# STUDY ON THE FLORAL BEHAVIOR AND PETAL COLORATION OF SOME ROSE CULTIVARS

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# STUDY ON THE FLORAL BEHAVIOUR AND PETAL COLORATION OF SOME ROSE CULTIVARS

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## *CERTIFICATE*

This is to certify that the thesis entitled **"STUDY ON THE FLORAL BEHAVIOR AND PETAL COLORATION OF SOME ROSE CULTIVARS"** submitted to the Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE in HORTICULTURE**, embodies the result of a piece of *bona fide* research work carried out by **SHAHRIN SHARMIN,** Registration No. **07-02510** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

**Dated: December, 2013**
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***The Authoress***

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## ABSTRACT

An experiment was conducted at Horticulture farm in Sher-e-Bangla Agricultural University, Bangladesh to evaluate the floral behavior of rose cultivars during the period from October 2012 to March 2013. Field experiment included forty four rose cultivars $V_1$ to $V_{44}$. Rose cultivars varied significantly with different characteristics on growth, floral behavior and petal coloration. Among 44 cultivars 17 red , 9 pink to pinkish, 6 yellow to yellowish, 3 orange, 2 white to whitish, 2 violet, 2 creamy white, 1 magenta and 1 black colored flower producing cultivars were found respectively. A single cultivar was wild type. Cultivars $V_3$, $V_4$, $V_{14}$, $V_{16}$, $V_{21}$, $V_{23}$, $V_{25}$, $V_{26}$, $V_{30}$ and $V_{35}$ were found best as cut flowers those contained solitary flower in a single stalk and petal arrangements were compact and the rests were suitable as pot or bedding flower.

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## ABBREVIATIONS AND ACRONYMS

| | | |
|---|---|---|
| ANOVA | = | Analysis of Variance |
| RCBD | = | Randomized Complete Block Design |
| CRD | = | Completely Randomized Design |
| LSD | = | Least Significant Difference |
| *et al.* | = | And others |
| Viz. | = | Namely |
| df | = | Degree of Freedom |
| CV | = | Coefficient of Variation |
| DAT | = | Day After Transplanting |

# CHAPTER I

# INTRODUCTION

Floriculture is one among the promising ventures which has emerged in the recent past as flowers and flowering plants and have been a fascinating part of our life. Cut flowers like Rose, Carnation, Gerbera, Lillium and Gladiolus always have steady demand in Indian and International cut flower trade (Lemper, 1976).

Among cut flowers, Rose (*Rosa* spp) has occupied a unique position both in beauty and trade. It is an ornamental plant of family Rosaceae and can be exploited for growing in beds, borders, walls, arches and screens (Khan, 1978). Climatic and edaphic factors play crucial role for successful production of roses. These factors not only affect the growth, production and yield but also quality of crop. Among these light, humidity and temperature are promising parameters which directly influence the plant growth. The ideal temperature for rose production is 20-25ºC during the day and 13-16ºC at night along with 8 hours of sunlight (Shin *et al.*, 2001). Bangladesh has a great potential for rose production. So, due to favourable agro-climatic conditions of the country, a wide range of cut and bed/pot rose cultivars can be grown to uplift the economic status of growers. Most of the hybrid rose cultivars have been developed in cool climate of world so they do not perform well in hot climatic conditions. Growth, flowering and yield varied significantly due to the variation of variety and it was previously found in gerbera (Singh and Ramachandran, 2002; Sankar *et al.*, 2003; Mahanta *et al.*, 2003 and Reddy *et al.* 2003), and tomato (Gautam *et al.*, 2013; Olaniyi *et al.*, 2010) due to their genetic variation (Hammad, 2009). Varietal performance was also studied in rose by Ranchana *et al.*(2014) and significant variations were observed in each cultivar for length and number of petals per flower, number of prickles, fragrance, flower persistence life and color, bush shape and overall performance with respect to climatic conditions (Nadeem *et al.*, 2011). Morphological variables of a set of germplasm or cultivars were determined to provide information for breeders (Mehraj *et al.*, 2014). Addition of sugar to the

vase solution counteracted the adverse effects of defoliation on petal color and overcome the increased bud blasting (Susan, 2003). The use of 125 $mgL^{-1}$ salicylic acid the vase life was significantly extended (Feigel-Terek *et al.*, 2010 and Fariba *et al.*, 2012). Citric acid and sucrose combined had significant effect on cut rose (Shirin and Mohsen, 2011). Silver Thiosulphate with sucrose increased fresh weight, water uptake, flower diameter and flower vase life (Shirin and Mohsen, 2011).

Considering the above facts the current study was undertaken with following objectives:

- ◊ To evaluate the performance of rose cultivars and their grouping based on different quality traits.
- ◊ To find out the suitable preservative solution for extending the vase life of the cut rose.

# CHAPTER II

# REVIEW OF LITERATURE

Rose is one of the most popular flowers in the whole world also in Bangladesh. Its demand and production area is increasing day by day. A wide ranges of rose cultivars present in Bangladesh. Some of them were cut flowers and some are used as pot flowers. There are variety in color rose flower present in Bangladesh. Some rose were fragrant in nature while some has no smell. Some of important and informative works have so far been done in home and abroad related to this experimentation have been presented (year wise) in this chapter.

**Experiment I (Floral behavior and petal coloration related)**

Tarannum and Naik (2014) conducted an experiment to evaluate the performance of eight different genotypes of carnation namely Dona, White Dona, Harish, Big Mama, Soto, Liber, Golem and Big Net. Among these genotypes, maximum plant height was found in Soto (111.13 cm) and minimum in Liber (56.96 cm). Maximum numbers of shoots/plant were found in Soto (6.80) and minimum in Big Net (4.60). Numbers of leaves/plant were found Soto (149.73) and minimum in Big Net (79.07). Maximum days were taken to flower bud initiation found in Big Mama (135.34) and minimum in Soto (95.16). Maximum flower diameter was found in Soto (5.86 cm) and minimum in Liber (4.70 cm).

Ranchana *et al*. (2014) conducted an experiment on ten varieties of roses such as Aloynica, Biyanka, Golden Gate, Grand Gala, Konfity, Noblesse, Passion, Polo, Skyline and Tropical Amazon. Maximum days were taken for sprouting found in Noblesse (46.17) and minimum in Passion (32.83). Maximum days were taken for flowering found in Noblesse (46.65) and minimum Passion (36.35). Maximum numbers of petals/plant were found in Passsion (49.48) and minimum in Tropical Amazon (35.39). Maximum plant height was found in Passion (115.59 cm) and minimum in variety Aloynica (65.66 cm). Maximum stem length was found in Passion (85.59 cm) and minimum in Aloynica (52.63 cm).

Maximum neck length was found in Passion (11.56 cm) and minimum in Konfity (5.31 cm). Maximum flower diameter was found in the Passion (6.66 cm) and minimum both in Biyanka and Tropical Amazon (4.32 cm).

Ramzan *et al*. (2014) studied performance of nineteen hybrid tea rose cultivars namely Bara Bara, Abby De Culnry, Mamorial Day, Rough Royal, Saran Bepti, Pink Peace, Julias Rose, Signature, Cendrila, M. Murad, Double Delight, Elizabeth Harkness, Allice, Red, Barkroloe Baragla Marandi, Head Liner, Honey Perfume, Decent Peace, American Beauty and Jagua. Maximum plant height was found in Jugua (100 cm) and minimum in Double Delight (66 cm).Maximum number of flowers/plant were found in Honey Perfume (52) and minimum number of flowers/plant were found in both Saran Bepti and Barkrole Baragla Marandi (10). Maximum numbers of shoot/plant were found in Abby de Culnry (7.3) and minimum in Signature (3). Maximum stalk length was found in Double Delight (24.6 cm) and minimum in Decent Peace (5 cm).

An experiment was conducted by Mehraj *et al.,* (2014) at Sher-e-Bangla Agricultural University (SAU), Bangladesh during the period from June 2011 to March 2012 to morphological characterization of three strawberry germplasm. Strawberry germplasm, *viz.,* $V_1$ (Germplasm-01), $V_2$ (Germplasm-02), $V_3$ (Germplasm-03) were exploited on the experiment; which was outlined in Complete Randomized Design with five replication. Morphological variables in this set of germplasm were determined to provide information for breeders. Grouping was done to classify strawberry germplasm based on morphology. Germplasm-01 commercially suitable (except the seedling production) for the farmers. But the grower who desired the both seedling and yield with quality can select Germplasm-03. Germplasm-01 was found as the best for commercial production in Bangladesh.

Maitra and Roychowdhury (2013) conducted an experiment on ten standard carnation cultivars namely Dark Red, Yellow with Red, Bright Red, Pink, C. Rimo, Decio, Orange Isac, Lilac Tarres, Tashman Pink and Orange Triumph.

Maximum plant height was found in Dark Red (78.36 cm) and minimum in Decio (51.96 cm). Maximum days were taken for flower bud development found in Orange Isac (24.98) and minimum in Bright Red (18.98). Maximum numbers of flowers/plant were flound in Dark red (4.54) and minimum in Bright Red (2.65). Maximum days were taken for flower bud initiation found in Orange Isac (104.68) and minimum in Lilac Tarres (69.66).

Singh *et al*. (2013) conducted an experiment on eight carnation varieties namely Diana, Aurturo, White Dona, Pink Dona, Soto, Red King, Tuareg and Dona. Among these varieties, maximum numbers of shoots/plant were found in Red King (8.00) and minimum in Diana (3.66). Maximum numbers of flowers/ plant were found in Red King (35.60) and minimum in Tuareg (22.00). The Longest stem length was found in Red King (75.00 cm) and the shortest in Pink Dona (53.40 cm). Maximum flower diameter was found in Red King (7.80 cm) and minimum in Tuareg (5.70 cm).

Hossan *et al.* (2013) conducted an experiment on three different strawberry germplasms SG-1, RABI-3, SG-3. Maximum plant height was found in SG-1 (28.0cm) and minimum in RABI-3(26.0cm). Maximum numbers of leaves/plant were found in SG-1(11.7) and minimum in SG-2 (9.8). Maximum leaf area/plant was found in SG-1(69.8cm$^2$) and minimum leaf area RABI-3(50.4cm$^2$). Maximum number of flowers/plant was found in SG-3 (29.3) and minimum in RABI-3(20.9). Maximum days were taken for flowering found in RABI-3 (98.4 days) and minimum in SG-3 (85.5).

Mahmood *et al*. (2013) evaluated ten gerbera cultivars such as Labinel, Lilla, Alp, Alberino, Bonnie, Avemaria, Mammut, Lexus, Terramixa & Sarolta. Among these cultivars, maximum stalk length was found in Alberino (60.3 cm) and minimum in Avemaria (40.6 cm). Maximum numbers of leaves/plant were found in Alberino (28.6) and minimum in Sarolta (17.6). Maximum flower diameter was found in variety Alberino (9.6 cm) and minimum Sarolta (5.3 cm). Maximum

number of flowers/plant was recorded in Alberino (24.6) and minimum in Alp (14.3).

Shruti and Gajbhiye (2013) evaluated thirteen varieties of gerbera namely Charmander, Dalma, Diablo, Francella, Goldengate, Goldflor, Magnum, Ornella, Rosalin, Sangria, Savannah, Sunanda and Vino. Maximum numbers of leaves/plant were found Savannah (31.20) and minimum in Magmum (22.26). Maximum leaf area was found in savannah (264.43 $cm^2$) and minimum in Ornella (111.53 $cm^2$).

Munikrishnappa *et al*. (2013) conducted an experiment on ten varieties of china aster namely Kamini, Shashank, Poornima, Violet Cushion, Phule Ganesh Pink, Phule Ganesh Purple, Phule Ganesh White, Phule Ganesh Violet, Ostrich Plume Mixed and Mixed Variety Local to evaluate suitable varieties on growth and flower yield. Among the varieties, maximum plant height was found in Phule Ganesh Violet (74.56 cm) and minimum in Violet Cushion (51.95 cm). Maximum numbers of primary branches/plant were found in Phule Ganesh Violet (35.28) and minimum in Mixed Variety Local (20.70). Maximum numbers of secondary branches/ plant were found in Phule Ganesh Purple (36.18) and minimum in Phule Ganesh Pink (23.25). Maximum numbers of flowers/ plant were found in Phule Ganesh Violet (55.43) and minimum in Shashank (40.92).

Four tomato varieties, namely Kashi Vishesh, Kashi Anupam, Kashi Amrit and Hisar Arun (S-7), were evaluated against the variety Navoday in farmer's field with farmer’s participation for yield potential and other yield characters at during rainy seasons of two consecutive years 2009 and 2010. All varieties had more yield potentiality than Navoday variety. Kashi Vishesh took the least time to flowering (44.49 days) and first harvest (73.14 days) after transplanting, gave the highest survivability of plants at harvest (91.25%), produced the maximum number of clusters per plant (11.90), number of flowers per cluster (1.99), number of fruits per plant (23.02), the highest marketable fruit yield (290.29 q/ha) and had the low incidence of Yellow Leaf Curl Virus disease. The investigation

led to infer that Kashi Vishesh was the best-performing variety, and therefore, it could be recommended for commercial production during rainy season under rain fed conditions in well drained soils of the undulating terrain. Kashi Anupam with moderate high yield and some tolerance to Tomato Yellow Leaf Curl Virus might be regarded as other potential variety for the rainy season production of tomato (Gautam *et al.*, 2013).

Zosiamliana *et al*. (2012) conducted an experiment on seven cultivars of china aster namely Violet Cushion, Kamini, Phule Ganesh Purple, Phule Ganesh White, Phule Ganesh Violet, Phule Ganesh Pink and Local. Among these varieties, maximum plant height was found in Phule Ganesh Violet (66.50cm) and minimum in local (43.13 cm). Maximum numbers of primary branches/ plant were found in Phule Ganesh Violet (21.40) and minimum in local (15.93). Maximum number of secondary branches/ plant were found in Phule Ganesh Violet (32.80) and minimum in Phule Ganesh Pink (16.80). Maximum numbers of branches/ plant were found in Phule Ganesh Violet (192.73) and minimum in local (146.67). Maximum days were taken to flower bud initiation were found in found Local (65.93) and minimum in Phule Ganesh Pink (57.20) . Maximum flower diameter was found in Phule Ganesh White (7.37 cm) and minimum in local (4.79cm). Maximum days were taken for flowering found in Kamini (71.02).

Gharge *et al*. (2011) conducted an experiment to evaluate ten cultivars of carnation (*Dianthus caryophyllus*) namely Gaudina, Viking, Buemonde, Yellow Firatc, Firato, Diana, Pink Shiva, Aicardi, Alibaba, Dali. Maximum plant height was found in Yellow Firato (134.0cm) and minimum Viking (99.14 cm). Maximum number of shoots/plant was found in Yellow Firato (7.64) and minimum in Viking (5.33). Maximum length of shoot was found in Yellow Firato (107.4 cm) and minimum in Alibaba (81.34 cm). Maximum numbers of leaves/plant were found in Yellow Firato (214.4) and minimum in Alibaba (172.8). Maximum numbers of flowers/plant were found in Yellow Firato (7.64) and minimum in Viking (5.33).

Khattak *et al.* (2011) conducted an experiment on ten rose cultivars namely Bright Smile, Fellowship, Black Gret, Lintern, Bridal Neck, Day Dream, Baby Bray, Smear Gold, Trust 2000 and Sharif Asma. Maximum days were taken to sprout found in Day Dream (10.38) and minimum in Lintern (6.50). Maximum days were taken for flowering found in Baby Bray (39.50) and minimum in Bright Smile (28.00). Maximum numbers of petals/flower were found in Baby Bray (47.6) and minimum in Bright Smile (10.13). Maximum flower diameter was found both in cultivars Sharif Asma and Fellowship (7.1cm) and minimum in Lintern (5.2 cm). Maximum flowers/plant was found in Baby Bray (20.6) and minimum in Lintern (5.6).

Datta *et al.* (2011) conducted an experiment on five mustard cultivars namely $V_1$-WBBN-1, $V_2$ –NC-1, $V_3$-YST-151, $V_4$-Ragini, $V_5$-$B_{9.}$ Among these varieties, maximum chlorophyll content was found in $V_4$ (1.550 $mgg^{-1}$) and minimum in $V_1$ (1.311 $mgg^{-1}$).

Ahmad *et al.*, (2011) conducted an experiment on five hybrid rose cultivars namely Amalia, Anjlique, Kardinal, Whisky Mac and Rosy Cheeks. Maximum plant height was found in Rosy Cheeks (83.0 cm) and minimum in Kardinal (46.7 cm). Maximum numbers of leaves/plant were found in Rosy Cheeks (10.8) and minimum in Kardinal (8.8). Maximum leaf area was found in Whisky Mac (104.86 $cm^2$) and minimum in Anjlique (65.20 $cm^2$). Maximum leaf chlorophyll content was found in Whisky Mac (58.12mg $g^{-1}$) and minimum in Rosy cheeks (49.80 mg $g^{-1}$). Maximum bud diameter was found both in Amalia and Whisky Mac (3.1 cm) and minimum in Rosy Cheeks (2.6 cm). Maximum flower diameter was found in Amalia (5.8 cm) and minimum in Anjlique (4.8 cm).

Exotic cultivars of hybrid roses respond uncertainly to new habitat. It is necessary to explore the potential of the introduced cultivars to judge the suitability in a new habitat. In the present study, nine *Rosa hybrida* cultivars including Autumn Sunset, Ice Berg, Paradise, Angel Face, Louise Odier, Casino, Grand Margina, Handel and Gruss-an-Teplitz were evaluated for growth and yield attributed

under the climatic conditions of Faisalabad. Results indicated that there was decreasing trend in the growth and flowering of the bushes as the temperature increased above $32^0$C and humidity decreased to 29%. Number of flowers per bush and diameter of flower decreased as the temperature increased and humidity decreased in contrast to increment in height of the plant and number of primary branches per plant in succeeding months. Interaction between yield traits and months was also significant. Overall, significant variations were observed in each cultivar for length and number of petals per flower, number of prickles, fragrance, flower persistence life and color, bush shape and overall performance with respect to climatic conditions of Faisalabad (Nadeem *et al.*, 2011).

Paramagoudar (2010) conducted an experiment on ten cultivars of rose namely Red Burlin, First Red, Passion, Tropical Amezon, Naranga, Grand Gala, Upper Class, African Dawn, Shakira, Gold Strike. Among these cultivars number of shoots/plant were found in Naranga (3.46) and minimum in African Dawn (2.05). Maximum leaf area was found in Grand Gala (25.48 $cm^2$) and minimum in African Dawn (12.75 $cm^2$). Maximum number of leaves/plant was found in Gold Strike (5.80) and minimum in African Dawn (3.33). Maximum days were taken for flower bud initiation found in African Dawn (24.53days) and minimum in Grand Gala (16.40days).Maximum number of flowers/plant were found in Naranga (14.13) and minimum in African Dawn (8.47). Maximum number of petals/flower was found in Naranga (36.67) and minimum in Upper Class (20.07).

Jamal Uddin *et al.* (2010) evaluated the adaptability of seven lisianthus cultivars namely Micky Rose, Pink Rose, Azuma No Yosooi, Purple Edge Glass, Piccolo Blue, Mellow Purple and Royal Violet. Maximum plant height was found both in Pink rose and Mellow Purple (46.0 cm) and minimum in Piccolo Blue (39.0 cm).Maximum days were taken for flower bud initiation found in Royal Violet (117.0) and minimum both in Mellow Purple and Azuma No Yosooi (99.0). Maximum days were taken to bloom were found in Micky Rose (22.0) and minimum in Azuma No Yosooi (16.0). Maximum numbers of flower buds/plant were found in Piccolo blue (18.0) and minimum in Pink Rose (10.0). Maximum

numbers of flowers/plant were found in Piccolo blue (16.0) but minimum in Pink Rose (7.0).

Joshi *et al*. (2010) conducted an experiment on seven varieties of chrysanthemum namely IIHR-6, Shyamal, Mayur, Red Gold, Honey Comb, Panchon, Nilima. Among these varieties maximum number of shoots/plant were found in Red Gold (6.41) and minimum in Mayur (4.42). Maximum numbers of flowers/ plant were found in Red Gold (96.25) and minimum in IIHR-6 (40.00). Maximum days were taken to flower bud initiation found in IIHR-6 (54.75) and minimum in Mayur (24.91).

Experiments were conducted to evaluate the growth, fruit yield and quality of seven varieties of tomato in the Guinea Savannah zone of South West Nigeria. The varieties tested were, DT97/162A(R), DT97/215A, Tropical, Roma VF, UC82B, Ibadan local and Ogbomoso local. These were assigned randomly into three blocks each containing seven beds and fitted into randomized complete block design. Growth, yield, mineral content and quality attributes of tomato were assessed. The results showed that DT97/162A(R) gave the highest height whereas Ogbomoso local recorded the highest number of leaves at 6 weeks after transplanting. Higher fruit yield was recorded from UC82B, closely followed by Ibadan and Ogbomoso local. Although, there is inconsistence in the results of the nutritional compositions of tomato fruits, the local varieties (Ogbomoso and Ibadan Local) closely followed by UC82B recorded most of the nutritional values more than the other varieties (Olaniyi *et al.*, 2010).

Chobe *et al*. (2010) evaluated the performance of gerbera cultivars namely Entourage, Baston, Softcell, California, Monthblance, Danelli, Frisbel, Fiction, Carambole, Scope, Picobella, Onedine, Loveliness, W.Grizzly, Lombogine, Dina, Esperenza, Gucci, Grizzly, Solem, Verginia, Tecla, Devil, Banesa, Martinque, Skyline, Viviane, Opium, Women, Sonata. Among these cultivars, maximum numbers of leaves/plant were found in Sonata (48.33) and minimum in Bastion (30.77). Maximum leaf area was found in Grizzly (274.93 $cm^2$) and minimum in

Softcell (143.89cm$^2$). Maximum flower diameter was found in Martinque (13.33cm) and minimum in Sonata (4.48cm). Maximum stalk length was found in Danelli (70.71cm) and minimum in Onedine (52.40cm). Maximum number of flowers/ plant was recorded in Sonata (62.87) and minimum in Onedine (42.27).

Kumari *et al*. (2010) conducted an experiment to evaluate five cultivars of Gerbera such as Dhoni, Zingaro, Roselin, Dune. Among these varieties, maximum plant height was found in Balance (41.05cm) and minimum in Dhoni (29.82cm). Maximum numbers of leaves/plant were found in Balance (25.91) and minimum in Dhoni (14.81). Maximum leaf area was found in Balance (5895.00 cm$^2$) and minimum in Dhoni (1994.06 cm$^2$). Maximum numbers of leaves /plant were found in Balance (10.59) and minimum in Dhoni (3.77).

Pattanashetti (2009) conducted an experiment on ten gerbera cultivars namely Mademoiselle, Lamborghini, Grizziy, Hope, Virginia, White Grizziy, Onedin, Dino, Baron, Solemio. Among these varieties maximum numbers of leaves/plant were found in Dino (27.5 and 32.30 respectively in rainy and winter seasons) and minimum in Baron (20.4 and 26.0 respectively in rainy and winter seasons). Maximum leaf area was found in White Grizziy (212.6 cm$^2$ and 235.6 cm$^2$ respectively in rainy and winter seasons). Maximum days were taken for flower bud initiation found in Mademoiselle (17.9 and 16.3 days respectively in rainy and winter seasons) and minimum in Dino (12.6 and 11.0 days respectively in rainy and winter seasons).

Pralhad (2009) conducted an experiment on ten cultivars of carnation namely Gaudina, Viking, Buemonde, Yellow Firato, Firato, Diana, Pink Shiva, Aicardi, Alibaba, Dali. Among these cultivars, maximum number of shoots/plant was found in Yellow Firato (7.64) and minimum in Viking (5.33). Maximum numbers of leaves/plant were found in Yellow Firato (214.4) and minimum in Alibaba (172.8). Maximum days were taken for bud initiation found in Gaudina (91.47days) and minimum in Diana (67.58 days).Maximum number of

petals/flower was found in Gaudina (74.18) and minimum in Yellow Firato (46.36).

An experiment was conducted to determine the genetic relationships among the most important *Bougainvillea* cultivars grown at most of the gardens in Egypt using random amplified Polymorphic DNA (RAPD) technology and isozymes patterns. Ten random decamer primers were screened and five were selected for final RAPD analyses. Each primer produced a unique set of amplification products ranging in size from. Isoenzyme patterns peroxidase, esterase, Poly phenyl-oxidase (PPO) and Alkohol-Dehydrogenase (Adh) were studied in five cultivars of *Bougainvillea* having different bracts colors (purple, red, orange, white and dwarf plant) commonly grown in Egypt. Isozymes revealed higher polymorphism among bougainvillea cultivars with all enzymes used. The cluster analysis based on isozymes data showed that the entire cultivars fell in one group but the purple and red is very close to each other and orange cultivar is the different (Hammad, 2009).

Ijoyah *et al*. (2008) conducted an experiment on four onion varieties namely Onion Orient, Lucy 15205, CAL 606, and Red Creole-2. Among these varieties, maximum numbers of leaves/plant were found in CAL 606 (13.0) and minimum in Red Creole-1(7.8).

Ahmad *et al*. (2007) conducted an experiment to evaluate eleven tomato varieties namely Local Round, Red Blast, Modi Red, Nagina, Gala, Pesto-mech-II, Nemadina, Shalkot, Roma, Linger-87 and Rio Grande. Maximum plant height was found in Local Round (110.50 cm) and minimum in Liger-87 (47.60 cm). Maximum numbers of branches/ plant were found in Local Round (10.77) and minimum in Liger-87 (5.25).

Katung (2007) conducted an experiment on two okra varieties namely White Velvet and Ex-Borno. Among these varieties, maximum number of leaves/plant

was found in Ex-Borno (19.2) and minimum in White Velvet (11.8). Maximum leaf area was found in Ex-Borno (1073.5cm$^2$) and White Velvet (701.2cm$^2$).

Moniruzzaman *et al,*. (2007) conducted an experiment on three varieties of French bean namely V1 = BARI Jhar Sheem-1, V2 = BARI Jhar Sheem-2 and V3 = Local. Among these varieties, maximum plant height was found in local (41.06 cm) and minimum in BARI Jhar Seem-2 (38.75cm). Maximum numbers of branches/plant were found in Bari Jhar Seem-2 (4.40) and minimum in Local (3.59).

Manjula (2005) conducted an experiment on ten cultivars of rose namely Grand Gala, Samurai, First Red, Konfittee, Skyline, Tineke, Lambada, Ravel, Eternal, Versilia. Among these cultivars, maximum number of shoot/plant found in Tineke (3.46) and minimum in Versilia (2.05). Maximum number of thorns/plant found in Konfittee (21.53) and minimum in Tineke (6.20). Maximum leaf area found in Grand Gala (152.63 cm$^2$) and minimum in Lambada (98.43 cm$^2$). Maximum number of leaves/plant found in Konfittee (6.39) and minimum in Versilia (2.91). Maximum days were taken for flower bud initiation found in Versilia (24.53) and minimum in Grand Gala (16.40). Maximum numbers of petals/flower were found in Tineke (40.98) and minimum found in Lambada (17.48).

Susan (2003) conducted an experiment to evaluate the role of sugar in the vase solution on post harvest and leaf quality of oriental lily ‘Stargazer’ and found that addition of 2% sugar into the vase solution neither affected the longevity nor the size of the flowers but significantly enhanced the anthocyanins content and the intensity of the petal color. Flower showed lighter color petals when placed in a solution without sugar. Cut rose flower can be increased by using the vase life extending solutions. Addition of sugar to the vase solution counteracted the adverse effects of defoliation on petal color and overcome the increased bud blasting. However, it enabled more flowers to open fully which without sugar remained only partially open.

In a performance study of five gerbera varieties, the cv. Essandre was found to have maximum plant height (21.43 cm), number of leaves (16.87), leaf area (1276.28 $cm^2$) and number of flowers (17.69/ plant). Whereas, the cv.Tamara was very poor in flower production (8.0/plant). Flower diameter (9.59 cm) and stalk length (56.77 cm) were maximum in cv. Yanara (Sankar *et al.*, 2003).

Mahanta *et al.* (2003) observed five black centered gerbera cultivars under naturally ventilated polyhouse and reported maximum number of flowers/plant (5.66) and number of flower (51.00/$m^2$) in cv. Ellymay followed by cv. Aquilla (5.00 and 45.00/$m^2$) respectively. Maximum flower diameter (9.92 cm) was observed in cv. Aquilla and the longest blooming period (19.55 days) with maximum vase life (12.22 days) was observed in cv. Golden Gate.

Reddy *et al.* (2003) studied the performance of eleven gerbera cultivars under naturally ventilated greenhouse. Among the cultivars, Sangria, Kabana, Marisol and Tamra were superior for their growth, yield and quality as compared to the other genotypes. The cv. Sangria performed well with maximum plant height (48.31 cm), number of leaves (47.31), number of suckers per plant (7.54), number of flowers per plant (57.54), stalk length (69.46 cm), thickness (0.73 cm) and diameter of the flower (12.16 cm).

Singh and Ramachandran (2002) studied the vegetative characters of nine gerbera cultivars at the age of one year of crop growth under naturally ventilated greenhouse. The cv. Lyonella registered maximum height (47.10 cm), plant spread (70.19 cm) and number of suckers per plant (4.85 cm), whereas the cv. Orenella recorded maximum number of leaves/plant (46.10) and cv. White Sun produced dwarf plant (35.40 cm) with plant spread of 59.34 cm. The cv. Tara registered minimum number of suckers (3.66) and leaves (31.66) per plant.

Tabassum *et al.* (2002) evaluated ten rose cultivars namely Alexendra , Double Delight, Day Dream , Englique, Freesia, Golden Time , Paradise, Regret Berg , Red Sex and Yankee Doodle. Maximum plant height was found in Englique

(139.83cm) and minimum in Double Delight (87.17cm). Maximum days were taken for bud sprouting found in Englique (46.17) and minimum in Golden Time (34.67). Maximum days were taken for flowering found in Day Dream and Englique (54.67 days) and minimum in Red Sex (41.83 days). Maximum numbers of shoot/plant were found in Paradise (12.50) and minimum in Freesia (4.17). Maximum numbers of flowers/plant were found in Day Dream (41.00) and minimum in Double Delight (5.33). Maximum flower size was found both in Alexandra and Paradise (7.93) and minimum in Regret Berg (5.17). Maximum numbers of petals/flower were found in Yankee Doodle (59.20) and minimum in Regret Berg (18.97). Longest flower persistency was found in Golden Time (17.17) and shortest in Regret Berg (5.67). Maximum vase life was in Freesia (8.00 days) and minimum in Regret Berg (5.00 days).

The response of 'Kardinal' rose plants to temperature was measured to develop a model for predicting rose flower size for a range of greenhouse conditions. The number of days from bud break (BB) to flowering increased from 21.6 to 63.0 days as temperature decreased from 30 to 15°C. The number of days to flower was primarily influenced by the temperature after the visible bud (VB). This suggests that the temperature before VB may not significantly affect the rate of flower development. Leaf area, stem length and stem diameter generally increased with decreasing temperature, but the best quality of stems was observed at 18°C. Flower dry weight, however, increased from 0.7 to 3.0 g as temperature decreased from 30 to 15°C. When plants were moved to lower temperature at VB stage, flower dry weight increased. Temperature has it's most pronounce influence on flower development during the period between VB and flowering so that during commercial greenhouse rose production any reduction in temperature during that period can result in increasing the size of rose flower buds (Shin *et al.*, 2001).

Mohanty and Prusti (2001) observed the behavior of twelve varieties of onion namely Nasik Red, 2-4-1, Agrifound Dark Red, Agrifound Light Red, N53, Punjab Red Round, Arka Pitamber ,Arka Kalyan, Arka Niketan,Pusa Madhavi,

Pusa Red, Pusa Ratnar. Among these varieties, maximum number of leaves/plant found in Pusa Red (16.50 and minimum in Agrifound Light Red (7.40).

Malhotra and Kumer (2000) observed that pruning is a very important and necessary step towards rose beneficial growth and increases the aesthetic values like profuse and larger blooms with inspiring color and quality of the flowers. Pruning intensity has a definite role in regulating flower production in roses.

Khan (1978) stated that among cut flowers, Rose (*Rosa spp*) has occupied a unique position both in beauty and trade. It is an ornamental plant of family Rosaceae and can be exploited for growing in beds, borders, walls, arches and screens.

Lemper (1976) said that floriculture is one among the promising ventures which has emerged in the recent past as flowers and flowering plants and have been a fascinating part of our life. Cut flowers like Rose, Carnation, Gerbera, Lillium and Gladiolus always have steady demand in Indian and International cut flower trade Lemper (1976)

**Experiment II (Post harvest related)**

The effects of salicylic acid (SA), 8-Hydroxyquinoline sulfate (8-HQS), and sucrose on cut gerbera was studied. SA (0, 100 and 150 $mgl^{-1}$), 8-HQS (0 and 200 $mgl^{-1}$), and sucrose (0 and 30 $gl^{-1}$) and their combinations were tested as preservative mixture. SA increased vase life and reduced stem curvature at the concentration of 100 $mgl^{-1}$. SA at 150 $mgl^{-1}$ increased mean absorbed preservative solution. 8-HQS increased vase life, dry weight, wet weight, flower diameter, mean absorbed preservative solution, and quality score. 8-HQS also decreased the stem curvature. Sucrose decreased vase life, flower diameter, and quality score, whereas increased dry weight. The treatment containing 8-HQS (200 $mgl^{-1}$) had vase life of 12.9 days which was not significantly different from the combination of SA (100 $mgl^{-1}$) + 8-HQS (200 $mgl^{-1}$) which resulted in the

longest vase life of 15.6 days. The results show that SA could increase vase life in combination with 8-HQS (Banaee *et al*., 2013).

Effect of applying citric acid and salicylic acid at pre-harvest stage on vase-life of rose (Rosa hybrida L. cv. Avalanch) was investigated. The factorial experiment was carried out as a randomized complete blocks design. Three levels of citric acid concentration (0, 2 and 4 mM) and salicylic acid (0, 1 and 2 mM) were applied as foliar spray at 5 pre-harvest stages on the leaves of roses grown under controlled conditions in greenhouse. The results showed that salicylic acid and citric acid increased longevity, water absorption, flower diameter and flower quality and delayed the effective weight loss of fresh rose flower. Maximum vase-life (with an average of 9 days) was achieved by combined foliar application of 4 mM citric acid and 1 mM salicylic acid. Also, the minimum vase-life (with an average of 7.3 days) was obtained at the 2 mM salicylic acid treatment. The higher vase-life of rose flower was accompanied with greater fresh weight and more water absorption (Hajireza *et al*., 2013).

Effect of salicylic acid on vase life and postharvest quality of cut carnation (Dianthus caryophyllus L. 'Liberty Abgr') had been investigated. The experiment was conducted based on completely randomized design with salicylic acid in 4 concentrations (0, 50, 100 and 150 $mgl^{-1}$) and 3 replications. Analysis of variance revealed that the effect of salicylic acid on vase life and water absorption ($p \leq 0.05$) and bacterial colonies population in vase solution and dry matter percentage ($p \leq 0.01$). According to mean comparisons, 150 $mgl^{-1}$ salicylic acid had the priority in 3 traits: 12.67 days vase life, 48.17 log10CFUml-1 bacterial colonies and 12.86% dry matter percent; and 50 mgl-1 had the most water uptake (1.59 $mll^{-1}$ F.W.) (Fariba *et al*., 2012).

Effect of salicylic acid (SA) continuous treatment on the quality and vase life of cut Gladiolus cv 'wing's sensation' flowers over four developmental stages (bud stage; half bloom; full bloom; senescence) were investigated by Hatamzadeh *et al.* (2012). This research was conducted in a split plot in time experiment based on completely randomized design with 3 replications. The flowers were treated in different concentrations of SA (50, 100, 150 and 200 mg/L). Results showed that

the SA delayed flower senescence and leakage of ion in petals, as well as decreased fresh weight loss and lipid peroxidation. In addition, these treatments also increased antioxidant enzyme activities of peroxidase (POD) and maintain protein content. The (150 mg/L) SA treatment was the most effective on vase life of cut gladiolus flowers. Moreover, the results showed that the post harvest application of SA (150 mg/L) maintain higher spike fresh weight, antioxidant enzyme, stability of membrane and leading to delay in petal senescence.

Effect of different concentrations of Nickel (0, 1.5 and 2.5 mM), Salicylic acid (0, 1 and 2 mM), Cobalt (0, 1 and 2 mM) and sucrose (0, 2.5%) on flower longevity, Acc-oxidase activity, anthocyanin leakage, microbial population, water uptake and SPAD value as a measure of leaf greenness of Lily was investigated. To evaluate the effect of these treatments, a study was carried out based on the randomized complete design with five replications. Results of this experiment showed that the best treatment in extending the longevity of the flowers were solutions containing 2 mM SA, 2 mM SA+ 2.5% sucrose and 2.5mM Ni+ 2 mM SA+2 mM Co with 2.5% sucrose. SA, Ni and Co decreased the anthocyanin leakage, whereas the highest concentrations of SA, Ni and Co reduced ACC-oxidase activity. The Maximum of chlorophyll content was observed for flower kept in solution containing 2 mM SA and 2 mM SA+ 2.5% sucrose compared to the control and solution containing Ni and Co. Ni and Co treatments had no positive effect on increasing the water uptake and fresh weight of Lily. Overall, the results suggest that SA, Ni, CO and sucrose increase the vase-life by improving the membrane stability and reducing the oxidative stress damages during Lily flower senescence (Kazemi and Ameri, 2012).

In experiment, C0; tap water (Control), C1; distilled water, C2; sucrose solution (100 ppm), C3; lemon juice solution (100 ppm), C4; sucrose + lemon juice solution (100 ppm) and C5; GA3 solution were exploited to assess vase life of cut rose (Rosa hybrida L.) against different available solution. Experiment was accomplished at The Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. From analyzed data, C4 illustrated minimum flower diameter (99.00 mm) with maximum petal number (40.00 petals) and

ceiling petal thickness (0.25 mm) on 8th days after treating. Least stem bending (14.330), petal discoloration score (2.00), freshness of flower (2.50) on 8th days after treating were exposed by C4. Utmost flower longevity (14.00 days) also revealed on C4 whereas least flower longevity was traced in C0 and C5 (8.50 days) (Mehraj *et al*., 2013).

Chrysanthemum (Dendranthema grandiflorum (Ramat.) Kitamura cv. Pattriot is one of the most important and marketable cut flowers in the world. However, a relatively limited vase life reduces its marketability. The aim of this study was to evaluate the efficacy of salicylic acid (SA) and citric acid (CA) in extending the vase life of chrysanthemum flowers. Therefore, a factorial experiment based on completely randomized design with SA at (0, 100, 200, 300 ppm) and CA at (0, 100, 200 ppm) was conducted. Applying SA and CA increased vase life, petal water content (%), initial fresh weight (%) and marketability, significantly. SA treatments increased leaf relative water content (RWC), petal water content (%) and initial fresh weight (%) by 49, 73 and 23 %, compared to the controls, respectively. The highest vase life (21.77 days) was observed for the treatments of SA (300 ppm). The significant increase (300%) in vase life is considered to be due to plant regulating and anti-stress properties of SA and CA. According to the results of this experiment, SA and CA as natural, cheap, safe and biodegradable compounds are suitable alternatives for conventional chemical treatments in order to prolong vase life of cut flowers of chrysanthemum (Vahdati Mashhadian *et al.,* 2012).

The effect of exogenous salicylic acid (SA) on the vase life of cut rose flowers was investigated. ‘Yellow Island’ roses were obtained from a commercial grower. The roses were pulse treated with SA (0, 50, 100, 150, 200 mg l-1) for 18 hours. Compared to the control treatment (DW), the greatest delay in senescence was obtained in cut roses treated with 150 mg l-1 SA. With this treatment, flower vase life was doubled. The physiological characteristics such as protein concentration, lipid peroxidation (MDA) level and enzyme activity such as lipoxygenase (LOX), superoxide dismutase (SOD) and peroxidase (POD) were measured only in the control (DW) and those kept in a solution of 150 mg l-1 salicylic acid (SA) for

over 8 days of vase life. Degradation of protein and accumulation of MDA during vase life was shown to be suppressed by 150 mg l-1 SA. The activity of LOX and POD gradually increased with progressing flower senescence, while SOD activity declined. The flowers which had been pulsed with SA exhibited lower LOX and POD activity, and a higher activity of SOD. Overall, the results suggest that SA increases vase life by improving the antioxidant system and reducing oxidative stress damages during rose flower senescence (Gerailoo and Ghasemnezhad, 2011).

A study was carried out to investigate the effect of chemical treatments and sucrose on vase life of three new rose cultivars, ‘Bouing’, ‘Creamly’ and ‘Sena’. Treatments were included distilled water (control), 10 $gL^{-1}$ sucrose, 10 $gL^{-1}$ sucrose + 100 $mgL^{-1}$ citric acid, 10 $gL^{-1}$ sucrose + 100 $mgL^{-1}$ aluminium sulphate, 10 $gL^{-1}$ sucrose + 0.5 mM silver thiosulphate for 2 h. Results showed that the best treatment for ‘Sena’ was silver thiosulphate + sucrose that increased fresh weight, water uptake, flower diameter and flower vase life. On the other hand, this treatment caused petal burning in ‘Creamly’ in spite of its other improved traits. Best treatment for other cultivars was citric acid + sucrose that had significant effect on all investigated factors. Aluminium sulphate just had a positive effect on ‘Sena’. This treatment did not have positive effect in ‘Creamly’ and even decreased vase life of ‘Bouing’ in comparison with control (Shirin and Mohsen, 2011).

The effect of salicylic acid and other compounds on carnation cultivar ’Reina’ was studied in the case of different concentrations. The treatments were the followings: distilled water (DW) as a control solution, 10 $gl^{-1}$ Spring, DW + 1, 5 and 2 $mll^{-1}$ Clorox, DW + 10, 25, 50, 75, 100, 125, 150, 200, 250 and 500 $mgl^{-1}$ salicylic acid. As for SPAD values best result was achieved in the Spring and 250 $mgl^{-1}$ salicylic acid solution. The highest diameter of flowers was obtained by using 125 and 250 $mgL^{-1}$ salicylic acid solution. Similar results were measured in the case of 2 $mll^{-1}$ Clorox and 50 $mgl^{-1}$ salicylic acid solution too. The condition (state) of flowers was the best at the treatment of 125 $mgl^{-1}$ solution with 3.9

value. The longest vase life (11.1 day) was observed in the case of 125 $mgl^{-1}$ salicylic acid solution. In this treatment the vase life was prolonged by 2.4 days. As regards the calculated ornamental values, the following result could be concluded: 125 $mgl^{-1}$ salicylic acid solution with 141.9 points. As a final conclusion of the experiment it can confirmed, that with the use of 125 $mgl^{-1}$ salicylic acid the vase life was significantly extended (Feigel-Terek *et al.*, 2010).

Anserwadekar and Patil (1986) carried out the vase life of gladiolus. The treatments were 6% sucrose, 60-ppm $GA_3$ and distilled water. It was observed that sucrose maintained prolonged vase life for 11 days than other treatment.

# CHAPTER III

# MATERIALS AND METHODS

A field experiment was conducted at the field of Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from October 2012 to March 2013 to study the floral behavior and petal coloration of some rose cultivars (experiment I). Another experiment was conducted in 2aBiotech Lab to find out the suitable preservative solution for extending the vase life of rose during the period of January 2013 (experiment II).The materials and methods that were used and followed for conducting the experiment presented under the following headings-

## Experiment I

### 3.1 Experimental site

The study was conducted in the Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh to study growth, floral behavior and petal coloration of some rose cultivars. The location of the experimental site is 23074$^{o}$N latitude and 90035$^{o}$E longitude and at an elevation of 8.2 m from sea level (Anon., 1989).

### 3.2 Climatic condition

Experimental site was located in the subtropical monsoon climatic zone, set aparted by heavy rainfall during the months from April to September (Kharif season) and scant of rainfall during the rest of the year (Rabi season). Plenty of sunshine and moderately low temperature prevails during October to March (Rabi season), which is suitable for rose growing in Bangladesh.

### 3.3 Selection of the plants for the experiments

The rose cultivars were planted in the field in 2009 considering the RCBD maintaining all the management practices. During this time the plants held in the field for getting the desired maturity level for the experimentation.

### 3.4 Pruning of the plants

Plants were pruned at 13$^{th}$ October, 2012. Pruning is a very effective practice for increasing the number of flowers. Pruning intensity has a definite role in regulating flower production in roses (Malhotra and Kumar, 2000).

### 3.5 Treatments and layout of the experiment

The experiment was undertaken to study growth, floral behavior and petal coloration of some rose cultivars in SAU Horticultural Farm. The single factorial experiment was laid out in Randomized Complete Block Design (RCBD) with three replications.

Single factorial experiment was conducted and the treatments were as follows:

**Factor**: **Rose cultivars**

| | | | |
|---|---|---|---|
| Wild rose | -$V_1$ | Yellow gold | -$V_{23}$ |
| Crazy love bicolor | -$V_2$ | Ocean heart | -$V_{24}$ |
| Tajmahal | -$V_3$ | Sleepy moon | -$V_{25}$ |
| Yellow star | -$V_4$ | Sweet doll | -$V_{26}$ |
| Ekuse lal | -$V_5$ | Moon light | -$V_{27}$ |
| Afrodita | -$V_6$ | Pain blue | -$V_{28}$ |
| Black divorce | -$V_7$ | Ruin night | -$V_{29}$ |
| Attarcted red | -$V_8$ | Chrysanthemum rose | -$V_{30}$ |
| Missing love | -$V_9$ | Mystery love | -$V_{31}$ |
| Pinky smile | -$V_{10}$ | SAU king | -$V_{32}$ |
| Sweet love | -$V_{11}$ | Ice barg | -$V_{33}$ |
| Red baby | -$V_{12}$ | Yellow erecta | -$V_{34}$ |
| Star fire | -$V_{13}$ | Sweet sakata | -$V_{35}$ |
| Lavender gold | -$V_{14}$ | Anindo kun hazari | -$V_{36}$ |
| Lemon star | -$V_{15}$ | Yellow papiliom | -$V_{37}$ |
| Compassion | -$V_{16}$ | Red eye | -$V_{38}$ |
| Charming lady | -$V_{17}$ | Sympathy | -$V_{39}$ |
| Dream bangla | -$V_{18}$ | Mini master | -$V_{40}$ |
| Printed moon | -$V_{19}$ | Pretty girl | -$V_{41}$ |
| Fire & Ice | -$V_{20}$ | Sad 23 | -$V_{42}$ |
| SAU hero | -$V_{21}$ | Aranchan | -$V_{43}$ |
| SAU prince | -$V_{22}$ | Sweet mum | -$V_{44}$ |


**Plate 1. Forty four rose cultivars (continued)**

**Continued**


$V_{19}$


$V_{20}$


$V_{21}$


$V_{22}$


$V_{23}$


$V_{24}$


$V_{25}$


$V_{26}$


$V_{27}$


$V_{28}$


$V_{29}$


$V_{30}$


$V_{31}$


$V_{32}$


$V_{33}$


$V_{34}$


$V_{35}$


$V_{36}$

**Plate 1. Forty four rose cultivars (continued)**

**Continued**


$V_{37}$


$V_{38}$


$V_{39}$


$V_{40}$


$V_{41}$


$V_{42}$


$V_{43}$


$V_{44}$

**Plate 1. Forty four rose cultivars**

$V_1$: Wild rose; $V_2$: Crazy love bicolor; $V_3$: Tajmahal; $V_4$: Yellow star; $V_5$: Ekuse lal; $V_6$: Afrodita; $V_7$: black divorce; $V_8$: Attarcted red; $V_9$: Missing love; $V_{10}$: Pinky smile; $V_{11}$: Sweet love; $V_{12}$: Red baby; $V_{13}$: Star fire; $V_{14}$: Lavender gold; $V_{15}$: Lemon star; $V_{16}$: Compassion; $V_{17}$: Charming lady; $V_{18}$: Dream bangla; $V_{19}$: Printed moon; $V_{20}$: Fire and ice; $V_{21}$: SAU hero; $V_{22}$: SAU prince; $V_{23}$: Yellow gold; $V_{24}$: Ocean heart; $V_{25}$: Sleepy moon; $V_{26}$: Sweet doll; $V_{27}$: Moon light; $V_{28}$: Pain blue; $V_{29}$: Ruin night; $V_{30}$: Chrysanthemum rose; $V_{31}$: Mystery love; $V_{32}$: SAU king; $V_{33}$: Ice barg; $V_{34}$: Yellow erecta; $V_{35}$: Sweet sakata; $V_{36}$: Anindo kun hazari; $V_{37}$: Yellow papiliom; $V_{38}$: Red eye; $V_{39}$: Sympathy; $V_{40}$: Mini master; $V_{41}$: Pretty girl; $V_{42}$: Sad 23; $V_{43}$: Aranchan and $V_{44}$: Sweet mum

### 3.6 Intercultural Operations

Irrigation

Light over-head irrigation was provided through a pipe at the base of each plant as and when necessary during the crop field.

Weeding

Weeding was done two times at 20 and 40 days after pruning for removal of weed.

Disease and pest control

In order to protect the plants from fungal infection Diathene M-45 were sprayed and to control the insects Pyrithrum @1.5ml/l were sprayed 3 times at 15 days interval.

### 3.7 Parameters of the field experiment (Experiment I)

- Number of shoots/plant
- Number of leaves/10 cm shoot
- Number of thorns/10 cm shoot
- Leaf area ($cm^2$)
- Chlorophyll content
- Days to flower bud initiation
- Number of flower/plants
- Petals per flower

### 3.8 Data collection for field experiment (Experiment I)

The data were collected from each treatment. Data were collected in respect of the plant growth characters and yield contributing characters.

### 3.8.1 Number of shoots/plant

Numbers of shoots/plant were counted and the data were recorded at 30 days after pruning and mean values were calculated.

### 3.8.2 Number of leaves/10 cm shoot

Numbers of leaves/10cm shoot were counted and the data were recorded at 30 days after pruning and mean values were calculated.

### 3.8.3 Number of thorns/10 cm shoot

Numbers of thorns/10 cm shoot were counted and the data were recorded at 30 days after pruning and mean values were calculated.

### 3.8.4 Leaf area ($cm^2$)

Leaf area was measured by using CL-202 leaf area meter in non-destructive method from each of the treatments and expressed in $cm^2$ at 30 days after pruning. For measuring the leaf area 5 mature leaves were randomly selected and the mean values were calculated.

### 3.8.5 Chlorophyll content (%)

Chlorophyll content was measured by using SPAD-502 from each of the treatments and expressed in $cm^2$ at 30 days after pruning. For measuring the chlorophyll content 5 mature leaves were randomly selected and data were taken from three portions of each leaves randomly then the mean values were calculated.

### 3.8.6 Days to flower bud initiation

Days were counted from pruning to flower bud initiation were taken after 25 days pruning and the mean values were calculated.

### 3.8.7 Number of flowers/plant

Number of flowers /plant were counted at the end of the experiment and the mean values were calculated.

### 3.8.8 Number of petals/flower

Petals /flower were counted at 25 days after pruning and the mean values were calculated.

## Experiment II

### 3.9 Selection of the flower for vase life analysis

From 44 rose cultivars Sleepy moon was selected for vase life analysis as it is commonly used commercial cut flower in Bangladesh.

### 3.9.1 Experimental design

The single factor experiment was laid out in Completely Randomized Design (CRD) with three replications.

### 3.9.2 Treatments of the experiment

Ten chemical preservative solutions were used for vase life analysis and these were as follows:

Tap water (Control) = $T_0$

Sugar (50-ppm) = $T_1$

Citric Acid (50-ppm) = $T_2$

Salicylic Acid (50-ppm) = $T_3$

Chitosan (50-ppm) = $T_4$

Silvar Thiosulphate (50-ppm) = $T_5$

Sugar + Citric Acid (50-ppm) = $T_6$

Sugar + Salicylic Acid (50-ppm) = $T_7$

Sugar + Chitosan (50-ppm) = $T_8$

Sugar + Silvar Thiosulphate (50-ppm) = $T_9$

### 3.9.3 Keeping the flowers in vase solution

Cut roses were placed on 200 ml vase solution and the nozzles of the bottles were air tight to prevent the loss of vase solution.

### 3.10 Parameters for the vase life analysis (Experiment II)

- Stem diameter (mm)
- Flower head diameter (cm)
- Petal discoloration score
- Flower freshness score
- Days taken for first petal spreading
- Solution uptake
- Petal water content
- Vase life

### 3.11 Data collection for vase life analysis (Experiment II)

#### 3.11.1 Stem diameter (mm)

Diameter of the flower stem was measured by using Digital Caliper -515 (DC-515) in millimeter (mm) at 3, 5 and 7 days after treating. Mean of each treatment was calculated.

#### 3.11.2 Flower head diameter (cm)

Diameter of the flower head was measured by using centimeter scale in centimeter (cm) at 3, 5 and 7 days after treating. Mean of each treatment was calculated.

#### 3.11.3 Flower freshness score

Flower freshness score were taken at 3, 5 and 7 days after treating. Freshness of flower was determined by wilting of score (Macnish *et al.*, 1999). Freshness of flower was scored on 1-5 scale (1 = fresh flower, 2 = very slight petal enrolling, 3 = noticeable in-rolling, 4 = petal shriveling and 5 = maximum petal shriveling).

#### 3.11.4 Petal discoloration score

Petal discoloration score were taken at 3, 5 and 7 days after treating. Flower petal color change or discoloration (fading) was assessed according to the procedures described by Macnish *et al.* (1999) with rating scale of 1 = none/slight fading, 2 = moderate fading and advanced fading.

#### 3.11.5 Solution uptake

Solution uptake was measured by subtracting the solution at the last days in flower vase from the initial solution of the flower vase.

### 3.11.6 Petal water content

Petal water content (% WP) was determined with the below equation (Kalate Jari *et al.*, 2008):

$$\%WP = \{(FW-DW) \div DW\} \times 100$$

### 3.11.7 Vase life

Vase life for the cut rose was measured by counting the days in vase solution from the setting up the treatments.

## 3.12 Statistical analysis

The data obtained for different characters were statistically analyzed to fine out differences among the treatments on rose. The mean values of all the characters were evaluated and analysis of variance was performed by the 'F' (Variance ratio) test following MSTAT-C computer package program. Significance of the difference among the treatment means was estimated by the Least Significant Difference (LSD) test at 5% level of significance.

# CHAPTER IV

# RESULTS AND DISCUSSION

The research work was done to study the floral behavior and petal coloration of some rose cultivars. Crops characteristics differed among the cultivars due to their genetic variation. 44 rose cultivars were evaluated on the experiment that was differentiated in terms of different characters. In this chapter, findings of performed research work have been put forwarded and discussed. Data have been summary of the analysis of variances in respect of all parameters have been shown in appendices. Results have been presented, discussed and possible interpretations are given under the following heads.

## 4.1 Field experiment

### 4.1.1 Number of shoots/plant

Number of shoot/plant varied significantly among the cultivars (Appendix I). Maximum number of shoot/plant was found from $V_{36}$ (42.0) whereas minimum from $V_1$, $V_{13}$, $V_{33}$, $V_{39}$, $V_{42}$ (4.0) (Table 1). Variation in number of shoot/plant was also observed previously in Rose (Tabassum *et al*., 2002; Ramzan *et al*., 2014; Manjula, 2005 and Paramagoudar, 2010), in Carnation (Gharge *et al*., 2011; Tarannum and Naik, 2014; Singh *et al*., 2013 and Pralhad, 2009), in China Aster (Zosiamliana *et al*., 2012 and Munikrishnappa *et al*., 2013), in French bean (Moniruzzaman *et al*., 2007), in Tomato (Ahmad *et al.*, 2007). Number of shoot is an important growth related morphological character. Number of shoots/ plant plays an important role in productivity. Terminal portion of a plant bearing flower exhibit apical dominance. After pruning the apical dominance hinders and enhanced the lateral shoots. That's why the more the number of shoot appears the more the number of flowers will appear in the plant. Number of shoots/plant has

positive and significant relation with the number of flowers as well flower production.

### 4.1.2 Number of leaves/10 cm shoot

Number of leaves/10 cm shoot varied significantly among the cultivars (Appendix I). Maximum number of leaves/10 cm shoot was found from $V_{12}$ (7.0) whereas minimum from $V_2$, $V_7$, $V_{10}$, $V_{11}$, $V_{17}$, $V_{21}$, $V_{30}$, $V_{32}$, $V_{33}$, $V_{34}$, $V_{35}$, $V_{42}$ (3.0) which is statistically similar to $V_3$, $V_4$ (3.3) (Table 1). Variation in number of leaves/10cm shoot was also observed previously in rose (Ahmad *et al*., 2011; Manjula, 2005 and Paramagoudar, 2010), in carnation (Gharge *et al*., 2011; Tarannum *et al*., 2014 and Pralhad, 2009), in Okra (Katung, 2007), in Onion (Ijoyah *et al*., 2008 and Mohanty *et al*., 2001), in Gerbera (Mahmood *et al*., 2013 ; Chobe *et al*., 2010; Kumari *et al*., 2010; Pattanashetti, 2009 and Shruti *et al*., 2013), in Strawberry (Hossan *et al.*, 2013). Leaves are the functional units of photosynthesis. Increased rate of flowering depends on the rate of photosynthesis. More a plant gets more leaves more photosynthesis will take place as a result higher dry matter accumulation will take place and which in turn gives profuse flowering.

### 4.1.3 Number of thorns/10 cm shoot

Number of thorns/10 cm shoot varied significantly among the cultivars (Appendix I). Maximum number of thorns/10cm shoot was found in $V_{20}$ (47) whereas minimum from $V_4$, $V_{14}$, $V_{15}$, $V_{29}$, $V_{30}$, $V_{37}$, $V_{41}$, $V_{43}$ (0.3) (Table 1). Variation in number of thorns/10 cm shoot was also observed previously in Rose (Manjula, 2005). Due to varietal differences some plants posses so dense thorns in their stem and some posses sharp, large thorns. Presence of too minute and densely grown thorns reduces consumer's preference. Normally those flowers are used as cut flowers produce long thorns. A stem free of thorns is the desirable characteristics of cut flower.

### 4.1.4 Leaf area ($cm^2$)

Leaf area varied significantly among the cultivars (Appendix II). Maximum leaf area was found from $V_{25}$ (69.5 $cm^2$) which is statistically similar to $V_{16}$ (68.4 $cm^2$) and $V_{21}$ whereas minimum from $V_{42}$ (23.5 $cm^2$) which is statistically similar to $V_1$ (24.6 $cm^2$) (Table 1). Variation in leaf area was also observed previously in Rose (Ahmad *et al*. 2011; Manjula, 2005 and Paramagoudar, 2010), in Okra (Katung, 2007), in Gerbera (Chobe *et al*., 2010; Kumari *et al*., 2010; Pattanashetti, 2009 and Shruti *et al*., 2013), in Strawberry (Hossan *et al.*, 2013). Large sized and higher number of leaves gives higher leaf area. Maximum leaf area increased the photosynthetic efficiency of leaf surface leading to increased production of flowers.

**Table 1. Performance of rose cultivars to different growth attributes[X]**

| Cultivar[Y] | Number of shoots/plant | Number of leaves/10cm shoot | Number of thorns/ 10cm shoot | Leaf area($cm^2$) |
|---|---|---|---|---|
| $V_1$ | 4.0 q | 4.0 d | 2.0 q | 24.6 u |
| $V_2$ | 12.0 j | 3.0 e | 7.0 l | 35.0 opqr |
| $V_3$ | 9.0 m | 3.3 e | 11.0 i | 34.5 pqr |
| $V_4$ | 7.0 o | 3.3 e | 0.3 s | 48.1 e |
| $V_5$ | 9.0 m | 5.0 c | 15.0 f | 30.0 t |
| $V_6$ | 10.0 l | 5.0 c | 1.0 r | 47.1 e |
| $V_7$ | 26.0 d | 3.0 e | 11.0 i | 36.8 lmno |
| $V_8$ | 9.0 m | 2.0 f | 3.0 p | 34.7 opqr |
| $V_9$ | 6.0 p | 5.0 c | 26.0 b | 43.0 fgh |
| $V_{10}$ | 11.0 k | 3.0 e | 9.0 j | 41.8 ghi |
| $V_{11}$ | 23.0 e | 3.0 e | 1.0 r | 41.8 ghi |
| $V_{12}$ | 10.0 l | **7.0 a** | 15.0 n | 38.6 klm |
| $V_{13}$ | 4.0 q | 4.7 c | 13.0 g | 39.0 jkl |
| $V_{14}$ | 10.0 l | 4.7 c | 0.3 s | 56.7 c |
| $V_{15}$ | 9.0 m | 2.0 f | 0.3 s | 31.9 st |
| $V_{16}$ | 8.0 n | 2.0 f | 24.0 c | 68.4 a |
| $V_{17}$ | 31.0 c | 3.0 e | 8.0 k | 37.0 lmno |
| $V_{18}$ | 8.0 n | 5.0 c | 2.0 q | 44.6 f |
| $V_{19}$ | 13.0 i | 4.0 d | 9.0 j | 44.5 f |
| $V_{20}$ | 7.0 o | 4.0 d | **47.0 a** | 35.1 opqr |
| $V_{21}$ | 11.0 k | 3.0 e | 15.0 f | **67.2 a** |
| $V_{22}$ | 8.0 n | 4.0 d | 5.0 n | 39.5 ijk |
| $V_{23}$ | 11.0 k | 6.0 b | 7.0 l | 38.2 klm |
| $V_{24}$ | 14.0 h | 4.0 d | 18.0 d | 42.1 Ghi |

(continued)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **$V_{25}$** | 13.0 | i | 2.0 | f | 3.0 | p | 69.5 | a |
| **$V_{26}$** | 12.0 | j | 2.0 | f | 5.0 | n | 41.1 | hij |
| **$V_{27}$** | 32.0 | b | 4.0 | d | 8.0 | k | 36.4 | mnopq |
| **$V_{28}$** | 13.0 | i | 4.0 | d | 26.0 | b | 37.6 | klmn |
| **$V_{29}$** | 6.0 | p | 4.0 | d | 0.3 | s | 33.3 | rs |
| **$V_{30}$** | 9.0 | m | 3.0 | e | 0.3 | s | 52.1 | d |
| **$V_{31}$** | 18.0 | f | 2.0 | f | 2.0 | q | 52.4 | d |
| **$V_{32}$** | 11.0 | k | 3.0 | e | 11.0 | i | 38.5 | klm |
| **$V_{33}$** | 4.0 | q | 3.0 | e | 2.0 | q | 63.7 | b |
| **$V_{34}$** | 8.0 | n | 3.0 | e | 11.0 | i | 33.6 | rs |
| **$V_{35}$** | 17.0 | g | 3.0 | e | 2.0 | q | 33.2 | rs |
| **$V_{36}$** | **42.0** | **a** | 5.0 | c | 4.0 | o | 35.6 | nopqr |
| **$V_{37}$** | 8.0 | n | 5.0 | c | 0.3 | s | 42.7 | fgh |
| **$V_{38}$** | 7.0 | o | 4.0 | d | 12.0 | h | 37.9 | klmn |
| **$V_{39}$** | 4.0 | q | 4.0 | d | 1.0 | r | 42.8 | fgh |
| **$V_{40}$** | 9.0 | m | 5.0 | c | 17.0 | e | 25.3 | u |
| **$V_{41}$** | 6.0 | p | 4.7 | c | 0.3 | s | 30.2 | t |
| **$V_{42}$** | 4.0 | q | 3.0 | e | 1.7 | q | 23.5 | u |
| **$V_{43}$** | 10.0 | l | 4.0 | d | 0.3 | s | 34.0 | qrs |
| **$V_{44}$** | 6.0 | p | 5.0 | c | 6.0 | m | 44.1 | fgh |
| **LSD0.05** | 0.0 | | 0.6 | | 0.4 | | 2.4 | |
| **CV%** | 0.0 | | 9.4 | | 3.1 | | 3.7 | |

[X]In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

[Y]Rose cultivars

### 4.1.5 Chlorophyll content (%)

Chlorophyll content varied significantly among the cultivars (Appendix II). The highest chlorophyll percentage was found in $V_{35}$ (68.9%) followed by $V_{21}$ (61.2%) whereas the lowest from $V_{15}$ (35.0%) (Table 2). Variation in chlorophyll content was also observed previously in Rose (Ahmad *et al.*, 2011), in Mustard (Datta *et al.*, 2011). The difference in chlorophyll percentage among the cultivars might be due to influence of the genetic makeup of cultivars. Chlorophyll is a pigment associated with photosynthesis process. The process photosynthesis has taken place only in presence of this pigment. So higher chlorophyll content induce photosynthesis in higher rate, as a result flower production increases.

### 4.1.6 Days to flower bud initiation

Days to flower bud initiation varied significantly among the cultivars (Appendix II). Maximum days were taken to flower bud initiation found in $V_6$ (40.0 days) followed by $V_{10}$ (36.0 days) whereas minimum from $V_7$ (18.0 days) (Table 2). Variation in days to flower bud initiation was also observed previously in Rose (Manjula, 2005 and Paramagoudar, 2010), in Carnation (Maitra *et al*., 2013; Tarannum *et al*., 2014 and Pralhad, 2009), in China aster (Zosiamliana *et al*., 2012), in Lisianthus (Jamal Uddin *et al.,* 2010), in Gerbera (Pattanashetti, 2009). In case of any flowering plant, flower is the ultimate output. And different variety exhibit difference in flower producing period. Some cultivars exhibit early flowering and some are late flowering. Those cultivars exhibit early bud initiation can be categorized as the early cultivars and others can be as late cultivars.

### 4.1.7 Number of flowers/plant

Number of flowers/plant varied significantly among the cultivars (Appendix III). Maximum number of flowers were found in $V_{43}$ (68.0/plant) whereas minimum

from $V_{3,}$ $V_{9,}$ $V_{13,}$ $V_{21,}$ $V_{22,}$ $V_{25,}$ $V_{33}$, $V_{39}$, $V_{42}$ (1.0/plant) (Table 2). Variation in number of flowers/plant were also observed previously in rose (Tabassum *et al*., 2002; Ramzan *et al*., 2014 and Paramagoudar, 2010), in chrysanthemum (Manoj *et al*., 2010), in carnation (Gharge *et al*., 2011; Maitra *et al*., 2013 and Singh *et al*., 2013), in china aster (Munikrishnappa *et al*., 2013), in gerbera (Mahmood *et al*., 2013 and Chobe *et al*., 2010), in lisianthus (Jamal Uddin *et al.*, 2010), in strawberry (Hossan *et al.*, 2013). Some flowers produce profuse flowering and some are not. Higher number of flower does not justify the criteria's for being a flower as a cut flower. If the plant produces too much flower without compact petal arrangement it would not considered as the cut flower. These flowers will be considered as the pot or bedding flower.

### 4.1.8 Number of petals/flower

Number of petals/flower varied significantly among the cultivars (Appendix III). Maximum number of petals/flower was found in $V_{30}$ (83.0/flower) whereas minimum from $V_{44}$ (15.7/flower) (Table 2). Variation in number of petals/flower was also observed previously in Rose (Tabassum *et al*., 2002; Khattak *et al*., 2011; Ranchana *et al*., 2014; Manjula, 2005 and Paramagoudar, 2010), in Carnation (Pralhad, 2009). Number of petals/ flower is another important quality character in a cut flower. Arrangement of petals gives the flower a good appearance thus increasing the consumer's preference. If the number of petals/ flower is less then it will bloom fully in short time revealing the central portion and thus decreases its demand as a cut flower. On the other contrary if the flower contain too many petals /flower then it will take too much time to open or poorly open. So flowers need to be recommended as a cut flower should have petals 27-32. Flowers possessing a slow and uniform mode of opening have better consumer acceptance.

**Table 2. Performance of rose cultivars to different growth and flowering attributes[X]**

| Variety[Y] | Chlorophyll Content (%) | Days to flower bud initiation | No. of flowers/plant | No. of petals/flower |
|---|---|---|---|---|
| $V_1$ | 45.3 jklmnopq | 27.0 g | 3.0 l | 16.7 vwx |
| $V_2$ | 47.3 ijklmnop | 24.0 j | 15.0 d | 31.0 j |
| $V_3$ | 59.0 bc | 30.0 d | 1.0 n | 19.0 st |
| $V_4$ | 52.0 cdefghijk | 22.0 l | 4.0 k | 42.0 f |
| $V_5$ | 47.2 ijklmnop | 24.0 j | 3.0 l | 30.0 jk |
| $V_6$ | 58.9 bc | **40.0 a** | 2.0 m | 16.3 wx |
| $V_7$ | 45.0 klmnopq | 18.0 o | 9.0 g | 19.0 st |
| $V_8$ | 50.0 efghijkl | 24.0 j | 7.3 i | 21.0 qr |
| $V_9$ | 54.0 bcdefghi | 25.0 i | 1.0 n | 16.3 wx |
| $V_{10}$ | 45.0 klmnopq | 36.0 b | 11.0 e | 53.0 d |
| $V_{11}$ | 57.7 bcde | 20.0 m | 20.0 b | 33.0 i |
| $V_{12}$ | 58.9 bc | 24.0 j | 2.0 m | 36.0 h |
| $V_{13}$ | 47.1 ijklmnop | 24.0 j | 1.0 n | 16.3 wx |
| $V_{14}$ | 58.1 bcd | 29.0 e | 5.0 j | 20.0 rs |
| $V_{15}$ | 35.0 r | 28.0 f | 2.0 m | 28.0 l |
| $V_{16}$ | 50.5 defghijkl | 19.0 n | 4.0 k | 39.0 g |
| $V_{17}$ | 44.8 klmnopq | 22.0 l | 19.0 c | 24.0 no |
| $V_{18}$ | 38.7 qr | 25.0 i | 3.0 l | 19.0 st |
| $V_{19}$ | 55.8 bcdefgh | 24.0 j | 3.0 l | 23.0 op |
| $V_{20}$ | 59.2 bc | 22.0 l | 2.0 m | 57.0 c |
| $V_{21}$ | 61.2 ab | 29.0 e | 1.0 n | 22.0 pq |
| $V_{22}$ | 47.2 ijklmnop | 23.0 k | 1.0 n | 42.0 f |
| $V_{23}$ | 52.7 cdefghijk | 29.0 e | 2.0 m | 22.0 pq |

(continued)

(continued)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **$V_{24}$** | 59.3 | bc | 23.0 | k | 4.0 | k | 47.0 | e |
| **$V_{25}$** | 56.5 | bcdefg | 24.0 | j | 1.0 | n | 39.0 | g |
| **$V_{26}$** | 49.6 | fghijklmn | 23.0 | k | 11.0 | e | 26.0 | mn |
| **$V_{27}$** | 53.2 | cdefghijk | 24.0 | j | 10.0 | f | 17.0 | uvw |
| **$V_{28}$** | 41.1 | opqr | 25.0 | i | 9.0 | g | 16.7 | vwx |
| **$V_{29}$** | 41.7 | nopqr | 24.0 | j | 3.0 | l | 22.0 | pq |
| **$V_{30}$** | 53.3 | bcdefghij | 26.0 | h | 4.0 | k | **83.0** | **a** |
| **$V_{31}$** | 54.0 | bcdefghi | 25.0 | i | 8.0 | h | 30.0 | jk |
| **$V_{32}$** | 48.6 | ghijklmnop | 26.0 | h | 8.0 | h | 31.0 | j |
| **$V_{33}$** | 52.0 | cdefghijk | 25.0 | i | 1.0 | n | 16.7 | vwx |
| **$V_{34}$** | 57.2 | bcdef | 24.0 | j | 3.0 | l | 30.0 | jk |
| **$V_{35}$** | **68.9** | **a** | 25.0 | i | 9.0 | g | 16.0 | wx |
| **$V_{36}$** | 47.3 | ijklmnop | 25.0 | i | 9.0 | g | 18.0 | tu |
| **$V_{37}$** | 48.0 | hijklmno | 26.0 | h | 2.0 | m | 29.0 | kl |
| **$V_{38}$** | 42.0 | mnopqr | 24.0 | j | 2.0 | m | 18.0 | tu |
| **$V_{39}$** | 56.4 | bcdefg | 26.0 | h | 1.0 | n | 52.0 | d |
| **$V_{40}$** | 43.3 | lmnopq | 24.0 | j | 5.0 | j | 80.0 | b |
| **$V_{41}$** | 39.9 | pqr | 24.0 | j | 3.0 | l | 17.7 | uvw |
| **$V_{42}$** | 46.0 | jklmnopq | 26.0 | h | 1.0 | n | 25.0 | mn |
| **$V_{43}$** | 49.7 | fghijklm | 27.0 | g | **68.0** | **a** | 16.3 | wx |
| **$V_{44}$** | 48.0 | hijklmno | 35.0 | c | 3.0 | l | 15.7 | x |
| **LSD0.05** | 8.0 | | 0.1 | | 0.3 | | 1.1 | |
| **CV%** | 9.7 | | 0.1 | | 2.7 | | 1.7 | |

[X]In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

[Y]Rose cultivars

## 4.2 Classification of rose cultivars

### 4.2.1 Classification of rose cultivars on the basis of their color

Rose cultivars were classified into 9 groups in accordance to their color. A numerous variation in color was found among 44 rose cultivars. Color was measured by visual observation.

- **Red to reddish:** 17 among the 44 rose cultivars were found as red to reddish in color. $V_2$, $V_3$, $V_5$, $V_8$, $V_9$, $V_{12}$, $V_{13}$, $V_{19}$, $V_{20}$, $V_{22}$, $V_{24}$, $V_{25}$, $V_{29}$, $V_{31}$, $V_{32}$, $V_{38}$ and $V_{40}$ were found red to reddish color with a little mix with other colors (Table 3).
- **Yellow to yellowish:** 6 rose cultivars were found in yellow to yellowish in color. $V_4$, $V_{15}$, $V_{23}$, $V_{34}$, $V_{37}$, and $V_{42}$ were yellow to yellowish in color (Table 3).
- **Pink to pinkish**: 9 rose cultivars were found as pink to pinkish in color and these were $V_1$, $V_{10}$, $V_{11}$, $V_{17}$, $V_{18}$, $V_{27}$, $V_{36}$, $V_{41}$ , $V_{43}$ and $V_{44}$ (Table 3).
- **Orange:** 3 cultivars were in orange color group. $V_{16}$, $V_{26}$ and $V_{21}$ were orange in color (Table 3).
- **White to whitish:** Only two cultivars consisted in this group ($V_{33}$ and $V_{39}$) (Table 3).
- **Violet:** Two cultivars consisted in this group ($V_{14}$ and $V_{28}$) (Table 3).
- **Magenta:** $V_{35}$ was magenta in color (Table 3).
- **Creamy white:** $V_6$ and $V_{30}$ were creamy white in color (Table 3).
- **Black:** Only one cultivar represented the black color group ($V_7$) (Table 3).

### 4.2.2 Classification of rose cultivars on the basis of their fragrance

On the basis of fragrance roses were divided into 3 groups viz. high, medium and low fragrance. Fragrances were measured by organoleptic test.

- **High:** 16 rose cultivars among the 44 had high fragrance and these were $V_3$, $V_4$, $V_{12}$, $V_{13}$, $V_{15}$, $V_{16}$, $V_{22}$, $V_{25}$, $V_{29}$, $V_{32}$, $V_{34}$, $V_{35}$, $V_{37}$, $V_{38}$, $V_{39}$, and $V_{40}$ (Table 4).
- **Medium :** 17 rose cultivars among the 44 had high fragrance and these were $V_2$, $V_8$, $V_{10}$, $V_{11}$, $V_{14}$, $V_{20}$, $V_{21}$, $V_{24}$, $V_{26}$, $V_{27}$, $V_{28}$, $V_{31}$, $V_{33}$, $V_{36}$, $V_{41}$, $V_{42}$ and $V_{44}$ (Table 4).
- **Low :** 10 rose cultivars among the 44 had high fragrance and these were $V_5$, $V_6$, $V_7$, $V_9$, $V_{17}$, $V_{18}$, $V_{19}$, $V_{23}$, $V_{30}$ and $V_{43}$ (Table 4).

### 4.2.3 Classification of rose cultivars on the basis of uses

On the basis of uses rose cultivars were divided into 2 groups' viz. cut flower and pot/bed flower.

1. **Cut flower:** 10 rose cultivars among the 44 were posed the characteristics of the cut flower (Table 5).

   For being a cut flower a flower must have posses some characteristics:

   - Petal arrangements need to be compact. Petals need to be thick. The flower needs to be harvested at half bloomed condition.
   - Flower containing stalk need to be erect and a single stalk should carry a solitary flower.
   - A cut flower should have fewer thorns in its stem.

2. **Pot/bed flower:** 33 rose cultivars among the 44 had no characteristics of the cut flower (Table 5) and these showed the characteristics of the pot/bed flowers.

**Table 3. Classification of the rose cultivars according to color**

| SL. No. | Color | Cultivars |
|---|---|---|
| 1. | Red to reddish | $V_2$, $V_3$, $V_5$, $V_8$, $V_9$, $V_{12}$, $V_{13}$, $V_{19}$, $V_{20}$, $V_{22}$, $V_{24}$, $V_{25}$, $V_{29}$, $V_{31}$, $V_{32}$, $V_{38}$, $V_{40}$ |
| 2. | Yellow to yellowish | $V_4$, $V_{15}$, $V_{23}$, $V_{34}$, $V_{37}$, $V_{42}$ |
| 3. | Pink to pinkish | $V_1$,$V_{10}$, $V_{11}$, $V_{17}$, $V_{18}$, $V_{27}$, $V_{36}$, $V_{41}$, $V_{43}$, $V_{44}$ |
| 4. | Orange | $V_{16}$, $V_{21}$, $V_{26}$ |
| 5. | White to whitish | $V_{33}$, $V_{39}$ |
| 6. | Violet | $V_{14}$, $V_{28}$ |
| 7. | Magenta | $V_{35}$ |
| 8. | Creamy white | $V_6$, $V_{30}$ |
| 9. | Black | $V_7$ |
| 10. | Wild Type | $V_1$ |

**Table 4. Classification of the rose cultivars according to Fragrance**

| SL. No. | Fragrance | Cultivars |
|---|---|---|
| 1. | High | $V_3$, $V_4$, $V_{12}$, $V_{13}$, $V_{15}$, $V_{16}$, $V_{22}$, $V_{25}$, $V_{29}$, $V_{32}$, $V_{34}$, $V_{35}$, $V_{37}$, $V_{38}$, $V_{39}$, $V_{40}$ |
| 2. | Medium | $V_2$, $V_8$, $V_{10}$, $V_{11}$, $V_{14}$, $V_{20}$, $V_{21}$, $V_{24}$, $V_{26}$, $V_{27}$, $V_{28}$, $V_{31}$, $V_{33}$, $V_{36}$, $V_{41}$, $V_{42}$, $V_{44}$ |
| 3. | Low | $V_5$, $V_6$, $V_7$, $V_9$, $V_{17}$, $V_{18}$, $V_{19}$, $V_{23}$, $V_{30}$, $V_{43}$ |
| 4. | Wild Type | $V_1$ |

**Table 5. Classification of the rose cultivars according to uses**

| SL. No. | Fragrance | Cultivars |
|---|---|---|
| 1. | Cut flower | $V_3$, $V_4$, $V_{14}$, $V_{16}$, $V_{21}$, $V_{23}$, $V_{25}$, $V_{26}$, $V_{30}$ and $V_{35}$ |
| 2. | Pot/bed flower | $V_2$, $V_5$, $V_6$, $V_7$, $V_8$, $V_9$, $V_{10}$, $V_{11}$, $V_{12}$, $V_{13}$, $V_{15}$, $V_{17}$, $V_{18}$, $V_{19}$, $V_{20}$, $V_{22}$, $V_{24}$, $V_{27}$, $V_{28}$, $V_{29}$, $V_{31}$, $V_{32}$, $V_{33}$, $V_{34}$, $V_{36}$, $V_{37}$, $V_{38}$, $V_{39}$, $V_{40}$, $V_{41}$, $V_{42}$, $V_{43}$ and $V_{44}$ |
| 3. | Wild Type | $V_1$ |

$V_2$

$V_3$

$V_5$

$V_8$

$V_9$

$V_{12}$

$V_{13}$

$V_{19}$

$V_{20}$

$V_{22}$

$V_{24}$

$V_{25}$

$V_{29}$

$V_{31}$

$V_{32}$

$V_{38}$

$V_{40}$

**Plate 2. Red to reddish rose cultivars**

$V_4$

$V_{15}$

$V_{23}$

$V_{34}$

$V_{37}$

$V_{42}$

**Plate 3. Yellow to yellowish rose cultivars**

$V_1$

$V_{10}$

$V_{11}$

$V_{17}$

$V_{18}$

$V_{27}$

$V_{36}$

$V_{41}$

$V_{43}$

$V_{44}$

**Plate 4. Pink to pinkish rose cultivars**

$V_{16}$

$V_{21}$

$V_{26}$

**Plate 5. Orange rose cultivars**

$V_{33}$

$V_{39}$

**Plate 6. White to whitish rose cultivars**

$V_{14}$ $V_{28}$

**Plate 7. Violet rose cultivars**

$V_{35}$

**Plate 8. Magenta rose cultivars**

**$V_6$** **$V_{30}$**

**Plate 9 : Creamy white rose cultivars**

**$V_7$**

**Plate 10. Black rose cultivars**

## 4.3 Vase life analysis

### 4.3.1 Stem diameter

Stem diameter of rose showed significant variation among different vase solutions at different days after treating (Appendix IV). Maximum stem diameter was found from $T_7$ (4.6 mm) followed by $T_9$ (3.9 mm) whereas minimum from $T_0$ (1.0 mm) at $7^{th}$ days after treating (Fig. 1).

### 4.3.2 Flower head diameter

Flower head diameter varied significantly due to the variation of vase solution (Appendix V). However, minimum flower head diameter was found from $T_7$ (31.8 mm) which was statistically identical with $T_9$ (34.4 mm) while maximum from $T_0$ (52.0 mm) at $7^{th}$ days after treating (Fig. 2). Silver Thiosulphate with sucrose increased flower diameter (Shirin and Mohsen, 2011).

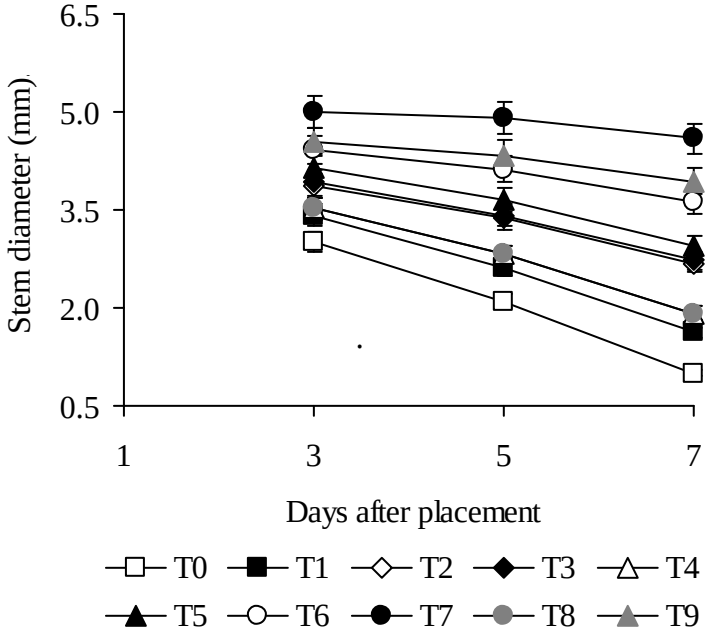


Fig. 1. Response of different chemical solutions to stem diameter of rose

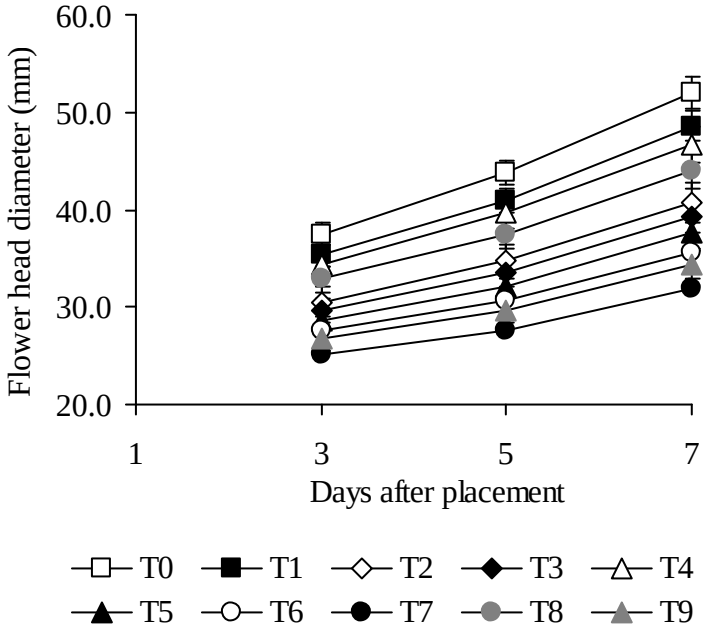


Fig. 2. Response of different chemical solutions to flower head diameter of rose

### 4.3.3 Flower freshness score

Flower freshness score showed significant variation among the vase solutions (Appendix VII). Minimum score was recorded from $T_7$ (3.0) followed by $T_9$ (3.7) while maximum from $T_0$ (5.0) at $7^{th}$ days after treating (Fig.3). Mehraj *et al.*,(2013) was also found the freshness score about 2.50 which presented the resemblance of the present study. Effect of long life pulsing in keeping flower stems fresh seems to be mainly associated with its effect on ethylene action since ready foods of flowers contain anti ethylene compounds, which is beneficial for maintenance of flowers as fresh as possible for a longer period. Effects of ethylene can however be prevented by citric acid and sucrose acted as ready foods for cut flowers (Mehraj *et al.*, 2013). But in present study salicylic acid performed in a better way.

### 4.3.4 Petal discoloration score

Score for the petal discoloration was varied significantly among the vase solution (Appendix VI). Minimum petal discoloration score was found from $T_7$ (1.5) followed by $T_9$ (1.8) while maximum petal discoloration score was found from $T_0$ (2.8) at $7^{th}$ days after treating (Fig. 4). Rose flower provided petal discoloration score about 2.0 using sucrose and lemon juice solution (Mehraj *et al.*, 2013). In current experiment it was found petal discoloration score less than 2.0 which may be due to the use of salicylic acid in vase solution. In this case sucrose may act as the CHO supplier and salicylic acid acted as the germicides. Addition of sugar to the vase solution counteracted the adverse effects of defoliation on petal color and overcome the increased bud blasting (Susan, 2003).

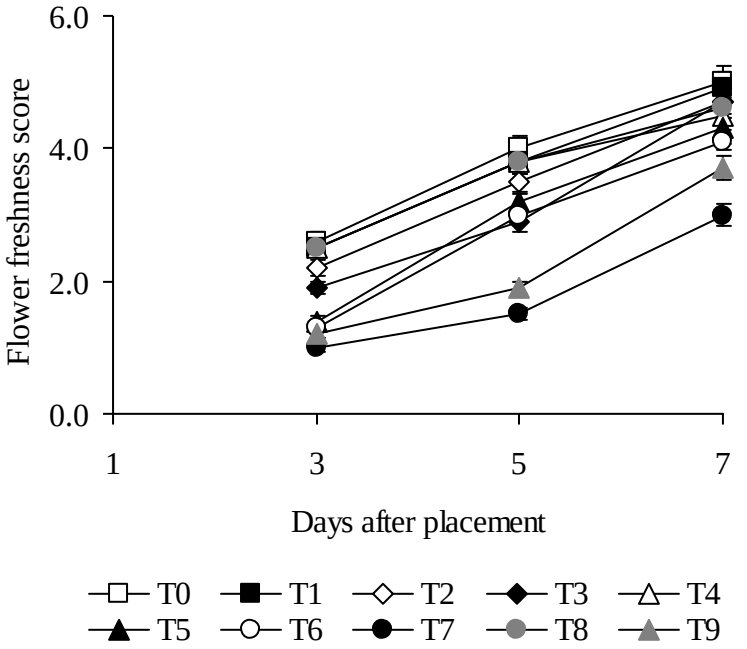


Fig. 3. Response of different chemical solutions to flower freshness score

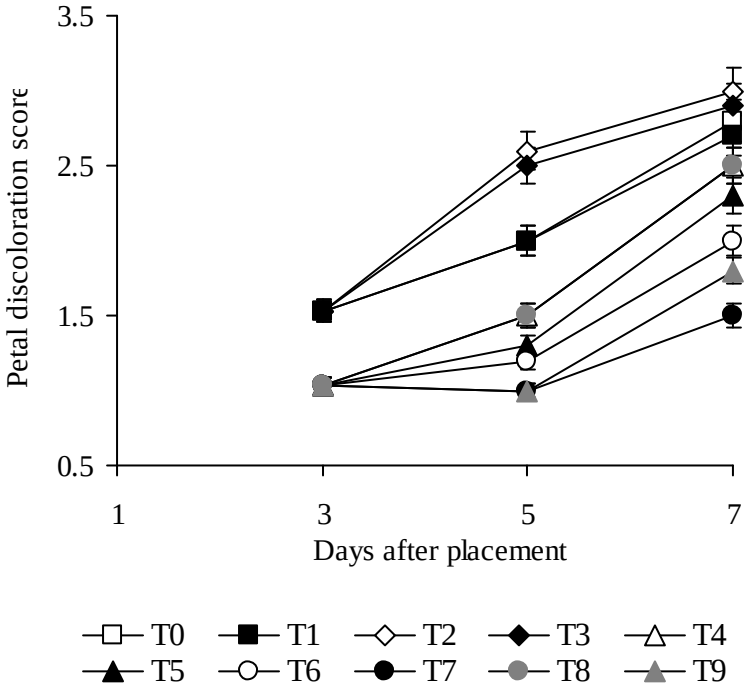


Fig. 4. Response of different chemical solutions to petal discoloration score

### 4.3.5 Days taken for first petal spreading

Days taken for first petal spreading were varied significantly among the vase solutions (Appendix VIII). However, maximum days for first petal spreading was required by $T_7$ (6.1) while minimum from $T_2$ and $T_3$ (2.1 days) (Table 6).

### 4.3.6 Solution uptake

Solution uptake by flower varied significantly among the vase solutions (Appendix VIII). Maximum vase solution was up taken by $T_2$ and $T_3$ (79.2 ml) followed by $T_7$ (74.2 ml) and $T_9$ (73.2 ml) whereas minimum from $T_0$ (63.2 ml) (Table 6). The more water absorption was occurred due to the application of salicylic acid (Hajireza *et al.*, 2013) and sucrose (Shirin and Mohsen, 2011) in comparison with control. Silver thiosulphate with sucrose also increased water uptake (Shirin and Mohsen, 2011). Here, cut flowers get necessary food from sucrose salicylic acid control the germicidal action into vase solution and prevent the vascular blockage and that may be responsible for the maximum solution uptake. SA at 150 mg $L^{-1}$ increased mean absorbed preservative solution (Banaee *et al.*, 2013).

### 4.3.7 Petal water content

Petal water content of cut rose varied significantly among the vase solutions (Appendix IX). Maximum petal water content was found from $T_7$ (65.4%) whereas minimum from $T_0$ (28.6%) (Table 6). SA treatments increased petal water content (%) by 73% compared to the controls in chrysanthemum (Vahdati Mashhadian *et al.*, 2012). Post harvest application of SA (150 mg/L) maintain higher antioxidant enzyme, stability of membrane and leading to delay in petal senescence (Hatamzadeh *et al.*, 2012).

### 4.3.8 Vase life

Vase life of cut rose varied significantly among the vase solutions (Appendix IX). Maximum vase life was found from $T_7$ (15.7 days) followed by $T_9$ (14.0 days) while minimum from $T_0$, $T_2$ and $T_3$ (8.3 days) which was statistically identical with $T_1$ (8.7 days) (Table 6). Rose flower showed maximum 14.0 days in flower vase (Mehraj *et al.*, 2013). It was observed that sucrose maintained prolonged vase life for 11 days than other treatment (Anserwadekar and Patil, 1986). Salicylic Acid and sucrose increases vase life by improving the antioxidant system and reducing oxidative stress damages during rose flower senescence (Gerailoo and Ghasemnezhad, 2011) and Lily flower senescence (Kazemi and Ameri, 2013). The significant increase (300%) in vase life is considered to be due to plant regulating and anti-stress properties of salicylic acid and citric acid (Vahdati Mashhadian *et al.*, 2012). On the other hand, silver thiosulphate with sucrose also increased fresh weight, water uptake, flower diameter and flower vase life (Shirin and Mohsen, 2011).

**Plate 11: Vase life analysis**

**Table 6. Response of cut rose on some vase life characteristics to different vase solutions[X]**

| Treatments[Y] | Days taken for first petal spreading | Solution uptake (ml) | Petal water content (%) | Vase life (days) |
|---|---|---|---|---|
| **$T_0$** | 2.1 e | 63.2 g | 28.6 j | 8.3 e |
| **$T_1$** | 4.1 c | 66.2 f | 30.6 i | 8.7 e |
| **$T_2$** | 1.1 f | **79.2 a** | 33.0 f | 8.3 e |
| **$T_3$** | 1.1 f | **79.2 a** | 33.6 e | 8.3 e |
| **$T_4$** | 3.1 d | 74.2 b | 31.0 h | 10.7 d |
| **$T_5$** | 4.1 c | 69.2 e | 52.2 c | 13.7 b |
| **$T_6$** | 5.1 b | 72.2 d | 54.1 b | 14.0 b |
| **$T_7$** | **6.1 a** | 74.2 b | **65.4 a** | **15.7 a** |
| **$T_8$** | 4.1 c | 69.2 e | 31.8 g | 12.0 c |
| **$T_9$** | 5.1 b | 73.2 c | 48.8 d | 14.0 b |
| **LSD0.05** | 0.7 | 0.9 | 0.5 | 0.7 |
| **CV%** | 3.2 | 5.7 | 4.6 | 3.6 |

[X]In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

[Y]Different vase solutions

# CHAPTER V

# SUMMARY AND CONCLUSION

## 5.1 Summary

Rose is a commonly used cut and pot flower. There are over 100 species and thousands of cultivars. They form a group of plants that can be erect shrubs, climbing or trailing with stems that are often armed with sharp prickles. Flowers vary in size and shape and are usually large and showy, in colours ranging from white through yellows and reds. Rose cultivation as a cut flower is gaining popularity in Bangladesh and its farmers are making good profit by producing it. Its cultivation begun on a small scale in Bangladesh but now cultivation area is increasing rapidly whereas Bangladesh has lack (or very little) of information and technology thus can provide as a guideline for the profitable production.

In order to characterization and performance evaluation of rose cultivars, a research for inspection of growth and flowering of rose cultivars also their classification was conducted at Horticultural farm, Sher-e-Bangla Agricultural University, Dhaka during period from October 2012 to March 2013. Single factorial experiment included rose cultivars $V_1$: Wild rose, $V_2$: Crazy love bicolor, $V_3$: Tajmahal, $V_4$: Yellow star, $V_5$: Ekuse lal, $V_6$: Afrodita, $V_7$: black divorce, $V_8$: Attarcted red, $V_9$: Missing love, $V_{10}$: Pinky smile, $V_{11}$: Sweet love, $V_{12}$: Red baby, $V_{13}$: Star fire, $V_{14}$: Lavender gold, $V_{15}$: Lemon star, $V_{16}$: Compassion, $V_{17}$: Charming lady, $V_{18}$: Dream bangla, $V_{19}$: Printed moon, $V_{20}$: Fire and ice, $V_{21}$: SAU hero, $V_{22}$: SAU prince, $V_{23}$: Yellow gold, $V_{24}$: Ocean heart, $V_{25}$: Sleepy moon, $V_{26}$: Sweet doll, $V_{27}$: Moon light, $V_{28}$: Pain blue, $V_{29}$: Ruin night, $V_{30}$: Chrysanthemum rose, $V_{31}$: Mystery love, $V_{32}$: SAU king, $V_{33}$: Ice barg, $V_{34}$: Yellow erecta, $V_{35}$: Sweet sakata, $V_{36}$: Anindo kun hazari, $V_{37}$: Yellow papiliom, $V_{38}$: Red eye, $V_{39}$: Sympathy, $V_{40}$: Mini master, $V_{41}$: Pretty girl, $V_{42}$: Sad 23, $V_{43}$: Aranchan and $V_{44}$: Sweet mum were outlined in Randomized Complete Block Design (RCBD) with three replications.

On the other hand, from 44 rose cultivars Sleepy moon was selected for vase life analysis as it is commonly used commercial cut flower in Bangladesh. Single factorial experiment was consisted ten treatments viz. $T_0$: Tap water (Control), $T_1$: Sugar (50-ppm), $T_2$: Citric Acid (50-ppm), $T_3$: Salicylic Acid (50-ppm), $T_4$: Chitosan (50-ppm), $T_5$: Silvar Thiosulphate (50-ppm), $T_6$: Sugar + Citric Acid (50-ppm), $T_7$: Sugar + Salicylic Acid (50-ppm), $T_8$: Sugar + Chitosan (50-ppm) and $T_9$: Sugar + Silvar Thiosulphate (50-ppm) following Completely Randomized Design (CRD) with three replications.

Collected data were statistically analyzed for the evaluation of performance of the varieties. Summery of the results and conclusion have been described in this chapter.

Considering the characteristics of the rose cultivars maximum number of shoot swas found from $V_{36}$ (42.0/plant) and minimum from $V_1$, $V_{13}$, $V_{33}$, $V_{39}$, $V_{42}$ (4.0/plant). Maximum number of leaves was found from $V_{12}$ (7.0/10 cm shoot) and minimum from $V_2$, $V_7$, $V_{10}$, $V_{11}$, $V_{17}$, $V_{21}$, $V_{30}$, $V_{32}$, $V_{33}$, $V_{34}$, $V_{35}$, $V_{42}$ (3.0/ 10 cm shoot). Maximum number of thorns was found in $V_{20}$ (47/10 cm shoot) and minimum from $V_4$, $V_{14}$, $V_{15}$, $V_{29}$, $V_{30}$, $V_{37}$, $V_{41}$, $V_{43}$ (0.3/ 10 cm shoot). Maximum leaf area was found from $V_{25}$ (69.5 $cm^2$) and minimum from $V_{42}$ (23.5 $cm^2$). Maximum chlorophyll content was found in $V_{35}$ (68.9%) and minimum from $V_{15}$ (35.0%). Maximum number of flowers was found in $V_{43}$ (68.0/plant) and minimum from $V_3$, $V_9$, $V_{13}$, $V_{21}$, $V_{22}$, $V_{25}$, $V_{33}$, $V_{39}$, $V_{42}$ (1.0/plant). Maximum number of petals was found in $V_{30}$ (83.0/flower) and minimum from $V_{44}$ (15.7/flower). Maximum days were taken to flower bud initiation found in $V_6$ (40.0 days) and minimum from $V_7$ (18.0 days). Maximum stem diameter was found from $T_7$ (4.60 mm) and minimum from $T_0$ (1.0 mm).

Rose cultivars were classified in accordance to their different characteristics. On the basis of the colour rose cultivars were classified into 9 different groups and these were Red to reddish, Yellow to yellowish, Pink to pinkish, Orange, White to whitish, Violet, Magenta, Creamy White and Black.

On the basis of the fragrance rose cultivars were classified into 3 different groups and these were high, medium and low fragrance. On the basis of the usage, the rose cultivars were classified into two groups and these were cut flower and pot/bed flower.

Considering the characteristics of rose cultivars maximum flower head diameter was found from $T_0$ (52.0) while minimum from $T_7$ (31.8). Maximum petal discoloration score was found from $T_2$ (3.0) and minimum from $T_7$ (1.5). Maximum freshness of flower was found from $T_0$ (5.0) and minimum from $T_7$ (3.0). Maximum days taken for flower petal spreading were found from $T_7$ (6.1) and minimum from $T_2$, $T_3$ (1.1). Maximum solution uptake was found from $T_2$, $T_3$ (79.2 ml) and minimum from $T_0$ (63.2 ml). Maximum petal water content was found from $T_7$ (65.4%) and minimum from $T_0$ (28.6%). Maximum vase life was found from $T_7$ (15.7 days) and minimum from $T_2$ (8.2 days).

## 5.2 Conclusion

From the above result and discussion it can be concluded that forty four rose cultivars varied significantly for number of shoots/plant, number of leaves/10 cm shoot, number of thorns/10 cm shoot, leaf area, chlorophyll content, days to flower bud initiation, number of flowers/plant, number of petals/flower. Rose cultivars were also varied in color, fragrance and usages. Different vase solution significantly affected the vase life related attributes and vase life of the rose cut flowers. From the current study it was found that Sugar + Salicylic Acid (50-ppm) was the best chemical treatments for increasing the vase life of the cut Sleepy moon ($V_{25}$) rose cultivar.

The findings of this research concluded in the following:

- Tajmahal ($V_3$), Yellow star ($V_4$), Lavender gold ($V_{14}$), Compassion ($V_{16}$), SAU hero ($V_{21}$), Yellow gold ($V_{23}$), Sleepy moon ($V_{25}$), Sweet doll ($V_{26}$), Chrysanthemum rose ($V_{30}$), Sweet sakata ($V_{35}$) recommended for production in farmer's field as cut flowers after further trial using the cut rose cultivars

- Rest of the rose cultivars can be produced as pot/bed flowers in accordance of the user choice
- Sugar + Salicylic Acid (50-ppm) can be used to increase the vase life of the cut Sleepy moon ($V_{25}$) rose for commercial purpose

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# APPENDICES

**Appendix I. Analysis of variance of the data on no. of shoot/plant, no. of leaves/10cm shoot, no. of thorns/10cm shoot of rose varieties**

| Source of Variation | Degrees of freedom (df) | Mean square of Number of shoot/plant | Number of leaves/10cm shoot | Number of thorns/10cm shoot |
|---|---|---|---|---|
| Factor A (Rose varieties) | 43 | 190.521 * | 3.962 * | 259.486 * |
| Error | 86 | 0.000 | 0.125 | 0.061 |

*** : Significant at 0.05 level of probability**

**Appendix II. Analysis of variance of the data on leaf area, chlorophyll content, no. of flowers/plant of rose varieties**

| Source of Variation | Degrees of freedom (df) | Mean square of Leaf area($cm^2$) | Chlorophyll content (%) | Days to flower bud initiation |
|---|---|---|---|---|
| Factor A (Rose varieties) | 43 | 352.090 * | 147.536 * | 48.474 * |
| Error | 86 | 2.246 | 24.231 | 0.000 |

*** : Significant at 0.05 level of probability**

**Appendix III. Analysis of variance of the data on no. of petals/flower, days to flower bud initiation of rose varieties**

| Source of Variation | Degrees of freedom (df) | Mean square of Number of flowers/plant | | Number of petals/flower | |
|---|---|---|---|---|---|
| Factor A (Rose varieties) | 43 | 336.101 | * | 765.820 | * |
| Error | 86 | 0.030 | | 0.236 | |

*** : Significant at 0.05 level of probability**

**Appendix IV. Analysis of variance of the data on stem diameter of rose varieties**

| Source of Variation | Degrees of freedom (df) | Mean square of stem diameter | | | | | |
|---|---|---|---|---|---|---|---|
| | | 3 DAT | | 5 DAT | | 7DAT | |
| Factor A (Vase solutions) | 9 | 1.089 | * | 2.227 | * | 3.775 | * |
| Error | 18 | 0.011 | | 0.011 | | 0.011 | |

*** : Significant at 0.05 level of probability**

**Appendix V. Analysis of variance of the data on flower head diameter of rose varieties**

| Source of Variation | Degrees of freedom (df) | Mean square of flower head diameter | | |
|---|---|---|---|---|
| | | 3 DAT | 5 DAT | 7DAT |
| Factor A (Vase solutions) | 9 | 49.545 * | 85.267 * | 130.679 * |
| Error | 18 | 0.000 | 0.000 | 0.000 |

*** : Significant at 0.05 level of probability**

**Appendix VI. Analysis of variance of the data on petal discoloration of rose varieties**

| Source of Variation | Degrees of freedom (df) | Mean square of petal discoloration | | |
|---|---|---|---|---|
| | | 3 DAT | 5 DAT | 7 DAT |
| Factor A (Vase solutions) | 9 | 0.200 * | 1.133 * | 0.333 * |
| Error | 18 | 0.000 | 0.000 | 0.000 |

*** : Significant at 0.05 level of probability**

**Appendix VII. Analysis of variance of the data on freshness of flower of rose varieties**

| Source of Variation | Degrees of freedom (df) | Mean square of freshness of flower | | |
|---|---|---|---|---|
| | | 3 DAT | 5 DAT | 7 DAT |
| Factor A (Vase solutions) | 9 | 2.667 * | 2.133 * | 2.133 * |
| Error | 18 | 0.000 | 2.133 | 0.000 |

*** : Significant at 0.05 level of probability**

**Appendix VIII. Analysis of variance of the data on days taken for first petal spreading and solution uptake of rose varieties**

| Source of Variation | Degrees of freedom (df) | Mean square | |
|---|---|---|---|
| | | Days taken for first petal spreading | Solution uptake |
| Factor A (Vase solutions) | 9 | 8.833 * | 80.533 * |
| Error | 18 | 0.000 | 0.000 |

*** : Significant at 0.05 level of probability**

**Appendix IX. Analysis of variance of the data on petal water content and vase life of rose varieties**

| Source of Variation | Degrees of freedom (df) | Mean square | |
|---|---|---|---|
| | | Petal water content (%) | Vase life (days) |
| Factor A (Vase solutions) | 9 | 505.440 * | 24.478 * |
| Error | 18 | 0.000 | 0.167 |

*** : Significant at 0.05 level of probability**