STANDARDIZATION OF MEDIA AND NUTRITION FOR LISIANTHUS (*Lisianthus russellianum*)

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DIVISION OF HORTICULTURE
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STANDARDIZATION OF MEDIA AND NUTRITION FOR LISIANTHUS (*Lisianthus russellianum*)

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CERTIFICATE

This is to certify that the thesis entitled **"STANDARDIZATION OF MEDIA AND NUTRITION FOR LISIANTHUS *(Lisianthus russellianum)*"** submitted by **Mr. SACHIN SHETTY** for the degree of **MASTER OF SCIENCE (HORTICULTURE)** in **FLORICULTURE** to the University of Agricultural Sciences, Bangalore, is a record of research work carried out by him during the period of his study in this University under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or any other similar title.

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SEPTEMBER , 2000

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CONTENTS

LIST OF TABLES

LIST OF PLATES

INTRODUCTION

I. INTRODUCTION

Lisianthus russellianum [Eustoma grondiflorum (Raf.) Shinner.] commonly called *Lisianthus,* is also known as Texas Blue Bell or Prairie Gentian. It belongs to the family Gentianaceae and is believed to be originated from Central America (Nebraska to Lousiana) and Texas. Generally it produces bluish purple flowers but occasionally pink or white flowered plants are found in native stand (Frett *et al.*, 1988).

Lisianthus is an annual or biennial day neutral species. Long day promotes stem elongation, more particularly in white coloured varieties (Abraham and Anton, 1984). It requires a light intensity of 3000 foot candles. In the natural habitat lisianthus is found to grow on the banks of water bodies producing long roots to access fresh water . Initially it forms rosettes of basal leaves followed by leafy stem which bears long pedicelled flowers at the axis of upper leaves, and the stem ends with the flower. The plant can grow upto a height of 50-75 cm and each stem bears about 16-24 flowers. Each flower will be of about 7-8 cm across and 7-10 cm long and resembles the Tulip flowers. Flowers have varied colours. The recent breeding work by many workers around the world has led to the development of flowers with multicoloured and multiwhorled flowers. This crop is extensively hybridised by Japanese, where it was introduced 50 years back. (Halevy and Kofranek, 1984). It was introduced for commercial cultivation around the world especially in Japan, America and many European countries. Presently Kenya has also taken up commercial cultivation of Lisianthus. For cut flower purpose whole plant is cut at the base as in china aster. At Netherlands auction center it has jumped to 15th position in terms of total sales and the demand is increasing day by day. The increasing demand is evident by the increased sales at Holland auction center. As reported by APEDA the volume of sale has doubled in just 3 years from 48.6 million stems in 1992 to 97.4 million stems in 1995. This increasing demand is due to the beautiful flowers that last for 2 to 2½ week without any treatment. Unlike in other cut flowers like rose, carnation etc., in lisianthus we don't need any foliage cover of other (filler material) to prepare a bouquet, due to its attractive, large sized, abundant foliage.

Lisianthus is commercially propagated by seeds. The seeds are very small and sold as paleted seeds. Each gram contains about 800-1300 seeds depending on the variety. The crop needs to be transplanted. Total crop cycle takes about four to four and a half month. Seedlings grow slow initially and first leaves are relatively small compared to many other pot plants. It takes about 2 months to attain the stage of transplanting at 4-6 leaf stage. In the seedling stage the root growth will be faster than the shoot growth.

Lisianthus grows best in 18/24°C day and night temperature. Higher daily temperature (more than 24-26°C) in the early days causes rosetting of seedlings. This can be avoided by reducing night temperature when the days are hotter. Rosetted plants do not produce flowers or produce only few flowers.

Lisianthus is gaining importance as a cut flower in the international market and can earn foreign exchange for India. For better growth of any crop, along with better climatic conditions good media and nutrient is also necessary. As with most new crops, due to limited cultural information, commercial producers have struggled with different aspects of production and management of this crop. Presently media consisting of peat and perlite is used. Since the cost of this media is very high there is a need to develop suitable media with indigenous materials. In Lisianthus ratio of nitrogen to potassium plays an important role (Harbaugh *et al,* 1998). Hence standardizing media and nutrient will be helpful in producing export quality flowers in our country.

The present investigation was conducted by using different media and nutrient concentration with the following specific objectives.

(i) To standardise the indigenously available media for growing Lisianthus.

(ii) To standardise the nutrients for growing Lisianthus.

(iii) To findout the effect of media and nutrients on the vase life of cut flowers.

REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

Lisianthus is an important cut flower crop, which has gained importance in recent past. Performance of any crop species is generally influenced by media, nutrient and the environment in which it is growing. This crop was introduced for cultivation without much work being carried out in its media and nutrition (especially in India). Therefore, work done on various other ornamental flower crops is reviewed under the following headings.

2.1 Effect of media on plant growth and post harvest life

2.2 Effect of nutrients on the growth and post harvest physiology of ornamental crops

2.1 Effect of media on plant growth and post harvest life

2.1.1 Plant growth

An essential part of modern crop management in flower production is the operation according to a carefully conceived cultural schedule. For the cultural programmes to succeed the grower should be able to exercise a certain control over growing conditions. Above ground environment however has generally not reached such an advanced stage. The grower can only exercise limited control over the root medium through adjusting watering and feeding practices, because these adjustments largely depend on the physical and chemical properties of the pot medium. The availability of well standardised pot media is therefore very important to the grower.

Foliar chlorosis or bleaching, interveinal chlorosis, leaf edge and tip necrosis, a poor root system and stunted growth of *Eustoma grandiflorum* seedlings were associated with a medium pH of 5.0 or 5.5 but not when the values ranged from 6.4 to 7.5. The range of medium pH resulting in the best growth of seedlings and flowering plant was 6.3 to 6.7. Shoot fresh weights at pH 5.0 and 5.5 were only 23 per cent to 66 per cent of corresponding value for plants grown at pH 6.4. also leaf tissue Zn was extremely high (1050 mg per kg dry leaf tissue) at a medium pH of 5.0, but other macro and micro nutrients in leaves were not at abnormal levels (Hanbaugh and Woltz. 1991). Low pH causes toxicity of Zn in plant (Habaugh *et al.*, 1998). The crop should be maintained in a pH range of 6.3 to 7.0 to avoid build up of high nutrient concentration (Singh., 1998).

Wolf (1990) observed best growth of chrysanthemums, pelargoniums and begonias on compost and peat mixture (50:50) followed by T.K.S. and R.K.S. (plant residues) commercial substrates. He also suggested that the media should have a pH of 6.0 to 6.5 and salt content of 200 mg per liter (<1500 mg/l K) and heavy metal content should to be 300 mg(1.60mg/l Zn). Total gerbera flower production per meter square was greatest at pH 6.0 (Gubo, 1994). Sogni (1988) in Itally found that the lisianthus require a pH of 6-7.

Chrysanthemum plants grow taller (34.5 cm) with highest stem diameter (0.51 cm) when grown on filter press mud (Scoltanzal *et al.*, 1982) and soil + bamboo compost (Putrasamedja and Satapradja, 1989). The potted chrysanthemum plants grown in media containing aged conifer bark + perlite + sand + peat (1:1:1:1 v/v) and 2:1:1 v/v of aged conifer bark + perlite + sand were tall, fully developed and saleable as pot plants (Cotler and Gomez. 1978).

Vita-M-De and De-Vita-M, (1993) reported that flowering was advanced in lisianthus grown out doors in soil amended with 10 kg vinasse/m^3 or 5 kg peat /m^3 and also the cut flower quality was better. Sogni (1988) reported that lisianthus requires a fairly light, free draining soil with a good organic matter.

Chrysanthemum plants grown on coarse sorghum peat moss and precompressed peat pellets were taller and had higher fresh weight (Gisierod, 1988). Karlovich and Fonrend (1986) observed non-significant difference with respect to height, top fresh weight and dry weight in chrysanthemum cultivar Spice Gran on bark, soil and peat media. Plants grown on T.K.S. substrate (plant residue) with high moisture level gave highest dry weight (Rober and Hafez 1982). Lee and Goldsberry (1988) reported superior plant height and biomass yield when grown on rockwool. Best performance of chrysanthemum plants was observed when grown in soil + Peat + perlite mixture (Boodley *et al.*, 1983). Paul and Rajeevan (1992) observed that brick and gravel were the best medium with regards to survival and growth performance of dendrobium.

Growth index and shoot dry weight of pentas and ixora plants were significantly better in coir based medium (Meerow, 1994). In chrysanthemum, Huang *et al.* (1989) obtained best growth and highest fertilizer efficiency in a mixture of peat + sand (75:25 by volume). They also observed that adequate aeration of the medium was of great importance for both chrysanthemum and tagetus. Leinfelder and Rober (1991) observed no effect on yield and quality of carnation cuttings produced on peat + perlite on grounded coconut shell (Kumar, 1992).

Smith and Treaster (1991) observed that aster did not respond well to sludge treatments which were used as a soil additive and soil mulch in mineral soils but when composted municipal wastes were used as media the plant growth was equal to or better than that of soil. (Bugbee *et al.*, 1991).

Bugbee and Frink (1989) noticed that the growth of marigold was improved when some or all the peat was replaced with composted food flavouring waste. Plant growth in non-liquid fertilized media containing other composts was superior to that of conventional peat medium.

Lohr *et al.* (1984) reported that high quality transplants of marigold were obtained when grown in 25 per cent aged spent mushroom compost, while acceptable plants of slightly reduced quality were produced in 50 per cent aged spent mushroom compost due to high salinity.

When chrysanthemum was grown in soilless media with organic waste there was little difference in plant growth than that of control. Mixture containing 33-50 per cent organic matter was satisfactory for plant growth (Criley and Watanabe, 1974). A comparative study using bark and FYM as substrate for chrysanthemum was conducted by Strojny (1979). He found that bark was beneficial for plant growth.

When worm casts were used as growth medium in china aster and salvia, the mychorhizal root in chrysanthemum was higher and the contribution was beneficial on stem girth. (Kale *et al.* 1987). The plant height in china asters increased with increasing level of organic manure and was highest due to phospho compost (5% P_2O_5 as rock phosphate and 10% P_2O_5 as pyrites). The leaf number and number of branches increased due to application of FYM with recommended NPK, followed by mechanical plant compost (Srinivas and Gowda, 1995).

Kozik (1993b) recommended application of NH_4NO_3 at 180-300 mg per cubic decimeter for aster grown in plastic tunnels to obtain higher flower yield and quality. In 1992, Kozik obtained highest flower yield and best ornamental value of the crop with N at 0.16 – 0.4 grams per cubic decimeter of substrate and with K at 0.16 – 0.64 g per cubic decimeter of substrate.

Garibaldi and Deambrogio (1990) revealed that when begonia was grown in a substrate consisting of earth worm worked urban compost, small plants with few flowers were obtained.

Maximum flower yield in china aster was obtained after application of phosphorus – compost and recommended N and K (Srinivas, 1992).

2.1.2 Flower quality

Media have significant role on flower quality. Habaugh and Woltz (1991) reported that higher fresh weight and higher number of buds were observed at pH of more than 7 in lisianthus.

Boudt (1991) observed more number of chrysanthemum flowers in cultivar White Resette and higher flower weight in cultivars Bronze Redgan and Old Golden Resette grown on peat and border soil. Best growth and flowering was recorded in plants grown on 1:1 v/v ground bark and peat (Strojny, 1986). Karlovich and Fontend (1984) recorded highest number of flowers in chrysanthemum cultivar “Spice Gran” on bark, peat and soil. Highest number of gerbera flowers per meter square were obtained on pumice (Malorgio and Magnani, 1994) Rober and Hafez (1982) observed highest dry weight of chrysanthemum flowers when grown on T.K.S. substrate. Superior quality of chrysanthemum flowers was found on rock wool grown plants. (Lee and Goldsberry, 1988).

2.1.3 Post harvest life

Storage life of cut flowers was significantly influenced by media components. Gerbera flowers gave maximum vase life when grown on a mixture of composted pine bark and peat receiving 250 mg/l N and 150 mg/l Mg (Rudniclci and Nowak, 1976).

Hicklenton (1983) observed that chrysanthemum cut flowers wilted earlier in sawdust grown plants than the peat grown flowers.

2.1.4 Effect of media on root growth

Root growth of many crops depends on the physical and chemical properties of a growing medium, season and planting material. Jothi *et al.* (1987) observed better rooting percentage, root number and root length in chrysanthemum cuttings planted in sand during June-July and in Peat + Perlite during May. Lainfelden and Rober (1991) in Peat filled pots,(Mol *et al.* 1978). However Gisierod (1988) opined that root quality was not affected by media. Best rooting and fresh and dry weight of roots were obtain in rockwool grown plants (Bijdevaate and Black, 1990). Dry weight of pentas and ixora roots were significantly higher in coir based media (Merrow, 1994).

Availability is the major consideration for using a particular medium for a particular crop which can be overcome by using related medium for its character.

Smith and Hall (1993) suggested that perlite based potting mixture is a good alternative to peat based ones. Coir dust and coir basal media were found to be an acceptable substitute for sphagnum or sewage peat media (Meerow, 1994). Ground automobile tyres may be used as a component of container media for ornamental. Paul and Rajeevan (1992) considered brick and gravel as best media with regards to cost effectiveness for dendrobium production.

2.2 Effect of Nutrients on the growth and post harvest physiology of ornamental crops

2.2.1 Effect of Nutrients on growth

Harbaugh *et al.* (1998) in a study on nutrition of lisianthus found that lisianthus plants are heavy feeders similar to chrysanthemum and poisettia. They also found that 1N:1.5K ratio results in the production of high quality plants. It also responds well to high Ca in the range of 150 ppm in the irrigation water or fertilizer solution.

Singh (1998) reported that the fertilizers should be applied to ensure better flowers and the best growth of lisianthus is observed at high fertility levels in the soil. Supplementary fertilization should be in the form of potassium nitrate, magnesium sulphate or calcium nitrate. He also reported that during flowering season potassium nitrate should be given. The E.C should be around 0.8 to 1.

Labeke *et al.*, (1995) conducted an experiment to optimise the nutrient solution for eustoma in soilless culture. It was grown on rock wool stratus and fertigated with various nutrient solution mixture. They found that the stem weight is significantly affectal by cation and anion ratio of the nutrient solution. The cation ratio has a significant influence on flower stem quality of eustoma and the optimum range for potassium is situated at 3.5 to 4 mval/l, for calcium it ranged from 10 to 11 mval/l, for megnesium 2 mval/l, for nitrate 11 to 11.5 m val/l and for sulphate 3 to 3.5 m val/l.

Alt *et al.* (1993a) conducted an experiment to study the nutrient requirement of eustoma and impatiens and found that both showed similar reaction to nitrogen, phosphorus and potassium deficiency but differed considerably in their response to NH_4, Mn and Cl. eustoma responded well to the N:K_2O ratio of 1:1.7.

In another experiment Alt *et al*, (1993b) found that Eustoma had developed better with nitrate N than with ammonium N, particularly at low subtrate pH value, and the ammonium proportions above 25 per cent should be avoided. Eustoma is less sensitive to chloride.

The general recommendation of 300 plus mg N/l in summer is given by Gruebre *et al.* (1985). Two hundred mg N/liter plus 5 grams Osmocote 14-6.7-11.6 NPK per 10.5 cm pot have been suggested by Rho and Lawson (1984).

Among the essential elements required for the normal plant growth nitrogen has great influence right from cell division to development of vegetative and reproductive organs.

Gruise and Joiner (1961) in their study on flowering and chemical composition of Petunia and marigold opined that application of smallest dose of N with P and K, weekly for four weeks was sufficient for satisfactory growth and flowering. Tayana and Kiplinger, (1967) opined that the maintenance of sturdy growth of the plants could be achieved by regular application of fertilizer in earlier period. Tsurushima and Date (1971) observed an improvement in vegetative growth and flowering with nitrogen and phosphorous application in marigold, Pansy and Zinnia.

Ingawale (1979) reported that a balanced application of nutrients brought about a significant increase in number of branches, plant spread, stem thickness and leaf area index in marigold. In chrysanthemum, Jayanthi and Gowda (1988) observed that plant height, plant spread, number of shoots and total dry matter production were increased due to application of 30g N along with 40 g P_2O_5 per m^2.

In everlasting flower, Sharanabasappa (1990) recorded the tallest plants with more number of branches, leaves, leaf area and leaf area index by application of 150 kg N + 100 kg P_2O_5. Venugopal (1991) also noticed increased value for plant height, number of branches, number of leaves, leaf area, leaf area index and dry matter production due to increase in the nitrogen levels upto 200/kg/ha (Jayanthi and Gowda, 1988).

Nalawadi (1982) observed delayed flowering with increased level of Nitrogen in marigold. Kumara (1987) recorded early flowering (40.40 day) at 200 kg/ha Nitrogen and delay in flowering at highest level of N (250 kg/ha) in marigold and the results were however not significant.

Arora and Jaswindersingh (1980) in a nutritional study in African Giant, Double Orange marigold concluded that 40 gN and 40 g of P_2O_5 increased flower yield per plant. Venkatesh (1983) observed that there was an increase in flower number per plant with an increase in N levels upto 50 kg/ha. Similarly more number of flowers per plant was recorded at 30 kg of P per ha. He also observed that K levels did not have significant effect in promoting the number of flowers per plant.

In marigold, Dongre (1984) reported increased number of flower per plant with increase in N and P_2O_5.

Khimani (1991) recorded higher plant height, number of leaves per plant, number of branches per plant, leaf area per plant, leaf area index, leaf area duration, crop growth rate, net assimilation rate and total dry matter production at 100 kg Nitrogen per hectare than at 75 and 150 kg nitrogen per ha.

Nalawadi (1982) observed that nitrogen was effective in increasing vegetative growth over P_2O_5 and he noted that increase in N level from 75 to 225 kgs per ha was more effective in increasing the plant height of marigold. Dongre (1984) reported that increased plant height at 40 gram Nitrogen per m^2 is due to higher level of P ($40g/m^2$).

Chezhriyan *et al* (1986) recorded highest plant height in chrysanthemum (Co-1) with the application of 20gN, 20g P_2O_5 and 20g K_2O /m^2.

Arora and Saini (1976) found an increase in number of branches in Carnation when N and P were applied at 40 and 20g per m^2 respectively. The reports of Arthur and Hedley (1976) indicated that number of branches was reduced gradually in early cultivar of Snap Dragon when N was increased from 0 to 40 grams per bustle of soil.

Increased number of branches by an application of increased level of N at 180 kg/ha was observed by Maheshwar (1977) and Narayangowda (1985) in China Aster. Nalawadi (1982) attributed increased number of branches and plant spread to the increased level of N from 75 to 225 kg per ha in marigold. Dongre (1984) reported in marigold, an increased number of branches and plant spread due to the application of higher dose of N and P at 40 g m^2.

Kumara (1987) observed maximum number of branches (46.96) at pre blossom stage in marigold with 250 kg N and 200 kg P per ha.

Nalawadi (1982) reported increased plant spread in marigold owing to increased level of N from 75 to 225 kgs/ha. In chrysanthemum maximum plant spread (44.66 cm) was observed at 40 g N/m^2.

Raghuraja (1992) noticed an increase in plant height, number of leaves and total dry matter production at the cost of flower yield of gaillardia by the application of higher levels of nitrogen (150 ml 200 kg/ha). Contrary to this, Mokashi (1988) reported no response of plant growth parameters to the application of N (150 to 250 kg/ha) along with P (80 to 120 kg/ha). The plant height, number of branches, number of leaves and plant spread did not increase due to increase in N and P levels. Ryagi (1994) noticed an increase in plant height, number of leaves, leaf area and total dry matter production due to increase in N levels, in golden rod.

In glass house grown 'Parel van Allsmers' roses, Johansson (1978) reported that with low N, compared with a normal N level there was a reduction in flower weight, petal number, stem weight, root weight and total growth. Increasing the levels of N from 300 to 900 or 2700 kg/planted acre had the greatest beneficial effect on stem length of 'Christian Dior' and 'Happiness' roses (Young *et al.* 1976). Penningsfeld (1968) reported a positive linear effect on growth of roses with increased level of N and suggested 168 kg N/ha to the optimum. In an experiment with Super Star roses, Waters (1967) found an increased number of stem due to nitrogen application. Similarly, Young *et al.* (1973) obtained an increased number of stem due to nitrogen application. Jayaprasad (1976) obtained a maximum stem length with 8g of N and 16g of K per plant in 'Super Star' roses. Plants receiving no N flowered earlier than those receiving the highest N 16g per plant. Hassan *et al.* (1976) observed that the stem length and flower weight were improved by spraying urea (1 per cent) + CCC (100-300 ppm a.i.) in Rouge Melliand roses.

Potassium ensures hardiness of plants, helps the wood to ripen, increases the quality of blooms and resistance to cold and diseases, particularly powdery mildew (Culbert and Wilde, 1948; Seeley, 1950; Heatly, 1959; West, 1966; Bik, 1972a, b). The deficiency of K causes marginal browning of lower leaves resulting in marginal leaf scorch. Stems become weak and the growth of the plants become stunted. Buds fail to open and the flower colour become pale (Pal, 1972; Woodson and Boodley, 1982b). Seeley (1950) was of the view that when rose plants were grown with insufficient supply of potassium, they produced short flowering shoots and small sized flowers followed by chlorosis resembling that of a mild iron deficiency.

Johansson (1978) investigated the effect of low levels of nutrients effect on glasshouse rose cv. 'Parel Van Aalsmeer' in sand culture and found that low K reduced stem length and stem and root weight. Nanjan and Muthuswamy (1974) compared four levels of NPK foliar feeding in 'Edward' roses and found that an increase in K supply was associated with better growth of shoots. The stem length of 'Christian Dior' and 'Happiness' roses increased to reach maximum with 1700 lb of K per acre (Young *et al.* 1973). Increasing K supply improved stem length and slightly reduced colour intensity in 'Carol' roses grown under glass (Bik, 1972a) Bik (1972b) found that flower fresh weight was markedly increased by K_2O rates upto 6 g per pot and keeping quality was also enhanced, but colour intensity was adversely affected. Pruning and K supply influenced flower characters and increased neck length, bud length and bud diameter (Uma and Gowda, 1987).

Increasing the K supply from 1.0 to 10.0 meq per litre to 'Forever Yours' roses grown in recirculating nutrient solution, increased No_3-N in NO_3-N fertilized plants and lowered NH_4-N in NH_4-N fertilized plants

Leaf K concentration was reduced and K deficiency symptoms were developed after 5 weeks in plants which received 0.25 m eq K per litre (Woodson and Boodley, 1982). Increasing K concentration form 0.25 to 10.00 m eq per litre had no antagonistic effect on Ca or Mg accumulation in the leaves.

Nalawadi (1982) observed that Nitrogen was effective in increasing vegetative growth over P_2O_5 and he noticed N increased plant height in marigold. Dongre (1984) reported that increased plant height at 40 gram nitrogen per square meter is due to highest level of P at 40 g per m^2. Chezhiyan *et al.* (1986) recorded highest plant height in chrysanthemum due to higher N.

Young *et al.* (1973) and Young *et al.* (1976) did not observe marked response by 'Christian Dior' and 'Happiness' roses to P_2O_5 fertilization Bakly (1974) reported that P_2O_5 at or above 450 g/plant was injurious to rose plants.

2.2.2 Flower production and post harvest life

Gruise and Joiner (1961) suggested the application of optimum levels of nitrogen and potassium in Aster as the low and high levels of nitrogen and potassium reduced the flower size and stem length. Elengoven (1975) recommended a judicious and balanced application of nutrient for overall improvement of quality of flower and yield in Petunia.

Ingawale (1979), obtained higher yield by balanced application of nutrient in marigold.

In china aster, Maheshwar (1977) noticed the influence of nitrogen on yield parameters. The flower yield as contributed by size and number of flowers was increased by the application of nitrogen. Fifty per cent flowering was the only the yield parameter not influenced. Ramachandra (1982) registered delayed flowering, more number of flower per plant and increased duration of flowering at fertilizer levels of 120 kg N and 60 kg P_2O_5 per hectare. Mantur (1988) obtained higher flower yield by using still higher dose of fertilizer of 180 kg N, 120 kg P_2O_5 and 75 kg K_2O per hectare.

Anuradha *et al.* (1990) reported that the increase in fertilizer levels from 0 to 90 kg per hectare of both nitrogen and phosphorus significantly increased the number and weight of flowers in marigold. Earlier to this work, Nalawadi (1982) obtained best results at the fertilizer dose of 225 kg N, 20 kg P_2O_5 and 60 kg K_2O per hectare. At this dose, number of flowers, size of flower, length of flower, flower weight, duration of flowering and yield of flowers were significantly increased. The higher levels of N and P prolonged the initiation of flowering.

Khimani (1991) noticed that the initiation of flowering and 50 per cent flowering was delayed at higher levels of Nitrogen (150 kg N/ha) in gaillardia. Regarding the number of flowers per plant and flower yield, 100 kg N/ha was found best. Ryagi (1994), in his study on golden rod observed that the yield was increased with the increase in levels of nitrogen and was maximum at 100 kg/ha (6.9 t/ha).

Maharana and Pradhan (1976) found that the flower number and yield per plant of 'Celebration' roses were the highest with nitrogen fertilizer alone at the rate of 15 grams per pot applied in the form of ammonium sulphate. Young, *et al.* (1973) noticed that most flowers were produced with 2300 pound of N per acre for 'Christian Dior' and 2100 pound per acre for 'Happiness' roses; the highest level of leaf N after 18 months growth occurred with 2100 pound per acre. An increase in the number of flowers with increase in N dose from 6g to 16 g/plant was observed by Jayaprasad (1976). Increasing levels of N (from 300 to 900 or 2700/lb per planted acre) had the greatest beneficial effect on flower yield and quality of 'Christian Dior' and 'Happiness' roses (Young *et al.*, 1976).

Bik (1972a) and Bik (1972b) assessed the effect of N and K rates on pot grown 'Carol' roses in a two year trial and noticed that raising the N application rates (0.56 to 11.2 g/pot) increased flower numbers and fresh weight per flower; Keeping quality was also enhanced, but colour intensity was adversely affected. The keeping quality of 'Caliente rose' was not significantly affected by N treatment (Armitage and Tsujita 1979)

Khimani (1991) in his shelflife studies in gaillardia, noticed maximum loss under polythene bags and open conditions at higher levels of nitrogen (100 and 150 kg/ha) than at lower levels of N (0 and 50 kg/ha).

Post and Fischer (1951) reported that a potassium level of 100 lb per acre was insufficient to obtain higher yield of flowers. However, there was no advantage in maintaining a level higher than 300 lb per acre. Woodson and Boodley (1982) found that low K limited growth and flower production in 'Forever Yours' roses grown in recirculating nutrient solution, regardless of N form (NH_4 or NO_3 form). As the K rate rose, flower production fell in 'Christian Dior' and 'Happiness' roses (Young *et al.*, 1973). However, Bik (1972a) reported that increasing K supply had no significant effect on flower yield or keeping quality but slightly reduced colour intensity in 'Carol' roses grown under glass. Bik (1972b) reported that there were slight differential effects of the K levels on flower number, colour intensity and keeping quality; keeping quality was enhanced but colour intensity was adversely affected. Jayaprasad (1976) obtained good quality bloom with 16g of K per plant in 'Super Star' roses under Bangalore conditions.

MATERIAL AND METHODS

III. MATERIAL AND METHODS

An experiment was conducted to standardize the media and nutrition for Lisianthus var. F1. Deep Blue, under polyhouse at Indo-American Hybrid Seeds (India) Private Limited, Channasandra, Bangalore, during December 1999 to May 2000. The details of the materials and methods pertaining to the present experiment are given below.

3.1 Geographical location of the experimental site

The experimental site is located 28 km from UAS, Bangalore at 12°58' North latitude and 77°35' East latitude with an elevation of about 930 meters above mean sea level. The meteorological data for the experimental period inside the polyhouse is presented in Appendix I.

3.2 Plug production

Paleted seeds obtained from Pan-American Seeds Chicago, United States of America were sown in portrays of 98 cell size filled with peat media. Seeds are sown at a depth of 0.2 cm and it took about 15 days to germinate. The tray was irrigated regularly. The plugs were transplanted to the pots of 12.5 cm size filled with different media.

Plate 1 – General View Of Experimental Plot On Effect Of Media And Nutrient On Plant Growth, Flowering And Flower Quality In Lisianthus

3.3 Cultural operations

Before transplanting, the media was steam sterilized and pots were filled with different media as per the treatment. Two days after transplanting feeding was started and one week after transplanting a drench of *Trichoderma viridi* and *Agrobacterium florescerce* was given. Pots were watered on alternate days to maintain the moisture level in the media and fed with nutrient solution at the rate of 200 ml per pot on alternate days. General prophylactic sprays with pesticides and fungicides were given periodically to control pest and diseases.

3.4 Experimental details

Germination and growth of seedlings were not uniform. Two batches were formed in order to get uniformity in transplanted plug first batch with early germinated seedlings and second batch with late germinated seedlings. The two batches differed in days taken for transplanting by 3 weeks.

3.4.1 Standardisation of media and nutrition for Lisianthus

Coirpeat, Sand, and Soil (v/v) were mixed in different proportions, by varying the levels of coirpeat, as shown in the surceding Table.

Nutrient solution was fed to plants from two days of transplanting at every alternate days. N:K ratio was maintained at different levels by varying the K levels as shown in surceding Table.

Treatments	Coirpeat	Sand	Soil	N	K
T_1	0.5	2	1	1	1.25
T_2	0.5	2	1	1	1.50
T_3	0.5	2	1	1	1.75
T_4	1	2	1	1	1.25
T_5	1	2	1	1	1.50
T_6	1	2	1	1	1.75
T_7	2	2	1	1	1.25
T_8	2	2	1	1	1.5
T_9	2	2	1	1	1.75

Number of treatments : 9

Number of replications: 3

Number plants per replication: 30

Experimental design : Factorial CRD

Pot size : 12.5 cm

3.4.2 Preparation of pot mixture

There were three media combinations and each media combination composed of different proportions of coir peat.

The treatment T_1, T_2, T_3 composed of. 0.5 peat: 2 sand: 1 soil (v/v). These components were thoroughly mixed with the help of spade and this mixture gave the required media combinations. Likewise in case of T_4, T_5, T_6, T_7, T_8 and T_9 the peat : sand: soil proportions were mixed in the proportion indicated in the preceding Table.

3.4.3 Preparation of nutrient solution

Three nutrient solution combinations with different nitrogen to Potassium ratio were prepared by using MAP, Urea and MOP. Variation in the ratio of N to K was achieved by varying the levels of K.

The treatment T_1, T_4, and T_7 composed of 1 portion nitrogen (200 ppm) and 1.25 portion potassium (250 ppm). These nutrients were mixed in plain water along with 100 ppm of phosphorus. The solution gave the required treatment combinations. Like-wise T_2, T_3, T_5, T_6, T_8 and T_9 solutions were prepared in the proportion indicated in the preceding Table showing the treatments.

3.4.4 Selection of plugs

Vigorously growing uniform plugs of two month age with 4 fully opened leaves were selected for transplanting to pots of size 12.5 cm. Plugs were divided into two groups based on the days taken to attain the stage of transplanting.

3.4.5 Transplanting

Uniform plants with 4 leaves were transplanted to the pots with minimum damage to the roots. Plugs were transplanted before they became root bound. Plugs were transplanted to the pots of size 12.5 cm, at the rate of one plug per pot.

3.4.6 Feeding

Nutrient solution was applied to the pots at the rate of 200 ml per pot starting from two days after transplanting, on every alternate day till the date of harvest of the flowers.

3.4.7 Irrigation

Every pot was irrigated with tap water on every alternate day to maintain the moisture content of the media

3.4.8 Staking of plants

Plants were staked with single bamboo stake till the initiation of bolting and in later stages provided with Triangular stakes to hold the heavy top straight. Three Bamboo stakes of 75-80 cm were used per pot.

3.4.9 Harvesting

Plants were harvested when two flowers were fully opened. Whole plant was cut from ground level by giving a slanting cut at the bottom. After harvest the stalk was immediately placed in plain water. Three pairs of leaves at the bottom were removed to avoid leaves touching water.

3.4.10.1 Stem height

Height of the plant was measured from the ground level to the top of the inflorescence. Average height of five plants was found out and expressed in centimeter.

3.4.10.2 Branches per plant

Number of branches in the five selected plants of each replication was counted and average was workedout.

3.4.10.3 Leaves per stem

Total number of leaves in each of the selected plants was recorded after harvesting the stem average was workedout.

3.4.10.4 Stem girth

Stem diameter was measured just below the first basal node, in centimeter with the help of vernier calipers at the time of harvest and the average was calculated.

3.4.10.5 Leaf size

Six leaves were selected at random from each treatment and the average leaf size was calculated and expressed in cm^2.

3.4.10.6 Cutflower weight

Fresh weight of five selected plants were recorded immediately after harvest and the average weight was expressed in grams.

3.4.10.7 Fresh weight of roots

Weight of the roots from the five marked plants were taken after washing the roots with tap water and the average weight was expressed in grams.

3.4.10.8 Flowering components

Flowering components such as appearance of buds, bud opening, fifty per cent flowering, bud number, flower diameter, length of flower and days to harvest after transplanting were recorded.

3.4.10.8.1 Appearance of Flower buds

The period taken for the appearance of flower bud from the time of planting in the five selected plants was recorded. The average number of days taken for flower bud appearance was calculated.

3.4.10.8.2 First flower opening

Number of days taken for opening of flower bud from the time of transplanting recorded in the five selected plants and the number was averaged out.

3.4.10.8.3 Fifty per cent flowering

The number of plants that flowered was counted each day after appearance of flower bud. Time taken for flowering by fifty per cent of plants in each replication was calculated.

3.4.10.8.4 Number of flower buds per plant

In the selected plants, number of flower buds including the opened flowers was counted at the time of harvest and the average number was calculated.

3.4.10.8.5 Flower diameter

From the sampled plants, the diameter of two fully opened flowers was measured by using a scale and expressed in centimeters.

3.4.10.8.6 Flower length

From the sampled plants, the length of two fully opened flowers from pedicel to the tip of the petal was measured by using a scale and expressed in centimeter.

3.4.11 Chemical analysis of soil

Soil samples were collected before filling the pots and also after the crop harvest. These samples were analysed for chemical properties such as Phosphorous, Potassium, soil pH, EC, and organic carbon.

3.4.11.1 Soil pH

Soil pH was determined in 1:2.5 soil : water suspension by glass electrode using digital pH meter (Jackson, 1973).

3.4.11.2 Electrical conductivity (E.C.)

After measuring the pH, supernatant solution was used to measure the electrical conductivity using conductivity bridge and expressed in ds/m.

3.4.11.3 Organic carbon

Organic carbon was determined by Walkey and Black's wet oxidation method as described by Jackson (1973).

3.4.11.4 Available phosphorus

This was determined by chlorostannous reduced molybdo-phosphoric blue colour method in hydrochloric acid system by using Olsons extract (Jackson, 1973).

3.4.11.5 Available potassium

Available potassium was estimated by using ammonium acetate method. Five gram of soil was mixed with 25 ml neutral ammonium acetate solution. The contents were shaken, filtered and fed to flame photometer. The amount of potassium was calculated with a standard curve. (Jackson, 1973).

3.4.12 Climatic factors

Climatic data of the polyhouse was recorded with regards to temperature, humidity and day length.

3.4.12.1 Temperature

Minimum and maximum temperature inside the polyhouse was recorded daily and expressed in degree centigrade. The weekly average of maximum and minimum temperatures is presented in Appendix I.

3.4.12.2 Relative humidity

Relative humidity inside the greenhouse was recorded by using Hygrometer and the observation were expressed in percentage. Weekly average of relatively humidity is presented in Appendix-I .

3.4.12.3 Day length

Total hour of light inside the greenhouse was recorded and the weekly average day length is presented in Appendix -I

3.4.13 Post harvest life of cut flowers

The post harvest life of cut flowers was studied after harvesting the flowers from each of the treatment.

Flowers were harvested at two fully opened flower stage. The stems were cut at the base by giving a slanting cut. The lower 3 pair of leaves were removed from base and placed in bottles filled with 200 ml tap water. Every alternate day water was changed and every fourth day one cm stem end was cut. Observations were taken for vase life, per cent flower opening and number of coloured flowers.

3.4.13.1 Vase life

Wilting of more than fifty per cent of the flowers was considered as the end of potential useful longevity of the stem. The number of days taken for this was recorded by daily observation of flowers.

3.4.13.2 Per cent flower opening

Number of flower opened to the number of buds present, including the two opened flowers in the stem was counted and expressed as percentage.

3.4.13.3 Number of coloured flower per stem

Number of opened flowers with blue colour, per stem was counted and expressed in numbers.

3.4.14 Statistical analysis

Statistical analysis and interpretation of the data were done by following the Fisher's analysis of variance techniques as given by Panse and Sukhatme (1967). The results were compared at 5 per cent level of significance.

EXPERIMENTAL RESULTS

IV. EXPERIMENTAL RESULTS

The results of the investigation conducted during 1999-2000 to standardise the media and nutrients for Lisianthus (*Lisianthus russelianum* (Raf.) Shinner) are presented here under:

4.1 Number of branches per plant

The foregoing data (Table-1) reveals that media had a significant effect on the number of branches produced by the plants. The media M_3 (5.56 branches) was found to be significantly superior over M_1 (2.69 branches) and M_2 (4.53 branches).

Non-significant differences were observed among the different nutrient levels with respect to number of branches. Highest number of branches were observed in N_1 (4.38) and the least number of branches were recorded in N_2 and N_3 (4.20 each).

Interaction of media and nutrient had a significant effect on the number of branches produced by plants. Maximum number of branches was recorded in M_3N_1 (6.13) which was found significantly superior over all the other treatments. Least number of branches were observed in M_1N_3 (2.60) which was found to be on par with M_1N_2 (2.67) and M_1N_1 (2.80).

Table – 1. Number of branches per plant inLisianthus as affected by media and nutrient

Treatment	N_1 (1N:1.25K_2O)	N_2 (1N:1.5K_2O)	N_3 (1N:1.75K_2O)	**Mean**
M_1 (0.5 coir peat : 2 sand : 1 soil)	2.80	2.67	2.60	**2.69**
M_2 (1 coir peat : 2 sand : 1 soil)	4.20	4.80	4.60	**4.53**
M_3 (2 coir peat : 2 sand : 1 soil)	6.13	5.13	5.40	**5.56**
Mean	**4.38**	**4.20**	**4.20**	

	S.Em±	C.D. (5%)
Media	0.084	0.254
Nutrition	-	NS
Media x Nutrition	0.147	0.441

T_1 : 0.5 Coir Peat : 2 Sand : 1 Soil + 1N : 1.25 K_2O

T_3 : 0.5 Coir Peat : 2 Sand : 1 Soil + 1N : 1.75 K_2O

Plate 2 – Effect Of Media and Nutrient On Plant Growth

T_4 : 1.0 Coir Peat : 2 Sand : 1 Soil + 1N : 1.25 K_2O

T_5 : 1.0 Coir Peat : 2 Sand : 1 Soil + 1N : 1.50 K_2O

T_6 : 1.0 Coir Peat : 2 Sand : 1 Soil + 1N : 1.75 K_2O

Plate 3 – Effect of Media and Nutrient on plant

T_7 : 2.0 Coir Peat : 2 Sand : 1 Soil + 1N : 1.25 K_2O

T_8 : 2.0 Coir Peat : 2 Sand : 1 Soil + 1N : 1.50 K_2O

T_9 : 2.0 Coir Peat : 2 Sand : 1 Soil + 1N : 1.75 K_2O

Plate 4 : Effect of Media and Nutrient On Plant Growth

4.2 Number of leaves per stem at flower opening

Data on number of leaves per cut stem are presented in the Table-2. It is evident from the table that number of leaves in different media was significantly different. The media M_3 (2 coir peat : 2 sand : 1 soil) recorded significantly higher number of leaves (34.22) over M_1 with 19.80 leaves. However M_2 was found to be on par with M_3 with 33.60 leaves.

Nutrient also had a significant effect on the number of leaves per cut stem. N_2 (1 Nitrogen: 1.5 potassium) recorded significantly higher number of leaves (30.56) over N_3 (29.73) and N_1 (27.33).

Interaction of media and nutrient had significant influence on the number of leaves. The interaction of M_3N_3 lead to higher number of leaves (35.87). However M_3N_2 (35.73 leaves) and M_2N_2 (35.33 leaves) were found to be on par with M_3N_3. Interaction of M_1N_1 recorded least number of leaves (18.27).

4.3 Leaf size

Average leaf size as affected by media and nutrition is presented in Table -- 3.

A perusal of Table-3 shows significant difference in the leaf size as influenced by different media. M_3 is found to be significantly

Table – 2 . Number of leaves per stem at flower opening in Lisianthus as affected by media and nutrient

Treatment	N_1 (1N:1.25K_2O)	N_2 (1N:1.5K_2O)	N_3 (1N:1.75K_2O)	**Mean**
M_1 (0.5 coir peat : 2 sand : 1 soil)	18.27	20.60	20.53	**19.80**
M_2 (1 coir peat : 2 sand : 1 soil)	32.67	35.33	32.80	**33.60**
M_3 (2 coir peat : 2 sand : 1 soil)	31.07	35.73	35.87	**34.22**
Mean	**27.33**	**30.56**	**29.73**	

	S.Em±	C.D. (5%)
Media	0.410	1.229
Nutrition	0.410	1.229
Media x Nutrition	0.710	2.129

Table – 3. Leaf size (cm^2) of Lisianthus as affected by media and nutrient

Treatment	N_1 (1N:1.25K_2O)	N_2 (1N:1.5K_2O)	N_3 (1N:1.75K_2O)	**Mean**
M_1 (0.5 coir peat : 2 sand : 1 soil)	13.77	14.13	14.50	**14.13**
M_2 (1 coir peat : 2 sand : 1 soil)	38.20	39.73	40.43	**39.46**
M_3 (2 coir peat : 2 sand : 1 soil)	44.17	45.07	44.57	**44.60**
Mean	**32.04**	**32.98**	**33.17**	

	S.Em±	C.D. (5%)
Media	0.157	0.470
Nutrition	0.157	0.470
Media x Nutrition	0.272	0.814

superior in terms of leaf size(44.60 cm^2) over M_1 (14.13 cm^2) and M_2 (39.46 cm^2).

Nutrient also had a significant effect on the average leaf size of plants. Significantly higher leaf size was observed in N_3 (33.17 cm^2) over N_1 (32.04 cm^2). However N_2 was found on par with the N_3 which recorded a leaf size of 32.98 cm^2.

Interaction of media with nutrition also had a significant effect on the leaf size. Interaction of M_3N_2 recorded significantly superior leaf size (45.07 cm^2) over all the other treatments. However, interaction of M_3N_3 was found to be on par with M_3N_2 with the average leaf size of 44. 57 cm^2.

4.4 Leaf area per plant

The data presented in Table-3a shows that media has a significant effect on the leaf area per plant M_3 medium (2 coir peat : 2 and : 1 soil) recorded significantly higher leaf area per plant (1434.05 cm^2) over M_2 (1248.66 cm^2) and M_3 media (254.81 cm^2).

Nutrient also had a significant effect on the leaf area per plant significantly higher leaf area of 1033.68 cm^2 was recorded in the plants fed with N_2 ($1N:1.5K_2O$) over N_1 ($1N:1.25\ K_2O$) (888.92 cm^2). However, N_3 ($1N: 1.75\ K_2O$) was found to be on par with N_2 with a leaf area of 1014.92 cm^2.

Table – 3a. Leaf area (cm^2) per plant of Lisianthus as affected by media and nutrient

Treatment	N_1 (1N:1.25K_2O)	N_2 (1N:1.5K_2O)	N_3 (1N:1.75K_2O)	**Mean**
M_1 (0.5 coir peat : 2 sand : 1 soil)	226.52	261.96	275.95	**254.81**
M_2 (1 coir peat : 2 sand : 1 soil)	1165.61	1134.33	1246.03	**1248.66**
M_3 (2 coir peat : 2 sand : 1 soil)	1274.62	1504.75	1522.79	**1434.05**
Mean	**888.92**	**1033.68**	**1014.92**	

	S.Em±	C.D. (5%)
Media	12.846	38.162
Nutrition	12.846	38.162
Media x Nutrition	22.249	66.098

Interaction of media and nutrient had a significant effect on the leaf area per plant. Interaction M_3N_3 recorded significantly higher leaf area per plant (1522.79 cm^2) over the other interactions. However interaction M_3N_2 was found to be on par with M_3N_3 with leaf area per plant of 1504.75 cm^2.

4.5 Fresh weight of roots

The data in Table-4 reveals that media had a significant effect on the root weight. M_3 (2 coir peat: 2 sand: 1 soil) recorded the maximum root weight of 10.69 grams. This was found to be significantly superior over M_1 which recorded a root weight of 4.41 grams. However, M_2 (1 coir peat : 2 sand : 1 soil) was found to be on par with the M_3 with 9.99 grams root weight.

Nutrient had a non-significant effect on root weight N_2 recorded a maximum root weight of 8.43 grams and the minimum root weight was observed in N_1 (8.28 grams).

Non-significant differences in root fresh weight was found in the interaction between media and nutrition. The interaction M_3N_1 showed highest weight of roots (11.37 grams) followed by M_3N_2 which recorded 10.57 grams. Minimum root weight was observed in M_1N_1 (3.67 grams) followed by M_1N_3 (4.77 grams) and M_1 N_2 (4.80 grams).

Table – 4. Fresh root weight (grams) of Lisianthus as affected by media and nutrient

Treatment	N_1 (1N:1.25K_2O)	N_2 (1N:1.5K_2O)	N_3 (1N:1.75K_2O)	**Mean**
M_1 (0.5 coir peat : 2 sand : 1 soil)	3.67	4.80	4.77	**4.41**
M_2 (1 coir peat : 2 sand : 1 soil)	9.80	9.93	10.23	**9.99**
M_3 (2 coir peat : 2 sand : 1 soil)	11.37	10.57	10.13	**10.69**
Mean	**8.28**	**8.43**	**8.38**	-

	S.Em±	C.D. (5%)
Media	0.462	1.385
Nutrition	-	NS
Media x Nutrition	-	NS

4.6 Days taken for flower bud appearance

Data on days taken for flower bud appearance is presented in Table-5. Days taken for flower bud appearance differed significantly among the different media. Plants grown in M_3 (2 coir peat : 2 sand 1 soil) took significantly lesser number of days for flower bud appearance (38.50 days) over M_2 (39.53 days) and M_3 (43.18 days).

Nutrition had non-significant difference on the number of days taken for flower bud appearance, after transplanting. However, N_3 (1 Nitrogen : 1.75 Potassium) had taken least number of days for flower bud initiation after transplanting (40.26 days).

Interaction of media with nutrition also had a non-significant difference with respect to days taken for flower appearance. Minimum number of days were taken for flower bud appearance, after transplanting in M_3N_3 (38.17 days) followed by M_3N_2 (38.47 days) and M_3N_1 (38.87 days). Maximum number of days were taken for flower bud appearance in M_1N_1 (43.47days) followed by M_1N_2 (43.07 days).

4.7 Days taken for first flower opening

Table 6 shows the days taken for first flower opening. The datas presented reveals that media had a significant effect on the days taken for first flower opening. M_3 (2 coirpeat : 2 sand : 1 soil) took significantly lesser number of days after transplanting for first flower

Table – 5. Days taken for flower bud appearance in Lisianthus as affected by media and nutrient

Treatment	N_1 (1N:1.25K_2O)	N_2 (1N:1.5K_2O)	N_3 (1N:1.75K_2O)	**Mean**
M_1 (0.5 coir peat : 2 sand : 1 soil)	43.47	43.07	43.00	**43.18**
M_2 (1 coir peat : 2 sand : 1 soil)	39.33	39.67	39.60	**39.53**
M_3 (2 coir peat : 2 sand : 1 soil)	38.87	38.47	38.17	**38.50**
Mean	**40.56**	**40.40**	**40.26**	

	S.Em±	C.D. (5%)
Media	0.113	0.339
Nutrition	-	NS
Media x Nutrition	-	NS

opening (57.92 days) over M_1 (63 days). However M_2 (1 coir peat : 2 sand : 1 soil) (58.50 days) was found to be on par with M_3.

Nutrition also had a significant effect on the number of days taken for first flower opening. N_3 (1 Nitrogen : 1.75 Potassium) took significantly lesser number of days to produce the first flower by taking 59.19 days after transplanting. N_1 (1 Nitrogen : 1.25 Potassium) took the longest time of 60.67 days for first flower opening. However N_2 (1 Nitrogen : 1.50 Potassium) was on par with N_3. in the number of days taken for first flower opening (59.56 days).

Interaction of media and nutrient had a nonsignificant effect on the number of days taken for opening of first flower. The interaction of M_3N_3 recorded least number of days for first flower opening (57.53 days) followed by M_3N_2 with 57.73 days. M_1N_1 took maximum number of 63.80 days after transplanting for the first flower opening.

4.8 Days taken for fifty per cent flowering

Media had significantly influenced the days taken for fifty per cent of flowering. M_3 (2 coir peat : 1 sand : 1 soil) had taken significantly lesser number of days for 50 per cent of plants to produce flower (56.33 days after transplanting) over M_1 (65.78 days after transplanting). However, M_2 (1 coirpeat : 25 sand : 1 soil) was found to

Table – 6. Days taken for first flower opening in Lisianthus as affected by media and nutrient

Treatment	N_1 ($1N:1.25K_2O$)	N_2 ($1N:1.5K_2O$)	N_3 ($1N:1.75K_2O$)	**Mean**
M_1 (0.5 coir peat : 2 sand : 1 soil)	63.80	63.00	62.20	**63.00**
M_2 (1 coir peat : 2 sand : 1 soil)	59.73	57.93	57.83	**58.50**
M_3 (2 coir peat : 2 sand : 1 soil)	58.48	57.73	57.53	**57.92**
Mean	**60.67**	**59.56**	**59.19**	

	S.Em±	C.D. (5%)
Media	0.327	0.980
Nutrition	0.327	0.980
Media x Nutrition	-	NS

be on par with M_3 in the number of days taken for 50 per cent flowering (57.33 days after transplanting).

Nutrition had non-significant effect on the number of days taken for fifty per cent of flowering. Minimum of 59.33 days after transplanting was taken by plants fed with N_3 (1 Nitrogen : 1.75 Potassium) and maximum number of days after transplanting for fifty per cent flower opening was taken by N_1 (60.22 days).

Significant difference in the number of days taken for fifty per cent flowering was found in the interaction of media and nutrients. The interaction M_3N_1 had taken significantly lesser number of days after transplanting for fifty per cent flowering (55 days) which was found to be on par with M_2N_2 which had taken 56.67 days after transplanting for fifty per cent flowering. The interaction of M_1N_1 had taken significantly more number of days for 50 per cent flowering (67.33 days after transplanting) and it was found to be on par with the interaction of M_1N_2 that had taken 66 days after transplanting.

4.9 Days taken for harvest

Effect of media on days taken for harvest after transplanting is presented in Table -- 8. A perusal of data presented shows significant differences in days taken for harvest after transplanting among different media. M_3 had taken significantly lesser number of days for harvest

Table – 7. Days taken for 50 per cent flowering by Lisianthus as affected by media and nutrient

Treatment	N_1 (1N:1.25K_2O)	N_2 (1N:1.5K_2O)	N_3 (1N:1.75K_2O)	**Mean**
M_1 (0.5 coir peat : 2 sand : 1 soil)	67.33	66.00	64.00	**65.78**
M_2 (1 coir peat : 2 sand : 1 soil)	58.33	56.67	57.00	**57.33**
M_3 (2 coir peat : 2 sand : 1 soil)	55.00	57.00	57.00	**56.33**
Mean	**60.22**	**59.89**	**59.33**	

	S.Em±	C.D. (5%)
Media	0.458	1.372
Nutrition	-	NS
Media x Nutrition	0.793	2.376

after transplanting (61.31 days). M_2 had taken 62.51 days and is found to be on par with M_3. M_1 had taken significantly more number of days for harvest (67.18 days), than M_2 and M_3.

Nutrient also had a significant effect on the number of days taken for harvest. N_3 had taken significantly lesser number of days after transplanting for harvest (62.76 days) than N_1 (64.48 days). However N_2 (63.76 days) was found to be on par with N_3.

Interaction of M_3N_3 had taken least number of days for harvest after transplanting (60.69 days) followed by M_3N_2 (61.07 days). Maximum number of days was taken by M_1N_1 (67.80 days). However the interaction effect on the days taken for harvest was found to be non-significant.

4.10 Stem length

Media had significantly influenced the stem length (Table – 9). The stem length recorded in M_3 (63.49 cm) containing 2 coir peat : 2 sand : 1soil (v/v) was significantly higher than M_2 (1 coirpeat : 2 sand : 1 soil) and M_1 (0.5 coirpeat : 2 sand : 1 soil) which recorded 59.00 cm and 44.32 cm respectively.

Significant effect of nutrients on stem length was also recorded. Significantly higher stem length of 57.08 cm was recorded in N_3 (1 Nitrogen : 1.75 Potassium) compared to N_2 (1 Nitrogen : 1.5

Table – 8. Days taken for harvest by Lisianthus as affected by media and nutrient

Treatment	N_1 ($1N:1.25K_2O$)	N_2 ($1N:1.5K_2O$)	N_3 ($1N:1.75K_2O$)	**Mean**
M_1 (0.5 coir peat : 2 sand : 1 soil)	67.80	67.47	66.27	**67.18**
M_2 (1 coir peat : 2 sand : 1 soil)	63.47	62.73	61.33	**62.51**
M_3 (2 coir peat : 2 sand : 1 soil)	62.18	61.07	60.69	**61.31**
Mean	**64.48**	**63.76**	**62.76**	

	S.Em±	C.D. (5%)
Media	0.415	1.242
Nutrition	0.415	1.242
Media x Nutrition	-	NS

Potassium) and N_1 (1 Nitrogen : 1.25 Potassium), which recorded 55.71 cm and 54.02 cm respectively.

Interaction of media and nutrient also had a significant effect on the stem length. Combination of M_3N_3 had a significantly higher stem length of 67.26 cm compared to other treatments. The treatment M_1N_1 had the lowest stem length (43.46 cm).

4.11 Cut flower weight

A perusal of data in Table-10 reveals that media had influenced the cut flower weight significantly. The cut flower weight in M_3(60.23grams) (2 coirpeat : 2 sand : 1 soil) was significantly higher than that of M_2 (53.31 grams) and M_1 (22.47 grams).

Nutrient also had a significant effect on the cut flower weight of Lisianthus. N_3 (1 Nitrogen : 1.75 Potassium) was found to significantly increase the cut flower weight (46.59 grams) compared to the N_1 (Nitrogen : 1.25 Potassium) which recorded 42.93 grams of cut flower weight. However N_2 with a cut flower weight of 46.40 grams was found to be on par with N_3.

Non-significant differences were found in the cut flower weight due to the interaction of media and nutrition. However the media and nutrient combination M_3N_3 had highest weight of cut flower (61.50 grms) and M_1N_1 (20.04 grams) had the lowest weight of cut flower.

Table – 9. Stem length (cm) of Lisianthus as affected by media and nutrient

Treatment	N_1 (1N:1.25K_2O)	N_2 (1N:1.5K_2O)	N_3 (1N:1.75K_2O)	**Mean**
M_1 (0.5 coir peat : 2 sand : 1 soil)	43.46	44.31	45.21	**44.32**
M_2 (1 coir peat : 2 sand : 1 soil)	58.43	59.79	58.79	**59.00**
M_3 (2 coir peat : 2 sand : 1 soil)	60.17	63.04	67.26	**63.49**
Mean	**54.02**	**55.71**	**57.08**	

	S.Em±	C.D. (5%)
Media	0.307	0.922
Nutrition	0.307	0.922
Media x Nutrition	0.532	1.597

Table – 10. Cut flower weight (grams) of Lisianthus as affected by media and nutrient

Treatment	N_1 ($1N:1.25K_2O$)	N_2 ($1N:1.5K_2O$)	N_3 ($1N:1.75K_2O$)	**Mean**
M_1 (0.5 coir peat : 2 sand : 1 soil)	20.04	23.17	24.21	**22.47**
M_2 (1 coir peat : 2 sand : 1 soil)	50.53	55.05	54.35	**53.31**
M_3 (2 coir peat : 2 sand : 1 soil)	58.23	60.97	61.50	**60.23**
Mean	**42.93**	**46.40**	**46.59**	

	S.Em±	C.D. (5%)
Media	0.393	1.178
Nutrition	0.393	1.178
Media x Nutrition	-	NS

T_1 : 0.5 Coir Peat : 2 Sand : 1 Soil + 1N : 1.25 K_2O

T_2 : 0.5 Coir Peat : 2 Sand : 1 Soil + 1N : 1.50 K_2O

T_3 : 0.5 Coir Peat : 2 Sand : 1 Soil + 1N : 1.75 K_2O

T_4 : 1.0 Coir Peat : 2 Sand : 1 Soil + 1N : 1.25 K_2O

T_5 : 1.0 Coir Peat : 2 Sand : 1 Soil + 1N : 1.50 K_2O

T_6 : 1.0 Coir Peat : 2 Sand : 1 Soil + 1N : 1.75 K_2O

T_7 : 2.0 Coir Peat : 2 Sand : 1 Soil + 1N : 1.25 K_2O

T_8 : 2.0 Coir Peat : 2 Sand : 1 Soil + 1N : 1.50 K_2O

T_9 : 2.0 Coir Peat : 2 Sand : 1 Soil + 1N : 1.75 K_2O

Plate-5 Effect of media and nutrition on cut flower quality.

4.12 Stem diameter

The results presented in Table-11 show a significant variation among the media with respect to stem diameter. M_3 recorded significantly higher stem diameter of 0.54 cm over M_2 with 0.50cm and M_1 with 0.29 cm.

Nutrition had non-significant effect on the stem diameter. Highest stem diameter (0.52 cm) was observed in N_3 (1 Nitrogen : 1.75 Potassium) which had differed non-significantly from N_2 with 0.45 cm and N_1 with 0.43 cm stem diameter.

Significant difference among the media and nutrient combination was found with respect to stem diameter. The combination of M_3N_2 recorded significantly higher stem diameter (0.56 cm) followed by M_3N_1 (0.53 cm), which were on par. Stem diameter was least in the treatment combination M_1N_1 (0.27 cm).

4.13 Number of Buds per plant

Effect of media on the number of buds per plant is presented in Table-12. Media had a significant effect on the number of buds per plant. Highest number of buds (22.11) was recorded in M_3 (2 coir peat :2 sand : 1 soil) which was found significantly higher than the number of buds present in M_1 (13.11), and M_2 (19.80).

Table – 11. Stem diameter (cm) of Lisianthus as affected by media and nutrient

Treatment	N_1 (1N:1.25K_2O)	N_2 (1N:1.5K_2O)	N_3 (1N:1.75K_2O)	**Mean**
M_1 (0.5 coir peat : 2 sand : 1 soil)	0.27	0.29	0.31	**0.29**
M_2 (1 coir peat : 2 sand : 1 soil)	0.50	0.49	0.52	**0.50**
M_3 (2 coir peat : 2 sand : 1 soil)	0.53	0.56	0.52	**0.54**
Mean	**0.43**	**0.45**	**0.52**	

	S.Em±	C.D. (5%)
Media	0.006	0.018
Nutrition	-	NS
Media x Nutrition	0.011	0.032

Table – 12. Number of Buds per stem of Lisianthus as affected by media and nutrient

Treatment	N_1 (1N:1.25K_2O)	N_2 (1N:1.5K_2O)	N_3 (1N:1.75K_2O)	**Mean**
M_1 (0.5 coir peat : 2 sand : 1 soil)	12.07	13.20	14.07	**13.11**
M_2 (1 coir peat : 2 sand : 1 soil)	19.53	19.33	20.53	**19.80**
M_3 (2 coir peat : 2 sand : 1 soil)	21.27	21.53	23.53	**22.11**
Mean	**17.62**	**18.02**	**19.38**	

	S.Em±	C.D. (5%)
Media	0.274	0.822
Nutrition	0.274	0.822
Media x Nutrition	-	NS

Nutrition also had a significant effect on the number of buds. N_3 recorded significantly higher number of buds (19.38) over N_1 which produced 17.62 buds per plant. However N_2 with 18.02 buds per plant was found to be par with the N_1.

Non-significant difference in the interaction of media and nutrition was found in the number of buds per plant. The Interaction of M_3N_3 recorded the maximum number of buds per plant (23.53) followed by M_3N_2 (21.53 buds per plant).Least number of buds per plant was produced in M_1N_1 with 12.07 buds per plant.

4.14 Length of flower

The data in Table-13a reveals that the media had a significant effect on the length of flowers. Media M_2 recorded significantly higher length of flowers (6.71 cm) compared to M_3 which recorded a flower length of 6.41 cm. Flower length of M_3 (6.41 cm) which was on par with that of M_1 in which the length of flower was 6.48 cm.

Nutrition had a non-significant effect on flower length. N_2 recorded maximum length of 6.58 cm followed by N_1 in which the length of flower was 6.52 cm. The minimum length of flower was observed in N_3 (6.49 cm).

Table – 13a. Length of the flower (cm) of Lisianthus as affected by media and nutrient

Treatment	N_1 (1N:1.25K_2O)	N_2 (1N:1.5K_2O)	N_3 (1N:1.75K_2O)	**Mean**
M_1 (0.5 coir peat : 2 sand : 1 soil)	6.55	6.57	6.33	**6.48**
M_2 (1 coir peat : 2 sand : 1 soil)	6.67	6.77	6.69	**6.71**
M_3 (2 coir peat : 2 sand : 1 soil)	6.35	6.42	6.45	**6.41**
Mean	**6.52**	**6.58**	**6.49**	

	S.Em±	C.D. (5%)
Media	0.064	0.191
Nutrition	-	NS
Media x Nutrition	-	NS

Table – 13b. Flower diameter (cm) of Lisianthus as affected by media and nutrient

Treatment	N_1 (1N:1.25K_2O)	N_2 (1N:1.5K_2O)	N_3 (1N:1.75K_2O)	**Mean**
M_1 (0.5 coir peat : 2 sand : 1 soil)	7.47	7.53	7.88	**7.63**
M_2 (1 coir peat : 2 sand : 1 soil)	7.73	8.03	7.93	**7.90**
M_3 (2 coir peat : 2 sand : 1 soil)	8.22	7.57	7.92	**7.91**
Mean	**7.81**	**7.71**	**7.91**	

	S.Em±	C.D. (5%)
Media	-	NS
Nutrition	-	NS
Media x Nutrition	0.149	0.446

Media and Nutrient interaction also had non-significant effect on the length of flower. Highest length of flower was recorded in the interaction of M_2N_2 (6.77 cm) followed by M_2N_3 (6.69 cm). The minimum length of flower was recorded in the interaction of M_1N_3 (6.33 cm).

4.15 Flower diameter

Data presented in Table 13b show non-significant difference in the diameter of flower due to the effect of media. Higher diameter of flower was recorded in M_3 (7.91 cm) followed by M_2 with 7.90 cm. Minimum diameter of flower was recorded in M_1 (7.63 cm).

Nutrient also had a non-significant effect on the diameter of flowers. However maximum diameter was recorded in N_3 (7.91 cm) Minimum diameter of flowers was found in N_2 which recorded 7.71 cm.

Interaction of media and nutrient had significant effect on the diameter of flowers. Significantly higher flower diameter was observed in M_3N_1 (8.22) which was found to be on par with M_2N_2 with 8.03cm diameter. Significantly lesser diameter of flower was recorded in the interaction of M_1N_1 (7.47) which was found to be on par with M_1N_2 (7.53 cm), M_3N_2 (7.57 cm), M_2N_1 (7.73 cm) and M_1N_3 (7.88 cm).

4.16 Per cent flower opening

Data on per cent flower opened is presented in the Table - 14. Significant differences were observed in the per cent flower opening.

Table – 14. Per cent flower opening of Lisianthus as affected by media and nutrient

Treatment	N_1 (1N:1.25K_2O)	N_2 (1N:1.5K_2O)	N_3 (1N:1.75K_2O)	**Mean**
M_1 (0.5 coir peat : 2 sand : 1 soil)	46.10	41.40	39.50	**42.33**
M_2 (1 coir peat : 2 sand : 1 soil)	37.13	38.40	33.96	**36.50**
M_3 (2 coir peat : 2 sand : 1 soil)	29.43	28.97	25.33	**27.88**
Mean	**37.56**	**36.22**	**32.93**	

	S.Em±	C.D. (5%)
Media	0.467	1.400
Nutrition	0.467	1.400
Media x Nutrition	0.809	2.425

Plate 6 – General View Of Cut Flower In Vase Study

Significantly higher per cent of flower opening was recorded in M_1 (42.33 per cent) over M_3 which recorded 27.88 per cent flower opening and M_2 which recorded 36.50 per cent flower opening.

Nutrient also had a significant effect on the per cent flower opening. Significantly higher per cent of flower opening was observed in N_1 (37.56 per cent) which was on par with N_2 (36.22 per cent). Significantly lower percentage of flower opening was recorded in N_3 (32.93 per cent).

Interaction of media and nutrient also had a significant effect on per cent flower opening. Significantly higher per cent of flower opening was recorded in M_1N_1 (46.10 per cent) followed by M_1N_2 with 41.40 per cent flower opening. M_3N_3 recorded significantly least per cent of flower opening (25.33 per cent) followed by 28.97 per cent in M_3N_2.

4.17 Number of flowers opened per cut stem

Effect of media on the number of flowers opened per cut stem is presented in Table – 14a. Media had a significant effect on the number of flowers opened per cent stem. Significantly higher number of flowers per stem opened in M_2 media (6.91) followed by M_3 media (6.53).

Nutrient had a significant effect on the number of flowers that opened per cut stem. Significantly higher number of flowers were

Table – 14a. Number of flowers opened per cut stem

Treatment	N_1 (1N:1.25K_2O)	N_2 (1N:1.5K_2O)	N_3 (1N:1.75K_2O)	**Mean**
M_1 (0.5 coir peat : 2 sand : 1 soil)	5.60	5.40	5.53	**5.51**
M_2 (1 coir peat : 2 sand : 1 soil)	6.53	7.00	7.20	**6.91**
M_3 (2 coir peat : 2 sand : 1 soil)	6.07	6.20	7.33	**6.53**
Mean	**6.07**	**6.20**	**6.69**	

	S.Em±	C.D. (5%)
Media	0.060	0.179
Nutrition	0.060	0.179
Media x Nutrition	0.104	0.310

opened (6.69) when plants were fed with 1N: 1.75 K_2O (N_3), with least number of flowers opened in N_1 (6.07) followed by N_2 (6.20).

Interaction of media and nutrient also had a significant effect on the number of fully opened flowers per cut stem. Interaction M_3N_3 resulted in significantly higher number of fully opened flower per stem (7.33) over the other interactions. However interaction of M_2N_3 (7.20) was found to be on par with M_3N_3.

4.18 Number of coloured flowers per cut stem

The results show significant variation among the media with respect to number of coloured flowers per cut stem. Significantly higher number of coloured flower per cut stem was recorded in M_3 (4.83) over M_1 (2.27). However M_2 was found to be on par with M_3 (4.77).

Non-significant differences were observed among the nutrients in the number of coloured flowers. However higher number of coloured flowers was observed in N_3 (4.02) with the least being in N_2 (3.88).

Interaction of media and nutrient recorded non-significant difference with respect to number of coloured flowers per stem. Maximum number of coloured flowers per stem was recorded in M_3N_3 (5.0) and the minimum being M_1N_2 (2.24) followed by M_1N_1 (2.27).

4.19 Vase life

It is evident from Table 16 that media had a significant effect on the vase life of the cut flowers. Significantly longer vase life of 10.38

Table – 15. Number of fully opened coloured flowers per cut stem of Lisianthus as affected by media and nutrient

Treatment	N_1 ($1N:1.25K_2O$)	N_2 ($1N:1.5K_2O$)	N_3 ($1N:1.75K_2O$)	**Mean**
M_1 (0.5 coir peat : 2 sand : 1 soil)	2.27	2.24	2.30	**2.27**
M_2 (1 coir peat : 2 sand : 1 soil)	4.77	4.77	4.77	**4.77**
M_3 (2 coir peat : 2 sand : 1 soil)	4.87	4.63	5.00	**4.83**
Mean	**3.97**	**3.88**	**4.02**	

	S.Em±	C.D. (5%)
Media	0.102	0.305
Nutrition	-	NS
Media x Nutrition	-	NS

Table – 16. Vase life of Lisianthus as affected by media and nutrient

Treatment	N_1 (1N:1.25K_2O)	N_2 (1N:1.5K_2O)	N_3 (1N:1.75K_2O)	**Mean**
M_1 (0.5 coir peat : 2 sand : 1 soil)	8.35	8.17	8.34	**8.29**
M_2 (1 coir peat : 2 sand : 1 soil)	8.77	9.80	10.20	**9.59**
M_3 (2 coir peat : 2 sand : 1 soil)	10.23	10.53	10.37	**10.38**
Mean	**9.12**	**9.52**	**9.68**	

	S.Em±	C.D. (5%)
Media	0.178	0.533
Nutrition	-	NS
Media x Nutrition	-	NS

days was recorded in M_3 (2 coirpeat :2 sand : 1 soil). Shorter vase life of 8.29 days was recorded in M_1 followed by M_2 (9.59 days).

Non-significant difference in the vase life was recorded among the nutrients. However longer vase life of 9.68 days was recorded in N_3 (1 N : 1.75 K) and shortest being in N_1 with 9.12 days. N_2 recorded 9.52 days of vase life.

Interaction effect of media and nutrient also recorded non-significant differences. Maximum vase life was recorded in M_3N_2 (10.53 day) and the least vase life was recorded in the interaction of M_1N_2 (8.17 days).

DISCUSSION

V. DISCUSSION

Lisianthus is an annual or a biennial herb mainly used as cut flower and potted plant. In the production of this crop improvement of root environment is becoming most important to have better control over feeding of water and nutrient, and pest and disease management so that good export quality crop which can compete in the international market can be produced.

Lisianthus is newly introduced to India for commercial cultivation. Even though much research work has been carried out in foreign countries to standardise the media and nutrition for Lisianthus, standardising the media with locally available media like coir peat is important from the point of adaptability to local conditions and also from the point of economic feasibility of the cultivation of this new crop. Hence in the present study three media combinations of varying coir peat levels of 0.5, 1 and 2 parts (v/v) along with 2 parts of sand and 1 part of soil was used. Three levels of nutrients in varying ratios of nitrogen to potassium with 1 Nitrogen : 1.25 Potassium, 1 Nitrogen : 1.5 Potassium and 1 Nitrogen : 1.75 Potassium were used. Combination of the three media with the three nutrient levels was used to standardise the media and nutrition for Lisianthus under greenhouse conditions during the year 1999-2000.

The results obtained from the experiments are discussed here under.

5.1 Effect of media and nutrient on growth of Lisianthus

5.1.1 Number of branches

Lisianthus is grown as both cut flower and potted plant. Compact growth with more number of branches will be preferred to get better look in vase as well as in pots. More number of lateral branches also help in producing greater number of flowers than that are produced on single stemmed plant.

Media had a significant effect on the number of branches produced by the Lisianthus plants. The plants grown on M_3 media prepared by mixing 2 part coir peat 2 part sand and 1 part soil (v/v) produced greater number of branches (5.56) which is significantly superior over the other two media combinations. This may be due to the higher organic carbon of 1.2 per cent and higher E.C of 0.39 m mhos/cm (Appendix II). The other two media M_2 and M_1 had organic carbon of 0.91 and 0.65 per cent respectively and the EC was 0.30 and 0.37 in M_2 and M_1 respectively (Appendix – II). These results are in accordance with the results obtained by Meerow (1994) in ixora plants grown in coir based media.

The different ratios of N and K_2O had non-significant effects on number of branches. These results may be because the variation in treatment is only potassium. Nitrogen plays an important role in vegetative growth which is not varied among the treatments.

The combination of media and nutrient significantly affected the number of branches. Two part of coirpeat, two part of sand and one part of soil (v/v) along with nitrogen and potassium in the ratio of 1:1.25 (M_3N_1) produced significantly higher number of branches per plant over other media and nutrient combinations. These results may be due to the higher N (1.2 per cent), higher E.C. (0.39 m mhos/cm), neutral pH (6.9) and higher available phosphorus in the media M_3. (Appendix-II).

5.1.2 Number of leaves at flower opening

Number of leaves plays an important role in the growth of plants, since it is the site of photosynthesis. In plants like Lisianthus leaves increase the beauty of the cut flower in the bouquet and reduce the requirement of foliage of other plants (filler) in flower arrangement. In addition to these uses higher number of leaves also influences the growth rate and number of buds produced by the plant

Media had a significant effect on the number of leaves produced per plant. Highest number of leaves (34.22) were recorded in plants grown in M_3 media [2 part coirpeat, 2 part sand and 1 part soil (v/v)].

On par result was recorded in plants grown in M_2 media containing 1 part coir peat, 2 part sand 1 part soil (33.60 leaves). This may be due to the higher organic N content of 1.2 per cent in M_3 and 0.90 per cent in M_2 media compared to 0.65 per cent in M_1 media. These two media also had higher available phosphorus and available potassium (Appendix – II). The higher nitrogen and other nutrient contents in these media help in greater vegetative growth resulting in higher number of leaves.

Nutrient also had a significant effect on the average number of leaves per plant at flower opening. Significantly higher number of leaves (30.56) were recorded in the plants supplied with N:K_2O in the ratio of 1:1.75. This may be due to the optimum ratio of N to K in N_3 which resulted in higher number of nodes (Number of nodes is equal to half of the number of leaves since each node will have one pair of leaves). This result is in accordance with the results obtained by Alt *et al.* (1993a) where they recorded greater growth rate and quality of Lisianthus plants when fed with 1 Nitrogen : 1.70 potassium.

Significant effect of media and nutrient combination was recorded with respect to average number of leaves. Highest number of leaves (35.87) was recorded when grown on media containing 2 part coir peat, 2 part sand and 1 part soil (v/v) and fed with the nutrient solution prepared by mixing N and K_2O in 1:1.75 ratio (M_3N_3). This may be due to the higher nitrogen in the M_3 media which boosts, the vegetative growth, along with higher available potassium and phosphorus (Appendix-1). This can also be attributed to the optimum ratio of $N:K_2O$ as reported by Alt *et al.* (1993a).

5.1.3 Leaf size

Leaf is the site of photosynthesis in plants. It helps the plant in trapping solar energy and convert it to carbohydrate to increase the vigour of the plant as well as cut flower quality. In Lisianthus leaves are very attractive and hence the increased leaf size will provide a beautiful background for the flower in the bouquet.

Media play an important role in variation in the leaf size of Lisianthus. Significantly higher leaf size (44.60 cm^2) was recorded in the plants grown on media containing 2 part coir peat, 2 part sand and 1 part of soil (v/v) (M_3). This may be due to the higher Nitrogen content (organic carbon of 1.2 per cent) in the media M_3. Nitrogen helps in vegetative growth of plants. In addition M_3 also recorded neutral pH (6.9), higher available phosphorus (9 kg/ac) and higher available potassium (246 kg/ac) (Appendix-II). The increased leaf size may also be due to higher water holding capacity of media M_3 due to the presence of higher proportion of coir peat. These results are in agreement with the findings of Boodley *et al.* (1983) who observed better growth in chrysanthemum when grown on peat lite media.

Nutrition also recorded significant effect on the average leaf size. Higher leaf size was recorded in plants fed with Nitrogen and Potassium in the ratio of 1:1.75 (N_3) and 1:1.5 (N_2). These treatments recorded a leaf size of 33.17 cm^2 and 32.98 cm^2 respectively. This may be due to the higher and balanced nutritent application. These results are in accordance with the observations of Harbaugh *et al.* (1998) who recorded better growth of Lisianthus plants fed with nutrients in the ratio of 1N:1.5 K_2O and Alt *et al.* (1993a)who recorded better growth of Lisianthsus plants fed with nutrients in the ratio of 1:1.70 of N: K_2O.

Media and nutrient interaction also had a significant effect on the leaf size of plants. Highest leaf size of 45.07 cm^2 was recorded due to the interaction of media containing 2 part coir peat, 2 part sand, 1 part soil (v/v) with the nutrient treatment containing nitrogen and potassium in the ratio of 1:1.5 (M_3N_2). On par result was recorded due to the interaction of M_3 with N_3 (2 coirpeat, 2 sand, 1 soil and 1N:1.75 K_2O) which recorded an average leaf size of 44.57 cm^2. These results may be attributed to the higher nitrogen and neutral pH of M_3 media (Appendix – II). Optimum ratio of N: K_2O may also be responsible (Alt *et al.*, 1993b).

5.1.4 Leaf area per plant

Leaf is the site of photosynthesis in plants. Greater leaf size will help in increased accumulation of carbohydrates, resulting in higher vigour of plants and better cut flower quality.

Media has significant effect on the leaf size per plant in lisianthus. The plants grown on M_3 media prepared by mixing 2 part coir peat, 2 part sand and 1 part soil (v/v) (M_3) produced greater leaf size per plant (1434.05 cm^2), which is significantly superior over the other two media. This may be due to the higher organic carbon (1.2 per cent), available phosphorus (9 kg/ac) and available potash (246 kg/ac) as reported in Appendix – II.

Nutrient also had a significant effect on the leaf size per plant. Significantly higher leaf size per plant (1033.68 cm^2) was recorded in the plants supplied with $N:K_2O$ in the ratio of 1:1.5 (N_2). This may be due to the greater number of leaves (Table – 2) present in these plants. These results are in accordance with the results obtained by Harbaugh *et al.* (1998).

Significant effect of media and nutrient combination was recorded with respect to leaf size per plant. Highest leaf size per plant (1522.79 cm^2) was recorded when grown on media containing 2 part coirpeat, 1 part sand and 1 part soil (v/v) and fed with the nutrient solution prepared by mixing N and K_2O in 1:1.75 ratio (M_3N_3). This may be due to the higher organic carbon in M_3 media as reported in Appendix-II and greater number of leaves (Table-3) recorded in this interaction.

5.1.5 Root weight

Media play an important role in the root growth. Greater root spread will help in increasing plant vigour , growth and number of buds. Root weight is related to the root spread. In Lisianthus root growth is faster than shoot growth in initital stages where the plugs root bound for a shorter period will not perform well in later stages (Harbaugh *et al.*, 1998). This shows the importance of root spread in the performance of plants.

The medium in which the plant is growing, significantly influences the root growth which in turn influences the root weight. The plants growing on media consisting of 2 part coir peat, 2 part sand, 1 part soil (M_3) recorded highest weight of roots (10.89 grams). M_2 (1 part coir peat, 2 part sand, 1 part soil) which was on par with M_3 recorded a root weight of 9.99 grams. These results may be due to the physical properties of media. Higher peat content will help in improving the texture of soil causing reduced soil compaction and thereby enhancing the root spread. The present findings are in agreement with those of other researchers. Maximum root dry weight of pentas and ixora were observed in coir grown plants by Meerow (1994).

Higher root weight (8.43 grams) was recorded in plants fed with nitrogen and potassium in the ratio of 1:1.5. However the difference was nonsignificant.

Interaction of media with nutrition had a non-significant effect on root weight of plants.

5.1.6 Days taken for flower bud initiation

Days taken for flower bud initiation is important to the grower as lesser the number of days taken for flower bud initiation lesser is the coot of production. Media has a significant effect on the days taken for flower bud initiation (Table 5). Significantly lower numbers of days (38.50 days after transplanting) were taken by plants grown on media containing 2 part coir peat, 2 parts sand and 1 part soil (M_3). This may be due to the higher potassium and phosphorus content recorded in M_3 as reported in Appendix – II. This may also be due to the higher leaf number (Table-2) and leaf size (Table-3) resulting in increased photosynthesis, which might have been responsible for early initiation of flower buds. These results are similar to the results obtained by Vita-M-De and De-Vita-M. (1993) who reported that Lisianthus grown in soil amended with 5 kg peat / m^3 or 10 kg Vinasse / m^3 advanced flowering.

Feeding the plants with nitrogen and potassium in the ratio of 1:1.75 recorded early initiation of flowering (40.26 days after transplanting). However the difference was found to be non-significant.

Media and nutrition interaction also showed non-significant differences among the treatments in number of days taken for flower initiation. However the interaction of media containing 2 part coir peat 2 part sand, 2 part soil with nutrient in the ratio of 1N : 1.75 K_2O had taken minimum number of days for flower opening (43.47 days after transplanting).

5.1.7 Days taken for first flower opening

Days taken for first flower opening indicates the number of days taken by the crop to start flowering. The earlyness in first flower opening is important from the growers point of view, as it helps in saving cost incurred in growing the crop. Earlyness of crop coupled with better quality is the requirement of the day in intensive cropping system.

The media used for growing the crop significantly influenced the earlyness of crop (Table-6). The crop raised in media containing 2 part coir peat, 2 part sand and 1 part soil (M_3) flowered earlier than the other media. Days taken for first flower opening by plants grown in M_3 medium was significantly lesser (57.92 days) than in M_1 medium (63.00 days). However, M_2 (58.5 days after transplanting) was on par with M_3. This may be due to higher nutrient levels in M_3 and M_2 medium (Appendix-II) and also due to the higher leaf size of plants grown in these two media (Table-3), which help in increased carbohydrate production thus resulting in earliness of flower opening. These results are in accordance with the results obtained by Vite-M-De and De-Vita-M (1993) who reported that when Lisianthus was grown on media ammended with 5 kg peat / m^3 or 10 kg vinases, flowering was advanced when compared to those grown in unamended soil.

Nutrient applied has a significant role to play on the earlyness of the flower opening. The plants fed with the nutrient solution containing nitrogen and potassium in the ratio of 1:1.75 (N_3) flowered earlier (59.19 days after transplanting). However the number of days taken by plants fed with N_2 nutrient solution in the ratio of 1N : 1.5 K_2O (59.56 days) was on par with N_3. The earliness in flower opening observed in nutrient treatments N_3 and N_2 may be due to the higher potassium used in the nutrient solution. Higher leaf size observed in these two treatments (Table-3) might also have helped in earliness of flowering, due to increased carbohydrate accumulation.

Non-significant effect of media and nutrient interaction was observed in the number of days taken by the plants for first flower opening. The non-significance in results can be related to nonsignificance in leaf size due to the interaction of media and nutrient.

5.1.8 Days taken for fifty per cent of flowering

Days taken for fifty per cent flowering indicates the number of days taken by fifty per cent of the plants to produce first flowers in any treatment. This indicates the synchronisation of flowering.

Days taken for 50 per cent flowering was significantly influenced by media (Table-7). Plants grown on media consisting of 2 part coir peat. 2 part sand, 1 part soil (M_3) flowered earlier. Number of days taken by fifty per cent of plants to flower was significantly lesser in media M_3 (56.33 days after transplanting) but M_2 was found to be on par (57.33 days after transplanting) with M_3. These results may be due to the higher nutrient contents in the media as presented in soil test report (Appendix-II) and greater number of leaves (Table-2) and greater leaf size (Table-3) and higher number of branches (Table – 1). This result is found to be in accordance with the results obtained by Vita-M-De and De-Vita-M (1993) who observed early flowering by growing Lisianthus in Peat amended soils.

Nutrient supplied had a non-significant effect on the number of days taken for fifty per cent of plants to open its first flower.

Interaction of media and nutrient had a significant effect on the days taken for fifty per cent flower opening. Significantly lesser number of days for fifty per cent flowering (55 days) was recorded due to the interaction of media containing 2 part coir peat, 2 part sand : 1 part soil and fed with 1N : 1.25 K_2O (M_3N_1). M_3N_3 (56.32 days) was found to be on par with M_3N_1. This may be due to the higher synchronization of growth in the plants grown on these two treatments.

5.1.9 Days taken for harvest

Days taken for harvest represents the crop duration. In Lisianthus crop is harvested when two flowers are fully open. The days taken by the crop to attain the stage of harvest is of greater importance in the farmers point of view, since this helps the farmer in planning the crop. Earliness in flowering will be of greater advantage to the grower, since it reduces the cost of cultivation and helps in taking up intensive cultivation.

Media has a significant role to play on the number of days taken by the plants to attain the stage of harvest. Significantly lesser number of days was taken by plants grown in M_3 media containing 2 part coir peat: 2 part sand: 1 part soil. This may be due to greater available nutrients present in the media and favourable pH 6.9 as presented in Appendix-II. These favourable media conditions in turn might have resulted in the production of greater leaf number (Table-2) and greater leaf size (Table-3) which help in higher carbohydrate production, thus advancing flowering and reducing the number of days taken for harvest. Similar to the results were obtained by Vita-M-De and M-Vita-De

(1993) by growing Lisianthus on peat ammended soil who observed early flowering in amended media.

Nutrient also had a significant effect on the days taken by plants to attain the stage of harvest. Plants fed with nutrient solution N_3 consisting of nitrogen and potassium in the ratio of 1:1.75 had taken significantly lesser number of days to attain the stage of harvest (62.76 days after transplanting). N_2 (63.76 days after transplanting) was on par with N_3. This earliness can be attributed to the larger leaf size, greater leaf number and greater number of branches in plants receiving these treatments.

Interaction of media with nutrient recorded nonsignificant differences in the number of days taken by plants to attain the stage of harvest after transplanting. Minimum number of days (60.69 days after transplanting) was required to attain the harvest stage when the plants were grown on 2 coir peat: 2 sand,: 1 soil and fed with 1N:1.75 K_2O (M_3N_3).

5.2 Effect of media and nutrient on the flower quality and post harvest life

5.2.1 Stem length

Lisianthus is mainly grown for its beautiful cut flower. One of the basic requirements of a good cut flower is long stem. In Lisianthus whole plant is cut at the base and used as a cut flower. Hence stem length is very important in Lisianthus.

The length of the stem was significantly influenced by media. The media combination of 2 coir peat: 2 sand: 1 soil recorded higher stem length of 63.49 cm. This may be due to the higher growth of plant due to higher nutrient status in the media (Appendix-II), greater leaf size (Table-3) and leaf number (Table-2) and also greater root growth (Table-4). Similar results were obtained by Karlovich and Fontene (1986) in chrysanthemum. Gisierod (1988) recorded taller plants when grown on coarse sphagnum peat moss. Organic matter increased the plant height in china aster (Scoltanzad *et al.*, 1982).

Significantly higher stem length was recorded at a nutrient ratio of 1 Nitrogen : 1.75 Potassium (57.08 cm). This increased stem length may be due to the optimum nutrition, greater leaf number (Table-2) and leaf size (Table-3) that are recorded in the treatments. Similar results were obtained by Alt *et al.* (1993a), who reported higher response in Eustoma when fed with 1 Nitrogen : 1.7 Potassium. These results are however contrary to the results obtained by Harbough *et al.* (1998) who recorded better growth at 1 Nitrogen : 1.5 Potassium.

Interaction of media and nutrient had a significant effect on the stem length. Combination of 2 coir peat, 2 sand. 1 soil (v/v) with

1 Nitrogen : 1.75 Potassium (M_3N_3) had a significantly higher stem length (67.26 cm). This may be due to the better nutrient status and neutral pH (6.9) of M_3 media (Appendix-II) and larger leaf size (Table-3) and greater leaf number (Table-2) in the treatment M_3N_3 good physical condition of media might also have influenced the result.

5.2.2 Cut flower weight

Lisianthus is cultivated mainly for cut flower market.

Media had a significant effect on cut flower weight. Significantly higher weight of cut flower (60.23 grams) was recorded in the M_3 media containing 2 part coir peat, 2 parts sand and 1 part soil (v/v). This increased cut flower weight may be due to longer stem length (Table-9), higher number of buds (Table-12) larger leaf size (Table-3), higher number of leaves (Table-2) and higher stem girth (Table-11) that was recorded in M_3 media.

Nutrition also had a significant effect on the cut flower weight. Plants fed with N: K_2O in 1: 1.75 ratio (N_3) produced significantly higher cut flower weight of 46.59 grams compared to those fed with the nutrient solution contain N:K_2O the ratio of 1:1.25 (N_1). The nutrient ratio of 1N : 1.5 K recorded a cut flower weight of 46.40 grams which was on par with N_3. These results may be due to the greater number of flower buds (Table-12) greater number of leaves (Table-2) greater leaf size (Table-3) and longer stem (Table-9), recorded in the treatments N_3 and N_2

Interaction of media with nutrient recorded nonsignificant difference in cut flower weight. However, the combination of M_3N_3 recorded higher cut flower weight (51.50 grams).

5.2.3 Stem diameter

For any cut flower with large number of buds, as in Lisianthus, it would be necessary to have a sturdy, straight stem with greater stem diameter to withstand the weight and to facilitate greater water uptake for longer vase life.

Media had a significant effect on the diameter of stem (Table-12). Media consisting of 2 part coir peat, 2 part sand and 1 part soil (v/v) (M_3) developed significantly higher stem diameter of 0.54 cm. This may be due to the greater leaf size (Table-3) higher number of leaves (Table-2) and also due to higher nutrient availability in M_3 media (Appendix-II). Similar results were recorded by Hicklenton, (1983) who reported thickest stem when chrysanthemums were grown in peatlite media.

Nonsignificant differences were recorded in he stem diameter with respect to nutrient supply. However higher stem diameter of 0.52 cm was recorded in plants fed with nitrogen and potassium in the ratio of 1:1.75.

Significant effect of interaction between media and nutrition was recorded. The combination of media containing 2 part coir peat, 2 part sand, 1 part soil (v/v) and nitrogen to potassium ratio of 1:1.5 (M_3N_2) resulted in higher stem diameter. This may be due to the greater number of leaves (Table-2) greater leaf size (Table-3) and greater root weight (Table-4). The results may also be due to higher organic carbon, available phosphorus and available potassium in M_3 media (Appendix-II). This result is in accordance with results obtained by Sogni, (1988) who recorded higher growth of lisianthus in media containing higher organic matter and Harbaugh *et al.* (1998) recorded greater growth of lisianthus when fed with N : K_2O in the ratio of 1:1.5.

5.2.4 Number of buds per stem

Number of buds per stem is an important factor deciding the quality of the cut flowers. More is the number of buds per stem more will be the attraction of stem in the vase or bouquet. When grown as a pot plant greater number of buds per plant will increase the duration of flowering as well as the beauty of potted plants.

Significantly higher number of buds per stem (22.11) was recorded when the plants were grown in the media containing 2 part coir peat 2 part sand and 1 part soil (M_3). This result may be due to the higher available nutrients in the M_3 media and neutral pH (6.9) as reported in soil test result (Appendix-II). This may also be due to the greater number of leaves (Table-2) and branches (Table-1) larger leaf size (Table-3) and greater root growth (Table-12) as observed in plants grown in M_3 media. Similar results were recorded by Hanbaugh *et al.* (1998).

Nutrient supplied to the plants also can significantly effect the bud number in the plants. Significantly higher number of buds (19.38) were recorded in plants fed with Nitrogen and potassium in the ratio of 1:1.75 (N_3). On par results were recorded in N_2 (1N:1.5 K_2O), which produced 17.62 buds per cut stem. These results may be due to the optimum nutrient supplied by the nutrient solutions (N_3 and N_2) and also due to greater number of leaves (Table-2) and greater leaf size (Table-3), observed in the plants receiving these two treatments.

Higher number of buds per plant (23.53) was recorded in the interaction of media containing 2 part coir peat, 2 part sand 1 part soil (v/v) with nutrient in the ratio of 1N : 1.75 K_2O (M_3N_3). However the interaction effect of media and nutrition on the number of buds per stem was found to be nonsignificant.

5.2.5 Flower size

Lisianthus produces bell shaped flowers and the improvement in the size of the flower will increase the beauty of the plant. The two parameters which contributed to the flower size, the length and the breadth of the flower are discussed here under.

5.2.5.1 Flower length

Media has considerable effect on the length of the flower (Table-13a). Significantly longer flower length (6.71 cm) were recorded in plants grown on M_2 media containing 1 part coir peat 2 part sand, 1 part soil (v/v). This increase in flower length may be due to greater leaf size (Table-3) greater leaf number (Table-2) and greater growth (Table-1 and Table-4). However the reduction of flower length in M_3 media can be related to greater number of buds (Table-12).

Nutrient had a nonsignificant effect on the flower length. Higher length of flower (6.58 cm) was recorded due to the Nitrogen : Potassium in the ratio of 1: 1.5 (N_2).

Interaction of media with nutrient had non-significant effect on the flower length. However maximum length of flower was recorded due to the interaction of M_2N_2 (1 coir peat : 2 sand : 1 soil : 1 N: 1.5 K_2O).

5.2.5.2 Flower diameter

Flower diameter is another parameter deciding the size of flower in Lisianthus. Non-significant differences were recorded in flower diameter due to media. However higher flower diameter (7.90 cm) was recorded in M_3 media.

Nutrition also had a non-significant effect on flower diameter. With the highest diameter (7.91 cm) was recorded in plants fed with N_3 nutrient (1N : 1.75 K_2O).

Interaction of media and nutrient had a significant effect on the flower diameter. Significantly higher diameter of flower (8.22 cm) was recorded in plants grown on media containing 2 part coir peat, 2 part sand and 1 part soil fed with Nitrogen and Potassium in the ratio of 1:1.25 (M_3N_1). This may be due to optimum nutrients in the media and optimum ratio of nutrient supplied through the nutrient solution.

5.2.6 Per cent flower opening

Lisianthus is a cut flower grown for its beautiful flowers. Hence the percentage of flower opening plays an important role in extending the vase life. When the percentage of flower opening increase it will increases the beauty of the cut flower in vase.

Media in which the plants were grown plays a significant role in the per cent flower opening (Table-15). In the present investigation significantly higher percentage of flower opening (42.33%) was recorded in plants grown on media containing 0.5 part coir peat 2 part sand and 1 part soil. This result was probably due to the lesser number of buds (Table-12) present in the plants grown un M_1 media. Eventhough greater number of flowers opened in the plants grown in other two media due to the greater number of buds present in those plants per cent flower opening has reduced.

Nutrient also had a significant effect on the per cent flower opening. Higher per cent of flower opening (37.56%) was recorded in plants fed with 1 Nitrogen : 1.25 Potassium (N_1) which was on par with N_2.

Interaction of media and nutrient also had a significant effect on per cent flower opening. Higher percentage of flower opening was recorded due to the interaction of M_1N_1 (0.5 coir peat: 2 part sand: 1 soil and 1 nitrogen : 1.25 potassium). These results might be due to the lesser number of buds (Table-12) present in these treatments.

In general, irrespective of the treatments percentage flower opening was low (27.87 to 42.00%). In this experiment flowers were harvested when two first formed flowers opened. At this stage the later formed buds were not fully developed. Hence percentage flower opening was low. This can be increased by harvesting at right stage, which has to be determined by further experiments in these lines.

5.2.7 Number of flowers opened per cut stem

Lisianthus is used as a cut flower and hence the number of flowers that open per cut stem plays an important role in increasing the beauty of the cut flower. This also help in increasing the vase life of the cut flower.

Media in which the plants were grown plays a significant role in the opening of flowers in cut stem. In the present investigation significantly higher number of fully opened flowers per stem (6.91) was recorded in plants grown on media consisting of 1 part coir peat, 2 part sand and 1 part soil (M_2) was followed by plants grow on media consisting of 2 part coir peat 2 part sand and 1 part soil(M_3). This result may be due to the presence of higher number of matured buds at the time of harvest.

Nutrient supplied to the plants also can significantly effect the number of flower that open per cut stem. Significantly higher number of flowers (6.69) plants supplied with nutrient solution in the ratio of 1N : 1.75 K_2O (N_3). This may be due to the higher potassium content in the nutrient solution which may increase the vase life (Table-16) thus leading to great number of flower opening.

Significantly higher number of flowers were opened per cut stem (7.33) when grown on media containing 2 part coir peat, 2 part sand. 1 part soil and fed with N and K_2O in the ratio 1:1.75 (M_3N_3). This was found to be on par with M_2N_3. These results can be attributed to the higher potassium levels in M_3 and M_2 media (Appendix-II) and in the applied nutrient solution (N_3).

5.2.8 Number of fully opened coloured flowers per cut stem

In Lisianthus the major drawback is the fading of colour of the flowers that open after harvest, which is mainly observed in pink and blue coloured varieties. The colour development will occur just before the flower opens. Colour development will add to the beauty of the flower.

Media in which the plant were grown has significantly influenced the colour development. Significantly higher number of coloured flowers (4.83) were recorded in media composed of 2 part coir peat, 2 part sand, 1 part soil (M_3). However M_2 (1 part coir peat, 2 part sand, 1 part soil) produced 4.77 coloured flowers which was found to be on par with M_3. These increased number of coloured flowers in M_3 and M_2 may be due to the presence of higher number of buds that have developed colour at the time of harvest.

Nonsignificant differences were recorded in number of coloured flower due to nutrient supplied. However greater number of flowers (4.02) developed colour when fed with Nitrogen and Potassium in the ratio of 1:1.75.

Interaction of media with nutrient also had a non-significant effect. Higher number of coloured flowers (5.0) were recorded as a result of interaction M_3N_3 (2 coir peat: 2 sand: 1 soil and 1 Nitrogen : 1.75 potassium). This result may be due to the presence of more number of buds that have developed colour at the time of harvest.

5.2.9 Vase life

For any cut flower its vase life is a very important factor in gaining consumer preference. The flower that can stay longer in the vase is preferred over flowers with shorter vase life. Vase life of any flower is determined by its ability to restore its beauty in the vase. This will vary with crop. In the present study efforts are made to study the action of media, nutrients and their interaction on vase life of Lisianthus and the results obtained are discussed below:

Media had a significant role in increasing vase life. Longer vase life (10.38 days) was recorded in flowers grown in M_3 media containing 2 part coir peat, 2 part sand and 1 part soil (v/v). This may be due to the higher content of available potassium in the M_3 medium (Appendix-II) and also be due to the greater stem diameter of the cut flower (Table-11). Similar results were obtained by Rudnicki and Nowak (1976) who recorded longer vase life of gerbera when grown on pine bark and peat mixture.

Nutrient had a nonsignificant effect on the vase life of flowers in Lisianthus. However maximum vase life of 9.64 days was recorded when plants were fed with Nitrogen and Potassium in 1:1:75 ratio (N_3).

Interaction of media and nutrient resulted in non-significant differences in vase life of cut Lisianthus. However, longer vase life (10.53 days) was recorded in the interaction of M_3 (2 part coir peat, 2 part sand and 1 part soil) with N_2 (1 Nitrogen; 1.50 potassium).

SUMMARY

VI SUMMARY

Investigations were carried out to standardise the media and nutrient requirements of *Lisianthus russellianum* [*Eustoma grandiflorum* (Raf.) Shinner] at the Indo-American Hybrid Seeds (India) Pvt. Ltd., Bangalore, during 1999-2000. The broad objectives of the investigation were standisation of media standardisation of nutrient and to study the effect of media and nutrient on the vase life of cut Lisianthus. In the investigation, different media combinations and varied nitrogen to potassium ratios were tried.

Lisianthus var F_1 Deep Blue was grown on media containing varied levels of coir peat [0.5, 1 and 2 part (v/v)] along with sand and soil in 2:1 ratio. Using media consisting of 2 part coir peat along with 2 part sand and one part of soil showed superior results for number of branches, number of leaves at first flower opening, leaf size, root weight, stem length, stem weight, stem diameter, number of coloured flowers and vase life. This treatment also took less number of days for flower bud initiation, first flower opening, fifty per cent flowering and harvesting over the other two media containing 0.5 part coir peat and 1 part coir peat. Based on this study media consisting of 2 part coir peat 2 part sand and

1 part soil can be recommended for producing better quality flowers in *Lisianthus*.

The plants were fed with different levels of nutrients in varied ratios of nitrogen and potassium. (1N:1.25 K_2O, 1N : 1.50 K_2O and 1N : 1.75 K_2O). Feeding of plants with nutrient solution consisting of nitrogen and potassium in the ratio of 1:1.75 resulted in superior leaf size, stem length, stem weight and number of buds, and it had taken lesser number of days for first flower opening and for harvest.

Based on the study application of nutrient solution consisting of nitrogen and potassium in the ratio of 1:1.75 can be recommended for producing better quality flowers in Lisianthus.

The interaction of media and nutrient also had an effect on the performance of Lisianthus. Superior results for number of leaves at flower opening, stem length, stem weight, number of buds and number of coloured flowers were recorded along with less number of days for flower bud initiation, first flower opening and harvesting in the interaction M_3N_3 [2 coir peat: 2 sand: 1 soil (v/v) and 1 nitrogen : 1.75 potassium].

Based on these results it may be recommended that Lisianthus can be best grown in media containing 2 part of coir peat, 2 parts of sand and 1 parts of soil and fed with nitrogen and potassium in the ratio of 1:1.75.

Future line of work

1. There is a need to standardise phosphorus and micro-nutrient requirement of lisianthus to get better results.

2. It is necessary to standardise the harvesting time to achieve better post harvest life.

3. It is necessary to standardise the vase solution and other treatment to extend vase life and avoid fading of colours in cutflowers.

4. The effect of using higher proportion of coir peat in the media on the growth and production of lisianthus can be studied.

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*** Originals not seen**

APPENDICES

Appendix – I

Mean temperature and relative humidity prevailing inside the polyhouse during the study in week wise (after transplanting).

Week Number	Mean temperature (^{0}C)		Mean relative humidity (%)		Bright sunshine hour
	Maximum	Minimum	Maximum	Minimum	
1.	21.7	17.8	52	45	8.0
2.	22.7	19.4	58	46	7.3
3.	29.3	23.5	58	56	6.2
4.	33.9	23.2	70	65	6.2
5.	32.3	21.4	62	54	9.3
6.	38.5	17.5	58	50	8.9
7.	36.5	16.4	52	45	10.3
8.	35.4	17.8	56	46	8.9
9.	35.8	16.2	60	54	8.9

Appendix – II

Analysis of media for its chemical properties

Chemical property	M_1	M_2	M_3
pH	6.9	7.1	6.9
EC m mhos/cm at 25°C	37	30	39
Organic carbon (%)	0.65	0.90	1.2
Available phosphorus (kg/ac)	3	4	9
Available potash (kg/ac)	124	170	246

Appendix – III

Analysis of water for its chemical properties

Chemical properties		
pH	-	8.2
EC (m mhos / cm) at 25°C	-	1.9
CO^{3-} (meq / l)	-	1.5
HCO^{-}_{3} (meq/l)	-	7.4
Cl^{-} (meq/l	-	8.5
SO^{-}_{4} (meq/l)	-	1.2
Ca^{++} + Mg^{++} (meq/l)	-	14.0
Ca^{++} (meq/l)	-	9.2
Mg^{++} (meq/l)	-	4.8
Na^{+} (meq/l)	-	4.5
K^{+} (meq/l)	-	0.3
Sodium Absorption Ratio	-	1.7