PERFORMANCE OF ROSE CULTIVARS UNDER NATURALLY VENTILATED POLYHOUSE

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I. INTRODUCTION

Flowers are symbolic of beauty, love and tranquility, they form the soul of garden and convey the message of nature to mankind, especially, the rose since it is world's most favourite and unchallenged 'Queen of flowers', belonging to the family 'Rosaceae'. It is being grown for various purposes, such, as garden flowers, for aesthetic value, cut flowers for decoration and for making various products such as rose oil, rose water, gulkhand rose attar, garland etc.

Rose ranks first among the top ten cut flowers in the international flower market. The export trade of rose was 178.60 million dollars at international markets (Swarup, 1993). The major producers of rose cut flowers are Netherlands (65%), Columbia (13%), Israel (8%) and Italy (7%).

With the advent of Government of India's liberalization policies and floriculture development initiatives, several corporate bodies have entered to set up 100 per cent Export Oriented Units, since the implementation of new policies during 1991. Export Oriented Units are supported with technology and marketing tie up with the collaborators from Netherlands and Israel. These were setup in and around Bangalore, Pune, Hyderabad and Delhi mainly of rose, carnation and anthuriums. The area under greenhouse in India is estimated to be around 1400 ha, of this, many have received very encouraging results in terms of acceptance of quality in the major international markets (Anon., 2004)

Ornamental plant or cut flower production can be successful and economical only if the finished products are excellent both in terms of quality and quantity. Among the cut flowers, cultivation of rose is highly lucrative profession and also has good export potential. The heavy demand for rose cut flowers in the European markets is mainly from November to March due to the shortage of local production because of severe winter. Fortunately, this is the most congenial condition for successful production of most of the flowers, including roses, in India. It is pointed out that buyer at international market prefers a very high quality rose cut flowers.

As it is difficult to obtain good quality cut flowers under open conditions throughout the year. Hence the crops should be cultivated under cover to get good quality produce. Although greenhouses are expensive, polyhouse using polyethylene film may be usefull to produce quality blooms, year round at comparatively low costs.

Polyhouse is a framed structure covered with transparent polyethylene films, large enough to grow crops under partial or fully controlled environmental conditions to obtain optimum growth and quality production. The main advantages of polyhouse cultivation are the crops can be cultivated successfully throughout the year, getting high productivity with excellent quality, moreover it is easy to protect the crops against extreme climatic conditions and incidence of pests and diseases, thus the genetic potentiality of the crops can be exploited to the maximum extent.

Expressesion of characters such as number of flowers per plant, stem length and flower diameter vary due to genotype, environment and growing conditions such as soil and inputs.

Since the commercial rose cultivation is gaining importance, one should screen the varieties to find out their suitability for the particular area and growing condition before recommending them for cut flower production purposes.

An ideal cut flower should remain fresh with respect to its colour and without losing its quality for a reasonable length of time. It is estimated that two thirds of the life of cut flower, which depend on the environment to which the flower is exposed after harvest. The vase solution plays a major role in increasing the vase life of flower. Therefore, considering the utility, productivity and quality of the rose, the present study was taken up with the following objectives.

1. To find out the suitable rose cultivars under naturally ventilated polyhouse.
2. To study the productivity and quality of the rose cultivars under naturally ventilated polyhouse and.
3. To study the vase life of rose cultivars.

II. REVIEW OF LITERATURE

The literature pertaining to the performance of rose cultivars under naturally ventilated polyhouse and vase life as studied by several workers is reviewed and presented in this chapter under the following sub headings.

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2.1 VARIETAL PERFORMANCE

Lundstad (1962a) reported experimental findings of varietal trials with 31 floribunda roses during the period 1954-60. They were evaluated for different characterstics like height of the plant, colour, size of the flower. Based on the evaluation results two cultivars 'Border king' and 'Schweizer Cruss' were recommended for cultivation. Chandrashekaraiah (1973) evaluated eight rose cultivars during rainy and winter season and reported that maximum number of flowers per plant (7.28 and 8.32), Petals per flower (43.30 and 44.47), total stem length (64.10 and 56.69 cm) and bud length (4.61 and 5.00 cm) were obtained with Superstar, Kings Ramson, Fountain Beau and White Christmas, respectively.

In a trial 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 62.19 flowers/m^2, respectively (Millia, 1974).

Schroder (1975) reported that highest yield was recorded with Magic Moment (31.7 blooms/m^2) fallowed by Illona with 24 blooms/m^2, whereas least number of flowers was obtained with Cv. Baccara. The longest stem length (50-80cm) was recorded in Baccara and Illona.

Lundstad (1975) evaluated 45 new cultivars of Floribunda and Polyantha roses during the period 1968-1972. He found maximum plant height in cultivar Scarlet Elizabeth (84cm). The cultivars Gold Rausch and Tiptop produced flowers with high diameter (9.50 cm). The number of petals was maximum in cultivar. Based on the results of evaluation the cultivars Janspeck, Pernille, Pouisen and Tiptop were recommended as best.

In another test conducted by Plomacher (1976) among the nine cultivars, Marina produced highest cut flower yield of 4.80 blooms/plant and 34 blooms/m^2 gross area.

Gill and Atwal (1976) indicated that the experimental plants inside the tent flowered three weeks earlier than those grown outside and they produced 166 per cent more flowers and had stem length between 80.40 cm and 100.20cm. The uniform height and bloom and absolute freedom from any blemish or frost bite on the flowers grown inside the tent. Increase in yield and good quality of cut flower ascribed to the higher maximum temperature inside the polythene tent.

Kore *et al*. (1977) evaluated 56 rose cultivars for resistance to die back caused by *Diplodia rossarum* out of which 11 were highly resistant including white christmas, Royal Ascot, Blue moon, and Crimson Glory. Bogamzova (1978) studied 62 rose cultivars and reported that Baccara rose, Guazard and Superstar were found to be the most suitable cultivars for Plastic film houses and 'Bel Ange', 'Baccara', 'Gloria Dei', 'Mamorion', 'Ophelia', 'Superstar', 'Alska' were found to be most productive cultivars.

Gowda *et al*. (1980) evaluated eight hybrid tea roses for cut flowers. The character evaluated was shoot length which was found to be maximum in Mainauperle (36.00 cm) and minimum in Red Devil (18.58 cm). The Christian Dior variety had maximum stem length (47.09cm). The total numbers of well-developed petals were found to be maximum in Red Devil. The density of thorns per 2.5 cm shoot was observed to be maximum in Mainauperle (6.25) and minimum in pink Parafait (2.25).

Gowda *et al*. (1979) reported that rose Cv. Eiffel Tower produced highest number of marketable flowers (21.50/plant) followed by Jovencelle (16.50), Summer Queen (10.70) Elida Cardinal, First Prize, Agena and Jhon F. Kennedy (4.00).

Lundstad (1979) recommended, Koniginder Rosen, Pascali and Peer Gynt cultivars for cultivation based on flower number, flower size, number of petals, colour and scent.

The longest stem length was obtained with cultivars Folkore, Romantica-76, Corso and Carlita, whereas least stem length was recorded in Traumeria. There was reduction in number of cut stems (40%) due to frost. The early cultivars fetched the highest price in June whereas late cultivars were less productive but produced high quality flowers with long stems. The Cv. Folkore had the longest stems (90-120cm), whereas Traumerei had the shorter stems (50-80 cm) but with longest vase life (Plomacher, 1980) out of 24 new roses evaluated, Van (1980) recommended four best cultivars, namely Sandokan, Candida, Elvira and Ramco for cut flowers.

Henchen (1981) reported that highest average number of cut stems per plant was obtained with Spartan, Crimson Glory, Sutter's Gold of 20.30, 19.30 and 19.10 respectively. The longest average stem length was obtained with Banjour and Raokete of 46.70cm and 49.00cm, respectively.

Garica and Mejias (1982) reported that highest yield was obtained with Cv. Laminuette (551 flowers/335 plants) followed by Sabrina, Golden time, Candida Caste, Blanche, Bettina, Sonia, Mercedes, Visa and Samantha of 479, 477, 35, 291, 254 199, 129 and 39 flowers per 313-347 plants.

In a trial using two types of rose cultivars, viz., medium flower roses and mini roses, the Cv. Prominent produced high quality flowers and Belinda was useful for its high autumn winter yield, among medium flowered roses, whereas in mini roses more number of flowers (1816 flowers/m^2 in six years) was obtained with Cv. Carol and Cv. Zorina produced high quality long lasting flowers (Roxas, 1982).

Ginzburg *et al*. (1983) reported that Cv. Mercedes was more sensitive to low temperature than other cultivars like Sonia and Bingo where flower yield was reduced when the maximum air temperature was 14^0C or less. The cultivar Mercedes and Bingo exhibited higher yields during winter months.

Miske (1983) reported that the Cv. Athena (white), Cauana (copper yellow), Mirato (red yellow), Pasandena (orange red) proved superior among mini rose cultivars evaluated.

Gelder (1985) reported that rose cultivars Darling Ulsteta, Lovely Girl and Ruby were considered the best for cut flower production. Out of 35 rose cultivars evaluated, 19 were found to be outstanding including one yellow, three salmon orange, four pink red, ten deep red and one bi-colour cultivars (Larson,1985).

Vypari (1985) studied fifty rose cultivars and reported that cultivars Ambassador. Bul's Red, Ferry, Pozssche, Illona, Interflora and Vasavi having stalk length of 85.67, 65.67, 79.50, 61.17, 46.00, 77.17 and 53.25 cm respectively were found to be suitable for cut flower production.

Denchev and Groshkov (1989) studied the cost effectiveness of growing 7 cultivars viz., 'Baccara', 'Standard', 'Carina', 'Illona', 'Mount shasta', 'Pascali', Peer Gynt' and 'Sonia'

on *Rosa canina* cultivars Plovdiv-1 root stock in unheated houses was compared. The highest yield of cut flowers were produced by 'Carina' Sonia' and 'Pascali' respectively.

Bhattacharjee *et al*. (1993) reported longer stem length, highest diameter of shoots in Cv. Eiffel Tower, whereas highest diameter was recorded with Raktha Gandha, The Cv. Sonia Meilland was earliest to initiate flowering after pruning, the Cv. Raja surrender Singh of Nalagarh recorded maximum vase life of (10.60 days) fallowed by Dr. B.P. Pal (9.8 days) highest number of petals obtained with Dr. B.P. Pal (47.80). Whereas least number of petals was observed in Raja surrender Singh of Nalagarh.

2.2 EFFECT OF POLYHOUSE

Polyhouse is a framed structure cladded with polythene film, which can provide the favourable climatic condition for the growth and development of plant in several ways, viz., favourable environmental conditions, protection against wind, pest and diseases and other climatic conditions.

Most of the flower production in other countries is being done in climatically controlled greenhouse. This has also been identified as thrust area for development in our country. The data of some of the preliminary trials that have been conducted under polyhouse is furnished here under.

Gill (1984) observed flowers grown under modified growing environment of using plastic cover over rose plants during November-February to be of high quality, An yield of 1,20,000 cut roses of exportable quality was possible from a hectare by following close density planting.

Dadlani *et al* (1990) reported nearly 45 per cent for number of flowers per plant and per cent for bud size in rose plants grown under plastic greenhouse.

Guttal and Takte (1993) studied the effect of low cost polyhouse for production of chrysanthemum and obtained significant results, with respect to yield (20.19t/ha). Average weight of flowers per plant (389g), diameter of the flower (6.5 cm), vase life (12 days) and attractive colour compared to the cultivation under open conditions.

The cultivar Kiss produced the highest flower yield (80.96/$m^{2)}$ fallowed by Yunone (64.16/m^2) and Vivaldi (57.79/m^2), as compared to Gladiator, which produced the least number of flowers (44.13/m^2). Quality parameters viz., bud length, bud diameter and total stem length, were found to be superior in Gladiator fallowed by Yunone and Vivaldi. The Cv. kiss had better vase life (9.37 days). Gladiator recorded 9.0 days and Yunone 8.25 days' vase life, where as Eterna recorded the least vase life (7.25 days) (nagaraja,1996)).

Sindhu and Rameshkumar (2004) laid out an experiment to study the performance of four commercial cut flower rose varieties viz., Konfetti, Novajo, Grandprin and Rakathagandha under unheated polyhouse, Maximum number of flowers/m^2 (10.42) was produced by Novajo followed by Konfetti (8.60) and Rokatgandha (8.22). Length of the cut stem was minimum (47.64cm) in Novajo, Konfetti, Gradprin and Rakthagandha were at par with each other. Size of the flower and number of petals /flower were observed to be maximum (7.15cm and 21.60cm, respectively) in Grandprin resulting in the longest vase life.

Mandhar and Rathinakumari (2004) reported that naturally ventilated greenhouses of size 32 m length, 6m width and 3.5 m side height and 5 cm center height were designed and constructed for cultivation of rose under Bangalore conditions. Side ventilation of 83 per cent of floor area was provided with insect proof net of zero nylon mesh. The shade net (green colour) of 25 per cent cutoff value was provided at a height of 3.5 m. The crops were provided with drip irrigation .The side ventilation covered with white colour shade net to retain relative humidity and solar radiation. The temperature in rose greenhouse was within ± 2^0C in comparison with the ambient temperature and relative humidity was higher up to 5 per cent above ambient conditions. The percentage of solar radiation inside the greenhouse was 46 per cent to 44 per cent for rose under the above greenhouse microclimate conditions good crops could be maintained. The yield of rose was 160 flowers/m^2.

Chandragiri *et al*. 2004 reported that 20 exotic spay varieties of chrysanthemum evaluated for their performance under naturally ventilated greenhouse. Among them, Solomon Impala recorded the highest plant height (132.16 cm) at harvesting stage. Rafel

recorded least number of flowers per plant (6.93), while Variety Shuttle and Require recorded maximum flower diameter (7.39 cm). Caymen recorded the highest number of ray florets per flower head (314.27). Maximum vase life was observed in varieties Linekar and Linekar Amber. The study found that all the exotic varieties produced good quality cut flowers and can be grown successfully around Bangalore under protected structure.

Malhotra and Kumar (2000) conducted experiment in Department of Floriculture and Landscaping, P.A.U., Ludhiana and reported that the effect of different treatments overhead shading and polythene covering on rose Cv. Raktagandha. It was observed that maximum wood weight which were maintained under 50 per cent shading treatment during the summer. The maximum plant height and plant spread were observed in plants, which were given 25 per cent summer shading fallowed by winter covering. However, maximum number of flowers per plant was observed in plants maintained under 50 per cent shad and polythene covering. Performance of plants was best in plants maintained under 25 per cent shading treatments, as far as number of 'A' grade flowers are concerned. The plant produced blooms about 10 days earlier under 25 per cent shading than 50 per cent shade plants.

2.3 VASE LIFE STUDIES

Cut flowers are living, actively metabolizing, heterogeneous organs composed of floral and foliar parts each of which may be at different physiological and developmental stage. The termination of vase life of many cut flowers is characterized by wilting even though they are constantly held in water (Kende and Baumgartner, 1974).

The point of termination of vase life varies from the first sign of wilting and fading (Halevy and Kofranek, 1977) to the total death of all flowers (Salinger, 1975) with all the intermediates values between these points (Molnar and Parups, 1977).

Halevy and Mayak (1979) opined that the term vase life should represent the potential useful longevity of the flowers at the final consumer's home.

The short vase life of roses is often related to water stress characterized by incomplete bud opening, rapid loss of fresh weight, water deficit and poor maintenance of turgidity. Many studies have been carried out to evaluate the events leading to this phenomenon. The use of preservative solutions to promote the quality and prolong the vase life of cut flowers has been known for many years.

The use of chemical preservatives to extend the shelf life of cut flowers is an age-old practice. Water is the prime source for cut flowers. A source of repairable substrate is also very important for longevity of flowers (Rogers, 1973).

The importance of water, sugar and various other chemical preservatives to promote the keeping quality of cut flowers, has been reported by several workers (Halevy and Mayak, 1979; Shobha and Gowda, 1993).

The stage and time of harvest and stem length of the cut flower, life (Prince *et al*., 1980 and Bhattacharjee, 1992).

2.3.1 Effect of stem length on vase life

Roses are graded according to the length of their stem. Laurie *et al*. (1958) reported that the flowers are classified according to stem length and grades are fixed. The longer stem cut roses, had more vase life, it may be due to carbohydrate reserve is more compared to the shorter stem which enables the maintainence of dry matter and respirable substrates, especially in the petals which helps in extending keeping quality (Coorts, 1973).

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

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

Prince *et al*. (1980) reported that 40 cm length of cut rose stems Cv. Sonia had more vaselife and strong consumers acceptance. Mukhopandhyay (1990) reported that blooms with

long stems are accepted in export market. In the United States of America, grading of flowers is followed according to stem length. The minimum length of cut rose starts from 25 cm and then the grade increased by 5 cm increment .The long stem blooms have more longevity.

A long stem length increased the flower diameter and water uptake, enhancing the shelf life of rose cut flowers

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

2.3.2 Cutting of stems under water

Laurie (1936) reported that cutting of stems of flowers like roses, snapdragons and carnations, which have small conducting vessels under water, was more beneficial when compared to flowers like calendula which have large conducting vessels. He also worked with different types of flowers and using different depths of water ranging from 0.5 to 10 inch and he concluded that the shallow water treatment increased keeping quality by 2 to 3 days, mainly because less surface was exposed to bacterial decomposition in water.

2.3.3 Water relations with vase life

Neck droop of cut rose flower is caused by inadequate water transport through the neck tissue and tends to be varietal characterstics, Hence the water is an important component of cut flower and loss of water without replenishment causes the flower to wilt and droop. However, one cannot exclude the possibility that the antisenescence factor is water and the degradative changes in cut flower are results of water imbalance, an early symptom of senescence in cut flower is loss in fresh weight.

Rogers (1973) reported that the turgidity in plants and flowers is dependent on the rate of absorption and rate of water loss. Increase in fresh weight can occur when the rate of water absorption is more than the rate of transpiration. He also reported that the composition of 'tap water' varies greatly in various locations. This may influence the longevity of the flowers kept in tap water, as well as the efficiency of chemical solutions used for holding, pulsing or bud opening.

In cut flowers, the loss of water from all tissues depends on the environmental factors and immediately after cutting of flower a sharp decrease in water loss occurred due to closure of stomata (Mayak *et al*., 1974).

According to Halevy and Mayak (1981) the termination of vase life of many cut flowers is initiated by wilting, even though they are constantly held in water. The reduction in water uptake coupled with continuous transpiration leads to water deficit, which reduces turgidity in cut flowers. The balance of the two processes affects the fresh weight changes.

Shobha and Gowda (1993a) related the short post harvest life of rose of water stress, characterized by incomplete bud opening, rapid loss of fresh weight, more water deficit and less turgidity.

2.3.4 Water uptake and vascular blockage

In roses, the loss of petal turgidity and fresh weight was preceded by a decreased rate of water uptake, indicating that reduced uptake rather than excessive water loss is responsible. Since water tension in the flaccid flower are not transmitted to the base of stem a "stem blockage" was suggested within the xylem vessels (Durkin and Kuc, 1996). The reduction in stem conductivity is caused by several factors. Microbial growth paralleled the increase in stem resistance to water flow (Aarts, 1957a). Therefore, microorganisms were considered to be one of the main causes of reduced water uptake by cut flower.

Decrease in water conductivity ("stem blockage'') is not wholly dependent on microorganism's population. Durkin and Kuc (1966) suggested that vascular blockage was the result of oxidative processes induced from harvesting injury. A major factor contributing to the rapid senescence of the cut rose flower is a vascular blockage, which begins at the cut ends and move up into the stem with time.

Several other, have described the occlusions involved in stem plugging as a gummy substance (Aarts, 1957b). Pectinaceous or carbohydrates in nature (Burdett, 1970; Parups and Molnar, 1972); breakdown products of cell walls (Ramussen and Carpenter, 1974).

This was supported by the fact, that an increase in cellulose activity paralleled the decline in conductivity of cut roses and application of cellulose decreased water uptake (Mayak *et al*., 1974).

Lineberger and Steponkur (1976) demonstrated two type of vascular occlusions in rose stems; microbial occlusions were located at the base of the cut stem, while in the second type a gum deposition was found always above the solution level. Buys (1979) suggested that in roses, lilacs and mimosa, some chemicals, mainly polyphenols, leach out of the stem bases and submerged leaves in to the holding water and are then oxidized to quinones. These oxidative products poison the cells and plug the xylem vessels.

Air entering the base of the cut stems during shipment or storage may be a factor disturbing the dehydration of flower (Durkin, 1979 a,b).

2.3.5 Effect of sucrose

Sugars play an important role in flower development and opening either as energy source for respiration or as osmotically active substance, which aid in maintaining turgidity of the expanding corolla. However, sugars also maintain higher fresh weight in shoots of cut flowers by inducing Stomatal closure in the leaves and thus reducing water loss. The optimum concentration of sugar varies with the treatment and the flowers.

Generally, for a given flower the longer exposure to the chemical solution, the lower concentrations required and vice versa.

Flower senescence during vase life is correlated with reduction in sugar content of the flower (Nowak, 1979; Ferriera and Swardt, 1980) which resulted in wilting (Nicholas, 1973). Supplying cut flower with exogenous sugar, maintaining the respirable substrates in flower (Nicholas, 1973), Promotes respiration (Coorts, 1973) encourages protein synthesis (Paulin, 1986), delays the inset of excessive protein degradation (Coorts, 1973), and thus extends the longevity of cut flowers (Coorts, 1973 and Rogers, 1973).

Sucrose improves water balance in cut flowers (Bravdo *et al*., 1974; Halevy and Mayak, 1974). This was attributed to the effect of sugar on the closure of stomata and reduction of water loss there by, increasing their ability to absorb water and maintain turgidity (Halevy and Mayak, 1979).

Sucrose enhances the effect of cytokinin in delaying senescence of flower and reduced the effect of ethylene in promoting it, thereby, increasing vase life of flowers (Mayak and Dilley, 1976). The supplied sugars may also reduce naturally occurring starch hydrolysis and light degradation in roses (Molnar and Parups, 1977). It prevented on undesirable accumulation of free amino acids in the flower which is symptom of flower ageing (Ferriera and Swardt, 1980). The main effect of applied sugar in extending the longevity is to maintain mitochondria structure and functions (Kaltaler and Steponkur, 1976).

Sucrose in the vase solution is found to increase the vase life of roses (Paulin, 1986) whereas Sangama (1993) observed that glucose was better than sucrose in extending vase life of rose Cv.Happiness.

2.4 MINERAL SOLUTES

2.4.1 Effect of aluminium

Use of aluminium sulphate as a germicide in floral preservation is recommended by Nowak and Rudnicki (1990); Weinstein (1957) reported that the colour, form and longevity were more in aluminium treated flowers.

Aluminium sulphate (50 to 100 ppm) has been used in many preservative formulations of roses (Halevy *et al*. 1978; Weinstein and Laurencot, 1963) and other flowers (Aarts, 1957a). Weinstein and Laurencot (1963) attributed the effect of aluminium to lowering

the pH of rose petals and stabilizing the anthocyanins, thereby improving the keeping quality of rose cut flowers.

Mayak and Bar-yosef (1972) showed that roses exposed to aluminum for 12 hours only had reduced bent neck and wilting.

According to Rajgopalan and Khader (1993) aluminum sulphate at a concentration of 0.08 to 0.1 per cent reduced the bacterial growth of cut chrysanthemum. Flowers kept in 0.1 per cent aluminium sulphate gave minimum vase life (10-11 days) and minimum damage.

Shobha and Gowda (1993b) observed that aluminium sulphate (0.75mm) showed an increased vase life by 3.5 days over the control with improved quality of cut rose flowers.

Sangama (1993) suggested 100 ppm as the optimum concentration for aluminium sulphate for cut roses when aluminium sulphate (100 ppm) was added to the holding solution containing 8-HQC (200 ppm and glucose (2 per cent), the vase life was extended (8.5 days).

Karki *et al*. 2004 revealed that vase solution of aluminium sulphate and sucrose proved more effective in increasing vase life of cut flowers followed $AgNO_3$ (1mm)+ Al2 $(SO_4)_3$ (300ppm)+sucrose and Citric acid (300 ppm)+ sucrose in both the cultivars such as Cvs. Superstar and Happiness grown under low cost polyhouse condition.

Singh *et al*. 2004 indicated that sucrose at (1.5 per cent) in combination with aluminium sulphate (300ppm) considered as suitable treatment for improving vase life of First Red. Effect of $Al_2(SO_4)_3$ is apparently due to its biocidal nature and also improved water balance of cut roses.

Divya *et al.* 2004 reported that use of sucrose at 3 per cent + aluminium sulphate at 300 ppm significantly extended the vase life (12.67 days), increased flower diameter (4.70 cm), improved water uptake (22.59ml) and reduced the physiological loss in weight (13.12 per cent) at senescence as against control, which recorded the vase life of 9.78 days flower diameter of 4.28 cm and physiological loss in weight of 29.38 per cent.

Divya *et al*., 2004 under taken an experiment at the department of floriculture and landscaping to improve the post harvest life of cut rose, *Rosa hybrida* Cv. First Red. The holding solution with sucrose (1.5 %) + aluminium sulphate (300ppm) extended the vase life upto 9.88 days and recorded the highest values for the quality character viz., flower diameter (7.14cm), water uptake (18.72ml), carotenoid content (2.20 gm/100g) and freshness recorded lowest physiological loss in weight (19.94%).

2.4.2 Effect of citric acid

Organic acids play an important role in reducing the pH in preservative formulations. Generally, citric acid is used to lower the pH of vase solutions for gladioli (Rameshwar, 1974).

A pre-shipment treatment with citric acid (150ppm) added to the pulse solution was found to be effective in carnations (Halevy *et al*., 1978) Citric acid prevents the plugging of vascular bundles improved the water balance and enhanced the intensity of petal colour probable by changing the pH of cell sap (Asen, 1975; Parups, 1974; Durkin, 1979b). Use of Citric acid 0.7 and 0.5 per cent in holding solution promoted the floral development and keeping quality of cut spikies of tube rose (Mukhopadyay, 1982).

2.4.3 Effect of silver nitrate

All preservative formulations include atleast one compound with germicidal activity Ag+ is the most common and active mineral ion, which acts as a germicide (Halevy and Mayak, 1981). Silver nitrate and silver acetate (10 to 50 ppm) are the two most effective bactericides used in preservative formulations (Aarts, 1957 a).

Sampath (1961) recommended the addition of silver nitrate (0.003%) to promote shelf life of cut roses. The main disadvantage of silver salts is that they are photo oxidized and form black insoluble compounds which precipitate in the stem causing vascular blockage. Silver also reacts with chlorine present in tap waters to form insoluble silver chloride (Halevy and Mayak, 1981). However, impregnation of cut bases of flowers with high concentration (100-150ppm) of silver nitrate or other silver salts for 5 to 10 minutes enhanced the keeping quality a great deal of several flowers (Kofranek and Paul, 1974).

Tiwari and Singh, 2002 reported that more solution uptake was found in flowers kept in $Al_2 SO_4)_3$ (25ml). Variation in solution uptake may be due to disturbance in transpiration pool and bacterial and fungal species gaining predominance in vase solution of $Al_2(SO_4)_3$ enhanced solution uptake by acting as anti-bacterial agent.

The silver inhibits the ACC (1-Amino cyclo propane-1 corbonylic acid) content (Veen and Kwakkenbos, 1983) and the rise in respiration in carnation flowers (Veen, 1979b). Since silver nitrate is relatively immobile in stems of flowers (Veen and Van de Geijn, 1978), it could increase cut flower longevity only by reducing bacterial contamination or to some extent by acting as an anti ethylene action agent in wound on the cut stem surface.

2.4.4 Effect of calcium nitrate

Bhaskar *et al*. (2004) reported that calcium nitrate 250ppm in combination with sodium hypochlorite 20 ppm as well as ascorbic acid 150ppm have registered least changes in the anthocyanin content throughout the vase life period and also recorded longer vase life and no bluing of petal was observed.

Bhaskar *et al*. 2003 assessed that the influence of mineral salts on the physiological and biochemical changes during vase life period of cut rose (*Rosa hybrida* L) in relation to extension on vase life and flower opening when compared to control, $Ca(NO_3)_2$ and lower concentration of $Al_2(SO_4)_3$ and STS were found effective in increasing the permeability of cell membrane and keeping down the Per oxidatives changes.

2.4.5 8-Hydroxy quinoline sulphate (8-HQS)

Rogers (1973) reported that 8-HQS at the rate of 200 to 600ppm used as germicide. Amariuteri (1986) revealed that increased activity of calabooses peroxidases and polyphenol oxidases in flowers by using 8-HQC @ 200ppm. Garibaldi (1989) reported that 8-HQS at 200ppm+ 2g/lit sucrose appeared to be the best keeping solution for gerbera.

III. MATERIAL AND METHODS

The present investigation's were carried out to study the performance of different cultivars, with respect to productivity and quality of rose cut flowers under naturally ventilated polyhouse (NVPH) and to study the vase life of rose cultivar. The details of the material used and methods fallowed are presented in this chapter.

The experiment was conducted under NVPH at Saidapur Farm of Main Agricultural Research Station of the University of Agricultural Sciences, Dharwad.

3.1. Geographical location

Dharwad is situated in Northern transitional tract of Karnataka state at 15^0-26'N latitude and 75^0-7^0E longitude at an altitude of 678 meter above mean sea level. Dharwad is considered to be mild tropical rainy region. The outside mean maximum temperature during the period of experimentation ranged from (27-37^0C) whereas mean minimum temperature ranged from 12.5^0C to 21.5^0C. The mean relative humidity ranged from 42 to 83 Per cent. The mean rainfall during the period of experimentation was 675.5mm. The meteorological data or the periods of experiment from May 2004 to May 2005 are presented in Appendix-1.

3.2 Planting material

Ten cultivar of well established budded rose plants grown under naturally ventilated polyhouse condition.

3.3. CULTIVARS USED IN THE STUDY

The following ten cultivars were included in the present study.

Sl. No.	Cultivars	Colour
1	Grand Gala	Red
2	Samurai	Bright red
3	First Red	Dark red
4	Konfittee	Yellow with orange
5	Skyline	Yellow
6	Tineke	White
7	Lambada	Orange
8	Ravel	Dark pink
9	Eternal	Baby pink
10	Versilia	Creamish

3.4 EXPERIMENT DETAILS

3.4.1. Size of naturally ventilated polyhouse size (NVPH)

Length : 28 m

Breadth : 20 m

Gross size : 560 m^2

3.4.2 Number of cultivars - Ten

3.4.3. Number of replications - Three

3.4.5. Spacing - Row-row: 30 cm

Plant-plant: 20cm

Plate 1. General view of naturally ventilated polyhouse

3.5. STATISTICAL DESIGN OF THE EXPERIMENT

The experiment was laid out in Randomised block design.

3.6 NATURALLY VENTILATED POLYHOUSE

Ten rose cultivars were raised in a naturally ventilated polyhouse. It is made of galvanized iron pipe frame covered with 200 micron UV stabilized polyethylene sheet and the two sides covered with insect net for natural ventilation and protection against insect pests. Besides this insect net, a rollable flap of polyethylene sheet has also been provided out side of insect net to regulate the temperature and humidity depending on the season and weather conditions. The shade net with 50 per cent shade was also laid out above the headspace inside the greenhouse to reduce light intensity and temperature.

3.6.1 Land preparation

Land was thoroughly prepared, 30 days prior to planting by digging thrice, weeds and stubbles were removed completely and brought the soil in to a fine tilth.

3.6.2 Soil sterilization

The soil was sterilized thoroughly with five per cent formalin and covered with a polythene film to remain airtight for 48 hours. Then film was removed and the soil was aerated for 24 hours, later the sterilized field was thoroughly irrigated to drain the chemical residue.

3.6.3 Bed preparation

Raised beds of 45cm height and to entire length of greenhouse (26 m) were prepared with a walking space of 60 cm between beds. The beds were incorporated with well decomposed farmyard manure sand and coir pith in the ratio of 2:1:1 and also basal application of SSP + $MgSO_4$ + neem cake + vermicompost were applied to each between at the rate of 200g + 150g +5kg +5kg/m^2 respectively

3.6.4 Planting

Healthy budded plants were planted on 24th May 2004 in rows at spacing of 30 cm x 20 cm. The beds were irrigated thoroughly to maintain the optimum soil moisture condition.

3.6.5 Irrigation

During initial stage of crop growth the irrigation was given earlier up to four weeks with hose pipe for better establishment of roots, afterward drip irrigation system was installed for irrigation (two laterals per bed). Depending upon soil moisture conditions, the beds were irrigated to keep the soil moderately moist by giving 450-500 ml of water per plant per day.

3.6.6 Fertilizer application

Fertilizer (N, P and K) was applied through basal application upto 45 days, afterward it has been given through fertigation. The schedule of fertigation at different stages of crop growth for rose is given in Appendix-III.

3.6.7 Bending of rose plants

Bending was done 30 days after planting when stem attains pencil thickness size, bending at 45 angle and also bending of unproductive weak stems done repeatedly to enhance the production of basal lateral shoots.

3.6.8 Disbudding

In case of rose cultivars, the auxiliary buds are produced after development of main bud. Such buds were removed to promote the growth of terminal flower bud, which led to the production of quality flowers.

3.6.9 Polyhouse management

To create a favourable environment for plant growth, side ventilation as well as net were altered depending upon the season, whenever the temperature in greenhouse rises, the

rollable polythene flap was made to roll up, sufficient irrigation was given and foggers were turnedon to bring down the temperature. But under low temperature conditions, the rollable flap was made to roll down and mist was not operated to conserve the heat inside. The light intensity inside the greenhouse was controlled by either rolling or spreading the shade nets provided inside the greenhouse.

3.6.10 Weeding and plant protection measures

The entire beds were kept weed free by hand weeding at regular intervals. Diseases like die back and powdery mildew noticed were controlled by smearing blitox paste (0.2%) and spraying the plants with wettable sulphur (0.2%). The pests like mites, thrips and aphids were controlled whenever observed by spraying dicofol (0.2%) metasystox (0.2%) and Rogar (0.2%).

3.7 HARVESTING

Flowers were harvested when the calyx reflexed and first petal started opening out, leaving four nodes from the base of the shoot.

3.8 OBSERVATIONS RECORDED

3.8.1 Morphological parameters

Morphological parameters were recorded after bending viz., plant height, number of leaves, leaf area, leaf area index, leaf length and number of shoot production from the five plant randomly selected in each replication treatments wise.

3.8.1.1 Plant height

Plant height from the base of the plant to tip of main stem was measured and expressed in centimeter.

3.8.1.2 Number of leaves per10 cm shoot length

Number of leaves was counted from the 10 cm middle length of selected shoot from each tagged plant at monthly intervals (30, 60, 90, 120, 150 and 180 days after bending) and mean number of leaves per 10 cm shoot length was worked out.

3.8.1.3 Number of shoots

Total number of lateral basal shoots produced per plant after bending was recorded from the tagged plant.

3.8.1.4 Leaf length

The length of randomly selected 15 leaves from each tagged plant was recorded and average was worked out and expressed in centimeter.

3.8.1.5 Leaf area

Leaf area was recorded with the help of leaf area meter (LICOR-10 model) and was expressed in square centimeter.

3.8.1.6 Leaf area index (LAI)

Leaf area index was calculated by using the formula

$$LAI = \frac{\text{Leaf area/plant}}{\text{spacing}}$$

3.8.2 FLOWERING ATTRIBUTES

3.8.2.1 Days taken to flower bud initiation

Number of days taken for first flower bud initiation from the day of bending was recorded.

3.8.2.2 Days to first harvest

The number of days taken for first flowering bud initiation from the day of bending to the stage of harvest offer flower stalk was recorded.

3.8.2.3 Days to flower senescence in plant

Field life of flower was assessed in field condition by recording the days taken from harvesting stage to the wilting in the tagged plants.

3.9 YIELD AND QUALITY PARAMETERS

3.9.1 Number of cut flowers per plant per years

Number of flowers harvested from the labeled plants was recorded and mean number of flowers produced per plant was worked out.

3.9.2 Stalk weight

Stalk weight of flower was recorded by weighing five freshly harvested flowers along with stalk in each cultivar and then the average was worked out and expressed in grams per flower stalk.

3.9.3 Stalk length

The total length from base of the shoot to terminal node was taken as shoot length and expressed in centimeter.

3.9.4 Neck length

The length from the end of first terminal node to the base of the flower bud was taken as neck length and expressed in centimeter.

3.9.5 Flower bud length

The length from the base of the flower bud to tip was taken by vernier caliper and expressed in centimeters.

3.9.6 Total stem length

Combined length of shoot, neck and bud was taken as total stem length in centimeters.

3.9.7 Stem girth

The diameter of lower most part of stem was taken as stem girth in centimeter and was measured by vernier calipers.

3.9.8 Neck girth

The diameter of the pedicel at mid point was taken as neck girth and was measured by vernier calipers in centimeter.

3.9. 9 Flower bud diameter

Maximum diameter of bud was taken as diameter of bud and was measured by vernier calipers in centimeter.

3.9.10 Vase life (days)

Vase life of all the cultivars that were used in experiment was observed in normal tap water.

3.9.11 Number of petals per flower

The number of well developed petals were counted and recorded per flower.

3.9.12 Petal length

Maximum length of petal, randomly selected from the second whorl was measured in centimeter.

3.9.13 Petal breadth

The maximum breadth of the same petal, which was used for recording length, was recorded in centimeter.

3.10 CONSUMER PREFERENCE

Consumer preference of rose cut flowers was recorded with the help of score card is given in Appendix-III.

3. 11 GRADING

Grading of flowers was done according to the specification given by Post (1952) based on the stalk length.

Shorts	:	22.9 - 30.44 cm
Mediums	:	30.5 – 38.0 cm
Extras	:	38.1 – 45. 6 cm
Fancy	:	45.7 – 53.2 cm
Specials	:	3.3 – 60.9 cm
Extra specials	:	> 61cm

3.12 CORRELATION STUDIES

Simple correlation between vegetative characters like plant height, number of leaves, leaf area, thorn density; flowering characters like days to first flower bud initiation and yield components like number of flowers per plant; quality characters like bud length, bud diameter, stalk length, stalk diameter, neck diameter was worked out and correlation coefficient was tested by referring to correlation values.

3.13 EXPERIMENT-II

3.13.1 EFFECT OF CHEMICAL PRESERVATIVES ON VASE LIFE OF ROSE CV. GRANDGALA

3.13.1.1 Experimental details

Vase life experiment with one cultivar Grand Gala was conducted. There were eleven treatment combination comprising five chemicals with two concentrations of each along with control. Sucrose at two per cent was added to all the treatments.

3.13.1.2 Treatments details

T_1 Aluminium sulphate (100 ppm)

T_2 Aluminium sulphate (200 ppm)

T_3 Citric acid (200 ppm)

T_4 Citric acid (400 ppm)

T_5 8-Hydoxy quinoline sulphate (200 ppm)

T_6 8-Hydoxy quinoline sulphate (400 ppm)

T_7 Calcium nitrate (250 ppm)

T_8 Calcium nitrate (500 ppm)

T_9 Silver nitrate (200 ppm)

T_{10}	Silver nitrate (400 ppm)			
T_{11}	Control			
	Treatments	-	11	
	Replication	-	3	
	Design	-	Completely	randomised design

3.13.1.3 Observations

To collect the data flask with solution and with or without flower stalk were weighed every day from these data weights, solution absorption, solution loss and fresh weight were worked out.

3.13.1.3.1 Fresh weight (g)

Daily changes in fresh weight of each flower was recorded by weighing each flower individually on an electronic balance.

3.13.1.3.2 Solution uptake (g/flower)

The difference between consecutive weights of conical flask with solution (without flower) represents solution uptake.

3.13.1.1.3 Solution loss (g/flower)

The difference between consecutive weights of conical flask +solution + flower, represents the solution loss.

3.14 STATISTICAL ANALYSIS

The data on various biometrical parameters recorded during crop period of the study were subjected to statistical analysis as per procedure given by Panse and Sukhatme (1967).

3.15 ECONOMICS OF ROSE CULTIVATION IN NVPH ($560M^2$)

The economics of rose cultivation in polyhouse ($560m^2$) was worked out for one year using standard method suggested by NCPA (National Council For Plastic in Agriculture) (Annon,1995)

IV. EXPERIMENTAL RESULTS

The present investigations were aimed at identifying suitable rose cultivars for polyhouse cultivation with respect to productivity and quality of cut flowers. Ten rose cultivars were evaluated under naturally ventilated polyhouse (NVPH) during May 2004 to May 2005 in the experimental unit of 'Saidapur Farms', Main Agricultural Research Station Dharwad. Apart from the varietal evaluation vase life of different rose cultivar GrandGala was also studied during February 2005. The results of experiments have been presented separately under the following headings.

4.1 PERFORMANCE OF ROSE CULTIVARS UNDER NATURALLY VENTILATED POLYHOUSE

4.1.1 Morphological parameters

4.1.1.1 Plant height (cm)

The perusal data present in table 1 revealed that plant height of different cultivars of rose varied significantly at all stages of growth.

4.1.1.1.1 Plant height at 30 day after bending (DAB)

The height of the plant varied significantly among the different cultivars. Cultivars GrandGala (81.80cm), Skyline (77.93cm) were taller, but the first two were statistically on par with each other, while Versilia (51.66cm) Lambada (55.03cm) and were the shortest ones, other cultivars were medium in their heights.

4.1.1.1.2 Plant height at 60days after bending

Cultivar GrandGala (83.66cm) recorded maximum height followed by Skyline (76.56cm). Grand Gala while recorded highest plant height and was significantly superior over the other cultivars.

4.1.1.1.3 Plant height at 90 days after bending

Cultivar GrandGala was highly vigorous and significantly superior over the other cultivars with respect to plant height even at 90 DAB. The height ranged between 45.73 cm (Versilia) to 87.55 cm (GrandGala). Rest of the cultivars were found medium in their height.

4.1.1.1.4 Plant height at 120 days after bending

Even at 120 days after bending, highest height recorded in Cv. GrandGala (106.26 cm) and lowest in case of Versilia (55.60 cm), other cultivars showing moderate plant height.

4.1.1.1.5 Plant height at 150 days after bending

Cultivars GrandGala (93.17cm) recorded maximum height followed by Cv. Skyline (87.79 cm) while the lowest was recorded in Cv. Lambada (60.42 cm). Cultivars Tineke (82.79 cm), Konfittee (80.72 cm), Samurai (78.69 cm), Ravel (73.19 cm) and Eternal (70.39 cm) respectively showing moderate plant height.

4.1.1.1.6 Plant height at 180 days after bending

Plant height varied from 56.60 cm (Lambada) to 88.32 cm (GrandGala), followed by Skyline (85.11 cm), First Red (82.29cm). However, other cultivars were medium in their heights. Among the ten cultivars studied GrandGala, Skyline, and First Red showed significantly higher values compared to other varieties in all stages of plant growth. GrandGala exhibited superiority in plant height followed by First Red and Skyline and were found to be statistically on par with each other during all the stages of crop growth.

Table 1. Plant height (cm) of rose cultivars at different stages of plant growth under naturally ventilated polyhouse

Cultivars	Days after bending					
	30	60	90	120	150	180
GrandGala	81.80	83.66	87.55	106.26	93.17	88.32
Samurai	61.40	61.59	66.90	73.40	78.69	73.91
Konfittee	65.60	64.64	70.86	74.41	80.72	81.29
Skyline	77.93	76.56	82.54	91.01	87.94	85.11
Tineke	69.10	70.47	74.40	83.00	82.79	81.29
Lambada	55.03	53.18	52.63	62.84	60.42	56.10
Ravel	60.41	54.90	66.91	67.80	73.19	77.35
Eternal	56.23	58.60	60.35	63.83	70.39	75.32
FirstRed	71.23	73.48	73.82	86.96	83.68	82.21
Versilia	51.66	43.03	45.73	55.60	65.88	64.53
S.Em±	2.049	2.810	2.384	2.579	2.635	2.264
CD at 5%	6.085	8.524	7.080	7.659	7.824	6.724

Table 2. Numbers of leaves per 10 cm shoot length of rose cultivars at different stages of plant growth under NVPH

Cultivars	Days after bending					
	30	60	90	120	150	180
GrandGala	5.80	5.97	5.29	6.38	6.52	6.39
Samurai	4.33	5.41	4.46	4.93	5.22	4.55
Konfittee	6.59	6.69	6.46	6.53	6.73	6.39
Skyline	5.30	6.30	4.11	6.10	6.45	5.71
Tineke	5.24	5.94	4.33	5.39	5.91	5.44
Lambada	3.27	3.68	3.70	3.42	4.53	3.77
Ravel	3.93	5.00	4.73	5.06	5.13	4.46
Eternal	4.22	4.00	4.09	4.52	5.01	3.93
FirstRed	5.53	5.69	5.45	6.07	6.11	5.87
Versilia	2.70	2.96	2.12	2.40	3.61	2.91
S.Em±	0.155	0.410	0.284	0.209	0.277	0.184
CD at 5%	0.461	1.218	0.843	0.620	0.823	0.546

4.1.1.2 Number of leaves/ 10 cm shoot at different stages of plant growth

The observations on number of leaves per 10 cm of shoot at different stages of growth are presented in table 2.

4.1.1.2.1 Number of leaves /10 cm of shoot length at 30 days after bending (DAB)

Rose cultivars showed significant differences with respect to number of leaves at 30 DAB. Number of leaves per 10 cm of shoot were recoded maximum in Cv. Konfittee (6.30), FirstRed (5.53) and GrandGala (5.80) whereas Cv. Versilia was recorded minimum number of leaves (2.70). The number of leaves produced per 10 cm of shoot length were moderate in cultivars Tineke (5.24), Eternal (4.22), Skyline (5.30) Samurai (4.33), Ravel (3.93) and Lambada (3.27).

4.1.1.2.2 Number of leaves at 60 days after bending

Among the cultivars studied, number of leaves per 10 cm of shoot length varied from 2.96 to 6.69 at 60 DAB. The number of leaves produced per 10 cm of shoot length was maximum in Cv. Konfittee (6.69) which was on par with Skyline (6.30). FirstRed (5.45). GrandGala (5.97) and Tineke (5.94) cultivars Versilia recorded minimum number of leaves (2.96).

4.1.1.2.3. Number of leaves per 10 cm shoot length at 90 days after bending

Significant differences were observed among rose cultivars for leaf production, at 90 DAB. The number of leaves produced per 10cm shoot length was maximum in Cv. Konfittee (6.46), which was significantly higher than other cultivars, followed by FirstRed (5.45) and Grand Gala (5.29), Cv. Versilia was recorded minimum number of leaves (2.92).

4.1.1.2.4 Number of leaves at 120 days after bending

The number of leaves produced per 10 cm shoot length was in the range of 6.53 to2.40.Cv. Konfittee recorded maximum number of leaves, (6.53), however it was on par with the Cvs. GrandGala (6.38), Skyline (6.10) and FirstRed (6.07). While minimum numbers of leaves produced per 10 cm shoot length were Cv. Lambada (3.42) and Versilia (2.40) other cultivars were moderate in production of number of leaves.

4.1.1.2.5 Number of leaves at 150 days after bending

Significant variation among different rose cultivars varied significantly from a minimum3.61 to a maximum of 6.73 number of leaves produced per 10 cm of shoot was maximum in Cv. Konfittee (6.98) which was on par with Cv. GrandGala (6.52), Skyline (6.45), and First Red (6.11), whereas minimum number of leaves produced per 10 cm of shoot length in Cv. Versilia (3.61) while other cultivar were moderate in their leaves production.

4.1.1.2.6 Number of leaves at 180 days after bending

Maximum number of leaves produced per 10cm of shoot length in case of Konfittee (6.39) which was significantly higher followed by Skyline (551), GrandGala (5.71), FirstRed (5.87), while minimum number of leaves was observed in Versilia (2.91) and Lambada (3.77) rest other cultivars produced moderate.

4.1.1.3 Number of shoots produced after bending

Data pertaining to number of shoots produced after bending by different rose cultivars under naturally ventilated polyhouse is presented in table 3.

Significant variations were observed among the different cultivars evaluated with regard to the number of shoots produced. ‘Versilia’ produced lowest number of shoots (2.05) followed by Lambada (2.15) which were significantly lower than other varieties. Cv. Tineke (3.46) produced maximum number of shoots closely followed by GrandGala (3.20), First Red (3.05) and Skyline (3.04) were found to be statistically on par with each other.

Table 3. Number of shoots after bending, density of thorns, leaf length, leaf area and leaf area index of different rose cultivars under NVPH

Cultivars	Number of shoots after bending	Density of thorns	Leaf length (cm)		Leaf area (cm^2)	LAI
			30 DAB	180DAB		
GrandGala	3.20	13.13	12.13	14.88	152.63	0.16
Samurai	2.68	17.70	6.06	9.36	133.26	0.13
Konfittee	2.69	21.53	6.81	9.36	137.40	0.14
Skyline	3.04	14.00	9.90	13.02	147.33	0.15
Tineke	3.46	6.20	9.07	10.77	142.53	0.14
Lambada	2.15	12.80	5.66	7.20	98.43	0.06
Ravel	2.57	17.73	6.78	10.49	119.00	0.11
Eternal	2.27	18.13	6.31	9.32	124.33	0.12
FirstRed	3.05	10.80	10.14	13.27	145.66	0.14
Versilia	2.05	11.00	6.23	8.43	105.00	0.10
S.Em±	0.151	1.477	0.373	0.320	4.707	0.004
CD at 5%	0.449	4.388	1.109	0.951	13.98	0.012

4.1.1.4 Density of thorns per 10 cm shoot length

Observations on density of thorns per 10 cm shoot length of different rose cultivars under naturally ventilated polyhouse are presented in table 3.

Significant differences in the density of thorns per 10 cm shoot length was recorded, among cultivars tested 'Konfittee' registered maximum number of thorns (21.53), which was significantly higher than other cultivars and 'Tineke' recorded minimum number of thorns (6.20).

4.1.1.5 Leaf length (cm)

The data pertaining to length of leaf at different growth stages of rose cultivars are presented in table 3.

4.1.1,5.1 Leaf length at 30 days after bending

Rose cultivars varied significantly for length of leaf 30 DAB. It was maximum in Cv. GrandGala (12.13cm),while Minimum leaf length observed in Cv. Lambada (5.66cm) other cultivars such as First Red (10.14cm), Skyline (9.90cm), Tineke (9.07cm), Konfittee (6.81cm), Ravel (6.78cm) Eternal (6.31cm), Versilia (6.23cm) and Samurai (6.06cm) medium in their length.

4.1.1.5.2 Leaf length at 180 days after bending

Length of leaf varied significantly among rose cultivars at 180 days after bending. Cultivars GrandGala continued to record minimum leaf length (14.88cm) while Cv. Lambada continued to recorded minimum leaf length (7.20cm), where as other cultivars Tineke (10.77cm), Ravel (10.44cm), Samurai (9.36cm), Konfittee (9.36cm) and Eternal (9.32cm) and Versilia (8.30cm) had leaves of medium length.

4.1.1.6 Leaf area (cm^2)

Cultivars varied significantly with respect to leaf area per plant at 180 DAB. GrandGala recorded highest leaf area (152.63cm^2) followed by Skyline (147.33cm^2), Fisrt Red (145.66cm^2) which were on par with each other, whereas, Cv. Lambada recorded minimum leaf area (98.43 cm^2) followed by Versilia (105.66 cm^2). Leaf area was moderate in other cultivars such as Konfittee (137.40 cm^2), Samurai (133.26 cm^2)), Eternal (124. cm^2)and Ravel (119.00 cm2) (Table 3).

4.1.1.7 Leaf area index (LAI)

Cultivars varied significantly with respect to leaf area index per plant. Maximum LAI (0.16) was noticed in Cv. GrandGala followed by Skyline (0.15) FirstRed (0.14) and Tineke (0.14) which was statistically on par with each other, where as Cv. Lambada showed minimum LAI (0.06), followed by Versilia (0.10) (Table 3).

4.1.2 Flowering characters

4.1.2.1. Days to first flower bud initiation

Data pertaining to flowering characters like days taken for first flower bud initiation after bending (Table 4)

The Cv. GrandGala was found to be early for flowers bud initiation, which took least number of days (16.40), followed by Skyline FirstRed, Tineke (18.46, 18.00 and 18.66 days respectively) and were statistically on par with each other whereas Cv. Versilia took maximum number of days (24.53) to initiation of visible flower bud.

Table 4. Flowering characteristics of different rose cultivars

Parameters / Cultivars	Days to first flower bud initiation	Days to first harvest	Days to flower senescence in plant
Grandgala	16.40	36.41	15.06
Samurai	21.30	41.87	12.20
Konfittee	22.16	41.27	13.43
Skyline	18.46	40.89	12.86
Tineke	18.66	40.71	14.40
Lambada	23.56	42.71	10.46
Ravel	23.06	38.48	14.46
Eternal	23.26	42.16	13.73
FirstRed	18.00	36.36	15.13
Versilia	24.53	43.13	12.13
S.Em±	0.885	1.292	0.719
CD at 5%	2.489	3.83	2.134

4.1.2.2 Days to first flower harvest

Significant differences were observed among different rose cultivars for number of days taken to first flower harvest. Cultivars GrandGala took 46.36 days to first flowers harvesting and found to be statistically on par with FirstRed (46.41) and Skyline (48.48) whereas Cv. Versilia has taken maximum number of days (53.13) for first flower harvest.

Table 5. Yield per plant, stalk weight, shoot length, neck length, and bud length of cut flowers of rose cultivars under NVPH

Parameters / Cultivars	Yield/ plant	Stalk weight (g)	Shoot length (cm)	Neck length (cm)	Bud length (cm)
GrandGala	26.83	12.45	64.96	6.49	4.78
Samurai	23.53	8.77	41.40	5.50	3.96
Konfittee	24.83	12.55	45.33	4.44	3.91
Skyline	25.66	12.66	55.73	6.08	4.22
Tineke	27.84	10.55	46.06	5.86	4.06
Lambada	18.86	8.88	34.46	3.50	2.64
Ravel	22.61	13.88	41.40	4.86	3.82
Eternal	22.91	10.33	38.26	4.98	3.30
FirstRed	27.50	13.55	55.46	5.92	4.14
Versilia	14.50	7.44	14.50	4.83	3.17
S.Em±	0.033	0.611	1.786	0.184	0.147
CD at 5%	0.098	1.816	5.304	0.548	0.436

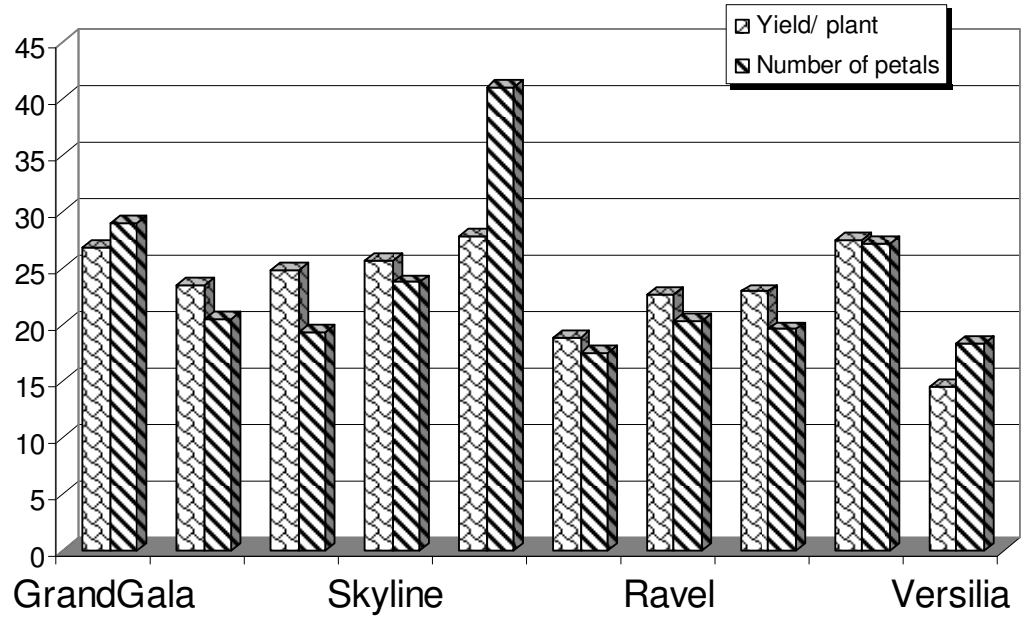
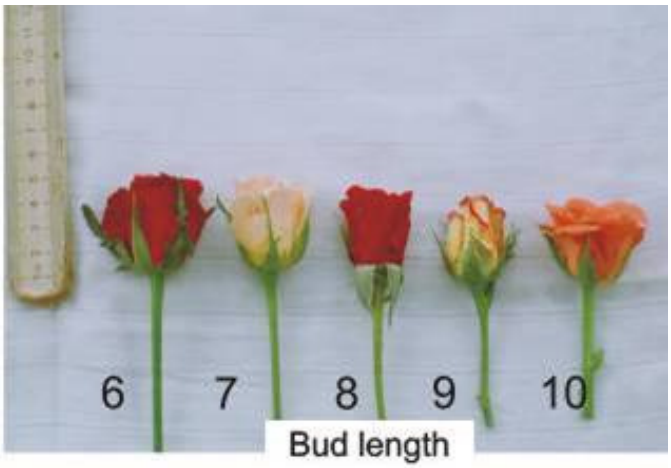


Fig. 1. Yield per plant and number of petals of rose cultivars under NVPH

Fig. 1. Yield per plant and number of petals of rose cultivars under NVPH

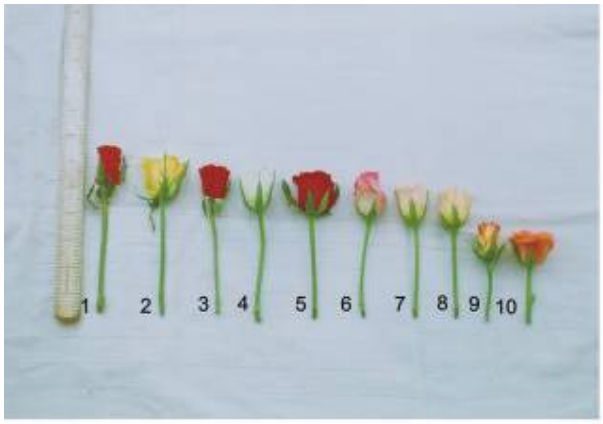
1. GrandGala
2. Skyline
3. Ravel
4. Tineke
5. Eternal

Bud length



6. FirstRed
7. Versilia
8. Samurai
9. Konfittee
10. Lambada

Bud length



1. GrandGala
2. Skyline
3. FirstRed
4. Tineke
5. Samurai
6. Ravel
7. Eternal
8. Versilia
9. Konfittee
10. Lambada

Neck length

1. GrandGala
2. Skyline
3. FirstRed
4. Tineke
5. Konfittee
6. Samurai
7. Eternal
8. Ravel
9. Versilia
10. Lambada

Stem length

Plate 3. Quality parameters of rose cultivars

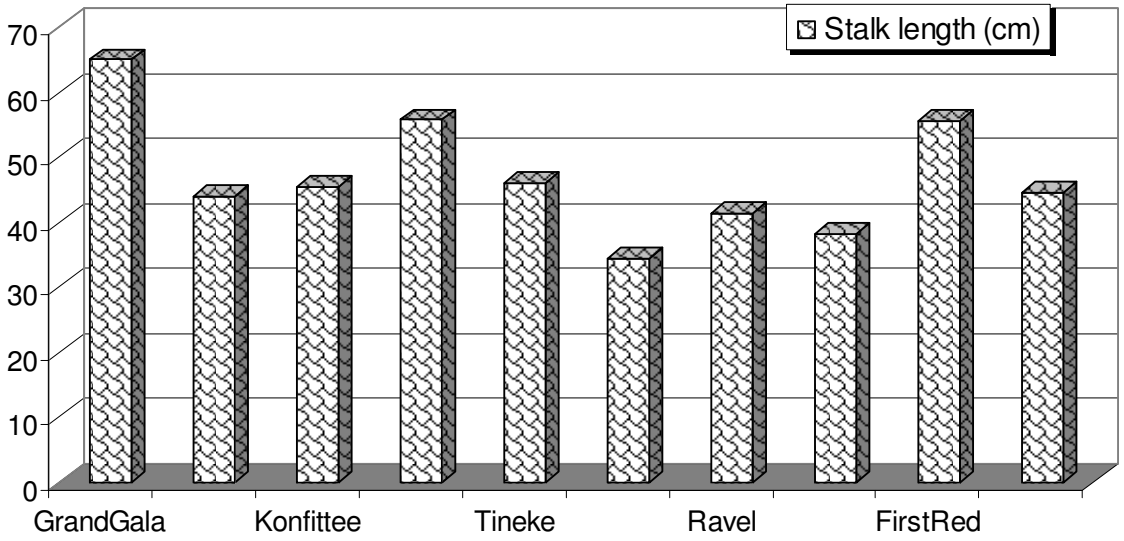


Fig. 2. Stalk length of rose cultivars at different stages of plant growth under NVPH

Fig. 2. Stalk length of rose cultivars at different stages of plant growth under NVPH

4.1.2.3 Days taken to flower senescence on the plant.

Days taken to flower senescence in plant significantly differed among the different cultivars. First Red had took maximum (15.13) days for flower senescence followed by GrandGala (15.06) and Ravel (14.46) which were found to be statistically on par with each other and significantly superior over other cultivars. However Cv. Lambada has taken only 10.46 days for the senescence on the plant.

4.1.3 Yield and quality attributes

Data on yield and quality characters such as number of flowers per plant, shoot length, neck length, total stem length, stalk weight, bud length, bud diameter, number of petal, Petal length, Petal breadth, neck girth, shoot girth, vase life, consumer preference, and grading of flowers were presented in table 5 to 9.

4.1.3.1 Yield of cut flowers per plant

The perusal data presented in table 5 revealed that, Tineke showed its superiority by yielding 27.84 cut flowers per plant which is significantly superior over rest of the cultivars studied, whereas Cv. Versilia registered minimum number of cut flowers per plant (14.50) (Fig. 1).

4.1.3.2 Stalk weight

Stalk weight varied significantly among the cultivars and it was maximum (13.88 g) Ravel followed by FirstRed (13.55 g), Skyline(12.66 g) and GrandGala(12.45 g) which were found to be statistically on par with each other, whereas Cv. Lambada registered minimum stalk weight (Table 5)

4.1.3.3 Stalk length (cm)

The observation on stalk length of cut flowers of the different rose cultivars are presented in table 5.

Significant differences in the stalklength were recorded among the cultivars evaluated GrandGala recorded maximum shoot length (64.96 cm), which was significantly superior over other cultivars. Whereas, Cv. Lambada (34.4 cm) was registered minimum shoot length followed by Versilia (38.20 cm) (Fig. 2)

4.1.3.4 Neck length (cm)

The data on neck length of cut flowers of different cultivars of roses are presented in table 5.

Significant differences in neck length were noticed among the cultivars tested. The maximum neck length (6.49cm) was recorded in GrandGala followed by Skyline (6.08cm) which was significantly on par with each other. The minimum neck length was recorded in Lambada (3.50cm) (Fig. 3 & Plate. 3).

4.1.3.5 Bud length (cm)

The data pertaining to bud length of cut flowers of different rose cultivars are presented in table 5

The maximum bud length was recorded in GrandGala (4.78 cm), which was significantly higher than other cultivars. Whereas, minimum bud length was noticed in Lambada (2.14 cm) (Fig. 3 & Plate. 3).

4.1.3.6 Total stem length (cm)

Perusal of data on total stem length in table 6 revealed that, significantly maximum total stem length was noticed in Cv. GrandGala (78.73 cm) which was significantly superior over other cultivars. While minimum total stem length was registered in Lambada (40.60 cm).

4.1.3.7 Number of petals

The perusal of data presented in table 6 revealed that, the highest number of petals of 40.98 per flower was recorded in Tineke, which was found to be significantly higher with

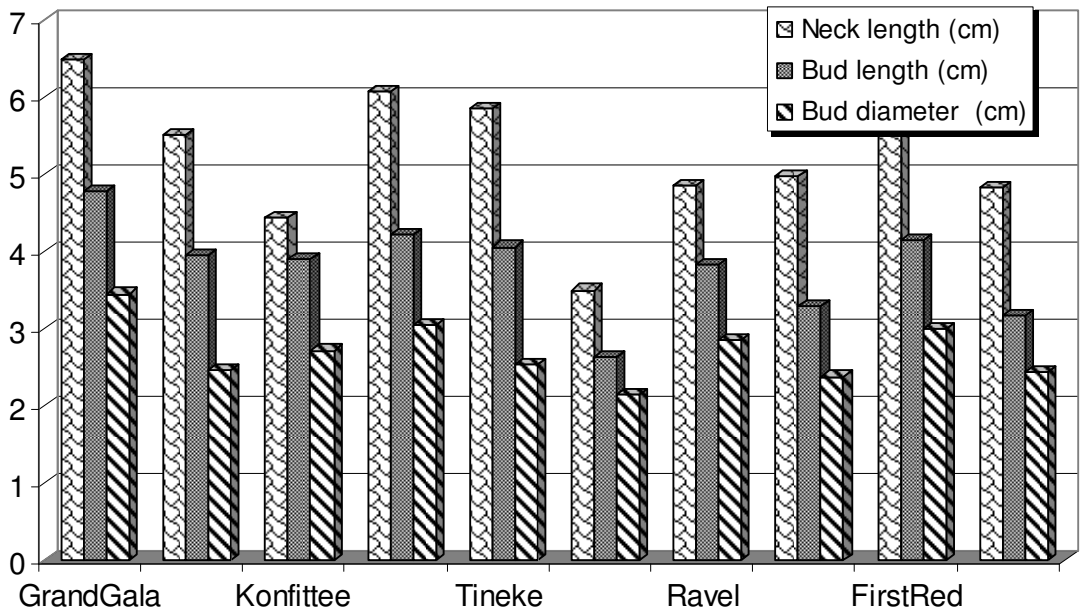


Fig. 3. Neck length, bud length and bud diameter of cut flowers of rose cultivars under NVPH

Fig. 3. Neck length, bud length and bud diameter of cut flowers of rose cultivars under NVPH

Table 6. Total stem length, number of petals, petal length and petal breadth of rose cultivars under NVPH

Parameters / Cultivars	Total stem Length (cm)	Number of petals	Petal length (cm)	Petal breadth (cm)
GrandGala	78.73	28.98	3.43	3.92
Samurai	53.46	20.45	2.56	2.54
Konfittee	53.35	19.33	2.73	2.71
Skyline	66.03	23.75	3.58	3.30
Tineke	55.98	40.98	4.17	3.42
Lambada	40.60	17.48	2.30	2.20
Ravel	54.08	20.35	2.91	2.77
Eternal	44.54	19.60	2.67	2.50
Firstred	65.52	27.21	2.99	2.85
Versilia	46.20	18.36	2.61	2.44
S.Em±	2.606	1.07	0.130	0.003
CD at 5%	11.97	3.48	0.385	0.009

respect to number of petals per flower than any other cultivars. While optimum number of petals were observed in GrandGala (27.98) and FirstRed (26.21) however, lowest number of petals were recorded in Lambada (17.48).

4.1.3.8 Petal length (cm)

The perusal of data pertaining to petal length presented in table 6 revealed that maximum petal length was recorded in Cv. Tineke (4.17cm) whereas Cv. Lambada recorded minimum petal length (2.30cm)

4.1.3.9 Petal breadth (cm)

The breadth of petal was maximum in GrandGala (3.92cm), whereas Versilia recorded minimum petal breadth (2.20cm) (Table 6).

4.1.3.10 Bud diameter (cm)

Bud diameter differed significantly among the cultivars. The maximum (3.45 cm) diameter was recorded in GrandGala. This cultivar was found to be superior over the rest of the cultivars, whereas minimum diameter (2.14cm) was recorded in Lambada (Table 7 Fig. 3 & Plate.3).

4.1.3.11 Stalk girth (cm)

Stalk diameter varied significantly among the cultivars and it was maximum (1.01cm) in Ravel followed by Skyline (1.00 cm) which was statistically on par with each other, whereas minimum stalk girth was recorded in Lambada (0.78 cm) which was significantly lesser than rest of the cultivars, followed by Versilia (0.80 cm) (Table 7 and Fig. 4).

4.1.3.12 Neck diameter (cm)

Rose cultivars varied significantly for the neck diameter. Skyline registered maximum neck diameter (0.40cm) which was found to be superior followed by FirstRed (0.36cm) Konfittee (0.36cm) and GrandGala (0.37cm) which were statistically on par with each other, however the minimum was registered in Lambada (0.27cm) followed by Versilia (0.29cm) which were having significantly lesser girth than the rest of the cultivars (Table 7 and Fig. 4).

4.1.3.13 Vase life

Significant differences were found among the different rose cultivars with respect to vase life in normal tap water Cv. GrandGala possessed a vase life period of 9.58 days followed by First Red (8.73) whereas, least number of days was recorded in Lambada (4.74 days) (Table 7).

4.1.3.14 Consumer preference

A close perusal of data in table 8 revealed that summing up scores assigned to the rose cut flowers based on consumer preference of 14 respondents regarding five character viz., flower colour, stalk length, bud length, bud diameter and overall acceptability. Cv. FirstRed with an over all score of 309 marks out of 350 total marks stood first, indicating that it is the most important among the cultivars tested, followed by Cv. GrandGala (272 marks) and Ravel (266 marks), whereas least marks was scored by Cv. Versilia (154marks), followed by Samurai (230marks).

4.1.3.15 Grading

According to Post (1952) grading was done based on stalk length and bud length GrandGala (69.74) produced 'Extra special' grade. However 'Special grade' was registered by First Red (59.60cm) and Skyline (59.95cm). Whereas, Samurai (47.96cm) and Konfittee (49.44cm) grouped under 'Fancy' grade, while 'Medium' grade was given to Lambada (37.10cm). However Versilia (41.37cm) and Ravel (45.22cm) could be categorized under 'Extras' (Table 9)

Table 7. Bud diameter, shoot girth, neck girth and vase life of different rose cultivars under NVPH

Parameters / Cultivars	Bud diameter (cm)	Shoot girth (cm)	Neck girth (cm)	Vase life (days)
GrandGala	3.45	0.99	0.37	9.58
Samurai	2.47	0.92	0.32	6.51
Konfittee	2.72	0.96	0.36	5.33
Skyline	3.04	1.00	0.40	6.36
Tineke	2.53	0.94	0.29	6.26
Lambada	2.14	0.78	0.27	4.74
Ravel	2.86	1.01	0.33	7.29
Eternal	2.38	0.95	0.30	5.36
FirstRed	3.01	0.98	0.36	8.73
Versilia	2.45	0.80	0.31	4.81
S.Em±	0.092	0.034	0.013	0.0261
CD at 5%	0.272	0.100	0.040	1.042

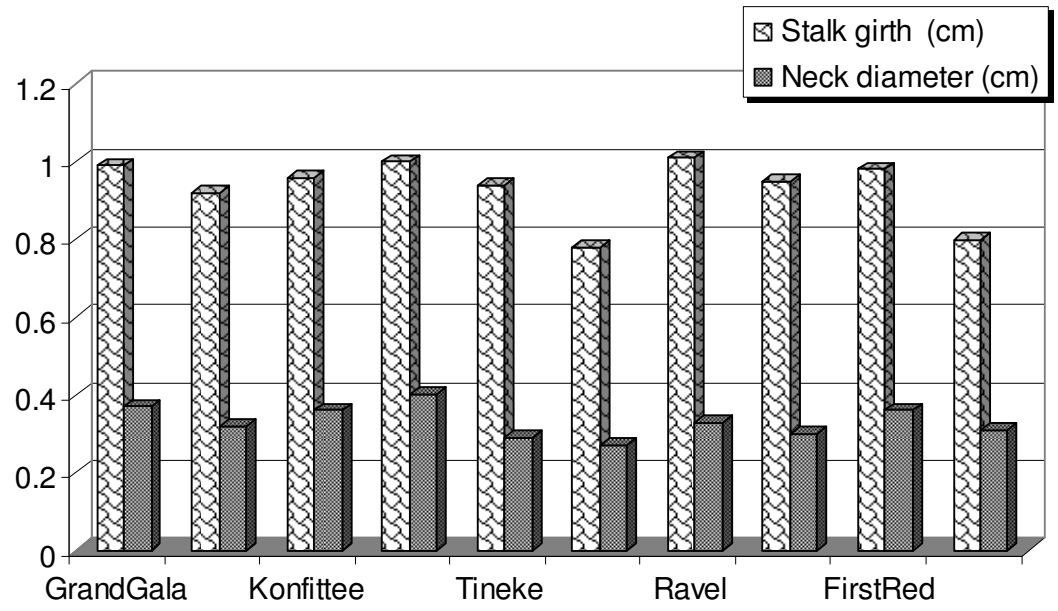


Fig. 4. Stalk girth and neck diameter of cut flowers of rose cultivars under NVPH

Fig. 4. Stalk girth and neck diameter of cut flowers of rose cultivars under NVPH

Table 8. Consumer preference of different rose cultivars

Cultivars	Total marks	Allotted marks	Ranks
GrandGala	350	272	II
Samurai	350	230	X
Konfittee	350	249	IV
Skyline	350	242	VI
Tineke	350	231	VIII
Lambada	350	233	VII
Ravel	350	266	III
Eternal	350	246	V
FirstRed	350	309	I
Versilia	350	154	IX

4.1.4 Correlation studies

Phenotypic correlations were computed between character pairs for all the thirteen quantitative and qualitative traits of ten rose cultivars are presented in table 10.

In case of plant height, at 180 days after bending, association of some of the characters viz., number of leaves at 180 days after bending, leaf area, shoot girth and stalk length was highly significant. However, yield per plant, bud length, bud diameter, neck length, neck diameter had positive and highly significant correlation whereas thorn density and number of petals shown positive and significant association, however days to flower bud initiation showed negative association with plant height.

Number of leaves production at 180 days after bending had positive and highly significant correlation with leaf area, stalk length, flower yield, bud length and bud diameter. Positive and significant association with shoot girth, neck length, neck diameter and weak

Table 9. Grading of flower was done according to the specification given by Post (1952)

Cultivars	Grades (Stalk length + bud length)
GrandGala	Extra special
Samurai	Fancy
Konfittee	Fancy
Tineke	Specials
Lambada	Medium
Ravel	Extras
Eternal	Extras
FirstRed	Specials
Versilia	Extras

Shorts	:	22.9	-	30.44cm
Medium	:	30.5	-	38.0cm
Extras	:	38.1	-	45.6cm
Fancy	:	45.7	-	53.2 cm
Specials	:	53.3	-	60.9 cm
Extra specials	:	>61cm		

Table 10. Correlation studies of different rose cultivars

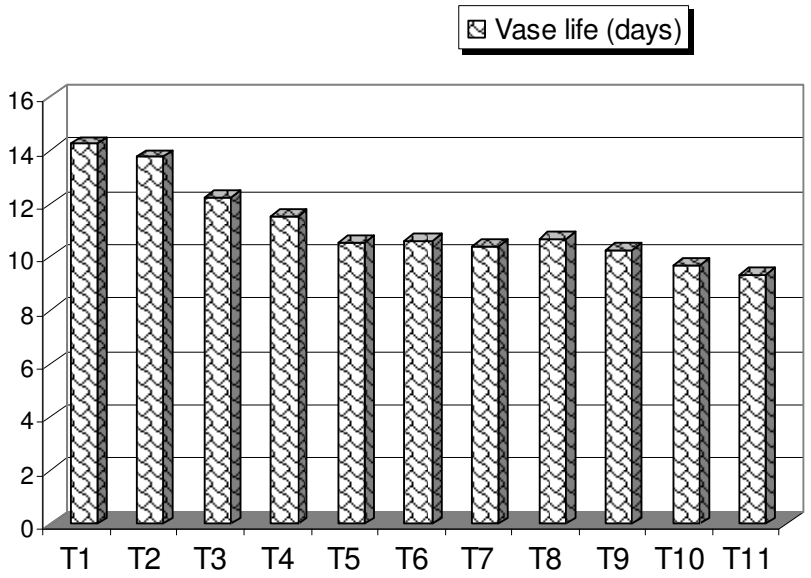
1.	1.000	0.869**	0.943**	-0.105	0.912**	0.822**	-0.760	0.926**	0.933**	0.823**	0.802**	0.766**	0.527
2.		1.000	0.925**	-0.0.57	0.747*	0.884**	-0.896**	0.961**	0.879**	0.795**	0.692*	0.723*	0.543
3.			1.000	-0.042	0.799**	0.876**	0.872**	0.965**	0.933**	0.760*	0.855**	0.757	0.596
4.				1.000	0.296	-0.206	-0.374	0.066	-0.808	-0.047	0.033	-0.808	-0.580
5.					1.000	0.651	-0.573**	0.848**	-0.851**	0.746*	0.657*	0.714*	0.355
6.						1.000	-0.930**	0.860**	-0.907**	0.928**	0.848**	0.635*	0.432
7.							1.000	-0.833	0.851	-0.774	-0.842	-0.551	-0.667
8.								1.000	0.888**	-0.783**	-0.743**	0.769**	0.47
9.									1.000	0.878**	0.878**	0.662*	0.525
10.										1.000	0.750*	0.615	0.271
11.											1.000	0.550	0.624
12.												1.000	0.387
13.													1.000

1. Plant height 2. Number of leaves 3. Leaf area 4. Thorn density
5. Stalk girth 6. Stalk length 7. Days to first flower bud initiation 8. Flower yield per plant
9. Bud length 10. Bud diameter 11.Neck length 12.Neck diameter
13.Number of petals

Table 11. Economics of different rose cultivars grown under NVPH

Cultivars	Total cost	Flower yield per 560m^2	Gross returns	Net returns	Benefit cost ratio (B:C)
GrandGala	85,900	1,12,686	2,81,715	1,92,715	2.16
Samurai	85,900	98,826	1,97,652	1,11,752	1.30
Konfittee	85,900	1,04,286	2,60,75	1,71,715	1.92
Skyline	85,900	1,07,772	2,69,430	1,80,430	2.02
Tineke	85,900	1,16,928	2,33,856	1,47,956	1.75
Lambada	85,900	79,212	1,58,424	72,524	1.84
Ravel	85,900	94,962	2,37,405	1,48,405	1.66
Eternal	85,900	96,222	1,92,444	1,06,544	1.24
FirstRed	85,900	1,16,760	2, 91,900	2,02, 900	2.27
Versilia	85,900	60,900	1,21,800	35,900	0.41
Mean	85,900	98,855	2,01,070	1,37,084	1.55

** GrandGala- Rs. 2.5 FirstRed - Rs. 2.5
Konfittee- Rs. 2.5 Ravel - Rs. 2.5



LEGEND

T1 - Al_2SO_4 @ 100 ppm
T2 - Al_2SO_4 @ 200 ppm
T3 - Citric acid @ 200 ppm
T4 - Citric acid @ 400 ppm
T5 - 8 Hq S @ 200 ppm
T6 - 8 Hq S @ 400 ppm
T7 - $CaNO_3$ @ 200 ppm
T8 - $CaNO_3$ @ 400 ppm
T9 - $AgNO_3$ @ 200 ppm
T10 - $AgNO_3$ @ 500 ppm
T11 - Control

Fig. 5. Effect of chemical preservatives on vase life (days) in rose cut flowers of cv. GrandGala

Fig. 5. Effect of chemical preservatives on vase life (days) in rose cut flowers of cv. GrandGala

association with number of petals, whereas negatively correlation with density of thorns and days to flowers bud initiation.

Leaf area had positive and highly significant association with shoot girth, stalk length, flowers yield, bud length, neck length whereas positive and significant association with bud diameter neck diameter and number of petals except for the thorn density and days to flower bud initiation did not exhibit significant association with leaf area.

None of the characters showed significant correlation with thorn density but, it had positive association with other characters such as shoot girth, days to flower bud initiation, flower yield and neck diameter. Rest of the characters showed negative association.

Shoot girth showed positive and highly significant correlation with characters viz., flower yield, bud length, bud diameter, neck length and significantly positive association with neck diameter whereas negatively significant correlation with days to flower bud initiation.

None of the characters showed significant correlation with days to flower bud initiation except for the thorn density, which was positively correlated with this parameter.

Flower yield was highly significant positive correlation with almost all character except for the number of petals and thorns densities, were showed positive association.

Bud length also showed positive and highly significant correlation with all the characters except for thorn density and day to flower bud initiation.

Bud diameter showed positive and significant association with neck length, whereas positive correlation with neck diameter and number of petals.

Number of petals showed positive association with all characters except for thorn density and days to flower bud initiation, which was independent of number of petals.

4.1.5 Economics

The total cost, gross returns, net returns and benefit to cost ratio of rose cultivars grown under NVPH are presented in table 11 and Appendix IV. First Red realized maximum gross returns (Rs 2,91,900 per 560m^2per year) and net returns (RS 2,02,900 per 560m^2 per year) followed by Grand Gala and Skyline (Rs 1,92,715 & Rs 1,80,430 per 560m2 per year - respectively), while minimum gross returns (Rs 1,21,800 per 560m^2 per year) and net returns (Rs 35,900 per 560m^2 per year) was obtained in Cv. Versilia. The benefit to cost (B: C) ratio was highest (2.27) in First Red followed by GrandGala (2.16) and Skyline (2.02) which were found to be superior compared to other cultivars studied (Fig. 6)

4.2 EFFECT OF CHEMICAL PRESERVATIVES AT DIFFERENT CONCENTRATIONS ON VASE LIFE OF ROSE CUT FLOWERS. CV. GRANDGALA

The data on different parameters such as solution absorption, solution loss, fresh weight of flowers and finally vase life as influenced by chemical preservatives at different concentration during different periods of vase life (2, 4, 6, 8, 10, 12th and 14th days) are presented in table 12 to15.

4.2.1. Solution absorption (g/flower)

Different chemical preservative exhibited significant influence on solution absorption by rose cut flowers and maximum solution absorption was recorded in $AlSO_4$ at 100ppm concentration (35.90, 33.26,2585, 22.01, 20.16, 9.04 and 4.89) during 2nd, 4th, 6th, 8th, 10th, 12th, and 14th, days of vase life period whereas minimum solution absorption was registered in $AgNO_3$ at 200ppm concentration (21.72, 18.69, 16.68, 10.41, 9.76, 5.82 and 0.36g) during entire vase life period (Table 12).

Table 12. Effect of different chemicals on solution absorption (g/flower) of rose cut flowers Cv. GrandGala

Treatment No.	Days / Treatments	Duration (Days)						
		0-2	2-4	4-6	6-8	8-10	10-12	12-14
T_1	$A1_2SO_4$ @ 100 ppm	35.90	33.16	25.85	22.01	20.16	9.04	4.89
T_2	$A1_2SO_4$ @ 200 ppm	34.92	30.10	23.15	20.24	16.04	7.39	3.85
T_3	Citric acid @ 200 ppm	33.85	26.80	23.14	17.61	12.24	6.54	3.23
T_4	Citric acid @ 400 ppm	34.55	28.60	23.26	19.47	13.77	7.51	2.82
T_5	8-HQS @ 200 ppm	32.81	25.81	22.84	14.80	10.93	6.49	2.34
T_6	8-HQS @ 200 ppm	30.13	23.48	19.95	13.51	9.76	6.25	2.17
T_7	$CaNO_3$ @ 250 ppm	24.76	20.56	16.56	11.53	10.38	6.14	1.52
T_8	$CaNO_3$ @ 500 ppm	27.43	25.47	19.40	13.61	10.74	7.14	2.31
T_9	$AgNO_3$ @ 200 ppm	22.22	20.14	17.73	11.92	10.78	5.36	1.82
T_{10}	$AgNO_3$ @ 400 ppm	21.72	18.69	16.68	10.41	9.76	5.82	1.23
T_{11}	Control	19.21	18.01	16.51	12.86	8.58	4.68	0.36
	S.Em ±	0.825	0.064	0.458	0.387	0.194	0.152	0.044
	CD at 1%	3.290	0.458	1.826	1.544	0.777	0.608	0.178

4.2.2. Solution loss (g/flower)

The perusal of data (Table 13) revealed that different preservative chemicals exhibited significant influence on solution loss by rose cut flowers. Aluminium sulphate at 100ppm concentration showed maximum solution loss (34.85, 32.28, 27.54, 23.05, 16.92, 12.75 and 4.84g) and 6.58g) at different days viz., 2^{nd}, 4^{th}, 6^{th},8^{th}, 10^{th} days 12^{th} and14^{th} day. However, the minimum 23.27, 19.50, 16. 82, 9.44, 7.43, 4.25 and 0.41g solution loss was noticed in $AgNO_3$ at 200ppm concentration.

4.2.3. Fresh weight (g/flower)

During the entire period of vase life (viz., 2^{nd}, 4^{th}, 6^{th},8^{th}, 10^{th} days 12^{th} and14^{th} day) the fresh weight of cut flower found to be maximum (47.68, 47.84, 39.62, 33.41, 21.59, 12.61 and 6.58 respectively) in vase solution containing $AlSO_4$ at 100ppm concentration (Table 14).

4.5.4. Vase life (Days)

The maximum vase life (14.24 days) was noticed in solution contained aluminum sulphate at 100 ppm concentration, followed by Al_2SO_4 at 200 ppm (13.75) and Citric acid @ 200ppm (12.24 days) which were found statistically and significantly on par with each other while the minimum vase life was (9.67 days) seen in $AgNO_3$ at 200 ppm concentration (Table 15 and Fig. 5).

Table 13. Effect of different chemicals on solution loss (g/flower) of rose cut flowers Cv. GrandGala

Treatment No.	Days / Treatments	Duration (Days)						
		0-2	2-4	4-6	6-8	8-10	10-12	12-14
T_1	$A1_2SO_4$ @ 100 ppm	34.85	32.28	27.54	23.05	16.92	12.75	4.84
T_2	$A1_2SO_4$ @ 200 ppm	34.68	29.56	26.11	22.44	16.11	9.55	3.60
T_3	Citric acid @ 200 ppm	34.57	29.00	24.39	18.27	9.36	5.75	4.24
T_4	Citric acid @ 400 ppm	33.27	30.40	25.05	20.20	15.42	7.40	3.16
T_5	8-HQS @ 200 ppm	33.65	28.21	24.37	16.82	9.56	5.24	2.22
T_6	8-HQS @ 200 ppm	31.54	25.64	18.84	12.78	8.18	4.15	1.92
T_7	$CaNO_3$ @ 250 ppm	26.15	22.11	17.11	10.15	8.78	5.75	1.48
T_8	$CaNO_3$ @ 500 ppm	28.50	25.95	17.99	10.78	10.14	6.25	1.31
T_9	$AgNO_3$ @ 200 ppm	27.48	23.89	18.62	11.85	8.60	4.83	0.88
T_{10}	$AgNO_3$ @ 400 ppm	23.27	19.50	16.82	9.44	7.43	4.25	0.41
T_{11}	Control	22.26	16.91	14.48	9.03	6.84	3.40	0.28
	S.Em ±	0.536	0.706	0.262	0.267	0.214	0.136	0.063
	CD at 1%	2.104	2.816	1.044	1.064	0.855	0.544	0.252

Table 14. Effect of different chemicals on fresh weight (g/flower) of rose cut flowers Cv. GrandGala

Treatment No.	Days / Treatments	Duration (Days)						
		0-2	2-4	4-6	6-8	8-10	10-12	12-14
T_1	$A1_2SO_4$ @ 100 ppm	47.68	47.84	39.61	33.41	21.59	12.61	6.58
T_2	$A1_2SO_4$ @ 200 ppm	46.42	45.95	36.74	29.27	17.36	9.26	5.12
T_3	Citric acid @ 200 ppm	43.65	41.71	32.89	27.70	14.13	8.69	4.25
T_4	Citric acid @ 400 ppm	40.95	37.04	30.31	26.30	12.99	6.62	3.20
T_5	8-HQS @ 200 ppm	41.79	42.32	28.86	20.74	11.26	5.49	2.25
T_6	8-HQS @ 200 ppm	40.19	40.32	27.25	18.58	8.92	3.70	1.79
T_7	$CaNO_3$ @ 250 ppm	39.56	38.96	27.41	16.18	9.16	3.21	1.82
T_8	$CaNO_3$ @ 500 ppm	40.57	40.53	18.78	17.58	8.70	2.25	1.77
T_9	$AgNO_3$ @ 200 ppm	38.97	39.89	22.58	14.18	6.80	2.27	1.62
T_{10}	$AgNO_3$ @ 400 ppm	38.04	37.67	19.17	11.91	6.08	1.74	0.97
T_{11}	Control	37.20	37.09	18.84	11.09	5.64	0.62	0.27
	S.Em ±	0.403	1.080	0.437	0.236	0.306	0.140	0.054
	CD at 1%	2.983	4.307	1.745	1.936	1.220	0.198	0.218

Table 15. Effect of different chemicals on vase life (Days) of rose cultivar GrandGala

Treatments	Vase life (days)
$A1_2SO_4$ @ 100 ppm	14.24
$A1_2SO_4$ @ 200 ppm	13.75
Citric acid @ 200 ppm	12.24
Citric acid @ 400 ppm	11.52
8-HQS @ 200 ppm	10.55
8-HQS @ 200 ppm	10.61
$CaNO_3$ @ 250 ppm	10.41
$CaNO_3$ @ 500 ppm	10.67
$AgNO_3$ @ 200 ppm	9.67
$AgNO_3$ @ 400 ppm	10.27
Control	9.34
S.Em ±	0.632
CD at 1%	2.522

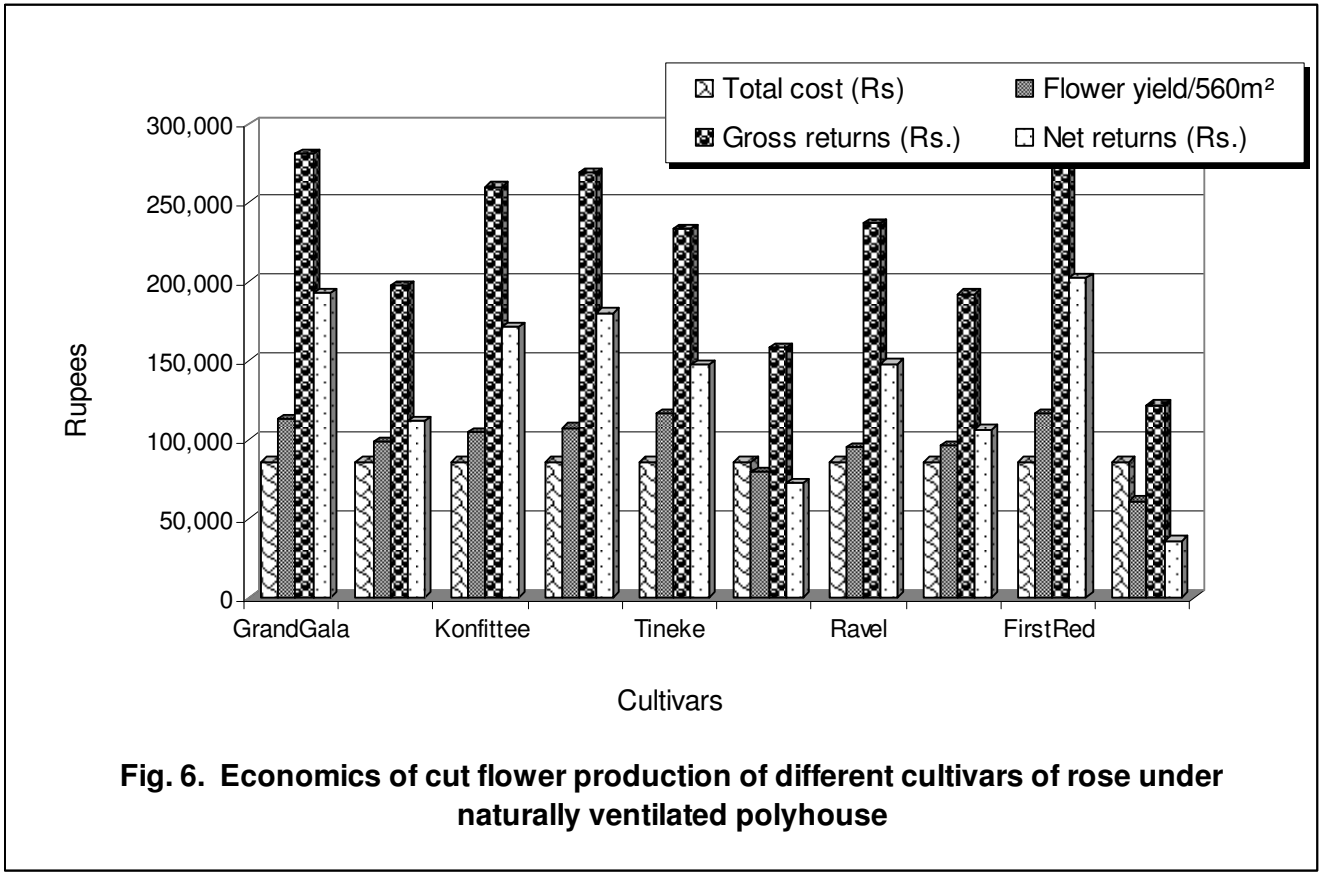


Fig. 6. Economics of cut flower production of different cultivars of rose under naturally ventilated polyhouse

Fig. 6. Economics of cut flower production of different cultivars of rose under naturally ventilated polyhouse

V. DISCUSSION

The crop growth and yield of any crop are influenced by various factors like genotype, climate, soil, nutrition, various cultural manipulations, pest and diseases and interaction of all these factors. Among these factors, cultivars themselves contribute much to the performance of any flower crop. However, the performance of cultivars of any crop differs from one region to another region. When different cultivars are grown under identical conditions, it is the genetic potential that expresses the morphological differences. Hence, selection of cultivars is an important criterion for successful cultivation of any crop. The present investigation was carried to study the performance of ten rose cultivars under naturally ventilated polyhouse (NVPH) and quality including the vase life of rose cultivars under different chemical preservatives.

5.1 PERFORMANCE OF ROSE CULTIVARS UNDER NATURALLY VENTILATED POLYHOUSE

The experiment on performance of rose cultivars under NVPH was carriedout during May 2004 to May 2005 by including ten cultivars. The findings of present investigations are discussed based on the characters studied.

Performance of different rose cultivars under naturally ventilated polyhouse with respect to plant growth, development, flower production, quality and vase life have been studied by several workers Nagaraja, (1996); Gowda *et al*., (1997); Sindhu and Ramesh, 2004; Chandragiri, *et al*., (2004) in chrysanthemum.

5.1. 1 Growth parameters

The growth parameters decide the final yield of crops, which include plant height, number of leaves, leaf length, leaf area, leaf area index and number of shoot etc.

Plant height is an important growth related morphological characters of crop plants. Plant height plays an important role in plant duration and productivity of any genotype. In the present investigations, the height of the plant varied significantly among the different rose cultivars. GrandGala, recorded maximum plant height followed by Skyline and First Red at all stages of plant growth, which were highly vigorous and significantly superior over other cultivars .Versilia recorded minimum plant height which was less vigorous growth, this may be attributed due to varietal characters. Similar variation in plant height was reported by Vypari (1985).

Leaves are the functional units for photosynthesis, which greatly influence the growth and flower yield of many crop. Number of leaves produced per 10 cm shoot length varied significantly among rose cultivars studied, maximum number of leaves per 10 cm shoot length was produced in Konfittee followed by Skyline, GrandGala, First Red and Tineke. The production of more number of leaves in these cultivars was due to increased plant height and number of shoot production. The Cv. Versilia produced less number of leaves due to varietal difference. This was in accordance with the findings of Bhattacharjee (1993).

Significant differences were also observed among rose cultivars for length of leaf. The leaf length was maximum throughout the growing period in Cvs. GrandGala, First Red, Skyline and Tineke. while the Cvs. Lambada and Versilia recorded the minimum leaf length during its growth period. Variations in leaf size were due to varietal character also observed previously in cornation (Ulinger and Lindgren, 1984).

In general the Cvs. GrandGala, Skyline, First Red, Tineke and Konfittee recorded maximum leaf area. Higher leaf area in these cultivars was due to more number of leaves. Leaf area was minimum in Cv.V ersilia. Lesser number of leaves and shorter the leaves in this cultivars resulted in minimum leaf area. Since the cultivars varied for their number of leaves and length of leaves, leaf area also varied. Variation in leaf area among cultivars was also observed in carnation by Mahesh (1996).

Leaf area index was found to be higher in Cv. GrandGala followed by Skyline, First Red and Tineke due to maximum leaf area which might have increased the photosynthetic efficiency of leaf surface leading to increased production of flowers. Minimum leaf area index

was noticed in Cv. Versilia, it might be due to the variation in the genetic make up apart from low number and small size of leaves.

With respect to number of shoot production significant differences were observed among different rose cultivars. Cvs. GrandGala, Tineke, Skyline and FirstRed recorded maximum number of stalk which might be due to the bottom breaks or bending of shoot that hinders the apical dominance and enhanced the production of basal shoots due to higher light interception and increased photosynthetic efficiency especially in vigours cultivars Henchen (1981) Cvs. Lambada and Versilia recorded least number of shoot production this may be due to variation in genetic constitution.

Performance of any cultivar depends upon its genetical make up. Variation in plant vigour among the cultivars could be attributed to the variation in their genetical make up. Since these characters are genetically controlled ones, variations among the cultivars are found to occur. Hence, vigorous growing cultivars were superior over other cultivars in some or in most of the vegetative characters like plant height, stem girth, number of shoots number of leaves, leaf size etc. which are further interdependent on each other.

5.1.2 Flowering characters

Cultivars GrandGala, FirstRed and Skyline were early to initiate flower bud whereas, cultivars Lambada and Versilia were late to initiate bud Tineke, Samurai, Konfittee, Ravel and Eternal were found mid late cultivars. This could be because of varietal characters were. Similar finding also observed by Bhattacharjee (1993). Least number of days for first harvest was noticed in Cv. GrandGala, it may be due to early bud initiation, whereas, maximum number of days to first harvest was in case Cv. Versilia followed by Lambada. Similar kind of variation was also reported by Chandrashekariah (1985) in roses. Among the different cultivars of rose, GrandGala and First Red had maximum field life or senescence period in plant (Nair and medhi, 2004) in gerbera. The cultivars variation recorded in different flowering characters may be due to differences in the inherent make up of these cultivars.

5.1.3 Yield attributes

Ultimate aim of crop improvement is to achieve higher yields with good quality. Among the Cvs. Studied Tineke, GrandGala, First Red produced maximum number of flowers per plant and can be grouped under high yielder whereas, Ravel, Eternal, Samurai and Konfittee fall into the category of moderate yielders, however, Cvs. Lambada and Versilia can be classified as the low yielders. In the present investigations, higher yield may be due to increased morphological parameters like plant height, more number of leaves and leaf area which help in production of more photosynthates resulting in greater accumulation of dry matter which inturn directly or indirectly leads to production of more number of flowers per plant. Variation in flower yield was also observed previously in rose by Nagaraja, *et al*. (1996); Sindhu and Ramesh Kumar. (2004).

Significant differences in stalk weight of the flower were noticed among cultivars tested. The average weight of stalk was maximum in Ravel, followed by Skyline, FirstRed and GrandGala whereas, it was minimum in Lambada. Variation among the cultivars was mainly because of increased flower size with prominent stalk length and also due to presence of fairly more number of well developed petals. Further being a genetical factor variations were expected among the cultivars of rose.

5.1.4 Quality parameters

The rose cultivars were evaluated for commercial cut flowers production on the basis of various characters. The various characters like, shoot length, bud length, bud diameter, vase life, flower opening, neck bending 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. The other varietal characters such as, shoot girth and density of thorns are considered to be secondary importance. A good variety possessing the desirable primary characters is considered as a good variety for cut flower production, taking in consideration that it may or may not possess one or more of the secondary characters. Various characters of the ten rose cultivars are discussed below with regard to their importance in cut flower production.

A strong, long, slender shoot length is a pre requisite for an ideal rose cut flowers as blooms with longer, straight stems fetch a better price in the market and are accepted in the export market (Hussein, 1955, Malik, 1968; Mukhopadhyay, 1990). This could be because of the convenience and beauty of such flowers in flower arrangement, strong consumer acceptance and increased vase life (Prince *et al*., 1980: Gothmare, 1993). The carbohydrate storage in longer stem is much more as compared to shorter stems and it is probably the carbohydrate reserve in the stem which enables the maintenance of dry matter and respirable substates, especially in the flowers petal which helps in extending the keeping quality of cut flowers with longer stems Coorts, (1973), Halevy (1976) also reported similar results, that the translocation of sugars from stem to corolla increased the water uptake and helped to maintain turgidity in the stem, thus prolonging the shelf life. The stem was said to possess increased sucrose inversion capacity aiding the increase in shelf life (Chin and Sacalis, 1977).

Among the ten cultivars evaluated, highest shoot length were observed in Cv. GrandGala significantly superior over the others cultivars. Cv. Lambada recorded minimum shoot length, which was significantly lower than the others. Similar results with regard to varietal differences were obtained by Patil and Kanamadi (1993). Thus variation in shoot length among the cultivars evaluated may be attributed to the varietal characters of the ten cultivars. Post (1952) classified cut flowers in to six different grades according to their stalk length. A strong consumer demand exists for all the grades. Long stalk for cut roses are pre requisite in the international market. Whereas, short stalk roses sell well in India, especially, in the local markets, where 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. In the present investigation, Cvs. GrandGala, Skyline, First Red and Tineke produced more stalk length, while Cvs. Lambada and Versilia produced lower stalk length, this was mainly due to the differences in the varietal characters.

According to Post (1952) classification of grading was done based on stalk length and bud length Cv. GrandGala produced ‘Extra special’ grade. However ‘Special grade’ was registered by Cvs. FirstRed and Skyline. Whereas, Samurai and Konfittee grouped under ‘Fancy’ grades while ‘Medium’ grades flowers were produced by Lambada. However Versilia and Ravel could be categorized under ‘Extras’.

Significant variations among the cultivars were observed with regard to neck length, neck girth, bud length, bud diameter and number of petals. Neck length is a vital character responsible for elegance of the flower, setting apart the flower from the foliage. Varieties possessing a medium neck length are preferred in general because a ‘too short’ or ‘too long’ neck looks disproportionate in proportion to the size of the flowers bud.

Variation in stalk length was recorded among the ten varieties tested. The highest stalk length was recorded in Cv. GrandGala fallowed by Skyline and First Red as such these three varieties are more desirable from this angle. The least shoot length was recorded in Cv. Lambada followed by Versilia. These variation in shoot length amongst the varieties my be attributed to the varietal differences.

Variations amongst the varieties in neck length, bud length and bud diameter were recorded. Neck length is an important character for good appearance of flowers, since it sets apart the flowers from the foliage as already quoted. Varieties with medium neck length are generally preferred. In the present investigations GrandGala, First Red and Skyline recorded medium neck length. Similar results were obtained by Appanna (1976) in roses. In addition to the stem length, quality of cut flowers is judged based on its bud length and diameter. Bud length and bud diameter of flower helps in judging its bud size. 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). The bud size produced by Cvs. GrandGala, First Red and Skyline were in the medium range whereas. Cv. Lambada recorded small bud size.

It is very essential for cut flowers to possess a strong stem of sufficient strength to hold bloom firmly erect (Malik, 1968). Stem and neck girth indicated the sturdiness of the cut flowers. Variation in stem and neck girth is often a sign of varietal difference, rather than a sign of poor culture (Thomson and Wilson, 1957). Stem girth was maximum in Cv. Ravel and neck girth in Skyline, whereas, they were minimum in Cv. Lambada and Versilia. Neck bending is often observed in some varieties. Neck bending is often associated with a weak

neck or less neck girth varieties, which have less neck girth, were often unable to bear the weight of the flowers causing the neck to bend under its weight. Neck bending was more common in Cv. Tineke and Lambada as it had minimum neck girth.

Number of petals per bloom is another important quality character in a cut flower, as it renders quality and appearance to the flower bud at the time of harvest and after opening. In case of less number of petals, the bloom opens quickly showing its open centre, which is extremely undesirable, however, if the petals are too many in number the flowers bud does not open at all or opens poorly many times resulting in bull heads, thus loosing its appearance. A good cut flower should not have excessive number of petals (Malik, 1980). Chandrashekharaiah (1973) reported that a quality cut flowers should have optimum number of petals in the range of 27-32. In the cultivars GrandGala and 'First Red', the number of petals optimum, less than optimum in Cv. Lambada and versilia, more than optimum in 'Tineke'. Flowers possessing a slow and uniform mode of opening have better consumer acceptance on account of their longer shelf life and fresh appearance. Among cultivars evaluated First Red and 'GrandGala' showed more slow and uniform mode of opening. This also may be attributed the difference in the genetic make up of the cultivars.

Results of the vase life of ten cultivars showed significant differences. Lambada recorded lowest vase life while GrandGala and First Red recorded highest vase life. This could be due to excessive accumulation of sugars in the stem, which are translocated to corolla, thus increasing the water uptake and maintaining turgidity in stem, resulting in prolonged vase life of the flower (Halevy, 1976). This variation between varieties with regard to vase life could also be due to difference in their genetic make up of the cultivars petal length and petal width differed significantly among the cultivars tested. However petal length was maximum in Cv. Tineke whereas, breadth was maximum is Cv. GrandGala both petal length and breadth were minimum in Cv. Lambada, this can attributed to inherent genetic makeup of the characters.

A stem as free of thorns as possible is a desirable character for a rose cut flowers variety (Malik , 1968), Lesser number of thorns also has a strong consumer acceptance. This is probably due to the ease of handling the cut flowers with lesser thorns. More number of thorns makes it difficult during flower packing, handling and transport, causing damage to the foliage and some times even bloom, decreasing their market quality. Among the varieties evaluated, Konfittee recorded highest density of thorns, while Cv. Tineke recorded lowest density of thorns. This may be attributed to the inherent difference in the genotypes studied considering the view of consumers, their most preferred cultivars was First Red which ranked first fallowed by GrandGala and Ravel which ranked 2^{nd} and 3^{rd} respectively. The preferred varieties First Red and GrandGala among the consumers might be due to its attractive warm red colour and exquisite shape. It mostly preferred in the occasions, especially during Valentines day it is in turn realizes a maximum price in the world market, red colour symbolize the love, affection and delicate beauty whereas, pink colour Ravel was indefinite in showing its meaning and expression happiness.

5.1.5 Correlation studies

Information on correlation between important economic traits is of considerable help in the selection programme. This is because correlation ensures simultaneous improvement in one or more variable traits and negative correlation bring out the need to obtain a compromise between the desirable traits. Correlation between characters may be due to either pleotrophy or genetic linkage (Harland, 1939). Knowledge of association of various characters among themselves and also with economic characters provides necessary information on indirect selection for improvement of economic characters. Relationship could be obtained from simple correlation co efficient, which helps in determining the direction and the number of characters to be considered in improving economic characters. High correlation between two characters indicates that selection for the improvement of one characters lead to the improvement in the other character depending upon the magnitude of association between them. The characters are considered to be independent when weak correlation exists between them and selection for a character may not affect the other in such case. In the present study, phenotypic correlation co efficient were observed for the most of the characters like growth, flowering and quality parameters.

Yield is a complex trait, the expression of which depends upon the action and multiple interaction of various components. In the present study, association of different cut flower characters with yield and among themselves was studied. Yield showed significant correlation with height of the plant and quality attributes like, shoot length bud length, bud diameter, neck length, neck diameter and number of petals but negatively significant relation with days to flowers bud initiation and thorn density.

Chaugule (1986) in chrysanthemum observed a significant correlation between yield per plant and characters like plant height, number of leaves, number of shoots per plant. Plant height was correlated with number of flowers per plant. Similar correlation was reported by Manjunatha Rao (1982) in China aster, Palai *et al*. (2003) in roses. Plant height had great influence over important vegetative parameters, flowers yield as well as quality attributes, and other yield contributing parameters like number of leaves had a significant positive association with leaf area and number of flowers per plant. Leaf area had highly significant and positive association with almost all the characters of rose cultivars except for thorn density and days to flower bud initiation, which showed weak association. Stalk girth and stalk length had significant association with number of flowers per plant at phenotypic level. This is in accordance with the finding of Bhattacharjee and Wahi (1982) in Dhalia.

Flowering characters like days to bud initiation possessed negatively significant correlation with the yield and other characters, which proved that it is highly independent variable during growth period. Similar findings were reported by Jhon *et al*. (1994) in zinnia and Chaugule (1985) in Chrysanthemum. Among the floral characters bud length, bud diameter showed positive association with number of petals per flowers (Chaugule, 1985). Neck length and neck diameters showed positively significant association with the number of petals singh *et al* (1986)

5.1.6 Economics

The economic analysis revealed that, the maximum gross returns (Rs 2,91,930 per 560m^2) was obtained from FirstRed followed by GrandGala and Skyline (Rs.2,81,715 and Rs 2,69,430 per 560m^2 respectively) with a net returns of Rs.2,02,900 Rs.1,92,715 and 1,80, 430 per 560m^2 respectively, compared to other cultivars. These cultivars had maximum B:C ratio of 2.27, 2.16 and 2.02 respectively (Table 11).

5.2 EFFECT OF DIFFERENT CHEMCIALS ON VASE LIFE OF ROSE CUT FLOWERS CV. 'GRANDGALA'

Floral preservatives are under use to increase the vase life of cut flower from many decades. Among many preservatives the use of sucrose and citric acid been recognized by Mayak and Dilley (1976); Ferreira and Swardt (1981) and Paulin (1986). Cost involved in the production of rose cut flowers was also worked out (Subramanya, 1989).

A flower, when detached from its source plant is deprived of its metabolic and water supply and shows tendencies of wilting. The development of opening of cut flowers is an active growth process characterized by an increase in the respiration rate during its opening which requires an adequate water supply. Thus, water is the most important and universal ingredient of a holding solution to which other chemical preservatives are added to increase the shelf life of the cut flowers. An Ideal cut flowers should remain fresh with respect to colour and fragrance and should have long vase life. To achieve this, different chemical preservatives were tested as holding solution for the rose cut flowers of Cv. Grand Gala and the results are discussed here under.

The addition of chemical preservatives to holding solution inorder to prolong the vase life of cut flowers was reported by several workers (Aarts, 1957a, b; Coorts *et al*., 1965; Halevy, 1976; Halevy and Mayak, 1979; Tiwari and Singh, 2002; Karki *et al*., 2004).

Optimum and continuous absorption of water by the cut stem is a necessary factor influencing the vase life of the cut flower. Which was assessed by determination of water uptake by the cut flower stem. Among the chemicals tested, maximum solution uptake by the cut roses was observed in aluminium sulphate, followed by citric acid. Minimum solution uptake was observed by the cut flowers held in silver nitrate. The aluminium sulphate at 100 ppm registered maximum solution uptake. The maximum solution absorption by aluminium

sulphate may be attributed to its germicidal and acidifying action in the holding solution, retarding bacterial growth and preventing vascular blockage there by encouraging continuous water uptake through the cut stem (Rameshwar, 1974); Nowak and Rudnick, 1990; Ruting; 1991; Shoba and Gowda, 1992; Singh *et al*., 2003; Karki *et al*., 2004.)

A low pH of the holding water reduced the microbial population (Aarts, 1957a). Low pH retards stem blockage even in bacteria free water. This could be the reason for increased solution uptake of citric acid by the cut roses in the present experiment. Several workers also reported that citric acid prevented plugging of vascular bundles there by improving water uptake and water balance (Parups, 1974, Durkin, 1979b, Karki, 2004).

The solution loss in all the treatments differed significantly. The maximum solution loss was observed in aluminium sulphate at100ppm, whereas minimum loss was notice in silver nitrate at 200ppm during the entire vase life period. The roses held in aluminium sulphate were most effective in maintaining an improved water balance as compared to other treatments. Aluminium in the holding water induced stomatal closure thereby reducing transpiration and improving water balance of cut roses (Schnable and Ziegler, 1975).

All the chemicals showed a significant increase in fresh weight on the second day. Cut roses held in aluminium sulphate solution showed maximum fresh weight. Whereas all the other treatments showed a significant differences. The aluminium sulphate at the rate of 100ppm concentration registered maximum fresh weight during the entire period of vase life. Aluminium in holding water besides its anti microbial action also reduced transpiration and improved water balance of cut roses by inducing stomatal closure (Schnable and Ziegler, 1975).

In the present experiment, all the treatments showed a significant increase in vase life over the control (tap water) Roses held in aluminium sulphate at 100 ppm concentration remained fresh for a longer period in comparison to other treatments, recording a significantly higher vase life (15.14 days) over the other treatments, this was mainly because it showed a better water balance and an increase in fresh weight upto fourth day. Rose exposed to aluminium for only twelve hours had reduced bent neck and wilting (Mayak and Bar-Yosef, 1972).

The Present investigation revealed that aluminium sulphate at 100ppm was found to be preservative the best chemical for prolonging the longevity of cut rose flowers Cv. GrandGala. Rose cut flowers held in aluminium sulphate solution showed an improved water balance there by maintaining turgidity of the rose petals. An increase in fresh weight of the cut rose flower was observed upto fourth day and the vase life recorded was 15.14 days. According to Rameshwar (1974) aluminium sulphate was an ideal preservative for cut roses. The advantages being easy availability, Lower cost and good solubility. Aluminium sulphate besides being an active biocidal also acidifies the holding solutions, thus reducing the amount of citric acid required to lower the pH of holding solution.

PRACTICAL APPLICATION

Considering various aspects of cut flower production and quality parameters Cvs. GrandGala, First Red, Skyline and Tineke are best suited for the naturally ventilated polyhouse cultivation under Dharwad condition (Plate. 2).

Aluminium sulphate at 100 ppm was found to be the best treatment, which increased the fresh weight and vase life significantly over control and other treatments tried

GrandGala

FirstRed

Skyline

Tineke

Plate 2. Promising cultivars of rose under naturally ventilated polyhouse

Ravel

Konfittee

Samurai

Eternal

Versilia

Lambada

Plate 4. General view of rose cultivars

FUTURE LINE OF INVESTIGATIONS

1. Studies on response of GrandGala, Skyline and FirstRed to varying plant density, with reference to flower production and quality may be tried
2. Studies on pending, pruning and other measures to regulate flowering are need to be standardized.
3. Response of these cultivars to fertilizer and growth regulators under polyhouse condition can be studied.
4. Evaluation of these cultivars for pest and disease resistance may be tried.
5. Studies on post harvest packaging may be tried to know the possibilities for extending the vase life of rose cut flowers.
6. Studies on micronutrients and their effect on growth, yield and quality of rose cultivar may be taken up.
7. Crop improvement through hybridization among the elite rose cultivars for higher yield and quality characters and pests and disease resistance, a need to be initiated.
8. Studies on integrated pest and disease management are need to be carried out.

VI. SUMMARY

The present investigation on “Studies on performance of rose cultivars under naturally ventilated polyhouse’’ was carried out in the Saidapur farm, Main Agricultural Research Station, Department of Horticulture, University of Agricultural Sciences, Dharwad, during May 2004 to May 2005. The experiment was conducted with ten cultivars in randomized block design, replicated thrice.

The main objectives of study were to know the performance of rose cultivars under naturally ventilated polyhouse with respect to yield and quality attributes and effect of chemical preservatives at different on vase life of rose cut flowers. The salient features of experimental findings are summarized below.

The rose cultivars showed great variations for growth, yield and quality parameters.

Maximum number of quality cut flowers were produced by Tineke (27.84), GrandGala (26.83) and FirstRed (27.80), hence these cultivars were grouped as high yielder, while Lambada registered minimum number of flowers per plant per year. However, higher stalk weight were noticed in Cvs. Ravel, FirstRed and Skyline.

There was wide variation with respect to shoot length in the cultivars studied. The Cv. GrandGala registered maximum stalk length (64.96cm), which was significantly higher over other cultivars and was found to be vigorous whereas, Lambada (34.46cm) recorded the minimum stalk length.

Least number of thorns per unit of stem length, a highly desirable characters was recorded in Tineke.

Among the different cultivars studied, GrandGala registered maximum bud length, neck length and bud diameter, which are regarded as important quality characters and followed by FirstRed, Skyline and Tineke.

Among the cultivars tested, there was variation in stem and neck girth. The stem girth was maximum in Ravel, whereas Skyline registered maximum neck girth, which is important character for sturdiness of rose cut flowers.

Variation in petal number was found in cultivars studied, the highest number of petal was found in Tineke while it was least in Lambada. Petal length and width was maximum in Tineke and GrandGala respectively.

GrandGala was recorded maximum vase life (9.58days) in tap water compared to other cultivars studied.

With respect to grading, GrandGala was categorized under ‘Extra special’ grades, whereas, Skyline and First Red were under ‘Special’ grades. This is a desirable character, since it can meet the flexible demands of different grades of flower in the market.

Considering the view of consumers the most preferred Cultivar was FirstRed which ranked first followed by GrandGala (2^{nd}) and Ravel (3^{rd}).

The rose cultivars showed variations for growth parameters. Among the cultivars GrandGala, Skyline, FirstRed and Tineke showed superior performance for growth attributes viz., plant height, number of leaves, number of shoots after bending, leaf length, leaf area, leaf area index hence these are regarded as vigorous cultivars.

Among the cultivars tested GrandGala and First Red took the least number of days for initiation of bud and harvest of the flowers hence these are registered as early cultivars, while Versilia can be regarded as late cultivar.

The maximum number of days for flower senescence on plant was observed in GrandGala, First Red and Ravel.

Positive and highly significant correlation was registered between number of flowers per plant, plant height, number of leaves, leaf area, shoot length, neck length, bud length, bud diameter, neck diameter and number of petals

However, negatively significant association was noticed with thorn density and days to flower bud initiation.

The cultivar FirstRed realized maximum net returns (Rs.2,02,900 per 560 m^2 per year) and B: C ratio (2.27) followed by GrandGal (1,92,750 per 560m^2 per year) and Skyline (1,80, 430 per 560 m^2 per year) compared to all other cultivars studied.

Variation in the extent of vase life existed among the chemical preservatives. The maximum vase life (14.24 days) of rose cut flowers were observed in the preservative solution containing aluminium sulphate at 100 ppm.

Aluminium sulphate at 100ppm concentration increased the solution uptake, solution loss by cut roses and gained more fresh weight.

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APPENDIX- I

Monthly meteorological data for the experimental year (2004-05) and average of past 54 years (1950-2004) recorded at the meteorological observatory, MARS, UAS, Dharwad

Month	Rainfall (mm)		Temperature (^{0}C)				Relative humidity (%)	
			Maximum		Minimum			
	2004-05	1950-2004	2004-05	1950-2004	2004-05	1950-2004	2004-05	1950-2004
May,04	61.1	0.086	33.6	29.15	21.4	19.23	66.0	63.37
June, 04	43.8	1.161	28.8	34.52	21.5	16.02	80.0	51.18
July,04	24.8	0.147	29.2	35.73	21.0	18.81	79.0	56.47
August, 04	160.7	48.45	27.0	37.00	20.3	21.32	83.0	76.98
September, 04	222.01	81.40	30.1	36.52	19.9	21.48	77.0	66.71
November,04	64.6	109.14	30.2	29.50	18.4	21.21	65.0	81.69
December, 04	0.6	15.77	29.4	22.06	15.9	20.95	52.0	87.46
January,05	0.00	95.30	30.7	22.01	12.5	20.62	45.0	86.51
February,05	4.8	100.54	33.4	28.75	15.0	20.16	49.0	82.40
March, 05	Traces	130.99	36.0	30.12	16.3	19.30	43.0	76.44
April, 05	Traces	32.04	36.3	29.46	18.9	15.50	42.0	68.13
May, 05	75.0	54.50	37.0	29.18	21.3	13.44	530	63.81
		-	-	-	-	-	-	-
Total		**615.52**						

APPENDIX II

Physical and chemical properties of soil from experimental site

Particulars	**Values**			**Method adopted**
Particle size analysis				
Coarse sand (%) Fine and (%) Silt (%) Clay (%)	29.84 9.54 42.96 17.36			International pipette method (Piper, 1966)
Soil texture	Loamy			
	Depth(cm)			
	0-15	15-30	30.45	
Apparent specific gravity (mg/m^3)	1.41	1.40	1.43	Core sampler method (Dastane, 1967)
Field capacity (%)	20.80	21.50	19.92	Field method (Dastane, 1967)
Permanent wilting point (%)	9.2	9.4	8.7	Pressure plate apparatus 15 bar
Chemical properties				
Available nitrogen (kg/ha)	220			Alkaline permanganate method (Subbaiah and Asija, 1956)
Available phosphorus (kg/ha)	21.15			Olsen's method (Jackson, 1967)
Available potassium	232			Flame photometer method (Jackson, 1967)
Available sulphur (kg/ha)	19.5			Turbid metric method (Tandon, 1993)
Organic carbon (%)	0.79			Wet oxidation method (Jackson, 1967)
Soil pH (soil water ratio 1: 2.5)	6.93			Buckman's pH meter (Piper, 1966)
EC (soil water ratio, 1:2.5 dS/m)	0.65			EC bridge (Jackson, 1967)

APPENDIX III

Fertigation schedule for rose production under protected cultivation

Days	Fertilizer	Quantity	
		m^2	560 m^2
Monday and Thursday	19:19:19 + 12:61:0 (MAP)	2g + 1g	1,120g + 560g
Wednesday and Saturday	$Ca(NO_3)_2$	1.5g	1,260g
Friday and Tuesday	0:0:50 + $MgSO_4$	1.5g + 1.0g	1,260g + 560g
Sunday	Micronelf-32 + Fe EDTA	0.7g + 0.01g	3 92g + 5.6g

APPENDIX IV

Economics of Rose Cultivation Under Naturally Ventilated Polyhouse (560m^2) for one Year

Particular		Total cost (Rs)	Depreciation cost (Rs/year)
I	**Non recurring contingency (NRC)** (For a life span of 10 years)		
1.	Construction of polyhouse @ Rs-450/m^2	2,52,000=00	25,200=00
	Top: UV stabilized plastic sheets		
	Side: 70% Agro shade net		
2	Irrigation system and other		
a.	Irrigation system including foggers and 2 HP motor	80,000=00	8,000=00
b.	Irrigation equipments and fertilizer storage	15,000=00	15,00=00
	Total of NRC	**3,47,000=00**	**34,700=00**
II	**Recurring contingency (ORC)** (For a life span of three years)		
a.	Planting materials (4200 Pl/unit) @ Rs. 7.5/plant	31,500=00	6,300=00
b.	Bed preparation (FYM, vermicompost neem cake, red soil, sand excavation, labour and fertilizers	50,000=00	10,000=00
c.	Soil sterilization	1,500=00	500=00
d.	Management cost		
d.1	Supervision, maintenance and harvesting (01 labour per unit for 01 year @ Rs. 1200/ month	14,400=00	14,400=00
d.2	Fertilizer and plant protection	-	15,000=00
d.3	Polyhouse maintenance including electricity charge.	-	5,000=00
	Total of ORC		**44,900=00**
	Grand total (NRC + ORC)		**85,900=00**

APPENDIX- V

Proforma for sensory evaluation of rose cut flowers

Name of the Judge: _____

Designation :_____ Date :_____

Using the scale on display, would you please rate each of the samples by placing a number in the appropriate column, rank the sample from higher to lower score in descending order of acceptability

Cultivars Code	Quality attributes				
	Stalk length	Flower Colour	Bud length	Bud diameter	Overall acceptability
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Score

Excellent : 5

Good : 4

Fair : 3

Average : 2

Poor : 1

PERFORMANCE OF ROSE CULTIVARS UNDER NATURALLY VENTILATED POLYHOUSE

G. MANJULA 2005 Dr. A.A. PATIL
MAJOR ADVISOR

ABSTRACT

An experiment was conducted at Saidapur Farm, Main Agricultural Research station, Department of Horticulture, University of Agricultural Sciences, Dharwad, during 2004-05 to study the performance of ten dutch rose cultivars under naturally ventilated polyhouse (NVPH), viz., GrandGala, Samurai, Konfitee, Skyline, Tineke, Lambada, Ravel, Eternal, FirstRed and Versilia. The results indicated that cultivars differed significantly with respect to various characters like number of flowers per plant; stalk length, bud length, neck length, bud diameter, number of petals per flowers and vase life. GrandGala found to be very vigorous and recorded the maximum stalk length. Cultivar Tineke recorded their maximum number of cut flowers per plant (27.84) followed by FirstRed (27.50) and GrandGala (26.83). However they were statistically at par with each other. Cultivar GrandGala produced maximum bud length, bud diameter and neck length, while Ravel showed maximum shoot girth whereas Skyline recorded maximum neck girth. GrandGala and First Red were found to be early for flower initiation. The same cultivars were graded as 'Specials' (53.3-60.9 cm) and 'Extra special' (>60 cm) based on their stalk length and other quality parameters. The longevity of cut flowers held in tap water was maximum in GrandGala followed by FirstRed.

Vase life study with five preservatives at two concentrations for shelf life indicated that aluminum sulphate at 100ppm was the best in maintaining the freshness of cut flowers with extended vase life of 14.04 days compared to 9.58 days in control

The present study revealed that the cultivars viz., GrandGala, FirstRed, Tineke and Skyline, emerged as promising cultivars for commercial cultivation under naturally ventilated polyhouse.