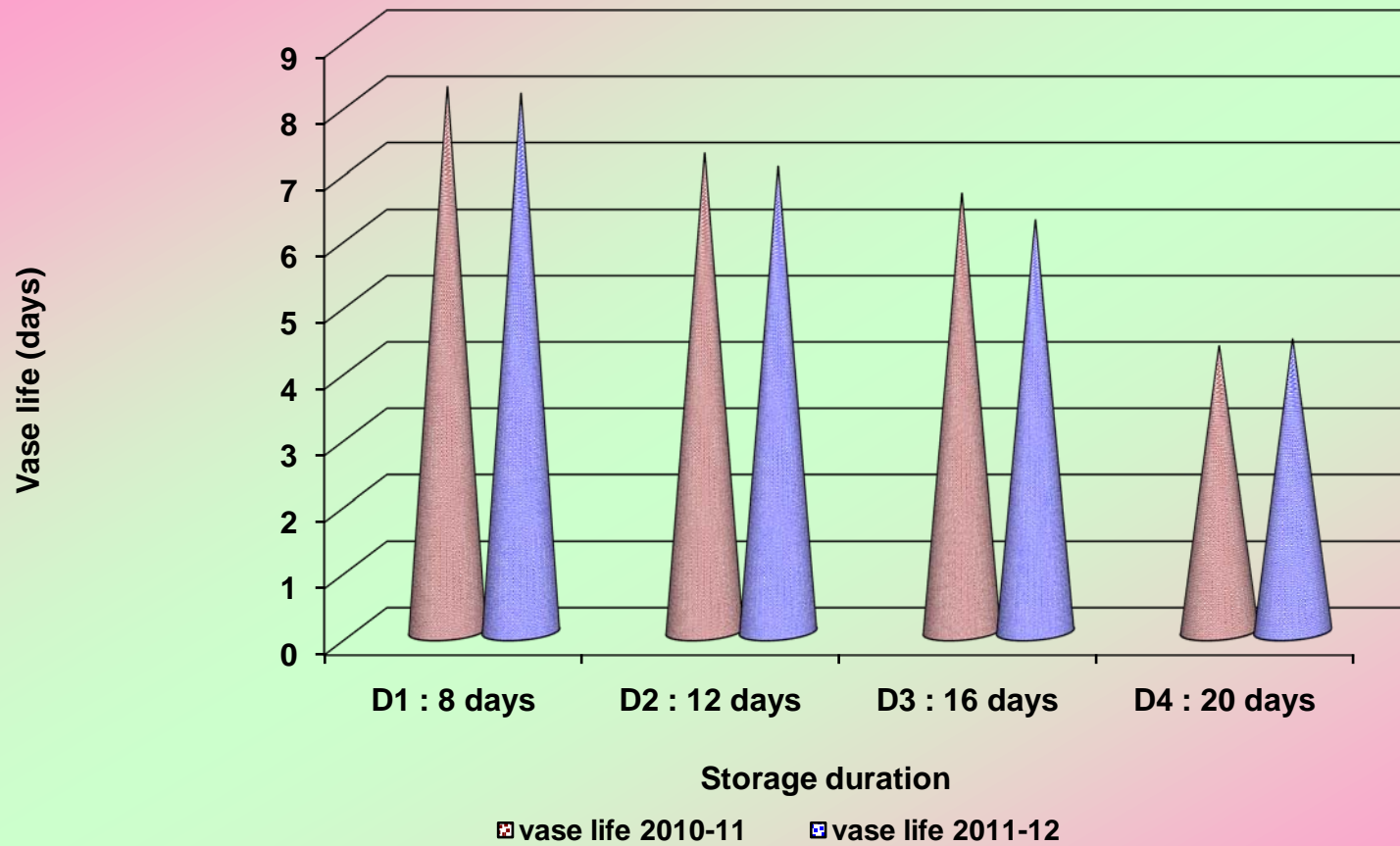




Plate-IX : Effect of storage duration of gerbera cv. Stanza at 0 DAS



Plate-X : Effect of storage duration of gerbera cv. Stanza at 4th DAS

Table : 63 Effect of storage durations on overall quality of gerbera (*Gerbera jamesonii*) cv. Stanza

Treatments	0 th DAS		2 nd DAS		4 th DAS		6 th DAS		8 th DAS	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
D₁ : 8 days	5	5	5	5	5	5	5	5	4	4
D₂ : 12 days	5	5	5	5	5	5	4	4	*	*
D₃ : 16 days	4	4	3	3	1	2	1	1	*	*
D₄ : 20 days	4	4	2	2	1	1	*	*	*	*

Note : * Indicate vase life was completed

Where,

1	Dull/Flaccid
2	Poor
3	Fair
4	Very good
5	Excellent

4.5.3 Vase Life (days) and Overall Quality

4.5.3.1 Vase Life (days)

The effect of storage duration on vase life of flower was recorded during 2010-11 and 2011-12 depicted in Table 62 and graphically illustrated in Figure 34.

Among the different storage duration 8 day storage (D₁) recorded maximum vase life (8.20 days, 8.10 days and 8.15 days) which was followed by 12 day storage (D₂; 7.20 days, 7.00 days and 7.10 days). Minimum vase life was recorded in 20 day storage (D₄; 4.30 days, 4.40 days and 4.35 days) in 2010-11, 2011-12 and in pooled analysis, respectively.

4.5.3.2 Quality Assessments: (on visual basis, 5 point scale)

The effect of storage duration on overall quality flower was visually examined at 0th DAS, 2nd DAS, 4th DAS, 6th DAS and 8th DAS on the basis of freshness, turgidity and overall acceptability and score was given (based on 5 point scale) accordingly. The result with regard to qualitative parameter has been mentioned in Table 63.

Flower stored for 8 days and 12 days at 6⁰C in polypropylene dry storage give better flower overall quality.



DISCUSSION

V. DISCUSSION

This research venture has four objectives with directions of special emphasis, first, to standardize harvest stage and stalk length in gerbera cv. Stanza, second to find out best pulsing and holding solution in gerbera cv. Stanza, third to evaluate and standardize packaging and storage technology with pre pulsing treatment in gerbera cv. Stanza and fourth standardize the cold storage durations like 8, 12, 16 and 20 days in order to increased keeping quality. Hence five experiments were conducted, *viz.*, experiment: I Standardization of harvest stage and stalk length in gerbera cv. Stanza, experiment: II Effect of pulsing on post harvest life in gerbera cv. Stanza, experiment: III Effect of holding solution on post harvest life of gerbera cv. Stanza, experiment: IV Effect of storage technique on post harvest life of gerbera cv. Stanza and experiment: V Effect of storage duration on post harvest life of gerbera cv. Stanza

Experiment: I Standardization of harvest stage and stalk length in gerbera cv. Stanza

Harvest stage (S) *viz.*, fully open ray florets, unopen disc florets (S₁), 30 % open disc florets (S₂) and 50 % open disc florets (S₃) significantly influence quantitative characters like change in fresh weight (gm), physiological loss in weight (PLW) (%), water uptake (ml), Membrane Stability Index (MSI), total dissolved solutes (TDS) and dry weight (%) and qualitative characters like flower size (cm), scape bending curvature (⁰),

pigment content (anthocyanin), vase life (days) and overall quality of gerbera cv. Stanza.

Stalk length of flower like 40 cm (L₁), 50 cm (L₁) and 60 cm(L₃) influence quantitative characters like change in fresh weight (gm), physiological loss in weight (PLW) (%), water uptake (ml), Membrane Stability Index (MSI), total dissolved solutes (TDS) and dry weight (%), qualitative characters like flower size (cm), scape bending curvature (⁰), pigment content (anthocyanin), vase life (days) and overall quality of gerbera cv. Stanza.

5.1. Effect of Harvest Stage

5.1.1.1 Quantitative Parameters

Harvest stage directly influence change in fresh weight (gm) and physiological loss in weight (%) in gerbera cv. Stanza.

Flower weight was evaluated periodically initial (0th day), 2nd day, 4th day, 6th day and 8th day. Maximum fresh weight was recorded under S₁ (fully open ray florets, unopen disc florets) as compared to 30% open disc florets (S₂) and 50 % open disc florets (S₃) in gerbera cv. Stanza.

Flower weight was directly influenced by water up take in gerbera. Weight gain in cut spikes accompanies water uptake while weight loss occurs due to continuous transpiration as well as respiration. In more advanced stages, transpiration rate is higher as compared to less advanced stages due to increased transpiring surface. The rate of respiration in many cut flowers reaches its peak at the time of the opening of flowers and then it declines

(Coorts, 1973, Bhattacharjee, 2001). In more advanced stages respiratory substrate is more, due to more number of opened florets and because of that respiration rate was higher. The increase in respiration rate directly leads to reduction in weight i.e. weight loss. In early stage of flower development less ethylene is produced than later stage. All the contributed towards higher flower weight in less advance stage as compared to more advance stage. Similar result have been reported by De and Barman (1998) in tuberose and Singh (2005) in gladiolus, Brahmankar *et al.*, (2005) in golden rod, Mangave (2010) in heliconia and Auty (2011) in orchid.

Water up take (ml) and total water up take (ml) significantly influenced by harvest stage. Maximum water uptake (ml) was found in S₁ (fully open ray florets, unopen disc florets) as compared to other harvest stage. A high level of turgidity is necessary for development of flower buds to full bloom maturity and for the continuation of normal metabolic activity in cut flowers (Rogers, 1962 and Mayak and Halevy, 1974). Turgidity is positively correlated with water uptake. Rate of transpiration and respiration increases while, absorption decreases after harvesting of flowers (Halevy and Mayak, 1974). Hence, to maintain turgidity continuous water uptake is essential. If the rate of water loss exceeds water uptake in the flower tissue, it experiences water stress. At senescence stage water uptake is known to continuously decrease (Van Doorn, 2004). In less advanced stage initially water uptake is at slow rate as the surface for transpiration is less, but with the opening of flower buds, surface of transpiration increases

but it decreases with commencement of senescence stage as also indicated by Brahmankar *et al.*, 2005 in Golden Rod and Singh *et al.*, (2003) in rose. In case of more advanced stage initially rate of water uptake is higher due to higher transpiration and respiration but due to earlier senescence total water uptake is lower as compared to less advanced stage. Staby *et al.* (1976) also reported greater water uptake in flowers harvested at bud stage as compared to fully open flowers in case of carnation, chrysanthemum and tulips. Similar effects of harvesting stages on water uptake have been recorded in golden rod (Brahmankar *et al.*, 2005) gladiolus (Singh *et al.*, 2005) and in heliconia (Mangave, 2010) and in orchid (Auty, 2011).

Membrane Stability Index (MSI) was significantly influenced by harvest stage in gerbera cv. Stanza. Physiological activities being continuous in cut flowers even after harvesting, continuous water loss and depletion of carbohydrate occur. If loss is not compensated with exogenous supply would lead to early fading or wilting i.e., water stress in the flower tissue would directly result into decrease in turgidity or wilting. At senescence stage there is loss of differential permeability which reflected in increased ion leakage, resulting in reduction in weight due to excessive water loss. Further, leakage of cell constituents due to loss of structural integrity of cell membrane results in death of flowers (Bhattacharjee, 2001). This MSI, fresh weight and water uptake maintain TDS and dry weight in gerbera cv. Stanza. Similar conclusion has been reported by Mangave (2010) in heliconia and Auty (2011) in orchid.

5.1.1.2 Quantitative Parameters

Harvest stages directly affect the flower size (cm) when shows at initial, 2nd day, 4th day, 6th day and 8th day of after harvest (Table 10). Higher flower size observed at initial (0th day) and 2nd day maximum, flower size observed with harvest at 50 % open disc florets but then after 4th, 6th and 8th day maximum flower size recovered at fully open ray florets, unopen disc florets in gerbera cv. Stanza. The expansion of cell is correlated with the carbohydrate accumulation (Waithaka *et al.*, 2001) as well as with turgidity maintenance and water uptake (Mayak and Halevy, 1974). Thus, advance harvest stage (S₃) displays more flower size at initial day but as the early stages (fully open ray florets, unopen disc florets) harvested flower start to open they show maximum flower size. Continuous water uptake and retained fresh weight helps in flower opening due to maintained flower turgidity. Similar results have been reported in orchid by (Ketsa and Boonrote, 1990) and in gladiolus by Singh *et al.* (2007).

Better results of scape bending curvature (⁰) and pigment content (anthocyanin) was found in flower harvest at fully open ray florets, unopen disc florets. More scape bending curvature and pigment content (anthocyanin) was observed in flower harvested at 50 % open disc florets. Water stress in the flower tissue would directly result into decrease in turgidity, fading or wilting of flowers. Fading can be attributed to water and carbohydrate stress (Burdett, 1970). Increase in scape bending curvature in 50% open disc florets was result of increase in water

stress due to lower water uptake loss in fresh weight and early senescence as indicated by end of vase life. Anthocyanin a water soluble pigment found in vacuoles, as water stress starts in flower the amount of anthocyanin content increase due to loss of water (Halevy and Mayak, 1974). The lower anthocyanin was due to highest water uptake, and high MSI which indicates intactness of cell structure.

5.1.1.3 Vase Life and Overall Quality

Harvest stages showed significant influence on vase life in gerbera cv. Stanza (Table 15 to 17). The maximum vase life was recorded in fully open ray florets (8.27 day) while advance stage showed minimum vase life. Any disruption in water uptake due to stem plugging leads to wilting and senescence of flowers (Halevy, 1976). A high level of turgidity that is directly correlated with water uptake is necessary for development of flower buds to full bloom maturity and for the continuation of normal metabolic activity in cut flowers (Rogers, 1962; Mayak and Halevy, 1974). If the rate of water loss exceeds water uptake in the flower tissue, it experiences water stress and further at senescence stage water uptake tends to continuously decrease (Van Doorn, 2004). Thus continuous and higher water uptake along with retained fresh weight contributed to higher vase life and overall quality in gerbera flower harvested at fully open ray florets, unopen disc florets as compared to advance stages. Similar effects on vase life with different harvest stages was reported in tuberose (De and

Barman, 1998), in Orchid (Ketsa and Kosonmethakul, 2001) and in rose (Singh *et al.*, 2003).

5.1.2 Effect of Stalk Length

Stalk length was significantly influence quantitative and qualitative parameters in gerbera cv. Stanza. Quantitative characters like change in fresh weight (gm), Physiological Loss in Weight (PLW) (%), water uptake (ml), Membrane Stability Index (MSI), Total Dissolved Solutes (TDS) and dry weight (%), qualitative characters like flower size (cm), scape bending curvature ($^{\circ}$), pigment content (Anthocyanin), vase life (days) and overall quality of gerbera cv. Stanza.

5.1.2.1 Quantitative Parameter

The different stalk length like i.e. 40 cm, 50 cm and 60 cm had significant effect on quantitative and qualitative characters i.e. change in fresh weight (gm), Physiological Loss in Weight (PLW) (%), water uptake (ml), Membrane Stability Index (MSI), Total Dissolved Solutes (TDS) and dry weight (%).

Change in fresh weight (gm), physiological change in weight (%) retention and water up take was observed significantly higher with longer stalk length then shorter stalk length. Weight of flower correlated with water up take, longer spike having more carbohydrate which helps in fresh weight retention. Further transpiration of water from flowers increases water up take due to osmotic pull, which was directly affect on flower weight (gm). The water up take decreased as the days advances irrespective of the

spike length, the total water uptake increased as the length of spike increased (Barman and Rajni, 2004). MSI decrease as cell starts starvation for food material which leads to break down of cell membrane and increase electrolytic leakage. Highest retained fresh weight and water uptake ensure continuous food and water balance in cells. This retained fresh weight, water uptake and MSI helps to maintain TDS and dry weight in gerbera flowers. Similar result was finding with Satpute and Patel (2002) and Barman and Rajni (2004) in gladiolus and Meman and Dabhi (2006) in gerbera.

5.1.2.2 Quantitative Parameters

In gerbera different stalk length significantly affect the all the quantitative parameters. Maximum flower size (cm), vase life (days) and minimum scape bending curvature ($^{\circ}$) and pigment content (anthocyanin) was observed in flower having longer stalk length. According to Sangama and Singh (1999) longer spike improved floret diameter due to higher carbohydrate availability for bud development in spike. Short stemmed flowers lasted for shorter duration, while with longer stems, flower buds developed fully, expanded well and remained fresh for a longer time therefore they expand the vase life. The carbohydrate reserved on shorter stems was less as compared to longer stem. There was successive rise in water uptake, flower diameter and longevity of flower in the vase with increase in stem length. Further, higher carbohydrate in stalk promotes respiration and expands the longevity. Similar result was obtained by Bhattacharjee, 1994 in rose, De and

Barman, 1998 in tuberose Barman and Rajni, 2004 and Satpute and Patel, 2002 in gladiolus.

5.1.2.3 Vase Life and Overall Quality

Good quality of flowers with excellent turgidity, bright colour and freshness were recorded in gerbera cv. Stanza with long stalk length. This was result of highly maintained turgidity due to higher water uptake retained fresh weight. Maximum vase life recorded in longer stalk length may be due to higher carbohydrate, this promote respiration and extending vase life (De and Barman, 1998). Similar result was obtained by (Bhattacharjee, 1994) in rose, (Satpute and Patel, 2002) and (Barman and Rajni, 2004) in gladiolus.

Experiment: II Effect of pulsing on post harvest life in gerbera cv. Stanza

5.2 Effect of Pulsing Solution Treatment

The different pulsing solution had significant effect on quantitative and qualitative parameters with respect to vase life of gerbera cv. Stanza.

5.2.1 Quantitative Parameters

Pulsing (3h) significantly influenced quantitative characters like change in fresh weight (gm), Physiological Loss in Weight (PLW) (%), water uptake (ml), Membrane Stability Index (MSI), Total Dissolved Solutes (TDS) and dry weight (%) in gerbera cv. Stanza.

All the quantitative parameters significantly influence as compared to control. Gerbera cut flowers pulsed with 8 HQC 250 mg/l + sucrose 10% (P₄) solutions showed lower physiological loss in weight (%), higher fresh weight (gm) retention and higher water uptake (ml) as compared to other pulsed cut gerbera flower of cv. stanza. Sucrose which is a source of respiratory pool help in increasing the level of moisture retention reduced transpiration loss and increased osmotic potential of the cytoplasm which helps in higher uptake. It is also known to act as an oxidisable respiratory substrate and an antidesiccant, which helps in maintaining fresh weight of the cut flowers (Marousky, 1969). Further, role of sucrose in influencing osmotic potential of petal cell and maintaining of better balance in flowers is well known (Borochoy *et al.*, 1976 and Ichimura *et al.*, 1999). 8-HQC decreased solution flow resistance by controlling microbial growth, (Burdett,1970) that restricted the growth of micro organisms in the solution and eliminated the vascular occlusion in xylem which ultimately resulted into resistance free solution flow (Singh *et al.*, 2005) and increased the uptake of sucrose solution during post period. Farther, it reduces transpiration loss of water and increase the fresh weight by partially closing the stomata (Marousky, 1969). Improved water uptake and fresh weight retention has been reported with 8-HQC and sucrose as pulse and vase solution in chrysanthemum (Bhat *et al.*, 1999), in orchids (Ketsa and Kosonmethakul, 2001; Dineshababu *et al.* 2002), in roses (Bhattacharjee, 1993; Madhubala *et al.* 2008), in tuberose (Kumar *et al.* 2007) in chrysanthemum (Suresha *et al.* 2009).

Consequence of the improved water balance, the cut flowers are believed to maintain their fresh weight for longer duration. The present investigation clearly supports their view point.

MSI in petal tissue was progressively decreased with advancement of flower stage at 4th and 8th day. The untreated (Control) cut flower of gerbera recorded maximum electrolyte leakage in petal tissue on 4th and 8th day (Table 22) whereas, those spikes treated with 8-HQC 250 mg/l + Sucrose 10 % (P₄) recorded significantly least recorded on 4th and 8th day. The electrolyte leakage continuously increased in all the treatments with the advance of flower life. The leakage of ions is known to coincide with the decrease in water content of the petals in rose (Meeteren, 1979, Singh *et al.*, 2008). The disturbed water relations in control lead to early breakdown of plasma membrane which released the leachates into the interspaces of plant tissue (Bhaskar *et al.*, 2006) as indicated by high electrolyte leakage. Further, Sucrose known to stabilize selective permeability of cell membrane contributed to lower electrolyte leakage (Santarius, 1973; Van Doorn, 2004). 8-HQC (being antibacterial) and sucrose being osmoticum improved water uptake (Table 4.7) retain petal turgor contributed to lower electrolyte leakage. Similar effects of reducing the electrolyte leakage with 8-HQC and sucrose as pulse or vase solution in rose (Pal *et al.*, 2003) and in gladiolus (Singh *et al.*, 2005; Singh *et al.*, 2007; Singh *et al.*, 2008)

Enhanced water uptake and (retained fresh weight maintain TDS) maintained levels of respiratory substrates as

evident from high petal TDS (Table 23) and dry weight further contributed to higher fresh weight retention of cut gerbera.

5.2.2 Qualitative Parameters

Qualitative characters like flower size (cm), pigment content in petals (anthocyanin) and scape bending curvature ($^{\circ}$) were significantly influenced by pulsing treatment in gerbera cv. Stanza.

This may be due to fully turgid petal cell and intact cell membrane because of higher water uptake as also suggested by Torre *et al.*, (1999) and the up-regulation of optimum metabolic activities (Halevy and Mayak, 1981). Further, higher respiratory substrate and increased level of sugar in petal (TDS status, Table 4.2.5) facilitated higher rate of respiration necessary of cell division and cell enlargement (Ho and Nichols, 1977) which lead to high petal expansion and increase in bud size and petal size. Pulsing treatment can be attributed to better water balance in flowers due to high water uptake (Table 21) as explained earlier, high respiratory substrate for metabolic activities as a result of low PLW % after storage (Table 20), as well as to high membrane stability index (MSI) (Table 22). 8-HQC has strong antimicrobial activity (Marousky, 1971) that restricted the growth of microorganisms in the solution and eliminated the vascular occlusion in xylem which ultimately resulted into resistance free solution flow (Singh *et al.*, 2005), it reduced scape bending curvature. Further, retention of pigment (anthocyanin) also contributed to good appearance. Whaithaka *et al.*, (2001) also

reported opening of gladiolus florets accompanied by increase in fresh weight, dry weight and carbohydrate content of the perianth. Similar effects of improving Qualitative characters with 8-HQC and sucrose reported in chrysanthemum (Bhat *et al.*, 1999), in anthurium (Maitra and Roychowdhari, 2005)

5.4.3 Vase Life and Overall Quality

Good quality of flowers with excellent turgidity, better colour and freshness were recorded in gerbera cv. Stanza. This was the result of highly maintained turgidity due to higher water uptake, retained fresh weight and low electrolytic leakage. Retention of pigment content (anthocyanin) in gerbera petals (Table 27) and maintained membrane stability as explained earlier, further resulted in improved overall flower quality and vase life in 8-HQC 250 mg/l + Sucrose 10 % pulsed gerbera cut flowers.

Gerbera cut flowers treated with different pulsing solutions, recorded significantly enhanced vase life as compared to untreated (control) cut flowers (Table 28). The maximum longevity of cut flowers was observed in treatment of P₄ (8-HQC 250 mg/l + sucrose 10 %, 10.90 days). The enhanced vase life of gerbera cut flowers in this treatment can be attributed to increase water uptake, higher retention of fresh weight and high petal sugar status (as explained earlier). These conditions contributed to optimum continuation of the cell metabolism that facilitated cell growth and development, formation of cellular constituents and the liberation of energy for other cellular functions. Further, it reduced water stress and stabilized membrane integrity and cellular structure as

indicated by maintained higher membrane stability index ultimately delayed petal senescence and increase the longevity. Use of antioxidants in retaining membrane integrity and for antisenescence effects during aging has been known (Singh, 2005). Thus, antioxidant property of HQC contributed to enhance vase life. Similar effects of improving vase life with 8-HQC and sucrose reported in chrysanthemum (Bhat *et al.*, 1999), in *Dendrobium* cv. hybrid Sonia-17 (Dineshababu *et al.*, 2002), in golden rod (Brahmankar *et al.*, 2005) and in gerbera (Patel *et al.*, 2008).

Experiment:III Effect of holding solution on post harvest life of gerbera cv. Stanza

5.3 Effect of Holding Solution

Different holding solution had significant effect on quantitative and qualitative parameters with respect to vase life of gerbera cv. Stanza.

5.3.1 Quantitative Parameters

Holding solution (H) significantly influenced quantitative characters like change in fresh weight (gm), Physiological Loss in Weight (PLW) (%), water uptake (ml), Membrane Stability Index (MSI), Total Dissolved Solutes (TDS) and dry weight (%) in gerbera cv. Stanza.

All the quantitative parameters significantly influenced as compared to control. Gerbera cut flowers kept in holding solution with Citric acid 300 mg/l + Sucrose 2 % (H₁) solutions

showed lower physiological loss in weight (%), higher fresh weight (gm) retention and higher water uptake (ml) which was at par with Citric acid 500 mg/l + Sucrose 2 % (H₂) and 8-HQ 200 mg/l + Sucrose 2 % compared to other holding solutions. Citric acid is a regular ingredient in many vase solution formulations; it acts as a pH regulator, reduces bacterial proliferation and enhances the water conductance in xylem of cut flowers (Goszczyńska and Rudnicki 1988, van droon, 2010). Significantly higher water uptake and water maintenance in cut flowers, subsequently increase the cut flower fresh weight as earlier known (Mayak and Halevy, 1974). Similar finding was reported with Madhavi, 2007 and Javad *et al.*, 2011 in gerbera and Mashhadian *et al.*, 2012 in chrysanthemum. Burdett (1970) reported that stem sterilization with 8-HQ solution decreased solution flow resistance by controlling microbial growth. Apart from being a broad spectrum bactericide and fungicide, 8-HQ has been reported to reduce physiological stem blockage in sterile tissue (Halevy and Mayak, 1981). Thus, it maintains clear solution flow inside stem and in flower tissue. This would have facilitated the higher intake of the sugar in the cell, which further enhanced water uptake due to osmotic pull (Ho and Nichols, 1975). It also known to be involved in mobilization of stored food (Srivastava, 2005) and further, it increase water uptake and water retention capacity in some plant tissues. These results are in confirmation with the finding of Bhat *et al.*, 1999 in chrysanthemum and Singh *et al.*, 2005 in gladiolus.

In case of MSI in petals, TDS and Dry weight (%) significantly higher observed with Citric acid 300 mg/l + Sucrose

2% (H₁) solutions as compared to other holding solution. The role of citrate as the substrate for synthesis of fatty acids (Ratledge, 2004), might describe part of responses by enforcing cell membranes with extra fatty acid production. Sucrose provides energy for fundamental cellular processes, such as maintenance of the structure and function of mitochondria and other organelles (Nowak and Rudnicki, 1990). The adequate levels of water balance and carbohydrate content in the petal cells (high TDS, Table 34) retained the bio-membrane fluidity and permeability and thus contributed in high MSI of the petal tissue as also reported by Singh *et al.*, (2007) in gladiolus. Higher Total dissolved solutes in the petal was maintained by Citric acid 300 mg/l + Sucrose 2 %. This can be attributed to lower degradation of cellular components and maintained levels of macro and micro molecules in petal cells due to higher fresh weight, dry weight and water uptake. This is also evident from high total soluble sugar and higher maintained membrane stability index (MSI) of the petal tissue. Similar effects of citric acid and sucrose was shown in rose (Patil and Singh, (1995), in Tuberose (Bhasker *et al.*, 2000) and in Gerbera (Javad *et al.*, 2011).

5.4.2 Qualitative Parameters

Qualitative characters like flower size (cm), pigment content in petals (anthocyanin), scape bending curvature (°) and overall flower quality were influenced by pulsing treatment in gerbera cv. Stanza.

Starch and sugars stored in the stem, leaves, and petals provide much of the food needed for cut flower opening and maintenance (Kader, 2002). Citric acid is considered to maintain the water balance and to reduce bacterial proliferation in vase solution, thus avoiding the obstruction of the xylem vessels. When combined with other substances, Citric acid gave the best result in terms of flower size, minimum scape bending and anthocyanin content compared to other combinations (Halevy *et al.*, 1978). It is possible that combining sucrose with Citric acid or other substances may produce additive or synergistic effects, either by increasing the vase life and quality of flowers or by reducing disease severity. Halevy *et al.*, 1978 also observed the similar result in bird of paradise flowers.

5.3.3 Vase Life and Overall Quality

Good quality of flowers with excellent turgidity, bright colour and freshness were significantly recorded in gerbera cv. Stanza when treated with Citric acid 300 mg/l + Sucrose 2 %. Citric acid treatment extended vase life in association with inhibition of ethylene production (Srivastava and Dwivedi, 2000). Citric acid is known as an acidifier which inhibits the growth of microorganisms and commercially advice for a number of cut flowers including chrysanthemum (Dole *et al.*, 1999). Citric acid can alleviate water uptake and extend vase life due to anti-embolism trait (Bhattacharjee *et al.*, 1993). Petals of a cut flower are the main ornamental parts and turgidity of these parts is important for a good looking product. Petal turgidity depends

largely on water uptake. Similar findings were observed (Bhat *et al.*, 1999) in chrysanthemum and (Singh *et al.*, 2005) in gladiolus.

Experiment: IV Effect of storage techniques on post harvest life of gerbera cv. Stanza

5.4.1 Quantitative Parameters

Storage techniques (wet and dry storage) had significant effect on physiological losses in weight in gerbera cut flowers, cv. Stanza just after storage at 6°C temperature for duration of 7 days.

Change in fresh weight (gm), physiological change in weight (%) and water up take (ml) Polypropylene packed in cold storage (6°C) of gerbera cut flowers exhibited, lower physiological losses in weight, as compared to CFB box. Wet storage (with AgNO₃, Sodium benzoate and water) showed minimum loss of water observed with sodium benzoate, where as dry stored CFB box flowers suffered maximum physiological loss in weight stored at 6°C temperature for 7 days.

The polypropylene packaging films possess low air permeability property (air diffusion rate) across the film, sealed packaging of fresh commodity with a film of selective permeability was also referred as passive modified atmosphere packaging (MAP) (Farber *et al.*, 2003). Such conditions are known for the evolution of beneficial equilibrium of modified atmosphere (EMA) with high CO₂, and low O₂ and high relative humidity on account of products, flowers and metabolic activities *viz.* respiration and transpiration. This further cause closure of stomata

and minimize the respirational loss of carbohydrates as well as transpirational loss of water from the cut flower and thereby retains higher fresh weight in flowers (Zeltzer *et al.*, 2001). Thus, polypropylene packaging of cut gerbera accompanied by low temperature (6°C) storage resulted into minimum PLW. This is also reported by Grover *et al.*, (2005) and Singh *et al.*, (2007) in polypropylene packed low temperature stored gladiolus.

MSI in petals, TDS and dry weight (%) significantly higher observed with pp (polypropylene) packaged gerbera cut flowers stored at low temperature (6°C).

Higher total dissolved solids in PP packaging can be attributed to lower degradation of cellular components and maintained levels of macro and micro molecules in petal cells due to higher fresh weight, dry weight and water uptake. Further, the adequate levels of water balance, higher water uptake and carbohydrate content in the petal cells of the polypropylene packaged gerbera cut flowers retained the bio-membrane fluidity and permeability and thus contributed in high MSI of the petal tissue as also reported by Singh *et al.*, (2007) and Yamane *et al.*, (1999) in gladiolus. The significant decrease in MSI in the petals of cut gerbera flowers dry stored in CFB box and wet storage was due to desiccation (high PLW%), water and sugar stress (low water uptake, petal TDS) and early senescence with shorter vase life as also observed in gladiolus by Singh, (2005) and in rose by Bhaskar *et al.*, 2005. Higher dry weight in polypropylene packaged cold stored (6°C) gerbera cut flowers can also be attributed to low

respiration loss of carbohydrates (during storage) and maintained high TDS in petals and higher MSI of petal tissues.

5.4.2 Qualitative Parameters

Different storage technologies had significant effect on various qualitative parameters like flower size, scape bending curvature and anthocyanin content in gerbera cut flowers cv. Stanza.

Flower size, including flower diameter were significantly higher in PP packaged cold stored (6⁰C) gerbera cut flowers as compared to other storage technology. The enhanced water uptake (Table 43) by PP packaged cut gerbera flowers after storage might have increased the cell-turgidity and cell enlargement leading to petal expansion. Further maintained level of sugar in petals of polypropylene packaged cut flowers as evident from higher total dissolved solids (Table 45) might have facilitated higher rate of respiration necessary for cell division and cell enlargement for development of the tissue structure (Ho and Nichols, 1977). This would have further contributed to increased flower size of PP packaged flowers cold stored gerbera cut flowers. Petal cells of dry stored gerbera cut flowers being water and sugar stressed may have resulted into improper water uptake (Table 43). Similar result was observed by (De and Bhattacharjee, 1997; Singh *et al.*, 2008; Singh *et al.*, 2007) and in rose (Singh and Mirza, 2004).

Polypropylene packaged cold stored (6⁰C) gerbera cut flowers showed significantly lower scape bending curvature as

compared to other storage. Lower scape bending curvature in PP packaged cold stored gerbera cut flowers at lower temperature (5⁰C) can be attributed to better water balance in stem and petals with maintained high water uptake, fresh weight and high petal TDS, as explained earlier. Correlation of low water uptake with high scape bending has been well established (Marousky, 1986). Similar results were earlier recorded in gladiolus in rose (Parups and Voisey, 1976) and (Yamane *et al.*, 1999). Increase in bent in wet stored flowers on 4th and 8th DAS was result of increase in water stress due to lower water uptake and senescence as indicated by end of vase life (Table 50).

5.4.3 Vase life and Quality

Storage technology showed significant influence on vase life and over all flower quality (on visual basis) in gerbera cv. Stanza. Maximum vase life and good quality (on the basis of turgidity, colour and freshness) was observed with the PP (polypropylene) packaged cut gerbera. Vase life and other quality parameters PP packaging showed better results. There was minimal cell damage in PP packaged rose cut flowers during storage as indicated by lower physiological loss in weight (PLW%). Further, there was continued and increased water uptake in the cut flowers during vase life after storage, followed by higher retention of fresh and dry weight and high content of total dissolved solids (TDS) in petals. These conditions contributed to optimum continuation of the cell metabolism for facilitation of cell growth and development, formation of cellular constituents and the liberation

of energy for other cellular functions. It reduced water stress, diminished ion leakage, and stabilized membrane integrity and cellular structure with higher MSI of petal tissue ultimately delayed petal senescence and increase flower longevity and improved flower quality. In addition to this, enhanced flower size, reduced bent neck and high stem turgidity and maintained petal pigments lead to improved over all flower quality of PP packaged cold stored over other storage techniques in gerbera cut flowers.

The significant decrease in vase life and quality of cut flowers dry stored in CFB box cut flowers was due to severe desiccation (due to high PLW%), water and sugar stress (low water uptake, petal TSS and TDS) and enhanced leakage of ions and decreased membrane stability index (MSI) which lead to short vase life (Jain *et al.*, 2007). Similar effects of packaging and cold storage have been reported in (Bhattacharjee, 1997)

Experiment: V Effect of storage duration on post harvest life of gerbera cv. stanza

5.5 Effect of Storage Durations

Best harvest stage (fully open ray florets, unopen disc florets) with 60 cm stalk length, (resulting from experiment I), best pulsing (8-HQC 250 mg/l + Sucrose 10 %) and post harvest holding solution Citric acid 300 mg/l + Sucrose 2 %) along with Dry storage + packaging material polypropylene (PP) significantly influence all quantitative parameters, qualitative Parameters and vase life and overall quality in gerbera cv. Stanza.

5.5.1 Quantitative Parameters

Significant influence of storage duration on various quantitative parameters like change in fresh weight, Physiological Loss in Weight (PLW%), water uptake, petal TDS and TSS, MSI and dry weight was observed in PP packaged cold stored gerbera cut flowers cv. Stanza.

The trend showed a decrease in vase life and quality with increase in storage duration. However, the PP packaged and cold stored cut gerbera stored for duration of 8 to 20 days.

Sealed packaging of fresh flowers with PP is known to develop MA (modified atmosphere) condition in cold storage. These conditions on account of low air permeability of PP packaging and metabolic activities of flowers lead to modifications of internal air constituents i.e. high CO₂, low O₂ and high relative humidity within the package (Zeltzer *et al.*, 2001). These conditions influence stomatal closure and further minimize respirational and transpirational loss from flowers. Thus, minimal respirational loss of CHO and water contributed to maintained fresh weight during storage for long duration i.e. up to 20 days. The minimal PLW during storage indicate minimal cell damage and xylem structure during storage duration which further contributed in enhancing water uptake and fresh weight after storage. In cold stored flowers for long duration higher PLW indicates some damage to xylem structure and decreased respiratory substrate. These conditions would have caused lower uptake of water uptake, low fresh and dry weight, decline in MSI

of petal tissue, low petal TDS and TSS in gerbera. This further resulted into decline in vase life as well as in qualitative parameters like higher pigment content, decrease in flower size and higher scape bending curvature. Many researchers studying storage techniques in cut flowers have reported adverse effect of increase in storage duration on flower quality and vase life of cut flowers like in rose (Palanikumar and Bhattacharjee, 2001 and Jain *et al.*, 2007), an in gladiolus (Singh *et al.*, 2007b), etc. Possibility of exploitation of sealed packaging of cut flowers with polypropylene films in cold storage for long term storage without much adverse effect on quality and vase life of cut flowers have been indicated in gladiolus (Singh *et al.*, 2005).

5.5.2 Qualitative Parameters

Qualitative parameters like flower size, anthocyanin and scape bending curvature were significantly influenced by storage duration.

This further resulted into decline in vase life as well as in qualitative parameters like higher pigment content, decrease in flower size and higher scape bending curvature. Many researchers studying storage techniques in cut flowers have reported adverse effect of increase in storage duration on flower quality and vase life of cut flowers like in rose (Palanikumar and Bhattacharjee, 2001 and Jain *et al.*, 2007), an in gladiolus (Singh *et al.*, 2007 and Grover, 2006), etc. Possibility of exploitation of sealed packaging of cut flowers with polymeric films in cold storage for long term

storage without much adverse effect on quality and vase life of cut flowers have been indicated in gladiolus (Singh *et al.*,2005).

5.5.3 Vase Life and Overall Quality

The trend showed a decrease in vase life and quality with increase in storage duration. However, the PP packaged and cold stored cut gerberas stored for duration of 8 to 20 days were at par with fresh flowers. PP packaged gerbera cut flowers stored for more duration of days showed a decline in qualitative and quantitative parameters as compared to short duration.



SUMMARY AND CONCLUSIONS

VI. SUMMARY AND CONCLUSION

Gerbera is the fourth most important cut flower in the world trade. It is gaining commercial importance in floriculture trade due to tremendous variability with reference to wide range of flower colours, shapes and sizes. Though the cut flower is harvested at right stage, proper post harvest handling methods are imperative to extend its vase life. Apart from grading, pre-cooling and pulsing, appropriate packing methods are most important to keep the cut flowers without deteriorating their quality until they reach the consumers. Water loss and external conditions are detrimental to the transported flowers. The main principles of packaging towards long storage life and keeping quality are to lower the rate of transpiration, respiration, and cell division during transportation and storage. Since flowers are delicate and highly perishable, they need great attention through advanced technologies in packaging to keep them fresh for consumer's satisfaction. Hence, the research work entitled 'Post harvest study on gerbera (*Gerbera jamesonii*) cv. Stanza' was conducted with a view to improve the post harvest flower quality and to enhance the vase life.

The experimental findings pertaining to the effect of different post harvest techniques adopted i.e. harvest stage, stalk length, pulsing solution, holding solution, storage techniques with cold storage (6°C) and storage duration on gerbera cut flowers quality and vase life are summarized as follows:

6.1 Standardization of Harvest Stage and Stalk Length

The effect of different harvest stages *viz.*, fully open ray florets, unopened disc florets (S_1), 30% open disc florets (S_2) and 50% open disc florets (S_3) with stalk length 40 cm (L_1), 50 cm (L_2) and 60 cm (L_3) was studied on the quality and vase life of gerbera cut flowers. The observations on different quantitative and qualitative parameters related to the post harvest life and quality were recorded during the vase life period when the cut flowers were held in water.

6.1.1 Effect of Harvest Stage

6.1.1.1 Quantitative Parameters

- 1) The maximum fresh weight was observed with flower harvested at fully open ray florets, unopen disc florets at 4th and 6th day (95.83 gm and 77.17 gm, respectively). At 8th day mean data presented maximum fresh weight observed with (S_1) in gerbera cv. Stanza.
- 2) Physiological change in weight (%) was observed at every alternate day in gerbera cv. Stanza. At 2nd day flower retain weight then afterwards, it was observed to be decreasing. The minimum physiological change in weight observed in flower harvested at fully open ray florets, unopen disc florets i.e. 6.41 %, -4.12 %, -20.11 % and -31.85 % at 2nd, 4th, 6th and 8th day, respectively. Maximum physiological loss was observed with 50% open disc florets.

- 3) Higher water uptake (106.40 ml) experiential when flower harvested at fully open ray florets, unopen disc florets in gerbera cv. Stanza.
- 4) MSI in petal (%) higher reported with fully open ray florets, unopen disc florets (21.80 % and 13.97 %) at 4th day and 8th day in gerbera cv. Stanza.
- 5) The data related to TDS (⁰B) and dry weight (%) was maximum observed with fully open ray florets, unopen disc florets i.e. 11.34 ⁰B and 7.30 %, respectively in gerbera cv. Stanza.

6.1.2 Qualitative Parameters

- 6) Higher flower size was observed with flower harvested at fully open ray florets, unopen disc florets at 4th and 6th day (9.71 cm and 8.50 cm, respectively). At 8th day mean data presented maximum fresh weight observed with (S₁) in gerbera cv. Stanza.
- 7) Scape bending curvature (⁰) was observed periodically at 4th day and 8th day. Maximum scape bending curvature (⁰) observed with 50% open disc florets (S₃; 28.21⁰) were as minimum observed with fully open ray florets, unopen disc florets (S₁; 21.28⁰ and 68.08⁰) at 4th and 8th day in gerbera cv. Stanza.
- 8) Higher pigment content (anthocyanin) was recorded in 50 % open disc florets and minimum was recorded in fully open

ray florets, unopen disc florets in gerbera cv. Stanza at 4th day.

6.1.1.3 Vase Life and Overall Quality (on visual basis):

- 9) Higher vase life was observed when gerbera flower was harvested at fully open ray florets, unopen disc florets (8.27 days) and minimum vase life recorded with 50% disc florets (6.60 days) in gerbera cv. Stanza.
- 10) Overall quality of gerbera cv. Stanza was observed maximum with excellent colour, turgidity and freshness on visual score in flower harvested at fully open ray florets, unopen disc florets.

6.1.2 Effect of Stalk Length

6.1.2.1 Quantitative Parameters

All quantitative parameters like change in fresh weight (gm) every alternate day, physiological change in weight (%), water uptake (ml), Membrane Stability Index (MSI) in petals, Total dissolved solutes (⁰B) and Dry weight (%) were maintained higher in 60 cm stalk length compared to other stalk length 50 cm and 40 cm during vase life period in gerbera cv. Stanza.

6.1.2.2 Qualitative Parameters

Qualitative parameter like flower size (cm) was recorded higher in 60 cm stalk length as compared to 50 cm and 40 cm whereas, qualitative parameters like scape bending curvature (⁰), pigment content (mg/gm) were recorded minimum in 60 cm stalk length as compared to 50 cm and 40 cm in gerbera cv. Stanza.

6.1.2.3 Vase Life and Overall Quality (on visual basis)

In case of three stalk lengths *viz.* 40 cm, 50 cm and 60 cm, enhanced vase life and maintained overall quality were recorded in 60 cm stalk length as compared to other two stalk length in gerbera cv. Stanza.

6.2 Standardization of Best Pulsing Solution

6.2.1 Quantitative Parameters

- 1) The change in fresh weight was influenced with the different pulsing solutions in gerbera cv. Stanza in both the year and in pooled analysis. Maximum fresh weight was observed with treatment P₄ (8 HQC 250 mg/l + Sucrose 10 %) (111.62 gm, 105.92 gm, 98.86 gm and 77.07 gm, respectively) which was at par with Ascorbic acid 250 mg/l + Sucrose 10 % on 4th day, 6th day, 8th day and 10th day in gerbera cv. Stanza.
- 2) 8-HQC 250 mg/l + Sucrose 10 % gave good result with regard to minimum physiological loss in weight (11.56 %, -3.28 %, -4.82 %, -7.16 % and -21.68 %, respectively) which was followed by Ascorbic acid 250 mg/l + Sucrose 10% at 2nd, 4th, 6th, 8th and 10th day in pooled analysis. Maximum loss was observed in control (7.16 %, 6.77 %, 10.51 % and 27.56 %, respectively) on 2nd, 4th, 6th, 8th day in pooled analysis.
- 3) Higher water uptake (45.58 ml, 43.38 ml, 38.48 ml, 34.50 ml and 28.90 ml) was recorded in treatment P₄ (8 HQC 250 mg/l + Sucrose 10 % solution), at 2nd, 4th, 6th, 8th and 10th day in

2010-11, whereas, total water uptake (191.82 ml) was recorded in pooled analysis in gerbera cv. Stanza.

- 4) MSI maximum (74.85 % to 50.77 %, 73.92 % to 51.91 % and 74.38 % to 51.34%) was recorded in (8 HQC 250 mg/l + Sucrose 10 % solution) at 4th day to 8th day in gerbera cv. Stanza during both the years and pooled analysis, respectively.
- 5) TDS was recorded maximum with pulsing solution of 8 HQC 250 mg/l + Sucrose 10 % (P₄; 11.23⁰B, 11.27⁰B and 11.26⁰B) which was at par with Ascorbic acid 250 mg/l + Sucrose 10 % at 4th day during 2010-11, 2011-12 and pooled analysis respectively.
- 6) Dry weight (8.76%, 8.47% and 8.62%) was recorded to be higher in treatment P₄ (8-HQC 250 mg/l + Sucrose 10 % solution), which was at par with treatment P₃ (Ascorbic acid 250 mg/l + Sucrose 10 % solution) at 4th DAS during 2010-11, 2011-12 and pooled analysis respectively.

6.2.2 Quantitative Parameters

- 7) At 2nd, 4th, 6th, 8th and 10th day, maximum flower size (10.73 cm, 10.97 cm, 10.19 cm, 9.03 cm and 7.78 cm, respectively) was recorded when gerbera cv. Stanza pulsing with 8 HQC 250 mg/l + Sucrose 10 %, which was statistically at par with Ascorbic acid 250 mg/l + Sucrose 10 % in pooled analysis.
- 8) Minimum scape bending (15.30° to 33.71°, 14.00° to 32.84° and 14.65° to 33.28°) was observed with pulsing in (8-HQC 250 mg/l + Sucrose 10 % solution), which was followed by

Ascorbic acid 250 mg/l + Sucrose 10 % at 4th to 6th DAS during both the years and pooled analysis, respectively. Whereas, gerbera cut flowers cv. Stanza without pulsing suffered maximum scape bending curvature, at 4th and 8th day during both the years and in pooled analysis.

- 9) The maximum anthocyanin content in petals was recorded in control (0.21 mg/gm and 0.98 mg/gm), whereas minimum anthocyanin content was registered in 8 HQC 250 mg/l + Sucrose 10 % (0.20 mg/gm and 0.73 mg/gm) in gerbera cv. Stanza during pooled analysis at 4th and 8th day, respectively. There was no incidence of disease found on visual basis in all pulsing solution.

6.2.3 Vase Life and Overall Quality (on visual basis)

- 10) Maximum vase life (10.85 days) and overall quality was observed with 8 HQC 250 mg/l + Sucrose 10 % pulsing solution in gerbera cv. Stanza.

6.3 Standardization of Best Holding Solution

6.3.1 Quantitative Parameters

- 1) Maximum fresh weight was observed in cut flowers kept in solution containing Citric acid 300 mg/l + Sucrose 2 % H₁ treatment (115.54 gm, 112.04 gm, 104.86 gm, 87.81 gm and 67.97 gm on 4rd, 6th, 8th, 10th and 12th day, respectively) followed by H₂ (112.22, 108.59 and 101.08 gm, respectively) and H₈ treatments (112.05, 108.14 and 100.00 gm, respectively) in pooled analysis.

- 2) Minimum physiological loss in weight (13.89 %, -0.60 %, -3.09 %, -6.30 %, -16.50 % and -22.74 %) was recorded in Citric acid 300 mg/l + Sucrose 2 % (H₁), followed by Citric acid 500 mg/l + Sucrose 2 % (H₂) on 2nd, 4th, 6th, 8th, 10th and 12th day, respectively in pooled analysis in gerbera cv. Stanza.
- 3) Maximum water uptake (51.08 ml, 50.60 ml, 48.30 ml, 45.35 ml, 40.32 ml and 36.23 ml on 2nd, 4th, 6th, 8th, 10th, 12th day) and total water uptake (271.84 ml) was observed with Citric acid 300 mg/l + Sucrose 2 % respectively in pooled analysis followed by Citric acid 500 mg/l + Sucrose 2 % in gerbera cv. Stanza.
- 4) Higher MSI was observed in Citric acid 300 mg/l + Sucrose 2 % (86.31 % to 87.42 %, 86.87 % to 78.45 % and 79.02 % to 78.74 %) on 4th to 8th day in 2010-11, 2011-12 and pooled analysis respectively.
- 5) Higher TDS (41.31°B, 14.52°B and 14.42°B) was recorded with H₁ (Citric acid 300 mg/l + Sucrose 2 %) followed by Citric acid 500 mg/l + Sucrose 2 % (14.03°B, 14.14°B and 14.09°B) while lowest in control (6.51°B, 7.08°B and 6.80°B) during both the years and pooled analysis respectively.
- 6) H₁ (Citric acid 300 mg/l + Sucrose 2 %) was recorded superior for dry weight (9.11 %, 9.08 % and 9.10 %) followed by H₂ (Citric acid 500 mg/l + Sucrose 2) during 2010-11, 2011-12 and pooled analysis respectively.

6.3.2 Qualitative Parameters

- 7) Maximum flower size (10.30cm, 10.71cm and 10.51cm) was recorded in H₁ (Citric acid 300 mg/l + Sucrose 2 %) followed by Citric acid 500 mg/l + Sucrose 2 % during 2010-11, 2011-12 and pooled analysis, respectively.
- 8) H₁ (Citric acid 300 mg/l + Sucrose 2 % solution) recorded minimum scape bending curvature (10.41° to 25.04°) at 4th and 8th day in pooled analysis.
- 9) Minimum anthocyanin content was found in H₁ (Citric acid 300 mg/l + Sucrose 2 %, 0.21 mg/gm to 0.63 mg/gm) followed by H₂ (Citric acid 300 mg/l + Sucrose 2 %, 0.26 mg/gm to 0.68 mg/gm) while, maximum anthocyanin content in H₉ (control, 0.42 mg/gm to 0.98 mg/gm) as on 4th to 8th day in pooled analysis in gerbera cv. Stanza.

6.3.3 Vase Life and Overall Quality (on visual basis)

- 10) The maximum vase life was recorded in Citric acid 300 mg/l + Sucrose 2 % (H₁; 13.20, 13.00 and 13.10 days) followed by Citric acid 500 mg/l + Sucrose 2 % (H₂; 12.80, 12.80 and 12.80 days) while, in control (H₉; 9.20, 8.53 and 8.87 days) in 2010-11, 2011-12 and pooled analysis respectively.
- 11) On visual basis maximum score with respect to turgidity, colour and freshness was recorded in Citric acid 300 mg/l + Sucrose 2 % in gerbera cv. Stanza.

6.4 Standardization of Storage Techniques

6.4.1 Quantitative Parameters

- 1) Maximum fresh weight was recorded with dry storage with wrapping material: PP (110.03 gm, 116.15 gm, 107.68 gm and 85.63 gm) at 0th DAS, 2nd DAS, 4th DAS and 8th DAS, respectively during pooled analysis.
- 2) Minimum physiological change in weight (%) was observed with dry storage with wrapping material: PP viz., -1.09 %, 5.56 %, -7.29 % and -20.29 % at 0th DAS, 2nd DAS, 4th DAS and 6th DAS, respectively. Maximum physiological change was recorded in wet storage + RO water.
- 3) Higher solution uptake was recorded in dry storage with wrapping material: PP and that final result in increases total solution uptake (150.57 ml), where as minimum total solution up take was observed in wet storage + RO water (62.42 ml) in gerbera cv. Stanza.
- 4) Higher MSI was observed in PP packaged gerbera flowers (79.00 %, 80.15 % and 79.58 %) followed by Sodium benzoate 200 mg/l + Sucrose 2 % (68.43 %, 67.62 % and 68.03 %) during 2010-11, 2011-12 and pooled analysis respectively.
- 5) TDS (⁰B) and dry weight (%) was recorded to be higher in dry storage with polypropylene packaged gerbera flower i.e. (12.56⁰B and 8.83 %, respectively) at 4th DAS.

6.4.2 Qualitative Parameters

- 6) Superior flower size was found in dry storage with wrapping material: PP (Q₁) followed by wet storage with Sodium benzoate 200 mg/l + Sucrose 2 % (Q₆) during 2010-11, 2011-12 and in pooled analysis.
- 7) Minimum scape bending curvature was observed in PP wrapping flowers (Q₁; 28.82⁰, 27.38⁰ and 28.10⁰) followed by Sodium benzoate 200 mg/l + Sucrose 2 % (Q₆; 36.88⁰, 37.60⁰ and 37.24⁰) during 2010-11, 2011-12 and in pooled analysis respectively.
- 8) Minimum anthocyanin content was found to be present in Q₁ (0.16 mg/g, in dry storage with wrapping material: PP) followed by Q₆ (0.18 mg/gm, Sodium benzoate 200 mg/l + Sucrose 2 %) in pooled analysis.

4.4.3 Vase Life and Overall Quality (on visual basis)

- 9) Dry storage with wrapping material: PP recorded maximum vase life (7.00, 7.20 and 7.10 days) followed by Sodium benzoate 200 mg/l + Sucrose 2% (6.00, 6.20 and 6.10 days) during 2010-11, 2011-12 and pooled analysis.
- 10) Dry storage with wrapping material polypropylene gerbera cut flowers recorded maintained overall quality in term of turgidity and colour & freshness (grade 5 to grade 4) as compared to other storage techniques.

6.5 Standardization of Storage Duration

6.5.1 Quantitative Parameters

- 1) Highest fresh weight retention (114.76 gm to 82.37 gm, 113.86 gm to 81.62 gm and 114.31 gm to 82.00 gm) was

- recorded in D₁ (8 day storage) in both years and in pooled analysis followed by D₂ (12 day storage).
- 2) D₁ (8 day storage duration) showed lowest physiological change in weight followed by D₂ (12 day storage duration) in 1st, 2nd year and in pooled analysis as compared to 16 and 20 days storage duration.
 - 3) Maximum water uptake (182.53 ml, 181.73 ml and 182.13ml) was recorded in D₁ followed by D₂ in all the years and in pooled analysis.
 - 4) D₁ recorded higher MSI value (86.23 % to 61.56 %, 84.67 % to 60.45 % and 85.45 % to 61.01 %) at 4th day to 8th day followed by D₂ (78.84, 79.88 and 79.36 mg/gm). Lowest MSI was recorded in D₄ (54.00, 55.98 and 54.99 mg/gm) during both years and pooled analysis.
 - 5) Maximum TDS was observed in 8 day (D₁) stored flowers (17.81°B, 17.98°B and 17.90°B) followed by 12 day (D₂) stored flowers (14.95°B, 15.08°B and 15.02°B). Lowest TSS was recorded in 20 day (D₄) stored flowers (11.23°B, 11.45°B and 11.34°B) in 1st year, 2nd year and in pooled analysis, respectively.
 - 6) Maximum dry weight was observed in 8 day storage duration (D₁, 9.00 %, 8.90 % and 8.95 %) followed by 12 day storage duration (D₂, 8.13 %, 8.34 % and 8.24 %). While, D₄, (20 day storage duration) recorded minimum dry weight (7.03 %, 6.98 % and 7.01 %) in 2010-11, 2011-12 and in pooled analysis.
 - 7) Storage duration of 8 day retained highest levels of TSS followed by storage duration of 12 day storage in 1st year, 2nd

year and in pooled analysis, whereas in 20 day storage (D₄) recorded least TSS.

6.5.2 Qualitative Parameters

- 8) Lowest change in flower size was recorded in D₁ (9.69 to 7.27, 9.73 to 7.24 and 9.71 to 7.26 cm) followed by D₂ (12 day storage duration)
- 9) Minimum scape bending curvature was recorded in D₁ (8 day storage) (9.32⁰ to 61.54⁰, 9.18⁰ to 60.37⁰ and 9.25⁰ to 60.96⁰ on 4th to 8th day, respectively) followed by D₂ (12 day storage) during both years and in pooled analysis.
- 10) Minimum anthocyanin content was recorded in 8th day storage (D₁, 0.51-0.72, 0.52-0.73 and 0.51-0.72 mg/gm) followed by D₂ (12 day storage), (0.61, 0.62 and 0.62 mg/gm) in 1st year, 2nd year and in pooled analysis respectively.

4.5.3 Vase Life and Overall Quality (on visual basis)

- 11) D₁ (8 day storage) recorded maximum vase life (8.20 days, 8.10 days and 8.15 days) followed by 12 day storage (D₂; 7.20 days, 7.00 days and 7.10 days) while, Minimum vase life was recorded in 20 day storage (D₄; 4.30 days, 4.40 days and 4.35 days) in 2010-11, 2011-12 and in pooled analysis.
- 12) Dry storage duration (8 days and 12 days) in gerbera cut flowers recorded maintained overall quality in terms of turgidity and colour & freshness as compared to other storage techniques.

Conclusion:

- Gerbera cut flowers should be harvested at fully open ray florets and unopen disc florets along with 60 cm stalk length for obtaining good post harvest quality and life.
- Further, pulsing solution consisting of 8 HQC 250 mg/l + Sucrose 10% can be use to improve post harvest quality and life by 10.85 days as compared to control 8.30 days.
- In addition to this, holding solution consisting of Citric acid 300 mg/l + Sucrose 2% can be use to improve post harvest quality and life by 13.10 days as compared to control 8.87 days.
- Among, different storage method comprising of dry storage with polypropylene packaging is found appropriate for storing of cut flowers for a period of 7 days in cold storage at 6⁰ C.

The combination of all this treatment can be further used for storage of gerbera cut flowers for duration up to 12 days without any deterioration of post storage quality along with post storage life on 7.10 days.



REFERENCES

REFERENCES

- Andra, S. M. (1994). Effect of sucrose pulsing in gladiolus. *Ann. Rept.*, NBRI, Lucknow. pp. 27.
- Anjum, M. A; Naveedh, F.; Shakil, F. and Amin, S. (2001). Effect on some chemical on keeping quality and vase life of tubrose (*Polianthes tuberosa* L.) cut flowers. *J. Res. Sci.*, **12** (1): 1-7.
- Anonymous (2006). Data base National Horticulture Board, Ministry of Agriculture, Gurgaon.
- Anonymous (2010). National Horticultural Board Database, 2010.
- Anonymous (2012). National Workshop on Floral Craft “The art and technique for value addition in flowers” organized by Navasari Agricultural University, Navsari, Gujarat from 11-12th April, pp. 22-26.
- Arora, J. S. and Singh, K. (2002). Pre and post harvest management of cut flowers. *Indian. Hort.*, Jan – March : 20-23.
- Auty, Y. K. (2011). Standardization of harvesting stage and chemical treatments in orchid cv. ‘Sonia Red’. *Thesis Submitted to Navasari Agricultural University, Navsari.*
- Babu, D. M.; Jawaharlal, M. and Kumar, M. N. (2001). *Floriculture Today*. Sept. issue. pp. 41-42.

References

- Bala; Kumar, R.; Singh, K. (2008). Effect of pulsing and holding solutions on keeping quality of cut flowers of rose (*Rosa* sp.). *J. Ornam. Hort.*, **11**(1): 54-57.
- Balestra, G. M. ; Agostini, R. ;Bellincontro, A.; Mencarelli, F. and Varvaro, L. (2005). Bacterial populations related to gerbera (*Gerbera jamesonii* L.) stem break. *Phytopathol. Mediterr.*, **44**, 291–299.
- *Belynskaya, E.V. and Kondrat'eva, V.V. (1990). Hormonal aspects of cut flower senescence during cold storage. *Byulleten-Glavnogo-Botanicheskogo-sada*, No. **157**, pp. 61-68.
- *Borochoy, A., Tirosh, T. and Halevy, A. H. (1976). Abscisic acid content of senescing petals of cut rose flowers as affected by sucrose and water stress. *Plant Physiol.*, **58** : 175-178.
- Beura, S. and Singh, R. (2003). Effect of storage temperature and wrapping material on postharvest life of gladiolus cultivar Her Majesty. *J. Ornam. Hort.*, **6** (4): 322-327.
- Bhattacharjee, S. K. (1993). Studies on post-harvest life of cut roses. *Indian J. Hort.*, **50** (2) : 174-179.
- Bhaskar, V. V.; Rao, P. V. and Babu, J. D. (2006). Effect of postharvest application of antioxidants on physiological and biochemical changes of cut roses (*Rosa hybrida* L.) petals during vase life period. *J. Ornam. Hort.*, **9** (2) : 75-79.

References

- Bhaskar, V. V.; Rao, V. P.; Reddy, S. R. (2005). Influence of germicides on the physiological and biochemical changes in the flower petals during vase-life period of cut rose cv. First Red. *J. Ornam. Hort.*, **62** (2): 171-174.
- Bhasker, V. V.; Rao, P. V. and Reddy, Y. N. (2000). Effect of certain chemicals on the post harvest life of cut tuberose cv. Double. *J. Ornam. Hort.*, **3** (1): 6-11.
- Bhat, A.; Tripathi, S. N. and Sehgal, O. P. (1999). Effect of pulsing and storage treatments on vase life of chrysanthemum cut flowers. *Advances Hort. and Fort.*, **6**: 125-131.
- Bhattacharjee, S. K. (1994). Post harvest life of cut roses as influenced by varietal differences. *South Indian Hort.*, **42** (5) : 331-334.
- Bhattacharjee, S. K. (1997). Packaging fresh cut flowers. *Indian Hort.*, Jan-Mar.; pp: 23-27.
- Bhattacharjee, S. K. (2001). Enhancing vase life of cut roses. *Floriculture Today, India*, pp. 26-38.
- Bhattacharjee, S. K. and Das, S. P. (2008). In: Orchids-Botany, Breeding, Cultivation, Uses and Post harvest management. *Aavishkar publisher and distributors, Jaipur*. pp. 138.
- Brahmankar, S.; Dhaduk, B. K. and Singh, A. (2005). Effect of harvesting stages and chemical preservatives on

References

- postharvest life of golden rod (*Solidago canadensis* Linn.) panicles. *J. Ornam. Hort.*, **8** (1) : 23-26.
- Burdett, A. N. (1970). The cause of bent neck in cut roses. *J. Amer. Soc. Hort. Sci.*, **95** (4) : 427-431.
- Burman, D. and Rajani, K. (2006). Effect of chemicals on post harvest life of cut rose cv. 'First Red'. *J. Ornam. Hort.* **9** (4) : 262-265.
- Chin, C. and Sacalis, J. N., 1977, Metabolism of sucrose in cut roses *American Society of Horticultural Science*, **21** (2): 224-227.
- Chuahan, N., 2004, Performance of gerbera genotypes under protected cultivation. *M.Sc. (Agri.) Thesis*, Uni. Agric. Sci., Dharwad.
- Coorts, G. D. (1973). Internal metabolic changes in cut flowers. *Hort. Sci.*, **8** : 195-198.
- Cushman, L.C.; Pemberton, H.B.; Miller, J.C. and Kelly, J.W. (1998). Interactions of flower stage, cultivar and shipping temperature and duration affect pot rose performance. *Hort. Sci.*, **33** (4): 736-740.
- Dantuluri, V. S.; Misra, R. L. and Singh V. P. (2008). Effect of polyamines on post harvest life of gladiolus spikes. *J. Ornam. Hort.*, **11** (1): 66-68.
- De, L. C. and Barman, D. (1998). Vase life of cut tuberose spikes as affected by stage of harvest, stalk length and sucrose. *Orissa J. Hort.*, **26** (1) : 66-69.

References

- De, L. C. and Bhattacharjee, S. K. (1999). Effect of chemicals for tight bud opening of rose cv. 'Super Star' at different stages of maturity. *Ann. Agril. Res.*, **20** (2) : 206-211.
- De, L.C. and Bhattacharjee, S. K. (1997). Post harvest life of cut gladiolus spikes as affected by cold storage. *Annals of Plant Physiology*, **11** (1) : 39-44.
- De. L. C.; Bhattacharjee, S. K. and Misra, R. L. (1996). Post-harvest life of pulsed gladiolus spikes as affected by different chemicals. *J. Ornam. Hort.*, **4** (1-2) : 18-22.
- Deambrogio, F., Dolci, M. and Accati, E., 1991, The effects of keeping solutions on the life of cut *Gerbera jamesonii hybrida* (*H. Bolus*), cv. Rebecca, flowers. *Adv. Hort. Sci.*, **5**(4): 135-138.
- Dineshbabu, M.; Jawaharlal, M. and Vijayakumar, M. (2002). Influence of holding solutions on the post harvest life of *Dendrobium* hybrid Sonia-17. *South Indian Hort.*, **50** (4-6) : 451-457.
- Dixit, P. N.; Kumbhar B. K.; Sankar, B. C.; Kumar Santosh and Singh Ranvir (2005). Effect of chemicals in preservatives solution and pulsing on vase life of rose. *Indian J. Hort.* **62** (1) : 56-59.
- Dole, J. M., Harold, F. and Wilkins, P. (1999). Floriculture principles and species. Prentice hall Inc, Upper saddle river new jersey. 613P.

References

- Doorn, W.G. and Perik, R.J. (1990). 8-HQC and low pH prevent vascular blockage in stems of cut rose flowers by reducing the number of bacteria. *J. Amer. Soc. Hort. Sci.*, **115** (6) : 979-981.
- Faragher, J. D.; Borochoy, A. and Halevy, A.H. (1982). Effects of low temperature on the physiology of cut flower. Abstracts, XXIst *International Horti. Congress* 1982, Vol. II, Abstract No. 1735.
- *Faragher, J. D. and Mayak, S. (1984). Changes in carbohydrates and osmotic potential during rhythmic expansion of rose petal. *J. American Soc. Hort. Sci.*, **113**: 884-888.
- Faragher, J.D.; Mayak, S. and Tirosh, T. (1986). Physiological response of cut rose flowers to cold storage. *Plant Physiol.*, **67** : 205-210.
- Farber, J. N.; Harris, M. E.; Beucher, L. R.; Suslow, T. V.; Gorney, J. R.; Garrette, E. H. and Bustta, F. F. (2003). Micro biological safety of controlled and Modified atmosphere packing of fresh produce. *Comprehensive review of food science and food safety*, **2**: 142-158.
- Gerasopoulos, D. and Chebli, B. (1998). Effects of Scape-injected 1-Aminocyclopropane-1-carboxylic Acid (ACC) on the vase life of 'Testarossa' cut gerberas. *J. Amer. Soc. Hort. Sci.* **123** (5): 921-924.

References

- *Goszezynska, D. M. And Rudnicki, R. M. (1988). Storage of cut flowers. In: Hort. Reviews.,II (Janick, J. ed.), AVI Publishing, Westport Conn.,pp 35-62.
- Gothmare, A., 1993 Influence of stage of harvest, stem length, packing methods and chemicals on post harvest life of cut rose cv. Paradise M.Sc. Thesis submitted to Punjabrav Krishi Vidyapith, Akola.
- Gowda, J. N. V. (1986). Post harvest life of china aster as influenced by chemical preservative. *Curr. Res.* **15** (12) : 138-139.
- Grover, J. K.; Singh, K.; Gupta, A. K. and Ashok K. (2005). Effect of pre-storage pulsing treatment on storage of gladiolus spikes under modified atmosphere. *Indian J. Plant Physiol.*, **10** (3): 248-253.
- Gupta, V. N.; Chakrabarty, D. and Datta, S. K. (2006). Influence of different holding solution on post-harvest behaviour of cut flowers: chrysanthemum (*Dendranthema grandiflora* Tzevlev). *J. Ornam. Hort.*, **9** (2) : 80-84.
- Halevy, A. H. (1976). Treatments to improve water balance of cut flowers. *Acta. Hort.*, **64**: 223-226.
- Halevy, A. H. and Mayak, S. (1981). Senescence and post harvest physiology of cut flowers. Part II. *Hort. Rev.*, **3**: 59-143.

References

- Halevy, A. H., and Mayak, S. (1974). Improvement of cut flower quality opening and longevity by pre-shipment treatments. *Acta Horti.*, **45** : 335-347.
- Halevy, A. H., Kofranak, A. M. and Besemer, S. T. (1978). Post harvest handling methods of bird of paradise flowers (*Strelitzia reginae* Ait.). *J. American Soc. Hort. Sci.*, **103** : 165-169.
- *Ho, L. C. and Nichols, R. (1975). The role of phloem transport in the translocation of sucrose along the stem of carnation cut flowers. *Ann. Bot. (London)*, **39**: 439-446.
- Ho, L.C. and Nichols, R. (1977). Translocation of ¹⁴C-sucrose in relation to changes in carbohydrate content in rose corollas cut at different stages of development. *Ann. Bot.*, **41**: 227-242.
- Hussain, C. T.; Misra, R. L.; Bhartacharjee, S. K. and Voleti, S. R. (2001). Changes in soluble carbohydrates and protein in cut gladiolus. *J. Ornam. Hort., New Series*, **4** (2): 83-86.
- *Ichimura, K. and Suto, K. (1999). Effects of the time of sucrose treatment of vase life, soluble carbohydrate concentrations and ethylene production in cut sweet pea flowers. *Plant Growth Regul.*, **28** : 117-122.
- Jain, R.; Bhalla, R., Gupta, Y. C., Thakur, K. S. and Thakur, R. (2006). Effect of wrapping materials and dry storage on

References

- post harvest quality of rose cv. First Red cut flowers. *J. Ornam. Hort.*, **9** (3): 192-195.
- Jain, Y. C.; Gupta, B. and Thakur, R. (2007). Effect of wet storage on postharvest quality of rose cv. First Red. *J. Ornam. Hort.*, **10** (4) : 260-263.
- Javad, N. D. M.; Ahmad, K.; Mostata, A. and Roya, K. (2011). Post harvest evaluation of vase life, stem bending and screening of cultivars of cut gerbera (*Gerbera jamesonii*) flowers. *African. J. Biotech.*, **10** (4): 560-566.
- *Jiang, W.B.; Sun, Z.R.; Yu, L.A. and Zhou, S.T. (1989). The effects of low temperature storage in combination with sucrose pulsing on cut gladiolus. *Acta Horti. Sinica.*, **16** (1) : 63-67.
- Jomy, T. G.; Sabina, G. T. and Saraswathi, P. (2003). Enhancement of vase life of *Dendrobium* varieties. *Abstract National symposium on Recent Advances in Indian Floriculture held at the Kerala Agricultural University.* pp: 364-365.
- Katwate, S.M.; Patil, M.T. and Singh, B.R. (1995). Influence of low temperature storage on longevity of cut spikes of tuberose. *J. Maharashtra Agri. Univ.*, **20** (2): 289-290.
- Kedar, A. A. (2002). Postharvesting handling system: ornamental crops in Postharvest technology of horticultural crops. *Uni. California Pub.*, **3311** : 315-326.
- Ketsa, S. and Boonrote, J. (1990). Holding solution for maximizing

References

- bud opening and vase-life of *Dendrobium*: Youppadeewan' flowers. *J. Hort. Sci.*, **65** (1) : 41-47.
- Ketsa, S. and Kosonmethakul, N. (2001). Prolonging the vase life of *Dendrobium* flowers: The substitution of aluminium sulfate and cobalt chloride for silver nitrate in holding solution. Proc.VII Int. Symp. On Postharvest Physiology Ornamentals. *Act. Hort.*, **543** : 41-46.
- Kumar, B.; Malik, S.; Kumar, M.; Singh, M. K. and Kumar V. (2007). Postharvest quality and vase life of tuberose (*Polianthes tuberosa* L.) cut spikes as affected by vase chemicals. *J. Ornam. Hort.*, **10** (4) : 274-275.
- Kumar, J. and Singh, D. (2004). Postharvest life of tuberose cultivar Pearl Double spike as affected by GA₃, NAA and sucrose. *J. Ornam. Hort.*, **7** (2) : 188-191.
- Kumar, J. Sambyal, S. and Rana, P. (2004). Effect of GA₃, NAA and Citric acid on the post harvest life of cut tuberose (*Polianthes tuberosa* L.) spikes cv. 'Double'. *J. Ornam. Hort.*, **7** (3-4): 386-389.
- Kumar, V.; Bhattacharjee, S.K.; Mishra, R.L. and Suchitra (2003a). Influence of pulsing followed by duration of dry cool storage on vase life of tuberose spikes. *Ann. Agric. Res. New Series*, **24** (3): 639-644.
- Kumar, V.; Bhattacharjee, S.K.; Suchitra; and Singh, K.P. (2003b). Influence of pulsing and dry cool storage on cut spikes

References

- of tuberosa cv. 'Double'. *J. Applied Hort., Lucknow*. **5** (1): 16-20.
- Lal, S.D.; Shah, A. and Pant, C.C. (1990). Effect of certain chemical substances on vase life and quality of gladiolus cv. "Silver Horn." *Prog. Hort.*, **22** (1-4) : 63-68.
- Larsen, F.E. and Cromotry, R.S. (1967). Micro-organism inhibition by 8-HQC as related to cut flower senescence. *Prog. Amer. Soc. Hort. Sci.*, **90** : 546-549.
- Madhavi, B. (2007). Studies on dry cool storage and pulsing treatments in gerbera (*Gerbera jamesonii*) cut flowers for export. *M.Sc. Thesis Submitted to University of Agricultural Sciences, Dharwad*.
- Madhubala, L.; Kumar, R. and Singh, K. (2008). Effect of pulsing and holding solutions on keeping quality of cut flowers of rose (*Rosa* spp.). *J. Ornam. Hort.*, **11** (1) : 54-57.
- Maitra, S. and Roychowdhury, N. (2005). Effect of pulsing and holding solution on postharvest life of cut flowers in *Anthurium andraeanum* Linn. cv. Nitta. *J. Ornam. Hort.*, **8** (3): 186-191.
- Mangave, B. D. (2010). Post harvest management of heliconia inflorescence cv. Golden Torch. *M.Sc. Thesis Submitted to Navasari Agricultural University, Navsari*.

References

- Mantur, S. M and nalawdi, U. G. (1989). Effect of chemical preservative on vase life of china aster cut flowers. *South Indian Hort.*, **37** (6) : 361-363.
- Marousky, F. G. (1986). Vascular structure of the gerbera scape. *Acta Hort.*, **181**: 399-405.
- *Marousky, F. G. (1971). Inhibition of vascular blockage and moisture retention in cut roses induced by pH, 8-Hydroxyquinoline citrate and sucrose. *J. Amer. Soc. Hort. Sci.*, **96**: 38-41.
- Marousky, F. J. (1969). Vascular blockage, water absorption, stomatal opening and respiration of cut 'Better times' roses treated with 8-Hydroxyquinoline and sucrose. *J. American. Soc. Hort. Sci.*, **94** : 223-226.
- Marousky, F. J. (1971). Inhibition of vascular blockage and increased moisture retention in cut roses induced by pH, 8-Hydroxyquinoline citrate and sucrose. *J. Amer. Soc. Hort. Sci.*, **96** (1) : 38-41.
- Marousky, F. J. (1972). Water relations effects of floral preservatives on bud opening and keeping quality of cut flowers. *Hort Science*, **7** : 114-117.
- Mashhadian, N. V.; TahraniFar, A.; Bayat, H. and Selahvarzi (2012). Salisilic and citric acid treatments improve the vase life of cut chrysanthemum flowers. *J. Agr. Sci. Tech.*, **14** : 869-887.

References

- Mayak, S and Halevy, A.S. (1974).The action of kinetin in improving water balance and delaying senescence process of cut rose flowers. *Plant Physiol.*, **50** : 341-346.
- Mayak, S. and Dilley, D. R. (1976). Effect of sucrose on response of cut carnation to kinetin, ethylene and abscissic acid. *J. American. Soc. Hort. Sci.*, **101**: 583-585.
- Meeteren, U. V. (1979). Water relations and keeping-quality of cut Gerbera flowers. III. Water content, permeability and dry weight of ageing petals. *Sci. Horti.*, **10** (3) : 261-269.
- Memam, M. A. and Dabhi, K. M. (2006). Effect of different stalk lengths and certain chemical substances on vase life of gerbera (*Gerbera jamesonii*) cv. 'Savana Red'. *J. Applied Hort.*, **8** (2) : 147-150.
- Michalczuk, B.; Goszczynska, D.M.; Rudnicki, R.M. and Halevy, A.H. (1989). Calcium promotes longevity and bud opening in cut rose flowers. *Israel-J. Botany*, **38** (4) : 209-215.
- Mor, Y., F.; Johnson, S. and Faragher, J. D. (1989).Long term storage of roses. *Acta Horti.*, **261** : 271-9.
- Mukhopadhyay, A. (1990). *Roses, National Book Trust, India.* New Delhi, 89-95.
- Mukhopadhyay, T. P. (1982). Effect of chemical on the floral development and vase life of tuberose (*Polianthes*

References

- tuberosa*. L) var. single. *South Indian Horticulture*, **30** (1-4): 281-285.
- Mwangi, M. and Bhattacharjee, S. K (2003). Influence of pulsing and dry cool storage on postharvest life and quality of 'Noblesse' cut roses. *J. Ornam. Hort.*, **6** (2): 126-129.
- Nair, S. A.; Singh, V. and Sharma, T. (2003). Effect of chemical preservatives on enhancing vase life of gerbera flowers. *J. Tropical. Agril*, **21** : 56-58.
- *Nair, S. A.; Sivasamy N.; Attri, B. L. and Sharma, T. V. R. S. (2000). *Indian Coconut J.* July pp. 29-31.
- Namita; Kumar, R. and Singh, K. (2006). Effect of pre-storage pulsing on storage life of gladiolus cut spikes. *J. Ornam. Hort.*, **9** (4) : 258-261.
- Nowak, J. and Rudnicki, R. M. (1990). Post harvest handling and storage of cut flower, florist greens and potted plants. Timber Press, Portland.
- Nowak, J. and Rudnicki, R.M. (1984). Cold storage of cut gladiolus spikes. *Prace-Institutu-Sadownictwa-i-Kwiaciarstwa-w-Skierniewicach,-B-Rosliny-Ozdobne.* **9**: 67-72.
- Pal, R. K.; Lahiji, M. F. and Roy, S. K. (2003). Influence of storage environment, 8-HQC and sucrose on post harvest quality of 'First Red' cut rose. *J. Ornam. Hort.*, **6** (2) : 130-133.

References

- Palanikumar, S. and Bhattacharjee, S. K. (2001). Effect of storage on postharvest life and flower quality of cut roses. *J. Ornam. Hort.*, New Series, **4** (2) : 87-90.
- Panse, V. G. and Sukhatme, P. V. (1967). Statistical Methods for Agricultural Workers. ICAR, New Delhi, India.
- Parups, E. V. and Voisey P. W. (1976). Lignin content and resistance to bending of the pedicel in greenhouse-grown roses. *J. Hort. Sci.*, **51**: 253-259.
- Patel, J.G., Valia, R.Z., Patel, Z.N., Tandel, Y.N. and Vahora, A.M. (2008). Extension of vase life of Gerbera (*Gerbera jamesonii*) cv. 'Bora Bora' through different chemicals. *Abstract, National Symposium on Recent Advances in Floriculture.*, N.A.U., Navsari, from 4th to 6th March, 2008.
- Patil, M. T. and Singh, B. R. (1995). Postharvest study in rose. *J. Maharashtra Agric. Univ.*, **20**(1): 124-125.
- Patil, M.T.; Katwate, S.M.; Singh, B.R.; Kale, P.N. and Deokar, A.B. (1994). Influence of low temperature storage on longevity of cut spike of Gladiolus cv. Suchitra. *J. Maharashtra Agric. Univ.*, **19** (1): 142-143.
- Patil, V. S. (2009). effect of chemical preservative on vase life of Daisy flowers. *J. Ornam. Hort.*, **12** (1): 54-58
- Prasanth, P. and Chandrasekhar, R. (2007a). Changes in postharvest life of cut gerbera as influenced by

References

- different concentrations of sucrose. *Indian Agric.*, **51** (1&2): 63-68.
- Prashanth, P. and Chandrashekar, R. (2007b). Effect of biocide in vase solution on scape bending and senescence in cut flower of gerbera (*Gerbera jamesonii* Bolus ex.Hook). *J. Ornam. Hort.*, **10** (3): 137-142.
- Rameshwar, A., 1974, Aluminum sulphate a new preservative for cut flowers. *Indian Journal of Horticulture*, **31** (1) : 95-96.
- Randhawa, G. S. and Mukhopadhyay, A. (1986). "Commercial Floriculture".In: *Floriculture in India*. pp 344-426.
- Ratledge, C. (2004). Fatty acid biosynthesis in microorganisms being use for single cell oil production. *Biochemie* **86** : 807-815.
- *Ranwala, A.P. and Miller, W.B. (1998). Gibberellin 4 + 7, benzyladenine and supplemental light improve post harvest leaf and flower quality of cold stored 'Stargazer' hybrid lilies. *J. Amer. Soc. Hort. Sci. Alexandria, V.*, **123** (4): 563-568.
- Redman, P.B.; Dole, J.M.; Maness, N.O. and Anderson, J.A. (2002). Post harvest handling of nine specially cut flower species. *Scientia Horticulture*, **92** : 293-303.
- *Rogers, M. N. (1962). Sell flowers that last, 8: Turgidity vital in vase life. *Flor. Rev.*, **131** (3385) : 29-30.

References

- Rogers, M. N., 1973, A historical and critical review of post harvest physiology research on cut flowers. *Horticulture Science*, 8: 189-194.
- Saini, R.S.; Yamdagni, R. and Sharma, S.K. (1994). Effect of some chemicals on the vase life of tuberose (*Polianthes tuberosa* L.) cv. Single. *South Indian Hort.*, **42** (6) : 376-378.
- Salicilic acid and citric acid treatments improve the vase life of cut chrysanthemum flowers. *J. Agr. Sci. Tech.*, **14** : 879-887
- Salunkhe, D. K.; Bhatt, N. R. and Desai, D. B. (1990). Post-harvest biotechnology of flowers and ornamentals plants. *Springer verlag, Berlin*. pp. 192.
- Sangama and Singh, K. P. (1999). Effect of spike length on postharvest qualities of gladiolus. *J. Ornam. Hort.*, **2** (2) : 144-145.
- Sankar, M.; Bhattacharjee, S. K. and Chatterjee S. R. (2007). Total free amino acid content in petals of cut rose as influenced by pulsing with different chemicals. *J. Ornam. Hort.*, **10** (3) : 193-194.
- Santarius, K. A. (1973). The protective effect of sugars on chloroplast membrane during temperature and water stress and its relationship to frost, desiccation and heat resistance. *Planta*, **113** : 105-114.
- Satpute, S. and Patel, N. L. (2002). Effect of spike length and chemicals substance on vase life and quality of

References

- gladiolus cv. White prosperity. *Gujarat J. Applied Hort.*, **1** (1): 1-14.
- *Serini, G. and Banfi, G. (1974). Azino di sostanze conservantic antibiotiche su flori. *Recisi Rivisla delta Qrto floro fuiticoltura*. Italbanna, **58** : 35-46.
- Serrana, M.; Martinez, Pretel, M. T.; Riquelme, F. And Romojaro, F. (1992). Cold storage of rose flowers (*Rosa hybrida*, M. cultivar Visa) : physiological alterations. *Scientia Hort*, **51**: 129-137.
- *Singh, A.; Kumar, J. and Kumar, P. (2005). Influence of 8-Hydroxy quinoline (8-HQ) and sucrose pulsing on membrane stability and post-harvest quality of gladiolus cut spikes. *J. Ornam. Hort.*, **8** (4): 243-248.
- Singh P. V. and Mirza A. M. (2004). Postharvest life and quality of cut rose cultivar Super Star as influenced by packaging material. *J. Ornam. Hort.*, **7** (1): 58-63.
- Singh, A. K. and Tiwari, A. K. (2002). Effect of pulsing on post harvest life of rose cv. Doris Rystermann. *South Indian Hort.*, **50** (1-3): 140-144.
- Singh, A.; Kumar, J. and Kumar, P. (2008a). Effects of plant growth regulators and sucrose on post harvest physiology, membrane stability and vase life of cut spikes of gladiolus. *Pl. Growth Regul.*, **55** : 221-229.
- Singh, A.; Kumar, P.; Kumar, J. and Singh, V. P. (2007). Membrane stability and post harvest keeping quality of

References

- gladiolus cut spikes as influenced by certain chemicals with sucrose in vase solution. *Indian J. Plant Physiol., New series.*, **12** (1): 63-71.
- Singh, K.; Singh, P. and Arora, J. S. (2003). Effect of sucrose on vase life of cut roses. *J. Ornam. Hort.*, **6** (2) : 145-146.
- Singh, K.; Singh, P.; Arora, J. S. and Mann, R. P. S. (2000). Studies on post-harvest management of gladiolus. *J. Ornam. Hort.*, **3** (2): 107-110.
- Singh, K.; Singh, R. and Kumar R. (2008b). Effect of different polymeric films on modified atmosphere storage of gladiolus cut spikes. *J. Ornam. Hort.*, **11** (1): 49 -53.
- Singh, V. P. (2005). Deterioration of membrane during flower senescence in gladiolus and its amelioration with free radical scavenger. *J. Ornam. Hort.*, **8** (1): 8-12.
- Singh, V. P. and Jegadheesan, A. (2003). Effect of α -lipoic acid on senescence in Gladiolus flowers. *Ind. J. Pl. Physiol. (special issue)*: 516-521.
- *Song, C.Y.; Shin, D.G.; Rho, T.H.; and Lee, J.S. (1992). Physiological responses of cut gladiolus flowers after shipment and cold storage. *J. Korean Soci. Hort. Sci.*, **33** (2): 209-219.
- Srivastava, L. M. (2005). Gibberellins in Plant growth and development hormones and environment. *Academic press, California, USA*. pp. 172-188.

References

- Srivastava, M. K. and Dwivedi, U. N. (2000). Delayed ripening of banana fruit by salicylic acid. *Plant Sci.* 158:87-96.
- Srivastava, R.; Kandpal, K. and Jauhari, S. (2005). Effect of pulsing solution, packaging material and storage duration on post harvest life of gladiolus. *J. Ornam. Hort.*, **8** (2): 115-118.
- *Staby, G. L.; Roberston, J. L.; Kiplinger, D. C. and Conover, C.A. (1976). Chain of life in *proc. Natl. Conf. On 'Commodity Handling'*, Ohio Flor. Assoc. Columbus, pp.71.
- Suresha, G. J.; Jayaprasad, K. V. and Chikkasubbanna, V. (2009). Extension of vase life of cut chrysanthemum (*Chrysanthemum moriifolium* Ramat.) flowers cvs. White fizii and peach fizii. *Asian Sci.*, **4** : 62-64.
- Swart, A. (1989). Dahlia as a cut flower. Short vasselife remains a selling problem. *Bloembollencultuur.*, **100** (5) : 24-25.
- Torre, S; Borochos, A. and Halevy, A. H. (1999). Calcium regulation of senescence in rose petals. *Physiologia Plantarum*, **107**: 214-219.
- Valsalakumari, P. K.; Rajeevan, P. K.; Juliemol, T.; Puspallatha, V. B. and Geetha, C. K. (2003). Improvement of post harvest quality of Dendrobium 'Sonia 17'. *Indian. Soc. Ornam. Hort.* pp. 389-393.
- Van Doorn, W. G. (2004). Is petal Senescence due to sugar starvation. *Plant Physiology*, **134**: 35-42. (Abstract)

- Van droon, W. G. (2010) water relations of cut flowers, Horticultural reviews. New York: John Wiley and sons, Inc., 1-85.
- Verma, A.; Gupta, Y. C.; Dhiman S. R. and Jain R. (2006). Effect of dry storage on postharvest quality of chrysanthemum (*Dendranthema grandiflora* Tzevlev) cv. Snow ball. *J. Ornam. Hort.*, **9** (1): 20-24.
- Whaithaka, K.; Dodge, L. L. and Reid, M. S. (2001). Carbohydrate traffic during opening of gladiolus florets. *J. Hort. Sci. and Biotech.*, **76**: 120-125.
- *Yamane, K.; Kawabat, S. and Fujishije, N. (1999). Changes in activities of Superoxide dismutase, Catalase and Peroxidase. *Journal of the Japanese Society for Horticultural Science*, **68**(4) : 798-802.
- Zeltzer, S., Meir, S. and Mayak, S. (2001). Modified atmosphere packaging of long term shipment of cut flowers. Proceedings of 4th International Conference on post harvest. (Ben, Arie, R. and Philosoph ,H., Eds). *Acta Hort.*, **553** : 631-634.
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* **Original not seen**



APPENDIX

Appendix I: Meteorological data recorded at navsari for the period of experiment during 2010-11 and 2011-12

Month and year	Standard week	Temperature (°C)		Relative humidity (%)	
		Max.	Min.	M	Ev.
November 2010	45	33.4	20.5	81.00	45.28
	46	31.1	21.8	91.14	62.85
	47	33.1	23.1	90.42	61.10
	48	29.9	21.5	91.33	60.33
December 2010	49	31.6	20.1	80.00	50.00
	50	27.5	11.7	86.00	40.28
	51	29.2	11.8	65.00	26.00
	52	29.1	11.7	89.00	36.50
	53	29.0	15.2	88.6	39.60
January 2011	1	28.0	13.5	57.00	29.00
	2	30.2	10.6	70.00	19.71
	3	29.9	10.6	82.00	24.85
	4	31.5	12.9	81.00	50.50
February 2011	5	33.7	14.8	71.00	26.12
	6	32.6	14.3	84.00	28.85
	7	29.4	14.0	83.00	51.28
	8	33.2	14.6	65.00	26.85
November 2011	45	36.0	19.3	68.90	39.00
	46	36.1	18.6	79.40	25.10
	47	35.1	17.2	72.20	38.60
	48	34.1	19.6	63.10	32.10
December 2011	49	34.4	17.7	81.00	33.10
	50	32.5	15.0	75.50	33.60
	51	32.7	15.1	75.90	30.30
	52	30.5	12.0	85.00	28.00
	53	30.4	11.5	84.00	26.10
January 2012	1	29.2	12.2	83.00	40.00
	2	28.0	11.9	73.00	51.00
	3	28.1	11.6	86.00	64.00
	4	29.7	13.0	83.00	75.00
February 2012	5	30.6	14.5	72.00	32.00
	6	28.0	12.0	59.00	24.00
	7	34.4	12.9	76.00	28.00
	8	35.1	15.1	70.00	23.00

CERTIFICATE

This is to certify that I have no objection to supply one copy of any part of this thesis at a time to any scientist through reprographic process for rendering reference services in a library or documentation centre.

Place : Navsari

Date : 23-07-2012

(Aditi. C. Joshi)

