PERFORMANCE STUDY AND EFFECT OF PRESERVATIVES ON VASE LIFE OF GLADIOLUS

MD. JAHID HASAN

DEPARTMENT OF HORTICULTURE
SHER-E-BANGLA AGRICULTURAL UNIVERSITY
DHAKA-1207

JUNE, 2014

PERFORMANCE STUDY AND EFFECT OF PRESERVATIVES ON VASE LIFE OF GLADIOLUS

BY

MD. JAHID HASAN

Reg. No. 07-02555

A Thesis Submitted to
The Department of Horticulture, Faculty of Agriculture
Sher-e-Bangla Agricultural University, Dhaka-1207
In partial fulfillment of the requirements
for the degree
of

MASTER OF SCIENCE (MS)
IN
HORTICULTURE

SEMESTER: JANUARY– JUNE, 2014

Approved by:

Dr. Kabita Anzu-Man-Ara PSO, Floriculture Division HRC, BARI, Gazipur **Supervisor**	**Prof. Md. Ruhul Amin** Dept. of Horticulture SAU, Dhaka **Co- supervisor**

Prof. Dr. Abul Faiz Md. Jamal Uddin
Chairman
Examination Committee

Floriculture Divsion
Horticultural Research Centre
Bangladesh Agricultural Research Institute
Joydebpur, Gazipur

কৃষিই সমৃদ্ধি
Fax : 88-02-9261495
Tel. 88-02-92561493
E.mail: dr.sharif_2011@yahoo.com
director_hrc@yahoo.com
hrcdirector@gmail.com

Ref :..... Date:.....

CERTIFICATE

This is to certify that thesis entitled, **"PERFORMANCE STUDY AND EFFECT OF PRESERVATIVES ON VASE LIFE OF GLADIOLUS"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (MS) in HORTICULTURE**, embodies the result of a piece of *bona-fide* research work carried out by **MD. JAHID HASAN**, Registration No. **07-02555** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

Dated: June, 2014
Place: Dhaka, Bangladesh

……..……..……

Dr. Kabita Anzu-Man-Ara
PSO, Floriculture Division
HRC, BARI, Gazipur
Supervisor

PERFORMANCE STUDY AND EFFECT OF PRESERVATIVES ON VASE LIFE OF GLADIOLUS

MD. JAHID HASAN

ABSTRACT

Two experiments on gladiolus were conducted at BARI, Gazipur, Bangladesh during October 2013 to June 2014. First experiment includes performance of ten gladiolus genotypes in respect of growth, yield and yield contributing characters to select promising line (s). Maximum leaves number and leaf area was obtained by V_7 and V_8 (11.0 and 80.0 cm^2) and minimum in V_5 and V_6 (6.0 and 70.0 cm^2), respectively. Earlier spike initiation was occurred in V_4, V_7 and V_8 (47 days). Genotypes varied from 75.0 to 90.0 and 40.0 to 50.0 cm in spike length and rachis length, respectively. Number of floret was the highest in V_7, and V_8 (14.0) closely followed by V_4 and V_9 (13.0). The highest vase life was found in genotype V_4, V_7, V_8 and V_9 (10 days). The maximum flower yield/ha (190,000 spikes) was obtained from V_7 and V_8 followed by V_4 and V_9 (185,000 spikes). Large variation in qualitative characters was also observed. Number of corm and cormels of the genotypes significantly differ and ranged from 1.0 to 4.0 and 7.0 to 15.0, respectively. Based on selection criteria, the genotypes V_4, V_7, V_8 and V_9 were identified as good genotypes. For determining the proper preservatives, the second study conducted with ten treatments: T_1= 3% sucrose, T_2= 4% sucrose, T_3= 100 ppm 8-HQS, T_4= 200 ppm 8-HQS, T_5=25 ppm citric acid, T_6= 3% sucrose + 100 ppm 8-HQS +25 ppm citric acid, T_7= 3% sucrose + 200 ppm 8-HQS +25 ppm citric acid, T_8= 4% sucrose + 100 ppm 8-HQS +25 ppm citric acid, T_9=4% sucrose + 200 ppm 8-HQS +25 ppm citric acid and T_{10}= Control. A synergized effect of 3 % sucrose + 200 ppm HQS + 25 ppm citric acid proved effective in maintaining quality and increasing vase life of gladiolus up to 12 days.

ACKNOWLEDGEMENTS

The author expressed his heartiest sense of gratitude to the **"Almighty Allah"** who has enabled him to complete his research work and submitted the thesis leading to MS degree in time.

The author would like to convey his deepest gratitude, sincere appreciation and immense indebtedness to his research supervisor **Dr. Kabita Anju-Man-Ara,** Principal Scientific Officer, Landscape, Ornamental and Floriculture Division, Horticulture Research Center (HRC), Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur for her help, day to day guidance, assistance, valuable suggestions, inspiration and keen interest in completing the research work and help for the preparation of this manuscript as well as development of his career for future betterment.

The author is especially grateful to his Co-supervisor of his Advisory Committee, **Md. Ruhul Amin,** Professor, Department of Horticulture, Sher-e-Bangla Agricultural University (SAU), Dhaka-1207 for his constructive criticism and valuable suggestion in preparation of this thesis.

The author also wishes to express his cordial appreciation and thanks to all respected teachers of the Department of Horticulture, Sher-e-Bangla Agricultural University (SAU), Dhaka, for their valuable suggestions and constant encouragement during all phases of study and research.

The author expresses his sincere gratitude and indebtedness to all staffs and workers of Floriculture Division, HRC, BARI for their helpful cooperation to complete the research work.

The author is grateful to all of his friends like Anarul Islam, Shoaib Muktadir, Amit Partha Mondal, Toufiqur Rashid, Abu Bakkar Siddik and others for their inspiration, co-operation and accompany during the study period.

Finally, the author is grateful to his beloved parents, Brothers, sister and relatives for their moral support, blessings, inspiration, sympathy and deep feelings in favour of the completion of this study.

The Author

LIST OF CONTENTS

LIST OF TABLES

LIST OF PLATES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATED TERMS

ABBREVIATIONS	FULL WORD
ANOVA	Analysis of variance
BARI	Bangladesh Agricultural Research Institute
CRD	Completely Randomized Design
CV%	Percentage of Coefficient of Variation
DAP	Days after planting
df	Degrees of Freedom
DMRT	Duncan's Multiple Range Test
et al.	And others
etc.	Etcetera
HQC	Hydroxy Quinolene Citrate
HQS	Hydroxy Quinolene Sulphate
HRC	Horticulture Research Centre
K	Potasium
mg/L	Miligram per litre
MoP	Muriate of Potash
N	Nitrogen
NS	Non Significant
^{O}C	Degree Celsius
P	Phosphorus
ppm	Parts Per Million
RCBD	Randomized Complete Block Design
SAU	Sher-e-Bangla Agricultural University
RH	Relative Humidity
TSP	Triple Super Phosphate

CHAPTER I
INTRODUCTION

The genus Gladiolus belongs to the family Iridaceae and is a native of South Africa. It is one of the most important cut flowers in the flower industry. It is known as the queen of the bulbous plants (Mukhopadhyay, 1998). In the international cut-flower trade gladiolus occupies fourth place (Bhattacharjee and De, 2010). It is mainly cultivated for cut-flowers because of its elegant appearance and prolonged vase life. Gladiolus spikes are most popular in flower arrangements and for preparing attractive bouquet (Bose *et al.,* 1999). The magnificent inflorescence with various colour have made it attractive for use in herbaceous borders, beddings, rockeries, pots and for cut-flowers. Apart from ornamental value, gladiolus have extensively utilized in medicines for headache, lumbago, diarrhea, rheumatism and allied pains (Bhattacharjee and De, 2010). Flower and corm of some gladiolus are used as food in many countries (Khan, 2009). The flowers of different *Gladiolus* sp. are used as uncooked salad by nipping of their anthers. It has been found that the corms of *Psittacinus* hybrids contain high amount of carbohydrate mostly as starch (65.4 to 78.6%) and protein (12.6 to 18.5%) (Bhattacharjee, 2006).

In Bangladesh, the agro ecological conditions are very conducive for the survival and culture of Gladiolus. It is commercially grown in Dhaka, Jessore, Gazipur, Rangpur, Chittagong, and Cox's bazar. Regarding the areas and production of gladiolus flowers, so far no authentic reports are available in the country. Khan (2009) reported that the area of flower production appears to have increased significantly and estimated area of around 10,000 ha and the annual trade at wholesale level to be worth between 500-1000 million taka in Bangladesh.

Momin (2006) reported that income from gladiolus flower production is six time higher than returns from rice. It was estimated from the information received from flower growers association and Upazilla agriculture office that 6.5 crores of gladiolus was produced in 350 acre of land in Jhikargacha during 2012-13. It has export potential as well. This study will therefore be undertaken to evaluate the performance of ten gladiolus genotypes in order to select promising lines in respect of quality flower and corm production.

Improvement of keeping quality and enhancement of vase life of cut flowers are important areas in Floricultural research. In the earlier times, most of the flowers were kept in water but now a days, scientists have introduced many floral preservatives to improve the vase life (quality) of cut flowers. Investigations pertaining to extend the vase life of Gladiolus cut flowers by chemical treatments after harvest have been made with varying success (Al-Humaid, 2004; Ranvir and Sashikala, 2002; Gowda, 1992; Suneetha and Kumar, 2002) in many countries of the world. But reports on genotypic effect and vase life of Gladiolus in Bangladesh are scanty. So, it is necessary to find suitable genotype (s) and preservative for better growth, yield and extending the vase life of gladiolus.

Considering the above mentioned facts, the present investigation was undertaken with the following objectives:

i) To study the morphological characteristics of gladiolus genotype (s);
ii) To evaluate the genotype (s) for yield and quality; and
iii) To identify the suitable preservative in extending the vase life of gladiolus.

CHAPTER II
REVIEW OF LITERATURE

Gladiolus, a member of the family Iridaceae, is one of the most popular ornamental bulbous plants grown commercially for its bewitching flowers. It was first introduced into France and soon after, it spread to England, Germany, Holland, North America and India. In Bangladesh, gladiolus was introduced during mid 80'S in Jhikargacha Thana of Jessore District. A lot of research works have been done all over the world by different workers on performance studies and vase life in gladiolus but information is meager under Bangladesh condition. Therefore, information available in the literature pertaining to those aspects of gladiolus have been reviewed briefly and presented below:

2.1 Review related to the performance of gladiolus genotypes

Shaukat *et al*. (2015) evaluated the performance of six cultivars of Gladiolus namely ‘Amsterdam’, ‘Applause’, ‘Fidelio’, ‘Nova Lux’, ‘Peter Pears’ and ‘Priscilla’ at Experimental Farm, Faculty of Agriculture under the climatic conditions of Rawalakot, Pakistan during 2008-09 for their adaptability and performance. Results on vegetative characteristics showed that cultivars ‘Applause’ and ‘Amsterdam’ took less number of days for sprouting. ‘Fidelio’ and ‘Priscilla’ produced more plants per corm and ‘Applause’ obtained maximum plant height. Results on floral characteristics showed that cultivar ‘Applause’ and ‘Peter Pears’ were earlier for spike emergence. ‘Priscilla’ and ‘Peter Pears’ took minimum days to flowering, maximum florets were produced by ‘Peter Pears’ and ‘Applause’. ‘Applause’ obtained maximum spike length and ‘Peter Pears’ remained attractive for longer time. Results on corm and cormels characteristics showed that ‘Peter Pears’ produced more corms, ‘Applause’

produced maximum cormels and gained maximum corm size. Maximum corm weight was recorded in ‘Fidelio’.

Experiment was carried out by Patra *et al*. (2015) to find out the best variety in vase taking 20 genotypes of gladiolus grown in Department of Floriculture and Landscaping. Study on vase life indicated that gladiolus varieties like ‘White Prosperity’, ‘NG-35’, ‘Friendship White’, ‘Victor Berge’, ‘Oscar’ and ‘Jessica’ exhibited better performance with respect to water uptake and gain in fresh weight up to 7th day of study while ‘Novalux’, ‘Huntingsong’, ‘Princess Margarate Rose’, ‘Bluesky’ and ‘Precillia’ recorded greater vase life. Varieties like ‘Charisma’, ‘Grandpics’, ‘Ocillia’, ‘Novalux’, ‘Princess Margarate Rose’ performed better with respect percent opening of floret in a spike while varieties such as ‘Purple Flora’, ‘White Prosperity’, ‘Victor Berge’, ‘Friendship White’, ‘Oscar’ and ‘NG-35’ recorded bigger florets with more length and width.

Sarkar and Chakraborty (2014) evaluated 15 indigenous and exotic varieties of gladiolus (‘Jester’, ‘Red Majesty’, ‘Mexican Rose’, ‘PresKilla, Swarnim’a, ‘Australian Fair’, ‘Spic’ and ‘Span’, ‘Moon Magic’, ‘Enchantres’, ‘Bigtime Supreme’, ‘Chamglow’, ‘Tilak’,’ Kumkum’, ‘Darshan’ and ‘IIHR-Hybrid’) in field gene bank of Regional Research station Kalimpong, North Eastern Himalayan Region in the years 2012-13 consecutively to observe the performances of important floral attributes (days to flowering, duration of flowering, spike length, rachis length, number of florets per spike, number of florets remaining open at a time , size (width) of floret, longevity (field life) of spike etc. In the pooled result after 2013, Jester was found to have highest number of days to flowering, spike length, rachis length, number of florets remaining open at a time, size (width) of floret, weight of harvested spike, ‘IIHR-Hybrid’ was found to have highest duration of flowering, ‘Kumkum’ was found to have highest number of florets per spike, Swarnima was found to have highest longevity (field life) of spike and ‘Darshan’ was found to have highest vase-

life of spike. Considering the very important floral parameters which are immensely valuable from the point of view of flower market in national and international areas, ‘Jester’, ‘Kumkum’ and ‘Swarnima’ are recommended among these varieties to the farmers for better economic return from the market.

Five potential, exotic cultivars of gladiolus, ‘Cantate’, ‘Corveira’, ‘Eminence’, ‘Essential’ and ‘Fado’ were evaluated by Saleem *et al.* (2013) to determine the cultivar effects on yield and quality, to compare their relative performance and recommend their suitability for commercial production. Among the tested cultivars, ‘Essential’ performed best for early spike emergence (74.2), greater number of leaves/plant (8.8), number of florets/spike (13.9), spike length (46.8 cm), spike diameter (1.0 cm), vase life (14.3), cormel diameter (0.7 cm) and average weight of a cormel (0.3 g). ‘Corveira’ ranked second for most of the above mentioned growth and yield indices. Earlier sprouting (4.6), and higher number of cormels/clump (283.0) was recorded in ‘Fado’, while leaf area and stem length was greater in ‘Cantate’, (98.6 cm^2 and 84.7 cm, respectively). ‘Eminence’ ‘Cantate’ and ‘Corveira’ had higher total leaf chlorophyll contents (0.2 mg g-1 each), while ‘Eminence’ took longer time for spike emergence (103.5) among all tested cultivars.

Hossain *et al*. (2011) carried out an experiment during the period from November 2008 to October 2009 to compare the morphology of five gladiolus flower genotypes with respect to plant height, length and breadth of leaf, number of leaves per plant, length of flowers, breadth of flower, weight of flower, weight of single stick, length of spike, length of rachis, flowers per plant, days to reach 50% spike initiation, number of corm and cormel per plant, breadth of corm and weight of cormel per plant.

The results indicated the significant variation amongest the gladiolus genotypes with respect to studied morphological characteristics as well as with yield, yield attributes and plant height. The average number of leaves was highest for white (12.25) followed by red, violet, orange and yellow, respectively. The recorded results clearly indicate that the white genotype has the best planting materials which may be planted for luxuriant growth of plants and production of excellent flowers.

Hossain *et al.* (2011) evaluated the morphology of 5 cultivars (‘white’, ‘yellow’ ‘red’, ‘orange’ and ‘violet’) at Commercial Flower Garden of Society and Human Development Organization, Tangail (SAHDOT), Bangladesh. Tallest plant was (58.6 cm) and shortest (45.5 cm) in ‘yellow’ and ‘oranged/red’, respectively. Minimum days were taken by white cultivar (60.0) and maximum by yellow (70.0) to reach 50% spike initiation. Longest spike (92.1 cm) was produced by ‘White’ cultivar which was followed by ‘yellow’, ‘violet’ and ‘red’ (73.9, 72.5 and 65.7 cm respectively) while shortest from orange variety (59.6 cm). Floret number varied from 8.4-14.3. Maximum corms was produced in ‘orange’ cultivar (2.6/plant) followed by ‘red’ (1.7/plant), violet (1.4/plant) and yellow (1.3/plant) ‘while’ minimum from white cultivar (1.2/plant). Weight of corm ranged from 18.2-36.8 g, number of cormel from 25.7-43.2/plant, weight of cormel from 6.4-5.2 g/corm.

Twenty-one genotypes were evaluated under field conditions for parameters of corm and cormel production at Indian Institute of Horticultural Research, Bangalore during August 2006 - June 2008 by Poon *et al*. (2010). All parameters such as number of corms per bed, number of corms per corm, weight of corm (g), corm diameter (cm), number of cormels per bed, number of cormels per corm, weight of cormel (g) and cormel diameter (cm) were highly significant. Genotype 'Hybrid selection 84-4-9' produced the highest number of corms per corm (3.16) and cormels per corm (134.25). Genotype 'Hybrid selection 87-1-1’ recorded the maximum corm weight

(124.5 g) and corm diameter (8.0 cm). Genotype '*Psittacinus* hybrid' produced the maximum weight of cormel (3.41 g) and cormel diameter (1.92 cm). Based on the results, genotypes: '*Psittacinus* hybrid', 'Hybrid selection 84-4-9' and '*Gladiolus callianthus'* can be utilized in varietal improvement program for corm production while genotypes: 'Shobha' and 'Sapna' can be utilized in varietal improvement program for cormel production.

Pragya *et al.* (2010) evalutated the performance of 37 gladiolus cultivars at the experimental farm of CITH-RS Mukteshwar (Uttarakhand), India. 'Chantiler' gave maximum plant height (147.3 cm) while Nova Lux was found earliest for spike initiation (62.3 days) and first floret showing color (69.3 days). The longest spike was recorded 88.7 cm (Pusa Jyotsana) followed by 88.3 cm (Nova Lux and High Style). Cultivar 'Pusa Jyotsana' and 'Pusa Swarnima' recorded maximum number of florets/ spike (20.3). Significantly maximum corm equatorial diameter (6.14 cm), corm polar diameter (2.65 cm), corm weight (55.5 g) and propagation co-efficient were observed in 'Legend' and 'Chantiler'.

Poon *et al.* (2009) evaluated floral biology of selected cultivars of gladiolus at Indian Institute of Horticultural Research (IIHR), Hessaraghatta, Bangalore, India. The selected genotypes were 'Aarti', 'Arka Kesar', 'Darshan', 'Dhiraj', 'Pink Friendahip', 'Kum Kum', 'Shobha', 'Tilak', 'Hybrid selection 82-11-27', 'Hybrid selection 84-7-11', 'Hybrid selection 87-1-1', 'Hybrid selection 87-22-1', 'Hybrid selection 88-4-8', *Gladiolus callianthus and 'Psittacinus'* hybrid. Days to spike emergence varied from 56.6 (Arka Kesar) to 71.9 (Dhiraj) days. Days to full spike emergence varied from 59.3 (Arka Kesar) days to 75.2 (Dhiraj) days. Days to bud separation varied from 62.3 (Arka Kesar) to 77.9 (Dhiraj) days. Days to bud separation varied from 62.3 (Hybrid

selection 84-7-11) to 77.9 (Dhiraj) days. Variations of days to first basal bud loosening were from 66.4 (Hybrid selection 84-7-11) days to 83.8 (Dhiraj) days. Days to flowering varied from 67.4 (Hybrid selection 84-7-11) to 84.9 (Dhiraj) days.

Kumar (2009) studied the performance of 16 gladiolus cultivars at experimental farm of the ICAR Research Complex, Umiam (Meghalaya). Cultivar 'Gold Beauty' gave maximum plant height (105.0 cm), early spike emergence (58.2 days), first floret showing color (68.8 days) and full opening of first floret (68.3 days) 'while' cultivar. 'Friendship Pink' gave longest spike (70.0 cm) and rachis (50.1 cm), maximum florets/spike (15.0) and long field durability (13.0 days). Significantly maximum corm diameter (5.8 cm), corm weight (55.1 g), polar (2.7 cm) and equatorial diameter (2.3 cm) and weight of 5 corms (300.0 g) were given by 'Green Bay'. 'Creamy White' gave largest flower (11.0 cm), maximum cormels (52.0) and cormel weight (4.1 g)/plant, whereas 'Australian Fair' recorded highest propagation co- efficient (251.7%).

Rashmi (2006) evaluated 10 elite gladiolus hybrids (Dharwad-1 to Dharwad-10) and one check variety (American Beauty) of gladiolus at the Saidapur farm of Main Agricultural Research Station, University of Agricultural Sciences, Dharwad. Plant height ranged from 42.7-73.7 cm, number of leaves from 4.9-9.2 plant. Days taken for spike initiation from 50.5-76.3, for first floret to show color from 65.4-86.6, for first floret to open from 69.4-90.3. The range of the spike length was recorded from73.7-102.4 cm, spike girth from 0.6-1.2 cm, rachis length from 44.1-66.7 cm, average weight of spike from 36.8-58.5 g. Number of florets ranged between 14.1-16.7/spike, length of floret 7.0-9.8, diameter of floret from 6.6-9.1 cm. Corm weight ranged from 14.6- 35.7 g, corm diameter from 3.1-5.2 cm.

Nazir and Dwivedi (2006) examined 22 gladiolus cultivar and found that days to sprouting ranged from 9.7 days (Morning) to 20.3 days (Jester), days to spike initiation from 89.5 (Bonos Memory) to 121.7 (Black Beauty). Maximum number of florets produced by Congo Song (16.0/ spike) followed by Jester (15.7/ spike).

Dalal *et al.* (2006) evaluated 3 cultivars of gladiolus viz. 'American Beauty', 'Her Majesty' and 'Jester' in Maharashtra, India. Significantly earliest 50% flowering (84.1 days) was observed in 'Her Majesty', followed by Jester (85.0) and last in American Beauty (91.1 days). Spike length (87.4 cm) and number of florets per spike (15.9) were significantly higher in 'American Beauty'. Corm weight (87.4 g) and number of cormels per plant (106.5) were highest in 'Her Majesty' and 'American Beauty' respectively.

Rani and Singh (2005) assessed gladiolus cultivars namely 'Jester', 'Red Majesty', 'Pink Friendship', 'Bluind', 'Yellow Pearl', 'Blorina', 'Thoinbolina', 'Sovenier', 'White Prosperity', 'American Beauty', 'Candiman', 'Summer Pearl', 'Her Majesty', 'Eku Thunder' and 'Rose Supreme'. Sprouting percentage ranged from 52.3 % ('Sovenier') to 96.9% ('American Beauty'). Plant height ranged between 75.0 (Rose Supreme) and 98.8cm ('American Beauty'). The maximum spike length was observed in 'American Beauty' (65.5 cm) and 'Rose Supreme' (36.4 cm). Thoinbolina took the least number of days for opening of basal floret (74.2 days) while Her Majesty took maximum (93.8 days). The maximum number of florets (17.2/spike) and largest floret size (12.2 cm) were exhibited by 'American Beauty'. Maximum vase life was in Pink 'Friendship' and 'American Beauty' (9.0 days). 'American Beauty' gave maximum corm diameter (5.7 cm) and corm weight (44.4 g).

Kishan *et al.* (2005) evaluated the performance of 23 gladiolus cultivars in New Delhi, India and found that variety 'Dhanvantari' produced tallest plants (130.8 cm), followed by Anjali (124.0 cm) whereas Sylvia was the smallest (74.3 cm) in height. The weight of single corm recorded maximum by 'Gold Dust' (124.7 g) and 'Dhanavantari' (120.0 g); while minimum by 'Vinks Glory' (66.7g). The cormels weight (16.0 g) was recorded highest in 'Chandani' and lowest (3.7 g) in Melody. Varietal African Star produced maximum cormels per plant and minimum by Gold Dust. The number of corms per plant was found to be non significant.

Kamble *et al.* (2004) evaluated nine gladiolus cultivars at experimental unit of Department of Floriculture and Landscape gardening, Kittur Rani Channamma College of Horticulture, Arabhvi, Karnataka, India. These nine cultivars were 'Summer Sunshine', 'Sylvia', 'Trust Maijic', 'Vedanapoli', 'American Beauty', 'Melody', 'Snow White' and 'Yellow Cup'. 'Snow White' showed earliness in spike emergence (58.2 days) and first floret opening (66.7 days) followed by 'American Beauty' (60.7 and 68.1 days respectively) while delayed spike emergence (80.8 days) and first floret opening (98.1 days) was noticed in 'Majic'. 'Summer Sunshine' (93.9 cm), 'Melody' (93.2 cm) and 'Trust' (89.6 cm) had longer spikes compared to other cultivars. More number of florets per spike was recorded in 'Summer Sunshine' (15.3), 'American Beauty' (15.1) and 'Snow White' (14.6). 'Summer Sunshine' (11.9 cm) produced large sized flowers followed by 'American Beauty' (10 cm) whereas minimum was recorded in 'Sylvia' (6.5 cm). Vase life was longest in 'Summer Sunshine' (8.3 days).

Nair and Shiva (2003) evaluated gladiolus cultivars ('Snow Princess', 'Pusa suhagin', 'Australian Fair', 'Green Willow', 'Darashan', 'Dhiraj', 82-18-16, 'Tikak', 'Kumjum'

and ‘Aarti’) for cut flower production at port ‘Blair’, ‘Andaman’ and ‘Nicobar Islands’, India. The cultivar ‘Darashan’ produced the maximum number of spikes per plant (3.0) and ‘Dhiraj’ had the maximum number of florets per spike (12.9) with 5.3 florets opening at a time. The maximum number of corms per plant was produced by ‘Green Willow’ (1.6), while ‘Pusa Suhagin’ produced the maximum number of cormels per plant (45.9). The cultivar ‘Pusa Suhagin’ had the longest vase life (9.2 days).

Patil (2003) examined the performance of nine exotic gladiolus cultivars (‘Sancerre’, ‘Poonam, Sapand’, ‘Tropic Seas’, ‘Happy End’, ‘Suchitra’, ‘Yellow Stone’, ‘Sylvia’ and ‘IARI Sel-1’) for export quality cut flower production in Maharashtra, India. Among the cultivars, ‘Sapana’ and ‘Happy End’ were earliest to flower (70.2 days) followed by Sancerre and Tropic Seas (81.3 days) while ‘Poonam’ required highest number of days to flower (93.5). Spike length ranged from 74.2 cm (‘Happy End’) to 115.5 cm (Sancerre). Sancerre had the highest number of florets per spike (18.5). The largest florets were recorded by ‘Sancerre’, ‘Poonam’, and ‘Yellow’ ‘Stone while’ smallest from ‘Happy End’. ‘Sancerre’ and ‘Yellow Stone’ had the highest number of corms per plant (2.4 and 2.6 respectively). Corm size was highest in ‘Yellow Stone’ followed by Sancerre and ‘Tropic Seas’. Vase life of flowers was highest in ‘Sancerre’ (10.7 days) followed by ‘Yellow Stone’ (9.6 days) and ‘Tropic Seas’ (9.6 days) and lowest in ‘Happy End’ (6.9 days). ‘Sancerre’, ‘Yellow Stone’ and ‘Tropic Seas’ were superior in terms of floret color, placement and texture. Based on qualitative and quantitative characters evaluated, ‘Sancerre’, ‘Yellow Stone’ and ‘Tropic Seas’ were best for commercial cultivation.

Jagadish *et al.* (2003) studied the performance of gladiolus cultivars (‘Aldebaran’, ‘Day Dream’, ‘Pink Friendship’, ‘George Mazure’, ‘Gold Dust’, ‘Ice Gold’, ‘Melody’, ‘Neelam’, ‘Oscar’, ‘Pusa Suhagan’, ‘Sancerre’, ‘Snow Princess’, ‘Sylvia’, ‘Surya Kiran’ and ‘Vick Lin’) in Uttaranchal, India. ‘Oscar’ cultivar showed best performance in respect of spike length (91.1 cm) and number of florets per spike (19.6). The number of corms per plant was highest in ‘Melody’ (4.0) and lowest in ‘Sylvia’.

Gupta *et al.* (2002) studied the performance of eight gladiolus cultivars in India, Madhya Pradesh. These cultivars were ‘American Beauty’, ‘Jester’, ‘Propelicious’, ‘Spring Green’, ‘Summer Sunshine’, ‘Thumbiliana’, ‘Tiger Flame’ and ‘White Prosperity’. ‘Thumbiliana’ showed the highest corm sprouting percentage at 30 DAP followed by ‘White prosperity’ and ‘American Beauty’. The maximum plant height was recorded by ‘White prosperity’ followed by ‘Spring Green’ and ‘Tiger Flame’ while the lowest was by ‘Summer Sunshine’. It was found that ‘American Beauty’ and ‘Spring Green’ recorded the maximum spike per corm (1.3) followed by ‘Propelicious’ (1.25) and ‘White Prosperity’ recorded maximum spike length (83.2 cm) followed by ‘Thumbiliana’ (72 cm).Vase life was highest for ‘White Prosperity’ (12.8 days).

Gupta *et al.* (2001) evaluated 11 cultivars of gladiolus. Maximum spike length was recorded in cultivar ‘Pacific White’ (72.5 cm). The highest number of florets per spike observed in cultivar ‘Pacific White’ (15.2) followed by ‘Day Dream’ (14).
The floret length ranged from 8.3 cm (‘Interpit Bicolor’) to 11.2 cm (‘Red Sparkle’). The maximum increase in spike length was noticed in the cultivar Red Sparkle (14.5 %).

Kamble (2001) studied the performance of gladiolus cultivar in 'Arabhavi' (Karanataka) and reported that cultivar Trust recorded maximum plant height (81.1 cm) and was significantly superior over other cultivars. Maximum spike length (93.9 cm), spike weight (127.3 g), diameter of florets (11.91 cm) and number of florets per spike were noticed in cultivar 'Summer Sunshine'. Maximum spike growth and spike yield per ha were flound in 'Oscar'. It was also found that size of daughter corm (6.8 cm) and weight of daughter corm (143.9) were maximum in cultivar 'Summer Sunshine'.

Roy and Sharga (2000) studied 10 gladiolus cultivars at Lucknow, India and found that mother daughter corm ratio was highest (1:1.8) in case of CV. Priscilla. Corm diameter was maximum in case of CV. Ice Gold (6.6 cm) and Rose Supreme (6.6 cm).

Rai *et al.* (2000) evaluated 16 cultivars of gladiolus under sodic wasteland. Based on different characters such as plant height and number of tillers per plant, the cultivars like 'White Prosperity', 'White Goodness', 'Red Beauty', 'Friendship', 'Venetei', 'Aldebran', 'First Lady' were found superior in comparison to others. Number of corms per plant was maximum in variety 'First Lady' (1.9 corms) followed by White Prosperity (1.6 corms). The corm size was maximum in 'Friendship' (10.9 cm) followed by 'White Prosperity' (10.2 cm).

Singh *et al.* (2000) studied the effect of cultivar response on keeping quality of gladiolus spikes and reported that cultivars 'Applause', 'Hunting Song', 'Jacksonville' 'Gold, Mayur', 'Melody' and 'White prosperity' showed 7-10 days vase life when harvested at 5-7 florest color.

Sanjai and Brahma (2000) evalutated 20 gladiolus cultivars for cut flower and corm production in Ladakh, India and found that cultivar 'Princess Margaret Rose' showed maximum plant height (136.6 cm). Cultivar Victor Borge (55.7) showed higher number of cormels per plant followed by 'White Prosperity' (50.2), 'Eurovision' (48.8) and 'Novelty' (48.8).

Sidhu and Arora (2000) evaluated six gladiolus cultivars for summer flower production at Ludhiana in Punjab, India and reported that cultivar White Prosperity produced significantly tall plants (130.9 cm) followed by Pole Position (11.6 cm). White Prosperity produced the longest spikes (102.3 cm) and size of florets was maximum in cultivar 'Rose Supreme' (8.9 cm). Corm and cormel weight was significantly highest in cultivar 'Novalux'. However, number of corms per plant was highest in cultivar 'White Prosperity' (1.3) and number of cormels per plant was highest in cultivar 'Summer Sunshine' (12). It was also found that cultivar 'Eurovision' (5.2 days) showed longest vase life.

Shirmagond and Hanamashetti (1999) evaluated eight gladiolus cultivars for their performance in terms of flower and corm yield characteristics at Kittur Rani Chennamma College of Horticulture, 'Arabhavi' (Karnataka). These cultivars were 'Chipper White', 'Summer Sunshine', 'Canadian Blood Red', 'Apple Blossom', 'Summer Pearl', 'Puppu Tears', 'Pacifica White' and 'American Beauty'. 'Puppu Tears' took minimum days to sprout (21.3 days) and to flower (80.7 days). 'Pacifica White' (49.7 cm) and 'Canadian Blood Red' (73.5) attained highest plant height at 30 and 60 DAP respectively. 'Pacifica White' (122.0 cm), 'Summer Pearl' (113.5 cm), 'Summer Sunshine' (1.8.7 cm) and 'Canadian Blood Red' (109 cm) proved best with regard to spike length which fell in to the Fancy grade according to International

market standards. ‘Summer Sunshine’ showed highest vase life (8 days) followed by ‘Canadian Blood Red’ (7.5 days).

An investigation was carried out by Singh *et al.* (1997) on gladiolus cultivars (‘Oscar’ and ‘Friendship’) in Nagaland, India. Spike length and number of florets per spike were higher in ‘Oscar’ (77.6 cm and 18.2 respectively) than in ‘Friendship’ (69.2 cm and 12.7 respectively) but floret diameter and floret length and vase life were similar in both the cases.

Pant *et al.* (1998) evaluated 40 cultivars of gladiolus at Uttar Paradesh, India. ‘Apple Blossom’ (92.8 cm), ‘Piccardy’ (87.44 cm) and ‘Oscar’ (86.9 cm) had longest spikes and ‘Carmine’ was the earliest to flower (82.3 days). ‘Friendship’ had more florets per spike (19.5) followed by ‘Oscar’ (17.5). ‘Hn Van Mac Green’ had the heaviest spikes (123.1 g) followed by ‘Oscar’ (122.3 g). Among the cultivars, ‘Hawai’ produced more corms per plant (4.4).

Singh *et al.* (1997) conducted varietal trial with five cultivars of gladiolus in port Blair, India. These cultivars were ‘Miss America’, ‘Snow Princes’, ‘Red Canna’, ‘Smoky Orange’ and ‘Sanjeevan’. Significant differences were observed in plant height, flower number per spike and the number of daughter corms and cormels. ‘Miss America’ had the maximum plant height (66.8 cm), spike length (42.6 cm), number of florets per spike (14.2) and corm weight (111.6 g). In the prevailing agro-climatic conditions of the Andaman islands, ‘Miss America’ was found to perform best, followed by ‘Snow princes’.

Jhon *et al.* (1996) evaluated 41 gladiolus cultivars for cut flower and cormel production at Kashmir, India. ‘Classic’, ‘Red Majesty’, ‘Rose Supreme’, ‘Oscar’,

‘Sunny Boy’ and ‘White prosperity’ were the most suitable cultivars for cut flowers production, flower spikes ranging in length from 106.1 cm for Oscar to 120.13 cm for White prosperity. ‘Buff Beauty’, ‘King Lear’ and ‘White Prosperity’ were found to be best for production of cormels.

Pasannavar (1994) evaluated ten gladiolus cultivars in Karantaka, India and reported that cultivar ‘Copper King’ produced maximum plant height (67.8 cm). It was also found that ‘American Beauty’ recorded maximum floret length (11.2 cm) and spike yield (2,32,100/ha). Spike girth (0.98 cm) and diameter of florets (10.8 cm) were maximum in cultivar ‘Copper King’ whereas ‘Sylivia’ recorded minimum floret length (8.5 cm) and floret diameter (6.7 cm). It was also reported that daughter corm weight (109.1 g) and size (7.7 cm) were maximum in cultivar ‘American Beauty’ (11.6 days).

Sindhu and Verma (1995) studied the performance of 14 gladiolus cultivars at Katrain in Himachal Pradesh, India and found that cultivars ‘Age Wonder’, ‘Thumbolina’ and ‘Sancerre’ were best with respect to plant height. ‘Age Wonder’ (124 cm, respectively), ‘Thumbolina’ (125.6 cm and 10.8 cm respectively) were best with respect to spike length and diameter of florets. ‘Thumbolina’, ‘High Fashion’, ‘G-55’ and ‘Wing Song’ were the best multipliers of the corms and cormels.

Hegde (1994) studied the performance of gladiolus cultivars under at Dharwad, India. From the experiment, it was found that cultivar ‘Summer Pearl’ recorded the longest spike (100.7 cm). It was also found that daughter corm weight (97.2 g) and size (7.2 cm) were maximum in cultivar ‘Summer Pear’l under same conditions.

Ravidas *et al.* (1993) evaluated 5 gladiolus cultivars (‘Agnirekha’, ‘American Beauty’, ‘Friendship’, ‘Mansoer Red’ and ‘True Yellow’) in Kerala, India. ‘American Beauty’ surpassed the other cultivars with regard to all vegetative and floral characters.

Saini *et al.* (1991) studied the performance of six gladiolus cultivars at Hissar in Haryana state, India and found that maximum plant height was recorded by the ‘CV. George Mazure’ (99.7 cm) and minimum by’ CV. Miniature’ (59.7 cm). It was also found that ‘Sylvia’ was superior in respect of spike length which ranged from 60.0 to 79.0 cm. ‘Melody’ was good for corm and cormel production.

Studies conducted at Akola in the state of Maharashtra in central India by Dod *et al.* (1989) revealed that ‘CV. Dibonar’ was best among different cultivars of gladiolus with respect to plant height and number of leaves.

A field experiment on performance of seven gladiolus cultivars was conducted by Lal and Plant (1989) and found that cultivars ‘House of Orange’ and ‘Oscar’ had the longest spikes (66.5 and 66.0 cm respectively) and the ‘House of Orange’ was also first to flower (92.2 days) and the ‘Oscar’ produced the highest number (17) of florets per spike. ‘House of Orange’ produced the largest number (146) of cormels/plant also. Efforts made at the Indian Agricultural Institute, New Delhi for developing new varieties namely,‘Agni Rekha’, ‘Pusa Suhagin’ and ‘Suchitra’ (Singh and Dadlani, 1988) based on the performance trials of very promising hybrids along with the standard cultivars.

In an experiment Shah *et al.* (1988) evaluated ten gladiolus cultivars in Chaubattia (Uttar Pradesh). These cultivars were ‘Mother Fischer’, ‘Gospel Song’, ‘King Lear’,

‘Apple Blossom’, ‘Mafie Gorrette’, ‘Carmine’, ‘Her Majesty’, ‘Happy End’, ‘Spite’ and ‘Glossy’. From the experiment, it was found that cultivar ‘Spite’ was early (89 days) to flower followed by ‘Carmine’ (89.5 days) and latest to flower was ‘Her Majesty’ (99.5 days).

Singh and Singh (1987) studied the performance of 41 gladiolus cultivars in Delhi and reported that cultivars ‘Friendship’ and ‘Melody’ were most suitable for floral characters. The number of days to first floret opening varied from 83.4 to 119.3 days. On the basis of this character, cultivars were grouped into early mid–season and late. The early cultivars which flowered between 75 to 85 DAP were ‘Snow Princess’, ‘Happy End’ and ‘Vinks Glory’. Cultivar ‘Green Wood Pecker’ was included under mid –season group which flowered between 86 to 95 DAP. The late cultivar which flowered 95 DAP was ‘Sylvia’. ‘Friendship’ and ‘Melody’ performed better for corm and cormel multiplication and found that the cultivar ‘Sylvia’ produced highest number of cormels.

Misra *et al.* (1987) in their two years experiment at Katrain in Himachal Pradesh of India with 12 cultivars of gladiolus found that cultivar ‘Salmon Queen’ had maximum spike length, highest number of florets and floret diameter whereas ‘Katrain Local’ and ‘Psittacinus’ remain poor.

Arora and Sandhu (1987) studied the performance of 15 gladiolus cultivars at Ludhiana in Punjab, India. With early planting days to sprouting ranged from 20 days (‘Snow princess’) to 39.3 days (‘Mayur’) while with late planting from 22 days (‘Vinks Glory’) to 26 days (‘Raj Niwas’). The cultivar ‘Oscar’ produced the longest (85.7-88.7 cm) and heaviest spikes (64-79 g) with biggest florets. The cultivars ‘Snow Princess’, ‘Sylvia’ and ‘Oscar’ had highest number of florets open per spike. Corm

production was highest in ‘Melody’ (6.7 and 4.7/plant for early and late planting respectively). Cormel production was highest in ‘Suchitra’ (123 and 113.3/plant for early and late planting respectively).

Studies were conducted by Arora and Khanna (1985) on thirty gladiolus cultivars over a period of three years at Ludhina, India for different characters. Cultivars ‘Suchitra’, ‘Melody’, ‘Ratans Butterfly’ and ‘Snow Princess’ were superior among many varieties evaluated under Ludhiana conditions with respect to spike length, which ranged from 80 to 90 cm. It was found that corm and cormel production was best in ‘Emerald Queen’, ‘Mayur’, ‘Melody’ and ‘Suchitra’.

Lal *et al.* (1984) evaluated the performance of 47 cultivars at Uttar Pradesh, India and reported the earliest to flower were ‘American Bon Voyage Sport’ and ‘Dutch Apple’ Bloom while the least were ‘Australian Over True’ and ‘American Gem’. The cultivars ‘Apple Bloom’ (98 cm), ‘Prof. Gourdian’ (94.8 cm), ‘Gilbert Herald’ (85.6 cm) and ‘Friendship’ (85.1 cm) produced the longest spike. It was observed that cultivar ‘Friendship’ produced maximum number of florets per spike (22).

Negi *et al.* (1982) carried out an experiment on the performance of four new gladiolus cultivars for different characters at the Hariana Agricultural University Farm, Hissar, India. These were ‘Sapna’, ‘Meera’, ‘Nazarana’ and ‘Poonam’. The number of flowers per plant varied from 5.33 to 20.00. It was found that all the four new cultivars are good for corm and cormel production.

The Indian Institute of Horticultural Research, Hessaraghatta, Banglore collected a wide array of gladiolus germplasm from indigenous and exotic sources. After thorough assessment on the basis of various vegetative and floral traits, eleven varieties, namely, ‘Beauty Spot’, ‘Cherry Blossom’, ‘Friendship’, ‘Jo Wagenaar’, ‘Melody’, ‘Picardy’, ‘Snow Princess’, ‘Tintorente’, ‘Tropic Seas’, ‘Watermelon

Pink', and 'Wild Rose' were recommended for commercial cultivation for cut flower and garden display purposes for Bangalore and other places with identical climatic conditions (Negi *et al*. 1981).

A large number of hybrids were raised at the Indian Institute of Horticultural Research, Hessaraghatta and Bangalore. These hybrids were evaluated on the basis of various vegetative and floral characteristics for 2-3 seasons. Based on the performance in the replicated trials, two hybrids were finally selected and released as 'Aarti' and 'Apsar' in 1980 (Raghava *et al*. 1981).

Evaluation of various exotic varieties at the Horticulture Experiment and Training Center, Chaubattia, Almora resulted in the selection of nine varieties, namely, 'Apple Blossom', 'Australian Dust', 'Australian Sunday Best', 'Friendship', 'Geliber Herald', 'House of Orange', 'Mozolia', 'Oscar' and 'Prof. Goudrin' for growing under U.P. hill conditions (Lal and Singh, 1978).

Misra and Choudhary (1976) studied the performance of 100 gladiolus cultivars at Simla, India and 37 cultivars were found outstanding for various quantitative characters. The cultivars which flowered within 70 DAP were grouped as early and 70 to100 days as midseason which include 'Friendship', 'Green Wood Pecker', 'Happy End', 'Oscar', 'Snow Princess' and 'Vinks Glory'. The group which required more than 100 days were categorized as late which include 'Sylvia'. The cultivar 'Vinks Glory' performed well with respect to spike production (1 to 1.3 mt). In yellow, 'Vinks Glory' and in deep red, 'Oscar' was the best. Cultivar 'Vinks Glory' was found to be the best multiplier of the corms and cormels. Other cultivars like 'Gold Dust', 'Sylvia' and 'Winter Gladioli' were also satisfactory multipliers of corms and cormels.

Swarup and Raghava (1972) evaluated many promising gladiolus cultivars for the North India plains. These genotypes were assessed on the basis of certain characteristics such as number of days taken for first floret opening, spike length and number of florets per spike. Cultivars were grouped into early, mid season and late flowering. The cultivars which produced flower spikes within 60 days after planting (DAP) were grouped as early and those which flowered in 60 to 80 DAP as mid season and those which took more than 80 DAP as late flowering types. They found that early flowering occurred in Sylvia and Snow Princess as promising cultivar having long spike and large florets. 'Ratans Butterfly', 'Snow Princess' and 'Apple Blossom' are good for multiplication of corm and cormel.

2.2 Response of different preservatives on vase life of cut flower

Vase life of gladiolus increased by placing spikes in solution containing 3.5 percent sucrose and 200 ppm 8-HQS solution (Bhattacharjee, 2006).

Fahmy (2005) reported that silver thiosulphate (STS) as pulsing solutions and sucrose; 8-hydroxy quinoline sulphate (8-HQS) and citric acid (CA) as holding solutions were most effective in prolonging vase life of cutflower.

A study was undertaken by Singh *et al.* (2003) to investigate the effect of different sucrose concentration (1-4%) as holding solution to increase vase life and quality of gladiolus cut flowers. The vase life of gladiolus was prolonged by using 3% sucrose. Singh and Sharma (2002) conducted an experiment to study the effect of sucrose (3%) in combination with metal salts 8-hydroxyquinoline sulphate (8-HQS) 200 mg/l increased the vase life of cut gladiolus spikes.

Ranvir and Sashikala (2002) noted that treatment with 3% sucrose and 200 ppm 8-HQS were good for extending the vase life of gladiolus cut flower, by increasing water uptake and maintaining higher fresh weight of flowers.

Singh *et al*. (2000) observed that synergized effect of BA, sucrose and 8-HQC on vase life as well as opening of buds of tuberose flowers.

Holding solutions containing 5% sucrose + 250 mg HQS increased solution uptake and fresh weight and decreased bent neck of cut tuberoses compared to tap water (Kumar, 2000).

Bose *et al.* (1999) conducted an experiment to investigate the effect of floral preservatives. They observed that the vase life, general appearance, fresh mass and volume of solution uptake of the inflorescences improved with sucrose and citric acid treatment. It was recorded that a concentration of 3% sucrose and 25 ppm citric acid was the most effective treatment.

Sucrose is an important ingredient in almost all chemical formulations of floral preservatives. Sugars in vase solution were found effective in delaying senescence and promoting vase life of cut gladiolus (Mukhopadhay, 1998).

A study was undertaken to investigate the effect of different sucrose concentration (1-4%) as holding solution to increase vase life and quality of cutflowers (Doi and Reid, 1995). They observed that gladiolus, chrysanthemum and anthurium flowers when kept in 3%, 2% and 1% sucrose respectively resulted in better water balance and longest vase life.

Singh *et al.* (1994) investigated the physiological role of GA (25-50 ppm), 8-HQS (200-300 ppm) and sucrose (3-4%) singly and in a combination of these chemicals in

extending the vase life of tuberose cut-flowers. The maximum vase life of 12 days was observed in flower spikes held in 3% sucrose, 300 ppm 8-HQS along with 50 ppm GA.

Reddy *et al.* (1994) noted that treatment with 4% sucrose and 200 ppm 8-HQS were good for extending the vase life of gladiolus cut flower, by increasing water uptake and maintaining higher fresh weight of flowers.

Reddy and Murali (1994) reported that STS 0.5 mM with 3% sucrose was found best for increasing water uptake and extending the longevity of cutflower.

Cut flowers harvested at 25% bloom stage and placed in holding solution containing a mixture of 3% sucrose and 200 ppm HQS increased the freshness of gladiolus flowers (Gowda, 1992).

Rogers and Tija (1990) stated that cut flower holding solution containing 4 % sucrose + 200 ppm HQS + 25 ppm citric acid attained maximum vase life 14 days as compared to control 10 days only.

Beneficial role of metal salt with sucrose in enhancing vase life of gladiolus has been reported by Murali *et al.* (1990).

Quinoline salts (HQS) and sucrose mixtures were reported to extend the vase life and improve the quality of several flowers. (Pathak, S. 1981).

Use of citric acid (0.1 to 0.5 per cent) in the holding solution promoted the floral development and keeping quality of cut spikes of gladiolus (Mukhopadhay, 1980).

CHAPTER III

MATERIALS AND METHODS

Details of experimental materials and methods followed during the time of the present investigation are described in this chapter.

Expt. 1. Performance study of gladiolus genotypes

3.1 Experimental site and duration

The experiment was conducted at the Floriculture Research Field, Horticulture Research Centre, Bangladesh Agricultural Research Institute (BARI), Gazipur. The experiment was conducted during October 2013 to June 2014. The site was about 35 km North from Dhaka city with $24^0 9^/$ North Latitude and $90^0 26^/$ East Longitude and elevation of 8.40 m from the sea level (Khan, 2009) in Agro – Ecological Zone of Madhupur Tract (AEZ No. 28).

3.2 Climatic condition

The climate of experimental site is subtropical. The experiment was carried out during Rabi season. The season is characterized by dry sunny weather, warm at the beginning and end, but cool in December- February. The average length of Rabi growing period ranged from 100-120 days.

3.3 Soil

The soil of the experimental field was silty clay loam in texture and acidic in nature. Soil sample of the experimental plot was collected from a depth of 0-30 cm before conducting the experiment and analyzed in the Soil Science Division, Bangladesh

Agricultural Research Institute (BARI), Gazipur and have been presented in Appendix- I.

3.4 Treatments

There was single factor in this experiment. The factor including 10 genotypes of gladiolus which are as follows: V_1 (GL-001), V_2 (GL-002), V_3 (GL-004), V_4 (GL-012), V_5 (GL-014), V_6 (GL-018), V_7 (GL-025), V_8 (GL-037), V_9 (GL-038) and V_{10} (BARI Gladiolus-4).

3.5 Planting materials used for the experiment

In this experiment ten (10) gladiolus genotypes were collected from different regions of Bangladesh and considered as the treatments of the experiment. The sources of the gladiolus genotypes are summarized in Table 1.

Table 1. Source name of the different genotypes of gladiolus

Genotypes	Source of collection
V_1 (GL-001)	Sharsha, Jessore
V_2 (GL-002)	Sharsha, Jessore
V_3 (GL-004)	Sharsha, Jessore
V_4 (GL-012)	Sharsha, Jessore
V_5 (GL-014)	Jhikargacha, Jessore
V_6 (GL-018)	Jhikargacha, Jessore
V_7 (GL-025)	Satkhira
V_8 (GL-037)	Benapol, Jessore
V_9 (GL-038)	Benapol, Jessore
V_{10} (BARI Gladiolus-4)	BARI

3.6 Land preparation

The land was brought to a fine tilth by ploughing. Weeds and stubbles were removed before final land preparation. Special care was taken to remove the rhizomes of mutha grass.

3.7 Recommended manure and fertilizer doses

Manures and Fertilizers	Dose/ha
Cowdung	**10 ton**
N	**200 kg**
P	**50 kg**
K	**150 kg**
S	20 kg
B	2 kg
Zn	2 kg

Source : Halder *et al.* (2007)

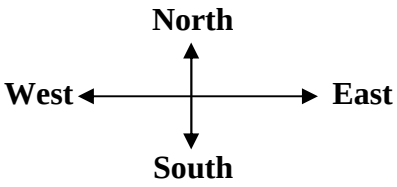
3.8 Application of recommended fertilizer doses

The entire amount of cowdung, P, K, S, B and Zn per hectare were applied during final plot preparation. N was applied in two installments at 30 and 60 days after planting of corms.

3.9 Design and Layout

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications (Figure 1). The 10 treatments were randomly allotted in each block. The unit plot size was 2.0 m × 1.5 m accommodating 70 plants per plot. Spacing was maintained at 20 cm from row to row and 20 cm from plant to plant. Two adjacent unit plots were separated by 60 cm space and there was 80 cm space between the blocks.

R_1	R_2	R_3
V_6	V_3	V_1
V_7	V_4	V_2
V_8	V_5	V_3
V_9	V_6	V_4
V_{10}	V_7	V_5
V_1	V_8	V_6
V_2	V_9	V_7
V_3	V_{10}	V_8
V_4	V_2	V_9
V_5	V_1	V_{10}



Plot size = 2.0 × 1.5 m
Plot to plot distance = 60 cm
Block to block distance = 80 cm
Plant spacing = 20 × 20 cm

V_1 (GL-001)
V_2 (GL-002)
V_3 (GL-004)
V_4 (GL-012)
V_5 (GL-014)
V_6 (GL-018)
V_7 (GL-025)
V_8 (GL-037)
V_9 (GL-038) and
V_{10} (BARI Gladiolus-4)

Figure 1. Layout of the experiment

3.10 Planting of corms

The corms were planted at a depth of 9 cm in furrows on mid October, 2013.

3.11 Weeding

Weeding was done periodically whenever necessary.

3.12 Irrigation

The experimental plot was irrigated as and when necessary during the whole period of plant growth following flood method.

3.13 Mulching

The soil was mulched frequently after irrigation by breaking the crust for easy aeration and to conserve soil moisture.

3.14 Earthing up

Three earthing ups were done at 30, 50 and 70 days after planting throughout the growing period.

3.15 Selections and tagging of plants

Ten plants from each plot were selected randomly and marked by tagging for recording data.

3.16 Harvesting of flowers

The spikes of gladiolus were harvested from January to February, 2014 at the tight bud stage and when three basal flower buds showed colour so that these may easily open indoors one by one (Bose *et al.*, 2003). Corm and cormel were harvested on June, 2014 when leaves turned brown (Khan, 2009).

3.17 Disease and pest management

Diseases can be a major factor for gladiolus production. The experimental crop was infected by leaf spot during the early growing stage. Data on disease incidence was based scoring, 0-1=Tolerant, 2=Moderately tolerant, 3=Susceptible, 4=Highly susceptible. The disease was controlled by spraying Ridomil (2g/l).

The fungicide was sprayed two times at 15 days interval. The crop was not attacked by any insect.

3.18 Data collection

Observations were recorded from randomly chosen 10 plants from each plot on following parameters.

3.18.1 Days required to 80% emergence of the crop

It was recorded by counting the days from corm planting to 80% completion of emergence of the crop and expressed in days.

3.18.2 Plant height

Plant height refers to the total length of the 10 randomly selected plants from ground level to tip of erect leaf measured by a meter scale and the mean was calculated and expressed in centimeter.

3.18.3 Leaves/plant

Number of leaves per plant was recorded by counting all the leaves from 10 randomly plants of each unit plot and the mean was calculated.

3.18.4 Plant/hill

Number of plant per hill was recorded by counting all the plant per hill from 10 randomly plants of each unit plot and the mean was calculated.

3.18.5 Days required to 50% spike initiation

It was recorded by counting the days from corm planting to 50% spike initiation from randomly selected 10 plants in each plot, then averaged and expressed in days.

3.18.6 Floret number/spike

It was recorded by counting number of floret from 10 randomly selected spikes and then mean was calculated.

3.18.7 Spike length

It was measured from the end where from it was cut off at the base to the tip of the spike by measuring scale from 10 randomly selected spikes and then mean was calculated and expressed in centimeter.

3.18.8 Rachis length

Length of rachis refers to the length from the axils of first floret up to the tip of inflorescence.

3.18.9 Spike weight

Ten spikes were cut from randomly selected plants from each unit plot and the weight of spikes were recorded to calculate their mean and expressed in grams.

3.18.10 Flower durability

Flower durability was recorded from the time of first floret opening to the maximum freshness in 10 randomly selected spikes and expressed in days.

3.18.11 Flower yield/ha

Flower yield per hectare was computed by counting numbers of spikes per plot and converted to hectare.

3.18.12 Vase life (days)

Vase life of gladiolus spikes of different varieties was observed in water. The spike with the second floret started to open were cut and were kept in tap water immediately. In the laboratory these flower spikes were kept in vases with tap water to study the vase life of spike in tap water without any chemicals.

3.18.13 Corm number

It was calculated from the number of corm obtained from ten randomly selected plants and mean was calculated.

3.18.14 Cormel number

It was calculated from the number of cormel obtained from ten randomly selected plants and mean was calculated.

3.18.15 Corm weight

It was determined by weighing the corm from ten randomly selected plants, their mean weight was calculated and expressed in grams.

3.18.16 10- cormel weight

Weight of 10 cormel/plant was recorded from the mean weight of ten randomly selected sample plants and expressed in grams.

3.19 Statistical Analysis

The recorded data on different parameters were statistically analyzed using 'MSTAT-C' software to find out the significance of variation resulting from the experimental treatments. The mean for the treatments was calculated and analysis of variance for each of the characters was performed by F (variance ratio) test. The differences between the treatment means were evaluated by Duncan's Multiple Range Test (DMRT) according to Steel *et al*. (1997) at 5% level of probability. The analysis of variance (ANOVA) of the data on different characters of gladiolus is given in Appendix II-IV.

Experiment 2. Effect of preservatives on vase life of gladiolus

3.20.1 Location and duration

This experiment was conducted at the Laboratory of Landscape, Ornamental and Floriculture Division of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur during the period from January 2014 to March 2014.

3.20.2 Experimental materials

Spikes of gladiolus flower were selected as experimental material. Fresh gladiolus spikes of about 55 cm was harvested from field of Landscape, Ornamental and Floriculture Division of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur in the morning to avoid excessive heat and immediately after harvest, the spikes were placed in plastic buckets containing cold water in order to rehydrate the flowers. The spikes were brought to the laboratory within ½ hour after harvest. Spikes were sorted into different groups (based on the size and number of florets per spike) in order to maintain uniformity in the material used for experiment. The spikes were again cut to uniform length of 50 centimeter and all the leaves were removed to avoid contact with the solution.

3.20.3 Treatments

The study consisted of ten treatments-

T_1= 3% sucrose

T_2= 4% sucrose

T_3= 100 ppm 8-HQS

T_4= 200 ppm 8-HQS

T_5=25 ppm citric acid

T_6= 3% sucrose + 100 ppm 8-HQS +25 ppm citric acid

T_7= 3% sucrose + 200 ppm 8-HQS +25 ppm citric acid

T_8= 4% sucrose + 100 ppm 8-HQS +25 ppm citric acid

T_9=4% sucrose + 200 ppm 8-HQS +25 ppm citric acid and

T_{10}= Control.

3.20.4 Experimental design

The experiment was laid out in a Completely Randomized Design with three replications.

3.20.5 Methods

Single spike of gladiolus flower was used for each bottle (Plate1). A total number of 30 flowers were used to hold the floral preservatives which were prepared freshly and dispensed into the bottles. Bottles were kept at room temperature (20-25^{O}C), relative humidity (RH) of 65-80% with adequate aeration.

Plate 1. Placement of gladiolus flower spike in vase solutions

3.20.6 Preparation of vase solutions

Procedure of applying different preservatives to the flowers of each type was as follows:

A. Sugar solution (3-4 %)

Thirty gram sugar was dissolved in 1 litre of water to prepare 3% solution. Similarly, 40 g sugar was dissolved in 1 litre of water to prepare 4% solution.

B. HQS solution (100-200 ppm)

Hundred mg of HQS was dissolved in 1 litre of water to prepare 100 ppm solution of HQS. Similarly, 200 mg of HQS was dissolved in 1 litre of water to prepare 200 ppm solution.

C. Citric acid (25 ppm)

To prepare 25 ppm solution 25 ml citric acid was dissolved in 1 litre of water.

D. Control solution

No preservative was added here. Tap water was used and collected from the Floriculture Laboratory of Horticulture Research Centre, Bangladesh Agricultural Research Institute.

E. Flower vase

Glass bottle (200 ml) was used as flower vase in this experiment. After preparing the solutions each glass bottle was filled with 150 ml of desired solution and one spike of gladiolus cut flower was placed in bottle and kept in laboratory at room temperature. Each bottle was marked for easy identification. Water level was marked with a permanent marker after placing flower spikes. The mouths of the glass bottles were kept open.

3.20.7 Collection of Data

Data were recorded for floret opening (%), total quantity of water uptake, total quantity of water loss, loss uptake ratio, fresh weight of spike, vase life etc.

3.20.7.1 Floret opening (%)

Recorded from the day when the first floret opening till the spike was discarded and expressed in percentage.

3.20.7.2 Water uptake (g/spike)

The difference between initial and final weights of the bottle with solution (without spike) represents the water uptake and expressed in grams.

3.20.7.3 Water loss (g/spike)

The difference between the initial and final weights of bottle with solution and spike represents the loss of water and expressed in grams.

3.20.7.4 Vase life (days)

Days were counted till the spike was moderately bent and petal was lost its original colour.

3.21 Statistical analysis

The data recorded on different parameters were statistically analyzed with the help of MSTAT-C software. The differences between treatments mean were compared by Duncan's Multiple Range Test (DMRT) according to Steel *et al.* (1997). The analyses of variance are presented in Appendix-V.

CHAPTER IV
RESULTS AND DISCUSSION

The present study was conducted during the period from October 2013 to June 2014 to investigate the performances in gladiolus genotypes. The results of the experiment were arranged under following heading in this chapter.

Expt. 1: Performance study of gladiolus genotypes

4.1 Plant characteristics

The plant characteristics like days to 80% emergence, plant height, number of leaves, leaf area, plants per hill were recorded and shown in Table 2.

4.1.1 Days to 80% emergence

Days to 80% emergence percentage was significantly influenced by genotypes (Appendix II). The genotypes V_3 took minimum days (15 days) to 80% emergence closely followed by V_4 (16 days). The maximum days (25 days) were required for 80% emergence by genotypes V_{10}. In a varietal trail, Munir (2013) and Nazir and Dwivedi (2006) reported that the gladiolus varieties required 15-25 days to 80% emergence which was in consonance with majority of the genotypes under investigation. The differences in days to 80% emergence might be due to the genetical factors of the genotypes concerned.

4.1.2 Plant height

Significant differences were recorded among the genotypes for plant height (Appendix II). The tallest plant was recorded from V_7 (70.0 cm) followed by V_4 and V8 (65.0 cm.) The shortest plant was recorded in V_5 (50.0 cm). Significant difference for plant height in gladiolus cultivars were also observed previously by Singh *et al.* (1997), Dod *et al*. (1989), Saini *et al*. (1991), Sidhu and Arora (2000) and Kishan *et al*. (2005).

The variation in plant height in different genotypes may be due to genetic variation and difference in adaption to the agro- climatic condition. Several cultivars of the same species behave different even grown under same environment (Kumar, 2009). The genotype V_{10} may cause weak photoperiod sensitivity than others and produce shorter plant. The function of plant hormone specially gibberellins which stimulate cell elongation in shoot apical meristems, causing the plant to grow taller may be different in various gladiolus genotypes. Similar result was observed in gladiolus cultivar (Munir, 2013).

4.1.3 Number of leaves

The number of leaves produced in different treatments varied significantly. The number of leaves per plant ranged from 6.0-11.0. The treatment V_7 and V_8 were superior and produced the highest number of leaves per plant (11.0) followed by V_4 and V_9. Adequate numbers of leaves are essential for normal growth and production. An increase in number of leaves causes the accumulation of greater photosynthates leading to better growth parameters. The treatment V_5 and V_6 produced the lowest number of leaves (6.0). This variation might be mainly due to genotype variation as well as environmental effects. Plants produce food materials through the process of photosynthesis. With the increasing number of leaves, photosynthesis will generally increase, thus plant can produce more photosynthesis (Plant food) that influences the growth and development of the plant. So, genotypes that can produce more leaves have more plant growth leading to higher yield.

Table 2. Plant characteristics of different genotypes of gladiolus

Treatments	Days required to 80% emergence	Plant height (cm)	No. of leaves	Leaf area (cm^2)	Plants/hill
V_1	19 bc	60.0 c	8.5 ab	71.0 bc	1.1 ab
V_2	22 ab	64.0 bc	9.0 ab	75.0 b	1.2 ab
V_3	15 c	63.0 bc	9.0 ab	75.0 b	1.2 ab
V_4	16 c	65.0 b	10.0 ab	78.0 ab	1.5 ab
V_5	23 ab	50.0 e	6.0 b	70.0 c	4.0 a
V_6	24 ab	57.0 cd	6.0 b	70.0 c	1.0 b
V_7	20 b	70.0 a	11.0 a	80.0 a	1.5 ab
V_8	20 b	65.0 b	11.0 a	80.0 a	3.5 a
V_9	21 ab	62.0 bc	10.0 ab	78.0 ab	1.8 ab
V_{10}	25 a	55.0 d	9.5 ab	73.0 bc	2.0 ab
Level of Significance	*	*	*	*	*
LSD (0.05)	2.01	1.96	1.12	1.84	0.08
CV %	9.9	11.2	10.3	10.9	11.8

V_1 (GL-001), V_2 (GL-002), V_3 (GL-004), V_4 (GL-012), V_5 (GL-014), V_6 (GL-018), V_7 (GL-025), V_8 (GL-037), V_9 (GL-038) and V_{10} (BARI Gladiolus-4)

4.1.3 Number of leaves

The number of leaves produced in different treatments varied significantly. The number of leaves per plant ranged from 6.0-11.0. The treatment V_7 and V_8 were superior and produced the highest number of leaves per plant (11.0) followed by V_4 and V_9. Adequate numbers of leaves are essential for normal growth and production. An increase in number of leaves causes the accumulation of greater photosynthates leading to better growth parameters. The treatment V_5 and V_6 produced the lowest number of leaves (6.0).

This variation might be mainly due to genotype variation as well as environmental effects. Plants produce food materials through the process of photosynthesis. With the increasing number of leaves, photosynthesis will generally increase, thus plant can produce more photosynthesis (Plant food) that influences the growth and development of the plant. So, genotypes that can produce more leaves have more plant growth leading to higher yield.

4.1.4 Leaf area

The genotypes showed significant differences with respect to leaf area (Appendix II). The maximum leaf area (80.0 cm^2) was recorded in the genotypes V_7 and V_8 closely followed by V_4 and V_9 (78.0 cm^2). The minimum leaf area was recorded in V_{10} (70.0 cm^2). Munir (2013) found that Lemon yellow cultivar showed maximum leaf area and white flower cultivar showed minimum ranged from 76.1-97.2 cm^2 in varietal evaluation of gladiolus. This may be due to different cultivars contain different concentration level of nitrogen, phosphorous and potassium. This may cause difference in CO_2 uptakes during photosynthesis and resulted in different leaf area.

4.1.5 Plants/hill

Significant variation regarding plants per hill was observed among the genotypes (Appendix-II). The highest number of plants per hill was produced by V_5 (4.0) followed by V_8 (3.5). The genotype V_6 produced the lowest number of plants per hill (1.0). The number of plants per hill varied from 1.0-5.0 as reported by Roy and Sharga (2000) from their experiment at Lucknow, India. Saini *et al.* (1991) reported that plants per hill was highest in genotype GL-006 (5.0).

4.2 Flower characteristics

4.2.1 Colour of flower

As regards to the colour of flower, the observed genotypes showed remarkable variation such as Off white, Yellowish orange, Lemon yellow, Violet, Orange, Majenta, Orange, Light pink, Red and Pink (Table 3).

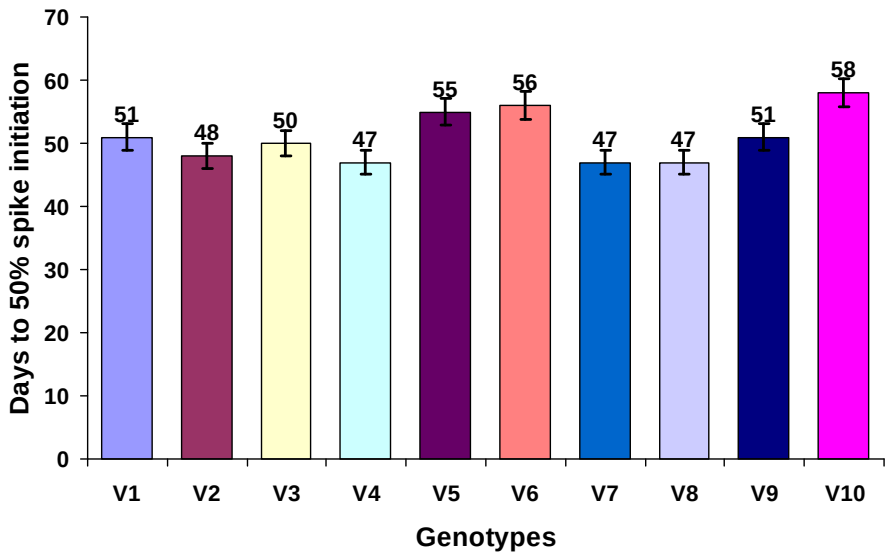
Table 3. Flower colours of different genotypes of gladiolus

Genotypes	Floret colour
V_1 (GL-001)	Off white
V_2 (GL-002)	Yellowish orange
V_3 (GL-004)	Lemon yellow
V_4 (GL-012)	Violet
V_5 (GL-014)	Orange
V_6 (GL-018)	Majenta
V_7 (GL-025)	Orange
V_8 (GL-037)	Light pink
V_9 (GL-038)	Red
V_{10} (BARI Gladiolus-4)	Pink

V_1 (GL-001), V_2 (GL-002), V_3 (GL-004), V_4 (GL-012), V_5 (GL-014), V_6 (GL-018), V_7 (GL-025), V_8 (GL-037), V_9 (GL-038) and V_{10} (BARI Gladiolus-4)

4.2.2 Days to 50% spike initiation

Days to 50% spike initiation was influenced by genotypes (Fig. 2). The minimum days for spike initiation were taken by V_4, V_7 and V_8 (47.0 days) (Fig. 2). Maximum days were taken by V_{10} genotypes to reach 50% spike initiation (58 days).



These results are more or less in

conformity with the result of Kamble *et al.* (2004) as they recorded the early spike initiation (48 days) in cultivar Snow White whereas delayed initiation (60 days) in Magic.

Fig. 2. Days to 50% spike initiation of different genotypes of gladiolus

V_1 (GL-001), V_2 (GL-002), V_3 (GL-004), V_4 (GL-012), V_5 (GL-014), V_6 (GL-018), V_7 (GL-025), V_8 (GL-037), V_9 (GL-038) and V_{10} (BARI Gladiolus-4)

4.2.3 Spike length

Significant variation in respect of spike length was found among the genotypes (Table 4). The longest spike was produced by genotypes V_7 and V_8 (90.0 cm) followed by V_4 and V_9 genotypes (88.0 cm) while the shortest spike was produced by V_5 (75.0 cm). Poon *et al*. (2010) recorded spike length ranged from 65. 0 to 115.0 cm in varietal evaluation of gladiolus. Length of flower spike was significantly influenced by different cultivar (Lal *et al*., 1984; Shiramagond and Hanamashetti, 1999; Dalal *et al*. 2006). 'Vinks Glory' performed well with respect to spike length (Misra and Choudhary, 1976). 'Pusa Joytsana' produced longest spike followed by 'Nova Lux' and 'High Style' (Pragya *et al*., 2010).

This may be due to different plant height of these genotypes. Plant height cxhibited direct effect on spike length and it was suggested that improving plant height can bring about improvement in spike length (Misra *et al.*, 1987).

4.2.4 Rachis length

A great deal of genotypic variation in rachis length was observed (Table 4) and varied from 40-50 cm. The highest rachis length was observed in V_7 and V_8 (50.0 cm) which was closely followed by V_4 and V_9 (48.0 cm) (Plate 2). The lowest rachis length was observed in genotypes V_5 (40.0 cm). Anuradha *et al.* (1996) reported that rachis length ranged from 40.0-55.0 cm in varietal evaluation of gladiolus.

Table 4. Floral characteristics of different genotypes of gladiolus

Treatments	Spike length (cm)	Rachis length (cm)	Floret number	Spike weight (g)	Flower durability (days)
V_1	80.0 c	45.0 b	11.7 ab	45.0 d	11.0 ab
V_2	83.0 bc	50.0 a	14.0 a	55.0 b	14.0 ab
V_3	85.0 b	47.0 ab	10.5 ab	50.0 c	11.0 ab
V_4	88.0 ab	48.0 ab	13.0 a	58.0 ab	14.0 ab
V_5	75.0 d	45.0 b	11.0 ab	55.0 b	9.0 b
V_6	80.0 c	40.0 c	8.0 b	48.0 cd	10.0 b
V_7	90.0 a	50.0 a	14.0 a	60.0 a	15.0 a
V_8	90.0 a	50.0 a	14.0 a	58.0 ab	15.0 a
V_9	88.0 ab	48.0 ab	13.0 a	52.0 bc	14.0 ab
V_{10}	85.0 b	45.0 b	11.0 ab	50.0 c	13.0 ab
Level of Significance	*	*	**	*	*
LSD (0.05)	2.30	2.08	1.41	1.50	1.60
CV %	11.5	10.8	9.7	12.6	8.3

V_1 (GL-001), V_2 (GL-002), V_3 (GL-004), V_4 (GL-012), V_5 (GL-014), V_6 (GL-018), V_7 (GL-025), V_8 (GL-037), V_9 (GL-038) and V_{10} (BARI Gladiolus-4)

4.2.5 Number of florets

The effect of genotype on number of floret was significantly influenced (Appendix-III). The maximum number of floret (14.0) was recorded in V_7 and V_8 closely followed by V_4 and V_9 (13.0) (Plate 2). Number of floret was significantly influenced by different cultivar by different workers (Lal and Shingh, 1978; Patil, 2003; Dalal *et al*., 2006) and floret number ranged from 5.3 to 20.0 (Negi *et al*., 1982), 14.1 to 16.7 (Rashmi, 2006) and 8.4 to 14.5 (Hossain *et al.,* 2011). Maximum number of floret produced by 'Pacific White' (Gupta *et al*., 2001), 'Dhiraj' (Nair and Shiva, 2003), 'American Beauty' (Rani and Singh, 2005) and 'Congo Song' (Nazir and Dwivedi, 2006). This may be due to different plant height and spike length of these cultivar. Plant height and spike length had direct influence on number of florets per spike and improvement in spike length and plant height directly increased number of florets per spike (Misra *et al.,* 1987).

4.2.6 Spike weight

Genotypes had displayed a wide range of variability among them in respect of spike weight. It ranged from 45.0-60.0 g (Table 4). Maximum spike weight was recorded from genotypes viz. V_7 (60.0 g) followed by V_4 and V_8 (58.0 g). The minimum spike weight was recorded in genotype V_1 (45.0 g). The differences in spike weight might be due to the genitical factors of the genotype concerned.

4.2.7 Flower durability

Flower durability varied significantly among the genotypes (Appendix-II). The maximum flower durability was observed in V_7 and V_8 (15.0 days) while the minimum in V_5 (9.0 days) (Table 2).

This result is in conformity with Shiramagond and Hanamashetti, 1999; Sidhu and Arora, 2000 and Patil, 2003; who found significant variation among cultivars for flower durability. Cultivar 'Applause', 'Hunting Song', 'Jacksonvile Gold', 'Mayur', 'Melody' and 'White Prosperity' had good flower durability quality ranged from 10.0 to 15.0 days (Singh *et al*., 2000).

4.2.7 Vase life

A great deal of genotypic variation was observed in case of vase life (Fig. 3). Vase life was observed in this experiment varied from 6 to 10 days. The highest vase life was found in genotype V_4, V_7, V_8 and V_9 (10 days) while the shortest vase life was found in genotype V_6 (6.0 days). In a varietal trial, Lal and Singh (1978) reported that the vase life of gladiolus lasted from 5 days to 15 days. Negi *et al*. (1981) indicated that vase life was essential character for selection of gladiolus varieties. The difference in vase life might be due to different genetic configuration of the genotypes.

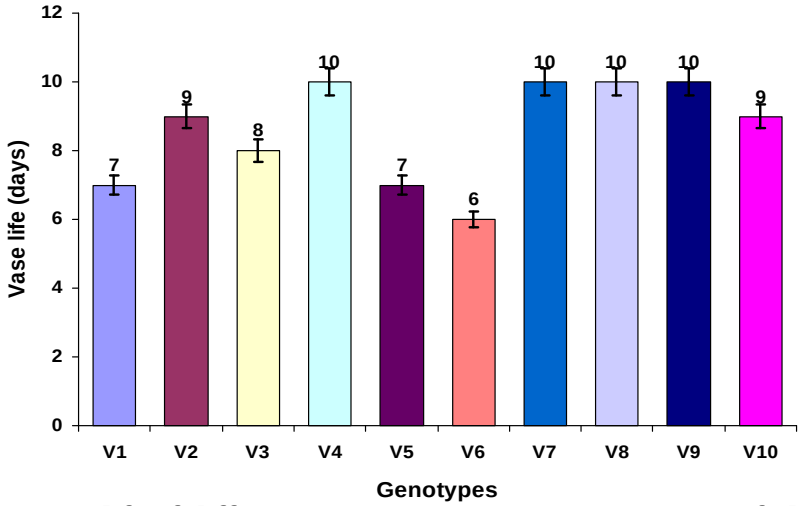


Fig. 3. Vase life of different genotypes of gladiolus

V_1 (GL-001), V_2 (GL-002), V_3 (GL-004), V_4 (GL-012), V_5 (GL-014), V_6 (GL-018), V_7 (GL-025), V_8 (GL-037), V_9 (GL-038) and V_{10} (BARI Gladiolus-4)

4.2.8 Flower yield

The genotypes varied enormously in flower yield (Fig. 4). The maximum flower yield/ha (190000 spikes) was obtained from the genotypes V_7 and V_8 followed by genotypes V_4 and V_9 (185000 spikes) whereas genotype V_6 attained minimum flower yield/ha (165000). This variation might be mainly due to genotype variation as well as environmental effects. Singh and Singh (1987) recorded flower yield ranged from 160000 to 200000 flower spikes in varietal evaluation of gladiolus.

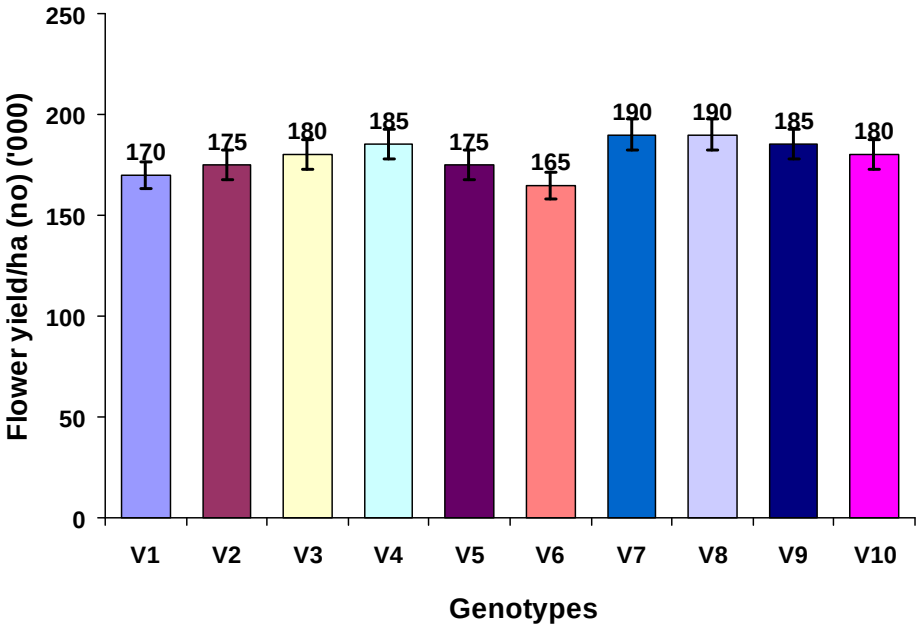


Fig. 4. Flower yield of different genotypes of gladiolus

4.3 Qualitative traits of gladiolus genotypes

The qualitative traits of the ten gladiolus genotypes are presented in (Table 5). In all the genotypes, the floret type was open- faced as in the standard BARI Gladiolus-4, whereas V_6 had funnel shaped floret. Two genotypes, viz. V_4 and V_5 had florets with wavy margins while the rest had florets with plain margins. The genotypes V_5 had thin floret texture while rest of the genotypes possessed thick floret texture.

All the genotypes were rated moderately tolerant to disease except V_5 was found susceptible to disease. There was no pest incidence in the field.

Table 5. Qualitative traits of gladiolus genotypes

Treatment	Floret type	Floret structure	Floret texture	Disease reaction	Pest incidence
V_1	Open faced	Plain	Thick	*MT	Nil
V_2	Open faced	Plain	Thick	MT	Nil
V_3	Open faced	Plain	Thick	MT	Nil
V_4	Open faced	Wavy margin	Thick	MT	Nil
V_5	Funnel shaped	Wavy margin	Thin	**S	Nil
V_6	Open faced	Plain	Thick	MT	Nil
V_7	Open faced	Plain	Thick	MT	Nil
V_8	Open faced	Plain	Thick	MT	Nil
V_9	Open faced	Plain	Thick	MT	Nil
BARI Gladiolus-4	Open faced	Plain	Thick	MT	Nil

*MT- Moderately tolerant, **S- Susceptible

V_4 **V_7** **V_8** **V_9**

Plate 2. Floret number of some promising gladiolus genotypes

4.4 Corm and cormel characteristics in gladiolus

4.4.1 Number of corms

Data recorded in respect of corm production of ten gladiolus lines of gladiolus are presented in Table 6. The number of corms produced per plant was the highest in V_5 (4.0) followed by V_7 (3.8). The lowest number of corms was produced by the genotype V_6 (1.0). The variation observed in corm production among the genotypes might be due to difference in genetically constituents as well as environmental effects.

Variation in corm production among some genotypes of gladiolus (1.0 to 4.0) was observed at Bangalore in India by Anuradha and Gowda (1994).

4.4.2 Number of cormel

Number of cormel per plant was significantly affected by genotypes (Table 6). The highest number of cormels per plant was obtained from the genotype V_7, V_8 and V_9 (15.0) which were closely followed by V_4 (14.0) (Plate 3). The genotype V_6 produced the lowest number of cormels per plant (7.0). Misra and Saini (1990) recorded 5.0 to 20.0 cormel per plant in gladiolus genotypes in a trial conducted at Bangalore, India.

4.4.3 Weight of corms

Genotypes had displayed a wide range of variability among them in respect of corm weight. It ranged from 40.0 to 56.0 g. The highest corm weight was recorded from the genotype V_4 (56.0 g) which was followed by V_7, V_8 and V_9 (55.0 g) (Plate 4). The lowest corm weight per plant was obtained from the genotypes V_5 (40.0 g) closely followed by genotypes V_6 (42.0 g). Sharma and Sharma (1984) reported that corm weight was the highest in genotype GL-004 (65.0 g) and lowest in genotype GL- 025 (30.0 g) which was more or less in consonance with the present investigation.

V_4

V_7

Table 6. Corm and Cormel production from different genotypes of gladiolus

Genotypes/Variety	No. of corm/ plant	No. of cormel/ plant	Wt. of corm/ plant (g)	10-cormel wt.(g)
V_1	1.4 ab	11.0 ab	45.0 c	30.0 c
V_2	1.8 ab	12.0 ab	50.0 b	35.0 b
V_3	1.6 ab	11.0 ab	52.0 ab	32.0 bc
V_4	2.5 ab	14.0 a	56.0 a	40.0 a
V_5	4.0 a	8.0 b	40.0 d	30.0 c
V_6	1.0 b	7.0 b	42.0 cd	25.0 d
V_7	3.8 a	15.0 a	55.0 a	38.0 ab
V_8	2.5 ab	15.0 a	55.0 a	38.0 ab
V_9	2.4 ab	15.0 a	55.0 a	38.0 ab
V_{10}	2.2 ab	10.0 ab	50.0 b	30.0 bc
Level of Significance	*	*	*	*
LSD (0.05)	0.92	1.43	2.04	2.31
CV (%)	13.24	11.65	14.70	13.48

4.4.5 Weight of 10-cormel

Genotypes had displayed a range of variability among them in respect of 10-cormel weight. It ranged from 30-40 g. The highest 10-cormel weight was recorded in V_4 (40.0 g), which was closely followed by V_7, V_8 and V_9 (38.0 g).The genotypes V_1 produced the lowest weight of cormel (30.0 g). Negi *et al.* (1982) reported that 10-cormel weight in gladiolus genotypes ranged from 30.0 to 45.0 g which is more or less similar result with the findings of the present investigation.

Expt. 2: Effect of preservatives on vase life of gladiolus

The effect of different parameters of preservatives on keeping quality and vase life of gladiolus were investigated in this study. Findings of the study are presented in (Table 7) and Figure (2, 3, 4 & 5) and have been discussed in the following heading.

4.5.1 Floret opening (%)

Floret opening in spikes for a period of 12 days differed with different vase solution (Figure 5). Spikes held in T_7 vase solutions (3% sucrose + 200 ppm HQS + 25 ppm citric acid) recorded the highest percent of floret opening (93%) which was closely similar (90%) with those held in solution T_6 (3% sucrose + 100 ppm HQS + 25 ppm citric acid) while, only 70% floret opened in T_{10} (control or tap water). The extension of floret opening as observed in the present investigations, accords with previous results obtained in gladiolus by Ranvir and Sashikala (2002).

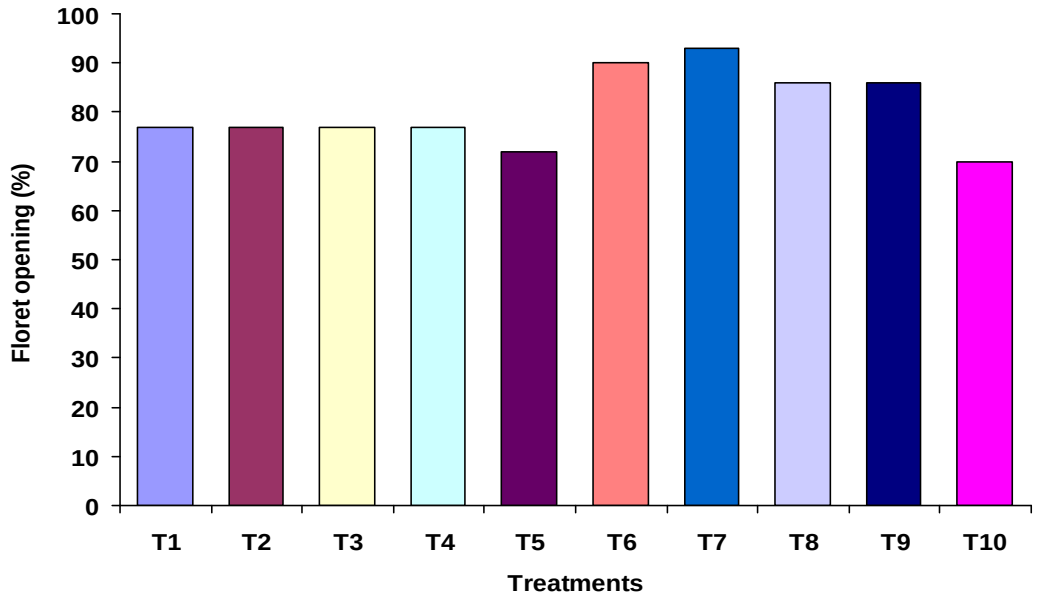


Figure 5. Effect of preservatives on floret opening in gladiolus

T_1= 3% sucrose, T_2= 4% sucrose, T_3= 100 ppm 8-HQS, T_4= 200 ppm 8-HQS, T_5=25 ppm citric acid, T_6= 3% sucrose + 100 ppm 8-HQS +25 ppm citric acid, T_7= 3% sucrose + 200 ppm 8-HQS +25 ppm citric acid, T_8= 4% sucrose + 100 ppm 8-HQS +25 ppm citric acid, T_9=4% sucrose + 200 ppm 8-HQS +25 ppm citric acid and T_{10}= Control

4.5.2 Water uptake (g/spike)

Total water uptake for a period of 12 days by the spike differed significantly in case of different vase solutions (Table 7). Spikes held in solution T_7 (3% sucrose + 200 ppm HQS + 25 ppm citric acid) had the highest water absorption (39.0 g) followed by those held in solution 3% sucrose + 100 ppm HQS + 25 ppm citric acid (32.0 g). Similar results were reported by Reddy *et al.* (1994) in gladiolus.

Table 7. Effect of different preservatives on post harvest physiology of gladiolus

Treatments	Water uptake (g/spike)	Water loss (g/spike)	Water loss uptake ratio
T_1	27.0 c	31.0 ab	1.2 b
T_2	25.0 cd	29.0 bc	1.2 b
T_3	26.0 cd	28.0 bc	1.1 b
T_4	28.0 c	30.0 b	1.1 b
T_5	25.0 cd	33.0 ab	1.3 b
T_6	32.0 b	28.0 bc	0.9 c
T_7	39.0 a	30.0 b	0.8 c
T_8	29.0 bc	32.0 ab	1.1 b
T_9	24.0 cd	25.0 c	1.1 b
T_{10}	21.0 d	35.0 a	1.6 a
Level of significance	*	*	*
LSD (0.05)	0.88	1.02	0.29
CV%	10.5	11.2	10.6

* 5% level of probability

T_1= 3% sucrose, T_2= 4% sucrose, T_3= 100 ppm 8-HQS, T_4= 200 ppm 8-HQS, T_5=25 ppm citric acid, T_6= 3% sucrose + 100 ppm 8-HQS +25 ppm citric acid, T_7= 3% sucrose + 200 ppm 8-HQS +25 ppm citric acid, T_8= 4% sucrose + 100 ppm 8-HQS +25 ppm citric acid, T_9=4% sucrose + 200 ppm 8-HQS +25 ppm citric acid and T_{10}= Control

4.5.3 Water loss (g/spike)

Water loss from the tissue during the experimental period significantly affected by different vase solution (Table 7). The spikes held in solutions without preservatives (control), having lower water uptake, recorded the highest water loss (35.0 g). The result agrees with the findings of Al Humid (2004) in gladiolus.

4.5.4 Water loss uptake ratio

This ratio significantly affected by different vase solutions. In Table 7, it was observed that the ratio was the lowest (0.8) for the spikes held in solution T_7 (3% sucrose + 200 ppm HQS + 25 ppm citric acid) and it was the highest (1.6) for the spikes held in tap water (T_{10}).

Figure 6. represents the changes fresh weight of spikes held in different vase solution up to 12^{th} day at 1 day interval. It was observed from the graphical presentation that in all treatments including control, a gentle increase in weight of spike was noted up to the 4^{th} day. There after depletion in weight of spike was observed. However, maximum fresh weight of spike was observed in treatment T_7 (66.0 g). Spikes held in solutions with 3% sucrose, 200 ppm HQS and 25 ppm citric acid maintained their weight above the initial one even up to 9 days of vase life, while those held in tap water gained their weight below their initial weight after 6^{th} day. These results indicated that 3% sucrose + 200 ppm HQS and 25 ppm citric acid helped the spike to maintain their weight.

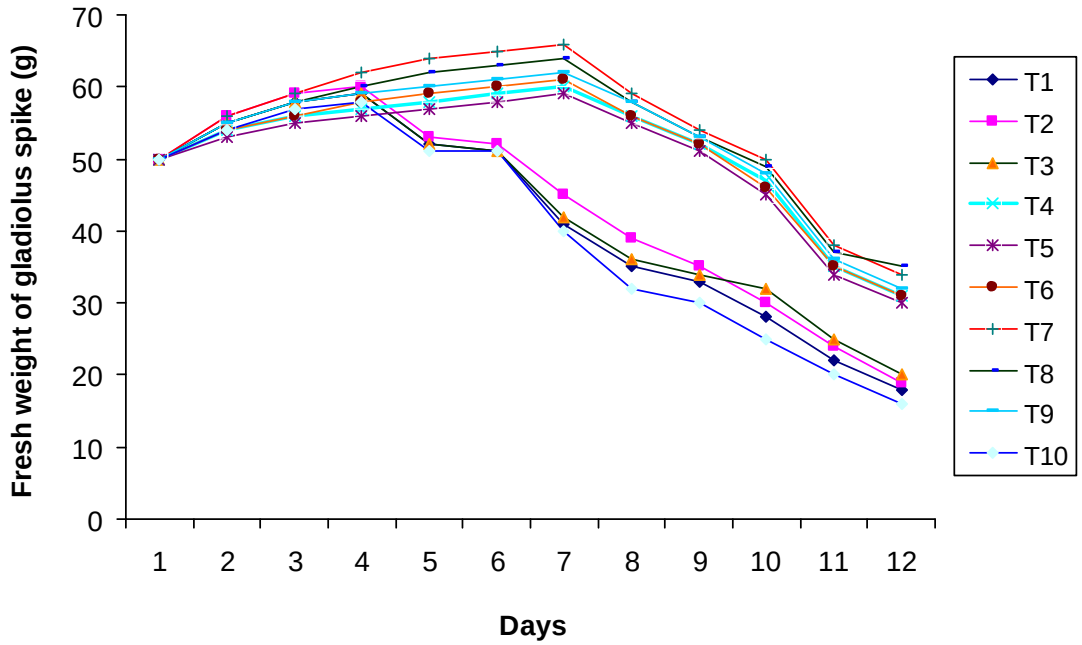


Figure 6. Changes in fresh weight of gladiolus held in different vase solution

T_1= 3% sucrose, T_2= 4% sucrose, T_3= 100 ppm 8-HQS, T_4= 200 ppm 8-HQS, T_5=25 ppm citric acid, T_6= 3% sucrose + 100 ppm 8-HQS +25 ppm citric acid, T_7= 3% sucrose + 200 ppm 8-HQS +25 ppm citric acid, T_8= 4% sucrose + 100 ppm 8-HQS +25 ppm citric acid, T_9=4% sucrose + 200 ppm 8-HQS +25 ppm citric acid and T_{10}= Control

4.5.5 Vase life

In Figure 7, it was observed that vase life differed with different vase solutions. Spikes held in solution T_7 (3% sucrose + 200 ppm HQS + 25 ppm citric acid) maintained a maximum vase life for 12 days which was closely similar (11 days) with those held in solution T_7 (3% sucrose + 200 ppm HQS + 25 ppm citric acid) compared with the control and other treatments. It was clear from the above results that 3% sucrose + 200 ppm HQS + 25 ppm citric acid proved to be effective in increasing the water uptake resulting prolongation of vase life. These might be due to a synergistic effect which improved water balance and osmotic potential since citric acid inhibits the microbial growth, sugar was observed to reduce moisture stress in cut flowers by affecting stomatal closure, preventing transpiration and water loss (Anjum *et al.*, 2001).

The findings of the experiment are further supported by those of Suneetha and Kumar (2002) in gladiolus. Similar results were also reported by Ranvir and Sashikala (2002) in gladiolus.

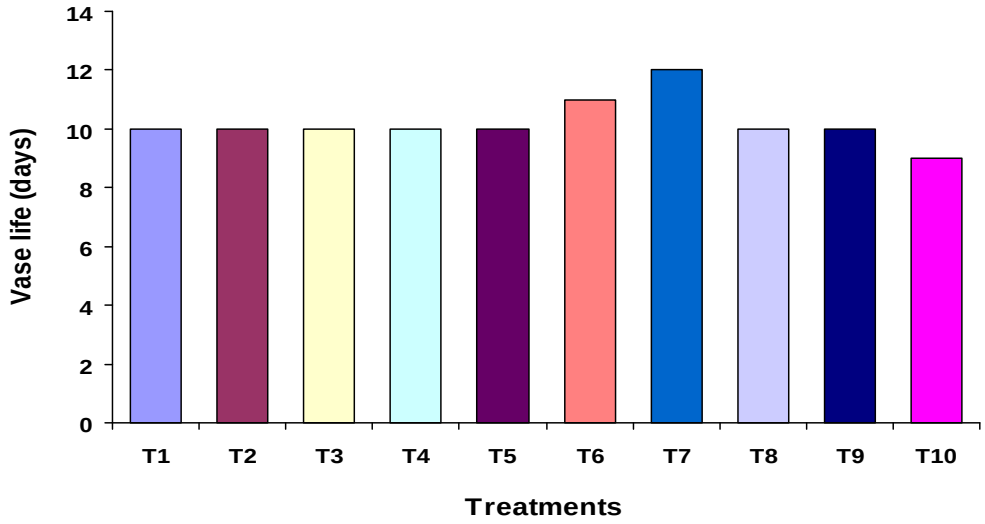


Figure 7. Effect of preservatives on vase life of gladiolus

T_1= 3% sucrose, T_2= 4% sucrose, T_3= 100 ppm 8-HQS, T_4= 200 ppm 8-HQS, T_5=25 ppm citric acid, T_6= 3% sucrose + 100 ppm 8-HQS +25 ppm citric acid, T_7= 3% sucrose + 200 ppm 8-HQS +25 ppm citric acid, T_8= 4% sucrose + 100 ppm 8-HQS +25 ppm citric acid, T_9=4% sucrose + 200 ppm 8-HQS +25 ppm citric acid and T_{10}= Control

Cut flower longevity has been shown to be associated with maintenance of fresh weight (Gowda, 1992). Spike held in 3 % sucrose + 200 ppm HQS + 25 ppm citric acid solution maintained their fresh weights above initial weight even up to 9 days of vase life, while those held in tap water and other treatments gained their weight below their initial weight after 6^{th} day. These results indicated that sucrose, hydroxy quinolene sulphate and citric acid helped the spike to maintain their weight.

CHAPTER V
SUMMARY AND CONCLUSION

Summary

An investigation was carried out at Floriculture Research Field of Horticulture Research Centre (HRC), Bangladesh Agricultural Research Institute (BARI), Joydebpur ,Gazipur during October 2013 to June 2014 to evaluate ten gladiolus genotypes (GL-001(V_1), GL-002(V_2), GL-004(V_3), GL-012(V_4), GL-014(V_5), GL-018(V_6), GL-025(V_7), GL-037(V_8), GL-038(V_9) and BARI Gladiolus-4 (V_{10}) for their performance in terms of flower and corm yield characteristics. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The unit plot size was 2.0m× 1.5 m accommodating 70 plants per plot. Spacing was maintained at 20 cm from row to row and 20 cm from plant to plant.

All the genotypes varied significantly with each other for all the characters studied. The genotypes V_7 (70.0 cm) and V_5 (50.0 cm) exhibited maximum and minimum plant height, respectively. The genotypes V_3 took minimum days (15) to 80% emergence and the maximum days (25) were taken by V_{10}. The highest leave number was obtained by V_7 and V_8 (11.0) and lowest in V_5 and V_6 (6.0). Leaf area ranged from 70 cm^2 (V_{10}) to 80.0 cm^2 (V_7 and V_8). The maximum number of floret was found in V_7 and V_8 (14) and minimum in V_6 (8), the genotypes V_4, V_7, and V_8 took minimum days (47) to 50% spike initiation. The maximum day was required for the genotype V_{10} (58 days). The highest spike length (90.0cm) was found in V_7 and V_8 and the lowest in V_5 (75.0cm). Regarding rachis length, the genotypes V_7 andV_8 produced the longest rachis (50.0 cm) closely followed by genotypes V_4 and V_9 (48.0cm).

The shortest rachis (40.0 cm) was observed in V_5. Considering flower vase life V_4, V_7, V_8 and V_9 were the best. The highest weight of spike was obtained from V_7 (60.0 g) closely followed by V_4 and V_8 (58.0 g) and lowest in V_1 (45.0 g). The genotypes varied enormously in flower yield. The maximum flower yield/ha (19000 spikes) was obtained from the genotypes V_7 and V_8followed byV_4 and V_9 (185000 spikes) whereas genotype V_6 attained minimum flower yield/ha (165000).

A large variation in quantitative traits of gladiolus genotype was recorded. As regards to colour of flower, the observed genotypes showed remarkable variation such as Off white, Yellowish orange, Lemon yellow, Violet, Orange, Mejenta, Orange, Light pink, Red and Pink colours. Genotypes V_5 had funnel shaped floret as well as thin floret texture. Openned faced floret and thick floret texture was recorded in rest of the genotypes. Two genotypes V_4 and V_5 had florets with wavy margin while the rest had florets plain with margins. All the genotypes rated moderately tolerant except V_5which was found susceptible disease. There was no pest incidence in the field.

The variation of corm and cormel production was remarkable. The highest and lowest number of corm was ranged from 1.0 to 4.0. The genotype V_4 had produced maximum (56.0 g) which was closely followed by V_7 and V_8 (55.0 g) and V_5 produced minimum (40.0 g) corm weight respectively. Number of cormel ranged from 7.0 to 15.0. The highest number of cormel (15.0) was observed inV_7 and V_8 and lowest (7.0) in V_6. As regards to cormel weight, V_4 produced the highest weight (40.0 g) which was closely followed by genotypesV_7, V_8 and V_9 (38.0 g) and V_1 produced the lowest weight of cormel (30.0 g).

Another experiment was conducted at the Laboratory of Landscape, Ornamental and Floriculture Division of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur during the period from January 2014 to March 2014 to identify the susceptible preservative (s) in extending the vase life of gladiolus. The study consist of ten treatments: T_1= 3% sucrose, T_2= 4% sucrose, T_3= 100 ppm 8-HQS, T_4= 200 ppm 8-HQS, T_5=25 ppm citric acid, T_6= 3% sucrose + 100 ppm 8-HQS+25 ppm citric acid, T_7= 3% sucrose + 200 ppm 8-HQS+25 ppm citric acid, T_8= 4% sucrose + 100 ppm 8-HQS+25 ppm citric acid, T_9=4% sucrose + 200 ppm 8-HQS+25 ppm citric acid and T_{10}= Control.The experiment was laid out in a Completely Randomized Design with three replications. The salient findings of the present studies have been summarized below:

Floret opening by the spikes of gladiolus differed with different vase solution. In response of different preservatives, gladiolus spikes in vase solutions with 3% sucrose + 200 ppm HQS + 25 ppm citric acid (T_7) recorded the maximum percentage of floret opening (93%), whereas vase solution containing tap water (T_{10}) recorded the minimum percentage of floret opening (70%).

Water uptake by the spike of gladiolus greatly influenced by vase solutions. The gladiolus spikes held in a solution 3% sucrose + 200 ppm HQS + 25 ppm citric acid (T_7) had the highest water absorption (39.0 g) followed by T_6 (32.0 g) those held in solution 3% sucrose + 100 ppm HQS + 25 ppm citric acid. The control treatment which received no vase solutions had the minimum water absorption (21.0 g).

Water loss from the tissue during the experimental period significantly affected by different vase solution labels. The spikes held in solutions without preservatives (control), having lower water uptake, recorded the highest water loss (35.0 g).

The water loss uptake ratio significantly affected by different vase solutions. The ratio was lowest (0.8) for the gladiolus spikes held in solution 3% sucrose + 200 ppm HQS + 25 ppm citric acid (T_7) and it was highest (1.6) for the spikes held in tap water (T_{10}).

The changes of fresh weight of spikes held in vase solution differed in case of different vase solution. It was observed that in all treatments including control, a gentle increase in weight of spike was noted up to the 4^{th} day. There after depletion in weight of spike was observed. However, the maximum fresh weight of spike (66.0 g) was observed in treatment T_7 (3% sucrose + 200 ppm HQS + 25 ppm citric acid).

Vase life differed with different vase solutions. Spikes held in solution 3% sucrose + 200 ppm HQS + 25 ppm citric acid (T_7) maintained maximum vase life for 12 days which was closely similar (11 days) to those held in solution 3% sucrose + 100 ppm HQS + 25 ppm citric acid (T_6).

Conclusion

- Evaluation of morphological characters indicated a great variation among the gladiolus genotypes in respect of both qualitative and quantitative characters. The genotypes V_4, V_7, V_8 and V_9 were found promising out of 10 genotypes.

- Using different preservatives, a mixture of 3% sucrose + 200 ppm HQS + 25 ppm citric acid (T_7) was found best keeping solution for improving postharvest quality and vase life of gladiolus.

APPENDICES

Appendix I. Analytical data of soil sample at Floriculture field of HRC, BARI

Year	p^H	Total N	OM	Ca	Mg	K
		%		Meq/100g		
2014	6.1	0.077	1.46	4.76	1.97	0.15
Critical level				2.0	0.8	0.2

Appendix I. Cont'd.

Year	p^H	P	S	B	Cu	Fe	Mn	Zn
		µg/g						
2014	6.1	15	38	0.32	6.0	232	10	3.30
Critical level		14	14	0.2	1.0	10.0	5.0	2.0

Source: Soil Science Division, Bangladesh Agricultural Research Institute, (BARI), Gazipur

Appendix II. Analysis of variance of the data on plant characters of different genotypes of gladiolus

Sources of variation	Degrees of freedom	Mean sum of square				
		Days to 80% emergence	Plant height	Leaf number	Leaf area	Plant/hill
Replication	2	11.57	10.12	20.30	15.66	03.81
Treatment	9	181.50*	216.20*****	330.12*****	225.40*	215.40*****
Error	18	8.31	07.30	04.50	4.85	05.52

* = Significant at 5% level of probability

Appendix III. Analysis of variance of the data on flower characters of different genotypes of gladiolus

Sources of variation	Degrees of freedom	Mean sum of square				
		Spike length	Rachis length	Floret number	Spike weight	Flower durability
Replication	2	2.26	2.40	2.50	7.58	11.00
Treatment	9	219.30*	472.56*	540.50*	265.21*	9.25*
Error	18	4.95	3.42	4.34	3.45	4.67

* = Significant at 5% level of probability

Appendix IV. Analysis of variance of the data on corm characters different genotypes of gladiolus

Sources of variation	Degrees of freedom	Mean sum of square			
		Corm number	Corm weight	Cormel number	10 Cormel weight
Replication	2	0.81	13.50	2.25	27.75
Treatment	9	1.04*	17.240*	20.40*	65.21*
Error	18	0.05	10.57	11.58	6.27

* = Significant at 5% level of probability

Appendix V. Analysis of variance of the data on vase life of gladiolus influenced by different preservative solutions

Sources of variation	Degrees of freedom	Mean sum of square		
		Water uptake	Water loss	Water loss uptake ratio
Replication	2	10.10	13.70	0.02
Treatment	9	80.72*	38.70*	0.03*
Error	18	04.45	4.02	0.01

* = Significant at 5% level of probability

REFERENCES

Al-Humaid, A. I. 2004.Effect of glucose and biocides on vase-life and quality of cut gladiolus spikes. J. *King Saud Univ. Agric. Sci.* **17** (1) :11-23.

Anjum, M. A., F. Naveed, F. Shakeel and S. Amin. 2001. Effect of some chemicals on keeping quality and vase life of tuberose cut flower. *Pakistan J. Res.***12(1):** 01-07.

Anuradha, S. and J. V. Gowda 1994. Correlation studies in Gladiolus. [In: floriculture Technology, Trades and Trends (Fds.) Prakashi, J. and K. R. Bhandry]. Oxford and IBH Publishing Co. Pvt. Ltd. Calcutta. pp. 285-287.

Anuradha, S., A. Prasad and J. V. N. Gowda. 1996. Varietal evaluation in gladiolus [In: floriculture Technology, Trades and Trends (Fds.) Prakashi, J. and K. R. Bhandry]. Oxford and IBH Publishing Co. Pvt. Ltd. Calcutta. pp. 285-287.

Arora, J. S. and Khanna, K. 1985. Evaluation of gladiolus cultivars.*J. Agric. Univ. Res*. **22** : 655-662.

Arora, J. S. and Sandhu, G. S. 1987.Effect of two planting dates on the performance of fifteen gladiolus cultivars.*Punjab Hort*. J. **27**: 243-249.

Arsad, H. M. 2013. Effect of corm size and plant growth regulators on growth and yield of gladiolus. An MS thesis submitted to Deptt. of Horticulture, SAU, Dhaka. pp. 1-66.

Bhattacharjee, S. K. 2006. Gladiolus.*Adv. Ornam Hort.* Pointer Publ. Joipur, India. p. 102.

Bhattacharjee, S. K. and De, L. C. 2010.Gladiolus.Advanced Commercial Floriculture.Vol. 1. Rev. Edn. Aavishkar Publ. Joipur, India. pp. 309-310.

Bose, T. K., Maiti, R. G., Dhua, R. S. and Das, P. 1999. Gladiolus.Floriculture and Landscaping.Nayaprakash, Calcutta, India. pp. 505-514.

Bose, T. K., Yadav, L. P., Pal, P., Das, P. and Parthasarathy, V. A. 2003.Gladiolus Commercial Flowers.2nd Rev. ed. Nayaprokash, Calcutta, India. pp. 1-112.

Dalal, S. R., Paithandar, D. N., Anokar, D. N. and Lande, S. S. 2006.Response of gladiolus varieties to different plantintg dates under Akola conditions. *Punja.KrishiVidyapeeth Res, J.* **20** (1) : 137-138.

Dod, V. N., Sadavarde, K.T., Kulwal, L.V. and Vaidya, S. W. 1989. Effect of different dates of planting and size of corm on growth, flowering and yield of gladiolus.*Punja.KrishiVidyapeeth Res, J.***13** (12) : 164-165.

Doi, M. and Reid, M. S. 1995. Sucrose improves the postharvest life of some cut flowers. *Hort. Sci.***30** : 1058-1060.

Fahmy, A. S. H. 2005. Postharvest studies on some important flower crops.Ph.D. Thesis, *Fac. Hort. Science,* University of Budapest.p. 168.

Gowda, J. V. N. 1992. Effect of harvesting stage and sucrose on vase life of gladiolus.*Crop Res.*,**2** (2) : 90-100.

Gowda, J. V. N. and Murthy, M. A. 1993.Effect of aluminum, calcium and sucrose on post harvest life of Gladiolus. [In J. Prakash (ed.) Floriculture: Technology. Trades and Trends], Oxford and IBH Pub Co Pvt. Ltd., New Delhi pp. 492-495.

Gupta, P., Pathak, A. C. and Banafar, R. N. S. 2002.Studies on the performance of gladiolus cultivar in Malwa region of Madhya pradesh.*South Indian Hort*. **50** (4-6) : 641-644.

Gupta, S. R., Singh, A. K. and Singh, O. P. 2001 Variation for flowering characters and their vase life in gladiolus (*Gladiolus floribundus* L.). *Adv. Plant Sci*. **14** (1): 133-136.

Halder, N. K., Rafiuddin, M., Siddiky, M. A., Gomes, R. and Ara, K. A. 2007.Performance of gladiolus as Influenced by Boron and Zinc.*Pakistan J. Biol. Sci.*, **10**: 581-585.

Hegde, M. V. 1994. Studies on variability, correlation, path analysis and performance of *Gladiolus hybridus*.M.Sc. (Agri.)Thesis, University of Agricultural Sciences, Dharwad, India. pp. 1-72.

Hossain, M. D. Talukder, K. H., Asaduzzaman, Mahmud, M. F., Amin, N. and Sayed, M. A. 2011. Study on morphological characteristics of different genotypes of gladiolus flower. *J. Sci. Foundation.* 9 (1 & 2) : 01-08.

Hossain, M. D., Choudhury, B. and Talukdar, K. 2011. Performance study of some gladiolus cultivars.*Indian Adv. Agric. Res.* **4(10):** 160-168.

Jagadish, C., Sujit, K., Yadav, K. and Kumar, S. 2003 performance gladiolus cultivars under valley conditions of Uttaranchal.*Prog Hort*. **35** (1) : 108-110.

Jhon, A. Q., Bichoo, G. A. and Siddique, M. A. A. 1996.Performance of gladiolus cultivars in Kashmir.*Flora and Fauna Jhansi*.**2** (1) : 75-77

Kamble, B. S. 2001. Evaluation of gladiolus (*Gladiolus hybridus* Hort.) varieties. M.Sc. (*Hort.*) Thesis, University of Agricultural Sciences, Dharwad, India. pp. 1-70.

Kamble, B. S., Reddy, B. S., Gangadharappa, P. M. and Kulkarni, B. S. 2004. Evaluation of gladiolus varieties for quality parameters, flower and corm yields. *Haryana J. Hort. Sci*. **33** (1&2) : 74-75.

Khan, F. N. 2009.Techniques of corm and cormel production in gladiolus. A Ph. D dissertation submitted to Dept. of Horticulture, BSMRAU, Salna, Gazipur. pp.1-3.

Kishan, S., Krishan, P. and Singh, K. P. 2005.Performance of gladiolus under Delhi conditions.*J. Ornam. Hort*., **8** (1) : 32-35.

Kumar, 2000. Improvement of postharvest life in several cut flowers by addition of sucrose. *J. ARQ*., **32**: 275–280.

Kumar, R. 2009. Evaluation of exotic gladiolus under sub-tropical mid-hills of Meghalaya. *Indian J. Agric. Sci*.,**79** (2) : 115-117

Lal, H. and Singh, D.S. 1978, Performance of some gladiolus varieties under Chakrata conditions. *Plant Sci.,* **10:** 177-178.

Lal, S.D. and Plant C.C. 1989. Some newly developed hybrids of gladiolus. *Prog. Hort*., 21: 189-93.

Lal, S. D., Seth, J. N. and Danu, N. S. 1984.Studies on varietal performance of gladiolus in UP hills.*Prog. Hort.,***16** (1) : 124-128.

Misra, R. L. and Choudhary, B. 1976.Selected gladiolus for the hills.*Indian Hort***., 20 :** 25-27.

Misra, R. L. and Saini, H. C. 1990.Geohistorical development of gladiolus. *Haryana J. Hort. Science.* 28 (1-2): 10-15.

Misra, R. L., Verma, J. S., Kumar, R., and Singh, B. 1987. Varietal significance in gladiolus number of two sizes corm on flowering and propagating materials. *Indian J. Hort*., **44** (1/2) : 104-107.

Momin, M. A. 2006. Floriculture Survey in Bangladesh. A Consultancy Report. FAO/UNDP (IHNDP/BGD/97/06).p. 60.

Mukhopadhay, A. 1998.Gladiolus.Publication and information Division.Indian Council of Agric. Res. KrishiAnusandhanBhavan. New Delhi, India. pp. 101-120.

Mukhopadhay, T. P. 1980. Effect of citric acid on the floral development and vase life of gladiolus.*South Indian Hort.,* **28** : 281-284.

Munir, M. 2013. Cutcorm as planting materials on flowering and corm-cormel production of gladiolus cultivars. An MS thesis submitted to the Deptt. of Hort. SAU, Dhaka. pp. 1-77.

Murali, A. S., Sujit and Paul, J. I. 1990. Effect of chemicals on post harvest life of cutflowers.*Floral Review*., 15-24.

Nair, S. A. and Shiva, K. N. 2003.Performance of selected gladiolus (*Gladiolus floribundus)* varieties under Bay island conditions.*Indian J. Agric. Sci*., **73** (7): 397-398.

Nazir, M. and Dwivedi, V. K. 2006.Evaluation of gladiolus cultivars for cut flower production under Western Uttar Pradesh conditions.*J. Asian Hort*., **2** (3): 222-225.

Negi, S. S., Raghava, S. P. S. and Sharma, T. V. R. S. 1981.Some promising varieties of Gladiolus. *Lal-Baugh J*. **26** : 13-15.

Negi, S. S., Raghava, S. P. S. and Sharma, T. V. R. S. 1982.New cultivars of gladiolus.*Indian Hort*., **26** (3) : 19-20.

Pant, C. C., Lal, S. D., Deepak, S. and Shah, D. 1998.Performance of some gladiolus cultivars under U.P. hill conditions. *Recent Hort*., **4** (1) : 73-75.

Pasannavar, R. 1994. Evaluation of elite cultivars of gladiolus for cut flower production under transitional tract of Karnataka. An M. Sc. (Agri.) thesis, Univ. Agric. Sci., Dharwad, India. pp. 1-70.

Pathak, S. 1981. Influence of different preservative solution on the opening and vase life of gladiolus and tuberose spikes. A Ph. D. thesis, University of Burdwan, West Bengal. 185 p.

Patil,K.B. 2003. Study of some exotic varieties of gladiolus.*Orissa J.Hort.,***31**(1):42-48.

Patra, S. K., Singh, A. and Mohanty, C. R. 2015.Vase life study in different varieties of gladiolus.*Intl. J. Agric. Sci. Res.*, **5** (2) : 27-32.

Poon, T. B., Rao, T. M., Kumar, D. P. and Dhananjaya, M. V. 2010.Evaluation of different genotypes of gladiolus for corm and cormel production.*Nepal Agric. Res. J.,* **10** : 25-30.

Poon, T. B., Rao, T. M., Kumar, D. P., Venugopalan, R. and Dhananjaya, M. V. 2009. Study on floral biology of gladiolus genotypes. *Nepal J. Sci. and Technology.* **10**: 37-43.

Pragya, K., Ranjan, J. K., Attri, B. L. Das, B., Krishna, H. and Ahmaed, N. 2010.Performance of gladiolus genotypes for cut flower and corm production under high altitude of Uttarakhand.*Indian J. Hort.,* **67** : 386-390.

Raghava, S. P. S., Negi, S. S. and Sharma, T. V. R. S. 1981.New cultivars of Gladiolus.*Indian Hort.,* **26** : 2-3.

Rai, S.K., Katiyar, R.S. and Singh, S.P. 2000. Prospects of gladiolus crops on sodic wasteland.*Proceedings of the National Conferences on Gladiolus*, January. pp. 104-106.

Rani, R. and Singh, C. 2005.Evaluation of different gladiolus cultivars for quality flower production.*J. BirsaAgril. Univ. Res.*, **17** (2) : 227-230.

Ranvir, S. and Sashikala, B. 2002.Vase life of gladiolus as influenced by floral preservatives.*J. Orn. Hort.*, **5** (1) : 76-79.

Rashmi, L. 2006. Evaluation of promising hybrids of gladiolus. An *M. Sc. (Agri.)* thesis, Univ. Agric. Sci., Dharwad, India. pp. 1-68.

Ravidas, L., Rajeevan, P. K. and Aravindakshan, M. 1993. Influence of the performance of selected gladiolus varieties. *J. Tropical Agric.*, **31** (2): 210-214.

Reddy T. V. and Murali, T. P. 1994.Post harvest life gladiolus as influenced by sucrose and metal salts. *Acta Hort.*,**343** : 313-320.

Reddy, B. S., Gupta, A. K. and Murali, T. P. 1994. Physiological role of 8-HQS and sucrose in the post harvest physiology of gladiolus CV. sylvia. Floriculture Technology, Trades and Trends.Oxford and IBH Publishing Co. Pvt. Ltd. Calcutta. pp. 496-502.

Reddy, B. S., Singh, K. and Singh, A. 1996.Effect of sucrose, citric acid and 8-hydroxyquinoline sulphate on the postharvest physiology of tuberose CV. *Single.Indian Adv. Agric. Res.,* **3** (10) : 161-167.

Rogers, M. N. and Tija, B. O. 1990.Vase life of gerbera.Gerbera. Timber Press, Portland, Oregon. pp. 63-74.

Roy, R. K. and Sharga, A. N. 2000. Studies on the performance of some exotic gladiolus cultivars under sub-tropical conditions: A comparative analysis. *Proceedings of National Conference on Gladiolus*, January. pp. 81-84.

Saini, R. S., Gupta, A. K. and Yamadgni, R. V. 1991.Performance of different cultivars of gladiolus (*Gladiolus grandiflorus* L.) under Hissar conditions.*South Indian Hort.,* **39** (2) : 99-101.

Saleem, M., Ahmad, I. and Khan, M. A. 2013. Cultivar effects on growth, yield and cormel production of gladiolus (*Gladiolus grandiflorus*L.). *Pakistan Hort. Sci*., **3** (1) : 45-50.

Sanjai, K.D. and Brahma, S. 2000. Gladiolus: A potential crop in ladakh. *Proceedings of the Vational Conference on Gladiolus*, January. pp. 75-80.

Sarkar, I. and Chakraborty, S. 2014. Varietal performances of important floral attributes of 15 indigenous and exotic varieties of gladiolus in North Eastern Himalayan region.*J. Agric. Technol.,* **1** (1) : 80-85.

Shah, A., Pant, C. C. and Lal, S. D. 1988.Floral biology of some gladiolus cultivars under temperate conditions.*Prog. Hort.,* **20** : 74-76.

Sharma, A. N. and Sharma, S. C. 1984.Some promising gladiolus hybrids. NAGC Bull., No. 157. pp. 51-52.

Shaukat, S. A., Shah, S. Z. A., Aslam, M., Shaukat S. K and Shoukat, S. W. 2015. Performance of gladiolus cultivars under RawalakotAj& K Conditions.*J. Recent Adv. Agric.*, **3** (2) : 351-355.

Shiramagond, M. S. and Hanamashetti, S. I. 1999. Evaluation of varieties of gladiolus under Ghataprabha command area. *Karnataka J. Agric. Sci.,* **12** (1-4): 159-163.

Sidhu, G. S. and Arora, J. S. 2000.Evaluation of gladiolus varieties for summer flower production. *Proceeding of the National Conference on Gladiolus*, January. pp. 115-117.

Sidhu, S.S. and Verma, J.S. 1995. Promising varieties of gladiolus for commercial floriculture.*Haryana J. Hort. Sci.,* 24(3-4): 197-203.

Singh, B. and Dadlani, N. K. 1988. Research Highlights (1971-1985). All Indian Coordinated Floriculture Improvement Project, ICAR, New Delhi. p. 65.

Singh, B. and Sharma S. 2002. The postharvest life of pulsed gladiolus spikes: The effect of preservative solutions. *Orissa J. Agric. Res*., **10** : 154-159.

Singh, B. and Singh, M. 1987. Studies on variability and genetic parameters in gladiolus.*Prog.Hort.,* **19** (3-4) : 271-275.

Singh, D. B., Sujatha Nair, A. and Sharma, T. V. R. S. 1997.Performance of gladiolus varieties in Andamans. *Flora and Fauna Jhansi.*, **3** (2) : 134.

Singh, K. P., Suchitra, K. and Kumar, K. V. 2003. Vase life and quality of gladiolus cut flowers as influenced by holding solutions. *J. Orn. Hort*., **6** (4) : 362-366.

Singh, K., Arora, J. S. and Singh, K. 2000. Effect of sucrose and 8-HQC on vase life as well as opening of buds of tuberose.*J. Orn. Hort*., **3** : 111-113.

Singh, K., Reddy, B. S. and Gupta, A. K. 1994. Role of gibberellic acid, 8-hydroxyquinolinesulphate and sucrose in extending post harvest vase life of Tuberose flowers CV. double. [*In*: Floriculture Technology, Trades and Trends (Eds) Prakash, J. and K. R. Bhandry.] Oxford and IBH Publishing Co. Pvt. Ltd. Calcutta. pp. 519-524.

Singh, K., Singh, P. and Arora, J. S. 2000.Effect of cultivar response, season, stage of harvest and sucrose on keeping quality of gladiolus spikes.*Proceeding of the National Conference on Gladiolus*, January. pp. 143-149.

Steel, R.G.D., Torrie J.H. and Dickey. D.A. 1997. Principles and Procedures of Statistics.A Biometric Approach.3rd ed. McGraw Hill Book Co. Inc., New York.pp. 107-109.

Suneetha, S. and Kumar, K. V. 2002.Post harvest life of cut gladiolus spikes as influenced by different preservative solutions. *J. Orn. Hort*., **1** (1) : 37-38.

Swarup, V. and Raghava, S. P. S. 1972.Promising varieties of gladiolus for the plains.*Indian Hort.,* 17: 27-29.