EFFECT OF CORM SIZE AND PLANT GROWTH REGULATORS ON GROWTH AND YIELD OF GLADIOLUS

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EFFECT OF CORM SIZE AND PLANT GROWTH REGULATORS ON GROWTH AND YIELD OF GLADIOLUS

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CERTIFICATE

This is to certify that thesis entitled, **"EFFECT OF CORM SIZE AND PLANT GROWTH REGULATORS ON GROWTH AND YIELD OF GLADIOLUS"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (MS) in HORTICULTURE**, embodies the result of a piece of *bona-fide* research work carried out by **HOSHAIN MOHAMMAD ARSHAD**, Registration No. **06-1912** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated: June, 2013
Place: Dhaka, Bangladesh

…………………………………………

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DEDICATED

TO MY

BELOVED PARENTS

EFFECT OF CORM SIZE AND PLANT GROWTH REGULATORS ON GROWTH AND YIELD OF GLADIOLUS

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ABSTRACT

A field experiment was conducted at the Floriculture Research Field, Bangladesh Agricultural Research Institute, Gazipur from October 2012 to May 2013. The experiment consisted of two factors such as Factor A: corm size (3 levels) : large (50 g) - S_1, medium (30 g) - S_2 and small (15 g) - S_3 and Factor B: plant growth regulator (seven levels) (G_0- Control, G_1- GA_3 100, G_2 - GA_3 150, G_3-GA_3 200, G_4-BAP 50, G_5-BAP 100 and G_6- BAP 150 ppm, respectively). This experiment was laid out in randomized complete block design with three replications. The results of the experiment showed that the corm size and plant growth regulators had significant effect on most of the parameters. Maximum yield of spike (230000/ha) was observed for largest corm size and minimum (180000/ha) for smallest corm size. Among all concentration of plant growth regulators, GA_3 at 200 ppm produced the highest yield per hectare (250000 spikes) while control produced lowest yield (200000 spikes). However, the treatment combination of large size corm and GA_3 at 200 ppm showed the best performance in respect of vegetative growth, flower and corm production in Gladiolus.

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LIST OF ABBREVIATED TERMS

ABBREVIATIONS	FULL WORD
%	Percent
@	At the rate
Agric.	Agriculture
Agril.	Agricultural
ANOVA	Analysis of variance
BAP	Bengyl Amino Purine
BARI	Bangladesh Agricultural Research Institute
CCC	Cycocel
CRD	Completely Randomized Design
CV%	Percentage of Coefficient of Variation
cv.	Cultivar (s)
cm	Centi-meter
df	Degrees of Freedom
DMRT	Duncan’s Multiple Range Test
et al.	And others
etc.	Etcetera
GA_3	Gibberellic Acid
HRC	Horticulture Research Centre
Kg	Kilogram
m^2	Square meter
Max.	Maximum
mg/L	Miligram per Litre
MH	
MoP	Muriate of Potash
ppm	Parts per million
RCBD	Randomized Complete Block Design
SAU	Sher-e-Bangla Agricultural University
Viz.	Namely

CHAPTER I

INTRODUCTION

Gladiolus is a popular flowering plant grown all over the world, from South Africa to West Asia. The name gladiolus was derived from the Latin word gladiolus, because of its sword-like leaves. It is popularly known as sword lily. It was introduced into cultivation at the end of the 16^{th} century (Parthasarathy and Nagaraju, 1999). The modern hybrids are botanically known as *Gladiolus grandiflorus* belonging to family Iridaceae.

Gladiolus is one of the most popular cut flower in Bangladesh. The agro-ecological conditions of the country are very conducive for its survival and culture as a crop. Regarding the areas and production of gladiolus flowers, so far no authentic reports are available in the country. Khan (2009) reported that the area of flower production appears to have increased significantly and estimated area of around 10,000 ha and the annual trade at wholesale level to be worth between 500-1000 million taka in Bangladesh. Momin (2006) reported that income from gladiolus flower production is six time higher than returns from rice.

In the international cut-flower trade gladiolus occupies fourth place (Bhattacharjee and De, 2010). It is mainly cultivated for cut-flowers because of its elegant appearance and prolonged vase life. Gladiolus spikes are most popular in flower arrangements and for preparing attractive bouquest (Mishra *et al.*, 2006). The magnificent inflorescence with various colour have made it attractive for use in herbaceous borders, beddings, rockeries, pots and for cut-flowers.

Apart from ornamental value, gladiolus have extensively utilized in medicines for headache, lumbago, diarrhea, rheumatism and allied pains (Bhattacharjee and De, 2010). Flower and corm of some gladiolus are used as food in many countries (Khan, 2009). The flowers of different Gladiolus *sp.* are used as uncooked salad by nipping of their anthers. It has been found that the corms of *Psittacinus* hybrids contain high amount of carbohydrate mostly as starch (65.4 to 78.6%) and protein (12.6 to 18.5%).

There are many factors which can affect plant growth and economic cultivation of gladiolus such as variety, size of corm and cormel, depth of planting, application of fertilizer etc. The number of florets per spike, longest spike and rachis length, flower quality, corm and cormel production etc. were found related to corm size (Bhattacharjee, 2010). Sudhakar and Kumar (2012) reported that plants raised from large size corm had the greatest plant height, maximum length of spike, longest rachis, highest number of florets per spike, maximum percentage of flowering plant, heaviest corm and highest number of cormels per plant.

Normal plant growth and development are regulated by naturally produced chemicals or phytohormones. Their role can often be substituted by application of synthetic growth regulating chemicals. These are becoming extremely important and valuable in the commercial control of crop growth in both agriculture and horticulture (Jinesh *et al*., 2011). The potential use of growth regulators in flower production has created considerable scientific interest in recent years. Many studies have indicated that the application of growth regulators can affect the growth and development of gladiolus flowers (Chopde *et al.*, 2011).

There is a scope of flower, corm and cormel production of gladiolus with the appropriate size of corm and application of growth regulators like GA_3, Ethrel, Paclobutrazol, Auxins, Cytokinins etc. Application of optimum level of growth regulators may not only ensure better yield and quality of gladiolus, as well as minimum wastage of growth regulators. In Bangladesh a few studies were done regarding the corm size and use of growth regulators for growth, flowering and corm production of gladiolus.

Considering the above mentioned facts, the present investigation was undertaken with the following objectives:

i. to study the growth, flowering and yield performance of gladiolus utilizing different sizes of corm as planting materials;

ii. to find out the optimum level of growth regulators for maximum vegetative growth and production of flowers; and

iii. to find out the best combination of corm size and growth regulators for maximum growth and yield of gladiolus.

CHAPTER II

REVIEW OF LITERATURE

Gladiolus is the fourth most popular cut flower in the world. Many research works have been done on various aspects of this important cut flower in different countries of the world. However, a limited research has been carried out on this flower in respect of corm size and growth regulators under Bangladesh condition. A review of literature related to the present study has been presented in this chapter.

2.1 Effect of corm size on growth and yield of gladiolus

Generally, corm and cormels are used as planting materials for propagation of gladiolus. Size of corm used at planting has direct effect on flower and corm production of gladiolus.

An experiment was carried out by Sudhakar and Kumar (2012) to study the effect of corm size and spacing on growth and flowering in gladiolus sp cv. white friendship in Tamilnadu condition. Corms of different sizes, viz. 3.5– 4.5 cm, 4.6-5.5 dia. cm and above 5.5 cm were planted at the spacing, viz. 30 × 20 cm, 30 × 25 cm and 30 × 30 cm were planted and found that corm size of large 5.5 cm and spacing of 30 × 30 cm were found excellent in respect of vegetative, floral and corm yield compared to others.

Ahmad *et al.,* (2009) observed the effect of different bulb size on growth, flowering and bulblet production of tuberose (*Polianthes tuberosa* L.) cv. Single under agro-ecological conditions of Faisalabad country during 2005-06 so as to explore the best bulb size for the best quality flower spikes production as well as maximum bulb and bulblet production. It was observed that large bulb size resulted in vigorous growth, maximum yield and more number of bulblet as compared to small and medium sized bulbs.

A field experiment was conducted to investigate the effect of corm size on the vegetative and floral attributes and corm and cormel production in gladiolus by (Memon *et al.,* 2009) in Pakistan.

For this purpose, corms of three commercially grown varieties, viz. ‘Traderhorn’, ‘White Friendship’ and ‘Peter Pears’ of three different sizes- small, (dia. 2.2-2.4 cm), medium (dia. 2.7-3.0 cm) and large (dia. 3.2-3.5 cm) were planted in split plot design consecutively for two years, i.e., 2006 and 2007. Large sized corms significantly increased the leaf breadth, length of flowering spike, and number of florets spike^{-1} over those produced from small and medium ones, whereas plant height was greatly decreased in response to large sized corms. Regarding corm production, large sized corms produced significantly higher weight of corms plant^{-1}, cormels plant^{-1} and combined total weight of corms and cormels plant^{-1} in all the three varieties of gladiolus.

A field trail at Haryana, India during 1997-99 was conducted by Sharma and Gupta (2003) to investigate the effects of corm size (3.1-3.5, 3.6-4.0, 4.1-4.5 and 4.6-5.0 cm) and spacing (10 × 40, 20 × 40, 30 × 40 and 40 × 40 cm) on the growth and flowering of gladiolus. Plant height, number of leaves per plant, spike length, number of florets per spike and number of spike per plant increased, whereas the number of days to spike emergence and blooming deceased with increasing corm size. The number of corms per plant, corm weight and diameter, number of cormels per plant and cormel weight per plant increased with increasing corm size and plant spacing.

In another experiment at Arabhavi, India, Kalasareddi *et al.,* (1998) reported that the largest corms took the shortest period for sprouting (5 days) and the smallest corms took the longest period (9.5 days). They also noticed that larger corms produced more leaves, taller plants and thicker stems. It was found that spike yield was the highest with the largest corms (2024 spikes/plant) and least with the smallest corms (0.96 spikes/plants).

Singh (1998) carried out an experiment in Jachh, Himachal Pradesh in 1994-95, gladiolus cv. Sylvia corms of 3 sizes, viz. large (6.0 ± 0.15 cm diameters), medium (4.2 ± 0.15 cm) and small (3.3 ± 0.15 cm) were planted in November. Percentage sprouting was highest in large corms (99.73%, compared with 81.90% and 67.60% for medium and small corms, respectively). Large corms were also superior in terms of number of shoots/corm, time to sprouting, plant height, spike length, number of spikes, number of florets/spike (15.53 vs. 12.51 and 9.52 for medium and small corms, respectively) and diameter of corm produced (5.98 cm vs. 3.98 and 3.67 cm for medium and small corms, respectively).

Singh and Singh (1998) studied the effect of corm size on flowering and corm production of gladiolus cv. Sylvia in Himachal Pradesh, India. Corms of three different sizes, viz. large (6.0 ± 0.15 cm), medium (4.2 ± 0.15 cm) and small (3.3 ± 0.15 cm) were planted in November. They found that the percentage of sprouting was the highest in large corms (99.73%) compared to 81.90% and 67.60% in medium and small corms, respectively. Large corms were also superior in terms of number of spikes, number of shoots per corm, time to harvest, plant height, spike length, number of flowers per spike (15.33, 15.51 and 9.52 for large, medium and small, respectively) and diameter of corm produced (5.98, 3.98 and 3.67 cm) for large, medium and small corms respectively.

Kalasareddi *et al.*, (1997) conducted an experiment to study the effect of corm size (very small, small, medium or large) on flowering of Gladiolus cv. Snow White. Corm size significantly influenced the time taken for spike, emergence, flowering, complete flowering, spike length, spike girth, number of flowers per spike and number of spikes per hectare. Large corms flowered earlier than smaller corms and produced better quality spikes. The highest yield of spikes (373.33 t/ha) was obtained from large corms.

Rabbani and Azad (1996) carried out an experiment to investigate the effect of plant spacing, viz. 20 × 10, 20 × 15, 20 × 20 cm and corm size, viz. large (30 g), medium (16.0 g) and small (6.5 g) on growth, flowering, corm and cormel production of gladiolus cv. 'Friendship'. Plant spacing had significant effect on days to 80% spike initiation, rachis length, number of florets, days required to 80 % spike harvest and yield of spike per hectare. Corm size had significant effect on all the parameters studied. Large and medium size corms were found superior than small size corm.

In an experiment, Singh (1996) studied the effect of cormel sizes and levels of nitrogen on corm production of gladiolus cv. Pink Friendship in India. The different cormel sizes were 1.30-1.90 or 1.91-2.50 cm in diameter and the rates of nitrogen were 100, 150, 200, 300 or 350 kg per hectare. It was found that large cormels produced large corms with the highest number of cormels per plant.

Mollah *et al.,* (1995) carried out an experiment to investigate the effect of cormel size and spacing on growth and yield of flower and corm of gladiolus at Pahartali, Chittagong, Bangladesh. They reported that large sized cormels (7.0 ± 0.2 g) with the widest spacing (15 × 15 cm) produced the maximum length of spike (36.34 cm), longest rachis (11.90 cm), maximum plant height (56.60 cm), maximum percentage of flowering plant (54.60), heavier corm (31 g) and highest number of cormels (21.87) per plant.

Ogale *et al.,* (1995) studied the role of corm size on flowering and corm yield of gladiolus at Mumbai, India. Flowering behavior and final corm yields from corms of 6 different sizes (<1-35 g) at different stages of developmental maturity were studied in cultivars Happy End and Apricot. In both the cultivars they found a direct correlation between corm size, flower production and final corm yield.

Patil *et al.,* (1995) conducted the effect of different spacing and corm sizes on the flower and corm production of gladiolus in India. Gladiolus corms of three sizes (2.1-3.0, 3.1 - 4.0 or 4.1 cm) were planted at spacing of 30 × 10, 30 × 20 or 30 × 30 cm. They found that corm size and spacing had no significant effects on floret size, number of florets per spike or size of corms produced. However, number of spikes and number of corms and cormels produced per plot were significantly affected by both factors, increasing with planting density and corm size at planting. The largest corms yielded 58.68 spikes, 56.67 corms and 722.85 cormels per plot, compared with 34.13 spikes, 33.96 corms and 437.48 cormels per plot for the smallest corms.

Effect of planting time and corm size on the duration of flower and corm production of gladiolus in Korea were investigated by Ko *et al.,* (1994). Corms of different size viz. 6-8, 8-10 or 10-12 cm were planted on 19 May, 17 June and 15 July of 1992. It was found that earlier planting with larger corms (10-12 cm in diameter) produced longer cut-stems and spikes and higher cut flower weight, maximum number of florets (14.3), floret length and diameter and higher percentage of best quality flowers.

Laskar and Jana (1994) studied the effect of planting time and size of corms on plant growth, flowering and corm production of gladiolus in India. Gladiolus corms of different sizes (1.5, 3.0 or 4.5 cm in diameter) were planted on 7 February, 27 February, 19 March or 8 April of 1989 and 1990. It was observed that the best flowering spikes and corms were obtained from large corm (1.86-1.95 corms and 1.58-1.63 flower spikes per plant).

Mohanty *et al*., (1994) conducted 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 planted in India. They noticed that corm size had significant effects on plant growth with plants produced form large corms being taller and thicker showing more leaves with wider leaf blades, longest spike and rachis than those from medium or small corms.

The productivity of corms of gladiolus cv. Oscar and Peter Pears were studied by in two year trial. Corms of different sizes viz. >8, 6-8, 4-6, 2-4 and >2 cm in circumference were used. In general, shoots form larger corms started to emerge earlier than those from smaller corms. Planting to emergence period was similar for both cultivars. The effect of corm size on new corm numbers/m^2 differed in the two experimental years. In one year the use of smaller corms increased corm number/m^2 and in the next year it deceased. The variety Oscar yielded 25 (4-14 cm) corms/m^2 and Peter Pears only 20. However, the yield of small cormels (<4 cm) and total corm yield (up to 14 cm) were similar for the two cultivars.

Hong *et al*., (1989) studied the effect of leaf number left after cutting the flower, corm lifting date and corm size on flowering and corm production in the next crop of gladiolus cv. ‘True Love’ at Suwon, Korea. It was observed that the number of daughter corms and flowering ability increased with increasing corm size up to 4-5 cm in diameter and then declined. Suh and Kwack (1990) also reported that with the use of large corms, formation of good quality corms was promoted.

Dod *et al.,* (1989) carried out an experiment to investigate the effect of different dates of planting and size of corm on growth and flower yield of gladiolus cv. Dibonar. They planted the corms of 1.0-2.0, 2.1-3.0 and >3.0 cm in diameter on 3 or 18 September or 3 October. The best results were obtained with the largest corms (>3.0 cm in diameter) planted on the earliest date.

In an experiment, Gowda (1988) studied the effect of corm size on growth and flowering of gladiolus cv. Picardy under the climatic and soil condition of Bangalore, India. The crop was planted using corms of 3.0-4.0, 4.1-4.5 and 4.5-5.0 cm in diameter. The best results in respect of growth and flowering were obtained from large corms. Medium size corm i.e. 4.1-4.5 cm diameter was suggested for the use under Bangalore condition.

Syamal *et al.,* (1987) studied the effect of 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 cm in diameter) gave earlier sprouting. Increased corm size gave a significant increase in inflorescence and stem length.

Sciortino *et al*., (1986) investigated 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 used the cormel size of 1-4 cm in diameter planted at the rate of 70-140 cormels per square meter. It was found that the best yield of corms (>14 cm in circumference) increased with increasing cormel size.

Misra *et al*., (1985) conducted experiment to study the effect of different sizes of planting materials on flowering and multiplication of gladiolus cv. 'White Oak' in India. They obtained the commercial grade spikes from corms of grade on. (1.9 - 2.5 cm diameter). But acceptable quality spikes were obtained from corm grades in the range of 1.3-1.9 to 0.8-1.0 cm in diameter.

Mukhopadhyay and Yadav (1984) evaluated the effect of corm size and spacing on growth, flowering and corm production of gladiolus in West Bengal, India. Corms ranging in size from 3.5-5.0 cm in diameter were planted at three spacing, viz. 30 × 10, 30 × 15 and 30 × 25 cm. It was observed that large corms (4.0-5.0 cm) produced more flowers, corms and cormels compared to medium and smaller corms.

Bhattacharjee (1981) investigated the effects of corm size, planting depth and spacing on flowering and corm production of gladiolus cv. 'Friendship' at Banglalore, India. Corms of three different sizes, viz. 2.5 - 3.5, 4.0 - 5.0 or 5.5 - 6.5 cm in diameter were planted at the spacing of 15, 20 or 25 cm at the depths of 5, 7 or 9 cm. It was found that spike length, floret number, flower diameter and size and weight of corms were increased with the increase in corm size.

An experiment was conducted by Mckay *et al*., (1981) in Australia to study the effect of corm size and division of mother corm on flowering in four cultivars of gladiolus. They used six sizes of gladiolus corm which were <50 mm, 38-50 mm, 33-38 mm, 25-33 mm, 19-25 and 13-19 min in diameter and were planted whole or after being cut into half parts corm from whole, large corms produced the highest inflorescence yield with better quality.

Bankar and Mukhopadhyay (1980) carried out an experiment to investigate effects of corm size, depth of planting and spacing on the production of flowers and corms in gladiolus. The experiment consisted of three corm sizes, viz. 1.5 - 2.5, 2.5 - 3.5 or 3.5-4.5; three depth of plantings viz. 3, 5 or 7 cm and three spacing, viz. 15, 20 or 25 cm. It was observed that large corms significantly increased the height of plant (58.61 cm) and length of spike (101.12 cm).

Gill *et al*., (1978) in their experiment observed the effect of corm size on the quality of gladiolus flower. Corms of six sizes (<2, 2-10, 10-20, 20-30, 30-40 or >40 g) were used in this experiment. They observed a positive correlation between corm size and plant height, number of leaves per plant and length of flower stalk.

2.2. Effect of growth regulators on growth and yield of gladiolus

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. 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.

A research work was performed by Muhshid (2013) in Varmin Research Center on two varieties namely "White prosperity and Rose supreme" of gladiolus. The treatments were applied on the corm and cormel as follows; gibberellic acid at 4 levels (0, 25, 50,100) mg/l and ethephon at 4 levels (0, 100, 200, 400) mg/l. The result of combined analysis showed that the treatment GA_3 at 100 mg/l and ethephon at 100 mg/l on Rose Supreme variety at the first year had significant effect on the days to sprouting and weight of corm.

Also the maximum number of flowers has been gained through the combination of gibberellic acid and ethephon at 100 mg/l on White prosperity variety at the second year. Combination of gibberellic acid and ethephon at 100 and 200 mg/l had significant effect on the number of cormels.

An experiment was carried out by Sudhakar and Kumar (2012) to study the effect of growth regulators on growth, flowering and corm production of *Gladiolus grandiflorus* L. cv. 'White friendship' in India. Four growth regulators, viz. GA_3, NAA, CCC and MH each at three concentrations in addition to water spray as control comprised thirteen treatments of this experiment. The experiment was laid out in a Randomized complete Block Design (RCBD) with three replication. The results revealed that the growth regulators application significantly influenced the growth and yield in gladiolus. The maximum number of florets/spike, spike length (cm) and flower length (cm) were obtained with GA_3 @ 100 ppm as compared to rest of the treatments. Whereas CCC @ 500 ppm was found the best interms of corm and cormels production.

An investigation was carried out by Taha (2012) at the Nursery of Ornamental plants, Faculty of Agriculture, Minia University, Egypt during the two successive seasons of 2008/2009 and 2009/2010 to study the effect of different concentrations of gibberellins (GA_3), cycocel (CCC) and alar on the growth, flowering and bulb production of iris plants. In this study, the plants of iris were sprayed three times with 0, 250, 500 and 750 ppm of GA_3, 250, 500 and 1000 ppm of CCC and 125, 250 and 500 ppm of Alar. Results showed that GA_3 @ 750 ppm increased number of flowers, flowering stalk diameter, fresh and dry weights of the flowering stalk, bulb and bulblet production compared to control and other treatments.

An experiment was conducted by Chopde (2011) to study the effect of growth regulators, viz. GA_3 and NAA on growth and flowering of three varieties of gladiolus viz. Phule Neelrekha, Phule Tejas and Phule Ganesh in split plot design at Nagpur, India. The results revealed that, the maximum leaves plant^{-1} and spikes hectare^{-1}, minimum days required for opening of first pair of florets and 50 per cent flowering were due to the variety Phule Tejas. Whereas, the maximum total chlorophyll content of leaves before the f1owering and the maximum length of spike, distance between two florets, longevity of flower on plant and length and width of florets were observed under the variety Phule Ganesh. However, effect of PGR was non-significant as regards leaves plant^{-1} and chlorophyll content of leaves. But significantly early opening of first floret and 50 per cent flowering and the maximum spike yield and spike quality parameters, viz. length of spike, distance between two florets, longevity of flower on plant and length and width of florets were noted under the treatment of GA_3 150 ppm.

An experiment was conducted by Jinesh *et al.*, (2011) at Anand Agricultural University, Anand during November, 2008 to March, 2009. The treatments comprised of four growth regulators with their two levels of each, viz. GA_3 (25 and 50 mg/l), NAA (50 and 100 mg/l), Ethrel (100 and 200 mg/l) and CCC (250 and 500 mg/l) including control (only water). The experiment was laid out in Randomized Block Design with nine treatments and three replications. The results revealed that treatment of GA_3 @ 50 mg/l took minimum days for corm sprouting as compared to control and rest of the treatments. Significantly the maximum plant height, leaf length and number of leaves per plant width were registered with the same treatment GA_3 @ 50 mg/l as compared to control. Whereas CCC @ 250 mg/l gave maximum yield of corms and cormels by increasing the number and weight of corms and cormels per plant as compared to control.

Bhattacharjee (2010) 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 in growth and flowering. It was revealed that the GA_3 (as berelex at 0.5 g/l) treated corms sprouted and flowered earlier than the control corms.

A field experiment at Madhya Pradesh, India, during the 2003-04 and 2004-05 cropping seasons, was conducted by Sharma *et al*., (2006) to study the effect of gibberellic acid levels (0, 100, 200 and 300 ppm) on growth, flowering and corm yield in gladiolus (Red Beauty, Jester and Summer Face). The corms of three in gladiolus (Red Beauty, Jester and summer Face). The corms of three cultivars were soaked in different concentrations of gibbrellic acid (GA_3) solution for 24 hr before planting. Results revealed that cultivars and GA_3 significantly affected all the growth, flowering and corm yield parameters. Earliest sprouting (6.54 and 6.82 days) and maximum plant height (100.47 and 102.39 cm), number of leaves per plant (9.49 and 9.68), leaf length (85.00 and 82.80 cm), spike length (73.96 and 75.45 cm), number of florets per spike (18.01 and 16.46), rachis length (62.85 and 60.47 cm), floret length (13.01 and 12.83 cm), number of corms per plant (57.16 and 48.22) and vase life (14.33 and 13.70 days) were recorded with GA_3 at 200 ppm and 'Red Beauty' cultivar.

Bose *et al*., (2003) conducted an experiment to study the effects of GA_3 in flowering and quality characteristics of gladiolus cv. 'Erovision'. Corms were soaked in solutions of 0 (control), 50 and 100 ppm GA_3 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 increased flowering percentage, spike length, the number of flowers per spike and diameter of flower stems.

Gaur *et al*., (2003) investigated 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 (width and length) of leaves and thickness and width of shoots; promoted earliness in spike emergence, colour break in the first floret and flowering; increased the length of spikes, number of florets per spike, size of florets and longevity of spikes; and increased the vase life of cut flowers and the number, weight and diameter of corms and cormels. The highest values for all parameters were recorded with GA_3 at 200 ppm.

Prasad *et al*., (2002) conducted an experiment during 1994-95 in Uttar Pradesh, India, to study the effect of gibberellic acid (at 0, 250 and 500 ppm) on the growth and flowering of gladiolus. GA_3 at 250 ppm increased plant height leaf number, spike length, rachis length, floret number in Tropic Seas.

An experiment at Madhya Pradesh, India, during 1998-99 was conducted by Kirad *et al*., (2001) to determine the effect of plant growth regulators (GA_3 at 50, 100 and 150 ppm; NAA at 25, 50 and 100 ppm; and cycocel at 2000, 4000 and 6000 ppm) on *Gladioulus sp*. cv. 'White Prosperity'. Plant growth regulators were applied by dipping for 12 h or spraying 40 days after planting. The earliest sprouting was obtained with GA_3 at 100 ppm. GA_3 at 100 ppm (dipping + spraying) resulted in the highest leaf number. The tallest plant resulted in the treatment with GA_3 @ 100 ppm (dipping + spraying).

Dutta *et al*., (2001) conducted an experiment during rabi 1999 - 2000 at Pune, Maharashtra, India to determine the effects of gibberellic acid (GA_3) treatment on the corm germination of 10 gladiolus hybrids. Corms of each hybrid were dehusked and cleaned prior to soaking in GA_3 solution at 100, 150 and 200 ppm and water for 24 h. GA_3 @ 200 ppm significantly increased the percentage of corm germination and reduced the number of days required for germination compared with other and control treatments. Seed corm germination values of 62.8 and 64.4% 66.5 were obtained with GA_3 at 100, 150 and 200 ppm, respectively.

Khattab *et al*., (2000) presoaked the cormels of gladiolus for 24h in GA_3 at 0 or 100 ppm in Alexandria, Egypt. Flowering behavior and final corm yields raised from replanting of corm produced from the treated plants were investigated during 1998 and 1999 in Alexandria, Egypt. GA_3 influenced the flowering, corm size and yield produced form replanting of these corms.
In a field trial at Kanpur, Uttar Pradesh, India, Prakash *et al*., (1999) investigated the effect 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 of 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 traits in gladiolus. Use of 150 ppm GA_3 in cv. Friendship produced the longest inflorescences 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 of 40 ppm) or ethrel (25, 50 or 100 ppm) for 12 or 24 hours. Corms were planted in the field 77 days after treatment. Soaking for 24 hours in 20 ppm GA_3 gave the longest spike length (91.0 cm), while 12 hours in 40 ppm GA_3 resulted in the 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 cormels produced per plant was the greatest (3.5) in the treatment of corms with 40 ppm GA_3 for 24 hours.

When 3 different sizes (1.0-2.5, 0.6-0.9 and <0.6 cm diameter) of gladiolus (cv. White Oak) cormels were planted at Katrain, India, Sindhu and Verma (1997) described that the number of days taken for sprouting was decreased, while plant height and spike length both were increased, as cormel diameter increased. On the other hand, GA_3 @ 200 ppm and urea application before planting reduced the number of days for sprouting and increased plant height, spike length, size and number of florets and the size of corms of gladiolus cv. White Oak.

In an experiment at Hissar, India, Reddy *et al*., (1998) reported that the number of bulbs and weight of bulbs per plant increased with increase in bulb size used for planting. Saleable bulbs per plant were greatest in the plants raised from bulbs measuring 2.1-3.0 cm in diameter. Bulb lets were smallest on plants from the smallest bulbs and largest on plants raised from large bulbs.

In an investigation, 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 91.94 cm and number of florets/spike from 10.19 to 10.67.

While working on implication of gibberellic acid on gladiolus corm cv. Sylvia at Kanpur, India, Misra *et al*., (1993) stated that GA_3 application at 0, 50, 100, 200 or 400 ppm enhanced vegetative growth, flowering and number of corm and cormels produced, but adversly affected individual corm weight. GA_3 at 200 ppm reduced the time of 1^{st} and plant emergence % of flowering.

It was concluded that, apart from corm size, GA_3 at 100 and 200 ppm gave encouraging results in respect of spike length, rachis length, floret number, spike yield etc.

Arora *et al*., (1992) carried out an experiment to investigate the effect 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, floral diameter and weight of corms and number, diameter and weight of cormels produced from corm. GA_3 at 100 mg/l accelerated sprouting of corms by 4.6, 3.2 and 4.8 days in cvs. Aldebaran, Pusa Suhagin and Mayur, respectively. Corm weight and diameter were increased by 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.

Suh and Kwack (1990) while working with GA_3 (200 ppm) observed the process of corm formation in gladiolus. Corms were treated with growth regulator viz. 200 ppm GA_3 for 6 hour before planting. In all cultivars, GA_3 treatment increased the weight of corms produced. They also noticed that with the use of large corms, formation of good quality corms was promoted.

In an experiment, Nilimesh and Roychowdhury (1989) studied the effect of growth regulating chemicals in 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). 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.

Mukhopadhyay and Bankar (1986) conducted an experiment to investigate the influence of pre-planting soaking of corm with gibberellic acid that modified growth and flowering of gladiolus cultivar 'Friendship'. Corms were soaked in solutions of 0, 10, 50, 100, 250 and 500 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 number of cormel but increased cormel weight per plant.

Effects of different chemicals (Thiourea at 1000 and 2000 ppm, ethrel at 100 and 200 ppm, gibberellic acid at 50 and 100 ppm or KNO_3 at 2000 ppm) in germination, growth, flowering and corm yield of gladiolus cv. Psittacnus hybrid were studied by Roychoudhuri *et al*., (1985) at Kalyani, India. Corms were soaked in solutions of several chemicals and were planted out. GA_3

@ 50 ppm increased the stalk length and GA_3 @ 100 ppm was effective in increasing the leaf number.

Chemical treatment of corms with 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 Bhattacharjee (1984). GA_3 at 10 and 100 ppm increased the vegetative growth, improved corm size and weight, induced more cormel production, stimulated flower stalk and rachis length, accelerated floret size and number per spike and lengthened the life of the spike. Application of GA_3 at 10 and 100 ppm increased the number of florets per spike. In a study, Dua *et al*., (1984) observed improved flower quality and better corm multiplication when the corms of gladiolus cv. Sylvia were soaked with 100 ppm GA_3 before planting.

Yadav *et al.*, (1984) studied the effect of four bulb sizes 1.5-2.0, 2.1-2.5, 2.6-3.0 and 3.1-3.5 cm in diameter on growth and flower production of tuberose (*Polianthes tuberosa* cv. Single) for a period of three years and recorded that plant crops with large bulb sized bulbs (3.1-3.5 cm) significantly improved the spikes. Considering the total production of three years planting of bulbs having 2.6-3.0 cm recorded the highest yield of spikes (15.1 lakhs/ha) and flowers (30.1 t/ha). In general, bulb having diameters between 2 and 3 cm are suitable for planting. Pathak *et al.*, (1980) noted that bulb size also influenced flowering. Larger bulb cause early flowering and gives higher yield of spikes and flowers.

EL-Meligy (1982) claimed significant effect of GA_3 on corm formation while conducting a field trial with the gladiolus cultivar ‘Eurovision’. Corms were soaked in solutions of GA_3 at 0-500 ppm. The controls were soaked in water. Soaking in GA_3 at 500 ppm gave a cormel yield of more than 1-5 times higher than in the control. Flower colour was also deeper in the treated plants due to higher anthocyanin content.

Soaking of bulbs of *Hippeastrum hybridum* in three concentrations of indole acetic acid, gibberellic acid, cycocel or ethrel showed various responses on growth and flowering as observed by Bose *et al*., (1980). GA_3 increased the stalk length, stalk number, size and weight of bulbs and bulblets compared to control plants.

CHAPTER III

MATERIALS AND METHODS

Details of experimental materials and methods followed during investigation are described in this chapter.

3.1 Experimental site and duration

The experiment was conducted at the Floriculture Research Field, Horticulture Research Centre, Bangladesh Agricultural Research Institute (BARI), Gazipur. The experiment was conducted during October 2012 to May 2013. The site was about 35 km North of Dhaka city with 24.9^{O} North Latitude and 90.26^{O} East Longitude and elevation of 8.40 m from the sea level (Khan, 2009).

3.2 Climate

The experimental site was situated in the subtropical climatic zone and characterized by heavy rainfall during the month of May to September while scanty rainfall during the rest of the year. The weather data of the growing period are presented in Appendix I.

3.3 Soil

The soil of the experimental field was silty clay loam in texture and acidic in nature. It belongs to the “Shallow red- brown Terrace” soil of Madhupur Tract. Soil sample of the experimental plot was collected from a depth of 0-30 cm before conducting the experiment and analyzed in the Soil Science Division, Bangladesh Agricultural Research Institute (BARI), Gazipur and have been presented in Appendix II.

3.4 Treatments

The experiment was set up to investigate the effect of plant growth regulators (GA_3, BAP) and corm size (large, medium and small) on the growth, flower and corm production of gladiolus (Plate 1). The study consisted of two factors, which are given below with their levels i.e. 21 treatments combination.

Factor A: Corm size

i) Large (Average weight 50 g)-S_1,

ii) Medium (Average weight 30 g)-S_2 and

iii) Small (Average weight 15 g)-S_3

Factor B: Pre-planting treatments of corm with plant growth regulators

G_0- Control (water) (without growth regulator),

G_1- $GA_3$100 ppm,

G_2- $GA_3$150 ppm,

G_3- GA_3 200 ppm,

G_4- BAP 50 ppm,

G_5- BAP 100 ppm and

G_6- BAP 150 ppm

Plate 1. Different sizes of corm in BARI Gladiolus-5

3.5 Preparation of plant growth regulator (BAP and GA_3) stock solutions

Stock solution of BAP and GA_3 was prepared by dissolving 1000 mg of each growth regulators in 1000 ml of water to get 1000 ppm. BAP was first dissolved by few drops of IN HCl and GA_3 was dissolved by few drops of ethyl alcohol and the volume was made up to 1000 ml with distilled water and stored in Erlenmeyer flask. Required concentrations for the experiment were prepared following the dilution factor $V_1S_1= V_2S_2$ where, V_1= Volume of the stock solution, S_1= Strength of the stock solution, V_2= Volume of the resultant solution and S_2 = Strength of the resultant solution.

3.6 Planting material

BARI Gladiolus-5 was selected as planting material and collected from Floriculture Division of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur.

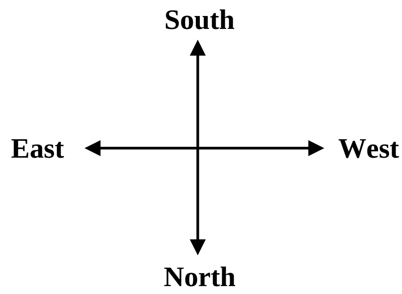
3.7 Treatment of corms with growth regulators

Corms of different sizes, viz. large, medium and small were soaked for 24 hours in solutions and also in water as per the treatment schedule. The soaked corms were dried shade in for 3-4 hours and then planted.

3.8 Design and Layout

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The 21 treatments were randomly allotted in each block. The unit plot size was 2.0 m × 1.5 m accommodating 70 plants per plot. Spacing was maintained at 20 cm from row to row and 20 cm from plant to plant. Two adjacent unit plots were separated by 60 cm space and there was 80 cm space between the blocks.

R_1	R_2	R_3
S_3G_0	S_1G_6	S_2G_2
S_3G_6	S_1G_3	S_2G_5
S_3G_5	S_1G_2	S_2G_0
S_3G_4	S_1G_1	S_2G_3
S_3G_3	S_1G_0	S_2G_1
S_3G_2	S_1G_5	S_2G_4
S_3G_1	S_1G_4	S_2G_6
S_2G_0	S_3G_4	S_1G_1
S_2G_6	S_3G_3	S_1G_5
S_2G_5	S_3G_1	S_1G_0
S_2G_4	S_3G_2	S_1G_3
S_2G_3	S_3G_0	S_1G_6
S_2G_2	S_3G_5	S_1G_4
S_2G_1	S_3G_6	S_1G_2
S_1G_0	S_2G_4	S_3G_3
S_1G_6	S_2G_3	S_3G_1
S_1G_5	S_2G_2	S_3G_6
S_1G_4	S_2G_1	S_3G_2
S_1G_3	S_2G_0	S_3G_5
S_1G_2	S_2G_6	S_3G_4
S_1G_1	S_2G_5	S_3G_0



Corm size

S_1 = Large (50 g)
S_2 = Medium (30 g)
S_3 = Small (15 g)

PGR Concentration

G_0 = 0 ppm
G_1 = GA_3 100 ppm
G_2 = GA_3 150 ppm
G_3 = GA_3 200 ppm
G_4 = BAP 50 ppm
G_5 = BAP 100 ppm
G_6 = BAP 150 ppm

Plot size = 2.0 × 1.5
Plot to plot distance = 60 cm
Block to block distance = 80 cm
Plant spacing = 20 × 20 cm

Figure 1. Layout of the experiment

3.9 Land preparation

The experimental plot was first opened on 1st week of October 2012 with a power tiller for sun curing for 7 days before next ploughing. The land was then ploughed and cross ploughed several times using power tiller to obtain a good tilth. Ploughing was followed by laddering for breaking large soil clods and for leveling the land surface. The weeds and stubbles were removed from the land just after laddering with special care to remove the rhizomes of mutha grass.

3.10 Recommended manure and fertilizer doses

Manures and Fertilizers	Dose/ha
Cowdung	**10 t/ha**
N	**200 kg**
P	**50 kg**
K	**150 kg**
S	20 kg
B	2 kg
Zn	2 kg

Source : Halder *et al.*, (2007)

3.11 Application of recommended fertilizer doses

The entire amount of cowdung (10 t), P (50 kg), K (150 kg), S (20 kg), B (2 kg) and Zn (2 kg) per hectare were applied during final plot preparation. N (200 kg/ha) was applied in two installments at 30 and 60 days after planting of corms.

3.12 Planting of corms

The corms were planted at a depth of 9 cm in furrows on mid October, 2012.

3.13 Weeding

Weeding was done periodically whenever necessary.

3.14 Irrigation

The experimental plot was irrigated as and when necessary during the whole period of plant growth following flood method.

3.15 Mulching

The soil was mulched frequently after irrigation by breaking the crust for easy aeration and to conserve soil moisture.

3.16 Earthing up

Three earthing ups at 30, 50 and 70 days after planting were done throughout the growing period.

3.17 Selections and tagging of plants

Ten plants from each plot were selected randomly and marked by tagging for recording data.

3.18 Harvesting

The spikes of gladiolus were harvested from January to February, 2012 at the tight bud stage and when three basal flower buds showed colour so that these may easily open indoors one by one (Bose *et al.,* 2003). Corm and cormel were harvested on May, 2012 when leaves turned brown (Khan, 2009).

3.19 Plant protection measure

Leaf blight disease is a serious problem for gladiolus cultivation. But the severity of this disease was not so prominent during the study period. Score @ 0.5 ml/L was applied once in a fortnight interval. Compared to disease, the insects of gladiolus are not so serious. Malathion @ 1 ml/L was applied to protect aphids and thrips.

3.20 Data collection

Observation were recorded from randomly chosen 10 plants from each plot on following parameters.

3.20.1 Days required to 80% emergence of the crop

It was recorded by counting the days from corm planting to 80% completion of emergence of the crop and expressed in days.

3.20.2 Plant height

Plant height refers to the total length of the 10 randomly selected plants from ground level to tip of erect leaf measured by a meter scale and the mean was calculated and expressed in centimeter.

3.20.3 Leaves/plant

Number of leaves per plant was recorded by counting all the leaves from 10 randomly plants of each unit plot and the mean was calculated.

3.20.4 Plant/hill

Number of plant per hill was recorded by counting all the plant per hill from 10 randomly plants of each unit plot and the mean was calculated.

3.20.5 Days required to 80% spike initiation

It was recorded by counting the days from corm planting to 80% spike initiation from randomly selected 10 plants in each plot, then averaged and expressed in days.

3.20.6 Florets number/spike

It was recorded by counting number of florets from 10 randomly selected spikes and then mean was calculated.

3.20.7 Spike length

It was measured from the end where from it was cut off at the base to the tip of the spike by measuring scale from 10 randomly selected spikes and then mean was calculated and expressed in centimeter.

3.20.8 Rachis length

Length of rachis refers to the length from the axils of first floret up to the tip of inflorescence.

3.20.9 Spike weight

Ten spikes were cut from randomly selected plants from each unit plot and the weights of spikes were recorded to calculate their mean and expressed in grams.

3.20.10 Flower durability

Flower durability was recorded from the time of first floret opening to the maximum freshness in 10 randomly selected spikes and expressed in days.

3.20.11 Flower yield/ha

Flower yield per hectare was computed by counting numbers of spikes per plot and converted to hectare.

3.20.12 Corm number

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

3.20.13 Corm weight

It was determined by weighting the corm from ten randomly selected plants, their mean weight was calculated and expressed in grams.

3.20.14 Corm diameter

Diameter of harvested corm was measured by using slide calipers from 10 randomly selected plants, averaged and expressed in centimeter.

3.20.15 Cormel number

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

3.20.16 10 cormel weight

Weight of 10 cormel/plant was recorded from the mean weight of ten randomly selected sample plants and expressed in grams.

3.21 Statistical Analysis

The recorded data on different parameters were statistically analyzed using 'MSTAT-C' software to find out the significance of variation resulting from the experimental treatments. The mean for the treatments was calculated and analysis of variance for each of the characters was performed by F (variance ratio) test. The differences between the treatment means were evaluated by Duncan's Multiple Range Test (DMRT) according to Steel *et al*., (1997) at 5% level of probability. The analysis of variance (ANOVA) of the data on different characters of gladiolus is given in Appendix III-V.

CHAPTER IV

RESULTS AND DISCUSSION

Results of this experiment and their discussion have been presented in this chapter in accordance with the parameters studied. Analysis of variances (ANOVA) for different characters has been shown in Appendix III-V. The effect of corm size and plant growth regulators (GA_3 and BAP) and their combined effects have been shown in Tables, Figures and Plates. The results of the study have been presented and discussed under the following headings.

4.1 Days required to 80% emergence of the crop

The number of days required to complete 80% emergence of the crop was significantly influenced by different corms sizes. Large sized corm took the shortest time (8 days) to complete 80% emergence and the small sized corm took the longest time (14 days). Emergence was found delayed gradually with the decrease in corm size (Table 1). This might be due to the fact that large corms were about 3 times larger than the small corm had more reserve food and shorter dormancy period, which helped in quick emergence of the crop. Memon *et al.*, (2009) and Ahmad *et al*., (2009) also reported more or less similar results that the number of days to spouting ranged from 6-8 days for the largest corms to 10-12 days for the smallest one in gladiolus.

Growth regulators showed significant effects on the days required to 80% emergence of the crops (Table 1). It was found that treatment of corm with GA_3 at 200 ppm took the shortest period (7 days) followed by GA_3 at 150 ppm (9 days) and the corm without growth regulators (control) required the longest period to 80% emergence of the crop (11 days). The results are in agreement with the findings of Islam *et al.,* (2012) who noted that GA_3 treatment @ 200 ppm took shorter period for sprouting in gladiolus. This might be because of GA_3 was known to promote corm sprouting (Mukhopadhyay and Banker, 1986). Moreover, sprouting involves enzymatic conversion of reserve materials into simpler compounds accompanied with the increase level of gibberellins (Bhattacharjee, 2010). As the process of sprout initiation started earlier with GA_3 treatments, the influence of exogenous application of this bud forcing chemical was evident.

A significant interaction was found between corm size and growth regulators in respect of days required to 80% emergence of the crop (Appendix III). Large corms treated with 200 ppm GA_3 took the shortest period (7.0 days) to 80% emergence of the crop as well as small corms treated with control (without growth regulators) took the longest time (14.3 days) to complete 80% emergence of the gladiolus (Table 2).

Table 1. Main effect of corm size and growth regulators on vegetative growth of gladiolus

Treatments	Days required to 80% emergence	Leaves/ plant	Plants/hill
Effect of corm size			
Large (S_1)	8.0 b	10.3 a	1.3 a
Medium (S_2)	11.0 ab	8.5 ab	1.1 ab
Small (S_3)	14.0 a	7.0 b	0.9 b
Level of significance	*	*	*
Effect of growth regulators			
Control (G_0)	11.0 a	8.8 b	1.0 c
GA_3 100 ppm (G_1)	10.0 ab	9.8 ab	1.2 bc
GA_3 150 ppm (G_2)	9.0 ab	10.1 ab	1.2 bc
GA_3 200 ppm (G_3)	7.0 b	10.9 a	1.5 b
BAP 50 ppm (G_4)	10.0 ab	9.2 ab	163 ab
BAP 100 ppm (G_5)	9.0 ab	10.0 ab	2.0 a
BAP 150 ppm (G_6)	10.0 ab	9.7 ab	1.7 ab
Level of significance	*	*	*
CV (%)	5.8	7.0	5.3

Means with the same letter (s) are not significantly different at 5% level by DMRT
* Significant at 5% level

S_1 = Large (50 g), S_2 = Medium (30 g) and S_3 = Small (15 g)
G_0 = Control, G_1 = GA_3 100 ppm, G_2 = GA_3 150 ppm, G_3 = GA_3 200 ppm, G_4 = BAP 50 ppm, G_5 = BAP 100 ppm and G_6 = BAP 150 ppm

Table 2. Combined effect of corm size and plant growth regulators on vegetative growth of gladiolus

Treatments	Days required to 80% emergence	Leaves/plant	Plants/hill
S_1G_0	10.1 bc	8.6 ab	1.2 bc
S_2G_0	11.5 ab	8.3 ab	1.4 bc
S_3G_0	14.3 a	8.1 b	1.0 c
S_1G_1	10.7 b	9.0 ab	1.3 bc
S_2G_1	12.4 ab	8.8 ab	1.2 bc
S_3G_1	13.1 ab	8.5 ab	1.1 bc
S_1G_2	8.2 bc	10.1 ab	1.4 bc
S_2G_2	8.9 bc	9.5 ab	1.5 bc
S_3G_2	13.5 ab	9.2 ab	1.2 bc
S_1G_3	7.8 c	11.1 a	1.6 b
S_2G_3	8.4 bc	10.5 ab	1.4 bc
S_3G_3	12.2 ab	9.7 ab	1.3 bc
S_1G_4	12.2 ab	9.5 ab	1.4 bc
S_2G_4	12.7 ab	9.7 ab	1.3 bc
S_3G_4	13.4 ab	9.0 ab	1.2 bc
S_1G_5	12.6 ab	9.9 ab	1.8 ab
S_2G_5	12.9 ab	9.5 ab	1.7 ab
S_3G_5	13.7 ab	9.2 ab	1.2 bc
S_1G_6	12.1 ab	10.3 ab	2.3 a
S_2G_6	12.4 ab	10.0 ab	2.0 ab
S_3G_6	12.8 ab	9.7 ab	1.3 bc
Level of significance	*	*	*
CV (%)	**5.8**	**7.0**	**5.3**

Means with the same letter (s) are not significantly different at 5% level by DMRT
* Significant at 5% level

S_1 = Large (50 g), S_2 = Medium (30 g) and S_3 = Small (15 g)
G_0 = Control, G_1 = GA_3 100 ppm, G_2 = GA_3 150 ppm, G_3 = GA_3 200 ppm, G_4 = BAP 50 ppm, G_5 = BAP 100 ppm and G_6 = BAP 150 ppm

4.2 Plant height

There was significant difference observed due to different corm sizes for plant height. Although the different corm sizes showed a gradual decreasing trend in plant height of gladiolus start from large to small size corm at different days after corm planting (Figure 2). At harvest, (85 days after corm planting) the highest plant height (46.0 cm) was recorded from the large corm. On the other hand the lowest plant height (35.0 cm) was obtained from small corm. Because of early emergence and higher reserve food the large corm showed better growth and ultimately gave maximum plant height in comparison to small corm. The results illustrate that plant height increased with the increase in corm size. Our results are supported by Ahmad *et al*., (2009) who observed taller plants in gladiolus which might be due to presence of more photosynthates in larger corms when larger corms were grown.

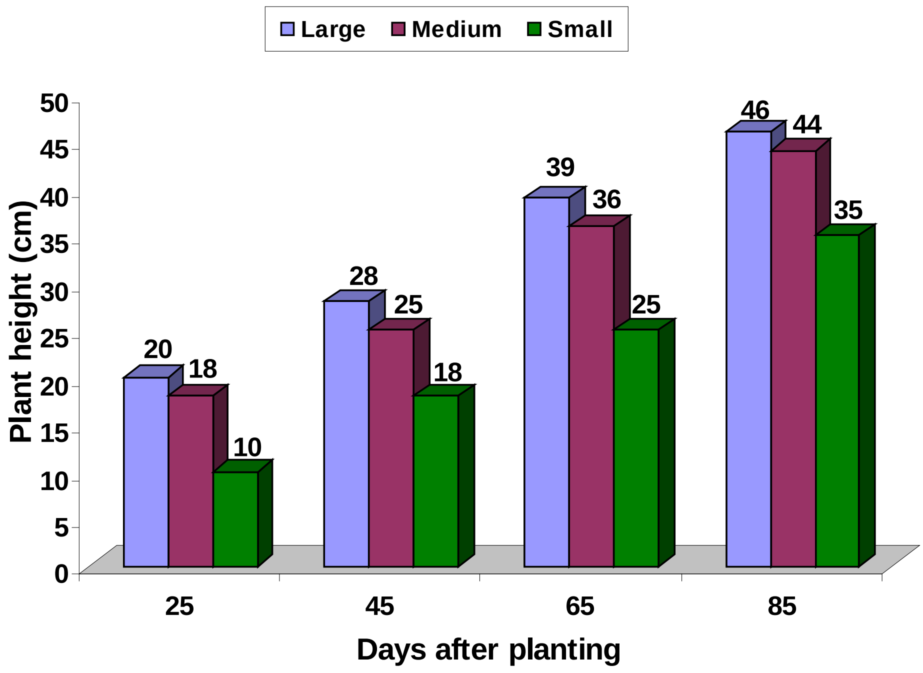


Figure 2. Effect of corm size on plant height of gladiolus at different days after planting

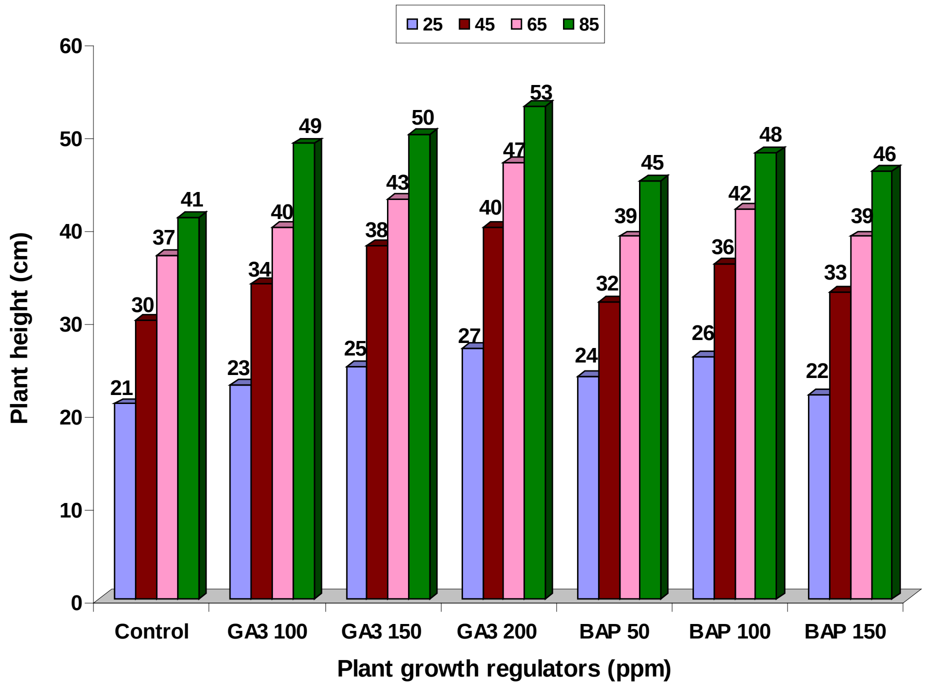


Figure 3. Effect of plant growth regulators on plant height of gladiolus at different days after planting

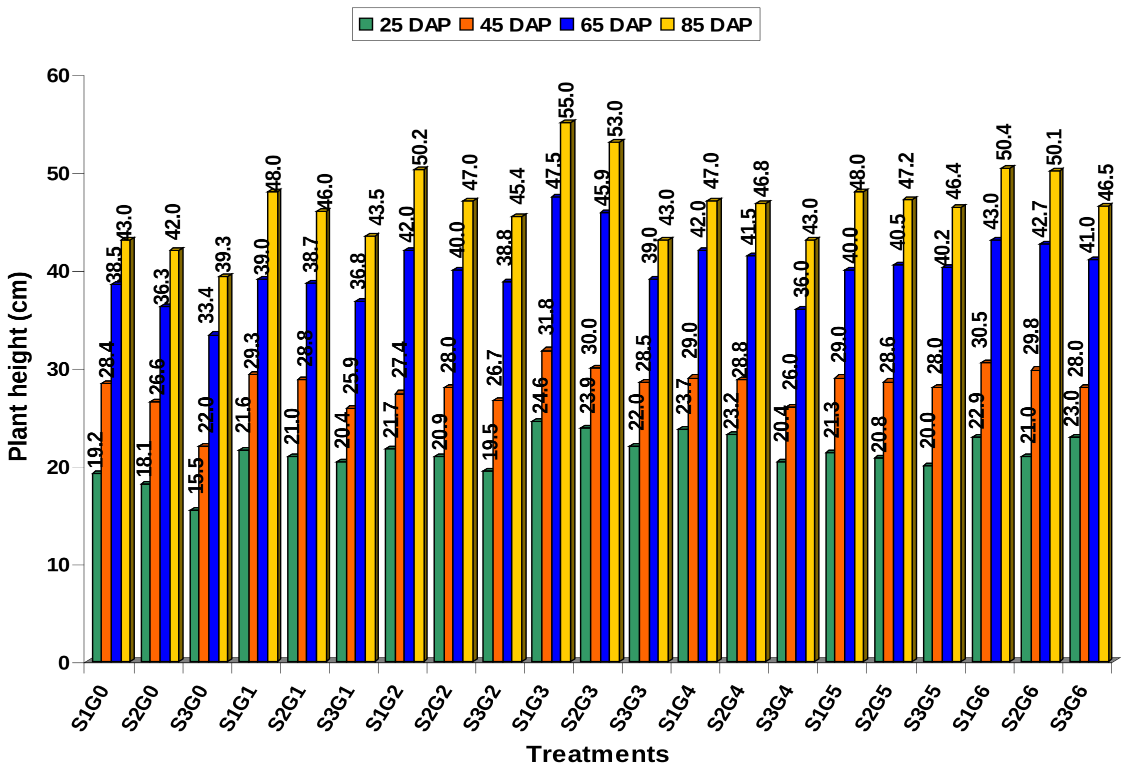


Figure 4. Combined effect of corm size and plant growth regulators on plant height of gladiolus

S_1 = Large (50 g), S_2 = Medium (30 g) and S_3 = Small (15 g)
G_0 = Control, G_1 = GA_3 100 ppm, G_2 = GA_3 150 ppm, G_3 = GA_3 200 ppm, G_4 = BAP 50 ppm, G_5 = BAP 100 ppm and G_6 = BAP 150 ppm

The effect of plant growth regulators was also found significant effect on plant height. At harvest (85 days after corm planting), the highest plant height (53.0 cm) was obtained from the corms treated with 200 ppm GA_3 (Figure 3). The observed results are in partial agreement with the findings of Mohanty *et al.,* (1994). They concluded that 250 ppm GA_3 had maximum influence on the plant height of gladiolus.

The combined effect revealed that large corm treated with 200 ppm GA_3 produced maximum plant height of 55.0 cm while it was least in the combination of small corm with control treatment (39.3 cm) (Figure 4). These results are supported by Islam *et al*., (2012) in gladiolus.

4.3 Number of leaves per plant

The corm sizes had significant effect on the number of leaves per hill. At harvest the maximum number of leaves per hill (10.3) was obtained from large corm and the minimum (7.0) was from small corm (Table 1). Kalasareddi *et al*., (1998) obtained similar results and reported that larger corm produced more leaves compared to smaller corms.

Growth regulators significantly influenced the number of leaves per hill. At harvest the maximum number of leaves (10.9) was obtained from the corms treated with 200 ppm $GA_{3,}$ while control produced the lowest number of leaves (8.1). The observation is similar to the findings of Misra *et al*., (1993) and Leen *et al*., (1992) in gladiolus. These variations in number of leaves per plant might be due to the fact that GA_3 improves the physiological efficiency of the plant such as improvement of rate of photosynthesis, control transpiration and photorespiration, efficient water and nutrient uptake, control of leaf senescence thus inducing resistant to environmental stress and ultimately increasing the harvest index.

The interaction effect between corm size and growth regulators in respect of number of leaves per plant was found significant (Appendix III). Large corm treated with 200 ppm GA_3 produced maximum number of leaves per hill (11.1) while the treatment combination of small corm and control produced 8.1 leaves.

4.4 Number of plant per hill

The corm size had significant effect on the number of plants per hill. The large size corm produced maximum number of plants per hill (1.3) while the small corm produced minimum number of plants per hill (0.9) (Table 1).

The number of plant per hill was influenced by the application of different growth regulators and the effect was statistically significant. BAP at 100 ppm showed the highest number of plants per hill (2.0) while control treatment produced (1.0 plant) lowest number of plant. Application of BAP might have resulted in cell division resulting in enhanced plant per hill (Bhattacharjee, 2010).

Large corm treated with 100 ppm BAP produced the highest number of plants per hill (2.3) while small corm and control produced lowest number of plants per hill (1.0).

4.5 Days required to complete 80% spike initiation

The days required to complete 80% spike initiation of the crops were significantly influenced by corm size. The average time required to 80% spike initiation ranged from 67 to 76 days. Small corm took 76 days to complete 80% visible spike initiation. On the other hand the large corm took the shortest time (67 days) to do the same.

Growth regulators significantly influenced the time required to complete 80% spike initiation of the plant. Corms treated with 200 ppm GA_3 required 66 days to initiate 80% spike followed by 150 ppm GA_3 (64 days) while control showed 78 days required to complete 80% visible spike initiation of the crop (Table 3). Similar observation was recorded by Ogale *et al.*, (1995) in gladiolus. This early flowering may be due to presence of more food reserves in large sized corms. These results are supported by Kalasareddi *et al.*, (1997) who observed that large sized corms produced flowers earlier in gladiolus as compared to small sized corms.

Table 3. Main effect of corm size and plant growth regulators on flowering of gladiolus

Treatments	Days required to 80% spike initiation	Spike length (cm)	Rachis length (cm)	Floret number	Spike weight (g)	Flower durability (days)
Effect of corm size						
Large (S_1)	67.0 c	76.0 a	43.0 a	12.0 a	67.0 a	12.0 a
Medium (S_2)	71.0 b	68.0 b	39.0 b	11.0 a	62.0 b	11.0 a
Small (S_3)	76.0 a	61.0 c	35.0 c	8.0 a	55.0 c	8.0 a
Level of significance	*	*	*	*	*	*
Effect of growth regulators						
Control (G_0)	78.0 a	63.0 d	39.0 c	9.0 b	56.0 d	9.0 b
GA_3 100 ppm (G_1)	61.0 e	75.0 b	42.0 bc	11 .0ab	65.0 b	10.0 ab
GA_3 150 ppm (G_2)	64.0 de	76.8 ab	45.0 b	12.0 ab	65.0 b	12.0 ab
GA_3 200 ppm (G_3)	66.0 d	80.0 a	50.0 a	13.0 a	70.0 a	13.0 a
BAP 50 ppm (G_4)	72.0 bc	70.0 c	42.0 bc	10.0 ab	63.0 bc	10.0 ab
BAP 100 ppm (G_5)	70.0 c	73.0 bc	44.0 bc	11.0 ab	66.0 ab	10.0 ab
BAP 150 ppm (G_6)	74.0 b	68.0 cd	40.0 bc	10.0 ab	60.0 c	10.0 ab
Level of significance	*	*	*	*	*	*
CV (%)	**12.6**	**9.8**	**8.5**	**6.3**	**11.8**	**6.5**

S_1 = Large (50 g), S_2 = Medium (30 g) and S_3 = Small (15 g)
G_0 = Control, G_1 = GA_3 100 ppm, G_2 = GA_3 150 ppm, G_3 = GA_3 200 ppm, G_4 = BAP 50 ppm, G_5 = BAP 100 ppm and G_6 = BAP 150 ppm

There was significant interaction effect found between corm sizes and growth regulators regarding the period required to 80% spike initiation (Appendix IV). The large corm treated with 200 ppm GA_3 took the shortest time (65 days) for 80% inflorescence initiation while 85.0 days was required by the treatment combination of small corm and control (Table 4).

This might be due to the combined effect of large corm having short dormancy period along with GA_3 that has a role in flower initiation resulting on quicker spike initiation.

4.6 Spike length

The length of spike varied significantly due to the effect of different corm sizes. The highest spike length (76.0 cm) was obtained from the large sized corm. It was followed by medium sized corm (68 cm). On the other hand, the shortest spike (61.0 cm) was produced by small corm (Table 3). The increased spiked length of large corm was probably due to the better vegetative and reproductive growth of the plant. The results also agreed with the findings of Memon *et al.*, (2009) and Dod *et al.*, (1989) who concluded that the increased spike length was due to the use of large corm.

Growth regulators had significant effects on the length of spike. The highest spike length (80.0 cm) was obtained from the plants treated with 200 ppm GA_3 followed by 150 ppm GA_3 (76.8 cm) whereas the length was minimum (63.0 cm) in the treatment control (Table 4). The results are more or less similar to the findings of Sindhu (1997) who concluded that the spike length was increased with 250 ppm GA_3 in gladiolus.

Table 4. Combined effect of corm size and growth regulators on flowering of gladiolus

Treatments	Days required to 80% spike initiation	Spike length (cm)	Rachis length (cm)	Floret number	Spike weight (g)	Flower durability (days)
S_1G_0	85 a	67.0 c	36.0 cd	10 ab	58 de	10 ab
S_2G_0	82 ab	65.0 cd	34.0 cd	10 ab	55 d	10 ab
S_3G_0	83 ab	60.0 d	32.0 d	9 b	50 e	9 b
S_1G_1	75 c	72.5 b	44.0 b	11 ab	59 de	11 ab
S_2G_1	76 bc	70.0 bc	42.0 bc	11 ab	58 de	11 ab
S_3G_1	80 b	69.0 bc	33.0 cd	10 ab	57.0 dc	10 ab
S_1G_2	69 cd	74.0 ab	46.0 ab	12 ab	68.0 ab	12 ab
S_2G_2	70 d	72.0 b	45.0 ab	12 ab	65.0 b	12 ab
S_3G_2	77 bc	70.0 bc	40.0 c	10 ab	60.4 c	10 ab
S_1G_3	66 e	77.5 a	52.0 a	14 a	72.0 a	14 a
S_2G_3	68 de	75.0 ab	50. ab	13 a	70.0 ab	13 a
S_3G_3	75 c	72.0 b	44.0 b	10 ab	65.0 b	10 ab
S_1G_4	75 c	70.0 bc	42.0 bc	10 ab	68.0 ab	10 ab
S_2G_4	75 c	68.0 bc	37.0 cd	10 ab	66.0 ab	10 ab
S_3G_4	79 bc	65.0 cd	35.0 cd	10 ab	62.0 bc	10 ab
S_1G_5	70 d	72.0 b	44.0 b	11 ab	69.0 ab	11 ab
S_2G_5	73 cd	70.0 bc	42.0 bc	11 ab	65.0 b	11 ab
S_3G_5	76 bc	65.0 cd	40.0 c	10 ab	61.0 bc	10 ab
S_1G_6	74 cd	70.0 bc	42.0 bc	10 ab	63.0 bc	10 ab
S_2G_6	75 c	68.0 bc	40.0 c	10 ab	61.0 bc	10 ab
S_3G_6	78 bc	65.0 cd	38.0 cd	10 ab	56.0 de	10 ab
Level of significance	*	*	*	*	*	*
CV (%)	**12.6**	**9.8**	**8.5**	**6.3**	**11.8**	**6.5**

Means with the same letter (s) are not significantly different at 5% level by DMRT
* Significant at 5% level

S_1 = Large (50 g), S_2 = Medium (30 g) and S_3 = Small (15 g)
G_0 = Control, G_1 = GA_3 100 ppm, G_2 = GA_3 150 ppm, G_3 = GA_3 200 ppm, G_4 = BAP 50 ppm, G_5 = BAP 100 ppm and G_6 = BAP 150 ppm

Significant interaction effect was also found between corm size and plant growth regulators in respect of spike length. However, the combined effect of corm size and plant growth regulators revealed that the maximum length of spike (77.5 cm) was produced from large corm treated with 200 ppm GA_3 while the minimum length of spike (60.0 cm) was obtained from small corm treated with control (without growth regulator).

4.7 Rachis length

The results of the present experiment revealed that variation in rachis length due to the effect of corm size was statistically significant. The rachis length was increased with the increase in corm size (Table 3). Plants from large corm produced the longest rachis (43.0 cm). On the other hand, plant grown from small corms produced the shortest rachis (35.0 cm). Better performance of the plants from larger corms might be due to the higher growth of the plants. This observation is similar to the findings of Memon *et al.*, (2009) and Mukhopadhyay and Yadav (1984) in gladiolus.

Growth regulators had significant effect on the rachis length. The highest rachis length (50.0 cm) was produced from the corms treated with 200 ppm GA_3 followed by 150 ppm GA_3 (45.0 cm) as shown in Table 3. Prakash *et al.*, (1999) reported that GA_3 stimulated the assimilate movement towards the inflorescence at the expense of corms which resulted in the better quality spike. Bhattacharjee (1984) also reported that increased rachis length when the corms were treated with GA_3. The lowest performance (39.0 cm) was found from the corms treated with control (without growth regulator).

The length of rachis was also influenced by the interaction effect of corm size and growth regulators. However, large corms treated with 200 ppm GA_3 produced the maximum rachis length (52.0 cm) and small corm treated with control showed the lowest rachis length (32.0 cm) in gladiolus.

4.8 Number of florets per spike

The floret number is in important parameter of gladiolus. There was significant difference on the number of florets per spike observed due to different sizes of corm used. The number of florets per spike was increased with the increase in corm size (Table 3). Plants from large corm produced the highest number of florets (12). On the other hand, plant grown from small corm produced the lowest number of florets (8). It was concluded that the large sized corms performed better and produced maximum number of florets/spike which might be due to availability of more photosynthates. These results are in conformity with the results of Singh (2000), Ogale (1995) and Dod *et al.*, (1989) who also observed that larger corms produced more florets in gladiolus.

The different growth regulator treatments had significant effect on the number of florets per spike. The maximum number of florets per spike (13) was obtained from corms treated with 200 ppm GA_3 followed by 150 ppm GA_3 (12). The minimum number of florets per spike (9) was produced in control plots (Table 3). The result agrees with the findings of Taha (2012) and Sharma *et al.*, (2006) who concluded that GA_3 increased the number of florets per spike in gladiolus.

The interaction effect of corm size and growth regulators on the number of florets per spike was found insignificant (Appendix IV). However, the combined effect of corm size and growth regulator treatment revealed that the maximum number of florets (14) was obtained from the treatment combination of large corm treated with 200 ppm GA_3 (Plate 2). On the other hand, the treatment combination of small corm and control (without growth regulators) produced minimum number of florets (9) per spike (Table 4).

Plate 2. Floret number influenced by corm size and growth regulators

4.9 Spike weight

Spike weight was significantly influenced by corm sizes. Large corm showed maximum spike weight (67.0 cm) of spike while small sized corm gave minimum weight (55.0 cm) of spike (Table 3). Similar results were reported by Satyavir and Singh (1998) in gladiolus.

Growth regulators significantly influenced of spike weight. The results showed that spike weight was increased with the increase in concentration of GA_3. GA_3 at 200 ppm gave the maximum weight (70.0 g) of spike while control showed minimum weight (56.0 g) of spike initiation (Table 3).

There was significant interaction effect between corm size and growth regulators regarding the weight of spike. When the combined effect was considered, the maximum weight of spike (72.0 g) was found in treatment combination of large corm treated with 200 ppm GA_3 while small corm treated with control showed the minimum (50 g) performance (Table 4).

4.10 Flower durability

Flower durability was significantly different due to the different corm sizes used. Spikes produced from large corms showed the maximum shelf life (12 days) whereas spikes obtained from small corm showed the lowest vase life (8 days) (Table 3). These results are in line with the results of Suresh *et al*., (2008) who attributed that duration of flowering was shortest for plants produced from small corms in gladiolus.

There was significant variation among the different growth regulator treatments in respect of flower durability of spike. Spikes obtained from corms treated with 200 ppm GA_3 showed maximum flower durability (13 days) followed by 150 ppm GA_3 (12 days). On the other hand, the minimum flower durability (9 days) was found from the spikes treated without growth regulators (control).

There was significant interaction effect of corm size and growth regulators was found in respect of flower durability (Appendix IV). However, spike obtained from large corm treated with 200 ppm GA_3 showed the highest flower durability (14 days) followed by 150 ppm GA_3 (13 days). The lowest performance (9 days) was found from the spike produced by small corm treated with control (Table 4). Similar results were obtained by Sudhakar and Kumar (2012) on gladiolus.

4.11 Flower yield

Corm size showed significant effect on the flower yield per hectare. The maximum 230000 spikes per hectare were obtained from the plant grown from large corm. On the other hand, the minimum yield (180000 spikes/ha) was observed when small corm was used as planting material (Figure 5).

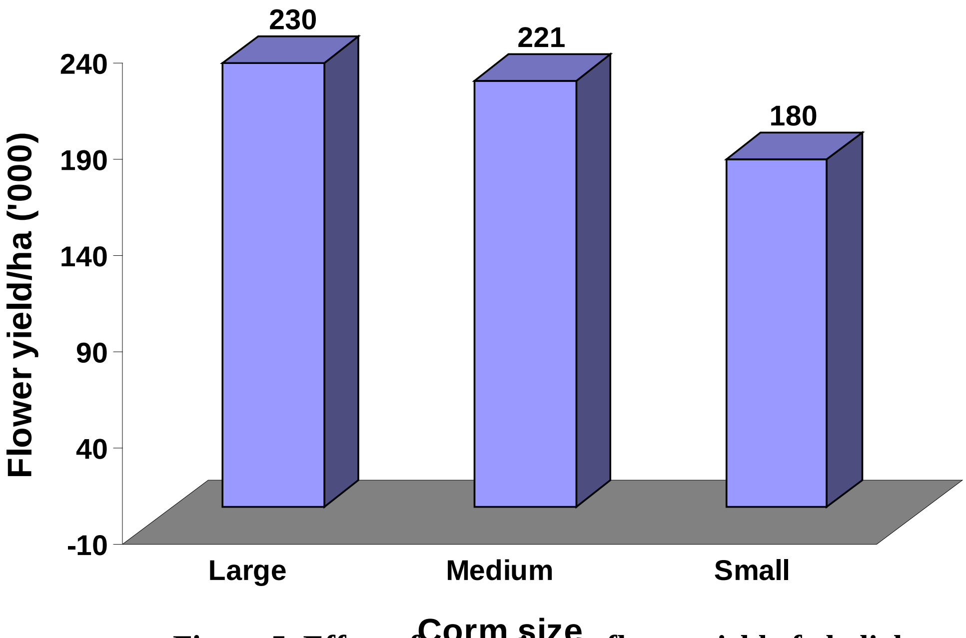


Figure 5. Effect of corm size on flower yield of gladiolus

Growth regulators significantly influenced yield of spike. The results showed that total flower was increased with the increase in concentration of GA_3. GA_3 at 200 ppm gave the highest yield per hectare (250000 spikes/ha) while control showed lowest yield (200000 spikes/ha) of gladiolus (Figure 6).

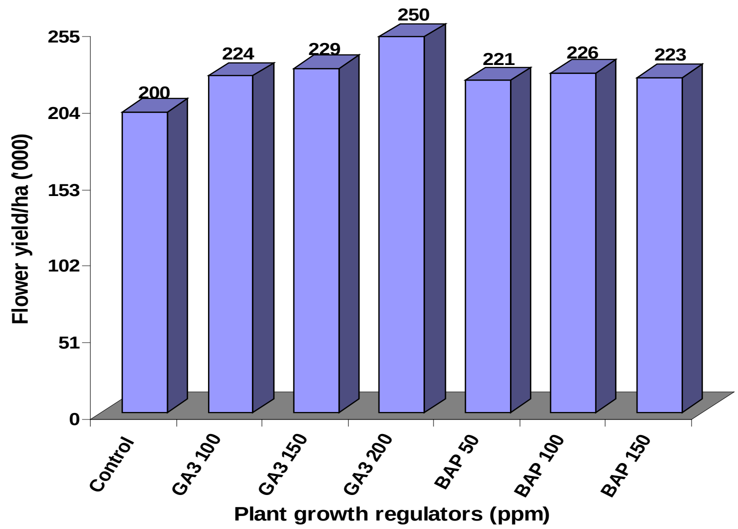


Figure 6. Effect of plant growth regulators on flower yield of gladiolus

There was significant interaction effect was observed between corm size and growth regulators in the respect of yield per hectare (Appendix V). When the combined effect was considered, the maximum yield (260000 spikes/ha) was found in the treatment combination of large corm treated with 200 ppm GA_3 and the minimum yield (200000 spikes/ha) was obtained from the treatment combination of small corm size with no growth regulator (Figure 7). These results are in accordance with findings of Leen (1992) in gladiolus.

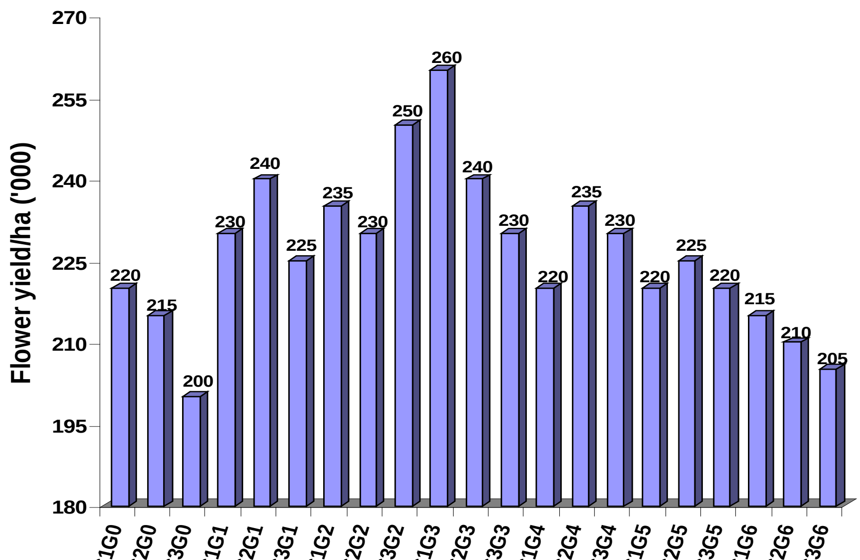


Figure 7. Interaction effect of corm size and plant growth regulators on flower yield of gladiolus

4.12 Number of corm per plant

The corm size had significant effect on the number of corm per plant. The large size corm produced maximum number of corm per plant (1.5) while the small corm produced minimum number of corm per plant (0.9) (Table 5). These results are in accordance with the results of Memon *et al*., (2009) and Mukhopadhyay and Revidas *et al.*, (1992) in gladiolus. They reported more corm and cormel produced from large size corms than other corm size.

The number of corm per plant was influenced by the application of different growth regulators and the effect was statistically significant. GA_3 at 200 ppm showed the highest number of corm per plant (2.4) while the lowest number of corm (0.9) was obtained from control (Table 5).

Table 5. Main effect of corm size and growth regulators on corm and cormel production of gladiolus

Treatments	Corm number/hill	Cormel number/hill	Corm Diameter (cm)	Corm weight (g)	10 cormel weight (g)
Effect of corm size					
Large (S_1)	1.5 a	15 a	6.0 a	48.0 a	35.0 a
Medium (S_2)	1.3 ab	10 b	5.5 ab	42.0 b	31.0 b
Small (S_3)	0.9 b	6 c	3.2 b	30. c	23.0 c
Level of significance	*	*	*	*	*
Effect of growth regulators					
Control (G_0)	0.9 b	9 c	3.9 b	35.0 d	25.0 c
GA_3 100 ppm (G_1)	2.0 ab	14 bc	5.3 ab	44.0 b	31.9 bc
GA_3 150 ppm (G_2)	2.2 ab	16 ab	5.8 ab	48.0 ab	35.0 ab
GA_3 200 ppm (G_3)	2.4 a	20 a	6.5 a	50.0 a	37.0 a
BAP 50 ppm (G_4)	1.9 ab	15 b	5.0 ab	40.0 c	30.0 bc
BAP 100 ppm (G_5)	2.0 ab	18 ab	5.5 ab	45.0 ab	33.0 b
BAP 150 ppm (G_6)	1.8 ab	13 bc	4.5 ab	43.0 bc	31.0 bc
Level of significance	*	*	*	*	*
CV (%)	**6.1**	**7.8**	**8.2**	**9.5**	**8.7**

S_1 = Large (50 g), S_2 = Medium (30 g) and S_3 = Small (15 g)
G_0 = Control, G_1 = GA_3 100 ppm, G_2 = GA_3 150 ppm, G_3 = GA_3 200 ppm, G_4 = BAP 50 ppm, G_5 = BAP 100 ppm and G_6 = BAP 150 ppm

Large corm treated with 200 ppm GA_3 produced the highest number of corm per plant (2.5) while small corm and control produced lowest number of corm (1.0) per plant.

Table 6. Combined effect of corm size and growth regulators on corm and cormel production of gladiolus

Treatments	Corm number/ hill	Cormel number/ hill	Corm diameter (cm)	Corm weight (g)	10 cormel weight (g)
S_1G_0	1.2 ab	12 cd	4.5 ab	42.0 cd	30.0 c
S_2G_0	1.2 ab	10 de	4.3 ab	38.0 d	27.0 cd
S_3G_0	1.0 b	8 e	4.0 ab	34.0 e	25.0 d
S_1G_1	1.3 ab	16 bc	4.9 ab	49.9 ab	33.0 cd
S_2G_1	1.2 ab	15 bc	4.7 ab	48.0 bc	31.2 cd
S_3G_1	1.0 b	14 c	3.5 b	45.0 c	29.0 cd
S_1G_2	1.4 ab	23 ab	5.8 ab	52.5 ab	38.0 ab
S_2G_2	1.3 ab	20 b	5.5 ab	51.0 ab	37.0 ab
S_3G_2	1.2 ab	14 c	4.2 ab	46.0 bc	30.0 c
S_1G_3	2.5 a	25 a	6.5 a	55.0 a	40.0 a
S_2G_3	2.3 ab	22 ab	6.0 ab	52.0 ab	37.0 ab
S_3G_3	1.5 ab	18 bc	4.3 ab	49.0 b	35.0 b
S_1G_4	1.6 ab	19 bc	5.0 ab	51.0 ab	31.0 bc
S_2G_4	1.5 ab	18 bc	4.9 ab	53.0 ab	33.0 bc
S_3G_4	1.3 ab	14 c	4.3 ab	48.6 bc	30.0 c
S_1G_5	2.0 ab	20 b	5.8 ab	52.0 ab	38.0 ab
S_2G_5	1.8 ab	16 bc	5.2 ab	51.0 ab	36.0 ab
S_3G_5	1.4 ab	12 cd	4.5 ab	44.0 cd	30.0 c
S_1G_6	1.6 ab	13 cd	4.8 ab	46.0 bc	31.4 bc
S_2G_6	1.4 ab	12 cd	4.6 ab	44.0 cd	30.3 bc
S_3G_6	1.3 ab	11 d	4.4 ab	42.0 cd	28.0 cd
Level of significance	*	*	*	*	*
CV (%)	**6.1**	**7.8**	**8.2**	**9.5**	**8.7**

Means with the same letter (s) are not significantly different at 5% level by DMRT
* Significant at 5% level
S_1 = Large (50 g), S_2 = Medium (30 g) and S_3 = Small (15 g)
G_0 = Control, G_1 = GA_3 100 ppm, G_2 = GA_3 150 ppm, G_3 = GA_3 200 ppm, G_4 = BAP 50 ppm, G_5 = BAP 100 ppm and G_6 = BAP 150 ppm

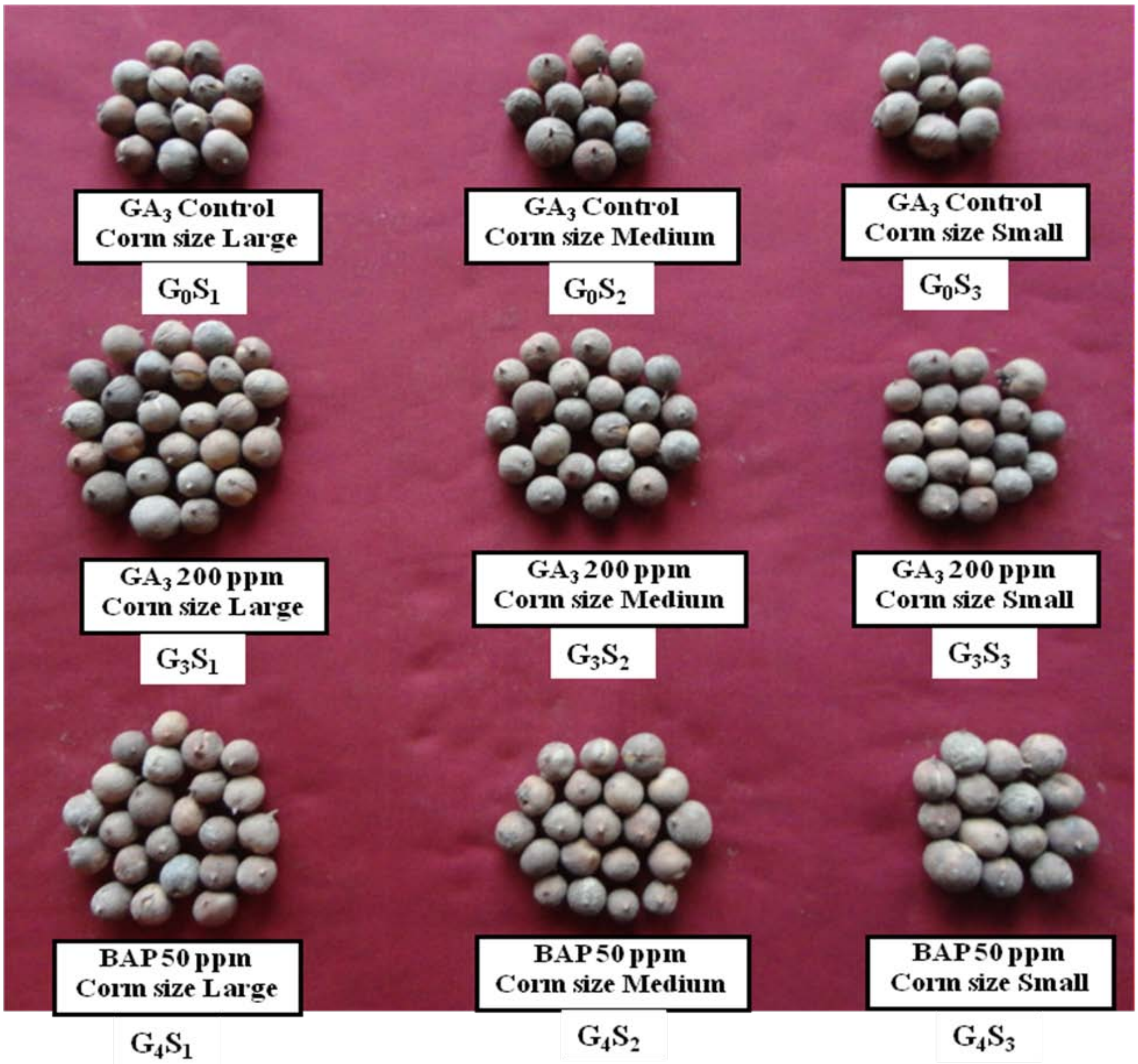
4.13 Number of cormel per plant

There was significant difference on the number of cormel per plant was observed due to different sizes of corm used. The number of cormel per plant was increased with the increase in corm size (Table 5). Plants from large corm produced the highest number of cormel (15). On the other hand, plant grown from small corm produced the lowest number of cormel (6). This might be due to higher food reserve in the large corm. The present results are in accordance with the findings of Bhattacharjee (1981) and Gowda (1988) who obtained the higher number of cormel in plants grown from large corm.

The different growth regulator treatments had significant effect on the number of cormel per plant. The maximum number of cormel per plant (20) was obtained from corms treated with 200 ppm GA_3 followed by 150 ppm GA_3. The minimum number of cormel per plant (9) was produced by corm untreated with growth regulator (control). The result agrees with the findings of Mohanty *et al.,* (1994) who concluded that GA_3 increased the number of cormel per plant in gladiolus.

The interaction effect of corm size and growth regulators on the number of cormel per spike was found significant (Appendix VI). However, the combined effect of corm size and growth regulator treatment revealed that the maximum number of cormel (25) was obtained from the treatment combination of large corm treated with 200 ppm GA_3 (Plate 6). On the other hand, the treatment combination of small corm and control produced the minimum number of cormel (8) per plant (Table 6).

Plate 3. Cormel number influenced by corm size and growth regulators



4.14 Corm diameter

The results of the present experiment revealed that variation in corm diameter due to the effect of corm size was statistically significant. The diameter of corm was increased with the increase in corm size (Table 5). Plants from large corm produced the maximum diameter (6.0 cm). On the other hand, plant grown from small corms produced minimum diameter (3.2 cm) of corm. Better performance of the plants from larger corms might be due to the better growth of the plants from in gladiolus corms. The observation is similar to the findings of Mukhopadhyay and Yadav (1984) in gladiolus.

GA$_3$ Control
Corm size Large

G_0S_1

GA$_3$ Control
Corm size Medium

G_0S_2

GA$_3$ Control
Corm size Small

G_0S_3

GA$_3$ 200 ppm
Corm size Large

G_3S_1

GA$_3$ 200 ppm
Corm size Medium

G_3S_2

GA$_3$ 200 ppm
Corm size Small

G_3S_3

GA$_3$ 150 ppm
Corm size Large

G_2S_1

GA$_3$ 150 ppm
Corm size Medium

G_2S_2

GA$_3$ 150 ppm
Corm size Small

G_2S_3

Plate 4. Corm diameter influenced by corm size and growth regulators

Growth regulators had significant effect on the corm diameter. The highest diameter (6.5 cm) was produced from the corms treated with 200 ppm GA_3 followed by 150 ppm GA_3 (5.8 cm) as shown in Table 5. Arora *et al.,* (1992) reported that GA_3 stimulated the assimilate movement towards the corm which resulted in the better quality corm. Kirad *et al.,* (2001) also reported increased corm diameter when the corms were untreated with GA_3. The lowest performance (3.9 cm) was found from the corms treated with growth regulator (control).

The diameter of corm was influenced by the interaction effect of corm size and growth regulators (Plate 4). However, large corms treated with 200 ppm GA_3 produced the maximum corm diameter (6.5 cm) and small corm treated with control showed the minimum corm diameter (4.0 cm) in gladiolus (Table 6).

4.15 Corm weight

Corm weight was significantly influenced by corm sizes. Large corm showed maximum corm weight (6.0 g) of spike while small sized corm gave minimum weight (3.2 g) of spike (Table 5). Similar findings were reported by Shiraz and Maurya (2005) in gladiolus.

Growth regulators significantly influenced of corm weight. The results showed that corm weight was increased with the increase in concentration of GA_3. GA_3 at 200 ppm gave the maximum weight (6.5 g) of spike while control showed minimum weight (3.9 g) of spike initiation (Table 5).

There was significant interaction effect between corm size and growth regulators regarding the weight of corm. When the combined effect was considered, the maximum weight of corm (6.5 g) was found in treatment combination of large corm treated with 200 ppm GA_3 while small corm treated with control showed the minimum (4.0 g) performance (Table 6).

4.16 Cormel weight

Corm size had significant influence on 10 cormel weight. The weight was highest (35.0 g) in plants grown from large corms whereas it was the lowest (23.0 g) when small corms were used as planting material. This is in line with the findings of Ogale *et al.,* (1995) in gladiolus.

Corm treated with 200 ppm GA_3 attained the highest weight (37.0 g) followed by 150 ppm GA_3 (35.0 g) whereas lowest weight in control (25.0 g) (Table 5). The results are in agreement with the results of Mohanty *et al.,* (1994) who reported maximum cormel weight was observed when GA_3 was used at 250 ppm.

The interaction effect of corm size and growth regulators on the cormel weight was found significant. It was minimum (25.0 g) in the treatment combination of small corm and control while it was maximum (40.0 g) in the treatment combination of large corm and GA_3 200 ppm (Table 6). These results are in accordance with the results of Memon *et al.,* (2009) in gladiolus.

CHAPTER V
SSUMMARY AND CONCLUSION

Summary

The experiment was conducted at the Floriculture Research Field, Horticulture Research Centre, Bangladesh Agricultural Research Institute (BARI), Gazipur with the objective to study the effects of corm size and growth regulators on the growth, flower and corm production of gladiolus during the period from October 2012 to May 2013. Three levels of corm size: large-50 g, medium-30 g and small -15 g and seven different pre-planting treatments of growth regulators (GA_3 at 100, 150 and 200 ppm, BAP at 50, 100 and 150 ppm and control) were used for this purpose. The two-factor experiment was laid out in randomized complete block design with three replications. There were all together 21 treatment combinations in this experiment.

Corms of gladiolus (*Gladiolus grandiflorus* L.) were planted on 15 October 2012 with spacing of 20 x 20 cm. The spikes of gladiolus were harvested from January to February, 2013 at the tight bud stage and when three basal flower buds showed colour so that these may easily open indoors one by one. Corm and cormel were harvested on May, 2013 when leaves turned brown. Data were collected on days required to 80% crop emergence, plant height, number of leaves, number of plants per hill, days required to 80% spike initiation, spike length, rachis length, number of florets per spike, spike weight, flower durability, flower yield, corm number, corm weight, corm diameter, cormel number and 10 cormel weight.

The results of the experiment revealed that corm size and pre-planting treatment of growth regulators had significant effect on all parameters studied. The longest time (14 days) to complete 80% emergence was required by small corm whereas it was least (8 days) with the use of large corm. GA_3 at 200 ppm (7 days) showed more prominent effects on time to complete 80% crop emergence compared to control (11 days).

Plant height and number of leaves per hill were significantly increased with the increase in size of corm. GA_3 at 200 ppm showed better performance in respect of plant growth over control. Large corm treated with BAP 100 ppm produced the highest number of plants/hill (2.3).

Time to 80% spike initiation was observed earlier in plant produced from large corm (67 days) than in plant produced from medium and small corm (71 and 76 days respectively). GA_3 at 200 ppm completed 80% spike initiation by 66 days earlier than the control (78 days).

The plant from large corm produced the highest spike length (76.0 cm) and the shortest spike length was produced in plant grown from small corm (61.0 cm). The length of spike was highest (80.0 cm) with the treatment of 200 ppm GA_3 followed by 150 ppm GA_3 (76.8 cm) over control (63.0 cm).

The plant from large corm produced the highest rachis length (43.0 cm) whereas it was least (35.0 cm) with the use of small corm. Growth regulator had also significant effect on rachis length. The length of rachis was maximum (52.0 cm) with the treatment of 200 ppm GA_3 in combination with large corm over control (32.0 cm).

Number of florets per spike was maximum in large corm (12) and was minimum in small corm (8). GA_3 at 200 ppm produced the maximum number of florets per spike (13) followed by GA_3 at 150 ppm (12) and the control treatment produced the minimum number of florets (9). However, the combined effect of corm size and growth regulator treatment revealed that the maximum number of florets (14) was obtained from the treatment combination of large corm treated with 200 ppm GA_3.

It was revealed that different corm size and growth regulators had significant effect on weight of spike. GA_3 at 200 ppm with large corm attained maximum weight of spike (72.0 g).

The maximum flower durability (14 days) was found from the spike produced by the large corm treated with GA_3 200 ppm while untreated corm (without growth regulator) showed the lowest performance (9 days). The highest flower yield per hectare (260000 spikes) was recorded from large corm treated with GA_3 @ 200 ppm.

Corm and cormel production also significantly influenced by different sizes of corm and growth regulator level. The maximum number of corm and cormel (2.5 and 25) were produced by large corm treated with GA_3 @ 200 ppm. The same level of GA_3 with large corm also showed better performance in corm diameter (6.5 cm), corm weight (55.0 g) and 10 cormel weight (40.0 g).

Conclusion

- ❖ BARI Gladiolus-5 planted at large size corm produced the tallest plant, maximum number of leaves, tallest spike of maximum weight, superior quality rachis of maximum length and maximum weight of individual corm and cormel per plant.

- ❖ All concentration of GA_3 and BAP significantly improved all characteristics of BARI Gladiolus-5 over control, while the most effective concentration was 200 ppm GA_3.

- ❖ Considering interaction effect between corm size and different growth regulators, it was found that large size corm in combination with 200 ppm GA_3 increased vegetative growth, flower and corm production of gladiolus under agro-ecological conditions of Joydebpur.

- ❖ The study was conducted only one growing season. So, such types of experiment may be conducted in different AEZ before final recommendation of the res

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APPENDICES

Appendix I. Mean monthly weather data during October 2012 to May 2013

Year	Month	Air temperature (°C)		Relative Humidity (%)	Rainfall (mm)
		Max.	Min.		
2012	October	29.75	26.80	85.28	183.40
2012	November	26.22	22.75	80.17	08.50
2012	December	19.90	15.45	89.05	0.00
2013	January	14.22	10.55	90.03	000.0
2013	February	23.75	18.81	86.63	06.49
2013	March	32.20	26.41	69.74	06.05
2013	April	32.15	28.20	74.93	058.6
2013	May	31.37	27.90	76.19	250.64

Source: Bangladesh Agricultural Research Institute, (BARI), Gazipur.

Appendix II. Analytical data of soil sample at Floriculture field of HRC, BARI

Year	p^H	Total N	OM	Ca	Mg	K
		%		Meq/100g		
2009	6.1	0.077	1.46	4.76	1.97	0.15
Critical level				2.0	0.8	0.2

Appendix II. Cont'd.

Year	p^H	P	S	B	Cu	Fe	Mn	Zn
		µg/g						
2009	6.1	15	38	0.32	6.0	232	10	3.30
Critical level		14	14	0.2	1.0	10.0	5.0	2.0

Source: Soil Science Division, Bangladesh Agricultural Research Institute, (BARI), Gazipur.

Appendix III. Analysis of variance of the data on different plant characters of gladiolus as influenced by corm size and growth regulators

Source of variation	Degrees of Freedom	Days required to 80% emergence	Leaves/ plant	Plants/ hill
Replication	2	0.336	27.62	4.51
Corm size (A)	2	154.91*	959.75*	50.15*
Growth regulators (B)	6	44.21*	3465.92*	80.57*
Interaction (A) x (B)	12	1.11*	1.83*	1.49*
Error	40	0.467	12.673	0.430

* = Significant at 5% level of probability

Appendix IV. Analysis of variance of the data on different flower characters of gladiolus as influenced by corm size and growth regulators

Source of Variation	Degrees of freedom	Days required to 80% spike initiation	Spike length	Rachis length	Florets /spike	Spike weight	Flower durability
Replication	2	74.62	39.46	6.04	0.48	4.50	0.34
Corm size (A)	2	230.21*	266.89*	239.59*	9.56*	8.35*	11.56*
Growth regulators (B)	6	3.2.61*	811.87*	432.28*	25.31*	23.16*	21.29*
Interaction (A) x (B)	12	1.65*	1.89*	3.34*	0.27*	0.24*	0.58*
Error	40	13.04	3.45	2.64	0.42	0.44	0.585

* = Significant at 5% level of probability

Appendix V. Analysis of variance of the data on different corm characters of gladiolus as influenced by corm size and growth regulators

Source of Variation	Degrees of freedom	Corm number	Corm diameter	Corm weight	Cormel number	10 Cormel weight
Replication	2	0.54	5.61	5.40	0.79	23.19
Corm size (A)	2	8.35*	7.35*	8.51*	11.60*	15.40*
Growth regulators (B)	6	20.28*	21.50*	20.42*	20.15*	18.56*
Interaction (A) x (B)	12	0.26*	0.60*	0.55*	0.69*	1.68*
Error	40	0.20	0.88	0.40	0.57	10.34

* = Significant at 5% level of probability