EFFECT OF GROWTH CHEMICALS ON DIFFERENT VARIETIES OF GERBERA

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CERTIFICATE

This is to certify that the thesis entitled ***"Effect of growth chemicals on different varieties of gerbera"*** *submitted to the Department of Horticulture, Faculty of Agriculture, 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 bonafide research work carried out by* ***Farjana Haque Shammy, Registration No. 08-3229****, under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.*

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

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ABSTRACT

An experiment was conducted at Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka during the period from July, 2009 to April, 2010. The experiment consisted with two factors, Factor A: (Growth chemicals viz. F_0: control; F_1: GA_3; F_2: 4-CPA and F_3: Flora) and Factor B: (Variety viz. V_1: red colored flower and V_2: yellow colored flower). In case of Growth chemicals, the longest peduncle length (25.71 cm), the highest flower diameter (7.67 cm) and maximum number of flower (14.13 / plant) was recorded with 4-CPA. Incase of variety, maximum number of leaf (29.63 / plant), diameter of flower (7.24 cm) and peduncle length (25.32 cm) was recorded from V_2 variety and maximum number of flower (14.13 / plant) was recorded from V_1 but all other parameters were the lowest at V_1. For combined effect the highest peduncle length (26.25 cm) and highest flower diameter (7.66 cm) was recorded from V_2F_2 and maximum number of flower (17.50 / plant) was recorded from V_1F_2 and minimum (11.50/plant) was in V_1F_0. So plants of yellow colored flower treated with 4-CPA were more effective for quality production of gerbera.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATE

ABBREVIATIONS AND ACRONYMS

AEZ	=	Agro-Ecological Zone
ANOVA	=	Analysis of variance
cv.	=	Cultivar
cm	=	Centimeter
CRD	=	Complete Randomized Design
DAT	=	Days After Transplanting
DBI	=	Days After Bud Initiation
DMRT	=	Duncan’s Multiple Range Test
DAT	=	Days After Transplanting
DMRT	=	Duncan’s Multiple Range Test
et al.	=	And others

GA3		Giberrelic Acid
LSD	=	Least Significant Difference
ppm		Parts Per Million
Sci.	=	Science
4-CPA	=	4-Cholorophenoxy Acetic acid
^{0} C	=	Degree Celsius

CHAPTER I
INTRODUCTION

Gerbera (*Gerbera jamesonii* L.) is an herbaceous perennial flower crop, with long stalks and daisy-like flower, a native of South Africa. It is a popular cut flower grown throughout the world in a wide range of climatic conditions. It is popularly known as 'Barbeton daisy' or 'Transvaal daisy'. Gerbera is a genus of ornamental flower from the sunflower family Asteraceae. Gerbera is the 5th most used cut

flower in the world after tulip, chrysanthemum, carnation and rose. It grows well in tropical and subtropical regions, but in a temperate climate should be protected from frost and cultivated in glasshouses. Genus Gerbera consists of 30 species, which are of Asiatic and African origin. Among the different species, *Gerbera jamesoii* is the only species under commercial cultivation. Development of *Gerbera jamesonii* as a floricultural crop is traced from its cultivation as a novelty in South Africa to its establishment as a commercial crop in 1930s. It is a diploid species with the somatic chromosome number 2n = 50. Modern gerbera arose from *Gerbera jamesonii* hybridized with *Gerbera viridifolia* and possibly other species (Leffriing, 1973). There is a wide range of variation available in this crop.

Gerbera species bear a large capitulum with striking, two-lipped ray florets in yellow, orange, pink, red, white and many others colors. The capitulum, which has the appearance of a single flower, is actually composed of hundreds of individual flowers (Chung-YongMo *et al*, 2005) Morphology of the flowers varies depending on their position in the capitulum. Its magnificent inflorescence with a variety of colour has made it attractive for use in garden decorations, such as herbaceous borders, bedding, and pots and for cut flowers as a long vase life (Bose *et al*., 2003). Gerbera plant also is used in the preparation of traditional Chinese medicine(tu-er-feng), derived from whole plants of gerbera, is used for curing cold with cough and for rheumatism (Ye *et al.*, 1990). In Bangladesh, gerbera was introduced recently and it is gaining

popularity. It has great potential for local as well as export market. In Bangladesh, gerbera is mainly grown in summer. It cannot tolerate extreme high temperature, cold and heavy rainfall (Labeke *et al*., 1999). Heavy rainfall and water logging conditions are very much harmful for gerbera. Good drainage is essential for gerbera cultivation. It can be grown on all types of soil but loamy soil with moist condition is better for its desired development. These plants grow slowly. Most

new gerbera developed for pot plant production are 6-8 inches in height and produce flowers up to 4 inches across. A pot size of 8-10 inches is recommended. Range of colors available has increased to include a wide array of pastel colors. Size of the distance between the plants is measured from heart to heart of the pot centre.

Plant breeder have done a wonderful job for developing outstanding flower colors, including purple, rose, pink, white, and various bicolor and introduced double and semi-double flowering forms, adding to the beauty of this flower. For this reason demand of gerbera as cut flower has increased dramatically in recent years in Bangladesh. These are mainly come form India and Chaina because there is no released variety of gerbera with high yield potential and better quality in Bangladesh. Research works are not conduct to develop high yielding and better quality gerbera by the research organization. They are mainly interested to work with vegetables and cereals crops. There are some local variety of gerbera which are small in peduncle length. These are not suitable variety as cut flower as low productivity. Lack of definite variety is one of the main constraints towards its production in Bangladesh.

Flower division of Bangladesh Agriculture Research Institute and Horticulture farm of Sher-e-Bangla Agricultural University have started research work on gerbera through foliar feeding to enhance production and quality. Foliar application with different growth chemicals shows positive effect on different flowers and vegetables (Karlovic *et al,* 2004)-

GA_3 spray increases spike length and floret numbers per spike in tuberose (Mukhopadhyay and Bankar, 2003). GA_3 at 100 ppm increased plant height, internal length and basal diameter in crysanthamum (Gautam *et al,* 2006). At 100ppm GA_3 increases plant height in cut flower (Gupta and Datta, 2001). Auxins are widely used commercially to produce more vigorous growth, to promote

flowering and fruiting and also root formation in plants those are not easy to propagate by stem cuttings, to retard fruit drop, and to produce seedless varieties. The principal natural Auxin is Indoleacetic acid, Naphthalene Acetic Acid are common but less frequent plant hormones include the lactones and kinins. Sprayng with 4-CPA (Group-Auxin) increase fruit set, fruit size and induces early yield. However, it may cause puffy fruits at high concentration or under high temperatures (AVRDC, 1990) in tomato. Fruit size related with flower size. If flower size is large than fruit size is also be large. So that 4-CPA can be used to increase flower size and quality as it is considered as a sufficiently safe plant growth regulator (Athanassios Hountas, *et al*, 2005). Flora (Nitrobenzene 20% w/w) is the flowering booster and plant energizer. Nitrobenzene based flower booster, used in floriculture industry for yielding excellent quality flower. It ensures uniform and profuse flowering, increase in flowering rate and improvement in the yield of flower up to 20%-40%.

In this aspect several objectives may be outline as below:

- To determine suitable gerbera variety in Bangladesh condition.
- To find out the influence of growth chemicals on the growth and yield of gerbera.
- To hasten the early flowering of gerbera.

CHAPTER II

REVIEW OF LITERATURE

Gerbera (*Gerbera jamesonii*) is a herbaceous perennial crop with long leafless stalk and daisy like flowers. It is a popular cut flower grown thought the world in a wide range of climatic conditions. A few number of research works have been done all over the world by different workers on the performance of gerbera genotypes and no information is available under climatic conditions of Bangladesh. Nevertheless, some of the important and informative works so far been done abroad on these aspects have been presented bellow-

'Liangfen' was developed by crossing female 'Aruba' and male 'True Love' by Li-Shen Chong *et al* (2008). It belongs to wide-petal standard cut flower gerbera (*Gerbera jamesonii*) cultivar, with pink petal, blank centre, semi-double. The diameter of flower head is 10-12 cm, the peduncle length is 50-55 cm, and the vase life can last 12-15 days. The annual yield is 30-35 stems per plant. It is highly resistant to *P. cryptogea* and is suitable for protected cultivation.

Pyrethrins and flower yield of pyrethrum (*Chrysanthemum cinerariaefolium* Viz.) plants were determined by Haque *et al*. (2007) after application of ethrel, chlormequat chloride and paclobutrazol. Ethrel at 50, 100, 250 and 500 mg /l produced a significant positive effect on pyrethrins level, decreased plant height, while 50 and 100 mg/l significantly increased fresh and dry flower yield. Chlormequat chloride at 1000 and 2000 mg /l and paclobutrazol (80 and 160 mg /l) increased pyrethrins level, single flower weight and decreased plant height and flower yield.

Application of gibberellic acid by Khan *et al* (2007), as presoaking plus foliar spray resulted in improved growth and flowering attributes while as paclobutrazol as bulb dip plus foliar spray repressed plant growth but improved scape thickness and flower diameter of tulip. GA_3 caused hastening of flowering, while PP_{333}

resulted in delayed flowering in tulip. The field life of tulip flower was significantly extended by GA_3 treatments in comparison to control and bulb dip was found more superior over foliar sprays.

Effects of the following treatments on the cut flower yield and quality of *G. jamesonii* were studied by Thane *et. al* (2007) under greenhouse conditions: 100% of the recommended fertilizer rates 150:50:150 g NPK/m2, 40 or 70% RFR + 0.5 g Azotobacter/m2, 40 or 70% RFR + 0.5 g PSB [phosphate solubilizing bacteria]/m2, 40 or 70% RFR + Azotobacter + 0.5 g PSB/m2, and Azotobacter + PSB. The application of 70% RFR + Azotobacter + PSB resulted in the greatest flower stalk length (52.96 cm), flower stalk diameter (0.7 cm), flower diameter (9.2 cm), number of flowers per plant (7.21) and per m2 (70.03), and vase life (8.95 days).

A field experiment was conducted by Moond *et al*. (2006) to investigate the effects of foliar sprays of gibberellic acid (GA_3; at 50, 100, 150, 200 and 250 ppm), CCC (chlormequat; at 2000, 4000, 6000, 8000 and 10 000 ppm) and maleic hydrazide (MH; at 250, 500, 700, 1000 and 1250 ppm) on the yield and quality of chrysanthemum (*Chrysanthemum indicum* cv. Local), well adapted under agroclimatic conditions of Udaipur, Rajasthan, India. Diameter and fresh weight of flowers increased significantly over the control with all the levels of GA_3 and flowers with the largest diameter (6.5 cm) and greatest weight (2.3 g) were recorded with GA_3 at 150 ppm. CCC and MH had no significant effect on flower diameter, although fresh weight of flowers increased significantly over the control (2.30 and 2.28 g at 2000 ppm CCC and 1250 ppm MH, respectively). All the treatments, except for GA_3 at 250 ppm, recorded significantly higher number of flowers per plant over the control. The highest number of flowers (371) was recorded by spraying 1250 ppm MH.

Studies were undertaken during 2002-03 by Gautam *et al*. (2006), in Udaipur, Rajasthan, India, to investigate the effect of plant growth regulators, i.e. GA_3 (50, 100, 150 and 200 ppm), NAA (50, 100, 150 and 200 ppm), Ethrel [ethephon] (>50, 1000, 1250 and 1500 ppm) and B-nine [daminozide] (1000, 1500, 2000 and 2500 ppm), on the growth, flowering and yield of chrysanthemum cv. Nilima. The results revealed that GA_3 at all concentrations and NAA at 100 ppm increased plant height, internal length and basal diameter, while ethrel and B-nine at all concentrations retarded plant height, number of nodes and internodal length over control. Extremely early or late flowering were recorded with GA_3 at 150 ppm and B-nine at 2500 ppm, respectively. Similarly, GA_3 at 150 ppm caused the longest flowering phase, while ethrel at 1500 ppm resulted in the shortest flowering phase. Number of flowers per plant was more than the control in all the treatments, except ethrel at 1250 and 1500 ppm. Among all the treatments, GA_3 at 200 ppm registered the maximum flower size and yield of chrysanthemum.

Paclobutrazol at 100 mg/litre was most effective in inhibiting shoot growth and promoting flower formation An experiment was conducted by Zhang-XiaoYue *et al* (2006). The flowering period was markedly delayed by spraying GA_3 from early September to middle October, and the extent of effective was positively correlated with GA_3 concentration. GA_3 at 100 mg/l gave the best result. The flowering period was advanced by spraying GA_3 from late October to November.

Youl-ChoiSeong *et al* (2006) was derived *Gerbera hybrida cv. Raon*, by crossing cultivars Kippros and Rora in Korea Republic in 1994, was selected in 2000 after the investigation its characteristics from 1995 to 1999. Raon is a cut-flower cultivar with large, double-type, dark orange flowers, with 11 days of vase life. It is adaptable in any greenhouse region in Korea.

Youl-ChoiSeong *et al* (2006) was derived *Gerbera hybrida* cv. *Noble Hugging*, a seedling selected from an F_1 population derived from crossing cultivars Michelle

and Picasso in Korea Republic in 1998, was finally selected in 2003 after the investigation of its characteristics. The single flower of cv. Noble Hugging consists of ivory ray flowers and black disc. And it has long, strong flower stalk and long cut-flower longevity. It is adaptable in any greenhouse region in the country.

Misty Red is a new red gerbera (*Gerbera hybrida*) cultivar developed by Chung-YongMo *et al.* (2005) from a cross between Ximena and Florense, followed by seedling and line selections at the Flower Breeding Research Institute, Gyeongnam Agricultural Research and Extension Services, Korea, in 2000. Misty Red is characterized by red, semi-double type, large flowers; good harmony in ray floret colour and flower centre colour; as well as stable flower shape. The vase life was 10.2 days. The average yield of Misty Red was 49.6 flowers per plant a year in greenhouse yield trails carried out from 2002 to 2003. Misty Red is suitable for cultivation under greenhouse conditions in Korea.

Performance of 9 exotic cultivars of gerbera (*Gerbera jamesonii*) was studied by Singh and Mandhar (2004) under fan and pad cooled greenhouse environments at the Indian Institute of Horticulture Research, Bangalore, Karnataka, India from July 1998 to June 1999. Greatest plant height (48.83 cm), and number of suckers (5.16) and leaves (46.27) per plant were obtained with Tiramisu, Lyonella and Ornella, while the lowest values of the aforementioned parameters were recorded for Whitsun (47.88 cm), Sunset (3.82) and Tiramisu (26.74), respectively. Flowering was earliest (47.88 and 57.47 days for 50 and 100% flowering, respectively) in Whitsun and latest (83.10 and 88.30 days) in Tiramisu. Greatest diameter of flower (10.70 cm) and length of flower stalk (58.27 cm) were recorded for Tiramisu and Lyonella, respectively. Thickest (0.70 cm diameter) and heaviest (22.20 g) flower stalks were observed in Twiggy, whereas the thinnest (0.60 cm diameter) and lightest (13.94 g) stalks were observed in Whitsun. Highest total

number of flowers produced per plot in a year, and the mean number of flowers per plant and per month in a year were obtained with Ornella (1058.00, 47.26 and 5.02, respectively), followed by Thalassa (988.00, 44.52 and 4.61), whereas the lowest were obtained with Tara (591.33, 29.48 and 2.82), followed by Sunset (600.00, 31.15 and 3.11). Percentage of 1^{st} grade flowers was highest in Lyonella (73.85), Sunset (70.41) and Tiramisu. (70.54), and lowest in Tara (47.16) and Thalassa (47.87). The highest percentage of discard flowers was recorded for Thalassa (37.30), followed by Whitsun (20.47). Based on the overall performance, Lyonella, Omella, Tiramisu and Twiggy are recommended for commercial cultivation.

A study was conducted at Saidapur Farm in Hi-tech Floriculture Unit, Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, during 2004-05. Among the 11 cultivars studied, there was a significant variation for various growth, cut flower yield and quality parameters. The cv. Lexus (38.82) produced maximum number of quality cut flowers followed by Alberino (37.20), Scilla (36.95) and Bonnie (31.26). The same cultivars also produced the longest stalk, bigger sized flowers and number of ray florets apart from vegetative parameters like more number of leaves per plant, plant spread, suckers production, leaf area and leaf area index. The cv. Lexus realized maximum net return of Rs. 2,70,672 in 560 m2 area with a B:C ratio of 2.65 followed by Alberino (Rs. 2,55,120; 2.50), Scilla (Rs. 2,52,720; 2.48) and Bonnie (Rs. 1,98,096; 1.94) compared to other genotypes studied.

Zhuang-ying Qiang (2004) studied that chemical preparations consisting of different concentrations of KH_2 PO_4 and 6-BA (6-benzyladenine) or tap water (control group) were sprayed on the foliage of Africa daisy (*Gerbera jamesonii*) when the flower bud was 0.5 cm and the flower stalk was 5 cm. The second spray was applied 5 days later. The contents of chlorophylls were measured 10 days

after the treatment. The freshness of cut flowers was observed and the soluble proteins, the peroxidase (POD) activity and the amount of malondialdehyde (MDA) in the petals were measured. It was found that the chlorophyll content, the height of flower stalk and the diameter of flowers were significantly higher in the chemical sprayed groups; the cut flower remained fresh longer, the soluble proteins in the petals remained at a high level, the POD was higher and the MDA was lower than those of the control. 20 mg/l 6-BA plus 0.1% KH_2 and PO_4 showed the best results.

Influence of a single foliar application of growth regulators on the height and number of inflorescence shoots of the chrysanthemum cultivar 'Revert' was investigated by Karlovic *et al*. (2004) during two growing seasons (2000, 2001) and two growth regulators were used, daminozide (Alar 85) and chlormequat (Cycocel). Daminozide was applied in concentrations of 1000, 2000 and 3000 mg /L and a control (without treatment) while chlormequat was used in concentrations of 2000, 3000, 4000 mg / L and a control (without treatment). The concentrations used differed significantly in their effects on plant height in both years whereas their effects on the number of inflorescence shoot were not significantly different. Daminozide concentration of 3000 mg/L was the most efficient concentration in the first year and that of 2000 mg l-1 in the second year. However, as no statistically significant differences between these two concentrations were recorded in either year, the use of the lower daminozide concentration in height regulation of 'Revert' chrysanthemum is recommended for environmental reasons. In the second trial year daminozide concentrations were more efficient in regulating the upward growth than chlormequat concentrations while this was not the case in the first year.

Regulation of growth and flowering in *Polianthes tuberose* L. with gibberellic acid and ethrel spray was studied by Mukhopadhyay and Banker (2003). Tuberose

single plants were sprayed 3 times before spike emergence, first at 40 days after planting and subsequently at fortnightly intervals, with gibberellic acid at 0, 52, 50,75, 100 mg/l and ethophon at 0, 500, 1000, 1500, 2000 mg/l. the plant height was reduced with increasing concentrations of ethrel spray. The GA_3 spray, in general, increased spike length and floret numbers per spike. The length of the also increased slightly with GA3 spray at 75 mg/l. ethrel spray at higher concentrations reduced spike and rachis length and also floret numbers. Longevity of spike in the field improved with 100 mg/l. both GA_3 and ethrel spray inhibited bulb production at all concentrations.

Gruszczyk and Berbec (2003) conducted a field experiment in Tamil Nadu, India, during 1999-2000 to determine the effects of GA_3, salicylic acid and triacontanol on the growth and development of chrysanthemum [Chrysanthemum morifolium, syn. Dendranthema morifolium] cultivars Baggi, Indira, Red Gold and Shymal. The treatments comprised: 100 and 150 ppm GA_3; 50 and 100 ppm salicylic acid; 1, 2 and 3 ppm triacontanol 0.1, 0.2 and 0.3 ppm brassinolide; and water (control). The treatments were applied thrice from 15 to 30 days after transplanting. Shymal treated with 150 ppm GA_3 gave the highest plant height (67.88 cm) while Bagg treated with 3 ppm triacontanol gave the highest number of suckers per plant. Red Gold treated with 150 ppm GA_3 and 100 ppm salicylic acid gave the highest number of branches per plant (15.75) and flower yield per plant (370.65), respectively.

A field experiment was conducted by Mohariya *et al.* (2003) in Nagpur, Maharashtra, India, during 2000-01 on Chrysanthemum morifolium cultivars Sonali Tara, Birbal Sahani, Sharad Shrungar, and Julia to determine the effect of plant growth regulators on growth, flowering, and yield characteristics. The treatments comprised of gibberellic acid (100 and 150 ppm) and TIBA (100 and 200 ppm). Gibberellic acid increased plant height, where Birbal Sahani had the

highest plant height with 150 ppm gibberellic acid. TIBA at 100 ppm recorded the highest number of branches per plant with Sharad Shrungar. Flowering was hastened with 150 ppm gibberellic acid but was delayed with TIBA. The earliest flowering date was observed with Sharad Shrungar. Gibberellic acid increased flower diameter and vase life, and was highest with Sonali Tara. The number of flowers increased with gibberellic acid treatments followed by TIBA treatments.

Mohariya *et al*. (2003) conducted an experiment to find out the effects of gibberellic acid (GA_3) at 100 and 150 ppm, and TIBA at 100 and 200 ppm on the growth and flowering of chrysanthemum [*Dendranthema morifolium*] cultivars Sonali Tara, Birbal Sahani, Sharad Shrungar and Julia in Maharashtra, India. The growth regulators were sprayed to plants at 30 and 60 days after the transplanting of rooted cuttings. Plant height was increased with GA_3 but was reduced by TIBA application. Birbal Sahani treated with 150 ppm GA_3 produced the tallest plants (52.80 cm). The number of branches, flower yield, and flower weight significantly increased with the application of both growth regulators. Sharad Shrungar sprayed with 100 ppm TIBA recorded the highest number of branches per plant (21.1). GA_3 induced early flowering, whereas TIBA delayed flowering. Sharad Shrungar sprayed with 150 ppm GA_3 exhibited the earliest flowering (85.6 days). Flower size increased with the increase in the concentration of GA_3 and TIBA. Sonali Tara with 150 ppm GA_3 produced the largest flowers (4.8 cm). Julia sprayed with 150 ppm GA_3 recorded the highest number of flowers per plant (90.2), whereas Birbal Sahani treated with GA_3 at similar concentration registered the maximum flower weight (80.8 g).

Moghadam and Mokhtarian (2003) conducted the experiment during 2000-2001 to examine the effects of application on different concentrations of ethephon and gibberellic acid (0, 50, 100, 200 and 300 mg /l) at the end of August, September and October to delay flowering in Gerbera. A factorial experiment was laid out in

Completely Randomized Block Design with 3 replications. Compared to the control results showed, 100 mg/l of ethephon applied at the end of October delayed full bloom approximately 3 days (2000) and 7 days (2001). Gibberellic acid applied at 300 mg/l at the end of August delayed full bloom about 5 days (2000) and at the end of September, 10 days (2001). During both year's gibberellic acid and ethephon applied at the higher concentrations resulted lower percentages of flower opening .

Narayanan *et al*,. (2003) carried out an experiment and reported that foliar feeding (N, P, K) on gerbera at the of 15 lb ac^{-1} as a solution at the pre flowering stage gave 6% more flower than control.

A study was conducted during 2002-03 in Hyderabad, Andhra Pradesh, India to investigate the effects of spraying of gibberellic acid (GA_3, 100 and 200 ppm), benzyladenine (BA, 100 and 200 ppm), salicylic acid (SA, 150 and 200 ppm) and Cycocel [chlormequat] (1500 and 3000 ppm) in rose. GA_3 (100ppm)-treated plants took less time (34.40 days) to flower and had the highest number of flowers per plant (108.0). Regarding flower quality attributes, the greatest flower diameter (5.17 cm) and highest number of petals per flower (22.06) were recorded with SA at 150 ppm. BA at 200 ppm recorded the maximum longevity (22.75 days).

The effect of gibberellic acid (GA_3; sprayed at 50, 100 and 200 mg/litre) on growth and flowering of C. morifolium cv. Jayanti was investigated by Gupta and Datta (2001) and reported that GA was effective at all concentrations in increasing the plant height and cut flower yield. The optimum increase in these parameters was observed at 100 mg GA/l.

Kim *et al*. (2001) studied the effects of shading and GA_3 and ethephon application on the growth and quality of cut flowers of Baegkwang chrysanthemums (*Dendranthema grandiflorum*) and found that generally, growth and flowering

were better in 30% shading treatment than in the non-shading control. Occurrence of physiological injury was remarkably reduced in 30% shading treatment compared to the non-shading control. This data indicates that a 30% shading treatment increases the yield of cut flowers. Plant height and length of flower stalk increased as the application level of GA_3 increased. The number of days to flowering was shortened by GA_3 treatment. The number and width of leaves increased with higher concentrations of ethephon, but were reduced by the shading treatment. Marketable yield of cut flowers reduced as the level of ethephon increased.

The dwarfing effect of daminozide and chlormequat on the spray chrysanthemum was investigated by Kwon *et al.* (2001) and found that the long neck of cut-chrysanthemum break easily. The peduncle length of cultivars “Biarittz” and “Vyking” were retarded by the foliar spray treatment of 1500 mg daminozide/litre. Daminozide application did not affect plant growth of “Biarittz” and “Vyking”. However, the number of days to flowering in “Biarittz” was delayed by 3 days by daminozide application. The length of cut flowers of “Vyking” was decreased by the application of daminozide. Chlormequat application did not affect dwarfing of peduncle length in chrysanthemum.

The effect of plant growth regulators (gibberellic acid and NAA at 10, 50 and 100 ppm, and CCC at 500, 1000 and 1500 ppm) on the growth and flowering of Chrysanthemum sp. cv. Local was investigated by Sharad *et al*. (2000) and reported that GA increased plant height, and the maximum height was obtained at 100 ppm GA. CCC at 1500 ppm reduced plant height compared to the control. NAA also increased plant height compared to the control. GA reduced the time required for flowering, while NAA and CCC delayed flowering. The highest delay in flowering was at 1500 ppm CCC and flowering was earliest at 100 ppm GA.

An experiment was conducted by Kim *et al.* (2000) about the cultivation of chrysanthemums (*Dendranthema grandiflorum*) cv. Baegkwang, in its second flowering, for off-season cut flower production and found that The replanted crops flowered 5-6 days earlier than the second flowering crops. Plant height and length of flowering stalk increased with increasing concentrations of gibberellic acid (GA_3 0, 100, 200 or 400 mg/l). However, the quality of cut flowers and marketable yield significantly increased with the GA_3 treatments compared to the control.

Anuradha and Gowda (2000) studied the association of cut flower yield with growth and floral characters in gerbera. In studies on 25 gerbera. genotypes at Bangalore, cut flower yield exhibited a high level of positive and significant correlation with number of leaves per plant, weight of ray florets and days taken to flower opening. Path analysis revealed that number of leaves per plant had the greatest positive direct effect on flower yield.

An experiment was conducted by Chandrappa *et al.* (2000) during 1997-99 in Karnataka, India, to determine the effects of growth regulators GA_3, benzyladenine (BA, TIBA) and their combinations on the growth and flower production of anthurium cv. Royal Red. Treatments comprised: control, GA_3 at 250, 500, 750 ppm; BA at 500, 1000, 1500 ppm; TIBA at 125, 250, 500 ppm; GA_3 at 250 or 500 ppm+BA at 500 or 1000 ppm; GA_3 at 250 ppm+BA at 500 ppm+TIBA at 125 ppm; GA_3 at 500 ppm+BA at 500 ppm+TIBA at 125 ppm; GA_3 at 250+BA at 1000+TIBA at 125 ppm; and GA_3 at 250 ppm+BA at 500 ppm+TIBA at 500 ppm. Among the treatments, GA_3 at 750 ppm produced the significantly highest plant height of 46.44 cm. The shortest plant height of 42.17 cm was recorded with TIBA at 500 ppm. The largest leaf area (248.66 cm2) was recorded in plants treated with GA_3 at 750 ppm. TIBA at 500 ppm produced the smallest leaf area (232.52 cm2). BA at 1500 ppm recorded the significantly highest number of lateral shoots.

A greenhouse study was carried out in Belgium to investigate the effects of heating on the growth of Gerbera cv. Tiffany (small flowers) and cv. Optima (large flowers), Labeke *et al*., (1999). Gerbera was planted on 11 August 1998 on rock wool mats (6/m^2 for cv. Tiffany and 4/m^2 for cv. Optima). Two independent heating systems (above-ground and sub-surface) were used. The day/night temperature regime was $20/18^0$ C. Treatments included the simultaneous use of both systems (control), and the use of the above-ground system if the minimum heating level was not reached with use of the sub-surface system alone (at 50^0 C). Data were collected weekly (until June 1999) on the number of flowers/plant, stem length, and weight and diameter of flowers. For cv. Optima, the sub-surface heating regime resulted in a significant increase in the number of flower (145.8 compared with 117.6 in the control treatment), and significantly shorter stems (between September and April). Non-significant differences in flower production were found for cv. Tiffany (286.8 and .240 flowers/m^2 for the 2 regimes, respectively). However, stem length and weight were significantly lower with the subsurface heating system.

An attempt was made by Farooqi *et al.* (1999) to introduce pyrethrum (*C. cinerariaefolium*) from the hills of Kashmir and Kodaikanal to Lucknow conditions of north Indian plains. The percentage of flowering plants increased significantly with application of kinetin (100 ppm) or GA_3 (100 ppm) + kinetin (100 ppm). The number of flowers/plant was significantly increased over the control in GA_3 treated plants. Application of kinetin increased pyrethrin content by 39% and pyrethrin yield by 27% over control. Seeds showed better germination when treated with 100 ppm GA_3.

Meher *et al.* (1999) carried out a field experiment at Pune in 1992-93, gerbera were planted in the first week of May, June or July and sprayed twice (30 and 50 days after planting) with 10, 20 or 30 ppm IAA, 50, 100 or 150 ppm GA or 150,

300 or 450 ppm maleic hydrazide and reported that of the growth regulator treatments, 50 ppm GA and 20 ppm IAA gave the highest yields. The number of days to 50% flowering was least from planting in July and following application of 20 ppm IAA. Maleic hydrazide tended to delay flowering compared with the other growth regulators. Flower diameter ranged from 4.43 cm with 450 ppm maleic hydrazide to 7.14 cm with 150 ppm GA.

Mahanta *et al*., (1998) studies on variability and heritability of some quantitative characters in gerbera (Gerbera jamesonii). Ten cultivars of gerbera were evaluated for 14 characters in trials conducted at Assam Agricultural University. For all these characters, data are tabulated on range, mean, genotypic and phenotypic coefficient of variability, heritability and genetic advance. Plant height, vase life, flower size exhibited greater genetic variability and high heritability coupled with high genetic advance. It was suggested that these characters be used as selection criteria for the improvement of gerbera. Broad-sense heritability estimates were very high for all the characters except days to flower.

Vijaya and Subbaiah (1997) observed that plant height, number of leaves, leaf length, leaf width, number of flower, diameter of flower and the height of flower stalk of gerbera increased with foliar feeding than control.

Dwivedi and Bajpai (1995) observed through using 0-90 kg N ha^{-1} as urea and foliar feeding (N, P, K) that flower yield increased with the increased rate of foliar feeding application and the yield was highest with foliar feeding and lowest with urea.

Wahi *et a*l., (1991) studied a factor analysis in gerbera. Factor analysis was performed using morphological traits in 31 genotypes of gerbera. Phenotypic correlation matrices indicated that flower number/plant is increased by selection for shoots/plants and leaves/plant. Results from genotypic correlation matrices

advocated selection for flower diameter, flower stalk length, leaves/plant and number of days from flower bud appearance to opening. Both correlation matrices showed leaf size to be related to flower longevity.

Dufault *et a*l., (1990) observed that nitrogen and potassium fertility and plant populations influence field production of gerbera. Gerbera seedlings (cv. Florist Strain Yellow) were planted in the field in drip-irrigated beds mulched with white-on-black plastic film (white side up) at plant densities of 24000, 36000 or 72000 plants/ha. N and K fertilizers were each applied at 55, 110 or 220 kg/ha. In the 1^{st} year of a 2-year Study, the number of marketable flowers increased as both N and K rates increased up to 110 kg/ha, but as the N rate was increased to 220 kg/ha cut flower production increased. In the 2nd year, marketable and cut yields increased as N rate increased but increasing K rate had no effect on yields. Marketable and cut yields also increased as plant density increased from 24000 to 72000 plants/ha in both years. Flower size and quality were unaffected by planting density. N and K rates had no effect on flower size, quality or vase life in either year.

Synthetic plant growth regulators (PGRs) such as 4-chlorophenoxy acetic acid (4-CPA) now used commercially in Korea, Japan and China are known to influence fruit settings in tomatoes. These are applied at 50 mg/l. as a spray on flower cluster when they are in bloom. Sprayng is usually done on each cluster at 7 to 14 days interval. It is claimed that the treatment increase fruit set fruit size and induces early yield. However, it may cause puffy fruits at high concentration or under high temperatures (AVRDC, 1990).

Sidahmed and Kliewer(1980) were studied the effects of defoliation, gibberellic acid and 4-chlorophenoxyacetic acid on growth and composition of thompson seedless grape berries. Fifty percent defoliation at berry shatter significantly reduced berry weight of Thompson Seedless grapes. Either gibberellic acid (GA_3)

or 4-chlorophenoxyacetic acid (4-CPA) applied to foliated vines produced significantly heavier berries than the control (no defoliation or hormones). GA_3 applied to 50% defoliated vines at berry shatter yielded berries similar in weight to those from control vines, whereas, 4-CPA applied to similar vines had little effect on increasing berry weight.The barley endosperm bioassay of gibberellin (GA)-like substances revealed higher activity in berries from control vines than in berries from defoliated vines sampled one week after berry shatter. GA-like activity in young berries increased in response to exogenous GA_3 application in both control and 50% defoliated vines. No measurable GA-like activity was detected in berry samples collected at véraison.Defoliation reduced the total amount of sugar (total soluble solids) per berry, but not the concentration of total soluble solids. GA_3 and 4-CPA, on the other hand, significantly increased the total sugar per berry, but markedly reduced the level of total soluble solids. The concentration of arginine in mature fruit was significantly less in defoliated vines than control vines, whereas, the levels of malate, tartrate and proline did not differ significantly between these two treatments. GA_3 and 4-CPA significantly increased the level of malate in mature fruits, but reduced the concentrations of proline compared to control fruits.

CHAPTER III

MATERIALS AND METHODS

This chapter deals with the materials and methods that were used in execution of the experiment.

3.1 Site of the experiment: The experiment was conducted at the Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka, during the period from July,

2009 to April 2010. Location of the site is 23º 74ó N latitude and 90º 35ó E longitude with an elevation of 8.2 meter from sea level (Anonymous, 1981).

3.2 Climate and weather: Climate of the experimental site is subtropical, characterized by heavy rainfall during the months from April to September (Kharif season) and scanty rainfall during the rest of the year (Rabi season). Maximum and minimum temperature, humidity and rainfall during the study period were collected from the Bangladesh Meteorological Department (climate division), Agargaon and have been presented in Appendix I.

3.3 Planting materials: Seedlings were collected from Bangladesh Green Rouf Movment Nursery, Rampura, Polashbag, Dhaka.

3.4 Treatments of the experiment: This experiment was conducted to find out the influence of varietals performance and different growth chemicals on Gerbera flower. There were two factors in this experiment. They were as follows:

Factor A: Growth chemicals

Different growth chemicals (plate 2) have been used as foliar application. The chemicals treatment were-

i. F_0: Control (Fresh water)
ii. F_1: GA_3 (Gibberelic acetic acid).
iii. F_2: 4-CPA (4-Chloro phenoxy acetic acid).
iv. F_3: Flora (Nitrobenzene 20% weight/ weight basis)

GA_3 were collected from Paradise Scientific Co. Limited, Tikatuli Dhaka and other two chemicals namely 4-CPA & flora were collected from ACI Fertilizer, Tejgong, Dhaka.

Factor B: Variety

i. V_1 =Variety-1: Red colored flower (plate 3).

ii. V_2 =Variety-2: Yellow colored flower (plate 4).

3.5 Doses, preparation and methods of application of the chemical treatments

- ✓ GA_3 -100 ppm.100mg GA_3 was dissolved in 1liter water. This was applied nine times, 10 days intervel.
- ✓ 4-CPA- 25ml/l-as instruction of manufacture guide. 25ml 4-CPA was dissolved in 1liter water. nine times,10 days interval.
- ✓ Flora- 3ml/ l (Nitrobenzene 20% w/w)- as instruction of manufacture guide. 3ml Flora was dissolved in 1liter water. nine times, 10 days interval.

3.6 Pot preparation: Soil and cowdung were mixed and pot were filled 7 days before transplanting. Pots were placed on 9th July 2009. The weeds and stubbles were completely removed from the soil.

3.7 Design and layout of the experiment: Two-factorial experiment was laid out in the Complete Randomized Design (CRD) with four replications. 32 pots were used in the experiment. Size of the each pot were 20 cm × 18 cm.

3.8 Production Methodology:

3.8.1 Planting of Suckers: Thirty two suckers were planted at 7 cm depth in 32 pot on 16^{th} July, 2009 under shade.

3.8.2 Weeding: Weeding was done in all the pots as and when required to keep the plant free from weeds**.**

3.8.3 Fertilization: The soil were mixed with NPK as it increases gerbera production (Dufault *et al*, 1990).

3.8.4 Irrigation: Frequency of watering depended upon the moisture status of the soil. However, water logging was avoided, as it is harmful to plants.

3.8.5 Disease and Pest management : Diseases can be a major factor limiting gerbera production. Experimental crop was infected by powdery mildew during the early growing stage. Disease was controlled by spraying Dithane M-45. Fungicide was sprayed two times at 15 days interval. Crop was also attacked by mites during the growing stage. Mite was controlled by spraying Dithane M-45 @ 1.5 ml/l. the insecticides was sprayed one time after 7 days of planting of suckers.

3.8.6 Harvesting of flowers: Flower spikes were harvested from 20th February, 2010 when the flower reached commercial stage.

3.9 Data collection: Data were collected from each pot. Data were collected in respect of the following parameters:

- ✓ Leaf Number/plants
- ✓ Leaf length
- ✓ Leaf width
- ✓ Diameter of flower bud
- ✓ Flower diameter
- ✓ Peduncle length
- ✓ Peduncle diameter
- ✓ Days from flower bud initiation to flower blooming
- ✓ Number of flower/ plant
- ✓ Leaf area

3.10 Number of leaves and flowers per plant: Number of leaves and flowers per plant was recorded by counting all the leaves and flowers from each plant of each pot and the mean was calculated.

3.11 Measurement of Leaf area: Leaf area was measured by using CL-202 Leaf Area Meter CID Inc., Van- couver, USA (plate1)

3.12 Leaf length and width measurement: Leaf length, width and peduncle diameter were measured by Digital Caliper -515 (DC- 515).

3.13 Statistical analysis: Collected data for various characters were statistically analyzed using MSTAT computer package programme. Mean for all the treatments was calculated and the analysis of variance for each of the characters was performed by F (variance ratio) test. Difference between treatments were evaluated by Duncan's Multiple Range (DMRT) test (Gomez and Gomez, 1984).

Plate 1: CL-202 Leaf Area Meter CID Inc., Van- couver, USA

Plate2: Defferent growth chemicals

Plate 3: Red colored flower

Plate 4: Yellow colored flower

CHAPTER IV
RESULTS AND DISCUSSION

Present experiment was conducted to determine the Effect of growth chemicals on different varieties of gerbera have been presented and discussed in this chapter. Some of the data have been expressed in table (s) and others in figure (s) for ease of discussion, comprehension and understanding. A summary of the analyses of variances in respect of all the parameters have been shown in Appendices. Results are presented under the following heads.

4.1 Number of leaves per plant

Significant difference in leaf number was found due to varietals performance and growth chemicals individually (Appendix II). Maximum leaf number (29.63) per plant was observed from V_2 and minimum number of leaves (26.88) was observed from V_1 treatment at 210 DAT (Fig.1).

When the plants treated with GA_3 maximum leaf number (31.88) was produced as it increase the plant height. Leaf number had the greatest positive direct effect on flower yield (Anuradha and Gowda, 2000). Lowest leaf number (22.75) was obtained from control (Fig. 2). Similar result was also found out by Gautam *et al*. (2006), Mohariya *et al*. (2003), Gruszczyk and Berbec (2003), Gupta and Datta (2001) and Sharad *et al*. (2000).

When combined effect of variety and growth chemicals was considered, it was observed that maximum leaves number (33.50) were produced by V_1 treated with GA_3 and minimum leaves number (22.00) were obtained from V_1F_0 (Table 1).

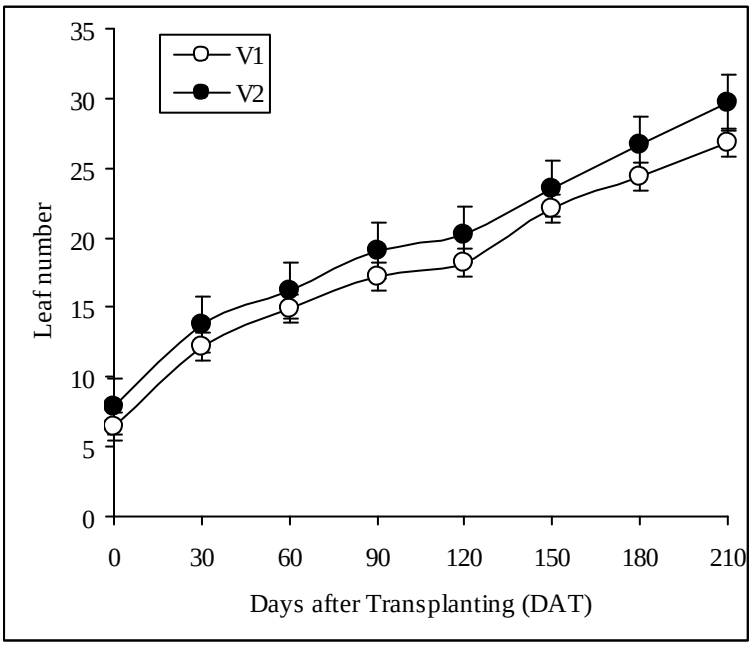

Fig. 1. Effect of variety on leaf number at different days after transplanting of gerbera. (V_1 :Red colored flower, V_2: Yellow colored flower)

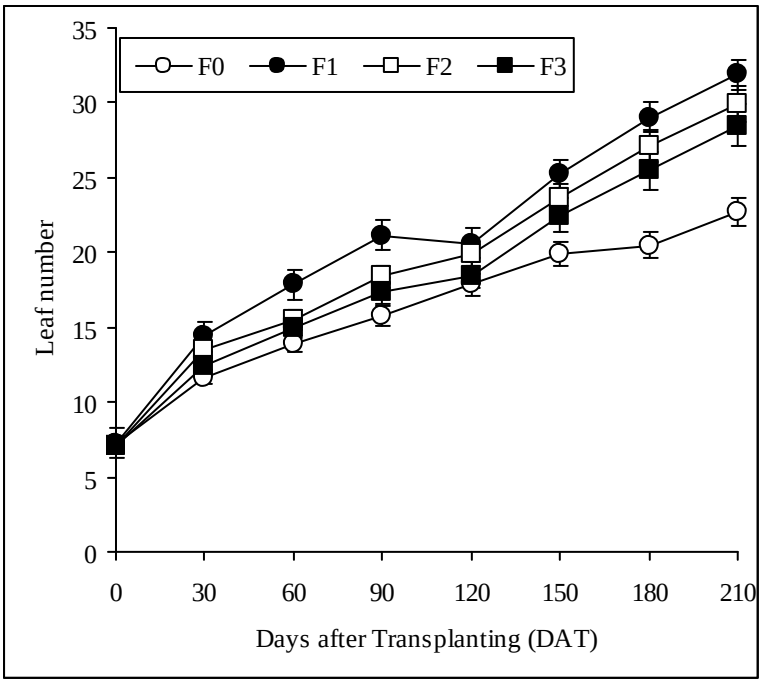

Fig. 2. Effect of growth chemicals on leaf number at different days after transplanting of gerbera. (F_0: Control; F_1: GA_3; F_2: 4CPA; F_3: Flora)

Table 1. Interaction effect of variety and growth chemicals on leaf number at different days after transplanting of gerbera [x]

Treatment [y]	Days after Transplanting (DAT)							
	Initial	30	60	90	120	150	180	210
V_1F_0	6.25 cd	10.50 c	13.25 c	14.75 cd	16.75 c	19.25 c	19.75 c	22.00 c
V_1F_1	6.00 d	13.25 b	16.25 b	19.50 b	18.75 b	24.25 ab	27.50 ab	30.25 ab
V_1F_2	7.50 abc	14.00 b	17.00 b	20.50 ab	20.25 b	24.50 ab	27.75 ab	30.00 ab
V_1F_3	6.25 cd	11.00 c	13.00 c	14.00 d	17.00 c	20.50 c	22.50 c	25.25 c
V_2F_0	8.25 a	12.75 b	14.50 c	16.75 c	19.00 b	20.50 c	21.25 c	23.50 c
V_2F_1	8.50 a	15.50 a	19.50 a	22.75 a	22.50 a	26.25 a	30.50 a	33.50 a
V_2F_2	6.75 bcd	13.00 b	14.00 c	16.25 cd	19.50 b	22.75 b	26.50 b	29.75 b
V_2F_3	8.00 ab	13.75 b	17.00 b	20.75 ab	20.00 b	24.50 ab	28.50 ab	31.75 ab
$LSD_{(0.05)}$	1.357	1.207	1.632	2.21	1.634	2.232	3.114	3.245
Level of significance	NS	0.01	0.01	0.01	0.01	0.01	0.05	0.05
CV(%)	12.84	6.33	7.13	8.28	5.78	6.65	8.29	7.81

[x] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

[y] V_1: Red colored flower, V_2: Yellow colored flower and F_0: Control; F_1: GA_3; F_2: 4CPA; F_3: Flora

4.2 Leaf length

As evident from (Appendix III) leaf length was significantly different from V_1 to V_2. Longest (23.57 cm) leaf was recorded from V_2 and the shortest (21.59 cm) leaf was obtained from V_1 at 210 DAT (Fig. 3).

Effect of growth chemicals on the leaf length was also found to be significant (Appendix III). Highest (25.30 cm) leaf length was obtained from the plant treated with F_1 and the shortest (19.92 cm) leaf length was recorded from F_0 (Fig. 4). Similar opinion was also put forwarded by Vijaya and Subhan (1997).

Interaction between variety and growth chemicals on leaf length was found to be significant (Appendix III). However, highest leaf length (27.57 cm) was obtained from V_2F_1 treatment, while the lowest (19.35 cm) was obtained from V_1F_0 (Table 2).

4.3 Leaf width

Significant variation was found among varieties in terms of leaf width (Appendix IV). Leaf width showed a gradual increasing tendency at 30, 60, 90, 120, 150, 180 and 210 DAT (Fig. 5). V_2 variety showed higher leaf width (12.93 cm) than V_1 variety (11.49 cm).

Growth chemicals showed significant variation in terms of leaf width (Appendix IV). Growth chemicals showed increasing trends of leaf width at 30, 60, 90, 120, 150, 180 and 210 DAT (Fig. 6). Highest (13.52 cm) leaf width was recorded in F_1. On the other hand the lowest (10.98 cm) leaf width was recorded from F_0. This finding is in agreement with the reports of Vijaya and subhan (1997).

Combine effect of variety with growth chemicals was found to be significant (Appendix IV). Highest (14.28 cm) leaf width was produced by the treatment combination of V_2F_1 and the lowest (10.00 cm) leaf width was obtained from V_1F_0 (Table 3).

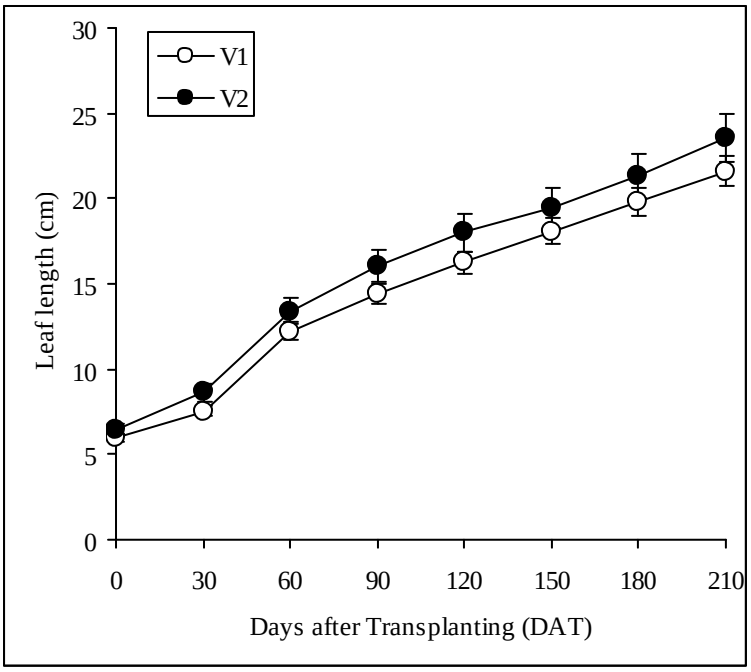

Fig. 3. Effect of variety on leaf length at different days after transplanting of gerbera, V_1: Red colored flower, V_2: Yellow colored flower

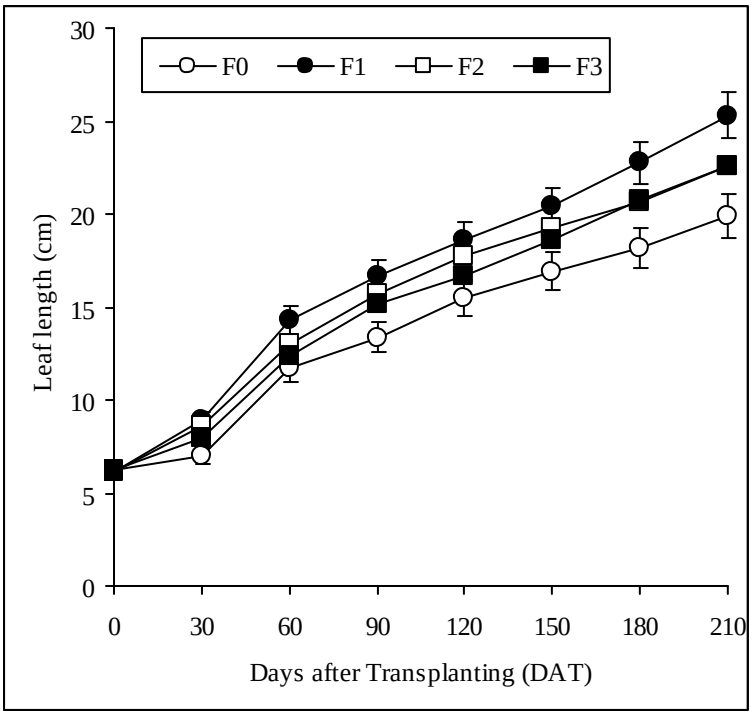

Fig:4. Effect of growth chemicals on leaf length at different days after Transplanting of gerbera. (F_0: control; F_1: GA_3; F_2: 4-CPA; F_3: Flora)

Table 2. Interaction effect of variety and growth chemicals on leaf length at different days after transplanting of gerbera [x]

Treatment [y]	Days after Transplanting (DAT)							
	Initial	30	60	90	120	150	180	210
V_1F_0	5.74 bc	6.36 c	10.77 e	11.90 e	14.76 d	16.38 d	18.17 d	19.35 e
V_1F_1	5.62 c	8.40 ab	13.41 bc	15.53 bc	17.05 bc	18.73 bc	21.02 bc	23.02 bcd
V_1F_2	6.31 ab	8.76 ab	13.98 b	16.82 ab	18.30 b	20.15 b	21.64 bc	23.77 bc
V_1F_3	6.17 abc	6.63 c	10.79 e	13.30 de	14.87 d	17.13 cd	18.30 d	20.22 e
V_2F_0	6.83 a	7.70 b	12.59 cd	14.78 cd	16.20 cd	17.42 cd	18.19 d	20.49 de
V_2F_1	6.63 a	9.37 a	15.20 a	17.83 a	20.25 a	22.02 a	24.49 a	27.57 a
V_2F_2	5.93 bc	8.39 ab	11.94 d	14.60 cd	17.12 bc	18.28 c	19.63 cd	21.35 cde
V_2F_3	6.41 ab	9.18 a	13.90 b	16.91 ab	18.38 b	20.03 b	23.17 ab	24.85 b
$LSD_{(0.05)}$	0.615	1.065	1.09	1.671	1.491	1.51	2.289	2.527
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CV(%)	6.75	8.94	5.78	7.47	5.92	5.47	7.56	7.61

[x] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

[y] V_1: Red colored flower, V_2: Yellow colored flower and F_0: Control; F_1: GA3; F_2: 4CPA; F_3: Flora

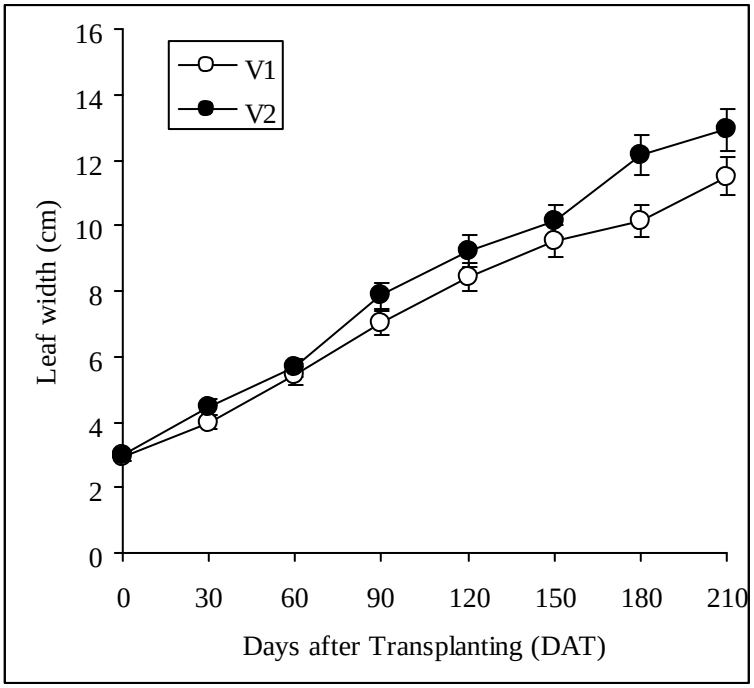

Fig. 5. Effect of variety on leaf width at different days after transplanting of gerbera. (V_1: Red colored flower, V_2: Yellow colored flower)

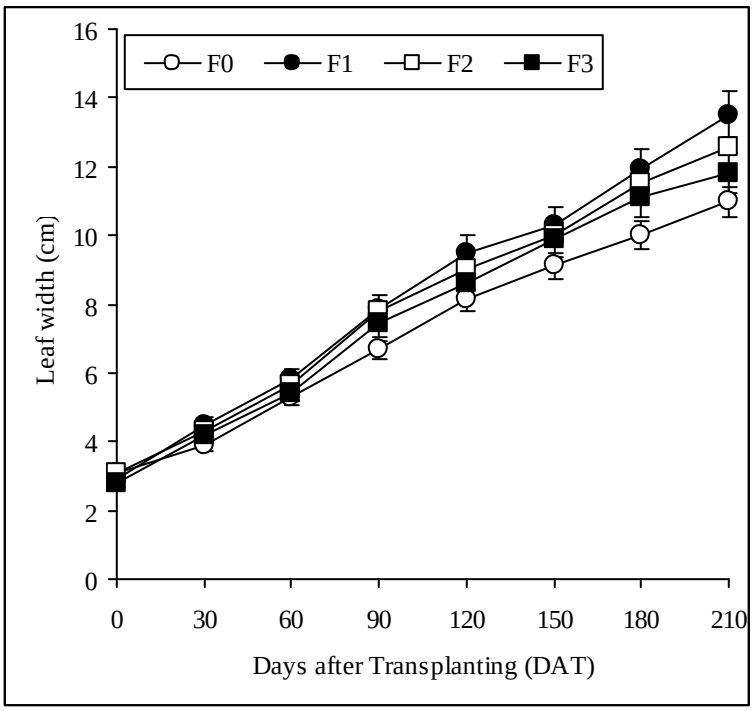

Fig. 6. Effect of growth chemicals on leaf width at different days after transplanting of gerbera. (F_0: Control; F_1: GA_3; F_2: 4CPA; F_3: Flora)

Table 3 Interaction effect of variety and growth chemicals on width of leaf at different days after transplanting of gerbera [x]

Treatment [y]	Days after Transplanting (DAT)							
	Initial	30	60	90	120	150	180	210
V_1F_0	3	3.57 e	5.07 c	6.15	7.57	8.46	8.74	10.00

				c	c	c	d	c
V_1F_1	2.95	4.26 bc	5.73 ab	7.47 ab	9.08 b	10.06 ab	11.02 bc	12.76 b
V_1F_2	3.05	4.28 bc	5.74 ab	7.66 ab	9.09 b	9.89 b	11.03 bc	12.77 b
V_1F_3	2.78	3.86 d	5.14 c	6.78 bc	7.92 c	9.66 b	9.72 cd	10.44 c
V_2F_0	3.12	4.21 c	5.50 b	7.18 ab	8.70 b	9.77 b	11.28 b	11.96 b
V_2F_1	2.86	4.72 a	5.91 a	8.24 a	9.93 a	10.58 a	12.83 a	14.28 a
V_2F_2	3.08	4.37 bc	5.51 b	7.91 a	8.92 b	10.10 ab	12.01 ab	12.32 b
V_2F_3	2.85	4.51 ab	5.74 ab	8.08 a	9.33 b	10.07 ab	12.50 ab	13.16 ab
$LSD_{(0.05)}$	--	0.228	0.287	0.952	0.579	0.534	1.376	1.134
Level of significance	NS	0.01	0.01	0.01	0.01	0.05	0.01	0.01
CV(%)	9.95	8.65	5.52	8.71	4.46	6.69	8.4	6.32

[x] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

[y] V_1: Red colored flower, V_2: Yellow colored flower and F_0: Control; F_1: GA_3; F_2: 4CPA; F_3: Flora

4.4 Diameter of flower bud

Flower bud of two varieties exhibited significant variation (Appendix V). But the diameter of flower bud was almost similar in all the treatments. The diameter of flower bud (1.56 cm) of V_2 was larger than the diameter (1.42 cm) of V_1. First day after flower bud initiation it was found that diameter of flower bud larger than 2 days after flower bud initiation. At 2, 3, 4, 5 days after flower bud initiation, diameter of flower bud gradually increased (Fig. 7) in very small scale. But it decreased at 6 days after flower bud initiation because when flower bloom the diameter of flower bud decreased.

Growth chemicals showed significant variation in the diameter of flower bud (Appendix V). Flower bud was observed at 5 days after flower bud initiation all the treatments were found more or less similar (Fig. 8). The diameter of flower bud gradually increases from 1 to 5 days after flower bud initiation in very small scale but decreased at 6 days after flower bud initiation due to flower blooming. The diameter of flower bud (1.61 cm) was largest in F_2 treatment and smallest was (1.37 cm) in F_0 treatment. It means 4-CPA increased diameter of flower bud that was disagreement with the results forwarded by Khan *et al.* (2007), Than *et al*. (2007), Moond *e .al*. (2006), Zhuang-yingoiang (2004) and Meher *et al*. (1999). But similar opinion was found out by Sidahmed and Kliewer (1980).

Combine effect of variety and growth chemicals was found to be significant in terms of the diameter of flower bud (Appendix V). Largest (1.69 cm) diameter of flower bud was produced by V_2 when plants were treated with 4-CPA that was in V_2F_2 treatment and the smallest (1.28 cm) was found in V_1F_0 at 5 days after flower bud initiation (Table 4).

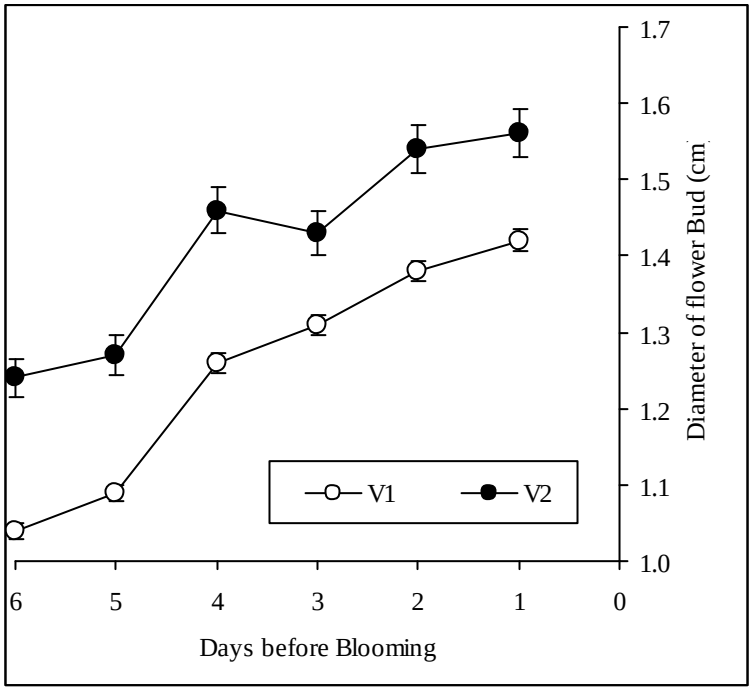

Fig. 7. Effect of variety on diameter of flower bud at different days after flower bud initiation of gerbera. (V_1: Red colored flower, V_2: Yellow colored flower)

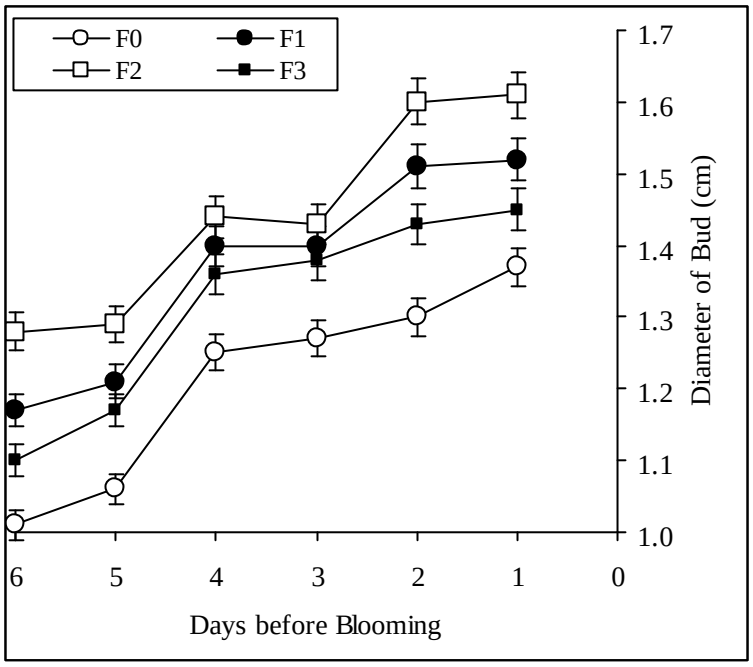

Fig. 8. Effect of growth chemicals on diameter of flower bud at different days after flower bud initiation of gerbera. (F_0: Control; F_1: GA_3; F_2: 4CPA; F_3: Flora)

Table 4. Interaction effect of variety and growth chemicals on diameter of flower bud at different days after flower bud initiation of gerbera

Treatment	Diameter of Flower bud (cm)					
	6 Day	5 Day	4 Day	3 Day	2 Day	1 Day
V_1F_0	0.84 d	0.92 d	1.12 d	1.12 d	1.28 c	1.18 c

V_1F_1	1.18 b	1.20 b	1.35 bc	1.52 ab	1.54 b	1.38 ab
V_1F_2	1.17 b	1.22 b	1.35 bc	1.56 ab	1.54 b	1.37 ab
V_1F_3	0.97 c	1.04 c	1.22 cd	1.32 c	1.32 c	1.32 b
V_2F_0	1.17 b	1.20 b	1.38 b	1.48 b	1.47 b	1.37 ab
V_2F_1	1.15 b	1.22 b	1.45 ab	1.51 ab	1.50 b	1.42 ab
V_2F_2	1.39 a	1.36 a	1.53 a	1.64 a	1.69 a	1.50 a
V_2F_3	1.24 b	1.30 ab	1.50 ab	1.55 ab	1.58 b	1.43 ab
$LSD_{(0.05)}$	0.114	0.114	0.14	0.14	0.104	0.114
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01
CV(%)	6.77	6.08	7.01	6.38	4.96	5.46

[x] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

[y] V_1: Red colored flower, V_2: Yellow colored flower and F_0: Control; F_1: GA_3; F_2: 4CPA; F_3: Flora

4.5 Diameter of flower

There was significant variation in respect of flower diameter was obtained due to the effect of variety and growth chemicals individually (Appendix VI). Diameter of flower showed a gradual increasing trend at 1, 2, 3, 4, 5 and 6 days after flower bloom (Fig. 9). Largest (7.24 cm) diameter of flower was observed in V_2 and the smallest (6.94 cm) diameter of flower was recorded from V_1.

Effect of growth chemicals on the diameter of flower was also found to be significant (Appendix VI). largest (7.67 cm) diameter of flower was found in F_2 treatment which also statistically similar with F_3 treatment (7.28 cm) and the smallest (6.39 cm) diameter of flower was found in F_0 (Fig. 10). Considering growth chemicals the diameter of flower was lowest under F_1 treatment though dissimilar opinion was put forwarded by Khan *et al.* (2007), Than *et al*. (2007), Moond *et al.* (2006), Zhuang-yingoiang (2004) and Meher *et al.* (1999).

Combine effect of variety and growth chemicals was found to be significant in terms of diameter of flower (Appendix VI). It was observed that largest (7.68 cm) diameter of flower was produced by V_1 treated with 4-CPA which was statistically almost similar with V_2F_2 treatment (7.66 cm). The lowest (5.51 cm) diameter of flower was found in V_1F_0 (Table 5).

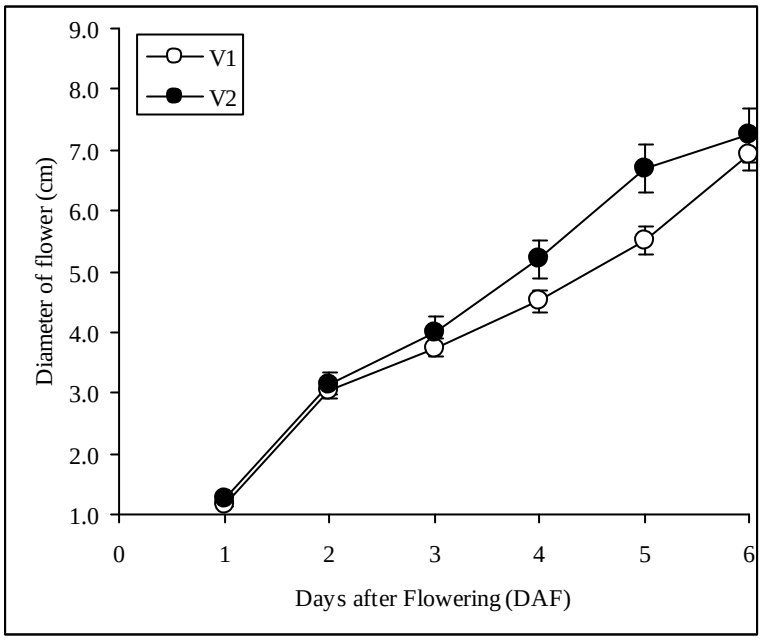

Figure 9. Effect of variety on diameter of flower at different days after flower bud initiation of gerbera. (V_1: Red colored flower, V_2: Yellow colored flower)

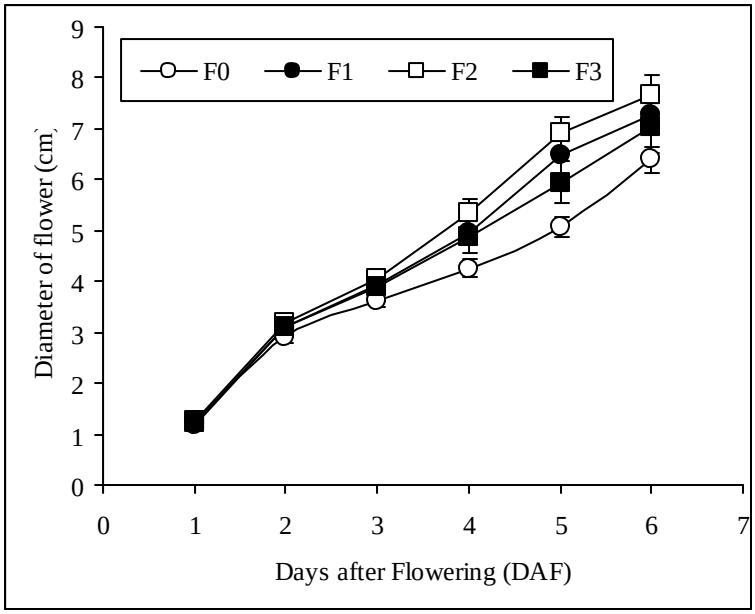

Figure 10. Effect of growth chemicals on diameter of flower bud initiation at different days after flower bud initiation of gerbera.(F_0: Control; F_1: GA_3; F_2: 4CPA; F_3: Flora)

Table 5. Interaction effect of variety and growth chemicals on diameter of flower at different days after flower bud initiation of gerbera

Treatment	Diameter of flower (cm) at					
	1 day	2 day	3 day	4 day	5 day	6 day
V_1F_0	1.04 c	2.58 b	3.36 c	3.53 d	4.10 c	5.51 b
V_1F_1	1.22 ab	3.21 a	3.86 ab	5.24 ab	6.24 ab	7.59 a
V_1F_2	1.24 ab	3.26 a	3.93 ab	4.99 abc	6.42 ab	7.68 a
V_1F_3	1.16 b	3.08 a	3.82 b	4.32 c	5.27 bc	7.00 a
V_2F_0	1.31 a	3.25 a	3.89 ab	4.98 abc	6.02 ab	7.28 a
V_2F_1	1.21 ab	3.02 a	4.02 ab	4.70 bc	6.75 a	6.98 a
V_2F_2	1.26 ab	3.14 a	4.14 a	5.71 a	7.39 a	7.66 a
V_2F_3	1.27 ab	3.16 a	3.99 ab	5.47 ab	6.61 ab	7.05 a
$LSD_{(0.05)}$	0.114	0.287	0.263	0.717	1.241	0.705
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01
CV(%)	6.61	6.35	4.59	10.04	13.83	6.77

[x] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

[y] V_1: Red colored flower, V_2: Yellow colored flower and F_0: Control; F_1: GA_3; F_2: 4CPA; F_3: Flora

4.6 Peduncle Length

Significant variation in respect of peduncle length was recorded due to varietal performance (Appendix VII). Highest (25.32 cm) length of peduncle was found in V_2 treatment and the lowest (24.05 cm) length of peduncle was found V_1 treatment at 18 days after flower bud initiation (Fig. 11).

Growth chemicals showed a gradually increasing trend from 3 to 18 days after flower bud initiation (Wahi *et al*,1991). This showed a statistically significant variation in terms of the length of peduncle at different growth chemicals (Appendix VII). Longest (25.71 cm) peduncle length was observed in F_2 which was also similar to F_1 (25.04) and smallest (28.4 cm) peduncle length was recorded from F_0 (Fig. 12). Although the peduncle length of flower was longer with 4-CPA than GA_3. This opinion was not similar with Zhuang-yingoiang (2004), Mukhopadhyay and Banker (2003) and Kim *et al* (2000) but similar with Kwon *et al*. (2001).

Combine effect of variety and growth chemicals showed statistically significant variation in terms of the length of peduncle (Appendix VII). The highest (26.25 cm) length of peduncle was observed in the treatment combination of V_2F_2 which is statistically similar with V_2F_1 (25.25 cm) and the lowest (21.87 cm) length of peduncle was found in V_1F_0 (Table 6) at 18 days after flower bud initiation.

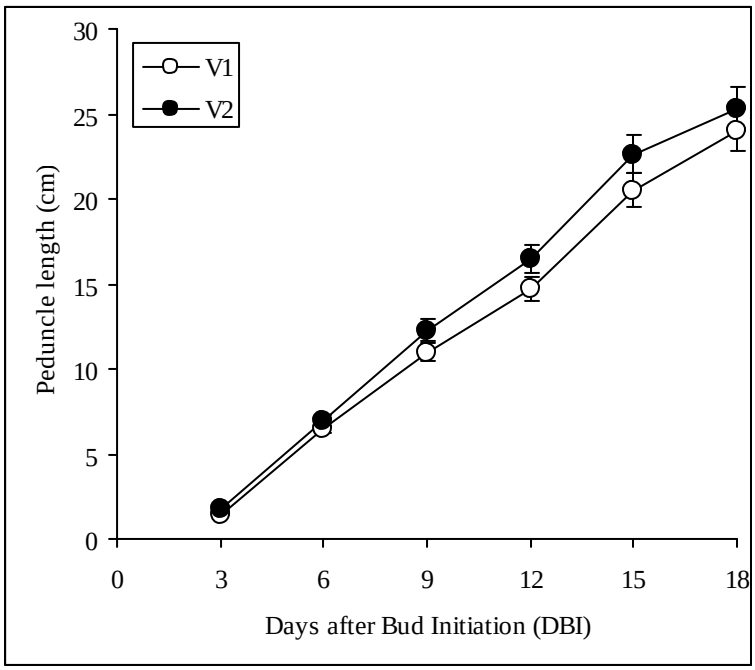

Fig. 11. Effect of variety on peduncle length at different days after bud initiation of gerbera.(V_1: Red colored flower, V_2: Yellow colored flower)

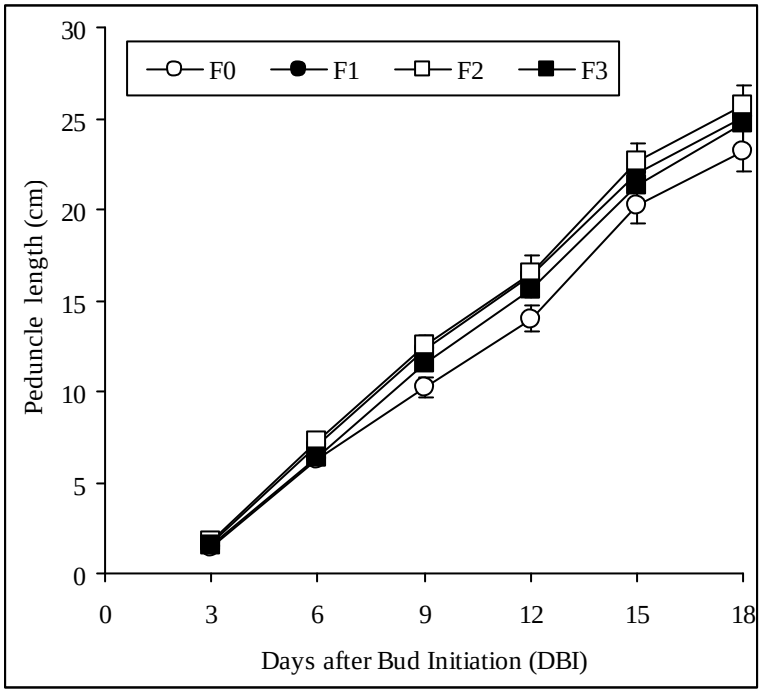

Fig. 12 Effect of growth chemicals on peduncle length at different days after gerbera flower bud initiation. (F_0: Control; F_1: GA_3; F_2: 4CPA; F_3: Flora)

Table 6. Interaction effect of variety and growth chemicals on peduncle length at different days after flower bud initiation of gerbera [x]

Treatment [y]	Days after Bud Initiation (DBI)					
	3	6	9	12	15	18
V_1F_0	1.12 c	5.91 e	9.23 c	12.91 c	18.29 e	21.87 c
V_1F_1	1.58 ab	6.82 bc	12.54 a	16.09 ab	21.41 c	24.83 b
V_1F_2	1.65 ab	7.04 b	12.10 ab	15.68 ab	21.75 bc	25.17 ab
V_1F_3	1.37 bc	6.27 de	10.15 c	14.23 bc	20.54 d	24.34 b
V_2F_0	1.64 ab	6.53 cd	11.23 b	15.09 ab	22.15 bc	24.57 b
V_2F_1	1.79 a	7.15 ab	11.99 ab	16.60 a	22.64 b	25.25 ab
V_2F_2	1.84 a	7.55 a	13.07 a	17.29 a	23.63 a	26.25 a
V_2F_3	1.73 a	6.52 cd	12.83 a	16.96 a	22.08 bc	25.20 ab
$LSD_{(0.05)}$	0.29	0.451	1.023	1.998	0.827	1.104
Level of significance	0.01	0.01	0.01	0.01	0.01	0.05
CV(%)	12.4	4.55	5.97	8.51	6.61	5.04

[x] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

[y] V_1: Red colored flower, V_2: Yellow colored flower and F_0: Control; F_1: GA_3; F_2: 4CPA; F_3: Flora

4.7 Peduncle diameter

As evident from Appendix VIII peduncle diameter was significantly affected by different gerbera variety. Peduncle diameter showed gradual increasing trend from 3 days to 18 days (Fig. 13). V_2 variety of gerbera was produced higher (1.11 cm) peduncle length than V_1 variety (1.05 cm).

Peduncle diameter of gerbera differs significantly for growth chemicals used as foliar application compared to control and among the chemicals (Appendix VIII). Peduncle diameter difference among all treatments was very small scale (Fig. 14). Highest peduncle diameter (1.12 cm) was observed in F_2 treatment which also similar with both F_1 and F_3 (1.09 cm) treatment. Lowest peduncle length was observed in F_0 treatment at 18 days. But the result found out by Gautam *et al*. (2006) was GA_3 increased peduncle diameter.

When combined effect of variety and growth chemicals was considered, it was observed that highest peduncle length (1.15 cm) were produced by the V_2 treated with 4-CPA which was also similar with V_2F_3 treatment (1.11 cm) and lowest peduncle length (0.95 cm) was obtained from V_1F_0. Although all treatments showed more or less similar diameter (Table 7).

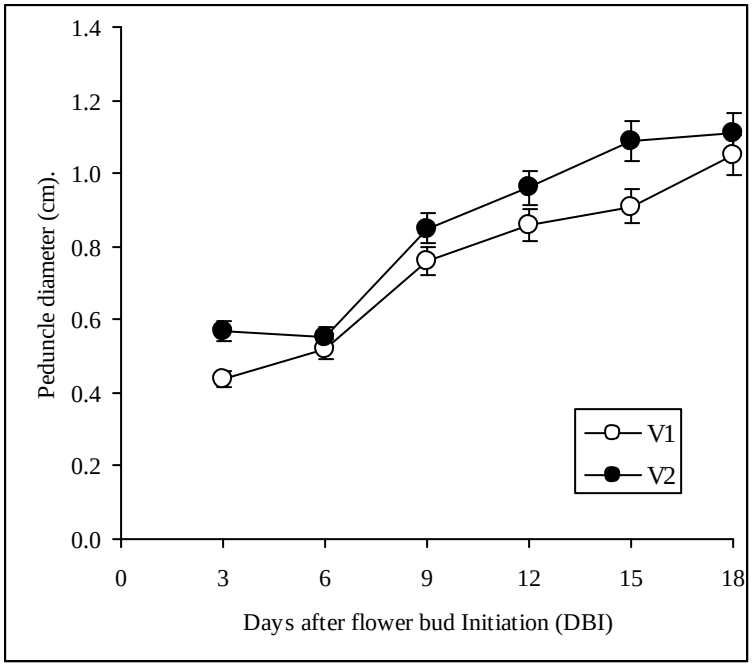

Fig.13. Effect of variety on diameter of peduncle at different days after flower bud initiation of gerbera. (V_1: Red colored flower, V_2: Yellow colored flower)

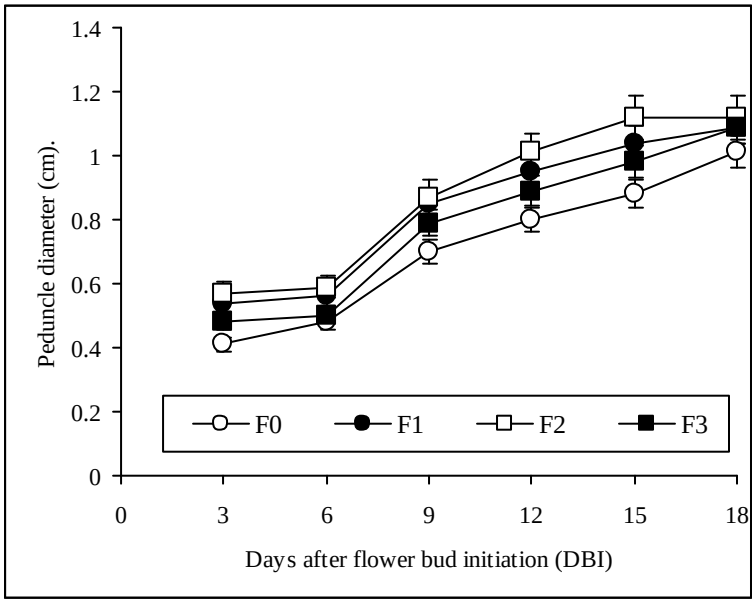

Fig.14. Effect of growth chemicals on diameter of peduncle at different days after flower bud initiation of gerbera. (F_0: Control; F_1: GA_3; F_2: 4CPA; F_3: Flora)

Table 7. Interaction effect of variety and growth chemicals on diameter of peduncle at different days of bud initiation of gerbera [x]

Treatment [y]	Days after Flower Bud Initiation (DBI)					
	3	6	9	12	15	18
V_1F_0	0.31 c	0.45 d	0.64 c	0.71 e	0.73 d	0.95 d
V_1F_1	0.49 ab	0.56 abc	0.86 a	0.94 bc	1.04 b	1.08 bc
V_1F_2	0.54 ab	0.57 ab	0.84 ab	0.98 ab	1.04 b	1.09 bc
V_1F_3	0.41 bc	0.49 cd	0.70 c	0.82 d	0.85 c	1.06 c
V_2F_0	0.51 ab	0.51 bcd	0.77 b	0.90 c	1.03 b	1.07 bc
V_2F_1	0.59 a	0.57 abc	0.83 ab	0.95 bc	1.03 b	1.09 bc
V_2F_2	0.61 a	0.62 a	0.90 a	1.03 a	1.20 a	1.15 a
V_2F_3	0.55 a	0.51 bcd	0.88 a	0.95 bc	1.11 b	1.11 ab
$LSD_{(0.05)}$	0.123	0.066	0.066	0.066	0.081	0.047
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01
CV(%)	16.08	7.38	6.01	4.84	5.01	7.31

[x] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

[y] V_1: Red colored flower, V_2: Yellow colored flower and F_0: Control; F_1: GA_3; F_2: 4CPA; F_3: Flora

4.8 Days form flower bud initiation to flower bloom

Different varieties exhibited variation in respect of days for flower bud initiation to flower blooming (Appendix VIII). V_2 variety took maximum time (16.13) from flower bud initiation to flower bloom than V_1 (14.25) variety (Table 8).

Effect of growth chemicals on days for flower bud initiation to flower bloom was also found to be statistically significant (Appendix VIII). Maximum days (17.25) was taken by F_0 treatment and minimum days (12.88) was taken by F_1 treatment from flower bud initiation to flower bloom. This also means GA_3 hasten flower bloom. The similar opinion was also put forwarded by Gautam *et al. (*2006), Zhan-xiaonYue *et al.* (2006), Kim *et al.* (2001) and Moghadam and Mokhtarian (2000-2001).

Interaction between variety and growth chemicals on flower bud initiation to flower bloom was found to be significant (Appendix VIII). Maximum days (18.00) was recorded from V_2F_0 and minimum days (12.50) was recorded from V_1F_3 which also statistically similar to the treatment V_2F_1 (12.75) from flower bud initiation to flower bloom (Table 9).

4.9 Number of flower per plant

Number of flower per plant was significantly varied with the varieties (Appendix VIII). Maximum (14.13 / plant) number of flower was recorded from V_1 while minimum (8.88 / plant) number of flower was recorded from V_2 (Table 8).

Growth chemicals significantly influenced the production of flower per plant (Appendix VIII).This was in agreement with Narayanan *et al*. (2003). Plant treated with F_2 produced maximum (14.0 / plant) number of flower, While minimum (9.38 / plant) number of flower was obtained from the F_0 treatment (Table 8). Similar opinions were also put forwarded by AVRDC (1990).

Combine effect of varietal performance and growth chemicals was found to be significant in terms of number flower per plant (Appendix VIII). Maximum (17.50 / plant) number of flower per plant was recorded from V_1F_2 and minimum (8.50 / plant) number of flower per plant was recorded from V_2F_1 (Table 9). This opinion was not similar with Farooqi *et al*. (1999) but similar with Li-ShenChong *et al* (2008).

4.10 Leaf area

A significant variation in respect of leaf area was recorded due to varietal performance. Maximum leaf area (37.49 cm^2) was found in V_2 treatment and minimum leaf area (35.15 cm^2) was obtained from V_1 treatment (Table 8).

Significant variation was showed by growth chemicals for leaf area (Appendix VI II). Leaf area was obtained maximum (39.48 cm^2) when the plants were

treated with GA_3 and the lowest leaf area (33.68 cm^2) was in F_3 treatment (Table 8). GA_3 application increased leaf area of gerbera and similar result was also found by Chandrappa *et al* (2000).

The combined effect of variety and growth chemicals showed a significant variation for leaf area (Appendix VIII). Leaf area varied form 40.70 cm^2 to 28.25 cm^2 due to interaction effect of variety and different growth chemicals. Among the combined effect the maximum leaf area was obtained from V_2F_1 treatment and was lowest in V_2F_0 (Table 9).

Table 8. Effect of variety and growth chemicals on leaf area and flowering of gerbera

Treatment [y]	LAI	Days to blooming	Flowers/ plant
V1	35.15	14.25 a	14.13 a
V_2	37.49	16.13 b	8.88 b
$LSD_{(0.05)}$	--	1.612	0.595
Level of significance	NS	0.05	0.01
F_0	38.18 ab	17.25 c	9.38 c
F_1	39.48 a	12.88 a	11.50 b
F_2	33.93 b	16.00 bc	14.00 a
F_3	33.68 b	14.63 ab	11.13 a
$LSD_{(0.05)}$	5.028	2.279	0.842
Level of significance	0.05	0.01	0.01
CV(%)	13.31	14.43	7.04

[x] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

[y] V_1: Red colored flower, V_2: Yellow colored flower and F_0: Control; F_1: GA_3; F_2: 4CPA; F_3: Flora

Table 9. Interaction effect of variety and growth chemicals on leaf area and flowering of gerbera

Treatment [y]	LAI	Days to blooming	Flowers/ plant
V_1F_0	35.66 abc	16.50 b	11.50 d
V_1F_1	38.68 ab	13.00 a	14.50 b
V_1F_2	39.60 a	15.00 ab	17.50 a
V_1F_3	36.01 ab	12.50 a	13.00 c
V_2F_0	28.25 c	18.00 b	7.25 f
V_2F_1	40.70 a	12.75 a	8.50 e
V_2F_2	40.28 a	17.00 b	10.50 d
V_2F_3	31.36 bc	16.75 b	9.25 e
$LSD_{(0.05)}$	7.11	3.223	1.19
Level of significance	0.05	0.01	0.01
CV(%)	13.31	14.43	7.04

[x] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

[y] V_1: Red colored flower, V_2: Yellow colored flower and F_0: Control; F_1: GA_3; F_2: 4CPA; F_3: Flora

CHAPTER V
SUMMARY AND CONCLUSION

There has been a slow progress in gerbera production in our country due to lack of information and records which serve as guides in the development of technology for profitable production. Farmers still practice the traditional method of the crop, resulting in low production and poor quality of flower. The improvement of gerbera production depends upon soil and climatic condition as well as cultural practice of maintaining the proper management.

In order to maximize the better production of gerbera, a research was conducted to investigate the growth and yield of gerbera by growth chemicals at the horticulture farm, Sher-e-Bangla Agricultural University, Dhaka during the period from July, 2009 to April, 2010. Experiment included two varieties viz. V_1 (red colored flower) and V_2 (Yellow colored flower) and growth chemicals viz. F_0 (control), F_1 (GA3), F_2 (4-CPA) and F_3 (Flora-Nitrobenzene 20% w\w). The two factor experiment was laid out in Complete Randomized Design (CRD) with four Replications. The size of the each pot was 20 cm × 18 cm. Suckers were planted on 16th July, 2009. Each pot containing single plant and single plant was selected and marked for the collection of data.

Data were taken for leaf number per plant, leaf length, leaf width, diameter of flower bud, diameter of flower, peduncle length, peduncle diameter, number of flower per plant, days from flower bud initiation to flower bloom and leaf area. All the collected data were statistically analyzed for evaluation of the treatments effect. The summary of the results and conclusion have been described in this chapter.

Influence of variety, growth chemicals and their interaction, in respect of the growth and yield contributing character were found to be significant. Regarding the flower characteristic maximum leaf number (29.63) was recorded by V_2, while minimum leaf number (26.88) was recorded from V_1. In

case of growth chemicals, maximum leaf number (31.88) was recorded from F_1 and minimum leaf number (22.75) was recorded from F_0. In combined effect of variety and growth chemicals maximum leaf number (33.50) was recorded from V_2F_1 and minimum leaf number (22.00) was recorded from V_1F_0.

Leaf length on variety, longest leaf (23.57 cm) was recorded from V_2 and shortest (21.59 cm) leaf length was obtained from V_1. In case of growth chemicals on the leaf length, longest (25.30 cm) leaf length was obtained from F_1 and shortest (19.92 cm) leaf length was recorded from F_0. Variety with growth chemicals on leaf length, longest (27.57cm) leaf length was found in V_2F_1, while shortest (119.35 cm) leaf length was obtained from V_1F_0.

Highest (12.91 cm) leaf width was obtained from the variety V_2 and lowest leaf width (11.49 cm) was recorded from V_1. Highest (13.52 cm) leaf width was recorded in F_1. On the other hand lowest (10.98 cm) leaf width was recorded from F_0 in terms of growth chemicals. Variety and growth chemicals was found to be highest (14.28 cm) leaf width was observed by treatment combination of V_2F_1 and lowest (10.00 cm) leaf width was obtained from V_1F_0.

Diameter of flower bud on variety highest flower bud diameter (1.24 cm) was recorded from V_2 and lowest (1.04 cm) was obtained from V_1. In case of growth chemicals highest (1.61 cm) diameter of flower was recorded from F_2 and lowest (1.37 cm) was obtained from F_0. In terms of variety and growth chemicals highest (1.69 cm) diameter of flower was recorded from V_2F_2 and lowest (1.28 cm) was obtained from V_1F_0 treatment.

In respect of diameter of flower on variety highest (7.24 cm) diameter of flower was observed in V_2 and lowest (6.94 cm) diameter of flower was recorded from V_1. In case of growth chemicals the diameter of flower highest (7.67 cm) diameter of flower was found in F_2 and lowest (6.39 cm) diameter of flower was found in F_0. Variety and growth chemicals highest (7.68 cm) diameter of flower was found in V_1F_2 which also similar with V_2F_2 (7.66 cm) and lowest (5.51 cm) diameter of flower was found in V_1F_0.

Peduncle length on variety longest (25.32 cm) length of peduncle was found in V_2 and shortest (24.05 cm) length of peduncle was found from V_1 variety. In the growth chemicals, longest (25.71cm) peduncle length was observed in F_2 and shortest (23.22 cm) peduncle length was recorded from F_0. In case of variety and growth chemicals longest (26.25 cm) peduncle length was observed in the treatment combination of V_2F_2 and shortest (21.87 cm) peduncle length was found in V_1F_0.

Peduncle diameter on variety highest (1.11 cm) peduncle diameter was found in V_2 and lowest (1.05 cm) peduncle diameter was found from V_1 variety. In case of growth chemicals, highest (1.12cm) peduncle diameter was observed in F_2 and lowest (1.01 cm) peduncle diameter was recorded from F_0. In case of variety and growth chemicals highest (1.15 cm) peduncle length was observed in the treatment combination of V_2F_2 and lowest (0.95 cm) peduncle diameter was found in V_1F_0.

Number of flower per plant on variety maximum (14.13 / plant) number of flower per plant was recorded from V_1 while minimum (8.88 / plant) number of flower per plant was recorded from V_2. In the growth chemicals maximum (14.0 / plant) number of flower per plant was obtained from the F_2. While minimum (9.38 / plant) number of flower per plant was obtained from the F_0 treatment. In interaction of variety with growth chemicals maximum (17.50 / plant) number of flower per plant was recorded from V_1F_2 and minimum (8.50 / plant) number of flower per plant was recorded from V_2F_1.

Days from flower bud initiation to flower bloom in V_2 treatment needed longest period and that was 16.13 and shortest period was needed for V_1 treatment and that was 14.25. Days from flower bud initiation to flower bloom was shortest (12.88) when the plants were treated with GA_3. Flower bloom was delayed and it had taken 17.25 days when the plants were just treated with only fresh water (F_0 treatment). In case of V_1F_3 treatment minimum days (12.50) required for flower bud initiation to flower bloom which also statistically

similar with V_2F_1 (12.75) treatment where as the maximum days (17.00) required for V_2F_2 treatment.

Maximum leaf area (37.49 cm^2) was found in V_2 treatment and minimum leaf area (35.15 cm^2) was obtained from V_1 treatment. The leaf area was obtained maximum (39.48 cm2) in case of F_1 treatment and the lowest leaf area (33.63) was due to F_3 treatment. Among the combined effect the maximum leaf area was obtained from V_2F_1 treatment and was lowest in V_2F_0.

Conclusion

V_2 that was yellow colored flower bore maximum leaf number per plant , leaf length, leaf width, diameter of flower bud, diameter of flower, peduncle length, peduncle diameter flower, leaf area and days from flower bud initiation to flower bloom than V_1 variety. But V_1 variety bore maximum flower number, because of vegetative growth suppresses the reproductive growth. Among the different growth chemicals leaf number per plant , leaf length, leaf width, days from flower bud initiation to flower bloom and leaf area was maximum when the plant was treated with GA_3 but diameter of flower bud, diameter of flower, peduncle length, peduncle diameter and number of flower was maximum in case of 4-CPA. In case of combined effect the flower number was maximum in V_1 treated with 4-CPA. But peduncle length, peduncle diameter, diameter of flower bud and flower diameter were found maximum under V_2F_2 combination. Considering the above circumstances, it may conclude that the V_1 is the suitable for getting maximum flower number but growth is very low and V_2 is suitable for commercial quality flower and sustainable variety for the commercial production in Bangladesh. Among the growth chemicals 4-CPA performs the best result in terms of flower number and quality of flower though growth was better in GA_3.

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

I. Further study is needed in different agro-ecological zones (AEZ) of Bangladesh for regional adaptability.
II. Other different combination of variety and growth chemicals may include for further study.

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