EVALUATION OF ROSE (*Rosa hybrida* L.) VARIETIES FOR GROWTH, YIELD AND QUALITY UNDER EASTERN DRY ZONE OF KARNATAKA

SOUJANYA P.

UHS16PGM807

DEPARTMENT OF FLORICULTURE AND LANDSCAPE ARCHITECTURE

COLLEGE OF HORTICULTURE, BENGALURU

UNIVERSITY OF HORTICULTURAL SCIENCES

BAGALKOT - 587104

JUNE, 2018

EVALUATION OF ROSE (*Rosa hybrida* L.) VARIETIES FOR GROWTH, YIELD AND QUALITY UNDER EASTERN DRY ZONE OF KARNATAKA

Thesis submitted to the
University of Horticultural Sciences, Bagalkot
in partial fulfilment of the requirements for the
award of Degree of

MASTER OF SCIENCE (Horticulture)

in

FLORICULTURE AND LANDSCAPE ARCHITECTURE

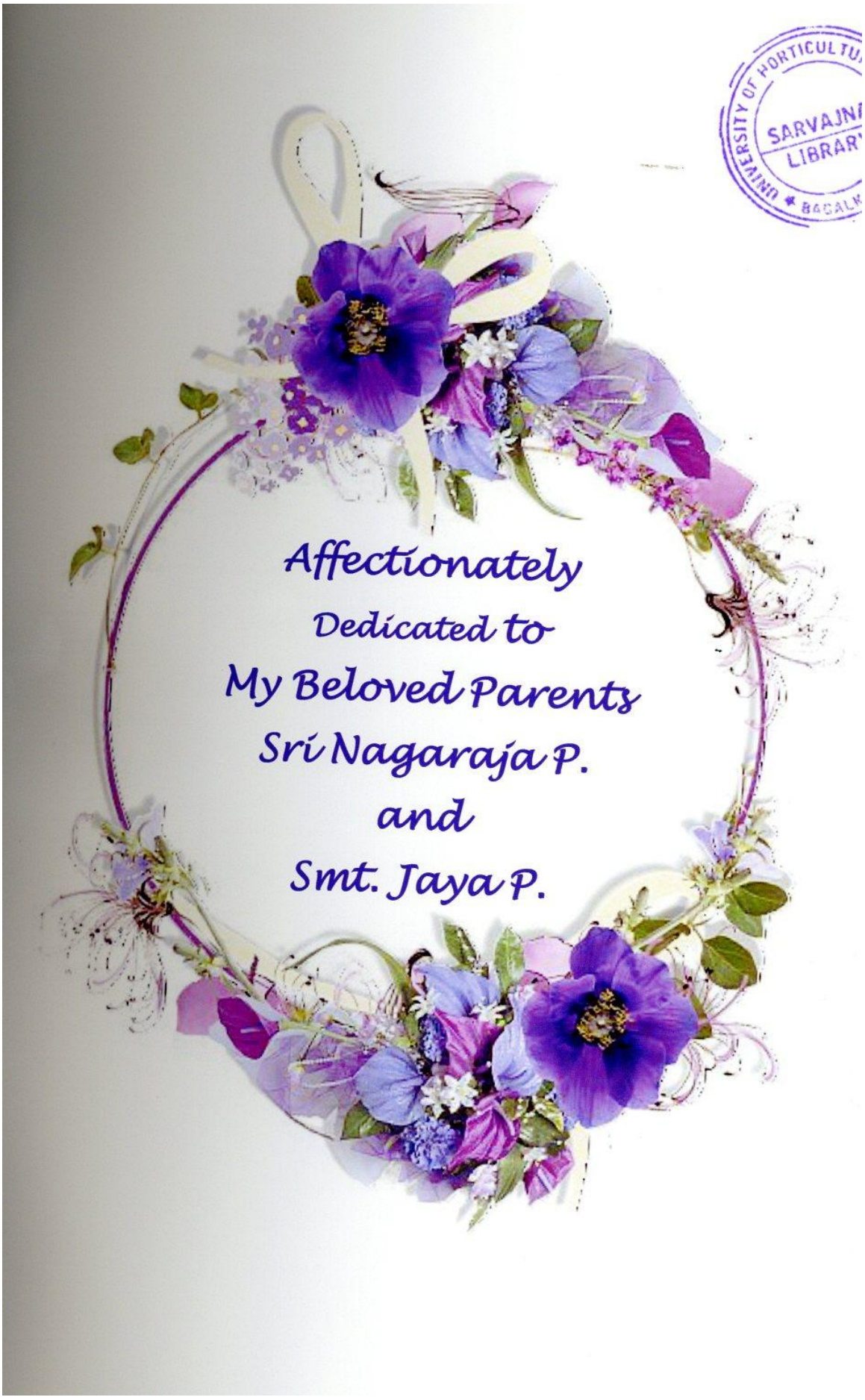
By

SOUJANYA P.

UHS16PGM807

DEPARTMENT OF FLORICULTURE AND LANDSCAPE ARCHITECTURE
COLLEGE OF HORTICULTURE, BENGALURU
UNIVERSITY OF HORTICULTURAL SCIENCES
BAGALKOT - 587104

JUNE, 2018



DEPARTMENT OF FLORICULTURE AND LANDSCAPE ARCHITECTURE
COLLEGE OF HORTICULTURE, BENGALURU
UNIVERSITY OF HORTICULTURAL SCIENCES
BAGALKOT

CERTIFICATE

This is to certify that the thesis entitled **"EVALUATION OF ROSE (*Rosa hybrida* L.) VARIETIES FOR GROWTH, YIELD AND QUALITY UNDER EASTERN DRY ZONE OF KARNATAKA"** submitted by **Ms. SOUJANYA P., ID. No. UHS16PGM807,** in partial fulfilment of the requirements for the award of the degree of **MASTER OF SCIENCE (Horticulture)** in **FLORICULTURE AND LANDSCAPE ARCHITECTURE** to the University of Horticultural Sciences, Bagalkot, is a record of *bona-fide* research work carried out by her during the period of her study in this University, under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar titles.

Place: Bengaluru
Date: June, 2018

(BALAJI S. KULKARNI)
Major Advisor

Approved by:

Chairperson : _____
(BALAJI S. KULKARNI)

Members : 1. _____
(RAJIV KUMAR)

2. _____
(MUNIKRISHNAPPA P. M.)

3. _____
(SHIVAPRIYA M.)

4. _____
(HARSHAVARDHAN M.)

ACKNOWLEDGMENTS

The beatitude and euphoria that accompanies successful completion of any task would be incomplete without expression of appreciation of simple certitude to the people who made it possible to achieve the goal by their encouraging guidance and proper steering. It is still great at this juncture to recall all the faces and spirit in the form of teachers, friends, near and dear ones.

I cannot but consider myself lucky to have worked under the guidance of excellence pursuing and ever helpful personality ***Dr. Balaji S. Kulkarni****, Professor and Head, Dept. of Floriculture and Landscape Architecture, College of Horticulture, Bengaluru, esteemed Chairman of my Advisory Committee. I am immensely grateful to him for his arduous and meticulous guidance, constant fomenting, punctilious and impeccable advice, sustained interest and above all his affectionate way of dealing with the things throughout the course of my investigation, which helped me to consummate the research work. I take this opportunity to express my heartfelt gratitude towards him.*

I deem it my privilege in expressing my fidelity to ***Dr. Rajiv Kumar****, Principal Scientist, Division of Floriculture and Medicinal Crops, ICAR, IIHR, Bengaluru, member of my Advisory Committee for his munificent acquiescence and meticulous reasoning to refine this thesis and most explicitly to reckon with set standards. Ineffable in my gratitude and sincere thanks to him for this transcendent suggestions and efforts to embellish the study.*

I sincerely extend my profound gratitude and appreciation to the member of my Advisory Committee, ***Dr. Shivapriya M****., Assistant Professor, Department of Biotechnology and Crop Improvement, College of Horticulture, Bengaluru, for her valuable help.*

I am extremely thankful and sincere gratitude to ***Dr. Munikrishnappa P. M.****, Associate Professor, Department of Floriculture and Landscape Architecture, College of Horticulture, Bengaluru,* ***Dr. Harshavardhan M.****, Assistant Professor, Department of*

Floriculture and Landscape Architecture, College of Horticulture, Sirsi, and ***Dr. Amreen Taj****, Assistant Professor, Department of Floriculture and Landscape Architecture, College of Horticulture, Bengaluru, who rendered valuable help, suggestions and constant encouragement provided at every stage of the thesis preparation.*

I allocate my highest respect and heartfelt regards from my inner core of heart to my ever loved parents, ***Sri. Nagaraja P.*** *and* ***Smt. Jayamma****, who have given me life and taught the concepts of life and their dedicated efforts to educate me to this level, and also to my grandmother* ***Smt. Sivamma*** *for her care and blessings. With boundless affection, elder brother* ***Sri. Santosh P.****, for constant encouragement throughout my career and they have been a fountain of inspiration throughout my life, without whose help in every walk of life, this work would not have been possible.*

I feel immense pleasure and joy in expressing my profound affection and gratitude to my seniors, ***Poornima, Rashmi, Nayana*** *and* ***Manjula,*** *and to my friends* ***Princess, Sushu, Prabhu, Ashwini, Rosalind, Yamuna, Meghana, Nagashree, Keerthi, Sandy, Malli, Reddy*** *and* ***Vidya*** *and to my juniors****, Partha, Shivu, Chaitra, Arpitha, Nayanamanohari, Vaibhava, Prajna, Jyothi, Ranjitha*** *and* ***Sheela,*** *for their help and moral support during the course of my study and in whose cheerful company I have never felt my work as burden.*

I express my immense and whole hearted thanks to all my dear friends for their cooperation, help during the course of study and research. Above all, whole hearted prostrations to the Almighty for sprinkling his blessings upon me.

Bengaluru
June, 2018 ***(Soujanya P.)***

EVALUATION OF ROSE (*Rosa hybrida* L.) VARIETIES FOR GROWTH, YIELD AND QUALITY UNDER EASTERN DRY ZONE OF KARNATAKA

ABSTRACT

An experiment entitled "Evaluation of rose (*Rosa hybrida* L.) varieties for growth, yield and quality under eastern dry zone of Karnataka'' was carried out during October 2017 to March 2018 in the Department of Floriculture and Landscape Architecture, College of Horticulture, Bengaluru in randomized block design replicated twice. Twenty five Hybrid Tea rose varieties were evaluated for growth, quality and yield parameters under open field condition. Significant variations were observed among twenty five varieties for growth, flowering and yield characters. Among the varieties, maximum plant height (118.50 cm) was recorded in var. Clarie Chazal, whereas var. Cherry Parfait recorded maximum plant spread (34.25 cm) in N-S direction, and var. Auguste Renoir recorded maximum plant spread (36.50 cm) in E-W direction. The maximum number of branches per plant (4.00) were recorded in var. Cherry Parfait. The maximum stem girth, chlorophyll content and individual leaf area were recorded in var. Clarie Chazal (10.60 mm, 58.90 and 25.07 cm^2, respectively). Among the varieties, var. Chantre took least number of days for bud initiation, flowering and days from bud initiation to full bloom stage (36.00, 13.20 and 15.00 days, respectively). Maximum number of cut flowers per plant and per m^2 (20.00 and 83.00, respectively) were recorded in var. Cherry Parfait. Flower yield on weight basis was maximum in var. Moonstone (243.43 g/plant and 900.30 g/m^2, respectively). Maximum flower bud diameter and flower diameter (2.59 cm and 9.40 cm, respectively) was recorded in var. Acapella. Maximum number of petals per flower (71.20) were recorded in var. Tata Centenary. Maximum stalk length (55.40 cm) was obtained in var. Clarie Chazal. Among the varieties, the maximum stalk girth and vase life (5.60 mm and 11.50 days, respectively) were recorded in var. Eterna.

Signature of the student
(Soujanya P.)

Signature of the Major Advisor
(Balaji S. Kulkarni)

ಕರ್ನಾಟಕದ ಪೂರ್ವ ಒಣ ವಲಯದಲ್ಲಿ ವಿವಿಧ ಗುಲಾಬಿ (ರೋಸಾ ಹೈಬ್ರಿಡ್ ಎಲ್.) ತಳಿಗಳ ಮೌಲ್ಯಮಾಪನ

ಸಾರಾಂಶ

ಕರ್ನಾಟಕದ ಪೂರ್ವ ಒಣ ವಲಯದಲ್ಲಿ ಗುಲಾಬಿ ತಳಿಗಳ ಬೆಳವಣಿಗೆ, ಇಳುವರಿ ಮತ್ತು ಗುಣಮಟ್ಟವನ್ನು ತಿಳಿಯಲು ಪುಷ್ಪ ಕೃಷಿ ಮತ್ತು ಉದ್ಯಾನ ವಿನ್ಯಾಸ ಶಾಸ್ತ್ರ ವಿಭಾಗ, ತೋಟಗಾರಿಕೆ ಮಹಾವಿದ್ಯಾಲಯ, ಬೆಂಗಳೂರಿನಲ್ಲಿ ಆಕ್ಟೋಬರ್-2017 ರಿಂದ ಮಾರ್ಚ್-2018 ರವರೆಗೆ ಕ್ಷೇತ್ರ ಆಧ್ಯಯನವನ್ನು ಕೈಗೊಳ್ಳಲಾಗಿತ್ತು. ಈ ಆಧ್ಯಯನವನ್ನು 2 ಪುನರಾವರ್ತನೆಗಳ 25 ತಳಿÀಗಳನ್ನೊಳಗೊಂಡ ಯಾದ್ರಚ್ಛಿಕಗೊಳಿಸಿದ ಪೂರ್ತಿ ಪ್ರತಿಬಿಂದಕ ವಿನ್ಯಾಸದಲ್ಲಲಿ (ಆರ್.ಸಿ. ಬಿಡಿ) ಸಿದ್ಧಪಡಿಸಲಾಗಿತ್ತು. ಇಪ್ಪತ್ತೈದು ಹೈಬ್ರಿಡ್ ಟೀ ಗುಲಾಬಿ ತಳಿಗಳು ಹೊರ ವಾತಾವರಣದಲ್ಲಿ ಬೆಳವಣಿಗೆ, ಇಳುವರಿ ಮತ್ತು ಗುಣಮಟ್ಟ ನಿಯತಾಂಕಗಳಿಗಾಗಿ ಮೌಲ್ಯಮಾಪನ ಮಾಡಲ್ಪಟ್ಟವು. ಬೆಳವಣಿಗೆ, ಇಳುವರಿ ಮತ್ತು ಗುಣಮಟ್ಟದಲ್ಲಿ 25 ತಳಿಗಳ ನಡುವೆ ಮಹತ್ವದ ವ್ಯತ್ಯಾಸಗಳು ಕಂಡು ಬಂದಿವೆ. ತಳಿಗಳ ಪೈಕಿ ಗರಿಷ್ಠ ಸಸ್ಯದ ಎತ್ತರ (118.50 ಸೆಂ. ಮೀ.) ಕ್ಲಾರಿ ಚಾಜಾಲ್ ದಾಖಲಿಸಿದೆ, ಉತ್ತರ-ದಕ್ಷಿಣ ದಿಕ್ಕಿನಲ್ಲಿ ಸಸ್ಯ ಹರಡುವಿಕೆ ಚೆರ್ರಿ ಪಾರ್ಫೆಟ್‌ನಲ್ಲಿ ಗರಿಷ್ಠವಾಗಿದ್ದು (34.25 ಸೆಂ. ಮೀ.), ಆಗಸ್ಟೆ ರೆನಾಯರ್ ಪೂರ್ವ-ಪಶ್ಚಿಮ ದಿಕ್ಕಿನಲ್ಲಿ ಗರಿಷ್ಠ ಸಸ್ಯ ಹರಡುವಿಕೆಯನ್ನು (36.50 ಸೆಂ. ಮೀ.) ದಾಖಲಿಸಿದೆ. ಚೆರ್ರಿ ಪಾರ್ಫೆಟ್‌ನಲ್ಲಿ ಗರಿಷ್ಠ ಕವಲುಗಳ ಸಂಖ್ಯೆ (4.00) ದಾಖಲಾಗಿದೆ. ಕ್ಲಾರಿ ಚಾಜಾಲ್‌ನಲ್ಲಿ ಗರಿಷ್ಠ ಕಾಂಡದ ಸುತ್ತಳv,É ಪತ್ರಹರಿತ್ತು ಮತ್ತು ಎಲೆ ವಿಸ್ತೀರ್ಣ (10.60 ಮಿ. ಮೀ., 58.90 ಸ್ಪ್ಯಾಡ್ ಮತ್ತು 25.07 ಸೆಂ. ಮೀ2., ಕ್ರಮವಾಗಿ) ದಾಖಲಾಗಿದೆ. ತಳಿಗಳ ಪೈಕಿ ಚಾಂಟೆ ತಳಿಯು ಅತಿ ಕಡಿಮೆ ಸಮಯದಲ್ಲಿ ಮೊಗ್ಗು ಬಿಟ್ಟಿದ್ದು (36 ದಿನಗಳು) ಮತ್ತು ಈ ತಳಿಯ ಹೂ ಬಿಡುವಿಕೆ ಮತ್ತು ಮೊಗ್ಗಿನಿಂದ ಪೂರ್ಣ ಹೂವು ಹಂತಕ್ಕೆ ಕನಿಷ್ಠ ದಿನಗಳನ್ನು (13.20 ಮತ್ತು 15.00 ದಿನಗಳು, ಕ್ರಮವಾಗಿ) ಪಡೆದಿದೆ. ಚೆರ್ರಿ ಪಾರ್ಫೆಟ್ ತಳಿಯಲ್ಲಿ ಗರಿಷ್ಠ ಸಂಖ್ಯೆ ಹೂವುಗಳು ಪ್ರತಿ ಸಸ್ಯಕ್ಕೆ ಮತ್ತು ಪ್ರತಿ ಸೆಂ. ಮೀ2. (20.00 ಮತ್ತು 83.00, ಕ್ರಮವಾಗಿ) ದಾಖಲಾಗಿದೆ. ತೂಕದ ಆಧಾರದ ಮೇಲೆ ಗರಿಷ್ಠ ಹೂವಿನ ಇಳುವರಿಯು ಮೂನೊ್ಸಟೀನ್‌ನಲ್ಲಿ (243.43 ಗ್ರಾಂ/ಸಸ್ಯ ಮತ್ತು 900.30 ಗ್ರಾಂ/ಮೀ2, ಕ್ರಮವಾಗಿ) ದಾಖಲಾಗಿದೆ. ಅಕಪೆಲ್ಲ ತಳಿಯಲ್ಲಿ ಗರಿಷ್ಠ ಮೊಗ್ಗಿನ ವ್ಯಾಸ ಮತ್ತು ಹೂವಿನ ವ್ಯಾಸ (2.59 ಸೆಂ. ಮೀ. ಮತ್ತು 9.40 ಸೆಂ. ಮೀ., ಕ್ರಮವಾಗಿ) ದಾಖಲಾಗಿದೆ. ಗರಿಷ್ಠ ಕಾಂಡದ ಉದ್ದವು 55.40 ಸೆಂ. ಮೀ. ರಷ್ಟು ಕ್ಲಾರಿ ಚಾಜಾಲ್‌ನಲ್ಲಿ ದಾಖಲಾಗಿದೆ. ಎಟರ್ನಾದಲ್ಲಿ ಗರಿಷ್ಠ ಕಾಂಡದ ಸುತ್ತಳತೆ ಮತ್ತು ಹೂದಾನಿ ಬಾಳಿಕೆ ಅವಧಿ (5.60 ಮಿ. ಮೀ. ಮತ್ತು 11.50 ದಿನಗಳು, ಕ್ರಮವಾಗಿ) ದಾಖಲಾಗಿದೆ.

ವಿದ್ಯಾರ್ಥಿಯ ಸಹಿ
(ಸೌಜನ್ಯ ಪಿ.)

ಮುಖ್ಯ ಸಲಹೆಗಾರರ ಸಹಿ
(ಬಾಲಾಜಿ ಎಸ್. ಕುಲಕರ್ಣಿ)

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF ABBREVIATIONS USED

%	-	Per cent	kg	-	Kilo Gram
^{o}C	-	Degree Celsius	mm	-	Millimeter
CD	-	Critical difference	m^2	-	Meter square
cm	-	Centimetre	mg	-	Milli Gram
cm^2	-	Square centimetre	MT	-	Million tones
cv.	-	Cultivar	S. Em±	-	Standard Error of Mean
cvs.	-	Cultivars	sq. m	-	Square meter
et al.	-	Et allii (and others)	t	-	Tonnes
etc.	-	And so forth	var	-	Variety
FYM	-	Farm Yard Manure	*viz.*	-	Namely
g	-	Gram	yr	-	Year
ha	-	Hectare			
i.e.	-	That is			

I. INTRODUCTION

India is having tradition of cultivating flowers since time immemorial. Besides ideal climatic conditions, soil and other natural resources, along with comparatively cheap labour, it should come as no surprise to anyone that floriculture is taking strong roots in India which has a long tradition of flowers and their uses. Government of India has identified floriculture as a sunrise industry and accorded it 100 per cent export oriented status. Owing to steady increase in demand of flowers, floriculture has become one of the important commercial trades in agriculture. Hence, commercial floriculture has emerged as hi-tech activity that taking place under controlled climatic conditions inside polyhouse as well as in open field conditions. Floriculture in India is being viewed as a high growth industry. Commercial floriculture is becoming important from the export angle. The liberalization of industrial and trade policies paved the way for development of export-oriented production of cut flowers. It has been found that commercial floriculture is a potential money-spinner, an economical viable agri-business. Indian floriculture industry has been shifting from traditional flowers to cut flowers for export purposes (Chawla *et al*., 2016).

The cut flower is an important floriculture product. Among all the cut flowers, rose ranks first in the International flower market. It is one of the natures beautiful creations and is universally known as “Queen of Flowers”. These are also used in today’s landscape as they have many advantages over other shrubs. No other flower is a better symbol of love, adoration, innocence, peace, friendship, affection, passion and other virtues than the rose since thousands of years. It is certainly the best known and most popular of all the cut flowers throughout the world and has been growing on this earth for many million years before the man himself appeared on earth. Rose contributes 95 per cent of total cut flower export from India.

Rose occupies an area of about 29.41 thousand ha with the production of 301.95 thousand MT in India. The quantity of roses exported from India is about 0.03 thousand MT, worth of 141.45 lakh rupees. Major rose producing states that contribute in export of rose are West Bengal, Karnataka, Gujarat, Chhattisgarh and Maharashtra (Anon, 2017).

The earliest fossil record of rose was found in Alaska and dates back to the Paleocene epoch which ended some 58 million years ago (Becker, 1963). The *Rosa* genus is endemic to temperate regions of the northern hemisphere, including North America, Europe, Asia and the Middle East, with the greatest diversity of species found in western China (Phillips and Rix, 1988; Ertter, 2001). It is also distributed in warmer areas such as New Mexico, Iraq, Ethiopia, Bengal and southern China (Nybom *et al.*, 2005).

The *Rosa* genus belongs to the family Rosaceae with chromosome number 2n = 4x = 28. The present day beautiful cultivars of exquisite shape, different sizes, bewitching colours and most delightful fragrance have made it an important flower crop. The success of rose culture however, depends on proper choice of type and cultivars of roses. The modern roses are considered to have originated largely from 10 species *viz., R. canina, R. chinenesis, R. foetida, R. gallica, R. gigantea, R. moschata, R. multiflora, R. phoenicia, R. rugosa, and R. wichuraiana.* The first modern roses were the Hybrid Tea roses, which were derived from crosses between Hybrid Perpetual and Tea roses (Marriott, 2003) and thus contained genes from *R. damascena*, *R. moschata, R. chinenesis, R. gigantean,* and *R. gallica.*

The first recognised Hybrid Tea was a cultivar called ‘La France’ is thought to be the result of a natural cross between unknown parents but it became the prototype for the new class of roses. The Hybrid Tea class (*Hybrides de The*) was first recognised in approximately 1880 by the French people, but it was not until 1893 that the British National Rose Society officially recognised the class (Filiberti, 2005). Hybrid Tea roses are grown specifically by commercial flower growers for the cut-flower market and they are also used for domestic and industrial landscaping. They have erect stems usually form plants that are 1-2 m tall. They are perennial

woody shrubs that continuously produce new shoots. Basically, a shoot comprises a succession of 8-15 repeating units, each one consisting of a leaf, an axillary bud, a node and an internode (Blom and Tsujita, 2003).

The selection of varieties is an important factor for successful cultivation of rose. Presently there are about 60,000 varieties of roses, with an addition of more than 10,000 hybrids every year around the globe differing widely in form, shape, size, colour, fragrance and growth habit. Therefore, it is very much necessary to assess the performance of available varieties of rose in order to suggest suitable varieties for maximizing the production, cost effective cultivation.

The majority of cut flower roses are grown in climate-controlled polyhouses where temperature, moisture and light can be adjusted to produce flowers at periods of peak demand. Some varieties of roses are successfully grown in our country under open conditions for cut flower and loose flower purposes. However, a limited research work is done to know the performance of outdoor rose cultivars. The cultivation of rose is gaining importance in Karnataka due to its relative ease in cultivation, high returns, increasing market demand and high communication facilities. So far, the research work done on the evaluation of rose cultivars to find out their suitability to this tract is meagre. Considering the importance and popularity of rose flowers both in domestic as well as International markets, it is important to study the performance of Hybrid Tea group of rose varieties and also to test the new hybrids for their performance in eastern dry zone of Karnataka.

Considering all the above points, a study on evaluation of rose (*Rosa hybrida* L.) varieties for growth, yield and quality under eastern dry zone of Karnataka was conducted with the following objectives:

1. To assess the performance of rose varieties for vegetative growth.
2. To study the flowering and yield of different varieties.
3. To assess the flower quality and consumer acceptance.

II. REVIEW OF LITERATURE

Rose ranks first among the top ten cut flowers auctioned in Alsmeer flower auction centre, the Netherlands. It is a leading cut flower crop commercially grown throughout the world. A wide range of diversity exists in flower shape, size, colour and fragrance among the varieties. Among various types of roses, Hybrid Teas and few Floribundas are found suitable for cut flower production. Several new rose varieties with attractive colours, growth habit, long vase life and combination of traits were developed every year by professional rose breeders, private firms, amateurs, hobbyists and corporates engaged in rose breeding brought to the market. The growth and performance of these genotypes exhibit wide range of variability with the prevailing climatic and growing conditions. Therefore, varietal evaluation becomes necessary to identify the suitable variety for cut flower production for the specific region.

In this chapter the review of literature pertaining to the performance of rose and other related flowers *viz.,* perennial shrubs regarding growth, flowering and yield attributes under varied agro-climatic conditions have been compiled to enable better understanding of the varieties and suitable growing conditions under the following sub headings.

2.1 Vegetative parameters

Lundstad (1975) evaluated 45 new cultivars of Floribunda and Polyantha roses. Maximum plant height (84 cm) was recorded in Scarlet Elizabeth. In another trial conducted by Raheela *et al*. (2002), among the ten cultivars, Angelique produced maximum plant height (139.83 cm).

Gowda *et al.* (1980) evaluated eight hybrid tea roses for cut flower production. The shoot length was maximum in the variety Mainauperle (36.00 cm) and it was minimum in Red Devil (18.58 cm). Grzeszkie and Rejman (1991) evaluated eight rose cultivars. Queen of Bermuda, Belle Epoque and Interflora produced longest stem lengths.

Murugesan *et al*. (1991) studied the performance of 85 rose cultivars. The lowest plant height was 41.5 cm in dwarf Polyantha cultivar ‘Chattion’ and maximum (178.8 cm) in tall errect hybrid tea cultivar, ‘American Heritage’

Mulla *et al.* (1995) observed that plant height was maximum in cv. Hokatu followed by cv. American Heritage among the rose cultivars grown on medium black soils of Maharashtra.

Malhotra (1997) evaluated six rose cultivars and reported maximum height of 122.67 cm in cv. ‘Sandra’ followed by 114.7 cm in cv. ‘Sonia Meiland’, the lowest height of 31.25 cm was recorded in cv. ‘Mercedes’. Maximum plant spread of 85.00 cm was observed in cv. ‘Sonia Meiland’ and minimum of 31.56 cm in cv. ‘Mercedes’.

Zarina *et al*. (2001) reported that Love and Double Delight proved to be best regarding early sprouting and maximum number of branches per plant. Hussain and Khan (2004) evaluated two rose cultivars and reported that *Rosa bourboniana* produced maximum plant height (94.30 cm) as compared to *Rosa gruss-an-teplitz* (42.00 cm).

Rabbi *et al*. (2004) conducted an experiment at Qarshi Herb centre, Hattar, Haripur Pakisthan. Five exotic rose cultivars were included in the trail. Maximum number of branches per plant (27.00) was recoded in cv. Indian Chief under the agro climatic conditions of Haripur.

Adnan and Atif (2005) observed that cv. Kardinal produced maximum number of shoots (2.90) followed by cv. Gold Medal (2.70) and cv. Wisky Mac (2.30) among the rose cultivars evaluated. Mohanty *et al.* (2011) observed maximum plant height (60.94 cm), maximum plant spread N-S (53.72 cm) and E-W (35.60 cm) in cv. Montezuma.

Qasim *et al.* (2008) evaluated two rose cultivars Amalia and Anjeleeq. They reported that the cultivar Anjelleq produced maximum plant height (65.16 cm), higher number of branches per plant (6.55) and maximum number of leaves (217.00) as compared to Amalia.

Singh *et al*. (2013) evaluated thirty floribunda rose cultivars for landscape use under subtropical climate of the Punjab. Maximum plant height (53.67 cm) was recorded in 'Banjaran', while plant-spread, leaf length and leaf breadth were maximum (90.83 cm, 12.73 cm and 9.10 cm, respectively) in 'Brown Velvet'.

Ramzan *et al*. (2014) conducted an experiment to assess the performance of exotic cultivars of Hybrid Tea roses under agro climatic conditions of Islamabad. Nineteen hybrid rose cultivars were studied. The maximum plant height (100.00 cm) was recorded in Jagua followed by Pink Peace and Honey Perfume (97.00 cm).

Buchem *et al*. (2015) conducted an experiment at the School of Agricultural Sciences and Rural Development (SASRD), Nagaland University, Medziphema Campus, under Dimapur district of Nagaland. Eleven cultivars of Hybrid Tea (HT) rose *viz*., Abhisarika, Classic, First Red, Ganga, Harmonie, Jawahar, Madhosh, Papillon, Raktagandha, Samourai and Super Star were evaluated. The maximum plant height was exhibited by Raktagandha (71.73 cm) followed by Super Star (70.13 cm), First Red (66.20 cm) and Samourai (66.23 cm).

Atram *et al*. (2015) conducted an experiment to assess the performance of 42 hybrid tea rose varieties. Results revealed that, in all respect of morphological traits, Chardony, Alliance, Kentucky Derby, Roter Champagner, Montreal and Melody varieties were superior.

Other crops

Ashwath *et al.* (2007) evaluated promising crossandra (*Crossandra undulaefolia* Salisb.) F_1 hybrids in IIHR, Bangalore. Maximum plant height was recorded in the germplasm collected from Karnataka (Mangalore) (92.20 cm) whereas, it was minimum in cv. 'Lakshmi' (37.20 cm).

Similar study was conducted to identify the promising F_1 hybrids at IIHR, Bangalore. Among F_1 hybrids maximum plant height was recorded in the local cultivar (62.60 cm) whereas minimum was recorded in Arka Ambara (35.60 cm) (Ashwath *et al.,* 2009).

Ramachandrudu and Thangam (2010) evaluated local germplasm of crossandra (*Crossandra undulaefolia* Salisb.) at ICAR research complex, Old Goa. Among the germplasm evaluated maximum plant height was recorded for accession CG-2 (114.16 cm) whereas, minimum plant height was recorded for accession CG-6 (89.48 cm).

Rahuldas (2017) evaluated eight genotypes of crossandra at UHS campus, Gandhi Krishi Vignana Kendra post, Bengaluru. Among the genotypes, maximum plant height was recorded with the genotype 'Arka Shravya' (56.95 cm). The plant spread in north-south direction and east-west direction was maximum in 'Arka Shravya' (60.09 cm & 60.21 cm, respectively).

2.2 Flowering parameters

Bhattacharjee *et al.* (1993) reported that cv. Sonia Meilland was earliest to initiate flowering after pruning. Manjula (2005) reported that among ten Dutch rose cultivars evaluated for cut flowers, Grand Gala and First Red were found to be early for flower initiation.

Malhotra (1997) reported that cv. 'Golden Times' commenced flowering 37 days after pruning which was followed by 'Sandra' (37.50 days) and the last blooming cv. was 'Mercedes' which took 49.75 days to commence flowering.

Fascella and Zizzo (2007) reported that cv. Maira had the earliest flowering (108 days after planting). Mohanty *et al*. (2011) evaluated three cultivars of rose under different growing conditions. Gladiator took minimum time for bud appearance after pruning.

Nine *Rosa hybrida* cultivars were evaluated for growth and yield attributed under the climatic conditions of Faisalabad. Overall, significant variations were observed in each cultivar for length, flower persistence life and color and overall performance with respect to climatic conditions of Faisalabad. It is concluded that the cultivars 'Autumn Sunset' and Gruss-an-teplitz performed better (Nadeem *et al*. 2011).

Shahrin *et al.* (2015) studied the flowering characters and categorized rose cultivars for color, fragrance and usage. Maximum days taken to flower bud initiation was found in Afrodita (40.00 days) followed by Pinky smile (36.00 days) whereas, minimum from Compassion (19.00 days).

Other crops

Rahuldas (2017) evaluated eight genotypes of crossandra at UHS campus, Gandhi Krishi Vignana Kendra post, Bengaluru. As regards to flowering parameters *viz.,* days to flower initiation (102.00 days) was recorded early in the genotype 'Arka Shravya'.

2.3 Yield parameters

Chandrashekaraiah (1973) evaluated eight rose cultivars during rainy and winter seasons and reported that maximum number of flowers per plant (7.28 and 8.32) were obtained with Superstar and Kings Ramson.

On evaluation of 13 cultivars grafted on *Rosa indica*, the highest yield was obtained from the cultivars Grandmere, Jenny, Camps, Elysees and Carina with 77.40, 66.90 and 32.19 flowers/m^2 , respectively (Millia, 1974).

Scharoder (1975) evaluated the rose cultivars and the results revealed that the highest yield was obtained from Magic Moment (31.7 blooms/ m^2) followed by Illona with 24 blooms/ m^2. Polmacher (1976) evaluated nine cultivars, Marina produced highest cut flower yield of 4.80 blooms/plant.

In a trail of eight Hybrid Tea roses for cut flowers, cv. 'Montezuma' produced the highest number of marketable flowers followed by 'Oklahoma' and 'Black Ruby'. Medium yield was observed in 'Maineuperle', 'Pink Parfait',

‘Chistian Dior’ and ‘Command Performance’ where as cultivar ‘Red Devil’ gave poor yield (Gowda *et al.*, 1979).

Gowda *et al.* (1980) evaluated eight Hybrid Tea roses for cut flowers and reported that cv. ‘Eiffel Tower’ produced highest number of marketable flowers (21.50/plant) followed by ‘Jovencell’ (16.50), ‘Summer Queen’ (10.70), ‘Elida Cardinal’, ‘First Prize’, ‘Agena’ and ‘John F. Kennedy’ (4).

Henchen (1981) assessed the productivity of 54 rose cultivars and reported that highest average number of cut stems per plant was obtained with Spartan, Crimson Glory, Sutter’s Gold (20.30, 19.30 and 19.10, respectively). Garica and Mejias (1982) reported that among the rose cultivars evaluated, the highest yield was obtained with cv. Laminuette followed by Sabrina, Goldentimes, Candia, Caste, Blanche, Bettina, Sonia, Mercedes, Visa and Samantha.

Wagenknecht *et al.* (1984) evaluated the performance of 7 rose cultivars in open field conditions and revealed that among the early cultivars ‘Iketha Speeathen’ produced highest flowers (22.5/plant) while lowest were in ‘Citrina’ (14.2). Among the late flowering cultivars cv. ‘Komet’ gave highest yield and cv. ‘Respono’ the lowest.

Out of eight rose cultivars evaluated under greenhouse condition, highest yield of cut flowers was obtained with cultivars Sonia, Carina and Queen of Bermuda (12.40, 9.50 and 8.60 flowers / plant, respectively), (Grzeszkie and Rejman, 1991).

Murugesan *et al*. (1991) studied the performance of 85 rose cultivars. Cultivar ‘Cactus blane’ had the highest number of flowers per plant and recommended for garden use. Among the ten cultivars evaluated, maximum number of flowers per plant (41.00) was observed in the rose variety, Day Dream (Raheela *et al*., 2002).

Sundaram *et al.* (1996) reported that cultivars Abhisarika, Anurag, Grand Mere Jenny, Happiness, Strawberry and Super Star produced more than 44.20 flowers per plant. The cultivars Ambassador, Arabian Night, Baccara, Casino Divine, Duet, Folk Lore, Garden Party, Grand Moghul, Grand Prix, Janina, Kalpana, Mary Jay Coopman, Mirage and Radiance produced more than 35.20 flowers per plant.

Dias and Patil (2003) evaluated three rose varieties among which marketable yield per bush was highest in Arjun (128.98) followed by Super Star (97.39) and Golden Times (57.81).

Sharma and Sharma (2003) conducted experiment on eleven Hybrid Tea and four Floribunda rose varieties and reported that HT rose varieties Jawahar

and Kasturi Rangan performed best under Tarai conditions of Pantnagar, whereas the Chambe-Di-Kali and Kasturi Rangan (HT) and Gene Boerner (Floribunda) produced the maximum marketable flowers.

Polara *et al*. (2004) evaluated nineteen cultivars of Hybrid Tea rose and ten cultivars of Floribunda group. The results revealed that cv. Peace recorded maximum flower yield per plant under Hybrid Tea group, whereas, cv. Samba recorded highest number of flowers per plant in Floribunda group.

Manjula (2005) reported that among ten Dutch rose cultivars evaluated for cut flowers, cultivar Tineke recorded maximum number of cut flowers per plant (27.84) followed by First Red (27.50) and Grand Gala (26.83). Fascella and Zizzo (2007) reported that, cultivars Red France and Dallas gave the highest cut flower yield of 24.80 and 24.10 flowers per plant, respectively.

Sloan and Susan (2008) conducted an experiment to assess the field production potential of cut flower stems in Mississippi. Based on 2 years of assessment, the best performing W. Kordes So¨hne roses were 'Fantasia Mondiale', 'Masquerade', and 'Pinguin', averaging three to 12 stems per plant per month that were at least 30 cm long, and the best Meilland Star cultivars for outdoor cut flower production were 'Frederic Mistral', 'Michelangelo', 'The McCartney Rose', and 'Traviata', averaging 3 to 20 stems/plant per month that were at least 30 cm long.

An experiment was conducted at the School of Agricultural Sciences and Rural Development (SASRD), Nagaland University, Medziphema Campus, under Dimapur district of Nagaland. Eleven cultivars of Hybrid Tea (HT) rose *viz*., Abhisarika, Classic, First Red, Ganga, Harmonie, Jawahar, Madhosh, Papillon, Raktagandha, Samourai and Super Star were evaluated. The cultivars *viz*., Ganga (24.33), First Red (23.67), Jawahar (22.00) and Super Star (21.00) were superior with regard to flower yield per plant and hence considered as high yielders (Buchem *et al*., 2015).

Wasnik *et al*. (2015) conducted an experiment to study the yield of flowers among the rose cultivars. The results of the experiment revealed that the cv. Sugandha recorded significantly maximum yield parameters in respect of number of flowers plant^{-1} (239.07), flowers plot^{-1} (2207.33) and flowers ha^{-1} (49.05 lakhs).

Other crops

Ashwath *et al.* (2007) studied the promising crossandra F_1 hybrids IIHR 2004-09 and IIHR 2004-11 with other local varieties and observed that the local variety collected from Karnataka showed the highest yield (112.40 g/plant) whereas, cv. Local Yellow recorded the lowest yield (83.34 g/plant).

Ramachandrudu and Thangam (2010) evaluated local germplasm of crossandra (*Crossandra undulaefolia* Salisb.). Among the accessions, CG-2 emerged as the best flower yielder (474.53 g/plant) while CG-6 as poor yielder (83.86 g/plant).

Rahuldas (2017) evaluated eight genotypes of crossandra at UHS campus, Gandhi Krishi Vignana Kendra post, Bengaluru. The flower yield per plant (232.60 g) and flower yield per hectare (12.79 t) was maximum in 'Arka Shravya'.

2.4 Flower quality

Wright *et al.* (1961) evaluated rose with respect to number of petals in different Hybrid Tea cultivars. The numbers of petals per flower varied among the cultivars *i.e*., 'Crimson Glory' (30.00), 'Etoile de Hollande' (24.00 'Lady Salvia' (33.00), 'Mrs. A.R. Barraolough' (40.00) and 'Mrs. Charles Lamplough' (50.00).

Eight rose cultivars were evaluated during rainy and winter seasons. The results revealed that the maximum number of petals per flower (43.30), total stem length (64.10 cm) and bud length (4.61 cm) were obtained with Kings Ramson, Fountain Beau and White Christmas, respectively (Chandrashekaraiah, 1973).

Gowda *et al.* (1980) evaluated eight hybrid tea roses for cut flowers. The total number of well-developed petals were found to be maximum in Red Devil.

Henchen (1981) reported that longest average stem length was obtained with Raokete (49.00 cm) and Banjour (46.70 cm). On evaluation of three rose cultivars 'Melbas', 'Kosland' and 'Ruimeva' the longest stem were reported in cv. 'Melbas' (Meneve and Moermans, 1986).

Gherghi *et al*. (1983) evaluated twelve rose cultivars for vase life and observed that vase life was highest in cultivars Mercedes, Zorina and Marimba (14.20, 12.70 and 11.70 days, respectively).

Bhattacharjee *et al.* (1993) reported that longer stem length (67.34 cm), highest diameter (1.10 cm) of shoots were found in cv. Eiffel Tower, whereas highest flower diameter was recorded with Raktha Gandha. The cv. Raja Surendera Singh of Nalagarh recorded maximum vase life (10.60 days), followed by Dr. B. P. Pal (9.80 days). Highest number of petals were obtained with Dr. B. P. Pal (47.80). Whereas, least number of petals was observed in Raja Surendera Singh of Nalagarh.

Out of 26 rose cultivars assessed, cvs. 'Parfait', 'Sonia', 'Lady Rose Gabriella Marina', 'Burgundy' 81, 'Mercedes' and 'Illona' produced stem with 40-50 cm in length. Other 12 cultivars produced stem length in the range of 50-60 cm (Wisniewska *et al.*, 1994).

Khattak *et al*. (1995) evaluated 10 exotic rose cultivars for their performance and adaptability in the D. I. Khan conditions. Among the 10 cultivars, Paradise was tallest and produced large sized flowers. Maximum number of petals per flower (91.00) was recorded in Yankee Doodle. Pink Delight had maximum vase life of flower (8.00 days).

Out of 33 cultivars evaluated for vase life in water, cvs. 'Divine', 'Calton' and 'Babylon' had the longest vase life of 7.00 days followed by 'Elisum' and 'Blue Moon'. While the cultivars

‘Shot Silk’, ‘Anvil Sparks’, ‘Armarg’, ‘Kiss of Fire’, ‘Grand Mere Jenny’, ‘Happiness’ and ‘Ambassador’ were short lived with average vase life of 3.50 days (Murugesan *et al.*, 1996).

Among six rose cultivars evaluated, maximum vase life of 6.33 days was observed in cv. ‘Sonia Meiland’ followed by 5.33 days in ‘Golden Times’ whereas minimum vase life of 3.33 days was observed in cv. ‘Mercedes’ (Malhotra, 1997). Ichimura *et al.* (2002) evaluated 25 cultivars for vase life among which Calibra showed highest vase life (14.50 days) and Bridal Pink showed lowest (3.80 days).

Sivasamy and Bhattacharjee (2000) evaluated ten varieties of rose for the vase life in tap water and found that Angelique expressed the longest vase life (10.33 days), while Queen Elizabeth, Eiffel Tower, Arjun and Raktagandha lasted for more than 7.00 days and Dr. B.P. Pal, Sonia Meilland, Super Star and Cara Mia lasted for 6 to 7 days.

Based on the results of evaluation, cvs. Alexandra and Paradise had the maximum flower size (7.93 cm) whereas, maximum number of petals (59.20) was in Yankee Doodle and longest life persistency (17.17 days) was in Golden Times. The maximum vase life of 8.00 days was observed in the variety Freesia (Raheela *et al*., 2002).

Tabassum *et al*. (2002) evaluated 10 rose cultivars for cut flower production. Results revealed that Alexendra and Paradise had maximum flower size (7.93 cm). Maximum number of petals per flower (69.20) was in Yankee Doodle and maximum vase life of 8.00 days was observed in Freesia.

Nineteen cultivars of Hybrid Tea rose and 10 cultivars of Floribunda group were evaluated in two separate experiments under South Saurashtra conditions of Gujarat. Cultivars Eiffel Tower and Dickson’s Flame recorded maximum stem length among the Hybrid Teas and Floribunda group, respectively. Cultivar Gladiator recorded maximum diameter of flower in Hybrid tea group, while cvs. Zorina and Dickson’s Flame recorded maximum diameter of flower in Floribunda group (Polara *et al*., 2004).

Among ten Dutch rose cultivars evaluated for cut flowers, cultivar Grand Gala produced maximum bud length, bud diameter and neck length, while Ravel showed maximum shoot girth whereas, Skyline recorded maximum neck girth (Manjula, 2005).

Madhubala *et al*. (2008) evaluated thirty hybrid tea rose cultivars for vase life and observed that vase life was highest in cultivars Imperatlice Farah, Impatient and Waiheke of 9.13, 9.13 and 9.00 days, respectively.

Bihari *et al.* (2009) reported that the cultivar Rakta Local had maximum bud diameter (6.86 cm). A field experiment was conducted to study quality of flowers as influenced by rose cultivars. Results revealed that, diameter of flower (8.88 cm), vase life (2.67 days), shelf life (15.04 hrs) were recorded maximum in the cv. Sugandha (Wasnik *et al*., 2015).

An experiment was conducted at the School of Agricultural Sciences and Rural Development (SASRD), Nagaland University, Medziphema Campus, under Dimapur district of Nagaland. Eleven cultivars of Hybrid Tea (HT) rose *viz*., Abhisarika, Classic, First Red, Ganga, Harmonie, Jawahar, Madhosh, Papillon, Raktagandha, Samourai and Super Star were evaluated. Longer vase-life was exhibited by Super Star (9.67 days), First Red (9.00 days) and Papillon (8.33 days) (Buchem *et al*., 2015).

Other crops

Ashwath *et al.* (2007) conducted an experiment on crossandra F_1 hybrids (*Crossandra undulaefolia* Salisb.). Maximum and minimum flower diameter was recorded in IIHR 2004-11 (4.16 cm) and Local Yellow (2.22 cm) respectively.

Ramachandrudu and Thangam (2010) evaluated local germplasm of crossandra (*Crossandra undulaefolia* Salisb.). The maximum and minimum diameter of fully opened flowers was measured in CG-2 (3.82 cm) and CG-1 (2.43 cm), respectively.

Rahuldas (2017) evaluated eight genotypes of crossandra at UHS campus, Gandhi Krishi Vignana Kendra post, Bengaluru. As regards to quality parameters *viz.,* flower diameter (3.87 cm) was observed in the genotype 'Arka Shravya' with the color intensity of Orange red 35 B.

Patel *et al.* (2018) evaluated seven commercially cultivated jasmine varieties of South India region, *i.e.,* Ramanathapuram Gundumalli, Madanban, Ramabanam, Single Mohra, CO.1 Mullai, Parimullai and CO.1 Pitchi. In this study, highest flower bud diameter (0.90 cm) was recorded in Single Mohra whereas, highest flower bud length recorded in CO. 1 Pitchi (3.85 cm). Highest hundred flower bud weight (28.60 g) and single flower bud weight (0.27 g) were observed in Madanban.

III. MATERIAL AND METHODS

The experiment entitled “Evaluation of rose (*Rosa hybrida* L.) varieties for growth, yield and quality under eastern dry zone of Karnataka’’ was conducted at College of Horticulture, University of Horticultural Sciences Campus, GKVK, Bengaluru during 2017-2018. The details of the material used and methods adopted are presented in this chapter.

3.1 Experimental site

The experimental site was located at the Department of Floriculture and Landscape Architecture, College of Horticulture, UHS Campus, GKVK, Bengaluru. The soil of experimental site was red sandy loamy soil.

3.2 Geographical location and climatic conditions of the experimental site

The experimental site was located at 13° 05’ Latitude and 77°33’ East Longitude. The center is at an altitude of 924 meters above mean sea level. The details of the meteorological data on weather conditions that prevailed during the experimentation period are presented in Appendix. The climatic conditions were pleasant with moderate weather, highly suitable for rose cultivation.

3.3 Experimental details

3.3.1 Experiment: Evaluation of rose (*Rosa hybrida* L.) varieties for growth, yield and quality under eastern dry zone of Karnataka

The experiment was laid out by adopting randomized complete block design (RCBD). The details are as follows:

(i)	Crop	:	Rose
(ii)	Type	:	Hybrid Tea
(iii)	Number of replications	:	Two
(iv)	Number of varieties	:	Twenty-five
(v)	Statistical design	:	RCBD
(vi)	Spacing	:	60 cm X 60 cm
(vii)	Season	:	October 2017- March 2018
(viii)	Date of planting	:	20/10/2017
(ix)	Fertilizers :	:	As per the UHS, Bagalkot package of practice (RDF)

3.3.2 Treatment details

Varieties		Name of the variety
V_1	:	Anika
V_2	:	Acapella
V_3	:	Auguste Renoir
V_4	:	Abhishek
V_5	:	A Modi Rose
V_6	:	Bora Bora
V_7	:	Chantre
V_8	:	Claire Chazal
V_9	:	Chitraranjini
V_{10}	:	Cherry Parfait
V_{11}	:	Double Delight
V_{12}	:	Eddy Mitchell
V_{13}	:	F. F. Rennaissance
V_{14}	:	Fragrant Plum
V_{15}	:	Eterna
V_{16}	:	Julio Iglesias
V_{17}	:	Mohana
V_{18}	:	Moonstone
V_{19}	:	Maurice Utrillo
V_{20}	:	Prescilla
V_{21}	:	Rose Rhapsody
V_{22}	:	Shi Un
V_{23}	:	Scandia
V_{24}	:	Tata Centenary
V_{25}	:	Temptress

ANIKA

ACAPELLA

AUGUSTE RENOIR

Plate 1. Hybrid Tea rose varieties

ABHISHEK

A MODI ROSE

BORA BORA

Plate 2. Hybrid Tea rose varieties

.

CHANTRE

CLARIE CHAZAL

CHITRARANJINI

Plate 3. Hybrid Tea rose varieties


CHERRY PERFAIT


DOUBLE DELIGHT


EDDY MITCHELL

Plate 4. Hybrid Tea rose varieties

F. F. RENNAISANCE

FRAGRANT PLUM

ETERNA

Plate 5. Hybrid Tea rose varieties


JULIO IGLESIAS


MOHANA


MOONSTONE

Plate 6. Hybrid Tea rose varieties


MAURICE UTRILLO


PRESCILLA


ROSE RHAPSODY

Plate 7. Hybrid Tea rose varieties

SHI UN

SCANDIA

TATA CENTENARY

Plate 8. Hybrid Tea rose varieties

TEMPTRESS

Plate 9. Hybrid Tea rose varieties

3.4 Details of production technology

3.4.1 Selection of plant varieties

Uniform, healthy and vigorously grown six months old budded plants of twenty-five Dutch rose cultivars were brought from K. S. Gopalaswami Iyengar & Sons, Chamarajpet, Bengaluru.

3.4.2 Preparation of main field

The planting area was ploughed twice and cleared from weeds and levelled. Pits of 45 cubic centimeter size were open at 60 cm apart. Farm Yard Manure (FYM) @ 2 kg per pit was applied and mixed well with the red soil and top soil.

3.4.3 Planting

Six months old budded rose plants were planted in the centre of the pits taking care that the bud union is well placed above the ground surface. The planting was taken up on 20-10-2017.

3.4.4 Irrigation

The plots were irrigated once in 3-5 days intervals depending upon the weather and growth stage of the crop. Irrigation was provided through drip irrigation method.

3.4.5 Fertilizer application

Well decomposed farm yard manure at the rate of 2 kg per pit was applied to the experimental plot uniformly before planting. The fertilizers *viz*., urea, single super phosphate and murate of potash were used as the sources of N, P_2O_5 and K_2O. The recommended dose of fertilizer is 10:10:15 g/plant. Entire dose of phosphorus and potassium was applied as basal dose whereas, the nitrogen were applied in 5 splits at 30, 60, 90, 120 and 150 days after planting. The major nutrients (NPK) were provided through soil application as per the recommended package of practices (UHS, Bagalkot).

3.4.6 Weeding

The experimental plot was kept weed free by hand weeding as and when weeds were noticed. Prominent weeds *viz.*, *Cyperus rotundus*, *Cynadon dactylon, Parthenium hysterophorus etc*. were found during the experimental period.

3.4.7 Plant protection measures

The following insect-pest and diseases were observed during the experimental period and suitably managed with chemicals.

Insect-pests	**Management**
Bud borer	Spraying 2% Melathion
Aphids	Spraying 0.25% Thiomethoxam
Thrips	Spraying 0.25% Thiomethoxam
Diseases	**Management**
Powdery mildew	Spraying 1% Carbendazim

3.4.8 Other cultural practices

Desuckering, hoeing and removal of water suckers were attended regularly. The flower buds emerged during first 15 days were pinched off to encourage vegetative frame work.

3.4.9 Harvesting

Flowers were harvested early in the morning hours as and when they attain tight bud stage for cut flower purpose. The flowers harvested from 1.11.2017 to 1.4.2018 were recorded from labelled plants to work out the total yield per plant and per hectare.

3.5 Observations recorded

3.5.1 Vegetative parameters

3.5.1.1 Plant height (cm)

The plant height was recorded by measuring the height of the plant from ground level to the peak growing shoot at 30 days intervals and expressed in centimeter.

3.5.1.2 Plant spread in East- West and North - South (cm)

The plant spread was measured at 30 days intervals from planting by taking width in two directions (north- south and east- west) at right angle to each other and the mean of each direction were calculated and expressed in centimeter.

3.5.1.3 Number of branches per plant

Number of branches per plant arising from the main stem was counted and recorded at 30 days interval and mean number of branches per plant in each replication was calculated and expressed in numbers. Since it is used as a cut flower the number of branches were maintained not more than 4 by pruning.

3.5.1.4 Stem girth (mm)

The stem girth was recorded at 30 cm above the ground level by using Vernier Callipers and expressed in millimeter.

3.5.1.5 Chlorophyll content

The chlorophyll content was identified at 30 days after planting by using SPAD chlorophyll meter (Pal *et al*., 2012).

3.5.1.6 Individual leaf area (cm^2)

The individual leaf area of fully matured leaves of middle third of the stem (as per DUS guidelines) was measured by using the leaf area meter at 30, 60, 90, 120 and 150 days after planting and expressed in cm^2.

3.5.2 Flowering parameters

3.5.2.1 Days to bud initiation

Number of days taken for first flower bud initiation from planting was recorded from each plant individually in all the 25 varieties and averages were worked out in each variety.

3.5.2.2 Days from bud initiation to tight bud stage

The number of days taken from emergence of flower bud to harvesting stage was recorded in all the 25 varieties and averages were worked out.

3.5.2.3 Days from bud initiation to full bloom stage

Number of days taken from bud initiation to full opening of flower was recorded from each plant individually in all the 25 varieties and averages were worked out.

3.5.3 Yield parameters

3.5.3.1 Number of cut flowers per plant and per m^2

Number of cut flowers per plant in all the 25 varieties was recorded. The total number of cut flowers per square meter was worked out.

3.5.3.2 Flower yield/plant (g)

This was calculated by totaling the weight of the flowers per plant recorded at each harvest and computed cumulative yield per plant and expressed in grams.

3.5.3.3 Estimated flower yield/m^2 (g)

This was calculated by totaling the weight of the flowers per m^2 recorded at each harvest and computed cumulative yield per m^2 and expressed in grams.

3.5.4 Quality parameters

3.5.4.1 Flower bud diameter (cm)

The diameter of the tight flower bud at its maximum width was measured by using Vernier Callipers in tagged plants of all the varieties and expressed in centimeter.

3.5.4.2 Flower diameter (cm)

Diameter of the fully opened flower was measured at the point of maximum breadth in the flower obtained from tagged plants in all the varieties and average diameter was calculated and expressed in centimeters.

3.5.4.3 Number of petals per flower

The number of petals produced in a fully opened flower was counted in all the flowers obtained from tagged plants in all the varieties and average number of petals was calculated.

3.5.4.4 Stalk length (cm)

The length of the cut flower along with straight, unbranched, without heal and uniform stem along with foliage and terminal flower bud with pedicel from its base on basic arm (shoot) to the tip of flower bud was measured with meter scale and expressed in centimeters.

3.5.4.5 Stalk girth (mm)

The diameter of the pedicel at mid-point was taken as neck girth and was measured using of Vernier Callipers and expressed in millimeter.

3.5.4.6 Vase life (days)

Vase life was expressed in terms of days taken from the date of harvest till the flowers were found unfit for continuing in vase *i.e.* just before they started showing the symptoms of wilting.

3.5.4.7 Flower petal colour (RHS colour chart)

Flower petal color was recorded from color chart of Royal Horticultural Society, U.K.

3.5.4.8 Fragrance (Absent/Present)

Sensory evaluation of the flowers of all varieties was carried out to know whether flowers are fragrant or non- fragrant.

3.5.5 Consumer acceptance

Visual observation was carried out to know the preference of the consumer for flower of each variety. Sensory evaluation by five different judges was done by giving 1-5 score.

5 - Excellent
4 - Very good
3 - Good
2 - Average
1 - Poor

3.6 Statistical analysis

Data pertaining to the various vegetative and floral parameters were tabulated and statistically analyzed using randomized complete block design (RCBD). After analysis, 'Fisher and Yates' tables were referred for obtaining the tabulated 'Y' values and the inference was drawn after comparing the calculated 'F' values with the table 'F' values at 5 per cent (P= 0.05) level of significance as suggested by Panse and Sukhatme (2002).

IV. EXPERIMENTAL RESULTS

The present investigation was carried out at Department of Floriculture and Landscape Architecture, College of Horticulture, UHS campus, Gandhi Krishi Vignana Kendra post, Bengaluru, Karnataka during 2017-18 for their growth, yield and quality characters.

The experiment was carried out during the period from October 2017 to March 2018 with twenty five varieties. The salient findings of the investigations are interpreted in this chapter. The results pertaining to different aspects of the present study has been furnished under the following heads.

4.1 Vegetative parameters

4.1.1 Plant height (cm)

Plant height is an important character which represents the vigour of the plant. Hence, the data with respect to the mean height of plants in different rose varieties are presented in Table 1, Fig. 1.

At 30 days after planting, rose varieties significantly differed for their plant height. The plant height varied from 15.38 cm to 45.75 cm among the different varieties which were evaluated. Significantly maximum plant height was observed in var. ‘Scandia’ (45.75 cm) followed by ‘F. F. Rennaissance’ (45.00 cm), ‘Rose Rhapsody’ (41.50 cm) and ‘Clarie Chazal’ (41.13 cm) when compared to all other varieties. The minimum plant height (15.38 cm) was noticed in the var. ‘Abhishek’.

Plant height varied significantly among the varieties at 60 days after planting. Maximum plant height (68.00 cm) was noticed in ‘Chitraranjini’, while the varieties ‘Rose Rhapsody’ (64.13 cm), ‘Scandia’ (63.25 cm), ‘Clarie Chazal’ (62.75 cm) and ‘Prescilla’ (62.00 cm) were statistically on par with var. ‘Chitraranjini’. The minimum plant height (23.63 cm) was recorded with the var. ‘Abhishek’.

Table 1: Plant height (cm) of different varieties of Hybrid Tea rose at various stages of plant growth

Variety	Plant height (cm)				
	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP
Anika	24.50	52.50	72.05	75.50	77.25
Acapella	27.50	55.63	72.13	77.25	78.00
Auguste Renoir	19.88	50.03	58.13	75.38	77.25
Abhishek	15.38	23.63	48.13	54.25	56.38
A Modi Rose	24.38	52.18	71.88	74.25	75.50
Bora Bora	26.38	29.38	56.75	58.25	60.00
Chantre	23.38	39.88	81.75	84.25	86.50
Claire Chazal	41.13	62.75	101.00	106.75	118.50
Chitraranjini	39.50	68.00	86.75	92.40	96.75
Cherry Parfait	24.38	42.38	50.75	52.75	57.00
Double Delight	36.28	47.75	56.13	58.50	61.25
Eddy Mitchell	21.75	27.50	38.13	44.13	48.50
F. F. Rennaissance	45.00	53.13	68.88	74.50	84.50
Fragrant Plum	24.63	56.13	61.75	74.50	78.50
Eterna	25.25	40.00	53.50	59.25	63.00
Julio Iglesias	25.38	37.63	51.50	54.75	57.25
Mohana	22.38	48.75	60.88	62.75	65.25
Moonstone	19.63	35.00	43.63	49.75	52.75
Maurice Utrillo	28.63	36.13	47.88	54.00	62.00
Prescilla	27.63	62.00	83.95	88.00	90.50
Rose Rhapsody	41.50	64.13	82.75	93.50	95.75
Shi Un	28.63	41.38	68.75	71.40	74.75
Scandia	45.75	63.25	90.38	90.75	93.50
Tata Centenary	24.75	37.13	42.63	43.00	47.00
Temptress	27.00	53.63	61.00	64.75	66.50
S. E. m±	2.31	2.17	2.31	2.48	3.12
CD at 5%	6.73	6.32	6.73	7.22	9.12

* DAP – Days after planting

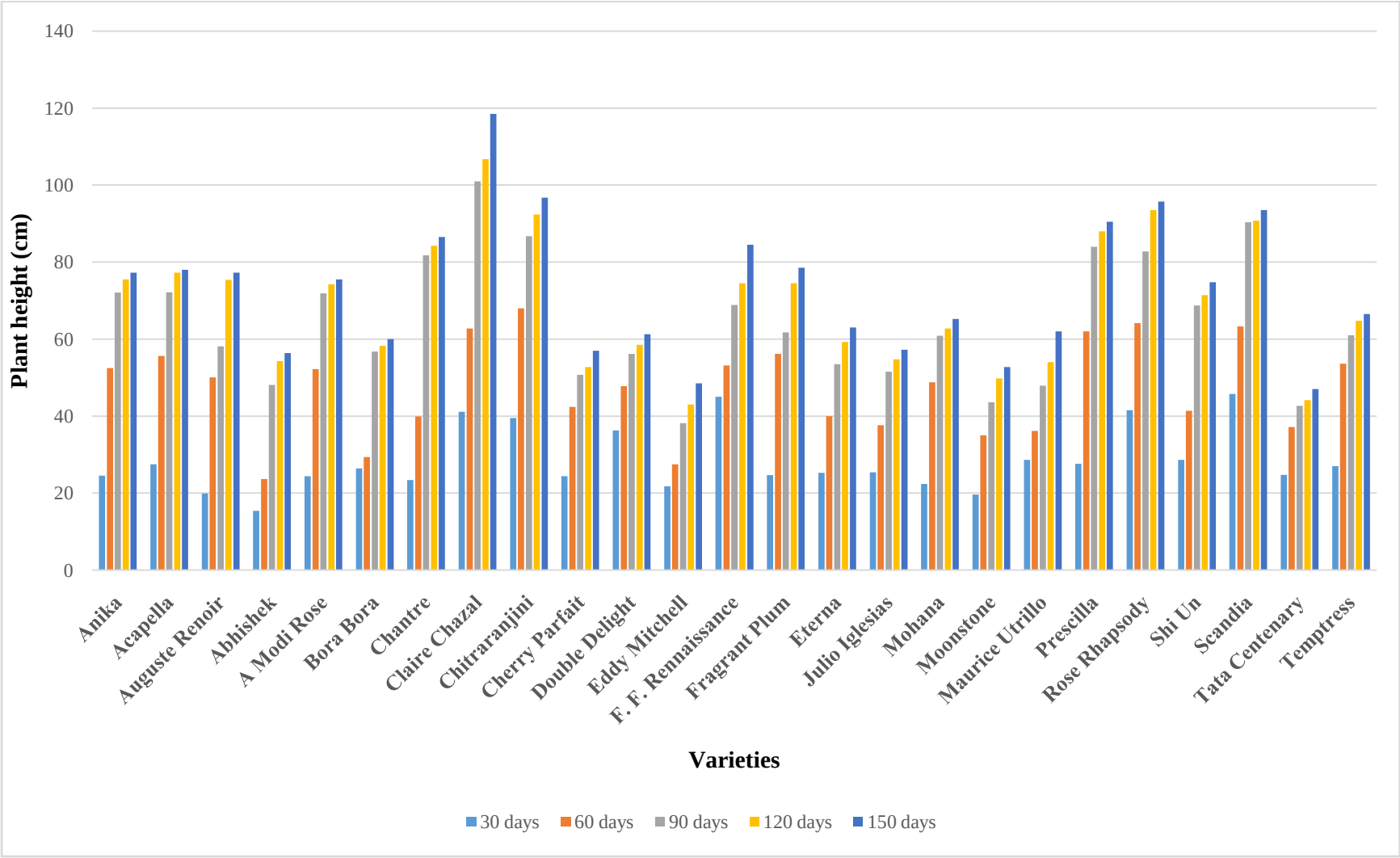


Fig. 1. Plant height (cm) of different varieties of Hybrid Tea rose at various stages of plant growth

There was a significant increase in the plant height at 90 days after planting in most of the varieties. Significantly highest plant height was recorded (101.00 cm) in var. 'Clarie Chazal' when compared with all other varieties. The minimum plant height was observed in 'Tata Centenary' (42.63 cm).

At 120 days after planting, the var. 'Clarie Chazal' recorded tallest plants with a height of 106.75 cm and was significantly superior when compared with all other varieties. The var. 'Tata Centenary' recorded the minimum plant height of 43.00 cm.

Plant height varied significantly among the varieties at 150 days after planting. The maximum plant height was observed in the var. 'Clarie Chazal' (118.50 cm) and was significantly superior when compared with all other varieties. The minimum plant height (47.00 cm) was recorded in the var. 'Tata Centenary'.

4.1.2 Plant spread (cm)

Plant spread from North to South (N-S) and East to West (E-W) directions varied among the cultivars at all the stages of plant growth.

4.1.2.1 Plant spread in North to South direction (cm)

There was a significant difference among the varieties at 30 days after planting with respect to plant spread in North to South directions (Table 2a). The maximum plant spread (N-S) was recorded in 'Shi Un' (17.88 cm) and it was on par with 'Clarie Chazal' (17.75 cm), 'Mohana' (17.25 cm), 'Rose Rhapsody' (17.25 cm), 'Temptress' (17.25), 'Moonstone' (16.63 cm) and 'Scandia' (16.00 cm). The minimum plant spread (N-S) was recorded in cv. 'Bora Bora' (10.50 cm).

Among the varieties at 60 days after planting, significantly maximum plant spread (25.86 cm) was noticed in var. 'Anika', while the varieties 'Chantre' (24.63 cm) and 'Clarie Chazal' (23.63 cm) were statistically on par with 'Anika'. The minimum plant spread (14.75 cm) was recorded with the var. 'Bora Bora'.

There was a significant increase in the plant spread at 90 days after planting in most of the cultivars. Plant spread was maximum (30.50 cm) in var. 'Anika' and was on par with the cultivars 'Tata Centenary' (29.50 cm), 'Chantre' (29.00 cm), 'Moonstone' (28.75 cm), 'Clarie Chazal' (28.38 cm), 'Cherry Parfait' (28.38 cm), 'Double Delight' (28.38 cm), 'Eddy Mitchell' (28.38 cm), 'Fragrant Plum' (28.38 cm), 'Temptress' (28.25 cm) and 'Shi Un' (28.13 cm). The minimum plant spread was observed in var. 'Bora Bora' (17.00 cm).

At 120 and 150 days after planting, the var. 'Cherry Parfait' recorded maximum plant spread of 32.75 cm and 34.25 cm, respectively. The minimum plant spread was observed in var. 'Bora Bora' (23.00 cm and 25.00 cm, respectively). The var. 'Fragrant Plum' also recorded least plant spread of 25.00 cm at 150 days after planting.

Table 2a: Plant spread in N-S direction (cm) of different varieties of Hybrid Tea rose at various stages of plant growth

Variety	Plant spread (N-S) (cm)				
	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP
Anika	13.25	25.86	30.50	32.13	34.00
Acapella	12.00	22.25	26.90	29.38	30.13
Auguste Renoir	13.50	19.75	26.25	28.88	29.63
Abhishek	10.63	16.75	24.13	26.00	26.88
A Modi Rose	15.88	19.13	26.00	28.50	29.50
Bora Bora	10.50	14.75	17.00	23.00	25.00
Chantre	15.25	24.63	29.00	30.50	31.25
Claire Chazal	17.75	23.63	28.38	30.50	31.88
Chitraranjini	15.38	20.00	24.50	27.25	29.75
Cherry Parfait	13.63	23.25	28.38	32.75	34.25
Double Delight	12.00	22.00	28.38	30.75	31.50
Eddy Mitchell	12.25	18.50	28.38	30.00	31.00
F. F. Rennaissance	15.00	22.00	27.50	31.50	32.38
Fragrant Plum	12.00	22.00	28.38	23.50	25.00
Eterna	15.50	19.63	22.25	26.75	27.88
Julio Iglesias	11.88	19.88	24.63	27.75	28.88
Mohana	17.25	20.88	22.88	25.63	26.63
Moonstone	16.63	20.25	28.75	32.00	33.00
Maurice Utrillo	12.75	21.38	27.75	31.50	32.00
Prescilla	13.63	18.50	22.25	24.00	25.38
Rose Rhapsody	17.25	20.88	23.13	28.50	29.38
Shi Un	17.88	21.88	28.13	29.75	30.25
Scandia	16.00	19.63	23.50	28.50	29.38
Tata Centenary	15.88	19.38	29.50	32.00	33.88
Temptress	17.25	21.25	28.25	31.50	32.13
S. E. m±	0.67	0.79	0.95	1.36	1.26
CD at 5%	1.95	2.29	2.77	3.98	3.67

* DAP – Days after planting

4.1.2.2 Plant spread in East to West direction (cm)

Significant differences were found with respect to plant spread in East to West directions in different varieties (Table 2b). At 30 days after planting, var. ‘Chitraranjini’ recorded highest plant spread of 26.63 cm whereas, it was lowest (9.50 cm) in var. ‘Abhishek’.

The plant spread increased gradually in subsequent months maintaining the same trend at 60, 90, 120 and 150 days after planting, significantly maximum plant spread of 28.63 cm, 30.63 cm, 35.63 cm and 36.50 cm, respectively was recorded in var. ‘Auguste Renoir’. The minimum plant spread (17.50 cm, 19.75 cm, 21.00 cm and 21.75 cm, respectively) was recorded in var. ‘Abhishek’.

4.1.3 Number of branches per plant

The data on number of branches per plant is presented in Table 3. The number of branches per plant were non- significant at 30, 60, 90, 120 and 150 days after planting.

4.1.4 Stem girth (mm)

Significant differences were found among the varieties with respect to stem girth at 90 days after planting (Table 4).

Stem girth was significantly highest in var. ‘Clarie Chazal’ (10.63 mm) followed by var. ‘Chitraranjini’ (9.80 mm). The minimum stem girth was recorded in var. ‘Tata Centenary’ (5.15 mm).

Table 2b: Plant spread in E-W direction (cm) of Hybrid Tea rose varieties at various stages of plant growth

Variety	Plant spread (E-W) (cm)				
	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP
Anika	21.00	27.08	28.38	31.38	31.88
Acapella	19.75	23.83	24.95	27.13	27.75
Auguste Renoir	19.88	28.63	30.63	35.63	36.50
Abhishek	9.50	17.50	19.75	21.00	21.75
A Modi Rose	15.88	26.25	28.63	30.00	30.88
Bora Bora	14.88	18.63	23.25	28.50	29.38
Chantre	19.75	27.88	29.13	30.25	31.50
Claire Chazal	18.63	28.00	28.88	31.25	32.63
Chitraranjini	26.63	28.58	30.00	32.50	33.88
Cherry Parfait	13.63	28.00	28.88	31.63	32.50
Double Delight	20.25	21.13	23.25	29.50	30.38
Eddy Mitchell	17.63	24.13	26.88	29.38	30.13
F. F. Rennaissance	18.25	23.63	25.38	32.00	32.88
Fragrant Plum	20.25	22.50	25.13	27.75	29.13
Eterna	17.53	21.25	23.13	27.88	28.63
Julio Iglesias	17.38	20.25	27.63	29.75	30.25
Mohana	19.63	21.50	23.88	25.75	26.88
Moonstone	22.93	25.38	27.38	31.00	31.38
Maurice Utrillo	19.50	21.13	29.38	32.25	33.00
Prescilla	22.75	24.25	26.13	29.25	30.63
Rose Rhapsody	22.25	23.88	25.25	27.75	30.63
Shi Un	20.25	22.25	27.50	30.25	31.25
Scandia	19.50	20.88	23.75	28.50	29.63
Tata Centenary	18.13	21.13	28.38	30.00	31.50
Temptress	22.00	24.00	27.38	31.00	32.50
S. E. m±	0.93	1.41	1.47	1.56	1.33
CD at 5%	2.72	4.13	4.28	4.54	3.88

* DAP- Days after planting

Table 3: Number of branches per plant of different varieties of Hybrid Tea rose at various growth stages

Variety	Number of branches				
	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP
Anika	2.50	3.75	3.75	4.00	3.75
Acapella	1.63	3.75	3.50	3.50	3.75
Auguste Renoir	2.25	3.50	4.00	3.75	3.25
Abhishek	2.00	3.50	4.00	4.00	3.75
A Modi Rose	2.75	3.75	3.75	3.75	3.75
Bora Bora	2.25	3.50	4.00	3.75	3.75
Chantre	2.75	3.50	3.75	3.75	3.75
Claire Chazal	2.25	3.25	4.00	3.75	3.75
Chitraranjini	2.50	3.50	4.00	3.75	3.75
Cherry Parfait	3.00	4.00	4.25	4.00	4.00
Double Delight	2.50	3.00	3.75	3.75	3.75
Eddy Mitchell	2.25	3.00	3.75	4.00	3.75
F. F. Rennaissance	2.25	3.25	4.00	3.75	3.75
Fragrant Plum	2.50	3.50	4.00	3.75	3.75
Eterna	2.25	3.25	3.75	3.50	4.00
Julio Iglesias	2.50	3.25	4.00	4.00	3.75
Mohana	2.00	3.25	4.00	3.75	3.75
Moonstone	3.00	4.00	4.25	4.00	4.00
Maurice Utrillo	2.50	3.50	4.00	3.75	3.75
Prescilla	2.00	3.75	4.00	3.50	3.75
Rose Rhapsody	2.25	3.25	4.00	4.00	3.75
Shi Un	2.75	3.75	4.25	4.00	4.00
Scandia	2.50	3.50	4.00	3.75	3.75
Tata Centenary	1.38	2.75	3.75	3.75	3.75
Temptress	2.50	2.75	4.00	3.75	3.75
S. E. m±	0.42	0.22	0.22	0.19	0.22
CD at 5%	NS	NS	NS	NS	NS

*DAP- Days after planting

4.1.5 Chlorophyll content

The data pertaining to chlorophyll content of leaves at 90 days after planting is presented in Table 4.

There was significant difference among the varieties with respect to chlorophyll content of leaves at 90 days after planting. The maximum chlorophyll content was recorded in var. ‘Clarie Chazal’ (58.90) and was significantly superior when compared with all other varieties. However, it was minimum in var. ‘Double Delight’ (41.24).

4.1.6 Individual leaf area (cm^2)

The data on individual leaf area is presented in Table 5.

Significant differences were observed among the varieties with respect to individual leaf area. The maximum leaf area (6.70 cm^2, 16.05 cm^2, 17.13 cm^2, 22.96 cm^2 and 25.07 cm^2) was recorded in var. ‘Clarie Chazal’ at (30, 60, 90, 120 and 150 days, respectively). However, it was minimum in var. ‘Tata Centenary’ (1.53 cm^2, 2.63 cm^2 5.20 cm^2, 6.38 cm^2 and 6.77 cm^2) at (30, 60, 90, 120 and 150 days, respectively).

4.2 Flowering parameters

The data pertaining to flowering parameters is presented in Table 6.

4.2.1 Days to bud initiation

There was significant difference among the varieties with respect to number of days to bud initiation (Fig. 2). Bud initiation was earliest (36.00 days) in var. ‘Chantre’ and late (45.50 days) in var. ‘Maurice Utrillo’.

Table 4: Stem girth (mm) and chlorophyll content of different varieties of Hybrid Tea rose at 90 days after planting

Variety	Stem girth (mm)	Chlorophyll content (SPAD values)
Anika	8.05	45.05
Acapella	7.90	54.82
Auguste Renoir	5.80	48.36
Abhishek	6.60	46.93
A Modi Rose	5.70	44.23
Bora Bora	5.95	51.49
Chantre	7.75	52.27
Claire Chazal	10.63	58.90
Chitraranjini	9.80	54.69
Cherry Parfait	7.35	47.74
Double Delight	6.90	41.24
Eddy Mitchell	5.73	45.76
F. F. Rennaissance	6.80	45.89
Fragrant Plum	8.80	50.75
Eterna	7.30	51.24
Julio Iglesias	7.70	52.67
Mohana	6.85	51.52
Moonstone	6.70	48.51
Maurice Utrillo	7.65	50.29
Prescilla	7.70	47.78
Rose Rhapsody	9.30	48.91
Shi Un	8.58	47.14
Scandia	8.05	49.70
Tata Centenary	5.15	42.75
Temptress	7.60	50.29
S. E. m±	0.02	1.82
CD at 5%	0.06	2.14

Table 5: Individual leaf area (cm^2) of different varieties of Hybrid Tea rose at various stages of plant growth

Variety	Individual leaf area (cm^2)				
	30 DAP	**60 DAP**	**90 DAP**	**120 DAP**	**150 DAP**
Anika	3.02	5.72	9.56	16.21	22.97
Acapella	1.86	5.48	14.10	15.72	16.98
Auguste Renoir	1.58	4.65	9.43	9.72	10.11
Abhishek	1.97	4.06	9.57	9.65	9.88
A Modi Rose	1.88	4.83	11.43	11.46	12.01
Bora Bora	1.66	4.14	9.92	12.01	10.15
Chantre	1.87	4.40	8.94	9.80	10.22
Claire Chazal	6.70	16.05	17.13	22.96	25.07
Chitraranjini	5.28	10.65	15.02	19.03	24.82
Cherry Parfait	3.07	9.38	10.73	11.13	11.44
Double Delight	4.54	6.52	8.36	11.71	18.55
Eddy Mitchell	2.17	3.96	7.44	8.56	9.48
F. F. Rennaissance	2.65	6.54	9.64	10.16	10.52
Fragrant Plum	2.44	8.69	12.09	14.94	18.16
Eterna	3.10	9.01	11.81	16.12	18.54
Julio Iglesias	4.02	5.97	11.16	11.41	12.54
Mohana	2.33	7.70	10.48	14.10	17.44
Moonstone	4.92	9.75	11.21	16.41	20.35
Maurice Utrillo	4.09	7.48	10.27	16.18	19.15
Prescilla	2.99	7.26	10.51	12.99	14.88
Rose Rhapsody	2.74	6.51	14.10	15.92	22.21
Shi Un	4.03	5.32	14.71	15.22	16.52
Scandia	4.72	9.08	13.05	19.02	19.31
Tata Centenary	1.53	2.63	5.20	6.38	6.77
Temptress	2.75	8.29	10.88	12.78	14.90
S. E. m±	1.22	0.26	0.40	0.62	0.58
CD at 5%	4.64	1.75	1.17	1.81	1.71

*DAP- Days after planting

4.2.2 Days from bud initiation to tight bud stage

Significant differences were obtained among the varieties with respect to days from bud initiation to tight bud stage. The least number of days from bud initiation to tight bud stage (12.80 days) was recorded in var. 'Chantre' followed by 'Fragrant Plum' (13.20 days), however, it was delayed (18.50 days) in the var. 'Cherry Parfait'.

4.2.3 Days from bud initiation to full bloom stage

Significant differences were obtained among the varieties with respect to days from bud initiation to full bloom stage. Among the varieties var. 'Chantre' took less number of days (15.00 days). Whereas var. 'Cherry Parfait' took maximum days (23.40) for bud to bloom.

4.3 Yield parameters

4.3.1 Number of cut flowers per plant and per m^2

Yield of a crop is the ultimate of what all is done to the crop to achieve same. Yield depends on the growth of the crop and the conditions prevailed during the cropping period. The data on number of cut flowers per plant and per m^2 is presented in Table 7.

Significant variation was observed for number of cut flowers per plant among different varieties (Fig. 3). Maximum number of cut flowers per plant (20.00) were recorded in var. 'Cherry Parfait' which was on par with var. 'Moonstone' (18.00). The least number of cut flowers per plant (11.25) were observed in 'Prescilla'.

Number of cut flowers per m^2 also varied significantly. Among the varieties, maximum number of cut flowers per m^2 (83.00) was recorded in 'Cherry Parfait' and was significantly superior when compared to all other varieties. Minimum number of cut flowers per m^2 (45.00) were observed in var. 'Prescilla'.

4.3.2 Flower yield/plant (g)

The data on flower yield per plant is presented in Table 7.

Table 6: Flowering parameters of different varieties of Hybrid Tea rose

Variety	Days to bud initiation	Days from bud initiation to tight bud stage	Days from bud initiation to full bloom stage
Anika	39.50	14.20	17.10
Acapella	42.00	13.90	17.40
Auguste Renoir	40.50	15.20	21.30
Abhishek	38.25	14.40	17.40
A Modi Rose	40.25	14.10	17.60
Bora Bora	44.25	14.80	17.20
Chantre	36.00	12.80	15.00
Claire Chazal	41.00	15.30	18.90
Chitraranjini	41.50	13.90	17.50
Cherry Parfait	39.50	18.50	23.40
Double Delight	41.50	14.80	18.40
Eddy Mitchell	37.25	15.30	19.00
F. F. Rennaissance	36.50	16.20	19.90
Fragrant Plum	38.75	13.20	16.40
Eterna	36.25	15.80	20.50
Julio Iglesias	40.50	13.60	18.60
Mohana	41.00	16.70	20.70
Moonstone	39.25	16.40	20.80
Maurice Utrillo	45.50	18.10	21.30
Prescilla	40.00	13.90	16.60
Rose Rhapsody	41.75	14.50	19.70
Shi Un	40.50	16.10	19.10
Scandia	39.50	17.00	18.60
Tata Centenary	40.50	16.60	19.20
Temptress	39.25	17.00	20.90
S. E. m±	0.41	0.38	0.31
CD at 5%	1.18	1.11	0.90

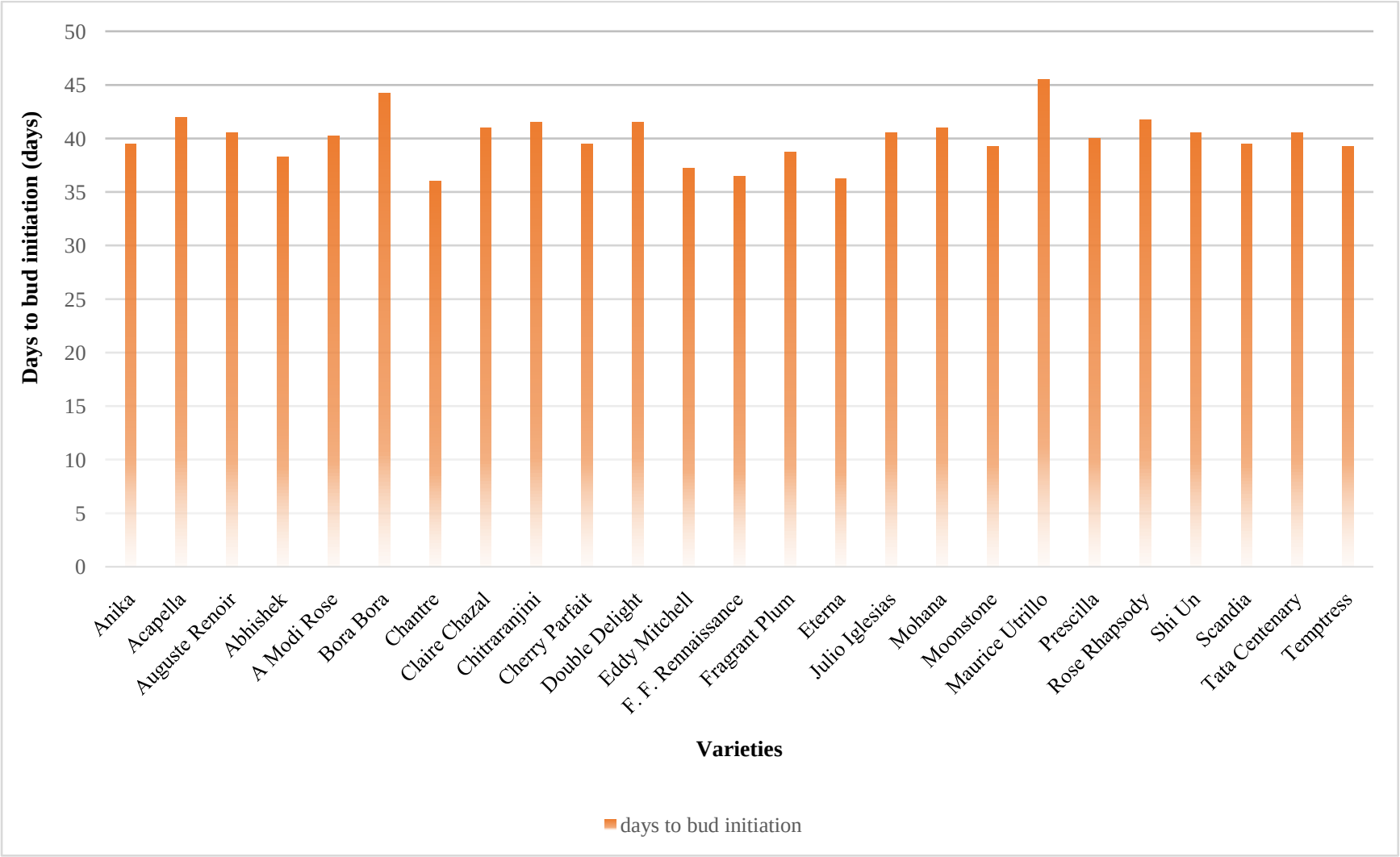


Fig. 2. Days to bud initiation of different varieties of Hybrid Tea rose

The data reveals that, there was significant difference with respect to flower yield per plant in different varieties. Among the varieties, 'Moonstone' recorded maximum flower yield/ plant (243.43 g) which was significantly superior when compared with all other varieties. The variety 'Cherry Parfait' was second highest flower yielder (217.25 g). Whereas, the lowest flower yield/ plant (83.40 g) was recorded in var. 'Prescilla'.

4.3.3 Estimated flower yield/m^2 (g)

The data on estimated flower yield per m^2 are presented in Table 7.

The data reveals that, there was significant difference with respect to flower yield per plant in different varieties. Among the varieties 'Moonstone' recorded maximum flower yield/ plant (900.30 g) which was significantly superior when compared with all other varieties. Followed by 'Moonstone', var. 'Cherry Parfait' recorded second highest flower yield/ plant (870.10 g). Whereas, the lowest flower yield/ plant (314.80 g) was recorded in var. 'Prescilla'.

4.4 Quality parameters

The data pertaining to quality parameters is presented in Table 8.

4.4.1 Flower bud diameter (cm)

Flower bud diameter varied significantly among different varieties. Significantly maximum flower bud diameter (2.59 cm) was observed in var. 'Acapella' when compared to all other varieties. Whereas, the lowest flower bud diameter (1.27 cm) was recorded in var. 'Abhishek'.

4.4.2 Flower diameter (cm)

Flower diameter differed significantly among the different varieties (Fig. 4). Significantly highest flower diameter (9.40 cm) was observed in var. 'Acapella' followed by 'Anika' (9.26 cm), 'Chitraranjini' (9.22 cm), 'Moonstone' (9.17 cm) and 'Temptress' (9.10 cm). Whereas, the lowest flower diameter (6.06 cm) was recorded in var. 'Abhishek'.

Table 7: Yield parameters of different varieties of Hybrid Tea rose

Variety	No. of cut flowers per plant	No. of cut flowers per m^2	Flower yield / plant (g)	Estimated flower yield / m^2 (g)
Anika	12.25	49.00	115.83	452.75
Acapella	14.00	56.00	113.13	461.50
Auguste Renoir	13.00	52.00	104.05	431.30
Abhishek	12.25	49.00	95.45	387.25
A Modi Rose	13.50	54.00	107.28	366.25
Bora Bora	15.00	62.00	168.71	609.30
Chantre	11.75	47.00	119.03	476.10
Claire Chazal	12.00	48.00	213.45	859.80
Chitraranjini	12.50	51.00	152.10	615.20
Cherry Parfait	20.00	83.00	217.25	870.10
Double Delight	12.50	50.00	125.63	502.50
Eddy Mitchell	13.50	52.00	93.78	345.10
F. F. Rennaissance	11.75	51.00	135.70	542.80
Fragrant Plum	14.50	58.00	139.03	646.60
Eterna	17.25	69.00	155.94	771.80
Julio Iglesias	12.25	50.00	88.70	365.10
Mohana	13.25	53.00	150.13	847.80
Moonstone	18.00	72.00	243.43	900.30
Maurice Utrillo	12.75	51.00	103.90	405.55
Prescilla	11.25	45.00	83.40	314.80
Rose Rhapsody	13.00	52.00	101.98	403.05
Shi Un	17.50	72.00	216.24	600.50
Scandia	14.50	58.00	111.88	447.60
Tata Centenary	14.00	57.00	84.90	347.40
Temptress	15.00	60.00	120.80	483.20
S. E. m±	0.84	3.23	3.62	2.11
CD at 5%	2.44	9.42	10.56	6.17

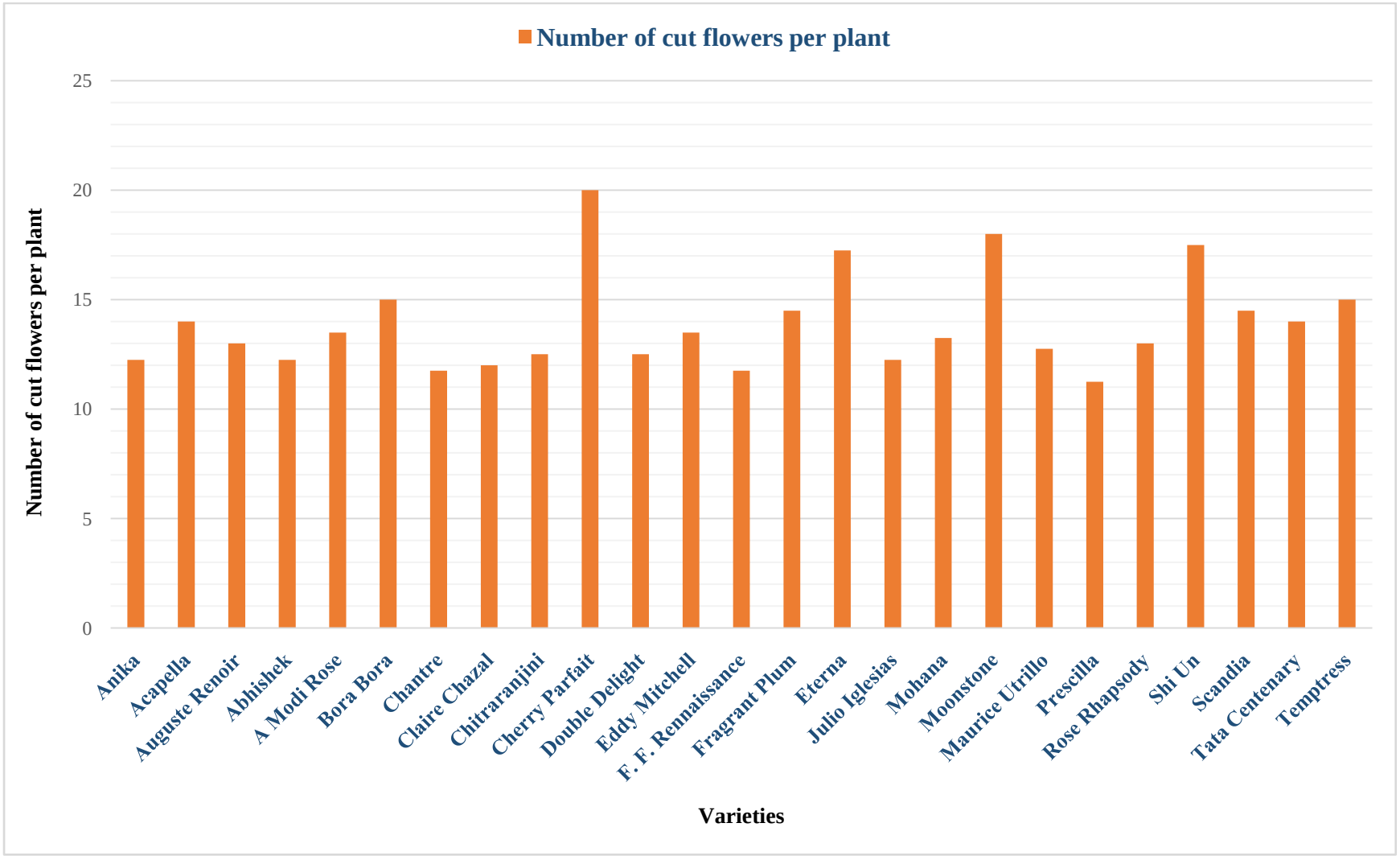


Fig. 3. Number of cut flowers per plant of different varieties of Hybrid Tea rose

4.4.3 Number of petals per flower

Significant differences were obtained among the varieties with respect to number of petals per flower. Significantly maximum number of petals per flower (71.20) were observed in 'Tata Centenary' when compared to other varieties, whereas, the lowest number of petals per flower was recorded in var. 'Abhishek' (20.60).

4.4.4 Stalk length (cm)

Flower stalk length differed significantly among different varieties (Fig. 5). Significantly maximum stalk length (55.40 cm) was obtained in var. 'Clarie Chazal' when compared to other varieties. Whereas, the minimum stalk length (20.20 cm) was observed in var. 'Tata Centenary'.

4.4.5 Stalk girth (mm)

Flower stalk girth differed significantly among different varieties. The maximum stalk girth (5.60 mm) was observed in var. 'Eterna' which was on par with var. 'Acapella' (5.40 mm), 'Fragrant Plum' (5.40 mm) 'Mohana' (5.40 mm) and 'F. F. Rennaissance' (5.35 mm). Whereas, the minimum stalk girth (4.00 mm) was observed in var. 'Tata Centenary'.

4.4.6 Vase life (days)

The vase life of rose flowers under room temperature showed significant differences (Fig. 6). Among the varieties, maximum vase life (11.50 days) was observed in var. 'Eterna' and was significantly superior when compared with all other varieties. Whereas, the minimum vase life (2.00 days) was observed in var. 'Chantre'.

4.4.7 Flower petal colour (RHS colour chart)

The data pertaining to flower petal colour is presented in Table 9.

Flower petal colour was recorded by using RHS (The Royal Horticultural Society, London) color chart. The flower petal colour of most of the varieties belonged to red purple group, like var. 'Acapella' belonged to red purple group N66A; Fan 2, var. 'Auguste Renoir' belonged to red purple group 67 D; Fan 2, var. 'Fragrant Plum' belonged to red purple group 70B; Fan 2 , var. 'Eterna' belonged to red purple group 69A; Fan 2, var. 'Prescilla' belonged to red purple group 73B; Fan 2, var. 'Shi Un' belonged to red purple group 64B; Fan 2 and 'Tata Centenary' belonged to red purple group 68A; Fan 2.

Followed by red purple group most of other cultivars belonged to red group like var. 'Abhishek' belonged to red group 45B; Fan 1, var. 'A Modi Rose' belonged to red group 41A; Fan 1, var. 'Clarie Chazal' belonged to red group 55A; Fan 1, var. 'F. F. Rennaissance' belonged to Red group 56B; Fan 1 and var. 'Rose Rhapsody' belonged to red group 43C; Fan 1.

Some of the varieties were double coloured and some had tinge of another colour at the tip of the petal, the flower petal colour of such flowers belonged various groups like var. 'Cherry Parfait' with primary colour as green white group 157D; Fan 4, and secondary colour as red purple group N57B; Fan 2, var. 'Double Delight' with primary colour as white group 155B; Fan 4, and secondary colour as red purple group N57A; Fan 2, var. 'Scandia' belonged to white group N155B; Fan 4, with tinge of red purple group 73D; Fan 2.

Among the varieties few belonged to group other than red and red purple like var. 'Bora Bora' belonged to orange group 26B; Fan 1, var. 'Chantre' belonged to yellow orange group 19B; Fan 1, var. 'Chitraranjini' belonged to orange- white group 159B; Fan 4, 'Eddy Mitchell' belonged to greyed purple group 187A; Fan 4, var. 'Julio Iglesias' belonged to white group 155A; Fan 4, with stripes of red group 53A; Fan 1, var. 'Mohana' belonged to yellow orange group 14A; Fan 1, var. 'Moonstone' belonged to green white group 157D; Fan 4, var. 'Maurice Utrillo' belonged to red purple group 62B; Fan 2 with the stripes of red purple group 59C; Fan 2, 'Temptress' belonged to green white group 155C; Fan 4.

Table 8: Quality parameters of different varieties of Hybrid Tea rose at grand growth stage of plant growth

Variety	Flower bud diameter (cm)	Flower diameter (cm)	No. of Petals/ flower	Stalk length (cm)	Stalk girth (mm)	Vase life (days)
Anika	2.44	9.26	33.60	31.55	5.20	8.50
Acapella	2.59	9.40	58.50	29.75	5.40	9.50
Auguste Renoir	2.29	8.89	43.00	29.05	5.10	5.50
Abhishek	1.27	6.06	20.60	20.45	4.85	5.50
A Modi Rose	1.77	7.19	49.50	23.35	5.20	7.50
Bora Bora	1.83	8.41	40.90	28.90	5.20	8.50
Chantre	1.87	8.73	27.20	29.80	5.15	2.00
Claire Chazal	2.27	8.17	40.00	55.40	5.00	8.50
Chitraranjini	2.41	9.22	36.40	42.60	5.10	8.00
Cherry Parfait	1.76	6.50	38.10	29.55	5.10	8.50
Double Delight	2.32	8.99	25.50	31.00	5.10	5.50
Eddy Mitchell	1.65	7.11	28.00	26.75	5.00	6.50
F. F. Rennaissance	2.00	8.99	37.10	30.25	5.35	7.50
Fragrant Plum	2.08	8.95	22.60	37.75	5.40	9.00
Eterna	1.90	8.58	30.30	35.15	5.60	11.50
Julio Iglesias	2.22	8.70	56.00	37.65	4.80	8.50
Mohana	2.19	8.00	20.90	41.80	5.40	8.50
Moonstone	2.27	9.17	25.70	31.50	5.00	8.50
Maurice Utrillo	1.59	8.58	32.95	34.35	5.00	8.50
Prescilla	1.89	8.76	32.00	27.80	5.00	5.50
Rose Rhapsody	2.12	8.97	51.90	33.50	5.15	7.50
Shi Un	1.49	8.50	29.50	29.65	5.20	8.50
Scandia	1.89	8.92	26.60	28.30	4.80	8.50
Tata Centenary	1.58	8.00	71.20	20.20	4.00	5.50
Temptress	2.18	9.10	41.60	28.88	5.20	8.50
S. E. m±	0.03	0.09	1.62	2.09	0.12	0.51
CD at 5%	0.08	0.26	4.74	6.10	0.36	1.48

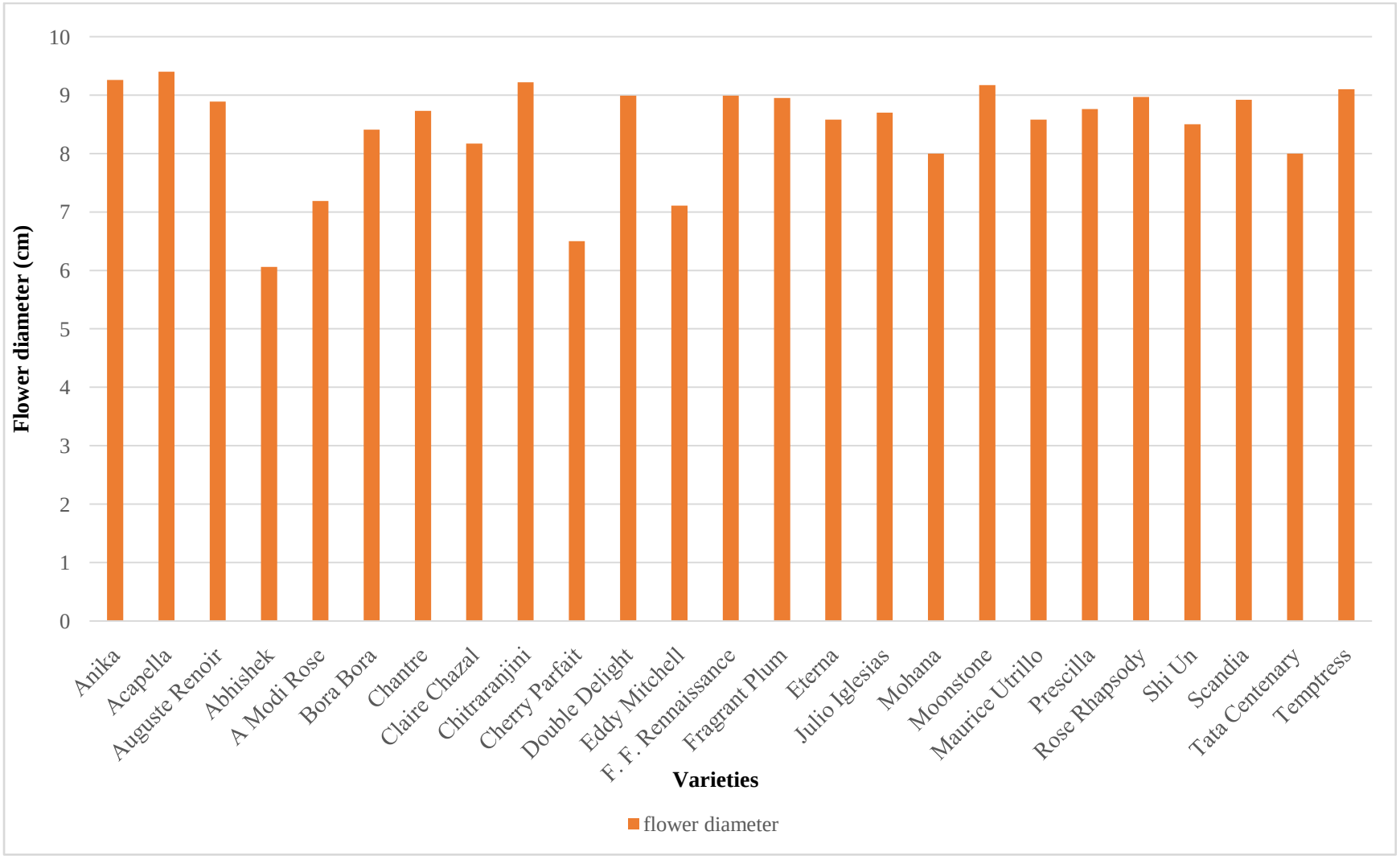


Fig. 4. Flower diameter (cm) of different varieties of Hybrid Tea rose

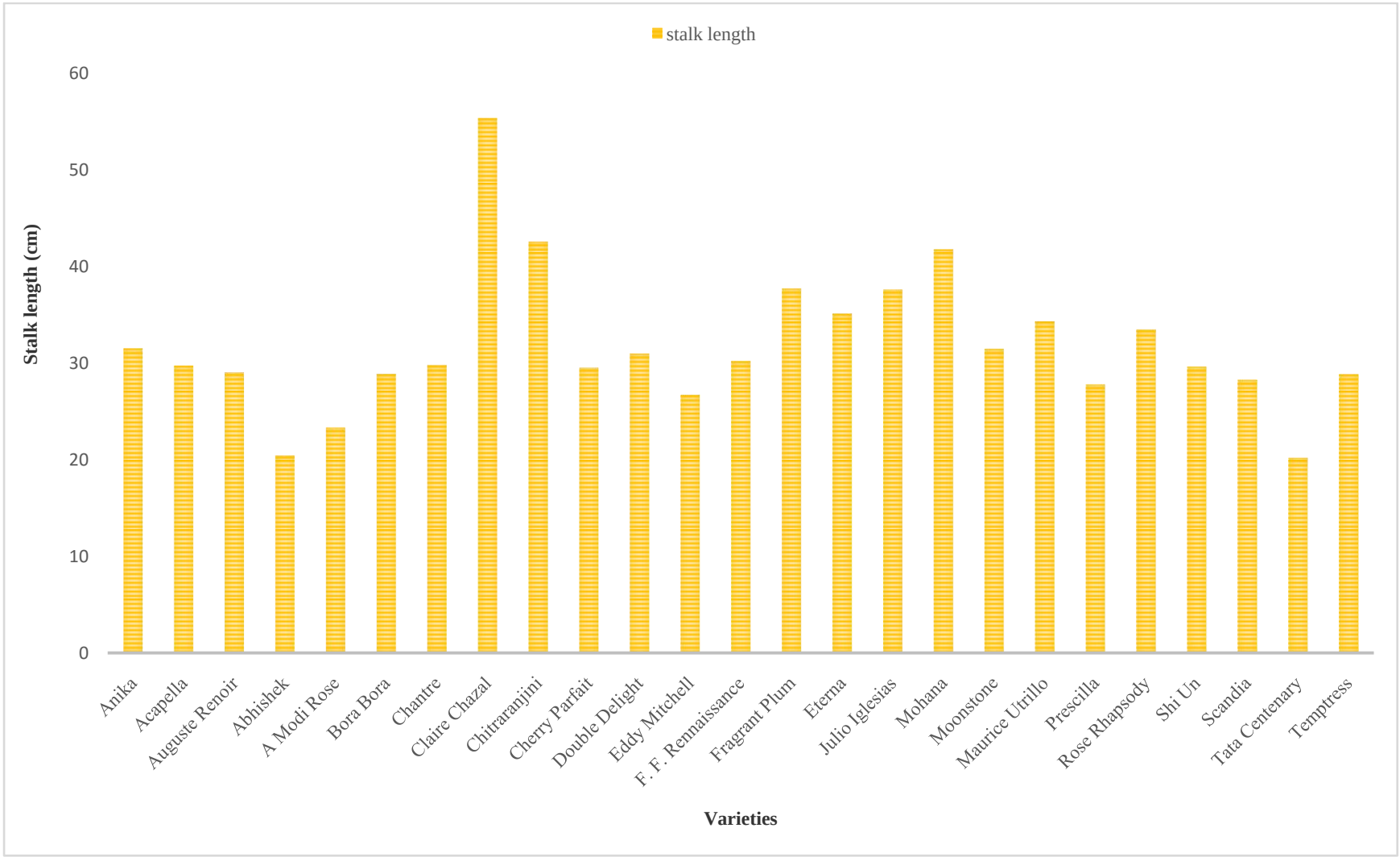


Fig. 5. Stalk length (cm) of different varieties of Hybrid Tea rose

Table 9: RHS Color chart and Fragrance of different varieties of Hybrid Tea rose at grand growth stage

Varieties	RHS Color chart	Fragrance
Anika	Yellow group 12A; Fan 1	Present
Acapella	Red purple group N66A; Fan 2	Present
Auguste Renoir	Red purple group 67 D; Fan 2	Present
Abhishek	Red group 45B; Fan 1	Present
A Modi Rose	Red group 41A; Fan 1	Present
Bora Bora	Orange group 26B; Fan 1	Present
Chantre	Yellow orange group 19B; Fan 1	Present
Claire Chazal	Red group 55A; Fan 1	Present
Chitraranjini	Orange- white group 159B; Fan 4	Present
Cherry Parfait	Green white group 157D; Fan 4, (Primary color) Red purple group N57B; Fan 2 (Secondary color)	Present
Double Delight	White group 155B; Fan 4, (Primary color) Red purple group N57A; Fan 2 (Secondary color)	Present
Eddy Mitchell	Greyed purple group 187A; Fan 4	Present
F. F. Rennaissance	Red group 56B; Fan 1	Present
Fragrant Plum	Red purple group 70B; Fan 2	Present
Eterna	Red purple group 69A; Fan 2	Present
Julio Iglesias	White group 155A; Fan 4, with stripes of Red group 53A; Fan 1	Present
Mohana	Yellow orange group 14A; Fan 1	Present
Moonstone	Green white group 157D; Fan 4	Present
Maurice Utrillo	Red purple group 62B; Fan 2, with stripes of Red purple group 59C; Fan 2	Present
Prescilla	Red purple group 73B; Fan 2	Present
Rose Rhapsody	Red group 43C; Fan 1	Present
Shi Un	Red purple group 64B; Fan 2	Present
Scandia	White group N155B; Fan 4, with tinge of Red purple group 73D; Fan 2	Present
Tata Centenary	Red purple group 68A; Fan 2	Present
Temptress	Green white group 155C; Fan 4	Present

4.4.8 Fragrance (Absent/Present)

The data pertaining to fragrance is presented in Table 9. The sensory evaluation was done, all the varieties were fragrant however the intensity of fragrance varied among the varieties.

4.5 Consumer acceptance- based on sensory evaluation

The data on consumer acceptance based on sensory evaluation are presented in Table 10.

The data reveals that, there was a visible difference with respect to consumer acceptance. The highest score (4.92, 4.80 and 4.70) was given by the consumer to the var. 'Mohana' for colour, shape and overall acceptability, respectively followed by var. 'Moonstone' (4.60, 4.66 and 4.48) for colour, shape and overall acceptability, respectively. Among the varieties which belonged to red purple group highest score (4.32, 4.10 and 4.20) was given to var. 'Eterna' for color, shape and overall acceptability, respectively. Among the varieties which belonged to red group highest score was given to var. 'A Modi Rose' (4.40 and 4.00) for color and shape, respectively. Whereas highest score for overall acceptability (4.14) among the red group was given to var. 'Clarie Chazal'. Highest score for fragrance was given to the var. 'Fragrant Plum' (4.96) followed by 'Double Delight' (4.92). Whereas, the lowest score (2.70, 2.80, 2.80 and 2.90) was given to var. 'Chantre' for Colour, shape, fragrance and overall acceptability, respectively.

Table 10: Consumer preference of different varieties of Hybrid Tea rose based on sensory evaluation

Variety	Consumer preference (out of 5)			
	Colour	Shape	Fragrance	Overall acceptability
Anika	3.90	3.10	3.10	3.40
Acapella	4.07	3.30	3.74	3.90
Auguste Renoir	3.04	2.96	3.34	3.04
Abhishek	4.04	3.86	3.16	3.76
A Modi Rose	4.40	4.00	3.66	3.88
Bora Bora	2.96	2.90	3.04	2.94
Chantre	2.70	2.80	2.80	2.90
Claire Chazal	4.12	3.94	4.08	4.14
Chitraranjini	3.04	3.94	4.30	3.70
Cherry Parfait	3.30	4.16	4.72	3.72
Double Delight	3.66	3.80	4.92	3.66
Eddy Mitchell	3.44	3.94	3.68	3.68
F. F. Rennaissance	3.34	4.00	4.36	3.96
Fragrant Plum	3.24	3.38	4.96	3.60
Eterna	4.32	4.10	3.90	4.20
Julio Iglesias	4.16	4.16	4.22	3.86
Mohana	4.92	4.80	3.36	4.70
Moonstone	4.60	4.66	4.50	4.48
Maurice Utrillo	3.34	3.74	3.68	3.72
Prescilla	3.34	3.46	3.58	3.30
Rose Rhapsody	4.20	3.98	4.30	3.86
Shi Un	3.24	3.12	3.42	3.46
Scandia	3.92	4.16	4.16	4.00
Tata Centenary	3.74	3.64	3.68	3.36
Temptress	3.96	3.80	4.16	3.44

Sensory score

5 - Excellent

4 - Very good

3 - Good

2 - Average

1 - Poor

V. DISCUSSION

Different varieties of the plant species express different behaviour with respect to growth, flowering, yield and quality parameters according to climatic conditions of a place. Thus, evaluation of varieties to know their suitability for particular location in order to select best performing ones which helps the farming community in order to maximize the production with quality produce.

Growth, development and productivity depend on the interactions between environmental factors and the genetic constitution of plants. Although, every plant has its specific inherent characters, such as color, size and growth rate, the environment under which it is grown dictates the realization of the genetic potential. Similarly, rose is one such crop which responds very much to the environment. The performance of cultivars of any crop differ from one region to another region so also their growing conditions. When different cultivars are grown under identical conditions, it is the genetic factor that expresses the morphological differences. Hence, selection of variety is an important criterion for successful cultivation of any flower crop. Several cultivars of Hybrid Tea have been released for commercial cultivation, however, their performance has not been tested under Eastern dry zone of Karnataka with respect to growth, yield and quality flowers.

Hence, the present investigation was carried out at Department of Floriculture and Landscape Architecture, College of Horticulture, UHS campus, Gandhi Krishi Vignana Kendra post, Bengaluru, Karnataka during 2017-18 for their growth, yield and quality characters.

The experiment was carried out during the period from October 2017 to March 2018 with twenty five varieties. The salient findings of the investigations are interpreted and discussed in this chapter in the light of similar research work done by other research workers. The discussion pertaining to different aspects of the present study has been furnished under the following heads.

Experiment: Evaluation of rose (*Rosa hybrida* L.) varieties for growth, yield and quality under eastern dry zone of Karnataka.

5.1 Vegetative parameters

The vegetative parameters decide the final yield of crops, which include plant height, plant spread, individual leaf area, stem girth, chlorophyll content and number of branches *etc.*

Plant height is an important growth related morphological character of crop plants. Plant height plays an important role in plant duration and productivity of any genotype. In the present investigation, the height of the plant varied significantly among the different rose varieties. Initially varieties ‘Scandia’ and ‘Chitraranjini’ recorded maximum plant height, in first and second month, respectively. Later on var. ‘Clarie Chazal’ recorded maximum plant height at all other stages of plant growth which was highly vigorous and significantly superior over other varieties. In the initial months of planting var. ‘Abhishek’ recorded minimum plant height and later var. ‘Tata Centenary’ recorded minimum plant height which was less vigorous in growth.

The increase in plant height could be due to rapid meristematic activity, probably due to rapid cell division and elongation during the tender growth stage (Sharova *et al.,* 1977). Variations for plant height is a varietal character (Kanamadi and Patil, 1993, in rose and Behera *et al.,* 2002, in chrysanthemum) and higher chlorophyll content of leaves might have increased the synthesis of carbohydrates, amino acids *etc.* from which phytohormones such as auxins, gibberellins and cytokinins have been synthesized resulting in increased plant height (Maynard and David, 1987).

Significant differences were observed among the different rose varieties with respect to plant spread. Maximum plant spread towards N-S direction during the initial months was recorded in the varieties 'Shi Un' and 'Anika', later it was maximum in var. 'Cherry Parfait'. Minimum plant spread towards north to south direction during the initial months was recorded in the var. 'Bora Bora', later it was minimum in 'Fragrant Plum'. Difference in plant spread of varieties might be due to genetic makeup of the variety. These results are in conformity with the finding of Malhotra (1997) in rose.

Plant spread towards E-W direction varied significantly among the different rose varieties. Maximum plant spread towards E-W direction was recorded in the var. 'Auguste Renoir'. Minimum plant spread was recorded in the var. 'Abhishek'. Difference in plant spread of varieties might be due to genetic makeup of the variety. These results are in conformity with the finding of Malhotra (1997) in rose.

Significant differences were also observed among rose varieties for stem girth. Stem girth was significantly highest in var. 'Clarie Chazal' followed by var. 'Chitraranjini'. The minimum stem girth was recorded in var. 'Tata Centenary'. Variation in stem girth is often a varietal character, rather than an indication of poor culture (Thomson and Wilson, 1957).

Leaves are the functioning units for photosynthesis particularly the chlorophyll content of leaf which influences the growth. The chlorophyll content in rose varieties varied significantly. In the present investigation, significantly maximum chlorophyll content was obtained in var. 'Clarie Chazal' whereas, minimum was in var. 'Double Delight'. The leaf chlorophyll content is a genetic character that differs according to varieties. Variation in chlorophyll content was also observed previously in rose (Ahmad *et al*., 2010) and in orchid (Thomas and Rani, 2008).

Significant differences were also observed among rose varieties for individual leaf area. In general the var. 'Clarie Chazal' recorded maximum individual leaf area. Individual leaf area was minimum in var. 'Tata Centenary'. The variation in the individual leaf area could be attributed to the genetic makeup of the varieties. These are in confirmation with the findings of Manjula (2005) and Sloan and Susan (2008).

Performance of any variety depends upon its genetic makeup and environmental conditions. Variation in plant vigour among the varieties could be attributed to the variation in their genetic makeup. Since these characters are genetically controlled, variations among the varieties are found to occur. Hence, vigorous growing varieties were superior over other varieties in some or in most of the vegetative characters like plant height, plant spread, individual leaf area, stem girth, chlorophyll content and number of branches *etc*.

5.2 Flowering parameters

There was significant difference among the varieties with respect to number of days to bud initiation. However bud initiation was earliest (36.00 days) in var. 'Chantre' and it was delayed in var. 'Maurice Utrillo'. This could be because of varietal characters. Similar findings were observed by Bhattacharjee *et al.* (1993) and Fascella and Zizzo (2007).

Flowers possessing a slow and uniform mode of opening have better consumer acceptance on account of their longer shelf and fresh appearance. Significant differences were obtained among the varieties with respect to days from bud initiation to tight bud stage. Among the varieties least number of days from bud initiation to tight bud stage was observed in var. 'Chantre' and it was delayed in var. 'Cherry Parfait'. This could be because of varietal characters. Similar results were obtained by Bhattacharjee *et al.* (1993), Nagaraja (1996) and Manjula (2005) in rose.

Significant differences were obtained among the varieties with respect to days from bud initiation to full bloom stage. Among the varieties, the least number of days from bud initiation to full bloom stage was recorded in var. 'Chantre'. However, it was delayed in var. 'Cherry Parfait'. Similar variations with respect to time taken for harvesting was reported by Chandrashekaraiah (1973) in rose. The variation among the varieties for different flowering characters may be due to differences in the inherent make up of these varieties.

5.3 Yield parameters

Ultimate aim of crop improvement is to achieve higher yields with good quality. The significant variation was observed for number of cut flowers per plant among the different varieties. Maximum number of cut flowers per plant was recorded in var. 'Cherry Parfait' which was on par with 'Moonstone'. The least number of flowers per plant was observed in var. 'Prescilla'. Number of cut flowers per m^2 also varied significantly among the varieties. Maximum number of flowers per m^2 was recorded in var. 'Cherry Parfait' and was significantly superior when compared with all other varieties. Minimum number of cut flowers per m^2 was observed in var. 'Prescilla'.

There was significant difference with respect to flower yield per plant in different varieties. Among the varieties 'Moonstone' recorded maximum flower yield/ plant which was significantly superior when compared with all other varieties. Followed by 'Moonstone', var. 'Cherry Parfait' was second highest flower yield/ plant. Whereas, the lowest flower yield/ plant was recorded in var. 'Prescilla'.

The flower yield per plant produced by these varieties could be at the expense of further leaf area development *i.e.,* source-sink relationship (Wang, 1999) as in case of anthurium. The favourable growing environment and climatic factors have also contributed for expressing their maximum yield potential (Betonia, 1996, Praneetha *et al.,* 2002 and Talia *et al.,* 2003).

5.4 Quality parameters

The rose varieties were evaluated for commercial cut flower production on the basis of various characters. The characters like, stalk length, bud diameter, vase life and number of petals were considered to be of prime importance (Primary characters) and should be more stressed upon as pre-requisites for cut flower purpose. A good variety possessing the desirable primary characters is considered as a good variety for cut flower production. Various characters of the twenty five rose varieties are discussed below with regard to their importance in cut flower production.

Flower bud diameter differed significantly among different varieties. Among the varieties, maximum flower bud diameter was observed in var. 'Acapella' and was significantly superior when compared with all other varieties. Whereas, the minimum flower bud diameter was recorded in var. 'Abhishek'. Probably, variation in flower diameter might be due to variation in the genetic makeup of varieties (Kanamadi and Patil, 1993 in rose and Mishra, 1999 in chrysanthemum). Similar findings were found in carnation by (Maitra and Roychowdhury, 2014).

Quality of cut flowers is judged based on flower diameter. Earlier in USA, big bloom varieties were preferred, however, now a days medium to small bloom varieties are preferred in the International market (Salunke *et al*., 1990). In the present study among the rose varieties evaluated, the flower diameter differed significantly among different varieties. The maximum flower diameter was observed in var. 'Acapella' which was on par with 'Anika', Chitraranjini, 'Moonstone' and 'Temptress'. Whereas, the minimum flower diameter was recorded in 'Abhishek'. The variation in flower size is mainly due to genetic makeup of the individual variety. Similar

variations in flower diameter were obtained by Murugesan *et al.* (1991), Polara *et al.* (2004) and Verma *et al.* (2008).

Significant differences were obtained among the varieties with respect to number of petals per flower. Maximum number of petals per flower was observed in var. 'Tata Centenary' and was significantly superior when compared with all other varieties. Whereas, the lowest number of petals per flower was recorded in var. 'Abhishek'. Difference in number of petals might be due to genetic makeup of the variety. Similar results while evaluating varieties for number of petals have been reported by Wright *et al.* (1961), Swarup *et al.* (1978) and Bhattacharjee *et al.* (1993).

Flower stalk length differed significantly among different varieties. Among the varieties maximum stalk length was observed in var. 'Clarie Chazal' and was significantly superior when compared with all other varieties. Whereas, the minimum stalk length was observed in var. 'Tata Centenary'. The variation in stalk length among the varieties may be attributed to the varietal character of the varieties. Long stalk for cut roses are pre-requisite in the International market. Whereas short stalk roses sell well in India, especially in the local market. Rose still occupies an important position as a traditional flower. However, the trend is fast changing in cities and urban areas resulting in a strong consumer demand for long stemmed roses. The difference in stalk length could be attributed to genetic factor which may vary among the varieties. Similar results while evaluating varieties for stalk length have been reported by Murugesan *et al.,* 1991, Bhattacharjee *et al*., 1993, Sundaram *et al.,* 1996, Ramzan *et al*., 2014; Mantur *et al*., 2005 and Fascella and Zizzo, 2005.

Flower stalk girth differed significantly among different varieties. The maximum stalk girth was observed in var. 'Eterna' which was on par with 'Acapella', 'Fragrant Plum', 'Mohana' and 'F. F. Rennaissance'. Whereas, the minimum stalk girth was observed in var. 'Tata Centenary'. Stalk girth is crucial character since it determines the sturdiness of the cut flowers. Malik and Dadlani (1986) recognized sturdiness of cut flowers as one of the important characters. The variation in the stalk girth is due to varietal differences, rather than poor culture (Thompson and Wilson, 1957).

Vase life of flower is considered to be important criteria for judging the commercial acceptability of the variety. Flowers with longer vase life are considered better. The range of vase life varied between 2 to 11 days in different varieties. Vase life in general is affected due to decline in water uptake and vascular blocking. The vase life of rose flowers under room temperature showed significant differences. Among the varieties maximum vase life was observed in var. 'Eterna' and was significantly superior when compared with all other varieties. Whereas, the minimum vase life was observed in var. 'Chantre'. Variation in vase life might be due to genetic makeup of the plant as some varieties show slow opening of petals while other show fast opening. Similar variations in vase life of varieties have been reported by Bhattacharjee *et al*. (1993), Bhattacharjee, (1994), Murugesan *et al*. (1996) and Malhotra (1997).

The rose varieties had variation in colour. Most of the varieties belonged to red purple group. The difference in flower colour in varieties might be due to genetic makeup of the variety. These results are in conformity with the findings of Murugesan *et al.* (1991).

All the varieties were fragrant however the intensity of fragrance varied among the varieties. On the basis of flower fragrance varieties have been considered as fragrant and non-fragrant. Fragrance in rose is due to presence of various substances like phenylethyl alcohol, citronellol, geraniol, nerol, citral, menthol *etc.* Fragrant roses are preferred over non fragrant roses. In the present investigation all the varieties were fragrant, however some had mild fragrance and some were more fragrant. Variation in flower fragrance among the varieties might be due to genetic makeup of the varieties. Fragrance also varies with age of flower as well as

prevailing environmental conditions. Similar variation in flower fragrance among varieties has also been reported by Malik and Dadlani (1986) and Murugesan *et al.* (1991).

5.5 Consumer acceptance- based on sensory evaluation

There was a significant difference with respect to sensory evaluation. However, highest score was given to var. ‘Mohana’ for colour, shape and overall acceptability by the judges, followed by var. ‘Moonstone’. Among the varieties which belonged to red purple group highest score was given to var. ‘Eterna’ for color, shape and overall acceptability. Among the varieties which belonged to red group highest score was given to var. ‘A Modi Rose’ for color and shape. Whereas highest score for overall acceptability among the red group was given to var. ‘Clarie Chazal’. Highest score for fragrance was given to var. ‘Fragrant Plum’ followed by ‘Double Delight’, whereas, the lowest score was given to var. ‘Chantre’ for colour, shape, fragrance and overall acceptability.

VI. SUMMARY

The present investigation on “Evaluation of rose (*Rosa hybrida* L.) varieties for growth, yield and quality under eastern dry zone of Karnataka’’ was undertaken during 2017-2018 at College of Horticulture, Bengaluru. The field experiment was conducted to evaluate twenty-five rose varieties under open field condition. The experiment was laid out in randomized complete block design with two replications. The results obtained from this investigation are summarized in this chapter.

Significant differences were observed among the varieties with respect to growth, yield and quality parameters.

6.1 Growth parameters

The rose cultivars showed significant variations for all the growth parameters studied. Among the cultivars evaluated, ‘Clarie Chazal’, ‘Chitraranjini’ and ‘Cherry Parfait’ showed superior performance for their growth attributes *viz*., plant height, plant spread number of branches, stem girth, leaf area and chlorophyll content. Hence, these varieties are regarded as vigorously growing varieties. The varieties ‘Tata Centenary’ and ‘Abhishek’ were found less vigorous in growth under field conditions.

6.2 Flowering parameters

Among different varieties bud initiation was recorded earliest in var. ‘Chantre’, however, it was delayed in var. ‘Maurice Utrillo’. The var. ‘Chantre’ recorded least number of days from bud initiation to tight bud stage, however, it was delayed in the var. ‘Cherry Parfait’. Among the varieties var. ‘Chantre’ took less number of days, whereas, var. ‘Cherry Parfait’ took maximum days for bud to bloom. Flowers possessing a slow and uniform mode of opening have better consumer acceptance on account of their longer shelf and fresh appearance.

6.3 Yield parameters

Maximum number of cut flowers per plant and number of cut flowers per m^2 were recorded in var. ‘Cherry Parfait’ followed by var. ‘Moonstone’. The least number of cut flowers per plant and number of cut flowers per m^2 were observed in ‘Prescilla’.

Among the varieties, ‘Moonstone’ recorded maximum flower yield/ plant and estimated flower yield/m^2. Var. ‘Cherry Parfait’ was second highest flower yielder. Whereas, the lowest flower yield/ plant and estimated flower yield/m^2 was recorded in var. ‘Prescilla’.

6.4 Quality parameters

The maximum flower bud diameter was found in var. ‘Acapella’, whereas, it was least in var. ‘Abhishek’. Highest flower diameter was observed in var. ‘Acapella’ followed by ‘Anika’, ‘Chitraranjini’, ‘Moonstone’ and ‘Temptress’. Whereas, the least flower diameter was recorded in var. ‘Abhishek’. Maximum number of petals per flower were observed in ‘Tata Centenary’ when compared to other varieties. Whereas, the lowest number of petals per flower was recorded in var. ‘Abhishek’.

Maximum stalk length was obtained in var. ‘Clarie Chazal’ when compared to other varieties. Whereas, the minimum stalk length was observed in var. ‘Tata Centenary’. The

maximum stalk girth was observed in var. ‘Eterna’ which was on par with ‘Acapella’, ‘Fragrant Plum’, ‘Mohana’ and ‘F. F. Rennaissance’. Whereas, the minimum stalk girth was observed in var. ‘Tata Centenary’. Maximum vase life was observed in var. ‘Eterna’ and was significantly superior when compared with all other varieties. Whereas, the minimum vase life was observed in var. ‘Chantre’.

The flower petal colour of most of the varieties belonged to red purple group followed by red group and only few varieties belonged to white group. In the present investigation all varieties were fragrant, however some were highly fragrant such as ‘Fragrant Plum’, ‘Double Delight’ and ‘Cherry Parfait’ with high consumer score and some varieties had mild fragrance. Whereas few varieties like ‘Chantre’, ‘Anika’ and ‘Abhishek’ were less fragrant with low consumer score.

6.5 Consumer acceptance- based on sensory evaluation

The highest score was given by the consumer to the var. ‘Mohana’, followed by var. ‘Moonstone’ for colour, shape and overall acceptability. Among the varieties which belonged to red purple group highest score was given to var. ‘Eterna’ for color, shape and overall acceptability. Among the varieties which belonged to red group highest score was given to var. ‘A Modi Rose’ for color and shape. Whereas highest score for overall acceptability among the red group was given to var. ‘Clarie Chazal’. Highest score for fragrance was given to the var. ‘Fragrant Plum’ followed by ‘Double Delight’, whereas, the lowest score was given to var. ‘Chantre’ for Colour, shape, fragrance and overall appearance.

Practical application

Considering various aspects of cut flower production and quality parameters, the varieties, ‘Acapella’, ‘Clarie Chazal’, ‘Cherry Parfait’, ‘Double Delight’, ‘Eterna’, ‘Moonstone’, ‘Mohana’, ‘Shi Un’ and ‘Scandia’ are the promising varieties with respect to most of the parameters investigated and are best suited for the open cultivation under eastern dry zone of Karnataka.

Future line of investigations

1. Standardization of agro techniques for promising varieties.
2. Screening of promising varieties for biotic and abiotic stresses.
3. Crop improvement using elite varieties.
4. Evaluation of promising varieties under polyhouse conditions.

VII. REFERENCES

Adnan, Y. and Atif, R., 2005, Effect of various hormones and different root stocks on rose propagation. *Caderno de Pesquisa serie Biologia.* 17(1): 111-118.

Ahmad, I., Khan, A. M., Qasim, M., Ahmad, R. and Randhawa, A. M., 2010, Growth, yield and quality of *Rosa hybrida* L. as influenced by various micronutrients. *Pak. J. Agric. Sci.,* 47(1): 5-12.

Anonymous, 2017, Horticulture Statistics at a glance 2017. Indian Horticos, 2018.

Ashwath, T., Rao, M. and Ramachandran, N., 2007, Promising crossandra (*Crossandra undulaefolia* Salisb.) F_1 hybrids IIHR 2004-09 and 2004-11. *J. Orn. Hort*., 10(1): 64-66.

Ashwath, T., Rao, M. and Ramachandran, N., 2009, Promising crossandra F_1 hybrids IIHR 2005-1 and 2005-2. *J. Orn. Hort*., 12(3): 211-212.

Atram, V. R., Panchabhai, D. M. and Patil, S., 2015, Evaluation of hybrid tea rose varieties suitable for Nagpur condition based on morphological, yield and yield contributing parameters. *J. Soils Crops,* 25(2): 300-305.

Becker, H. F., 1963, The fossil record of the genus *Rosa. Bulletin* of the Torrey Botanical Club. , 90: 99-100.

Behera, T. K., Sirohi, P. S. and Pal, A., 2002, Assessment of chrysanthemum germplasm for commercial cultivation under Delhi condition. *J. Orn. Hort.,* New series 5 (2): 11-14.

Betonia, G. L., 1996, Germplasm collection and evaluation of different anthurium cultivars. *J. Crop Sci.,* 20: 12.

Bhattacharjee, S. K., 1994, Post-harvest life of cut roses as affected by varietal differences. *South Indian Hort*., 42(5): 331-334.

Bhattacharjee, S. K., Singh, V. C. and Saxena, N. K., 1993, Studies on vegetative growth, flowering, flower quality and vase life of roses. *Singapur J. Primary Industries*, 21(2): 67-71.

Bihari, M., Suryanarayan and Singh, A. K., 2009, Effect of pruning levels and biofertilizers on production of rose cut flowers. *J. Orn. Hort.*, 12(1): 48-53.

Blom, T. J. and Tsujita, M. J., 2003, Cut rose production. *In A V Roberts*, Debener, T. and Gudin, S., (Eds) Encyclopedia of Rose Science. Elsevier, 2: 594-600.

Buchem, A. Y., Keditsu, R. and Lalthawmliana, A., 2015, Varietal performance of Hybrid Tea Rose in open field under foothill conditions of Nagaland. *J. Orn. Hort.*, 11(2): 23-26.

Chandrashekaraiah, T. S., 1973, Studies on evaluation of the hybrid tea roses for cut flowers. *M.Sc. (Agri.) Thesis*, Univ. Agric. Sci., Bangalore, India.

Chawla, S. L., Patil, S., Ahlawat, T. R. and Agnihotri, R., 2016, Present status, constraints and future potential of floriculture in India. *Comm. Hort*., 29-38.

Dias, S. M. F. and Patil, A. A., 2003, Performance of elite rose varieties at different population levels under transitional tract of Northern Karnataka. *Karnataka J. Agric. Sci*., 16(2): 271-275.

Ertter, B., 2001, Native California roses, an online Monograph published through the University of California, available at http://ucjeps.berkley.edu/ina/roses/ roses.html.

Fascella, G. and Zizzo, G. V., 2005, Effect of growing media on yield and quality of soil less cultivated rose. *Acta Hort.,* 697: 43-47.

Fascella, G. and Zizzo, G. V., 2007, Evaluating the productivity of red rose cultivars in soilless culture. *Acta Hort.,* 751: 138-140.

Filiberti, D, 2005, Hybrid Tea Roses. Available online at http://www.rosegathering.com/ hybridteas.html

Garica, A. L. and Mejias, R. J., 1982, Adaptation of ten rose cultivars to the American sand culture system in vinery type greenhouses. *Boletin Informative*, 2**:**2-11.

Gherghi, A., Amariutei, A. and Baloiu, I., 1983, Performance of some rose cultivars in preserving solutions in ambient conditions. *Lucraisi Stinfifice Institutul de ceretari legumeler sp Fructelor.* 14:125-129.

Gowda, J. V. N., Sulladmath, U. V. and Murthy, K., 1979, Evaluation of eight hybrid tea roses for cut flower. *Mysore J. Agric. Sci*., 13(3): 275-277.

Gowda, J. V. N., Sulladamath, U. V. and Murthy, R., 1980, Studies on evaluation of eight hybrid tea roses for cut flowers. *Prog. Hort*., 12(3): 23-28.

Grzeszkie, W. H. W. and Rejman, S., 1991, Evaluation of some rose cultivars in glasshouse production. *Instytut sadownictwa-ikwiaciarstwa- w-skierniewicach-seria-B-Rosliny-ozodobne*, 16: 7-19.

Henchen, E., 1981, Unter Schungen in Rosensortiment der DDR 6. Schinittleistung. *Archiv for Gartenbau*. 29: 307-315.

Hussain, A. and Khan, M. A., 2004, Effect of growth regulators on stem cutting of *Rosa bourboniana* and *Rosa gruss-an-teplitz*. *Int. J. Agric. Biol*., 6: 931-932.

Ichimura, K., Kawabata, Y., Kishimoto, M., Goto, R. and Yamada, K., 2002, Variation with the cultivar in the vase life of cut rose flowers. *Bull. Nat. Inst. Flor. Sci*., 2:9-20.

Kanamadi, V. C. and Patil, A. A., 1993, Evaluation of eight rose cultivars under Northern Transitional tracts of Karnataka. *The Indian Rose Annual*, 11: 139-142.

Khattak, A. M., Munir, M. and Baloch, J., 1995, Environmental response of some exotic rose cultivars to D. I. Khan conditions. *Pak. J. Bot*., 27(2): 399-403.

Lundstad, A., 1975, Cultivar testing of floribunda roses, 1968-1972. *Fprsk. Fors. Landbr*., 26(2): 233-244.

Madhubala, Ramesh, K. and Kushal, S., 2008, Evaluation of rose (*Rose spp*.) cultivars for post-harvest attributes. *J. Orn. Hort*., 11(1): 77-78.

Maitra, S. and Roychowdhury, N., 2014, Performance of different carnation (*Dianthus caryophyllus* L.) cultivars grown from seed in the Plains of West Bengal, India. *Int. J. Bioresour. Stress Manage*, 5(2): 294-297.

Malhotra, R., 1997, Studies on plant growth of flower production of commercial cultivars of rose (*Rosa hybrida* L.) under polyhouse and natural conditions. *M. Sc. Thesis*, Punjab Agic. Univ., Ludhiana, India.

Malik, R. S. and Dadlani, N. K., 1986, Genetic improvement of ornamental plants in India. *Indian J. Genet.,* 46: 253-66.

Manjula. B., 2005, Performance of rose cultivars under naturally ventilated polyhouse. *M. Sc. Thesis,* Univ. Agril. Sci., Dharwad, India.

Mantur, S. M., Bagali, A. N. and Patil, S. R., 2005, Influence of bending and pruning on different varieties of roses under naturally ventilated polyhouse. *Karnataka J. Agric. Sci*., 18(2): 474-477.

Marriott, M., 2003, *In A V Roberts*, Debener, T. and Gudin, S., (Eds) Encyclopedia of Rose Science., Elsevier, 1: 402-409.

Maynard, G. H. and David, M. O., 1987, The physiology of plants under stress. *A Wiley Inter Science Publications,* New York.

* Meneve, I. and Moermans, R., 1986, Comparative trial of rose cultivars grafted on different rootstocks. *Revue de and Agriculture* 39: 593-97. (Abstr. in Hort. Abstracts, Entry No. 8078, 1986).

Millia, M., 1974, Greenhouse variety trials with roses, *Acta Hort.*, 43 (1): 177-182.

Mishra, H. P., 1999, Evalaution of small flowered varieties of chrysanthemum for calcareous belt of North Bihar. *Indian J. Hort*., 56(2): 184-188.

Mohanty, C. R., Mohanty, A., Das, A. B. and Kar, D. S., 2011, Comparitive performance of rose varieties under open and protected environment. *The Asian J. Hort.* 6(2): 288 – 293.

Mulla, A. L., Patil, M. T. and Singh, B. R., 1995, Growth and flowering performance of rose cultivars. *J. Maharashtra Agric. Univ.* 29: 227-229.

Murugesan, S., Thamburaj, S. and Ramani, K., 1991, Performance of rose cultivars at Yercaud. *South Indian Hort*., 39: 359-362.

Murugesan, S., Thamburaj, S. and Thangaraj, T., 1996, After life of cut roses in vase. *South Indian Hort.,* 43: 168-70.

Acapella

Eterna

Shi Un

Plate 10. Promising rose varieties which belonged to red purple group

Clarie Chazal

Plate 11. Promising rose variety which belonged to red group

Cherry Parfait

Double Delight

Scandia

Plate 12. Promising rose varieties which were double coloured

Mohana

Plate 13. Promising rose variety which belonged to yellow orange group

Moonstone

Plate 14. Promising rose variety which belonged to green white group

Nadeem, M., Aslam K. M., Riaz, A. and Ahmad, R., 2011, Evaluation of growth and flowering potential of R*osa hybrida* cultivars under Faisalabad climatic conditions. *Pak. J. Agri. Sci.,* 48(4): 283-288.

Nagaraja, N. B., 1996, Performance of exotic rose cultivars under polyhouse condition. *M.Sc. (Hort.) Thesis*, Univ. Agril. Sci., Bangalore, India.

Nybom, H., Werlemark, G., Esselink, D. G. and Vosman, B., 2005, Sexual preferences linked to rose taxonomy and cytology. *Acta Hort.*, 690: 21-27.

Pal, P. K., Singh, R. K. and Prasad, R., 2012, Non-destructive estimation of chlorophyll and nitrogen content in leaf of *Rosa damascene* (Mill). *Soil Sci. Plant Nutrition*. 58(5): 604-610.

Panse, V. S. and Sukhatme, P. V., 2002, Statistical methods for agriculture workers, ICAR, New Delhi, pp: 152- 155.

Patel, M., Ganga, M., Jawaharlal M. and Jeyakumar, P., 2018, Assessment of qualitative and quantitative flower quality parameters of certain commercial jasmine varieties during flowering season. *Int. J. Pure App. Biosci.,* 6 (1): 1652-1655.

Phillips, R. and Rix, M., 1988, Roses, *Pan Books Ltd*. London.

Polara, N. D., Viradia, R. R. and Khimani, R. A., 2004, Evaluation of different rose cultivars in summer under south Saurashtra condition. *J. Orn. Hort.*, 7(3-4): 102-105.

Polmacher, H., 1976, Rose trails on kordes nursery, *Baumschul pronis,* 6(4): 108-109.

Praneetha, S., Jawaharlal, M. and Vijayakumar, M., 2002, Performance of anthurium under shadenet condition at Yercaud. *J. Orn. Hort*., 328-329.

Qasim, M., Iftikhar, A. and Tanveer, A., 2008, Optimizing fertigation frequency for *Rosa hybrida*. *Pak. J. Bot.,* 40(2): 533-545.

Rabbi, F. F., Hussain, K. and Rafiq, M., 2004, Evaluation of different rose cultivars under the agroclimatic conditions of Hattar, Haripur (NWFP) Pakistan. *Sarhad J. Agric*., 20(1): 43-45.

Raheela, T., Ghaffoor, A., Waseem, K. and Nadeem, A. M., 2002, Evaluation of rose cultivars as cut flowers production. *Asian J. Plant Sci.*, 1(6): 668-669.

Rahuldas, 2017, Evaluation of Crossandra (*Crossandra undulaefolia* Salisb.) genotypes under eastern dry zone of Karnataka. *M.Sc. (Hort.) Thesis*, College of Horticulture, Univ. Hort. Sci., Bagalkot, India.

Ramachandrudu, K. and Thangam, M., 2010, Characterization and evaluation of local germplasm of crossandra (*Crossandra undulaefolia* Salisb.). *J. Orn. Hort.*, 13(2): 138-141.

Ramzan, A., Hanif, M. and Sudheer, T., 2014, Performance of *Rosa hybrida* cultivars under agroclimatic conditions of Islamabad, Pakistan. *J. Agric. Res*., 52(1): 153-159.

Salunke, D. K., Bhati, N. R. and Desai, B. B., 1990, In: *Post harvest Biotechnology of Flowers and Ornamental Plants,* Naya Prakash Publication Kolkata, pp.2-4.

Scharoder, V., 1975, Does Baccaara have competition. *J. Hort. Sci*., 75 (19): 416-418.

Shahrin, S., Roni, M. Z. K., Taufique, T., Mehraj, H. and Uddin, A. F. M. J., 2015, Study on flowering characteristics and categorization of rose cultivars for color, fragrance and usage. *J. Biosci. Agric. Res*., 4(1): 20-30.

Sharma, and Sharma, S. K., 2003, Scoring technique for rose evaluation. *J. Orn. Hort.,* New series, 6(1): 50-54.

Sharova, N. L., Rybak, Yu, G. and Marins, W. E., 1977, Development of gladiolus under the influence of micronutrients. *Refractivnyi Zhurnal*. 6(55): 1093.

Singh, P., Dubey, R. K., Singh, R. and Ramesh K., 2013, Evaluation of floribunda rose (*Rosa hybrida* L.) cultivars for landscape use under Punjab condition. *J. Hort. Sci.,* 8(2):271-275.

Sivasamy, N. and Bhattacharjee, S. K., 2000, Studies on vase life of rose cultivars. *J. Orn. Hort*., 3(2): 128-130.

Sloan, C. and Susan, S. H., 2008, Field performance of cut flower rose cultivars in Mississippi. *Hort. Technol.,* 18(4): 734-739.

Sundaram, K. S., Rajamani, K., Rengasmy, P. and Azhakiamanavalan, R. S., 1996, Studies on the performance of hybrid tea rose cultivars. *South Indian Hort*., 44(3/4): 83-84.

Swarup, V., Malik, R. S. and Singh, A. P., 1978, Some new Indian roses. *Indian Hort.,* 23: 15-16.

Tabassum, R., Waseem, A. G. K. and Nadeem, M. A., 2002, Evaluation of Rose cultivars as cut flower production. *Asian J. Plant Sci*., 1: 668-669.

Talia, M. A. C., Cristiano, G., Forleo, L. R., Lipari, V., Noto, G. and Leonardi, C., 2003, Evaluation of new anthurium cultivars in soilless culture. *Acta Hort*., 614: 223-226.

Thomas, B. and Rani L. C., 2008, Assessment of floral characters in commercial varieties of monopodial orchids. *J. Orn. Hort*., 11: 15-20.

Thompson, R. and Wilson, H. V., 1957, Roses for pleasure, *D. Van Hostr and Company Inc. Princeton,* New York.

Verma, S., Santosh K. and Deepti, S., 2008, Studies on variability for various quantitative traits in rose (*Rosa spp.*). *J. Orn. Hort*., 11(1): 62-65.

*Wagenknecht, J., Rakke, A., Haenchen, E. and Moschner, D., 1984, Problems and possibilities of outdoor rose production of cut flowers. *Gartenbau* 31: 343-44 (Abstr. *In Orn. Hort Abstracts*, 11 Entry No. 815, 1985).

Wang, Y. T., 1999, Green house performance of six potted anthurium cultivars in a sub-tropical area. *Hort. Technol*., 9: 402-409.

Wasnik, P., Raut, V. U., Bhande, M. H. and Shambhavkar, V. B., 2015, Evaluation of scented rose varieties for yield and quality of flowers. *Plant Archives,* 15(2): 895-897.

*Wisniewska, G., Zkiewicz, H. and Witaszek, W., 1994, Evaluating the suitability of 26 rose cultivars grown for cut flowers in a heated plastic tunnel. *Instytutu Sadownie two kwiaciarstur W Skierniewicach* 1: 85-94 (Abstr. *In Orn. Hort. Abstracts*, 20, Entry No. 989, 1994).

*Wright, R. C. M., Brett, W. S., Antiss, L. A., Pearson, L. E., Chyampneys and Hercourt, P., 1961, Roses. Ward, Lock and Co., Guildford and London (Cited by Singh D (1995) Improvement of roses through controlled and open pollinated progenies. *M. Sc. Thesis*, Punjab Agric. Univ., Ludhiana.

Zarina, G., Ghaffer, A., Waseem, K. and Nadeem, M. A., 2001, Evaluation of six exotic rose cultivars by three different pruning intensities. *Sarhad J. Agric*., 17: 91-96.

---

* Original not seen

APPENDIX

Meteorological data recorded during the experimental period

Month	Total Rainfall (mm)	Temperature (ºC)		Relative Humidity (%)	
		Max.	Min.	Max.	Min.
October, 2017	264.0	28.1	19.0	91.0	56.0
November, 2017	11.4	26.9	17.5	90.0	60.0
December, 2017	8.8	26.3	14.9	89.0	58.0
January, 2018	0.0	27.4	14.1	87.0	52.0
February, 2018	3.0	29.4	15.3	86.0	48.0
March, 2018	62.2	32.0	17.7	75.0	35.0
April, 2018	37.0	33.2	20.8	83.0	39.0

*AICRP on Agrometeorology, GKVK, UAS, Bengaluru