PLANT DENSITIES AND CHLOROCHOLINE CHLORIDE ON GROWTH PRODUCTION AND SHELF LIFE OF GLADIOLUS

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A Thesis
Submitted to the Department of Horticulture and Postharvest Technology
Sher-e-Bangla Agricultural University, Dhaka
In partial fulfillment of the requirements
for the degree
of

MASTER OF SCIENCE (MS)
IN
HORTICULTURE

SEMESTER: JULY-DESEMBER, 2008

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CERTIFICATE

This is to certify that the thesis entitled **"Plant Densities and Chlorocholine Chloride on Growth Production and Shelf Life of Gladiolus"** submitted to the Department of Horticulture and Postharvest Technology, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of ***MASTER OF SCIENCE* in *HORTICULTURE***, embodies the result of a piece of bona fide research work carried out by **Md. Tipu Sultan Sapan**, Registration No. **07-02580** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

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Dedicated to

My Beloved Parents

&

Brother

ACKNOWLEDGEMENTS

All praises are due to Almighty Allah, the Great, Gracious and Merciful, Whose blessings enabled the author to complete this research work successfully.

The author like to express his deepest sense of gratitude sincere appreciation to his respected supervisor Professor Md. Ruhul Amin, Department of Horticulture and Postharvest Technology, Sher-e-Bangla Agricultural University (SAU), Dhaka, Bangladesh, for his scholastic guidance, support, encouragement and invaluable suggestions and constructive criticism throughout the study period and gratuitous labor in conducting and successfully completing the research work and in the preparation of the manuscript writing.

The author also expresses his gratefulness and best regards to respected Co-Supervisor and the Chairman, Department of Horticulture and Postharvest Technology, Sher-e-Bangla Agricultural University, Dhaka, Professor A. K. M. Mahatabuddin for his scholastic guidance, helpful comments and constant inspiration, inestimatable help, valuable suggestions throughout the research work and preparation of the thesis.

The author also expresses heartfelt thanks to all the teachers especially Assistant Professor Mohammad Humayun Kabir and Assistant Professor Dr. A. Faiz Md. Jamal Uddin of the Department of Horticulture and Postharvest technology, SAU, for their valuable suggestions, instuctions, cordial help and encouragement during the period of the study.

The author intend to express heartful indebtedness and sincere appreciation to his Deputy General Manager (Seed inspection and Agronomy), Bangladesh Sugar and Food Industries Corporation for his kind help in completing this thesis writing and also to convey the profound thanks to his friends Jamil and Yasmin for their heartiest assistance in my research period and tireless effort in completing this thesis writing. I would like to expresses cordial thanks to all other friends for their support and encouragement to complete this study.

The author expresses his sincere appreciation to his parents, brother, relatives and well wishers for their inspiration, help and encouragement throughout the study period.

The Author

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ABSTRACT

The study was conducted at the Horticultural Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from October, 2007 to June, 2008 to find out the effect of spacing and concentration of Chlorocholine Chloride (CCC) on growth, production and shelf life of gladiolus. The experiment consisted of two factors. Factor A: Three levels of plant densities i.e S_1: 25 cm × 15 cm; S_2: 25 cm × 20 cm and S_3: 25 cm × 25 cm and Factor B: Four levels of Concentration of CCC i.e C_0: 0; C_1: 200; C_2: 400 and C_3: 600 ppm respectively. The experiment was laid out with Randomized Complete Block Design with three replications. In case of plant densities the highest flowering plant (93.67%), yield of corm (17.06 t/ha) and cormel (14.08 t/ha) was recorded from S_2 and the lowest from S_1. In case of CCC the highest flowering plant (93.89%), shelf life (15.78 days), cormel per plant (22.54), yield of corm (16.20 t/ha) and cormel (14.40 t/ha) was recorded from C_2 and the lowest from C_0. For interaction effect, the highest flowering plant (98.33%), shelf life (16.67 days), cormel per plant (25.02), yield of corm (18.21 t/ha) and cormel (16.23 t/ha) was recorded from S_2C_2 and the lowest from S_1C_0. The highest benefit cost ratio (2.21) was obtained from the combination of S_2C_2. So, it may be concluded that 25 cm x 20 cm plant density with 400 ppm CCC is suitable for growth, production and shelf life of gladiolus.

LIST OF ABBREVIATED TERMS

ABBREVIATION	FULL NAME
AEZ	Agro-Ecological Zone
et al.	and others
BBS	Bangladesh Bureau of Statistics
Cm	Centimeter
°C	Degree Celsius
etc	and others
FAO	Food and Agriculture Organization of United Nations
ha	Hectare
hr	Hour
kg	Kilogram
Ltd.	Limited
m	Meter
mm	Millimeter
MP	Muriate of Potash
No.	Number
%	Per cent
RCBD	Randomized Complete Block Design
SAU	Sher-e-Bangla Agricultural University
m^2	Square meter
TSP	Triple super phosphate
UNDP	United Nations Development Program
DMRT	Duncan's Multiple Range Test
ANOVA	Analysis of Variance
CCC	Chlorocholine Chloride
DAP	Days After Planting
SRDI	Soil Resources Development Institute

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CHAPTER I

INTRODUCTION

Gladiolus (*Gladiolus grandiflorus* L.) is a herbaceous annual flower belongs to the family Iridaceae, one of the most popular bulbous flowering plant and occupying fourth place in international cut flower trade (Bose and Yadav, 1989). Gladiolus is now grown as a cut flower widely in Europe, particularly in Holland, Italy and Southern France (Butt, 2005). It is also known as the Sword Lily, due to its sword shaped leaves. Gladiolus seems to be originated in South Africa and its development started only at the beginning of the 18^{th} century. In Bangladesh gladiolus was introduced from India around the year 1992 (Mollah *et al.*, 2002).

Gladiolus is a very colorful decorative flower which is grown in herbaceous border, bed, rockery, pot and also for cut flower (Bose and Yadav, 1989). It is popular for its attractive spikes having florets of huge forms, dazzling colors, varying sizes and long durable quality as a cut flower. Gladiolus is frequently used as cut flower in different social and religious ceremonies (Mitra, 1992). It gained popularity in many parts of the world owing to its unsurpassed beauty and economic value (Chadha and Choudhuary, 1986). The aesthetic value of gladiolus in the daily life is increasing with the advancement of civilization for the spikes owing to its elegance and long vase life and spikes are most popular in flower arrangement and preparing bouquets (Mukhopadhyay, 1995). Scarcity of an alternative cut flower tuberose in winter season makes an opportunity to gladiolus to be more popular in Bangladesh.

Different management practices influence the production and quality of gladiolus flower as well as its corm and cormels (Khanna and Gill, 1983). Optimum plant spacing ensures judicious use of natural resources and makes the intercultural operations easier. Plant spacing is an important aspect of crop production for maximizing the yield. It helps to increase the number of leaves, branches and healthy foliage. Densely planted crop obstruct on the proper growth and development. On the other hand, wider spacing ensures the basic requirements but decrease the total number of plants as well as total yield. Crop yield may be increased upto 25% by using optimum spacing (Bansal *et al*., 1995).

Normal plant growth and development are regulated by naturally produced chemicals or endogenous plant hormones. Their role can often be substituted by application of synthetic growth regulating chemicals, which are becoming extremely important and valuable in the commercial control of crop growth in both agriculture and horticulture (Nickell, 1982). The potential use of growth regulators in flower production has created considerable scientific interest in the recent years. Many studies have indicated that the application of growth regulators can affect the growth and development of flowers. Application of CCC had a beneficial effect on the flowering stem thickness. Flowering stem thickness was increased by 45% when plants were sprayed with 800 ppm CCC, compared to the control. Moreover, spraying the plants with CCC resulted in more compact inflorescence with higher number of florets per spike compared with the control Al-Humaid (2001).

There is a scope of increasing flower yield, quality of flower, corm and cormel production of gladiolus using appropriate spacing and growth regulators. Considering the present situations and above facts the present investigation was undertaken with the following objectives-

i. to find out the optimum plant density for maximum flower, corm and cormel production and long shelf life of gladiolus.

ii. to evaluate the effect of concentration of CCC on growth, flowering, production and shelf life of gladiolus .

iii. to study the growth, flowering and yield performance of gladiolus under different combination of plant densities with concentration of CCC.

CHAPTER II
REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

Gladiolus is one of the important cut flower in Bangladesh and as well as many countries of the world. A very few studies related to growth, flower, corm and cormel production have been carried out in our country as well as many other countries of the world. The research work so far done in Bangladesh is not adequate and conclusive. Nevertheless, some of the important and informative works and research findings related to the effects of plant densities and concentration of Chlorocholine Chloride (Cycocel/CCC) on growth, flower, corm and cormel production of gladiolus reviewed under the following headings-

2.1 Effect of spacing on gladiolus

Rabbani and Azad (1996) conducted an experiment to investigate the effect of corm size and spacing on growth and flower production of gladiolus. They planted the corms at the spacing of 20 × 10, 20 × 15 and 20 × 20 cm. The highest yield of mother corm (13.17 t/ha) and cormel (22.36 t/ha) were recorded from the treatment combination of closet spacing (20 × 10 cm).

Patil *et al*. (1995) carried out an experiment to investigate the effect of different spacing and corm sizes on the flower and corm production of gladiolus in India. Gladiolus corms were planted at spacing of 30 × 10, 30 × 20 or 30 × 30 cm. The highest length of spike and more corms and cormels were obtained from closer spacing (30 × 10 cm).

Mollah *et al.* (1995) studied the effect of cormel size and spacing on growth and flower and corm of gladiolus in Bangladesh. They reported that the widest spacing (15 cm × 15 cm) produced the maximum length of spike (36.34 cm), longest rachis (11.9 cm), maximum plant height (56.60 cm), maximum percentage of flowering plant (54.60), heavier corm (31.33 g) and highest number of cormels (21.87) per plant.

Klasman *et al.* (1995) conducted an experiment on the effect of planting density on the production of gladiolus cv. 'Red Beauty' under greenhouse condition in Argentina. They planted 15, 25, 35 or 45 corms per square meter. They reported that the best commercial quality flower (in terms of spike length and number of flowers per spike) and higher number of cormels (12.85 per plant) were obtained from the planting density of 45 corms per square meter.

Cocozza *et al.* (1994) studied the effect of planting density on flower and corm production of gladioulus cv. 'Victor Borge' in Italy. Gladiolus cormels (<2 or 2.0-2.5 cm circumference) were planted at the densities of 400, 600 or 800 per square meter. It was reported that corms for cut flower production and propagating materials were obtained from the highest planting density and the highest corm yield was obtained when large cormels (2.0-2.5 cm) were used as planting material.

Sciortino and Incalcaterra (1993) investigated the effect of planting density and provenance of propagation material on corm enlargement processes in different cultivars of gladiolus in Italy. They found that higher planting density gave better results in all the cultivars.

Incalcaterra (1992) carried out an experiment to investigate the effect of planting depth and density on gladiolus corm production cv. 'Peter Pears' in Italy. The cormels were planted at the densities of 75, 100, 125 or 150 per square meter. It was found that increasing the planting density increased corm yield but reduced the corm quality. It was observed that the best yield and quality of corms were obtained from planting density of 125 cormels per square meter.

Sujata and Singh (1991) executed an experiment to find out the effect of different planting densities on growth, flowering and corm production of gladiolus cv. 'Friendship' in India. They used the plant densities of 15, 40, 60 or 80 corms per square meter. It was found that growth and flowering characteristics (including cut flower yields) decreased with the increasing plant density. They also found that planting density had no significant effect on corm production.

Groen *et al*. (1989) investigated the effect of planting density on yield of gladiolus in the Netherlands. It was found that the optimum spacing for gladiolus cormel depends on the season, soil condition, cultivars and time of lifting.

Nilimesh and Roychowdhury (1989) demonstrated an experiment to investigate the effect of plant spacing and growth regulators on growth and flower yield of gladiolus cv. 'Psittacinus' grown under polythene tunnel in India. They reported that higher planting density (33 corms per square meter) increased plant height, flower stalk length and yield of corms but decreased the number of florets per spike and flower length.

Gowda (1987) investigated the interaction effect of corm size and spacing on growth and flower production of gladiolus cv. 'Snow Prince'. Corms were planted at a spacing of 30 x 10, 30 x 15, 30 x20 or 30 x 25 cm. The best results were obtained from corms planted at a spacing of 30 x 25 cm.

Arora and Khanna (1987) studied the effect spacing on flowering and corm production of gladiolus cv. 'Sylvia' in India. They planted 27, 36, 45, 54, 65, 72, or 81 corms per square meter. It was found that number and weight of daughter corm and cormel per corm decreased at closer spacing. They also mentioned that the maximum number of daughter corms was obtained from planting 36 cormels per square meter and better flowers from 65 corms per square meter.

Syamal *et al.* (1987) observed the effect corm size, planting distance and depth of planting on growth and flowering of gladiolus cv. 'Happy End' in India. They found that large corms. (4-5 and 5-6 cm in diameter) gave earlier sprouting and increased inflorescence and stem length. On the other hand, planting distance (20 × 25, 30 × 25 or 40 × 25 cm) and depth of planting had no effect on total number and size of individual flowers. They reported that corm size, planting distance and depth of planting had no interaction effect on different parameters studied.

Sciortino *et al.* (1986) studied the effect of size of propagating materials and planting density on the yield of corms for forced flower production in gladiolus cv. 'Peter Pears'. They planted the cormel at the rate of 70-140 cormels per square meter. It was found that the best yield of corms increased with planting density i.e. 140 cormels per square meter gave the best result.

Talia *et al.* (1986) studied the effect of planting density on the production of gladiolus corm cv. 'White Friendship', 'Oscar' and 'Lavendel' Puff. They observed that the higher planting density gave lower yields of large corms (12-14 and > 14 cm). The cultivar 'Oscar' gave the highest proportion (93.3%) of large corms than the other cultivars.

Koutepas (1984) conducted an experiment with planting density of 26.7, 40 or 53.3 corms per square meter using gladiolus cultivars 'Jessica' and 'Peter Pears'. In both the cultivars, it was observed that population density was inversely related to the number of florets per spike and spike length. It was also found that the weight of cut flower and flowering percentage decreased with increasing planting density in case of 'Peter Pears'.

Mukhopadhyay and Yadav (1984) carried out an experiment to study the effect of corm size and spacing on growth, flowering and corm production of gladiolus. The planting spacing was 10 × 30, 15 × 30, 20 × 30 and 25 × 30. It was reported that wider spacing produced more flowers and corms and cormels than the closer spacing.

Borrelli (1984) studied an experiment to find out the effect of plant density and nitrogen fertilization for cultivation of gladiolus cv. 'Peter Pears' grown in an unheated glasshouse during summer and autumn. The crop was planted at the rate of 44.4, 53.5, 66.6 and 88.8 corms per square meter and it was reported that close spacing (44.4 corms per square meter) increased the yield of flower, corm and cormels.

Deswal *et al.* (1983) studied the effects of nutrients and plant population on growth and flower production of gladiolus in India. They planted the corms at 30 × 30 cm or 45 × 30 cm spacing. They found that wider spacing (45 × 30 cm) produced the tallest plant, higher number of florets per spike and cormels per plant.

Bhattacharjee (1981) investigated the effects of corm size, planting depth and spacing. Corms were planted at a spacing of 15, 20 or 25 cm. It was found that wide spacing (25 × 20 cm) was associated with the best flowering, corm weight and cormel production.

Cirrito and Vita (1980) conducted a three-year trial to study the effect of three different planting distance on the production of gladiolus corm. They planted 100, 150 or 200 corms per square meter and found that optimum size corms could be obtained from the highest planting density. They also observed that cormel production was not affected by planting density.

Grabowska (1980) observed the effect of planting density on flowering and quality of gladiolus cv. 'Kopernik' under plastic tunnel. Corms were planted at the rate of 60, 80 or 100 per square meter. It was found that high planting density delayed flowering, reduced the number of flowering plants and decreased plant height and spike length. It was recommended that 80 plants per square meter was optimum for moderate growth and vigor of gladiolus.

Banker and Mukhopadhyay (1980) carried out an experiment to investigate the effects of corm size, depth of planting and spacing on the production of flowers and corms in gladiolus. The experiment was consisted of three spacing, viz. 15, 20, 25 cm. They reported that increased planting density resulted in shortest rachis (38.26) and shallow planting increased the number of cormels per plant (28.59).

Fernandes *et al.* (1975) conducted an experiment to investigate the effect of spacing on flowering, corm and cormel production of gladiolus cv. 'Friendship'. They planted 20-60 corms per square meter with constant row spacing of 60 cm. They found that decrease in spacing reduced corm weight, number of cormels and spike length.

2.2 Effect of plant growth regulators on gladiolus

Maurya and Nagda (2006) conducted an experiment to investigate the effects of gibberellic acid (GA) at 50 and 100 ppm, Cycocel at 500 and 1000 ppm and NAA at 50 and 100 ppm on growth and flowering of gladiolus (*G. grandiflorus* cv. Friendship). Foliar application of GA at 100 ppm at 45 days after corm planting resulted in the highest plant height (104.5 cm), number of leaves (8.5 per plant), spike length (98.3 cm), number of florets (16.7 per spike), size of second florets (10.8 cm) and number of spikes per plant (1.73). The highest floret opening longevity or survival was obtained with Cycocel at 1000 ppm.

Kumer *et al.* (2005) studied an experiment with daughter corms of gladiolus cv. 'Congo Song' dipped in GA_3 (50, 100 and 150 ppm) and ehtrel (250, 500 and 750 ppm) separately for 24 hours both treated and untreated corms were planted in the field in Knapur, Uttar Pradesh, India. Data were recorded for number of leaves per plant, plant height, days to spike emergence, flowering duration, number of flowers per spike, spike length, number of corms per plant, corm diameter and corm weight. GA_3 and ethrel treatment in generally enhanced all parameters compared with the control. Such effect was more pronounced with the application of higher doses of growth regulators.

Gaur *et al.* (2003) observed the effects of GA_3 and IAA, both applied at 25, 50, 100 or 200 ppm, on the growth, flowering and corm production of gladiolus *cv.* 'Eurovision' during 1999, in Kanpur, Uttar Pradesh, India. High GA_3 and low IAA concentrations improved plant height, number and size of leaves, and thickness and weight of shoots; promoted earliness in spike emergence, colour break in first florets and flowering; increased the length of spikes, number of florets per spike, size of florets and longevity of spikes; increased the vase life if cut flowers and the number, weight and diameter of corms and cormels. The higher values for all parameter were recorded with GA_3 at 200 ppm.

Misra *et al.* (2002) conducted an experiment during 2000-2001 in New Dehli, India on gladiolus cv. 'Jester' to determine the effect of GA_3 (400 ppm). The number of leaves (7.66), per shoot leaf area (591 cm^2), plant height (76.33 cm), number of florets per spike (15.66), spike length (65 cm), and rachis (41.66 cm) were maximum in dipping + spraying at 40 + 65 + 90 days after planting (DAP) treatment. In addition, the days took 50% sprouting, size of corm at lifting, average weight of corm per plant, and propagation co-efficient increased with dipping + spraying at 40 + 65 + 90 DAP treatment.

Al-Humaid (2001) conducted a study in Saudi Arabia during 1996/97-1997/98 to determine the effect of cycocel (CCC) application on the growth and flowering of *Gladiolus gandavensis* cv. *Rosesupreme* plants. CCC was applied 3 times during the growth period at concentrations of 0.0, 50, 100, 200, 400 and 800 ppm. The results showed that flowering time was increased (delayed) as CC concentration increased. Plants sprayed with 800 ppm CCC flowered about 17-25 days later than did those of the control. Cycocel application had a beneficial effect on the flowering stem thickness. Flowering stem thickness was increased by 45% when plants were sprayed with 800 ppm CCC, compared to the control. Moreover, spraying the plants with CCC resulted in more compact inflorescence with higher number of florets per spike compared with the control. In addition, new corms and cormels production was markedly increased as CCC concentration increased compared to the control.

Khattab *et al.* (2000) studied an experiment during 1997 and 1995 in Alexandria, Egypt, Gladiolus cv. 'Sancerre' cormel were presoaked for 24 hours in gibberellic acid solutions at 0 or 100 ppm. A month after planting, plants were irrigated with diluted seawater at different concentrations (0, 5, 10, 15 or 20%). Each treatment was irrigated with non-magnetically or magnetically treated water. Generally, plant height, number of leaves, leaf area, leaf dry weight, corm volume, circumference and dry weight and number of cormels per plant were significantly reduced by saline treatments. Both GA_3 and magnetized seawater increased most of these characteristics. Using 5% magnetically treated seawater increased the values for plant height and corm volume and circumference than the control.

Ogale *et al.* (2000) evaluated PGR-potentiated flowering of gladiolus at Mumbai, India. Miniscule cormels (300 g) of cultivars Happy End and Apricot were soaked for 60 hours in solutions of Bayleton [triadimefon] (10-5 M), GA_3 (10-4), ABA (10-4), kinetin (10-4), Ethrel [ethephno] (10-4) or water, dried for 24 hours and then planted in wooden boxes filled with a soil/manure (3:1) mix. Growth regulators induced early and vigorous sprouting; Bayeton was effective for Happy End and GA_3 and ABA for Apricot, Growth regulators treatments had positive effects on leaf parameters (length, width and number). Spike appearance only occurred in Happy End.

Karaguzel *et al.* (1999) carried out an experiment to study the effects of GA_3 on flowering and quality characteristics of gladiolus cv. 'Erovision'. Corms were soaked in solutions of 0 (control), 50 and 100 mg/l GA_3 kg-1 for 1 hour and were planted 5 days later (late autumn) at 49 corms/m^2 on 24 November. GA_3 at 100 ppm shortened the time from planting to harvest, and flowering percentage, the length of flowering stems and spikes, the number of flower per spike and diameter of flower stems.

Prakash *et al.* (1998) conducted a field trial at Kanpur, Uttar Pradash, India, to investigate the effects of GA_3 on the floral parameters of gladiolus. Ten gladiolus cultivars were treated with 0, 100 and 150 ppm GA_3 and effects on flower parameters, viz. time on flowering, inflorescence length, spike length, floret length and number of florets per spike were studied. GA_3 treatment at 150 ppm followed by 100 ppm improved all the floral in gladiolus. Use of 150 ppm GA_3 in cv. 'Friendship' produced the longest inflorescence and spikes with the highest number of florets per spike.

Pal and Chowdhury (1998) observed significant effect on sprouting, growth, flowering and corm yield when corms of gladiolus cv. 'Tropic Sea' were dipped in water or an aqueous solution of GA_3 (10, 20 or 40 ppm) or ethrel (25, 50 or 100 ppm) for 12 or 24 hours. Corms were planted in the field of 77 days after treatment. Ethrel at 100 ppm for 24 hours significantly increased leaf area compared with control and also induced the early appearance of the flower spike. Ethrel also resulted in the maximum florets spike and the largest individual florets. Soaking for 24 hours in 20 ppm GA_3 gave the longest spike (91.0 cm), while 12 hours in 20 ppm GA_3 resulted in longest spike field life (16.2 days). Individual corm weight and volume were the greatest with 10 ppm GA_3 for 12 hours. Number of cormel produced per plant was greatest (3.5) in the treatment of corms with 40 ppm GA_3 for 24 hours.

Mukhopadhyay and Bankar (1996) conducted an experiment to investigate the influence of pre-planting soaking of corm with gibberellic acid that modifies growth and flowering of gladiolus cultiver 'Friendship'. Corms were soaked in solutions of 0, 10, 50, 100, 250 ppm GA_3 in the dark for 24 hours. Treatment with 10 ppm GA_3 advanced flowering by a few days. GA_3 increased the length of flower spike irrespective of concentration used. It also reduced the the number of cormel but increased cormel weight per plant.

Mohanty *et al.* (1994) observed an experiment where large (2.45-2.55 cm in diameter), medium (1.25-1.30 cm) and small (0.85-0.90 cm) corms of gladiolus cv. Vink's Beauty were soaked for 24 hours in solutions containing GA_3 at 50, 100 or 250 ppm; ethrel (ethephon) at 100, 250, or 500 ppm, or in distilled water (control) before planting. Corm size has significant effects on plant growth. The plants produced from large corms being taller and thicker showing more leaves with wider leaf blades, than those from medium or small corms. All concentrations of GA_3 increased plant height, and at 250 ppm, colour break in the basal florets occurred significantly earlier than in control plants. Ethrel had realizable effects on growth but at 100 ppm colour break was delayed, placement of the florets was improved and the width of the florets in the flower spike was increased. Based on above study, it was suggested that in cv. 'Vink's Beauty', small and medium size corm might be able to produce flower spikes of reasonable quality.

Mahesh and Misra (1993) studied the effect of gibberellic acid (200, 500 and 1000 ppm) on gladiolus cv. 'Snow Princess'. Significant changes in growth and flowering were obtained for many parameters. GA_3 at 200 ppm increased the plant height from 87.39 to 90.57 and 91.94 cm but the GA_3 at 1000 ppm increased the number of florets/spike from 10.19 to 10.67 and 10.66.

Misra *et al.* (1993) while working on implication of gibberellic acid on gladiolus corm cv. 'Sylvia' at Kanpur, India and stated that GA_3 application at 0, 50, 100, 200, or 400 ppm enhanced vegetative growth, flowering and number of corm and cormel produced, but adversely affected individual corm weight. GA_3 at 200 and 400 ppm reduced the duration of the whole spike. It was concluded that, apart from corm size, GA_3 at 100 ppm and 200 ppm gave encouraging results.

Muthoo and Maurya (1993) conducted an experiment at Varanasi, India to study the effect of soaking corms with benzyladenine and ethrel on sprouting and growth of gladiolus cv. 'Oscar'. Corms from summer and autumn crops were soaked for 6 hours in different concentrations of benzyladenine (100, 200, 300 or 400 ppm) and ethrel (2000, 4000, 6000 or 8000 ppm). Corms from each treatment were planted and sprouting percentage was recorded. Ethrel at 8000 ppm positively affected both seasons' corms with respect to sprouting percentage and days taken for 50% sprouting.

Arora *et al.* (1992) carried out an experiment to investigate the effects of GA_3 (5, 10, 25, 50, 75 or 100 mg/l) on growth and subsequent production of corm and cormel in 3 gladiolus cultivars ('Aldebaran', 'Pusa Suhagin' and 'Mayur'). After treatment, corms were planted and observations were made on the number of days to sprouting, final diameter and weight of corms and number, diameter and weight of cormel production/corm. GA_3 at 100 mg/l accelerated sprouting of corms by

4.6, 3.2 and 4.8 days in 'Aldebran', 'Pusa Suhagin' and 'Mayur', respectively. Corm weight and diameter were increased by 239.4 and 59.1% respectively, in Mayur when treated with GA_3 at 100 mg/l. Production of cormel was not significantly increased by GA_3 application although there was an increased in their diameter and weight.

Leena *et al.* (1992) carried out ax experiment at Kerala, India on Gladiolus cv. 'Friendship' during 1989-90 with TIBA (150 or 300 ppm), NAA (100 and 200 ppm), CCC [chloromequat] (250 or 500 ppm) or GA_3 (50 or 100 ppm) applied as a foliar spray at 4, 6 and 8 weeks after planting. Control plants were sprayed with distilled water. The 100 ppm GA_3 treatment was resulted in the greatest plant growth and earliest flowering. The greatest flower spike length, rachis length and number of florets/spike were obtained with the 50 ppm GA_3 treatment. The greatest corm weight (70.27 g) and size (71.00 cm^2) were obtained with the 100 ppm NAA treatment. The greatest number and weight of cormels (93.33 and 17.57 g, respectively) were obtained with the 500 ppm CCC treatment.

Auge (1992) conducted an experiment with gladiolus cv. 'sylvia' where corms were kept in GA_3 solutions for 24 hours in an attempt to find out the effect on growth and flowering. It was revealed that the GA_3 (as berelex at 0.5g/l) treated corms sprouted and flowered earlier than the control corms.

Suh and Kwack (1990) while working with GA_3 (200 ppm) and ethrel (200 ppm) observed the process of corm formation in gladiolus and reported that chemical treatment of corms with ethrel (at 500, 1000 and 2000 ppm) and GA_3 was found to be an effective technique to enhance growth, flowering, corm and cormel formation of gladiolus cv. 'friendship' at Bangalore, India as reported by. Corms were treated with different growth regulators, viz. 200 ppm GA_3 or 200 ppm ethephon for 6 hours before planting. The sprouting rates of the cultivars Red Beauty, Nova Lux and Spic and Span were increased by ethephon treatment. In all cultivars GA_3 treatment increased the weight of corms produced and in Spic and Spin. Nova Lux and True Love ethephon treatments increased corm diameter. They also noticed that with the use of large corms, formation of good quality corms was promoted.

Nilimesh and Roychowdhury (1989) studied the effect of growth regulating chemicals on growth and flower yield of gladiolus where corms (2.5 – 2.7 cm in diameter) were soaked for 6 hours in GA_3 (50 or 100 ppm) or ethrel (100 or 200 ppm) before planting. GA_3 treatment irrespective of concentration increased plant height, flower stalk length and yield of corms per unit area and decreased the days required to 50% inflorescence initiation and percentage of lodging plant. Ethrel at higher concentration inhibited plant growth but markedly increased corm yield.

Roychoudhuri *et al.* (1985) conducted an experiment at Kalyani, India to find out the effects of different chemicals (Thiourea at 1000 and 2000 ppm, ethrel at 100 and 200 ppm, gibberellic acid at 50 and 100 ppm of KNO_3 at 200 ppm) on germination, growth, flowering and corm yield of gladious cv. Psittacinus hybrid. Corms were soaked in solutions of several chemicals and were planted out. Ethrel (ethephon) at 100 ppm enhanced corm sprouting and also resulted in the maximum length of flower stalk while GA_3 at 50 ppm increased the stalk length. GA_3 at 100 ppm was effective in increasing the leaf number.

CHAPTER III
MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

The field experiment was conducted during the period from October, 2007 to June, 2008. The materials and methods that were used for conducting the experiment are presented in this chapter under the following headings:-

3.1 Experimental site

The experiment was conducted at the Horticultural Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka. The location of the study site is situated in $23^{0}74^{/}$N latitude and $90^{0}35^{/}$E longitude (Anon., 1989).

3.2 Characteristics of soil

The experimental soil belongs to the Modhupur Tract (UNDP, 1988) under AEZ No. 28. The selected experimental plot was medium high land and the soil series was Tejgaon (FAO, 1988). The characteristics of the soil were analyzed in the Soil testing Laboratory, SRDI, Farmgate, Dhaka and presented in Appendix I.

3.3 Weather condition of the experimental site

The climate of experimental site was under the subtropical climate, characterized by three distinct seasons, the winter season from November to February and the pre-monsoon period or hot season from March to April and the monsoon period from May to October (Edris *et al.*, 1979). Meteorological data related to the temperature, relative humidity, rainfalls and sunshine during the period of the experiment was collected from the Bangladesh Meteorological Department, Sher-e-Bangla Nagar, Dhaka and presented in Appendix II.

3.4 Planting materials

Corms of gladiolus were used as planting materials and which collected from Agri-tech Nursery, Farmgate, Dhaka.

3.5 Preparation and application of Chlorocholine Chloride (Cycocel/CCC)

Chlorocholine Chloride (CCC): A 1000 ppm stock solution of CCC was prepared by dissolving 1 g of it in a small quantity of ethanol prior to dilution with distilled water in one litre of volumetric flask. The stock solution was used to prepare the required concentration for different treatment i.e. 200 ml of this stock solution was diluted in 1 litre of distilled water to get 200 ppm CCC solution. In a similar way, 400 and 600ml stock solutions were diluted to 1 litre of distilled water to get 400 and 600 ppm solution, respectively. Control solution was also prepared only by adding a small quantity of ethanol with distilled water. CCC was obtained from John Baker Inc. Colorado, USA. CCC was applied in the field with hand sprayer covering whole plant for two times at 25 and 50 days after planting.

3.6 Treatment of the experiment

The experiment considered as two factors.

Factor A: Spacing: 3 levels

i. S_1: 25 cm × 15 cm
ii. S_2: 25 cm × 20 cm
iii. S_3: 25 cm × 25 cm

Factor B: Concentration of Chlorocholine Chloride (CCC): 4 levels

i. C_0: 0 ppm CCC (Control)
ii. C_1: 200 ppm CCC

iii. C_2: 400 ppm CCC

iv. C_3: 600 ppm CCC

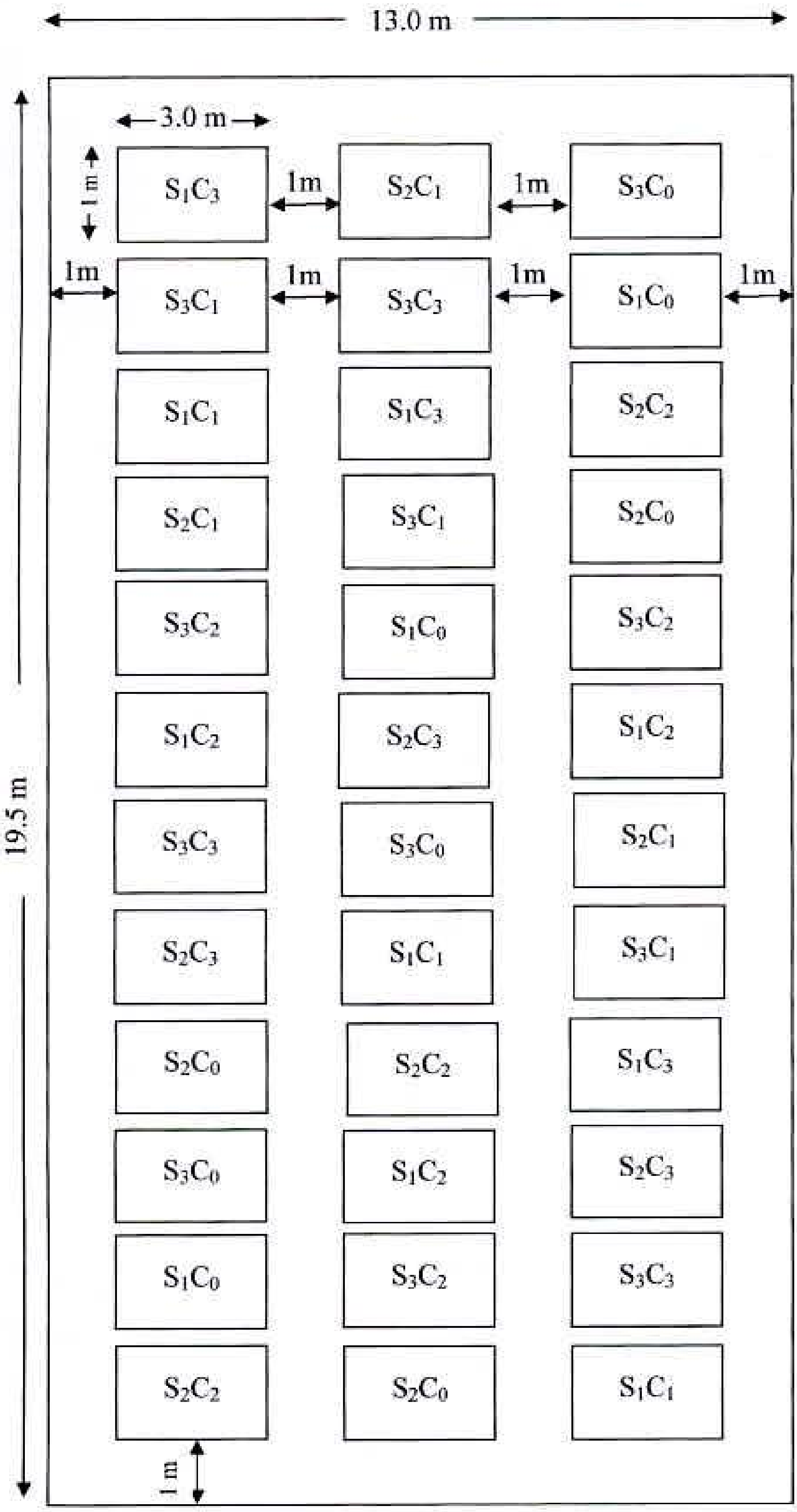
There were on the whole 12 (3 × 4) treatment combinations such as S_1C_0, S_1C_1, S_1C_2, S_1C_3, S_2C_0, S_2C_1, S_2C_2, S_2C_3, S_3C_0, S_3C_1, S_3C_2 and S_3C_3.

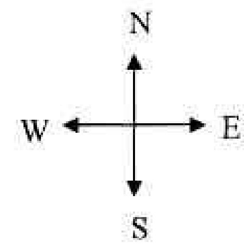
3.7 Experimental design and layout

The experiment was laid out following Randomized Complete Block Design (RCBD) with three replications. An area of 19.5 m × 8.5 m was divided into three equal blocks. Each block was divided into 12 plots where 12 treatment combinations were allotted at random. There were 36 unit plots altogether in the experiment. The size of the each unit plot was 3.0 m × 1.0 m. The corms were sown with maintaining distance according to the spacing treatment. The layout of the experiment is shown in Figure 1.

3.8 Land preparation

The plot selected for conducting the experiment was opened in the first week of October 2007, with a power tiller and left exposed to the sun for a week. After one week the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain good tilth. Weeds and stubbles were removed, and finally a desirable tilth of soil was obtained for sowing of gladiolus. The experimental plot was partitioned into unit plots in accordance with the experimental design mentioned in Figure 1. Well-decomposed cowdung manure and chemical fertilizers were mixed with the soil of each unit plot.





Plot size: 3.0 m × 1.0 m
Plot spacing: 50 cm
Between replication: 1.0 m

Factors A:

S_1: 25 cm × 15 cm
S_2: 25 cm × 20 cm
S_3: 25 cm × 25 cm

Factors B:

C_0: 0 ppm CCC (Control)
C_1: 200 ppm CCC
C_2: 400 ppm CCC
C_3: 600 ppm CCC

Figure 1. Layout of the experimental plot

3.9 Application of manure and fertilizers

The sources of N, P_2O_5, K_2O as urea, TSP and MP were applied, respectively. The entire amounts of TSP and MP were applied during the final land preparation. Urea was applied in three equal installments at 15, 30 and 45 days after planting cormels. Well-rotten cowdung also applied during final land preparation. The following amount of manures and fertilizers were used which shown as tabular form recommended by BARI, 2002.

Table 1. Dose and method of application of fertilizers in gladiolus field

Fertilizers	Dose/ha	Application (%)			
		Basal	15 DAP	30 DAP	45 DAP
Cowdung	10 tons	100	--	--	--
Urea	200 kg	--	33.33	33.33	33.33
TSP	200 kg	100	--	--	--
MP	150 kg	100	--	--	--

3.10 Intercultural operation

When the seedlings started to emerge in the beds it was always kept under careful observation. After emergence of seedlings, various intercultural operations, such as weeding, top dressing, were accomplished for better growth and development of gladiolus seedlings.

3.10.1 Irrigation and drainage

Over-head irrigation was provided with a watering can to the plots once immediately after germination in every alternate day in the evening. Further irrigation was done and when needed. Stagnant water was effectively drained out at the time of heavy rains.

3.10.2 Weeding

Weeding was done to keep the plots free from weeds, and easy aeration of soil, which ultimately ensured better growth and development. The newly emerged weeds were uprooted carefully after complete emergence of seedlings whenever it is necessary. Breaking the crust of the soil was done when needed and it was done for 2 times at 30 DAP and 50 DAP.

3.10.3 Top Dressing

After basal dose, the remaining doses of urea were top-dressed in 3 equal installments. The fertilizers were applied on both sides of plant rows and mixed well with the soil by hand. Earthing up was done with the help of nirani immediately after top-dressing of nitrogen fertilizer.

3.11 Plant Protection

For controlling leaf caterpillars Nogos @ 1 ml/L water were applied 2 times at an interval of 10 days starting soon after the appearance of infestation. No remarkable attack of disease was found.

3.12 Data collection

Data were recorded on the following parameters from the sample plants during the course of experiment. Ten plants were randomly selected from each unit plot for the collection of data and for that the plants in the outer rows of the plots and the extreme end of the middle rows were excluded from the random selection to avoid the border effect.

3.12.1 Plant height

The height of plant was recorded at 30, 45, 60 and 75 days after planting (DAP) in the experimental plots. The height was measured from the attachment of the ground level up to the tip of the growing point and expressed in centimeter (cm).

3.12.2 Number of leaves per plant

All the leaves of ten randomly selected plants were counted at an interval of 15 days at 30, 45, 60 and 75 days after planting (DAP) in the experimental plots.

3.12.3 Days required for emergence of spike

It was achieved by recording the days taken for emergence of gladiolus spike from each unit plot.

3.12.4 Days required for 80% emergence of spike

It was achieved by recording the days taken for 80% emergence of gladiolus spike from each unit plot.

3.12.5 Percentage of flowering plant

It was calculated by counting the numbers of plants that bearing flowers in each unit plot and divided by the number of plants emerged and converted to percentage.

3.12.6 Length of flower stock at harvest

Length of flower stalk was measured from the base to the tip of the spike and expressed in centimeter.

3.12.7 Length of rachis at harvest

Length of rachis refers to the length from the axil of first floret upto the tip of the inflorescence and expressed in centimeter.

3.12.8 Number of spikelet per spike

All the spikelets of the spike were counted from 10 randomly selected plants and their mean was calculated.

3.12.9 Number of spike/ha

Number of spikes per hectare was computed from numbers of spikes per plot and converted to hectare.

3.12.10 Shelf life

It refers to recording to days taken for most of the open florets lost their freshness in distilled water. Two spikes were used from each plot.

3.12.11 Individual corm thickness

Corms were separated from the plant and the thickness of corms was taken by a slide calipers and expressed in centimeter.

3.12.12 Individual corm weight

It was determined by weighting the corms from the ten randomly selected plants and mean weight was calculated.

3.12.13 Individual corm diameter

A slide calipers was used to measure the diameter of the corm and expressed in centimeter.

3.12.14 Number of cormel per plant

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

3.12.15 Weight of cormel

Individual weight of cormel was recorded from the mean weight of ten randomly selected sample cormels and expressed in gram.

3.12.16 Diameter of cormel

A slide calipers was used to measure the diameter of the cormel and expressed in centimeter.

3.12.17 Corm yield per hectare

Total corm yield per plot was recorded by adding the total harvested corm in a plot and expressed in kilogram and converted the yield of gladiolus corm per plot to per hectare and expressed in t/ha.

3.12.18 Cormel yield per hectare

Total cormel yield per plot was recorded by adding the total harvested corm in a plot and expressed in kilogram and converted the yield of gladiolus cormel per plot to per hectare and expressed in t/ha.

3.13 Statistical Analysis

The experimental data obtained for different parameters were statistically analyzed to find out the effect of plant densities and concentration of CCC on flowering, corm and cormel production of gladiolus. The mean values of all the recorded characters were calculated and analysis of variance was performing by the 'F' (variance ratio) test. The significance of the difference among the individual and treatment combinations means was estimated by the Duncan's Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

3.14 Economic analysis

The cost of production was analyzed in order to find out the most economic treatment of plant densities and concentration of CCC. All input cost were considered in computing the cost of production. The market price of spike, corm and cormel was considered for estimating the return. The benefit cost ratio (BCR) was calculated as follows:

$$\text{Benefit cost ratio} = \frac{\text{Gross return per hectare (Tk.)}}{\text{Total cost of production per hectare (Tk.)}}$$

CHAPTER IV
RESULTS AND DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was carried out to determine the effect of plant density and concentration of Chlorocholine Chloride (Cycocel /CCC) on the growth and yield of gladiolus. Data on different growth parameter and yield of flower, corm and cormel was recorded. The analysis of variance (ANOVA) of the data on different growth parameter and yield of flower, corm and cormel are presented in Appendix III-VII. The results have been presented and discussed and possible interpretations given under the following headings:

4.1 Plant height

Plant height of gladiolus showed statistically significant differences due to different plant densities at 30, 45, 60 and 75 DAP (Appendix III). At the different days after planting (DAP) the highest plant height (37.98 cm, 55.74 cm, 63.04 cm and 72.29 cm) was observed from S_1 (25 cm × 15 cm) which was statistically similar (36.73 cm, 54.86 cm, 61.89 cm and 68.14 cm) with S_2 (25 cm × 20 cm) at 30, 45, 60 and 75 DAP, respectively. On the other hand, at the same DAP the lowest plant height (34.55 cm, 52.73 cm, 58.01 cm and 66.22 cm) was recorded from S_3 (25 cm × 25 cm), (Table 2). It was revealed that with the increases of plant density plant height showed decreasing trend. In case of closer plant density plant compete for light than closer plant density helps to elongation of plant than the wider plant density. Mollah *et al.* (1995) reported that the widest plant density (15 cm × 15 cm) produced the maximum plant height (56.60 cm).

Table 2. Effect of plant density and CCC on plant height of gladiolus

Treatment	Plant height (cm) at			
	30 DAP	45 DAP	60 DAP	75 DAP
Plant densities				
S_1	37.98 a	55.74 a	63.04 a	72.29 a
S_2	36.73 a	54.86 a	61.89 a	68.14 b
S_3	34.55 b	52.73 b	58.01 b	66.22 b
$LSD_{(0.05)}$	1.71	1.15	2.18	2.29
Level of significance	0.01	0.01	0.01	0.01
Concentration of CCC				
C_0	32.72 c	50.84 d	56.89 c	64.71 c
C_1	36.02 b	54.06 c	61.18 b	68.95 b
C_2	39.65 a	57.44 a	64.53 a	72.49 a
C_3	37.28 b	55.43 b	61.31 b	69.39 b
$LSD_{(0.05)}$	1.98	1.32	2.52	2.64
Level of significance	0.01	0.01	0.01	0.01
CV (%)	6.44	5.33	7.12	9.33

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

S_1: 25 cm × 15 cm
S_2: 25 cm × 20 cm
S_3: 25 cm × 25 cm

C_0: 0 ppm CCC
C_1: 200 ppm CCC
C_2: 400 ppm CCC
C_3: 600 ppm CCC

Plant height of gladiolus differed significantly due to the application of different concentration of CCC at different days after planting (Appendix III). At 30, 45, 60 and 75 DAP the highest plant height (39.65 cm, 57.44 cm 64.53 cm and 72.49 cm) was found from C_2 (400 ppm CCC) which was closely followed (37.28 cm, 55.43 cm, 61.31 cm and 69.39 cm) by C_3 (600 ppm CCC), respectively. Again, the lowest (32.71 cm, 50.84 cm, 56.89 cm and 64.71 cm) was observed from C_0 as control for the same DAP, respectively (Table 2). It was revealed that with the increase of chlorocholine chloride plant height increase upto a certain concentration than decreases.

A statistically significant differences was recorded due to interaction effect of plant density and concentration of CCC in terms of plant height of gladiolus at 30, 45, 60 and 75 DAP (Appendix III). The highest plant height (41.66 cm, 58.89 cm, 67.34 cm and 73.70 cm) was observed from S_2C_2 (25 cm × 20 cm plant density + 400 ppm CCC) at 30, 45, 60 and 75 DAP, respectively where the lowest plant height (30.36 cm, 47.99 cm, 53.43 cm and 60.61 cm) was recorded from S_3C_0 (25 cm × 25 cm plant density + 0 ppm CCC) at 30, 45, 60 and 75 DAP, respectively (Table 3).

4.2 Number of leaves per plant

Statistically significant variation was found for number of leaves per plant due to different plant density at 30, 45, 60 and 75 DAP (Appendix IV). At different days after planting (DAP) the maximum number of leaves per plant (3.06, 6.25, 9.50 and 11.66) was recorded from S_2 (25 cm × 20 cm) which was closely followed

Table 3. Interaction effect of plant density and CCC on plant height of gladiolus

Treatment	Plant height (cm) at			
	30 DAP	45 DAP	60 DAP	75 DAP
S_1C_0	37.11 bcd	53.75 cd	62.35 bc	71.55 abc
S_1C_1	36.43 cd	55.37 bc	62.49 bc	71.75 abc
S_1C_2	40.38 ab	57.82 ab	66.01 ab	75.39 a
S_1C_3	37.99 bc	56.02 bc	61.30 bcd	70.48 abcd
S_2C_0	30.69 e	50.79 e	54.90 e	61.96 ef
S_2C_1	37.86 bc	55.23 c	63.63 abc	69.66 bcd
S_2C_2	41.66 a	58.89 a	67.34 a	73.70 ab
S_2C_3	36.69 bcd	54.53 c	61.69 bcd	68.59 bcd
S_3C_0	30.36 e	47.99 f	53.43 e	60.61 f
S_3C_1	33.76 de	51.57 de	57.43 de	65.43 de
S_3C_2	36.91 bcd	55.61 bc	60.24 cd	68.39 cd
S_3C_3	37.17 bcd	55.73 bc	60.94 cd	69.08 bcd
$LSD_{(0.05)}$	3.42	2.30	4.36	4.58
Level of significance	0.05	0.01	0.05	0.05
CV(%)	6.44	5.33	7.12	9.33

(2.83, 5.62, 8.90 and 10.77) by S_3 (25 cm × 25 cm) at 30, 45, 60 and 75 DAP, respectively. Again, at the same DAP the minimum number of leaves per plant (2.65, 4.83, 7.58 and 9.25) was recorded from S_1 (25 cm × 15 cm), respectively (Table 4). It was revealed that 25 cm × 20 cm plant density ensures maximum number of leaves per plant. Due to closer plant density plant compete for light than closer plant density which helps to elongation of plant with minimum number of leaves per plant than the wider plant density.

Number of leaves per plant of gladiolus differed significantly at 30, 45, 60 and 75 DAP due to the application of different concentration of CCC (Appendix IV). At the same days after planting (DAP) the maximum number of leaves per plant (3.09, 5.80, 9.02 and 11.06) was obtained from C_2 (400 ppm CCC) which was statistically similar (2.94, 5.73, 8.84 and 10.84) with C_3 (600 ppm CCC). On the other hand the lowest (2.50, 5.22, 8.09 and 9.81) was found from C_0 as control condition which was closely followed (2.82, 5.51, 8.69 and 10.52) by C_1 (200 ppm CCC) for the same DAP, respectively (Table 4). It was revealed that with the increase of concentration of CCC number of leaves per plant increase upto a certain concentration than decreases.

Interaction effect of plant density and concentration of CCC showed statistically significant variation for number of leaves per plant of gladiolus at 30, 45, 60 and 75 DAP (Appendix IV). The highest number of leaves per plant (3.47, 6.73, 10.20 and 12.57) was found from S_2C_2 (25 cm × 20 cm plant density + 400 ppm CCC) at 30, 45, 60 and 75 DAP, respectively. Again, the

Table 4. Effect of plant density and CCC on number of leaves per plant of gladiolus

Treatment	Number of leaves per plant at			
	30 DAP	45 DAP	60 DAP	75 DAP
Plant density				
S_1	2.65 c	4.83 c	7.58 c	9.25 c
S_2	3.06 a	6.25 a	9.50 a	11.66 a
S_3	2.83 b	5.62 b	8.90 b	10.77 b
$LSD_{(0.05)}$	0.137	0.216	0.382	0.395
Level of significance	0.01	0.01	0.01	0.01
Concentration of CCC				
C_0	2.50 c	5.22 c	8.09 b	9.81 c
C_1	2.82 b	5.51 b	8.69 a	10.52 b
C_2	3.09 a	5.80 a	9.02 a	11.06 a
C_3	2.94 ab	5.73 ab	8.84 a	10.84 ab
$LSD_{(0.05)}$	0.15	0.24	0.44	0.45
Level of significance	0.01	0.01	0.01	0.01
CV(%)	6.02	5.33	8.89	11.15

Table 5. Interaction effect of plant density and CCC on number of leaves per plant of gladiolus

Treatment	Number of leaves per plant at			
	30 DAP	45 DAP	60 DAP	75 DAP
S_1C_0	2.47 fg	4.53 f	7.20 g	8.80 h
S_1C_1	2.53 efg	4.67 f	7.47 g	8.87 h
S_1C_2	2.73 def	4.80 ef	7.73 fg	9.47 gh
S_1C_3	2.77 cdef	5.33 d	7.93 efg	9.87 fg
S_2C_0	2.63 efg	5.93 bc	8.60 cde	10.50 def
S_2C_1	3.13 b	6.33 ab	9.80 ab	11.97 ab
S_2C_2	3.47 a	6.73 a	10.20 a	12.57 a
S_2C_3	3.00 bcd	6.00 bc	9.40 abc	11.60 bc
S_3C_0	2.40 g	5.20 de	8.47 def	10.13 efg
S_3C_1	2.80 cde	5.53 cd	8.80 cd	10.73 de
S_3C_2	3.07 bc	5.87 bc	9.13 bcd	11.13 cd
S_3C_3	3.07 bc	5.87 bc	9.20 bcd	11.07 cd
$LSD_{(0.05)}$	0.27	0.43	0.76	0.79
Level of significance	0.05	0.01	0.05	0.05
CV(%)	6.02	5.33	8.89	11.15

lowest number (2.40) was recorded from S_3C_0 (25 cm × 25 cm plant density + 0 ppm CCC) at 30 DAP and at 45, 60 and 75 DAP the lowest number of leaves per plant (4.53, 7.20 and 8.80) was recorded from S_1C_0 (Table 5). It was revealed that optimum plant density and CCC ensures the highest number of leaves per plant and in any deviation it showed the lowest value for that.

4.3 Days required to emergence of spike

Days required for emergence of spike of gladiolus varied significantly due to different plant density (Appendix V). The maximum days required for emergence of spike (57.92) was recorded from S_3 (25 cm × 25 cm) which was statistically identical (57.17) with S_1 (25 cm × 15 cm) and the minimum days required for emergence of spike (54.42) was found from S_2 as 25 cm × 20 cm plant density (Table 6). It was revealed that 25 cm × 20 cm plant density produced spike with minimum days. In case of closer and wider plant density, plant spent extensive time for vegetative growth for that reproductive growth would be delayed and the ultimate results would be maximum days for spike emergence.

Significant variation was recorded for days required for emergence of spike of gladiolus due to the application of different concentration of CCC (Appendix V). The maximum days required for emergence of spike (61.11) was obtained from C_3 (600 ppm CCC) which was closely followed (58.11 and 55.78) by C_2 (400 ppm CCC) and C_1 (200 ppm CCC). On the other hand, the minimum (51.00) was found from C_0 as control (Table 6). It was revealed that with the increase of CCC days required for emergence of spike also increases.

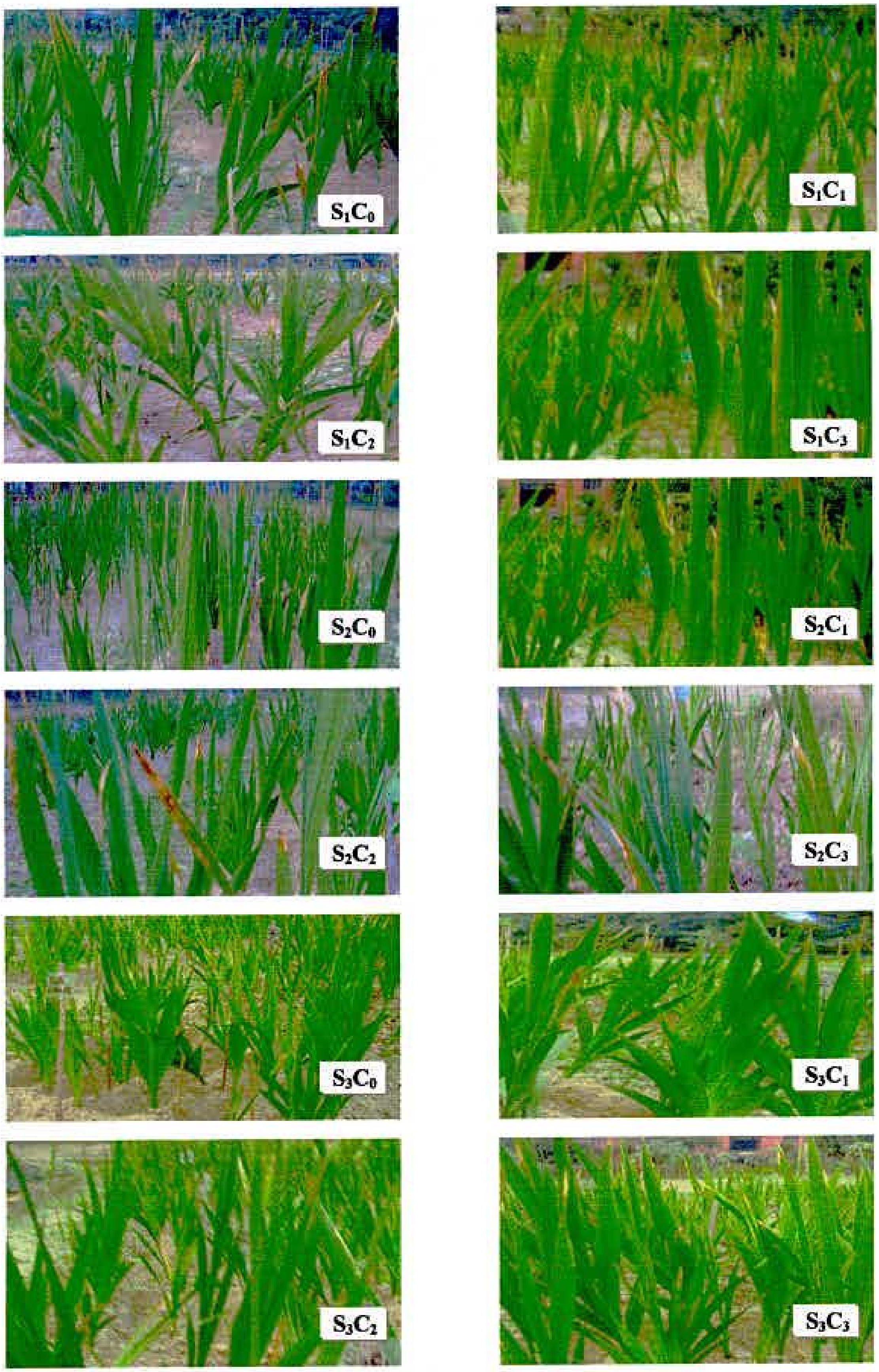


Plate 1. Vegetative growth of gladiolus for plant density and CCC.

Statistically significant variation for days required for emergence of spike was recorded for the interaction effect of plant density and concentration of CCC (Appendix V). The maximum days required for emergence of spike (63.67) was recorded from S_3C_3 and the minimum days required for emergence of spike (48.33) was recorded from S_2C_0 (25 cm × 20 cm plant density + 0 ppm CCC) (Table 7).

4.4 Days required to 80% emergence of spike

Days required for 80% emergence of spike showed statistically significant variation due to different plant density (Appendix V). The maximum days required for 80% emergence of spike (88.75) were recorded from S_3 (25 cm × 25 cm) which was statistically identical (87.33) with S_1 (25 cm × 15 cm). Again, the minimum (85.08) was found from S_2 as 25 cm × 20 cm plant density (Figure 2). It was revealed that 25 cm × 20 cm plant density produced 80% spike with minimum days. In case of closer plant density plant spent extensive time for vegetative growth for that reproductive growth would be delayed and the ultimate results would be maximum days for 80% spike emergence. Grabowska (1980) reported that high planting density delayed flowering of gladiolus.

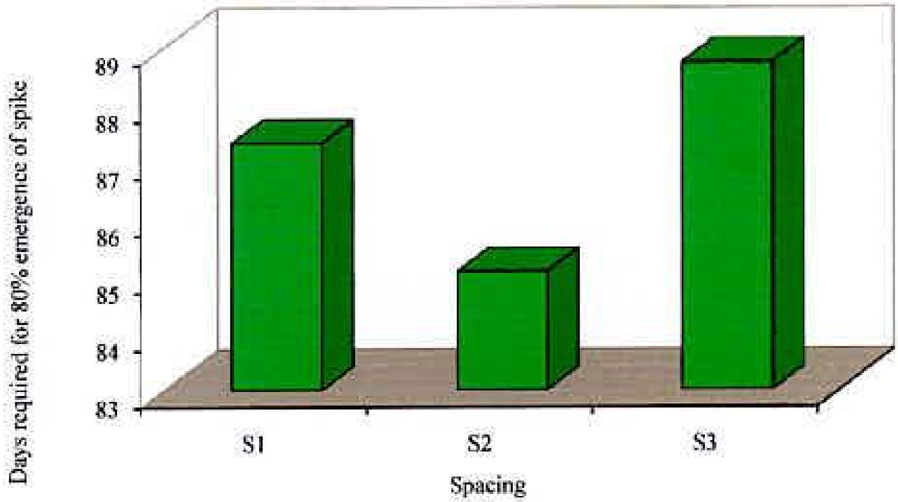
Different concentration of CCC showed significant differences for days required for 80% emergence of spike of gladiolus (Appendix V). The maximum days required for 80% emergence of spike (90.11) was found from C_3 (600 ppm CCC) which was statistically similar (87.56) with C_2 (400 ppm CCC). On the other hand, the minimum days (83.67) was found from C_0 which was closely followed

(86.89) by C_1 as 200 ppm CCC (Figure 3). It is revealed that with the increase of CCC days required for 80% emergence of spike increases. Al-Humaid (2001) reported that that flowering time was increased (delayed) as CCC concentration increased. Plants sprayed with 800 ppm CCC flowered about 17-25 days later than did those of the control.

Plant density and concentration of CCC showed significant interaction effect for days required for 80% emergence of spike (Appendix V). The maximum days required for 80% emergence of spike (92.33) was observed from S_3C_3 (25 cm × 25 cm plant density + 600 ppm CCC) and the minimum days (82.00) was recorded from S_2C_0 (25 cm × 20 cm plant density + 0 ppm CCC) (Figure 4).

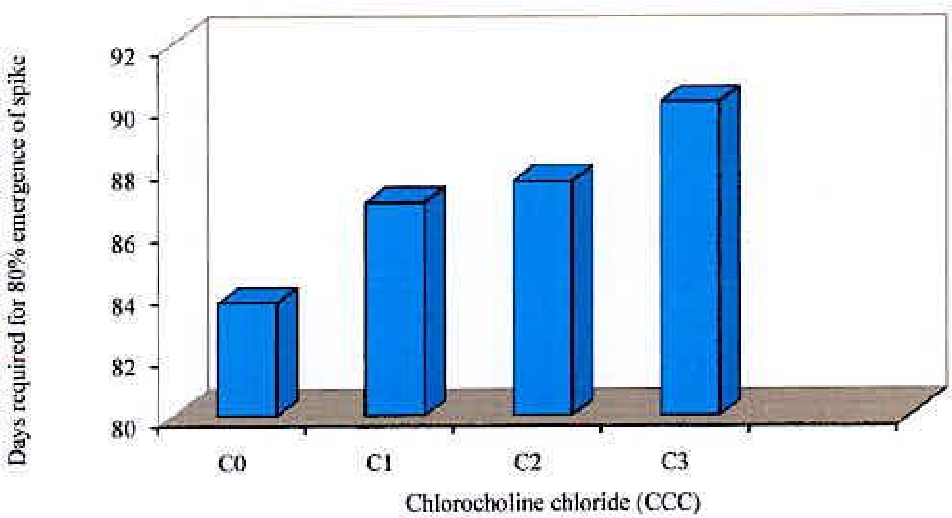
4.5 Flowering plant

Flowering plant of gladiolus showed statistically significant variation due to different plant density (Appendix V). The highest flowering plants (93.67%) were recorded from S_2 which was statistically identical (91.17%) with S_3. Again, the lowest flowering plant (86.67%) was observed from S_1 as 25 cm × 15 cm (Table 6). It is revealed that 25 cm × 20 cm plant density reported the maximum flowering plant. In case of closer plant density the lowest flowering would be found due to the highest lodging plant whereas in wider plant density it would be due to minimum number of plant with maximum vegetative growth. Mollah *et al.* (1995) reported that the widest plant density (15 cm × 15 cm) produced the maximum percentage of flowering plant.



S_1: 25 cm x 15 cm
S_2: 25 cm x 20 cm
S_3: 25 cm x 25 cm

Figure 2. Effect of plant density on days required for 80% emergence of spike



C_0: 0 ppm CCC
C_1: 200 ppm CCC
C_2: 400 ppm CCC
C_3: 600 ppm CCC

Figure 3. Effect of CCC)on days required for 80% emergence of spike

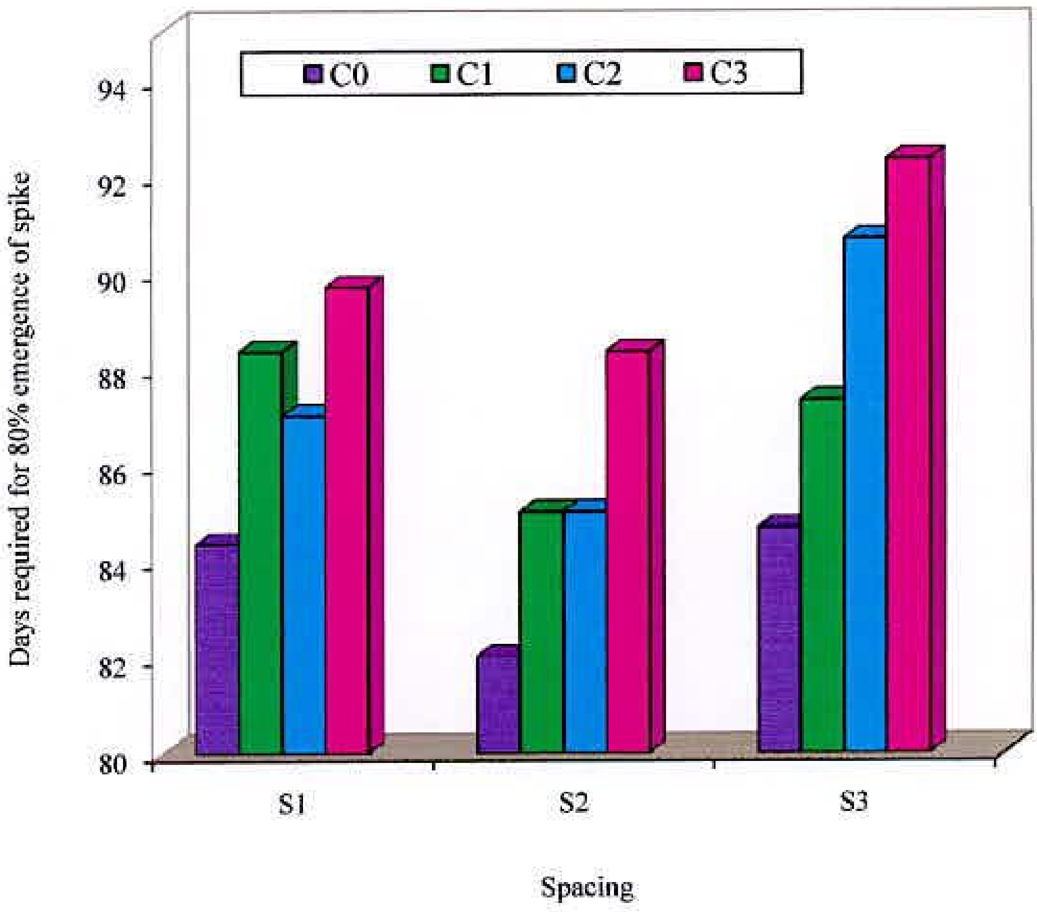


Figure 4. Interaction effect of plant density and CCC on days required for 80% emergence of spike

Table 6. Effect of plant density and CCC on yield contributing characters of gladiolus

Treatment	Days required to emergence of spike	Flowering plant (%)	Length of flower stalk at harvest (cm)	Length of rachis at harvest (cm)
Plant densities				
S_1	57.17 a	86.67 b	58.47 b	31.00 b
S_2	54.42 b	93.67 a	65.97 a	35.06 a
S_3	57.92 a	91.17 a	64.41 a	34.26 a
$LSD_{(0.05)}$	2.46	3.32	2.34	1.15
Level of significance	0.01	0.01	0.01	0.01
Concentration of CCC				
C_0	51.00 c	85.33 b	58.26 c	30.95 c
C_1	55.78 b	90.44 a	62.84 b	33.43 b
C_2	58.11 b	93.89 a	66.26 a	35.20 a
C_3	61.11 a	92.33 a	64.44 ab	34.17 ab
$LSD_{(0.05)}$	2.84	3.83	2.71	1.33
Level of significance	0.01	0.01	0.01	0.01
CV(%)	7.44	10.13	5.33	12.11

Table 7. Interaction effect of plant density and CCC on yield contributing characters of gladiolus

Treatment	Days required to emergence of spike	Flowering plant (%)	Length of flower stalk at harvest (cm)	Length of rachis at harvest (cm)
S_1C_0	53.67 cde	84.00 c	55.72 d	29.40 e
S_1C_1	57.33 bc	85.67 c	57.03 d	30.39 de
S_1C_2	58.00 bc	89.33 bc	60.94 cd	32.17 cd
S_1C_3	59.67 ab	87.67 bc	60.19 cd	32.02 cd
S_2C_0	48.33 e	86.33 c	58.70 d	31.16 de
S_2C_1	53.33 cde	95.00 ab	67.51 ab	35.82 ab
S_2C_2	56.00 bcd	98.33 a	70.91 a	37.82 a
S_2C_3	60.00 ab	95.00 ab	66.74 ab	35.42 ab
S_3C_0	51.00 de	85.67 c	60.35 cd	32.28 cd
S_3C_1	56.67 bc	90.67 bc	63.98 bc	34.06 bc
S_3C_2	60.33 ab	94.00 ab	66.92 ab	35.61 ab
S_3C_3	63.67 a	94.33 ab	66.40 ab	35.08 b
$LSD_{(0.05)}$	4.92	6.64	4.69	2.30
Level of significance	0.05	0.01	0.05	0.05
CV(%)	7.44	6.66	5.33	12.11

Flowering plant of gladiolus differed significantly due to the application of different concentration of CCC (Appendix V). The highest flowering plant (93.89%) was recorded from C_2 (400 ppm CCC) which was statistically identical (92.33% and 90.44%) with C_3 (600 ppm CCC) and C_1 (200 ppm CCC). On the other hand, the lowest (85.33%) was recorded from C_0 as 0 ppm CCC (Table 6). It is revealed that with the increase of CCC flowering of plant increases upto a certain concentration then decreases again.

Plant density and concentration of CCC showed statistically significant variation due to the interaction effect in consideration of flowering plant (Appendix V). The highest flowering plant (98.33%) was observed from S_2C_2 (25 cm × 20 cm plant density + 400 ppm CCC) and the lowest (84.00%) was recorded from S_1C_0 (25 cm × 15 cm plant density + 0 ppm CCC) (Table 7). It is revealed that optimum plant density and concentration of CCC ensured maximum flowering of plant due to optimum vegetative and reproductive growth.

4.6 Length of flower stalk at harvest

Length of flowering stalk at harvest varied significantly due to different plant density (Appendix V). The highest length of flowering stalk at harvest (65.97 cm) was recorded from S_2 (25 cm × 20 cm) which was statistically identical (64.41 cm) with S_3 (25 cm × 25 cm) and the lowest length of flowering stalk at harvest (58.47 cm) was recorded from S_1 as 25 cm × 15 cm (Table 6). It was revealed that highest plant density produced the highest length of flowering stalk at harvest. In case of closer plant density, it was the lowest due to minimum vegetative growth.

Mollah *et al.* (1995) reported that the widest plant density (15 cm x 15 cm) produced the maximum length of spike (36.34 cm).

Length of flower stalk at harvest of gladiolus differed significantly due to the application of different concentration of CCC (Appendix V). The highest length of flowering stalk at harvest (66.26 cm) was recorded from C_2 (400 ppm CCC) which was statistically identical (64.44 cm) with C_3 (600 ppm CCC). On the other hand, the lowest (58.26 cm) was obtained from C_0 (0 ppm CCC) which was closely followed (62.84 cm) by C_1 as 200 ppm CCC (Table 6).

Statistically significant variation was recorded due to the interaction effect of plant density and concentration of CCC for length of flowering stalk at harvest (Appendix V). The highest length of flowering stalk at harvest (70.91 cm) was observed from S_2C_2 (25 cm × 20 cm plant density + 400 ppm CCC) and the lowest (55.72 cm) was recorded from S_1C_0 (25 cm × 15 cm plant density + 0 ppm CCC) (Table 7).

4.7 Length of rachis at harvest

Different plant densities showed statistically significant variation for the length of rachis at harvest (Appendix V). The highest length of rachis at harvest (35.06 cm) was recorded from S_2 (25 cm × 20 cm) which was statistically identical (34.26 cm) with S_3 (25 cm × 25 cm). Again, the lowest length of rachis at harvest (31.00 cm) was observed from S_1 as 25 cm × 15 cm (Table 6). It is revealed that the highest plant density produced the highest length of rachis at harvest. In case of closer plant density it was the lowest due to lowest vegetative growth.

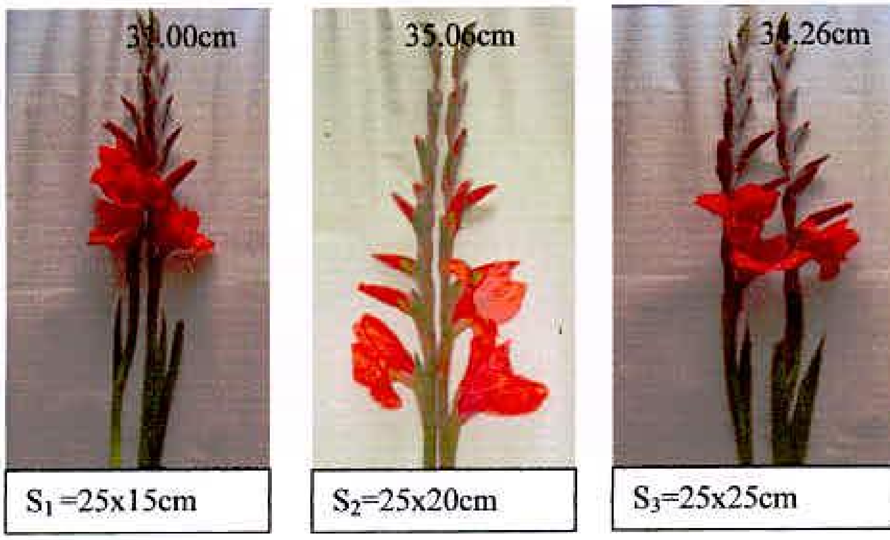


Plate 2: Effect of plant density on length of rachis at harvest (cm).

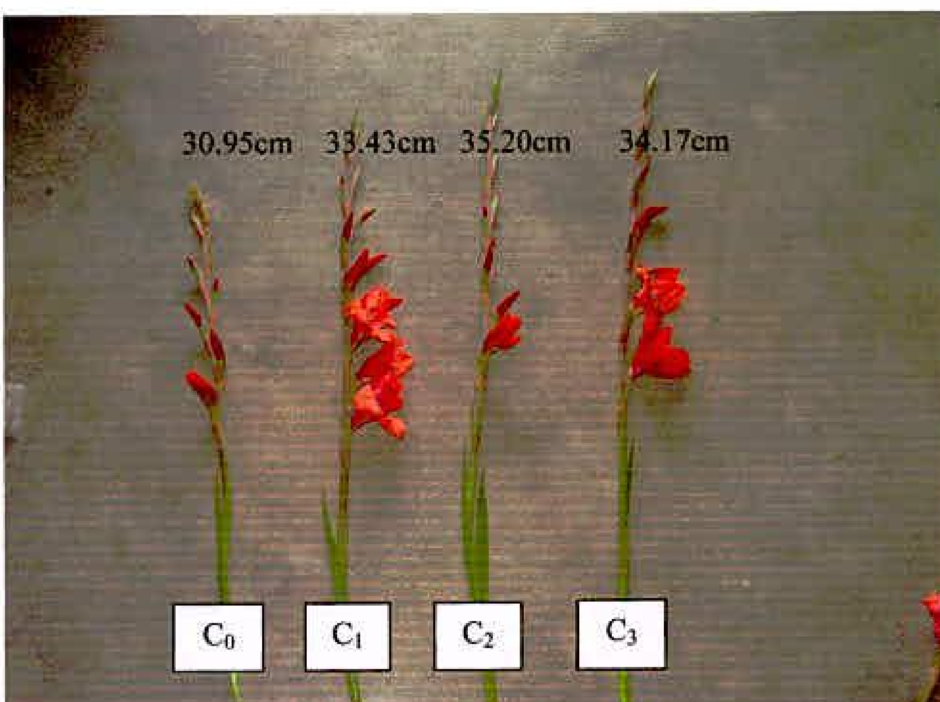


Plate 3: Effect of CCC on length of rachis at harvest (cm).

Mollah *et al.* (1995) reported that the widest plant density (15 cm ×15 cm) produced longest rachis (11.9 cm).

Length of rachis at harvest of gladiolus differed significantly due to the application of different concentration of CCC (Appendix V). The highest length of rachis at harvest (35.20 cm) was recorded from C_2 (400 ppm CCC) which was statistically identical (34.17 cm) with C_3 (600 ppm CCC). Again, the lowest (30.95 cm) was found from C_0 (0 ppm CCC) which was closely followed (33.43 cm) by C_1 as 200 ppm CCC (Table 6).

Interaction effect of plant density and concentration of CCC showed statistically significant variation for length of rachis at harvest (Appendix V). The highest length of rachis at harvest (37.82 cm) was observed from S_2C_2 (25 cm × 20 cm plant density + 400 ppm CCC) and the lowest (29.40 cm) was recorded from S_1C_0 (25 cm × 15 cm plant density + 0 ppm CCC) (Table 7). It is revealed that optimum plant density and CCC ensured maximum vegetative growth with the highest length of rachis per plant.

4.8 Number of spikelets per spike

Number of spikelets per spike showed significant differences due to different plant densities (Appendix VI). The highest number of spikelets per spike (14.79) was obtained from S_2 (25 cm × 20 cm) which was closely followed (13.69) by S_3 (25 cm × 25 cm) and the lowest (12.84) was observed from S_1 as 25 cm × 15 cm (Table 8). It is revealed that 25 cm × 20 cm plant density produced the highest number of spikelets per spike. In case of closer plant density it was lowest due to lowest vegetative growth. Nilimesh and Roychowdhury (1989) reported that higher planting density decreased the number of florets per spike.

Number of spikelets per spike of gladiolus differed significantly due to the application of different concentration of CCC (Appendix VI). The highest number of spikelets per spike (14.52) was observed from C_2 (400 ppm CCC) which was statistically identical (14.24) with C_3 (600 ppm CCC). Again, the lowest (12.49) was recorded from C_0 (0 ppm CCC) which was closely followed (13.84) by C_1 as 200 ppm CCC (Table 8).

Interaction effect of plant density and concentration of CCC showed statistically significant variation for number of spikelets per spike (Appendix VI). The highest number of spikelets per spike (16.02) was observed S_2C_2 (25 cm × 20 cm plant density + 400 ppm CCC) where as the lowest (12.03) was found from S_3C_0 (25 cm × 25 cm plant density + 0 ppm CCC) (Table 9). It is revealed that optimum plant density and CCC ensured maximum vegetative growth with maximum number of spikelets per spike.

4.9 Shelf life of cut flower

Shelf life of cut flower showed significant differences due to different plant density (Appendix VI). The highest shelf life (13.33) was obtained from S_3 (25 cm × 25 cm) which was closely followed (12.92) by S_2 (25 cm × 20 cm) and the lowest shelf life (12.67) was observed from S_1 as 25 cm × 15 cm (Figure 5). It was revealed that 25 cm × 25 cm plant density produced the highest shelf life. In case of closer plant density it was lowest due to lowest vegetative growth.

Table 8. Effect of plant density and CCC on yield contributing characters of gladiolus

Treatment	Number of spikelets per spike	Yield of spike per hectare (number)	Thickness of individual corm (cm)	Weight of individual corm (g)	Diameter of individual corm (cm)
Plant densities					
S_1	12.84 c	659.59 c	5.92 b	24.93 b	1.67 b
S_2	14.79 a	753.95 a	6.76 a	28.27 a	2.08 a
S_3	13.69 b	730.96 b	4.19 c	27.36 a	2.05 a
$LSD_{(0.05)}$	0.45	19.05	0.42	1.28	0.10
Level of significance	0.01	0.01	0.01	0.01	0.01
Concentration of CCC					
C_0	12.49 c	646.46 d	5.13 b	23.98 c	1.76 c
C_1	13.84 b	693.04 c	5.54 ab	26.84 b	1.90 b
C_2	14.52 a	777.21 a	6.05 a	28.47 a	2.07 a
C_3	14.24 ab	742.64 b	5.78 a	28.12 ab	2.01 ab
$LSD_{(0.05)}$	0.52	21.99	0.49	1.48	0.11
Level of significance	0.01	0.01	0.01	0.01	0.01
CV(%)	8.88	5.98	9.22	5.23	5.12

Table 9. Interaction effect of plant density and CCC on yield contributing characters of gladiolus

Treatment	Number of spikelets per spike	Yield of spike per hectare (number)	Thickness of individual corm (cm)	Weight of individual corm (g)	Diameter of individual corm (cm)
S_1C_0	12.37 efg	592.59 g	5.59 d	23.78 d	1.53 g
S_1C_1	12.19 fg	622.22 g	5.64 d	23.88 d	1.58 fg
S_1C_2	13.33 cde	719.18 cde	6.24 bcd	25.95 cd	1.75 ef
S_1C_3	13.48 cd	704.37 ef	6.21 bcd	26.12 cd	1.81 de
S_2C_0	13.08 def	675.07 f	5.89 cd	24.65 d	1.92 cde
S_2C_1	15.12 ab	748.15 bcd	6.88 ab	28.70 abc	2.10 abc
S_2C_2	16.02 a	837.04 a	7.56 a	30.99 a	2.26 a
S_2C_3	14.93 b	755.56 bc	6.72 abc	28.74 abc	2.04 abc
S_3C_0	12.03 g	671.70 f	3.91 e	23.50 d	1.81 de
S_3C_1	14.20 bc	708.74 def	4.09 e	27.96 bc	2.02 bcd
S_3C_2	14.22 bc	775.41 b	4.35 e	28.48 abc	2.22 ab
S_3C_3	14.32 bc	768.00 b	4.42 e	29.50 ab	2.16 ab
$LSD_{(0.05)}$	0.91	38.09	0.85	2.56	0.20
Level of significance	0.01	0.01	0.05	0.05	0.05
CV(%)	8.88	5.98	9.22	5.23	5.12

Shelf life of cut flower of gladiolus differed significantly due to the application of different concentration of CCC (Appendix VI). The highest shelf life (15.78) was observed from C_2 (400 ppm CCC) which was closely followed (14.22) by C_3 (600 ppm CCC). Again, the lowest (9.89) was recorded from C_0 (0 ppm CCC) which was closely followed (12.00) by C_1 as 200 ppm CCC (Figure 6).

Interaction effect of plant density and concentration of CCC showed statistically significant variation for shelf life of cut flower (Appendix VI). The highest shelf life of cut flower (16.67) was observed S_2C_2 (25 cm × 20 cm plant density + 400 ppm CCC) and the lowest (9.33) was found from S_1C_0 (25 cm × 15 cm plant density + 0 ppm CCC) (Figure 7). It was revealed that optimum plant density and CCC ensured maximum vegetative growth with maximum shelf life of cut flower.

4.10 Number of spike per hectare

Number of spike per hectare differs significantly due to different plant density (Appendix VI). The highest thousand number of spike per hectare (753.95) was recorded from S_2 (25 cm × 20 cm) which was statistically similar (730.96) with S_3 (25 cm × 25 cm) and the lowest thousand numbers of spikes per hectare (659.59) was obtained from S_1 as 25 cm × 15 cm (Table 8). It was revealed that 25 cm × 20 cm plant density produced the highest number of spike per hectare. In case of closer plant density it was the lowest due to lowest vegetative growth. Sujata and Singh (1991) reported that growth and flowering characteristics (including cut flower yields) decreased with increasing plant density.

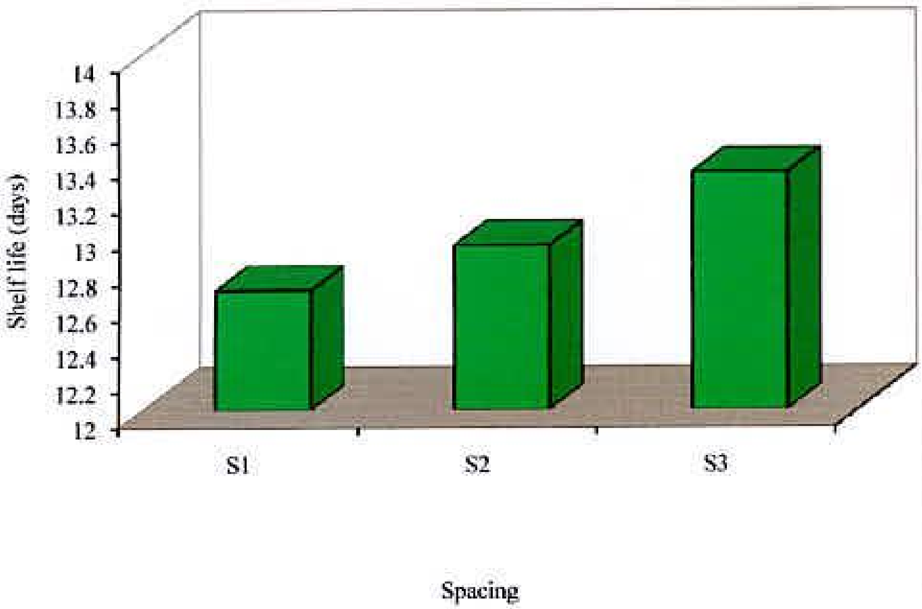


Figure 5. Effect of plant density on shelf life

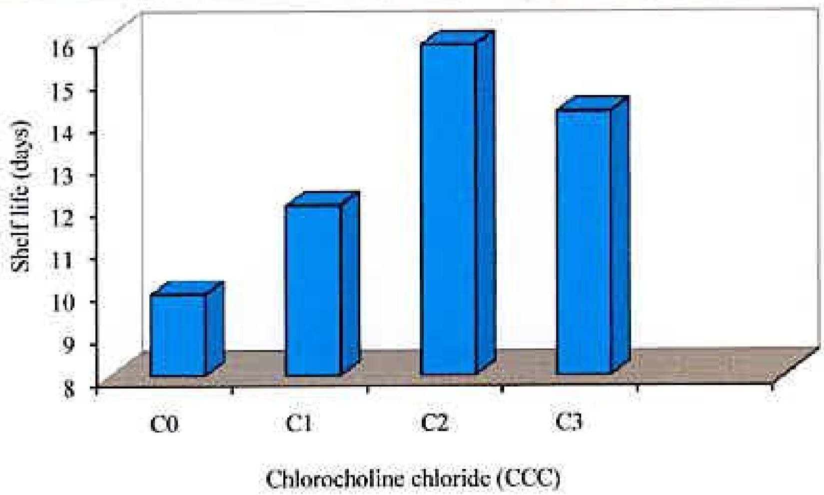


Figure 6. Effect of CCCon shelf life

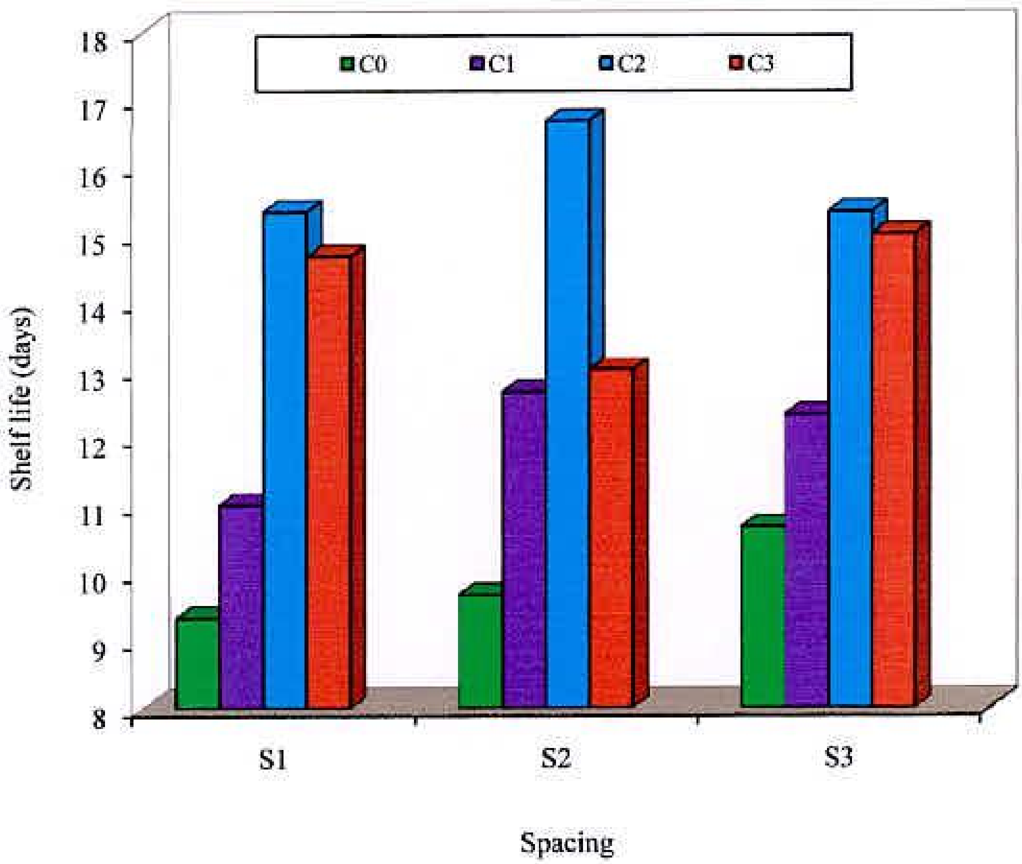


Figure 7. Interaction effect of plant density and CCCon shelf life

Due to the application of different concentration of CCC statistically significant variation was recorded for number of spike per hectare of gladiolus (Appendix VI). The highest thousand number of spike per hectare (777.21) was found from C_2 (400 ppm CCC) which was statistically identical (742.64) with C_3 (600 ppm CCC). On the other hand, the lowest (646.46) was recorded from C_0 (0 ppm CCC) which was closely followed (693.04) by C_1 as 400 ppm CCC (Table 8).

A statistically significant variation was recorded for the interaction effect of plant density and concentration of CCC for number of spike per hectare (Appendix VI). The highest number of spike per hectare (837.04) was obtained from S_2C_2 (25 cm × 20 cm plant density + 400 ppm CCC) and the lowest (592.59) was recorded from S_1C_0 (25 cm × 15 cm plant density + 0 ppm CCC) (Table 9). It was revealed that optimum plant density and CCC ensured maximum vegetative growth with maximum number of spike per hectare.

4.11 Thickness of individual corm

Different plant density showed statistically significant differences in consideration of thickness of individual corm (Appendix VI). The highest thickness of individual corm (6.76 cm) was recorded from S_2 (25 cm × 20 cm) which was statistically identical (5.92 cm) with S_1 (25 cm × 25 cm) where as the lowest thickness of individual corm (4.19 cm) was recorded from S_3 as 25 cm × 25 cm (Table 8). It was revealed that highest plant density ensure highest vegetative growth and the ultimate results would be the highest thickness of individual corm. In case of wider plant density it was lowest due to lowest vegetative growth.

Thickness of individual corm of gladiolus differed significantly due to the application of different concentration of CCC (Appendix VI). The highest thickness of individual corm (6.05 cm) was recorded from C_2 (400 ppm CCC) which was statistically identical (5.78 cm) with C_3 (600 ppm CCC). On the other hand, the lowest (5.13 cm) was found from C_0 (0 ppm CCC) which was closely followed (5.54 cm) by C_1 as 200 ppm CCC (Table 8).

Interaction effect of plant density and concentration of CCC showed statistically significant variation for thickness of individual corm (Appendix VI). The highest thickness of individual corm (7.56 cm) was observed from S_2C_2 (25 cm × 20 cm plant density + 400 ppm CCC) and the lowest (3.91 cm) was recorded from S_3C_0 (25 cm × 25 cm plant density + 0 ppm CCC) (Table 9). It was revealed that optimum plant density and CCC ensured maximum vegetative growth with highest thickness of individual corm.

4.12 Weight of individual corm

Weight of individual corm varied significantly due to different plant density (Appendix VI). The highest weight of individual corm (28.27 g) was recorded from S_2 (25 cm × 20 cm) which was statistically identical (27.36 g) with S_3 (25 cm × 25 cm) and the lowest weight of individual corm (24.93 g) was found from S_1 as 25 cm × 15 cm (Table 8). It was revealed that highest plant density ensure highest vegetative growth and the ultimate results would be the highest weight of individual corm. In case of wider plant density it was lowest due to lowest vegetative growth.

Weight of individual corm of gladiolus differed significantly due to the application of different concentration of CCC (Appendix VI). The highest weight of individual corm (28.47 g) was found from C_2 (400 ppm CCC) which was statistically identical (28.12 g) with C_3 (600 ppm CCC). Again, the lowest (23.98 g) was obtained from C_0 (0 ppm CCC) which is flowed (26.84 g) by C_1 as 0 ppm CCC (Table 8).

Interaction effect of plant density and concentration of CCC showed statistically significant variation for weight of individual corm (Appendix VI). The highest weight of individual corm (30.99 g) was recorded from S_2C_2 (25 cm × 20 cm plant density + 400 ppm CCC) where as the lowest (23.50 g) was recorded from S_3C_0 (25 cm × 25 cm plant density + 0 ppm CCC) (Table 9). It was revealed that optimum plant density and CCC ensured maximum vegetative growth with highest weight of individual corm.

4.13 Diameter of individual corm

Statistically significant variation was recorded for diameter of individual corm due to different plant density (Appendix VI). The highest diameter of individual corm (2.08 cm) was found from S_2 (25 cm × 20 cm) which was closely followed (2.05 cm) with S_3 (25 cm × 20 cm). Again, the lowest diameter of individual corm (1.67 cm) was recorded from S_1 as 25 cm × 15 cm (Table 8). It was revealed that highest plant density ensure highest vegetative growth and the ultimate results would be the highest diameter of individual corm. In case of closer plant density it was lowest due to lowest vegetative growth.

Diameter of individual corm of gladiolus differed significantly due to the application of different concentration of CCC (Appendix VI). The highest diameter of individual corm (2.07 cm) was obtained from C_2 (400 ppm CCC) which was statistically identical (2.01 cm) with C_3 (600 ppm CCC) where as the lowest (1.76 cm) was recorded from C_0 (0 ppm CCC) which was closely followed (1.90 cm) by C_1 as 200 ppm CCC (Table 8).

Plant density and concentration of CCC showed statistically significant interaction effect for diameter of individual corm (Appendix VI). The highest diameter of individual corm (2.26 cm) was found from S_2C_2 (25 cm × 20 cm plant density + 400 ppm CCC) again, the lowest (1.53 cm) was recorded from S_1C_0 (25 cm × 15 cm plant density + 0 ppm CCC) (Table 9). It was revealed that optimum plant density and CCC ensured maximum vegetative growth with highest diameter of individual corm.

4.14 Number of cormel per plant

Number of cormel per plant varied significantly due to different plant density (Appendix VII). The highest number of cormel per plant (23.29) was recorded from S_3 (25 cm × 25 cm) which was statistically identical (23.24) with S_2 (25 cm × 20 cm). Again, the lowest number of cormel per plant (18.13) was found from S_1 as 25 cm × 15 cm (Figure 8). It was revealed that highest plant density ensure highest vegetative growth and the ultimate results would be the highest number of cormel per plant. Mollah *et al.* (1995) reported that the widest plant density (15 cm × 15 cm) produced the highest number of cormels (21.87) per plant.

Number of cormel per plant of gladiolus differed significantly due to the application of different concentration of CCC (Appendix VII). The highest number of cormel per plant (22.54) was recorded from C_2 (400 ppm CCC) which was statistically identical (22.24) with C_3 (600 ppm CCC). On the other hand, the lowest (19.93) was observed from C_0 (0 ppm CCC) which was closely followed (21.50) by C_1 as 200 ppm CCC (Figure 9).

Interaction effect of plant density and concentration of CCC showed statistically significant variation for number of cormel per plant (Appendix VII). The highest number of cormel per plant (25.02) was recorded from S_2C_2 (25 cm × 20 cm plant density + 400 ppm CCC) and the lowest (16.99) was recorded from S_1C_0 (25 cm × 15 cm plant density + 0 ppm CCC) (Figure 10). It was exposed that optimum plant density and CCC ensured maximum vegetative growth with highest number of cormel per plant.

4.15 Weight of individual cormel

Significant variation was recorded in consideration of weight of individual cormel due to different plant density (Appendix VII). The highest weight of individual cormel (13.78 g) was found from S_2 (25 cm × 20 cm) which was closely followed (13.51 g) with S_3 (25 cm × 20 cm) and the lowest weight of individual cormel (11.75 g) was observed from S_1 as 25 cm × 15 cm (Table 10). It was revealed that highest plant density ensure highest vegetative growth and the ultimate results would be the highest weight of individual cormel. In case of closer plant density it was lowest due to lowest vegetative growth.

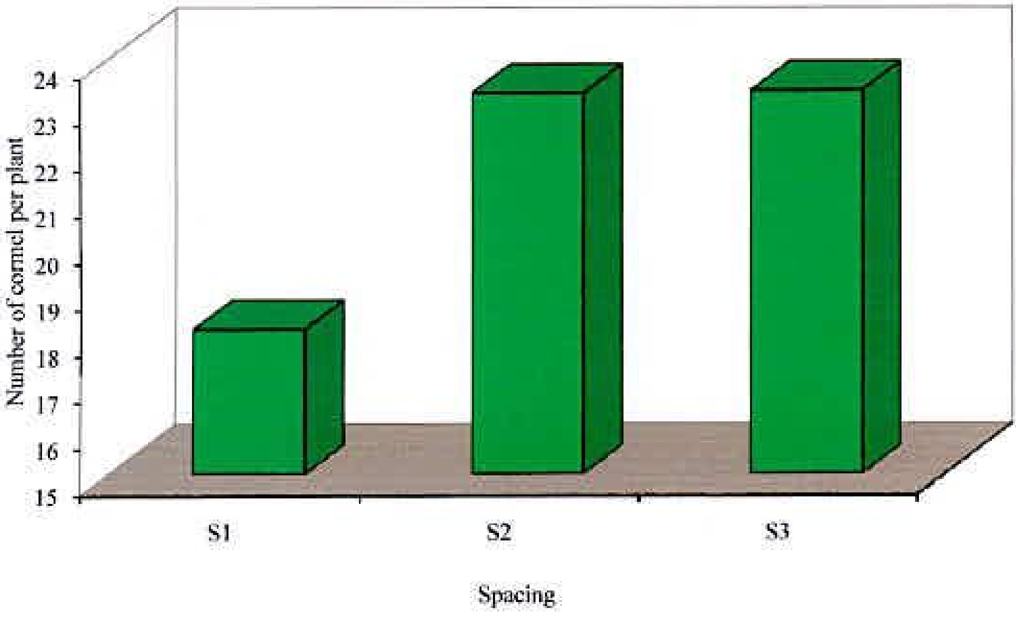


Figure 8. Effect of plant density on number of cormel per plant

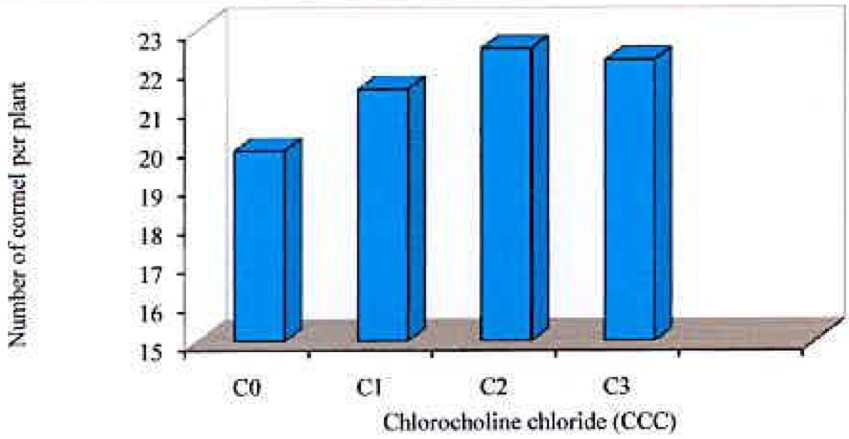


Figure 9. Effect of chlorocholine chloride on number of cormel per plant

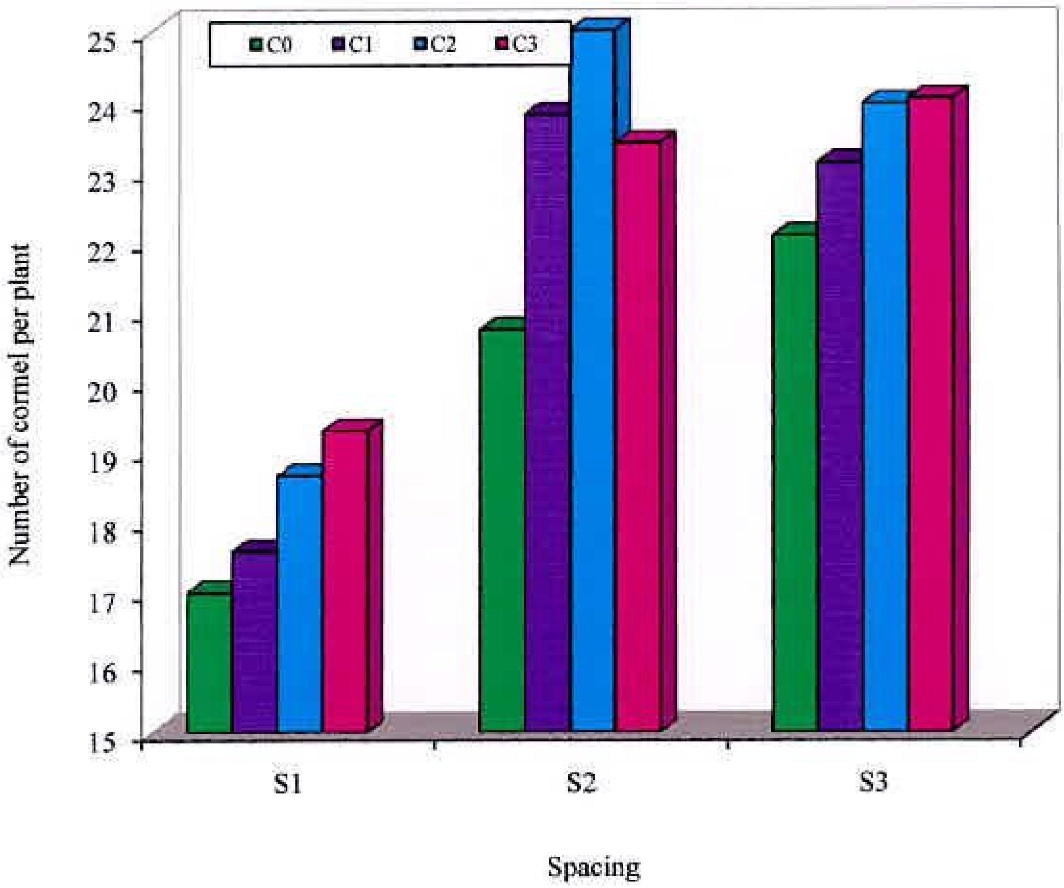


Figure 10. Interaction effect of plant density and chlorocholine chloride on number of cormel per plant

Table 10. Effect of plant density and CCC on yield contributing characters of gladiolus

Treatment	Weight of individual cormel (g)	Diameter of individual cormel (cm)	Yield of corm (t/ha)	Yield of cormel (t/ha)
Plant densities				
S_1	11.75 b	1.18 c	12.84 c	10.54 c
S_2	13.78 a	1.41 a	17.06 a	14.08 a
S_3	13.51 a	1.35 b	15.59 b	12.41 b
$LSD_{(0.05)}$	0.60	0.04	0.55	0.39
Level of significance	0.01	0.01	0.01	0.01
Concentration of CCC				
C_0	11.82 c	1.20 d	13.23 c	10.68 c
C_1	12.95 b	1.27 c	15.15 b	12.24 b
C_2	13.93 a	1.42 a	16.20 a	13.40 a
C_3	13.33 ab	1.36 b	16.07 a	13.05 a
$LSD_{(0.05)}$	0.69	0.05	0.63	0.46
Level of significance	0.01	0.01	0.01	0.01
CV(%)	6.78	7.22	9.05	5.56

Table 11. Interaction effect of plant density and CCC on yield contributing characters and yield of gladiolus

Treatment	Weight of individual cormel (g)	Diameter of individual cormel (cm)	Yield of corm (t/ha)	Yield of cormel (t/ha)
S_1C_0	10.95 d	1.05 e	11.71 e	9.51 g
S_1C_1	11.13 d	1.09 e	12.23 e	10.33 f
S_1C_2	12.44 c	1.28 cd	13.35 d	10.63 f
S_1C_3	12.46 c	1.28 cd	14.07 d	11.68 e
S_2C_0	12.42 c	1.29 cd	14.43 d	11.94 e
S_2C_1	13.96 b	1.42 b	17.53 a	13.65 c
S_2C_2	15.37 a	1.55 a	18.21 a	16.23 a
S_2C_3	13.35 bc	1.37 bc	18.06 a	14.52 b
S_3C_0	12.09 cd	1.25 d	13.56 d	10.60 f
S_3C_1	13.77 b	1.28 cd	15.68 c	12.75 d
S_3C_2	14.00 b	1.43 b	17.04 ab	13.34 cd
S_3C_3	14.18 ab	1.44 b	16.08 bc	12.97 cd
$LSD_{(0.05)}$	1.200	0.093	1.100	0.796
Level of significance	0.05	0.05	0.05	0.01
CV(%)	6.78	7.22	9.05	5.56

Weight of individual cormel of gladiolus showed statistically significant variation due to the application of different concentration of CCC (Appendix VII). The highest weight of individual cormel (13.93 g) was recorded from C_2 (400 ppm CCC) which was statistically identical (13.33 g) with C_3 (600 ppm CCC). Again, the lowest (11.82 g) was obtained from C_0 (0 ppm CCC) which was closely followed (12.95 g) by C_1 as 200 ppm CCC (Table 10).

Interaction effect of plant density and concentration of CCC showed statistically significant variation for weight of individual cormel (Appendix VII). The highest weight of individual cormel (15.37 g) was recorded from S_2C_2 (25 cm × 20 cm plant density + 400 ppm CCC) and the lowest (10.95 g) was recorded from S_1C_0 (25 cm × 15 cm plant density + 0 ppm CCC) (Table 11). Optimum plant density and CCC ensured maximum vegetative growth with highest weight of individual cormel.

4.16 Diameter of individual cormel

Diameter of individual cormel varied significantly due to different plant density (Appendix VII). The highest diameter of individual cormel (1.41 cm) was found from S_2 (25 cm × 20 cm) which was closely followed (1.35 cm) with S_3 (25 cm × 25 cm). On the other hand the lowest diameter of individual cormel (1.18 cm) was recorded from S_1 as 25 cm × 15 cm (Table 10). Highest plant density responsible for the highest vegetative growth and the ultimate results would be the highest diameter of individual cormel. In case of closer plant density it was lowest due to lowest vegetative growth.

Diameter of individual cormel of gladiolus differed significantly due to the application of different concentration of CCC (Appendix VII). The highest diameter of individual cormel (1.42 cm) was recorded from C_2 (400 ppm CCC) which was statistically identical (1.36 cm) with C_3 (600 ppm CCC). Again, the lowest (1.20 cm) was observed from C_0 (0 ppm CCC) which was closely followed (1.27 cm) by C_1 as 200 ppm CCC) (Table 10).

Interaction effect of plant density and concentration of CCC showed statistically significant variation for diameter of individual cormel (Appendix VII). The highest diameter of individual cormel (1.55 cm) was found from S_2C_2 (25 cm × 20 cm plant density + 400 ppm CCC) while the lowest (1.05 cm) was recorded from S_1C_0 (25 cm × 15 cm plant density + 0 ppm CCC) (Table 11). Optimum plant density and CCC enhance maximum vegetative growth with highest diameter of individual cormel.

4.17 Yield of corm

Statistically significant variation was recorded for yield of corm due to different plant density (Appendix VII). The highest yield of corm (17.06 t/ha) was obtained from S_2 (25 cm × 20 cm) which was closely followed (15.59 t/ha) with S_3 (25 cm × 20 cm) and the lowest yield of corm (12.84 t/ha) was found from S_1 as 25 cm × 15 cm (Table 10). It was remarked that the highest plant density ensure highest vegetative growth and the ultimate results would be the highest yield of corm. In case of closer plant density it was lowest due to lowest vegetative growth. But Rabbani and Azad (1996) reported the highest yield of mother corm (13.17 t/ha) from the treatment combination of closet plant density (20 × 10 cm). Incalcaterra (1992) reported that increasing the planting density increased corm yield but reduced the corm quality. Sujata and Singh (1991) found that planting density had no significant effect on corm production.

Due to the application of different concentration of CCC yield of corm of gladiolus differed significantly (Appendix VII). The highest yield of corm (16.20 t/ha) was obtained from C_2 (400 ppm CCC) which was statistically identical (16.07 t/ha) with C_3 (600 ppm CCC) where as the lowest (13.23 t/ha) was found from C_0 (0 ppm CCC) which was closely followed (15.15 t/ha) by C_1 as 200 ppm CCC (Table 10).

Interaction effect of plant density and concentration of CCC showed statistically significant variation for yield of corm (Appendix VII). The highest yield of corm (18.21 t/ha) was recorded from S_2C_2 (25 cm × 20 cm plant density + 400 ppm CCC) and the lowest (11.71 t/ha) was observed from S_1C_0 (25 cm × 15 cm plant density + 0 ppm CCC) (Table 11). It was revealed that optimum plant density and CCC ensured maximum vegetative growth with highest yield of corm.

4.18 Yield of cormel

Yield of cormel varied significantly due to different plant density (Appendix VII). The highest yield of cormel (14.08 t/ha) was observed from S_2 (25 cm × 20 cm) which was closely followed (12.41 t/ha) with S_3 (25 cm × 25 cm) and the lowest yield of cormel (10.54 t/ha) was recorded from S_1 as 25 cm × 15 cm (Table 10). It was revealed that highest plant density ensure highest vegetative growth and the ultimate results would be the highest yield of cormel. In case of closer plant density it was the lowest due to the lowest vegetative growth. But Rabbani and Azad (1996) reported the highest yield cormel (22.36 t/ha) from the treatment combination of closet plant density (20 × 10 cm). Mukhopadhyay and Yadav (1984) reported that wider plant density produced more and cormels than the closer plant density.

Yield of cormel of gladiolus differed significantly due to the application of different concentration of CCC (Appendix VII). The highest yield of cormel (13.40 t/ha) was recorded from C_2 (400 ppm CCC) which was statistically identical (13.05 t/ha) with C_3 (600 ppm CCC). Again, the lowest (10.68 t/ha) was found from C_0 (0 ppm CCC) which was closely followed (12.24 t/ha) by C_1 as 200 ppm CCC (Table 10).

Interaction effect of plant density and concentration of CCC showed statistically significant variation in consideration of yield of gladiolus cormel (Appendix VII). The highest yield of cormel (16.23 t/ha) was recorded from S_2C_2 (25 cm × 20 cm plant density + 400 ppm CCC) where as the lowest (9.51 t/ha) was observed from S_1C_0 (25 cm × 15 cm plant density + 0 ppm CCC) (Table 11). It was remarked that optimum plant density and CCC enhance maximum vegetative growth and the ultimate result was the highest yield of cormel.

4.19 Economic analysis

Input costs for land preparation, seed, fertilizer, irrigation and manpower required for all the operations from planting to harvesting of gladiolus flower, corm and cormel were recorded for unit plot and converted into cost per hectare. Price of gladiolus flower, corm and cormel was considered as per market rate. The economic analysis presented under the following headings-

4.19.1 Gross return

The combination of plant density and concentration of CCC showed different gross return. The highest gross return (Tk. 1,112,560) was obtained from S_2C_2 (25 cm × 20 cm plant density + 400 ppm CCC) and the second highest gross return (Tk. 1018450) was found in S_3C_2 (25 cm × 25 cm plant density + 600 ppm CCC). The lowest gross return (Tk. 762,350) was obtained from S_1C_0 (25 cm × 15 cm plant density + 0 ppm CCC) (Table 12).

4.19.2 Net return

Different treatment combinations showed different net return. The highest net return (Tk. 765,453) was found from S_2C_2 and the second highest net return (Tk. 671,343) was obtained from S_3C_2. The lowest (Tk. 428,012) net return was obtained from S_1C_0 (Table 12).

Table 12. Cost and return of gladiolus cultivation as influenced by plant density and CCC

Treatment	Cost of production (Tk./ha)	Yield of corm (t/ha)	Price of corm (Tk.)	Yield of cormel (t/ha)	Price of cormel	Number of cut flower (000)	Price of cut flower	Gross return (Tk./ha)	Net return (Tk./ha)	Benefit cost ratio
S_1C_0	334338	11.71	93680	9.51	76080	592.59	592590	762350	428012	1.28
S_1C_1	344553	12.23	97840	10.33	82640	622.22	622220	802700	458147	1.33
S_1C_2	347107	13.35	106800	10.63	85040	719.18	719180	911020	563913	1.62
S_1C_3	349660	14.07	112560	11.68	93440	704.37	704370	910370	560710	1.60
S_2C_0	334338	14.43	115440	11.94	95520	675.07	675070	886030	551692	1.65
S_2C_1	344553	17.53	140240	13.65	109200	748.15	748150	997590	653037	1.90
S_2C_2	347107	18.21	145680	16.23	129840	837.04	837040	1112560	765453	2.21
S_2C_3	349660	18.06	144480	14.52	116160	755.56	755560	1016200	666540	1.91
S_3C_0	334338	13.56	108480	10.60	84800	671.70	671700	864980	530642	1.59
S_3C_1	344553	15.68	125440	12.75	102000	708.74	708740	936180	591627	1.72
S_3C_2	347107	17.04	136320	13.34	106720	775.41	775410	1018450	671343	1.93
S_3C_3	349660	16.08	128640	12.97	103760	768.00	768000	1000400	650740	1.86

4.19.3 Benefit cost ratio

In the combination of plant density and different concentration of CCC the highest benefit cost ratio (2.21) was noted from S_2C_2 and the second highest benefit cost ratio (1.93) was estimated from S_2C_3. The lowest benefit cost ratio (1.28) was obtained from S_1C_0 (Table 12). From economic point of view, it was apparent from the above results that the combination of S_2C_2 was more profitable than rest of the combinations.

CHAPTER V

SUMMARY AND CONCLUSION

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The study was conducted at the Horticultural Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from October, 2007 to June, 2008 to find out the effect of plant densities and concentration of Chlorocholine Chloride (Cycocel/ CCC) on growth, production and self life of gladiolus. The experiment considered as two factors. Factor A: There were three levels of plant densities such as S_1: 25 cm × 15 cm; S_2: 25 cm × 20 cm and S_3: 25 cm × 25 cm and Factor B: Four levels of Concentration of CCC such as C_0: 0; C_1: 200; C_2: 400 and C_3: 600 ppm respectively. There were on the whole 12 (3 × 4) treatment combinations. The experiment was laid out following Randomized Complete Block Design with three replications.

At 30, 45, 60 and 75 DAP the tallest plant (37.98 cm, 55.74 cm, 63.04 cm and 72.29 cm) was recorded from S_1 (25 cm × 15 cm) and the lowest (34.55 cm, 52.73 cm, 58.01 cm and 66.22 cm) was observed from S_3 (25 cm × 25 cm). The maximum days required for 80% emergence of spike (88.75) were recorded from S_3 again the minimum (85.08) was found from S_2. The highest flowering plants (93.67%) were recorded from S_2 again, the lowest (86.67%) was observed from S_1. The highest length of rachis at harvest (35.06 cm) was recorded from S_2 again, the lowest (31.00 cm) was observed from S_1. The highest shelf life of cut flower (13.33) was obtained from S_3 and the lowest (12.67) was observed from S_1. The highest thousand number of spike per hectare (753.95) was recorded from S_2 and the lowest (659.59) was obtained from S_1. The highest thickness of individual corm (6.76 cm) was recorded from S_2 and the lowest (4.19 cm) was recorded from S_3. The highest weight of individual corm (28.27 g) was recorded from S_2 and the lowest (24.93 g) was found from S_1. The highest diameter of individual corm (2.08 cm) was found from S_2 and the lowest (1.67 cm) was recorded from S_1. The highest number of cormel per plant (23.29) was recorded from S_3 and the lowest (18.13) was found from S_1. The highest weight of individual cormel (13.78 g) was found from S_2 and the lowest (11.75 g) was observed from S_1. The highest diameter of individual cormel (1.41 cm) was found from S_2 and the lowest (1.18 cm) was recorded from S_1. The highest yield of corm (17.06 t/ha) was obtained from S_2 and the lowest (12.84 t/ha) was found from S_1. The highest yield of cormel (14.08 t/ha) was observed from S_2 and the lowest (10.54 t/ha) was recorded from S_1.

At 30, 45, 60 and 75 DAP, the tallest plant (39.65 cm, 57.44 cm 64.53 cm and 72.49 cm) was recorded from C_2 again, the shortest (32.71 cm, 50.84 cm, 56.89 cm and 64.71 cm) was observed from C_0. The maximum days required for 80% emergence of spike (90.11) was found from C_3 and the minimum (83.67) was obtained from C_0. The highest flowering plant (93.89%) was obtained from C_2 and the lowest (85.33%) was recorded from C_0. The highest length of rachis at harvest (35.20 cm) was recorded from C_2 and the lowest (30.95 cm) was found from C_0. The highest shelf life of cut flower (15.78) was observed from C_2 again, the lowest (9.89) was recorded from C_0. The highest thousand number of spike per hectare (777.21) was found from C_2 and the lowest (646.46) was recorded from C_0. The highest thickness of individual corm (6.05 cm) was recorded from C_2 and the lowest (5.13 cm) was found from C_0. The highest weight of individual corm (28.47 g) was found from C_2

and the lowest (23.98 g) was obtained from C_0. The highest diameter of individual corm (2.07 cm) was obtained from C_2 and the lowest (1.76 cm) was recorded from C_0. The highest number of cormel per plant (22.54) was recorded from C_2 and the lowest (19.93) was observed from C_0. The highest weight of individual cormel (13.93 g) was recorded from C_2 and the lowest (11.82 g) was obtained from C_0. The highest diameter of individual cormel (1.42 cm) was recorded from C_2 again, the lowest (1.20 cm) was observed from C_2. The highest yield of corm (16.20 t/ha) was obtained from C_2 and, the lowest (13.23 t/ha) was found from C_0. The highest yield of cormel (13.40 t/ha) was recorded from C_2 and the lowest (10.68 t/ha) was found from C_0.

At 30, 45, 60 and 75 DAP the tallest plant (41.66 cm, 58.89 cm, 67.34 cm and 73.70 cm) was recorded from S_2C_2 where the shortest (30.36 cm, 47.99 cm, 53.43 cm and 60.61 cm) was recorded from S_3C_0. The maximum days required for 80% emergence of spike (92.33) was observed from S_3C_3 and the minimum days required for 80% emergence of spike (82.00) was recorded from S_2C_0. The highest flowering plant (98.33%) was observed from S_2C_2 and the lowest (84.00%) was recorded from S_1C_0. The highest length of rachis at harvest (37.82 cm) was observed from S_2C_2 and the lowest (29.40 cm) was recorded from S_1C_0. The highest shelf life of cut flower (16.67) was observed S_2C_2 and the lowest (9.33) was found from S_1C_0. The highest number of spike per hectare (837.04) was obtained from S_2C_2 and the lowest (592.59) was recorded from S_1C_0. The highest thickness of individual corm (7.56 cm) was observed from S_2C_2 and the lowest (3.91 cm) was recorded from S_3C_0. The highest weight of individual corm (30.99 g) was recorded from S_2C_2 and the lowest

(23.50 g) was recorded from S_3C_0. The highest diameter of individual corm (2.26 cm) was found from S_2C_2 and the lowest (1.53 cm) from S_1C_0. The highest number of cormel per plant (25.02) was recorded from S_2C_2 and the lowest (16.99) was recorded from S_1C_0. The highest weight of individual cormel (15.37 g) was recorded from S_2C_2 and the lowest (10.95 g) from S_1C_0. The highest diameter of individual cormel (1.55 cm) was found from S_2C_2 and the lowest (1.05 cm) was recorded from S_1C_0. The highest yield of corm (18.21 t/ha) was recorded from S_2C_2 and the lowest (11.71 t/ha) S_1C_0. The highest yield of cormel (16.23 t/ha) was recorded from S_2C_2 and the lowest (9.51 t/ha) from S_1C_0. The highest benefit cost ratio (2.21) was noted from S_2C_2 and the lowest (1.28) was obtained from S_1C_0. From economic point of view, S_2C_2 was more profitable than rest of the combination.

Conclusion:

Considering the situation of the present experiment, further studies in the following areas may be suggested:

1. Such study is needed in different agro-ecological zones (AEZ) of Bangladesh for regional compliance and other performance.
2. Concentration of CCC had significant influence on the growth and yield of gladiolus. So, further study in needed to specify the concentration.

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APPENDICES

APPENDICES

Appendix I. Characteristics of Horticulture Farm soil as analyzed by Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Horticulture Farm, SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained

B. Physical and chemical properties of the initial soil

Characteristics	Value
% Sand	27
% Silt	43
% clay	30
Textural class	silty-clay
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100 g soil)	0.10
Available S (ppm)	45

Source: SRDI

Appendix II. Monthly record of air temperature, rainfall, relative humidity, soil temperature and Sunshine of the experimental site during the period from October 2007 to June 2008

Month	*Air temperature (°c)		*Relative humidity (%)	*Rain fall (mm) (total)	*Sunshine (hr)
	Maximum	Minimum			
October, 2007	27.4	19.3	79	43	6.7
November, 2007	25.8	16.5	78	00	6.8
December, 2007	22.4	13.5	74	00	6.3
January, 2008	24.5	12.4	68	00	5.7
February, 2008	27.1	16.7	67	30	6.7
March, 2008	31.4	19.6	54	11	8.2
April, 2008	33.6	23.6	69	163	6.4
May, 2008	34.7	25.9	70	185	7.8
June, 2008	34.5	26.8	76	213	7.1

* Monthly average,

Source: Bangladesh Meteorological Department (Climate & weather division) Agargoan, Dhaka - 1212

Appendix III. Analysis of variance of the data on plant height of gladiolus as influenced by plant density and CCC

Source of variation	Degrees of freedom	Mean square Plant height (cm) at			
		30 DAP	45 DAP	60 DAP	75 DAP
Replication	2	1.201	0.522	1.655	1.963
Spacing (A)	2	36.066**	28.846**	83.273**	115.728**
Chlorocholine chloride (B)	3	75.102**	69.215**	88.312**	92.199**
Interaction (A×B)	6	13.263*	6.760**	20.399*	21.695*
Error	22	4.101	1.847	6.654	7.343

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix IV. Analysis of variance of the data on number of leaves per plant of gladiolus as influenced by plant density and CCC

Source of variation	Degrees of freedom	Mean square Number of leaves per plant at			
		30 DAP	45 DAP	60 DAP	75 DAP
Replication	2	0.002	0.003	0.147	0.151
Spacing (A)	2	0.564**	6.043**	11.541**	17.791**
Chlorocholine chloride (B)	3	0.566**	0.612**	1.476**	2.666**
Interaction (A×B)	6	0.077*	0.233**	0.686*	0.501*
Error	22	0.026	0.065	0.203	0.218

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix V. Analysis of variance of the data on different growth parameter and spike yield of gladiolus as influenced by plant density and CCC

Source of variation	Degrees of freedom	Mean square				
		Days required to 50% emergence of spike	Days required to 80% emergence of spike	Flowering plant (%)	Length of flower stalk at harvest (cm)	Length of rachis at harvest (cm)
Replication	2	1.583	3.528	0.333	23.662	2.840
Spacing (A)	2	40.750**	41.028**	151.000**	187.815**	55.469**
Chlorocholine chloride (B)	3	163.889**	63.269**	124.630**	105.643**	29.514**
Interaction (A×B)	6	17.750*	13.769*	49.630**	10.131*	2.894*
Error	22	8.462	7.104	15.394*	7.691	1.859

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix VI. Analysis of variance of the data on different growth parameter and spike yield of gladiolus as influenced by plant density and CCC

Source of variation	Degrees of freedom	Mean square					
		Number of spikelets per spike	Yield of spike per hectare (number)	Shelf life (days)	Thickness of individual corm (cm)	Weight of individual corm (g)	Diameter of individual corm (cm)
Replication	2	0.697	1721.838	0.444	0.168	0.324	0.041
Spacing (A)	2	11.427**	29052.94**	1.361*	20.561**	35.720**	0.635**
Chlorocholine chloride (B)	3	7.272**	29443.56**	59.657**	1.370**	37.477**	0.174**
Interaction (A×B)	6	1.134**	1255.86**	2.546**	0.290*	4.683*	0.018*
Error	22	0.293	506.028	0.323	0.256	2.299	0.014

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix VII. Analysis of variance of the data on different growth parameter and corm and cormel yield of gladiolus as influenced by plant density and CCC

Source of variation	Degrees of freedom	Mean square				
		Number of cormel per plant	Weight of individual cormel (g)	Diameter of individual cormel (cm)	Yield of corm (t/ha)	Yield of cormel (t/ha)
Replication	2	0.743	0.815	0.018	0.137	0.295
Spacing (A)	2	105.230**	14.603**	0.179**	54.940**	37.820**
Chlorocholine chloride (B)	3	12.221**	7.126**	0.090**	16.864**	13.169**
Interaction (A×B)	6	1.641*	1.111*	0.010*	1.242*	1.694**
Error	22	1.534	0.502	0.003	0.422	0.221

**: Significant at 0.01 level of probability: *: Significant at 0.05 level of probability

Appendix VIII. Production cost of gladiolus per hectare

A. Input cost

Treatment	Labour cost	Ploughing cost	Corm Cost	Irrigation Cost	Pesticides	Chlorocholine chloride	Manure and fertilizers				Sub Total (A)
							Cowdung	Urea	TSP	MP	
S_1C_0	25000.00	12000.00	55000.00	10000.00	8000.00	0.00	30000.00	3000.00	16000.00	10800.00	169800.00
S_1C_1	25000.00	12000.00	55000.00	10000.00	8000.00	8000.00	30000.00	3000.00	16000.00	10800.00	177800.00
S_1C_2	25000.00	12000.00	55000.00	10000.00	8000.00	10000.00	30000.00	3000.00	16000.00	10800.00	179800.00
S_1C_3	25000.00	12000.00	55000.00	10000.00	8000.00	12000.00	30000.00	3000.00	16000.00	10800.00	181800.00
S_2C_0	25000.00	12000.00	55000.00	10000.00	8000.00	0.00	30000.00	3000.00	16000.00	10800.00	169800.00
S_2C_1	25000.00	12000.00	55000.00	10000.00	8000.00	8000.00	30000.00	3000.00	16000.00	10800.00	177800.00
S_2C_2	25000.00	12000.00	55000.00	10000.00	8000.00	10000.00	30000.00	3000.00	16000.00	10800.00	179800.00
S_2C_3	25000.00	12000.00	55000.00	10000.00	8000.00	12000.00	30000.00	3000.00	16000.00	10800.00	181800.00
S_3C_0	25000.00	12000.00	55000.00	10000.00	8000.00	0.00	30000.00	3000.00	16000.00	10800.00	169800.00
S_3C_1	25000.00	12000.00	55000.00	10000.00	8000.00	8000.00	30000.00	3000.00	16000.00	10800.00	177800.00
S_3C_2	25000.00	12000.00	55000.00	10000.00	8000.00	10000.00	30000.00	3000.00	16000.00	10800.00	179800.00
S_3C_3	25000.00	12000.00	55000.00	10000.00	8000.00	12000.00	30000.00	3000.00	16000.00	10800.00	181800.00

S_1: 25 cm × 15 cm
S_2: 25 cm × 20 cm
S_3: 25 cm × 25 cm

C_0: 0 ppm CCC
C_1: 200 ppm CCC
C_2: 400 ppm CCC
C_3: 600 ppm CCC

Appendix VIII. Contd.

B. Overhead cost (Tk./ha)

Treatment	Cost of lease of land for 12 months (13% of value of land Tk. 8,00000/year	Miscellaneous cost (Tk. 5% of the input cost	Interest on running capital for 12 months (Tk. 13% of cost/year	Sub total (Tk) (B)	Total cost of production (Tk./ha) [Input cost (A)+ overhead cost (B)]
S_1C_0	104000	22074	38464	164538	334338
S_1C_1	104000	23114	39639	166753	344553
S_1C_2	104000	23374	39933	167307	347107
S_1C_3	104000	23634	40226	167860	349660
S_2C_0	104000	22074	38464	164538	334338
S_2C_1	104000	23114	39639	166753	344553
S_2C_2	104000	23374	39933	167307	347107
S_2C_3	104000	23634	40226	167860	349660
S_3C_0	104000	22074	38464	164538	334338
S_3C_1	104000	23114	39639	166753	344553
S_3C_2	104000	23374	39933	167307	347107
S_3C_3	104000	23634	40226	167860	349660