INFLUENCE OF CORM SIZE AND ZINC ON GROWTH FLOWERING AND YIELD OF GLADIOLUS

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CERTIFICATE

This is to certify that thesis entitled, "INFLUENCE OF CORM SIZE AND ZINC ON GROWTH FLOWERING AND YIELD OF GLADIOLUS" submitted to the Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** in **HORTICULTURE,** embodies the result of a piece of *bona fide* research work carried out by **Tahmina Shahid, Registration No. 06-02011** under my supervision and guidance. No of part of the thesis has been submitted for any other degree of 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
Dhaka, Bangladesh

…………………………………
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DEDICATED TO

MY

BELOVED PARENTS

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ABSTRACT

The experiment was conducted in the Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka during November 2011 to June 2012.The experiment consisted with two factors. Factor A: Three levels of corm size i.e. C_1: Small (11-20 g); C_2: Medium (21-30 g) and C_3: Large (31-40 g) corm and Factor B: Five levels of zinc as Zn_0: 0 kg (control), Zn_1: 1 kg, Zn_2: 2 kg, Zn_3: 3kg and Zn_4: 4 kg/ha respectively. The experiment was laid out in a randomized complete block design with three replications. For corm size, highest no. of spike (290700/ha) and corm yield (15.67 t/ha) was from C_3 and lowest no. of spike (251600/ha) and corm yield (12.54 t/ha) was from C_1. For zinc, highest no. of spike (297800/ha) and corm yield (16.44 t/ha) was from Zn_3 while lowest no. of spike (238500/ha) and corm yield (11.51 t/ha) was from Zn_0. For interaction effect, highest no. of spike (337800/ha) and corm yield (19.69 t/ha) was from C_3Zn_3 while lowest no. of spike (231100/ha) and corm yield (10.31 t/ha) was from C_1Zn_0. The highest BCR (2.82) was from C_3Zn_3 and lowest (1.90) from C_2Zn_0. So, large size corm with zinc at 3kg /ha is the best for growth, flowering and yield of gladiolus.

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LIST OF ABBREVIATION AND SYMBOLS

ABBREVIATION	FULL NAME
AEZ	Agro Ecological Zone
ANOVA	Analysis of variance
@	At the rate of
BBS	Bangladesh Bureau of Statistics
BAU	Bangladesh Agricultural University
cm^2	Square Centimeter
CV%	Co-efficient of Variance
DMRT	Duncan Multiple Range Test
DAP	Days After Planting
et al.	and Others
LSD	Least Significant Difference
g	Gram
MP	Murate of Pottash
m^2	Square Meter
ppm	Parts per million
RCBD	Randomized Complete Block Design
SAU	Sher-e-Bangla Agricultural University
SRDI	Soil Resources Development Institute
TSP	Triple Super Phosphate
UNDP	United Nations Development Program

CHAPTER I
INTRODUCTION

Gladiolus (*Gladiolus grandiflorus* L.*)* is a herbaceous annual flower belongs to the family Iridaceae, is one of the most attractive and popular cut flower. It has also known as queen of bulbous flower and sword lily. Gladiolus seems to be originated in South Africa and the development of gladiolus started only at the beginning of the 18th century.

Gladiolus has gained popularity in many parts of the world owing to its unsurpassed beauty and economic value (Chadha and Chawdhuary, 1986). It is popular for its attractive spikes having floret of huge forms, dazzling colors, varying sizes and long durable quality as cut flower. The fascinating spike bears a large number of florets with varying sizes and forms with smooth ruffle of deeply crinkled sepals. It has been appropriately providing a symbol of glamour and perfection (Singh *et al*., 2012). Gladiolus is frequently used as cut flower on different social and religious ceremonies. It is also used as bedding flower, herbaceous border or does quite well in pots (Bose and Yadav, 1989). Gladiolus spikes are most popular in flower arrangements and for preparing attractive bouquet (Mishra *et al*., 2006). Flower and corm of some gladiolus are used as food in many countries (Khan, 2009).

Gladiolus occupies fourth place in international cut flower trade (Bhattacharjee and De, 2010). It has second rank after tulip among the bulbous flowers in India (Singh *et al.,* 2012). It is now grown as a cut flower widely in Europe, particularly in Holland, Italy and Southern France (Butt, 2005).

In Bangladesh gladiolus was introduced from India around the year 1992 (Mollah *et al*., 2002). The main gladiolus growing place in Bangladesh is Jassore, Saver, Comilla etc. Commercial cultivation of gladiolus is gaining popularity due to export potentials and prevalence of favorable growing condition in different parts of the country. Momin (2006) reported that income from gladiolus flower production in six times that returns from rice.

The area of flower production appears to have increased significantly and estimated area of around 10000 ha and the annual trade at wholesale level to be worth between 500-1000 million taka in Bangladesh (Khan, 2009).

There are many factors such as corm size, planting time, fertilizer management etc affect the growth, flowering and yield of gladiolus. Mohanty (1994) reported that corm size is one of the main factors of gladiolus production. 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 Kumer (2012) reported that plant raised from large size corm had the greatest plant height, maximum length of spike, longest rachis, highest number of floret per spike, maximum percentage of flowering plant, heaviest corm and highest number of cormels per plant. Large corms (4.6-50 cm in diameter) produce more flowers, corm and cormel than others (Mukhopadhyay and Yadav, 1984).

Zinc is one of the important micronutrient for the growth and development of gladiolus. The micronutrients play crucial and vital role in gladiolus production as well as major nutrients in growth and development of gladiolus (Singh *et al*., 2012). It was reported by many researchers (Singh, et al., 1996 and Das, 1998) that Zn had a significant effect on corm and cormel production of gladiolus. Zinc influenced the vegetative growth and size of spike (Katiyar, *et al.*, 2012). It was reported that about 2.0 million hectares of agricultural land are zinc deficient under different agroecological zones in Bangladesh. Zinc is required in small amount but critical concentrations to allow several plant physiological pathways to function normally. These pathways have important roles in photosynthesis and sugar formation, protein synthesis, fertility and seed production, growth, regulation and defense against disease (Bray and Kurtz, 1999). Zinc is involved in biosynthesis of tryptophan, a precursor of auxin which is essential for elongation. It has also been found to be essential for normal chlorophyll formation in plants.

Zinc mainly function as the metal component of a series of enzyme. Zinc deficiency is thought to restrict RNA synthesis which is inhibit protein synthesis (Katyal and Randhawa, 1983). Zinc application also helps in increasing the uptake of nitrogen & potassium.

There is a scope of increasing flower yield, quality of flower, corm and cormel production of gladiolus with the appropriate size of corm. An optimum dose of zinc will ensure better yield and quality of gladiolus. Considering the present situations and facts the present investigation was undertaken with the following objectives-

i. To find out the suitable corm size for growth, flowering and yield of gladiolus.

ii. To find out the optimum level of zinc for ensuring higher yield of gladiolus and

iii. To determine the best combination of corm size and zinc level for growth, flowering and yield of gladiolus.

CHAPTER II
REVIEW OF LITERATURE

Gladiolus is one of the most important cut flower. Many research works have been conducted on various aspects of this important cut flower in different parts of the world. But a very few studies related to growth, flowering, corm and comel production of gladiolus have been carried out in Bangladesh. A review of literatures related to effects of corm size and different levels of zinc on growth, flowering, corm and cormel production of gladiolus is given under the following headings-

2.1 Literature on corm size

Joshi *et al.* (2011) conducted an experiment to assess the effect of corm size and varieties on corm /cormels production and vase life of gladiolus (*Gladious grandiflorus* L.) under Chitwan condition, India. The experiment consisted of 12 treatment combinations laid out in two factorial Randomized complete block design (RCBD) with three replications. Four sizes of corms, viz. 2-3 cm, 3-4 cm, 4-5 cm and 5-6 cm and three varieties, viz. American Beauty, Interpret and Yellow Summer Sunshine formed 12 treatment combinations. Laboratory experiment was conducted to determine the effect of corm size and varieties on the vase life of harvested cut spikes of gladiolus at ambient temperature in Nepal. Corm size and varieties significantly affected corm/cormels production and vase life of gladiolus. Large sized corms (5-6 cm) performed better with respect to number of daughter corms and cormels per plant. Similarly, large sized corms (5-6 cm) showed better performance with respect to postharvest behavior such as total number of florets opened/spike (11.40), days to first and 100% floret withering as compared to small sized (2-3cm) corms. Significant variation among three varieties was observed in most of the characters. Numbers of daughter corms were found highest in Yellow Summer Sunshine while maximum numbers of cormels/plant were found in Interpret. Similarly, Interpret proved best having more number of florets opened per spike and more days needed to first and 100% floret withering.

Bhat *et al.* (2009) conducted a field trial to study the influence of corm size and planting geometry on growth, flowering and corm production in gladiolus cv. White Prosperity. Three corm sizes (4.1-4.5, 4.6-5.0 and 5.1-5.5 cm dia.) and three spacings (10 x 20,15 x 20 and 20 x 20 cm) were tested in RCBD replicated thrice. Data revealed that the plant height, number of leaves per plant, number of days taken for spike emergence, spike length, number of floret per spike, floret diameter and number, weight and size of corm and cormels produced significantly improved in the largest corm size (5.1-5.5 cm dia.).Wider plant spacing (20 x 20 cm) also improved growth, flowering and corm production parameters during both the years of study.

Noor-un-Nisa *et al*. (2009) conducted a field experiment to investigate the effect of corm size on the vegetative and floral attributes and corm and cormel production in gladiolus. Corm and cormel production of gladiolus has major role in the growth and development of gladiolus industry. 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 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 over those produced from small and medium sized 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 per plant, cormels per plant and combined total weight of corms and cormels per plant in all the three varieties of gladiolus.

Dilta *et al.* (2004) evaluated the performance of 10 gladiolus with respect to two corm sizes i.e. A-grade (>5.00 to < 6.00 cm dia.) and B- grade (>2.50 to < 3.50 cm dia.).The maximum plant height (111.34 cm) was recorded in cv. ‘Candiman’ while the minimum (83.62 cm) in ‘Black Beauty’ which was found to be at par with cv. ‘American Beauty (84.17 cm). A-grade corms resulted in increased plant height (107.50 cm) as compared to B-grade size corms (85.12 cm). The flowering was earliest in cv. ‘American Beauty’ (106.67 day) while cv. ‘Candiman’ took maximum days to flower (126.55). A-grade corms took less days to flower (112.64) than B-grade corms (120.09).The maximum number of florets/ spike (16.34) was recorded in cv. ‘Candiman’ while the cv. Poppy Tears produced minimum (14.25) florets/ spike. A-grade corms produced more number of florets/ spike (16.95) as compared to B-grade size corms (13.99). The maximum floret size (8.83 cm) was recorded in cv. ‘Candiman’ whereas cv. ‘Her Majesty’ produced florets of minimum size (7.10 cm). The floret size was more in A-grade corms as compared to B-grade size corms (7.22 cm).

Uddin *et al.* (2002) conducted a field experiment with gladiolus. The effect of corm size and depth of planting was studied on the growth and flowering of gladiolus cv. ‘Friendship’ using the combination of four corm sizes (15, 10, 5 and 3 g) and three planting depths (10.0, 7.5 and 5.0 cm). Corm size had significant influence on all the parameters studied. Large corm (15 g) took shortest time to complete 80% emergence (15.89 days) and flower initiation (60.44 days). The depth of planting had no marked effect on the parameters studied except percent lodging of plant. The highest lodging of plants (19.83%) was observed in shallowest depth of planting (5.0 cm), and the lowest (7.91%) was found in deepest planting depth (10.0 cm). The combined effect of corm size and depth of planting had significant effect on all the parameters studied except number of spikelets per plant. The highest plant height (97.56 cm), number of leaves (62.33), length of flower stalk (26.07 cm) and lodging of plants (33.14%) in the treatment combination of large sized corm planted at 5.0 cm depth and the lowest in the treatment combination of very small corm with 10 cm depth.

Paswan *et al. (*2001) conducted a field trial in the period of 1987-88, in Assam, India to study the effect of corm size and corm pieces on corm and cormel production of gladiolus cv. Sylvia. Corms were graded into Large-Jumbo (>5.1cm), Medium (3.2 to <3.8cm) and small (1.9 to <2.5cm) based on their diameters. Corms of large and medium grades were divided into two and three pieces, except the small grade corm which was divided into two. Large and medium sized whole corms produced more number of leaves with maximum length and breadth compared to small grade corms and all other pieced corm treatments. Among all treatments, whole corm of large and medium sizes produced the largest corms in terms of diameter and weight. Flowering grade corms were also produced by whole corms as well as corm pieces of all sizes. Although there was an apparent decrease in number of cormels per piece of corm with the increase fractionation compared to whole corms of all sixe grades, there was actually a substantial increase in number of cormels within the same size grade of corms.

Singh (2000) planted corms of 6 different size grade (from > 1.9-2.5 cm to > 6.0-6.5 cm) in the field at a spacing of 30 x 20 cm in a trial conducted over 3 years (1995-97) at Bangalore, India with Gladiolus cv. 'Pink Friendship. Large corms took longer to sprout but flowered earlier: plants were taller with larger leaves and flower spikes, had more florets per spike and produced more cormels /plant, compared with medium or small corms.

Singh *et al*. (1998) conducted a field experiment in Karnataka with gladiolus cv. 'Pink Friendship' to examine the effects of corm size on quality of flower spike and corm development. Large sized mother corms significantly induced earlier flowering produced longer spikes, highest florets /spike and the highest cormels and corm weight/ plant compared with medium or small sized corms. The duration of flowering and diameter and weight of individual corm was not affected by corm size.

Singh and Singh (1998) conducted an experiment to investigate the effect of corm size on flowering and corm production of gladiolus cv. 'Sylavia' in Himachal prodesh, India. The three corm sizes used were large, medium and small. It was found that percentage of sprouting was 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 of sprouting, plant height, spike length, number of flowers per spike (15.53, 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 respectively).

Kalasareddi *et al.* (1997) carried out an experiment to study the effect of different corm size (very small, small, medium and large) on flowering of gladiolus cv. 'Snow White' and found that corm size was significantly influenced the time taken for spike emergence, time taken for flowering, time taken for 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 (37333/ha in number) was obtained from large corms.

Azad (1996) carried out an experiment to investigate the effect of corm size and plant spacing on growth and flower production of gladiolus. Corms of there sizes (6.5, 16.0 and 30.0 g) were planted at the spacings of 20 x 10, 20 x 15 and 20 x 20 cm. The highest yield of mother corms (13.17 t/ha) and cormels (22.36 t/ha) were recorded from the treatment combination of close spacing (20 x 10 cm) and large corm (30.0 g).

Singh (1996) evaluated the effect of cormel size 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, 250, 300 or 350 kg per hectare.

It was found that large cormels produced large corms with the highest number of cormels per plant. The best treatments for producing large corms with maximum number of cormels were the planting of large cormels fertilized with N at 200 or 250 kg per hectare.

Patil *et al.* (1995) conducted an experiment to investigate the effect of different spacing and corm size on the flower and corm production of gladiolus. Corms of 3 sizes (>4.1, 3.1-4.0 and 2.1.-3.0 cm) were planted at the spacing of 30 x 20 or 30 x 30 cm. Corm size and spacing had no significant effects on spike length, floret size, number of florets per spike.

Ogale *et al.* (1995) evaluated the role of corm size on flowering and corm yield of gladiolus and reported that young gladiolus cormels required 2-3 seasons of vegetative growth before flowering can be induced. They have observed that there was a direct correlation between corm size, flower production and final corm yield.

Mollah *et al.* (1995) carried out an experiment at pahartali, Bangladesh to investigate the effect of cormel size and plant spacing on growth and yield of flower and corm of gladiolus.It was found that cormel of 7.0^{+}_{-} 0.20 g in size with widest plant spacing (15 x 15 cm) production the longest rachis (43.50 cm), maximum number of floret per rachis (11.5) , heavier corm (31.33) and highest number of cormels (21.87) per plant.

Laskar and Jana (1994) studied the effect of planting time and size of corms on plant growth, flowering and corm production of gladiolus. Corm and flower production were best with planting on 19 March (1.86 - 1.95) corms and 1.58 – 1.63 flower spikes per plant using the largest corms (1.72 - 1.78) corms per plant and 1.57 - 1.62 flower spikes.

Mohanty *et al.* (1994) studied the effect of corm size and pre-planting chemical treatment of corm on growth and flowering of gladiolus cv. ‘Vink’s Beauty’.
They planted the corm of different sizes viz. large (2.45 - 2.55 cm in diameter) medium (1.25 - 1.30) cm and small (0.85-0.90 cm) with soaking in solutions

containing GA3 at 50, 100 or 150 ppm and etherl at 100, 250 or 500 ppm or in distilled water for 24 hours. It was reported that taller and thicker plants with more leaves were obtained form the large corm than those from medium or small corms.

Ko *et al.* (1994) carried out an experiment to evaluate the effect of planting time and corm size on the duration of flower and corm production of gladiolus in Korea. Corms of different sizes (6-8, 8-10 or 10-12 cm) were planted on May 19, 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 floret (14.30), floret length and diameter and higher percentage of best quality flowers.

Vinceljak (1990) studied the effect of corm size on corm yield of gladiolus cv. Oscar and 'Peter Pears'. In general, shoots from larger corms started to emerge earlier than those from smaller corms. The effect corm size on production of new corm number/m^2 differed in the two experimental years, in one year the use of smaller corms increased corm number/m^2 in the next year it decreased .The yield of small cormels (> 4 cm) and total corm yield (4-14 t\ha) were similar for the two cultivars. Oscar produced about 14% higher yield of corms suitable for cut flower production (8-14 t\ha) than 'Peter Pears' .

Hong *et al.* (1989) studied the effect of leaf remaining after cutting the flower, corm lifting date and corm size on corm production and flowering in the next crop of gladiolus at Suwon, Korea. They observed that diameter of corm and weight of corm, number and weigh of cormels increased with increasing the number of leaves after cutting the flowers. They also reported that the number of daughter corms and flowering ability increased with increasing corm size up to 4-5 cm diameter.

Dod *et al* (1989) investigated the effects of different dates of planting and corm size on growth and flower yield of gladiolus in India. They reported that the best results could be obtained from the large corms (>3.0 cm in diameter) with the earliest date of planting.

Gowda (1988) studied the effect of corm size (viz. 3.0 – 4.0 cm, 4.1 – 4 .5 cm and 4.5 - 5.0 cm in dia.) on growth and flowering of gladiolus cv. ‘Picardy’ under Banglaore conditions, India. The best result in respect of growth and flowering was found when larger corms were used as planning materials.

Gowda (1987) reported that there was an interaction effect of corm size and spacing on growth and flower production in gladiolus cv. ‘Snow Prince’. Corms of 3.0-4.0, 4.1-4.5 and 4.6-5.0 cm in diameter were planted at 30x10,15, 20 or 25 cm and the effects on days to spouting plant height number of leaves and number of plantlets produced and number of flower spikes per plant were assessed. The best result was obtained by planting 4.1-4.5 cm corms.

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’. They observed that large corms (4-5 and 5-6 cm in diameter) gave earlier sprouting and deeper planting at 6 cm resulted in delayed sprouting. It was also found that increased corm size gave a significant increase in inflorescence and stem length.

Sciortino *et al.* (1986) studied the effect of size of propagating materials and plant density on the yield of corms for forced flower production in gladiolus cv. ‘Peter Pear’. They obtained higher yield with increasing cormel size (1-4 cm in circumference).

Misra *et al. (*1985) conducted an experiment to investigate the effects of different sizes of planting materials on flowering of gladiolus var. ‘White Oak’ in India. They observed that the commercial grade spikes were obtained from corms of grade (1.9-2.5 cm in diameter) but acceptable quality spikes were obtained from grades of corms in the range of 1.3-1.9 to 0.8-1.0 cm diameter.

Mukhopadhyay and Yadav (1984) conducted an experiment to study the effect of corm size and spacing on growth, flowering and corm production in gladiolus. They planted corms ranging in the sizes from 3.5 to 5.0 cm in diameter at 10 x 30, 15 x 30, 20 x 30 and 25 x 30 cm. It was found that large sized corms (4.5-5.0 cm) produced more flowers and corms and cormels than the other sizes.

Mckay *et al.* (1981) studied the effect of corm size and division of the mother corm in gladiolus. They used four sizes of gladiolus corms. Those were > 50 mm, 38-50 mm, 33-38 mm and 25-33 mm, 19-25 mm and 13-19 mm and were planted whole or after being cut in half. Plants from whole, large corms produced the highest inflorescence yield with better quality. For the large corms, cutting increased the yield of new corms by 93%.

Bhattacharjee (1981) observed that flower and corm production of gladiolus were influenced by corm size, planting depth and spacing. Corms of three sizes ,viz. 2.5-3.5, 4.0-5.0 and 5.5-6.6 cm in diameter of gladiolus cv. Friendship were planted at 3 depths, viz. 5.7 and 9 cm and 3 spacings viz. 15, 20 and 25 cm within the rows. Increasing of corm size increased the spike length, floret number, flower diameter and the size and weight of corms. Increasing in planting depth improved the quality of flower spikes as well as lifted corms.

Banker and Mukhopadhyay (1980) carried out an experiment to investigate the effects of corm size, depth of planting and spacing on the production of flowers and corms in gladiolus.

The experiment was consisted of three corm sizes, viz. 1.5-2.5, 2.5-3.5, 3.5-4.5 g; three depth of plating viz. 3, 5 or 7 cm and three spacing, viz. 15, 20 or 25 cm. It was observed that large corms increased the height of plant (58.61 cm) highly significant and length of spikes (101.12 cm).

Gill *et al.* (1978) in their experiment studied the effect of corm size on the quality of gladiolus flower. Corm of six sizes, viz. > 2, 2-10, 20-30, 30-40 and > 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 Literature of Zinc

Katiyar *et al.* (2012) carried out an experiment to investigate the effect of zinc, calcium and boron on spike production in gladiolus with foliar application in Kanpur in Randomized Block Design with four replications. The experimental plots were 32 with 8 treatments and two levels of each of zinc, calcium and boron treated by zinc sulphate 0.5%, calcium sulphate 0.75% and borax 0.2%, respectively. The results obtained revealed that the foliar spray of zinc at 0.5% to gladiolus plant was most effective to influence the vegetative growth and size of spike.

Singh *et al.* (2012) carried out an experiment in Kanpur to investigate the effect of zinc, iron and copper on yield parameters in gladiolus. The experiment consisted with two levels each of Zn (Zn_0 and Zn_1), Fe (Fe_0 and Fe_1) and Cu (Cu_0 and Cu_1) which were sprayed on gladiolus plant. The dose of foliar spray of zinc, iron and copper were 0.50%, 0.25% and 0.25%, respectively. Weight of corms significantly increased with the application of Zn and Cu (94.38 and 94.82 g, respectively). Diameter of corms influenced significantly with the application of Zn, Fe and Cu (5.71, 5.77 and 5.81 cm diameter, respectively). Foliar spray of Zn, Fe and Cu, significantly increased the number of corms per plant. Interaction between Zn x Fe and Zn x Cu, significantly enhanced number of corms per plant whereas, the number of corms per plant revealed by Zn (1.74), Fe (1.66) and Cu (1.68) over their respective controls. Maximum increase in cormels production per plant was influenced due to application of zinc (44.97) followed by spray of copper (43.18) and iron (42.11) over their respective controls.

Lahijie (2012) conducted a field experiment for two consecutive years to study foliar spray of $FeSO_4$ and $ZnSO_4$ on the growth and floral characteristics of gladiolus variety 'Oscar'. The experiment was laid out in a randomized complete block design with three replicates in the field, Varamin Research Center. The evaluated was response and to find out the optimum dose of the same for production of gladiolus variety 'Oscar' an efficient concentration of $FeSO_4$ and $ZnSO_4$ on quality and productivity of gladiolus. Plants were grown and treated with three levels of 0, 0.5%, and 1% of two micronutrients $FeSO_4$ and $ZnSO_4$ and their various combinations at two- leaf and six-leaf stages. The results disclosed that solutions of Feso4 and Znso4 significantly affected plant growth and floral characteristics of gladiolus. Higher contents of both $FeSO_4$ and $ZnSO_4$ speed the plant growth and increased flowering characteristics. Application of 1 % Feso4 accelerated flowering earlier than $ZnSO_4$, as well as elongated days to spike emergence (21.49 days) and first florets opening (38.28). The results showed that 2% of both $FeSO_4$ and $ZnSO_4$ solutions and their mixture delayed the days from basal floret opening and number of floret at a time. The flowering properties like plant height (83.47 cm), length of spike (66.03cm), number of leaves (9.52 /plant) floret number (11.55/spike), diameter of floret (8.53cm) were significantly different other treatments when a mixed solution of 2% FeSO4 and $ZnSO_4$ was applied. It is concluded that no application of micronutrients on gladiolus ornamental at the commercial scale will produce poor quality of vegetative growth and low number of florets. However, It is suggested that micronutrients play a vital role on the growth and development of gladiolus plants, because of its stimulatory and catalytic effects on flower yield and metabolic processes.

Reddy *et al.* (2009) carried out a field experiment to study the effect of zinc ($ZnSO_4$) at 0.5%, calcium ($CaSO_4$) at 0.5% and boron (borax) at 0.25% on growth and flowering in gladiolus cv. Red Majesty with four replications. Foliar application of $ZnSO_4$ at 0.5% found to be significant on different parameters like plant height (73.11 cm), leaf length (52.81 cm), days to flowering (66.11 days), length of spike (54.01 cm), length of rachis (46.26 cm), number of florets per spike (14.00) and floret length (9.08 cm). While borax and $CaSO_4$ have shown non-significant results for most of the characters except days to flowering (66.13 days) and number of florets (13.93) per spike with boron at 0.25%. However, the interaction between boron (0.25%), $ZnSO_4$ (0.5%) and $CaSO_4$ (0.5%), $ZnSO_4$ (0.5%) revealed significant results for plant height 73.27 and 73.33 cm, respectively. While the interaction between boron and $ZnSO_4$ was significantly affected by days to flowering (66.13 days) and rest of the interactions were non-significant.

Halder *et al.* (2007) conducted a field experiment to investigate the response of B and Zn on corm and cormel production and to find out the optimum dose of B and Zn for maximizing yield for gladiolus cultivation. It appeared in studied data reveals that B and Zn made promising response to the growth and floral characters of gladiolus. It is also reported that gladiolus is highly responsive to chemical fertilizers. The sixteen treatment combinations included in the study noted that B and Zn at the rate of $B_{2.0}$ $Zn_{4.5}$ kg\ha along with blanket dose of N_{375} P_{150} K_{250} S_{20} kg and CD 5 t\ha exhibited the best performance in flower production and stretched the vase life of flower. The studied parameters like plant height (79.83 and 87.61 cm), length of spike (71.2 and 67.33 cm) length of rachis (48.86 and 45.08 cm) and leaves number (10.77 and 9.87/plant) significantly responded to the combined application of boron and zinc at the rate of B2.0 Zn4.54 as compared to other treatment combinations.

Floral characters like floret number (12.85 and 12.45/spike), floret size (9.76 x 8.93 and 10.28 x 9.77 cm) and weight of stick (36.73 and 45.12 g) also significantly influenced by said treatment ($B_{2.0}$ $Zn_{4.5}$ kg\ha) which was markedly differed over rest of treatments combination. Single application of B and Zn also contribute to the yield parameters of gladiolus.

Singh *et al.* (2000) conducted an experiment in the in Uttar Pradesh, India to study the effects of different spacings and various levels of $ZnSO_4$ on the corms and cormels production of gladiolus cv. Sylvia. The corms were planted at 15 × 20, 20 × 20 and 25 × 20 cm distance and $ZnSO_4$ at a different levels viz. 0, 10 and 20 kg/ha was applied in the soil during the last ploughing. Planting of corms at 25 × 20 cm resulted to the highest weight of corms/plant, maximum diameter of corms/plant and number of cormlels/plant. Application of the highest level of $ZnSO_4$ caused the highest increase in weight of corms/plant, diameter of corms and average weight of corm. It is, therefore, suggested that gladiolus cv. Sylvia may be planted at spacing of 25 × 20 cm, and 20 kg $ZnSO_4$/ha may be applied during the last ploughing.

CHAPTER III

MATERIALS AND METHODS

A field experiment was conducted during the period from November, 2011 to June, 2012 to find out the effect of corm size and different levels of zinc on growth, flowering and yield of gladiolus. The materials and methods that were used for conducting the experiment are presented in this chapter under the following headings.

3.1 Experimental site:

The experiment was conducted at the Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka. The location of the experimental site is situated in 23^0 74' N latitude and 90^0 35' E longitude (Anon., 1989).

3.2 Characteristics of soil

The experimental soil belongs to the Modhupur Tract under AEZ No.28 (UNDP, 1988).The selected experimental plot was medium high land and the soil series was Tejgaon (FAO, 1988). The characteristics of soil under experimental plot were analyzed in the SRDI, Soil testing Laboratory, Khamarbari, Dhaka and presented in Appendix 1.

3.3 Climate

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

Fig.1. Experimental plot of gladiolus

3.4 Experimental Materials

The corm was collected from Barishal Nursery, Savar Bazar, Dhaka. In this research work the experimental material consisted of 675 corms as planting materials. Zinc oxide was used as source of zinc.

3.5 Treatment of the experiment

The experiment was carried out to find out the effect of zinc on growth flowering and yield of gladiolus. The experiment is consisted with two factors.

Factor A: Corm Size

C_1= Small size corm (11-20 g)
C_2= Medium size corm (21-30 g)
C_3= Large size corm (31-40 g)

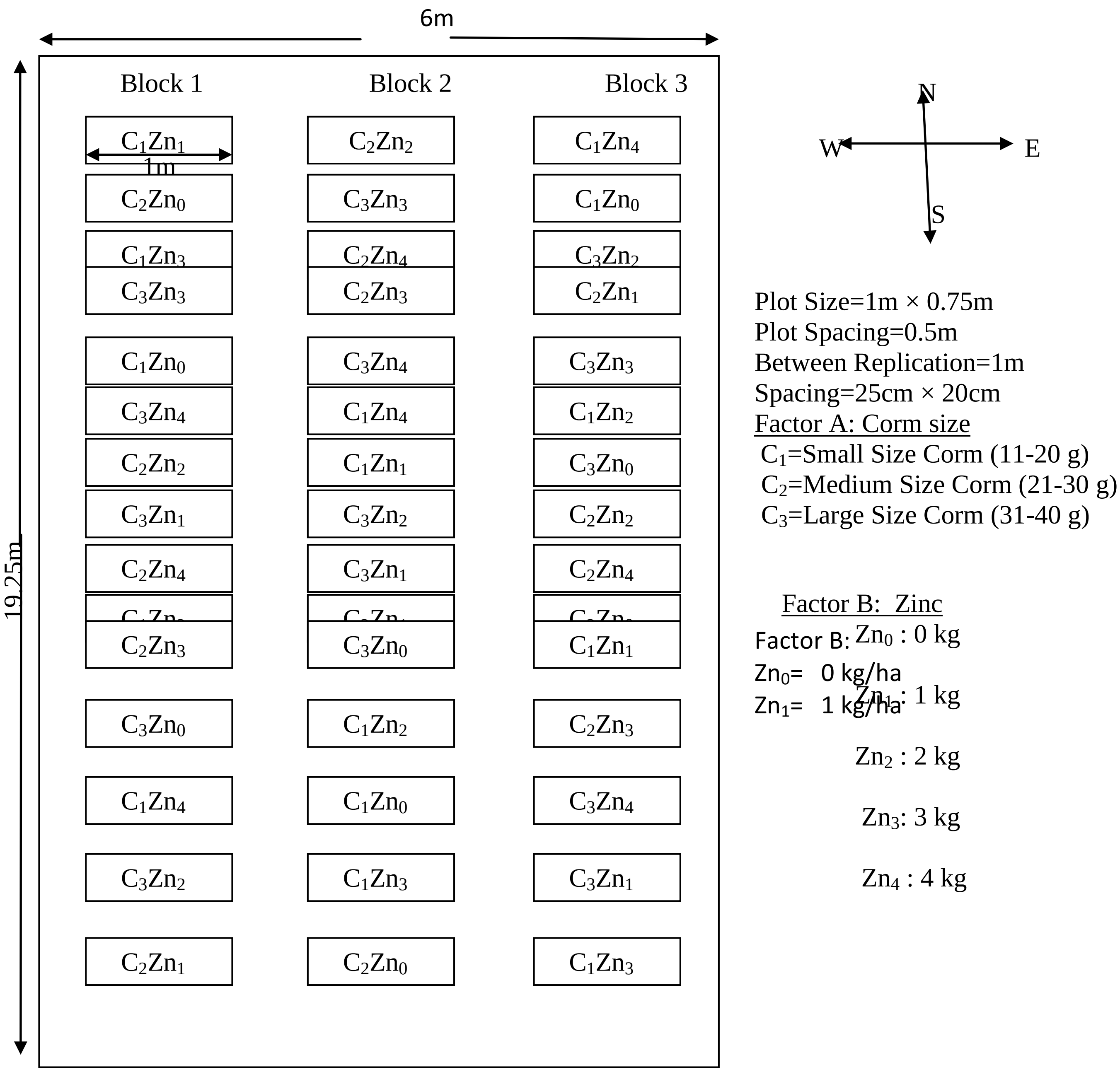
Factor B: Zinc

Zn_0= 0 kg Zn/ha (Control)
Zn_1= 1 kg Zn/ha (1.28 Kg ZnO)
Zn_2= 2 kg Zn/ha (2.56 Kg ZnO)
Zn_3= 3 kg Zn/ha (3.84 Kg ZnO)
Zn_4= 4 kg Zn/ha (5.12 Kg ZnO)

There were on the whole 15 (3×5) treatments combination as C_1Zn_0, C_1Zn_1, C_1Zn_2, C_1Zn_3, C_1Zn_4, C_2Zn_0, C_2Zn_1, C_2Zn_2, C_2Zn_3, C_2Zn_4, C_3Zn_0, C_3Zn_1, C_3Zn_2, C_3Zn_3, C_3Zn_4.

3.6 Experimental design

The experiment was laid out in a factorial (two factors) Randomized Complete Block Design (RCBD) with three replications. An area of 19.25 m x 6 m was divided into three blocks. Each block was divided into 15 unit plots where 15 treatments combination were allocated at random. Two adjacent unit plots and blocks were separated by 0.5 m and 1m space respectively. The unit plot size was 1 m × 0.75 m. The corm was planted into the soil maintaining row to row



distance at 25 cm and plant to plant distance at 20 cm. There were 15 plants containing in each plot. The layout of the experiment is shown in Figure 2.

3.7 Land preparation

The land was first open by ploughing with the help of power tiller and then it kept open to sun for seven days prior to further ploughing. Afterwards it was prepared by ploughing and cross ploughing followed by laddering. The weeds and stubbles were removed after each laddering. Simultaneously the clods were broken and the soil was made into good tilth.

3.8 Application of manure and fertilizers

The sources of N, P_2O_5, K_2O, Zn as urea, TSP and MP and zinc oxide were applied, respectively. The entire amounts of TSP, MP and zinc were applied during the final land preparation. Nitrogen (as urea) was applied in three equal installments at 15, 30 and 45 days after sowing seeds. Well-rotten cowdung also applied during final land preparation (Appendix III). The following amount of manures and fertilizers were used which shown as tabular form recommended by BARI, 2005.

Manure/ fertilizers	Dose
Cow dung	10 t/ha
Urea	200 kg/ha
TSP	200 kg/ha
MP	200 kg/ha
Zinc	As per treatment

3.9 Intercultural operation

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

3.9.1 Irrigation and drainage

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

3.9.2 Weeding

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

3.9.3 Top dressing

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

3.10 Plant protection

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

3.11 Data collection

Five plants were randomly selected from each unit of plot for the collection of data. The plants in the outer rows and the extreme end of the middle rows were excluded from the random selection to avoid the border effect.

3.11.1 Plant height

Plant height was measured from sample plants in centimeter (cm) from the attachment of the ground level up to the tip of the growing point and mean value was calculated. Plant height was also recorded at 10 days interval from 30 days of planting upto 80 days to observe the growth rate of plant.

3.11.2 Number of leaves per plant

The total number of leaves per plant was counted from each selected plant. Data were recorded as average of 5 plants selected at random from the inner rows of each plot from 30 DAT to 80 DAT at 10 days interval.

3.11.3 Days required for 50% emergence of spike

It was achieved by recording the days taken for 50% emergence of spike from each unit plot.

3.11.4 Days required for 80% emergence of spike

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

3.11.5 Percentage of flowering plant

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

3.11.6 Length of spike at harvest

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

3.11.7 Length of rachis at harvest

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

3.11.8 Number of floret per spike

Number of floret per spike was counted from the sample plants and their mean was calculated.

3.11.9 Number of spike per plot

Number of spike per plot was calculated from the number spike per plot obtained from counting all spike in a plot in each replication and mean was recorded.

3.11.10 Number of spike/ha ("000)

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

3.11.11 Individual corm thickness

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

3.11.12 Individual corm weight

Corm weight was determined by electrical balance and weighting the corms from randomly selected 5 plants from inner rows of each plot and mean weight was calculated.

3.11.13 Individual corm diameter

A slide calipers was used to measure the diameter of the corm from randomly selected 5 plants in the middle portion and expressed in centimeter.

3.11.14 Number of cormel per plant

Number of cormel per plant was calculated from the number of cormels obtained from randomly selected 5 plants in the middle portion and the average was recorded.

3.11.15 Weight of cormel

Individual weight of cormel was recorded from mean weight of selected sample and expressed in gram.

3.11.16 Diameter of cormel

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

3.11.17 Corm yield per plot

Total corm yield per plot was recorded by adding the total harvested corm in a plot and expressed in kilogram.

3.11.18 Cormel yield per plot

Total cormel yield per plot was recorded by adding the total harvested corm in a plot and expressed in kilogram.

3.11.19 Corm yield per hectare

It was calculated by converting the yield of corm per plot to per hectare.

3.11.20 Cormel yield per hectare

It was calculated by converting the yield of cormel per plot to per hectare.

3.12 Statistical analysis

The data obtained for different parameters were statistically analyzed to find out the significance difference at corm size and levels of zinc on flowering, corm and cormel production of gladiolus. The mean values of all the characters were calculated and analysis of variance was performing by the 'F' (variance ratio) test.

The significance of the difference among the treatment combinations means was estimated by the Ducan's Multiple Range Test (DMRT) at 1% or 5% level of probability.

3.13 Economic analysis

The cost of production was analyzed in order to find out the most economic treatment of corm size and zinc. All input cost were considered in computing the cost of production.

The market price of spike, corm and cormel was considered for estimating the return. The benefit cost ratio (BCR) was calculated as follows;

$$\text{Benefit Cost Ratio} = \frac{\text{Gross return per hectare (TK.)}}{\text{Total cost of production per hectare (TK.)}}$$

CHAPTER IV
RESULTS AND DISCUSSION

The present experiment was conducted to determine the effect of corm size and different levels of zinc on growth and yield contributing characters of gladiolus. The analysis of variance (ANOVA) of the data on different yield component and yield are given in appendix IV-VII. The results have been presented and discussed and possible interpretations have been given under the following headings:

4.1 Plant height

Significant difference was observed due to different sizes of corm for plant height (Appendix IV). At harvest, the highest plant height (76.32 cm) was recorded from large corm. On the other hand, the lowest plant height (68.64 cm) was obtained from small corm (Fig. 3). The results indicated that large corm produced the highest plant height with ensuring the nutrient elements adequately for newly emergence plants. Bhat *et al.* (2009), Singh (2000), Mohanty *et al.* (1994), Banker and Mukhopadhyay (1980) obtained similar findings from their earlier experiment.

Statistically significant variation was recorded for plant height for application of different levels of zinc (Appendix IV). At harvest, the highest plant height (78.52 cm) was obtained from Zn_3 while the lowest plant height (65.61 cm) was recorded from Zn_0 (Fig. 4). Zinc helps to make available other nutrient elements of the soil which also ensures the advanced growth of gladiolus plants. Similar results were reported by Reddy *et al.* (2009) and Singh *et al.* (2011).

Interaction effect showed significant variation on plant height (Appendix IV). Interaction effect revealed that large corm treated with 3kg zinc produced highest plant height (85.91 cm) while it was least (64.25 cm) in the combination of small corm with control treatment (Table 1).

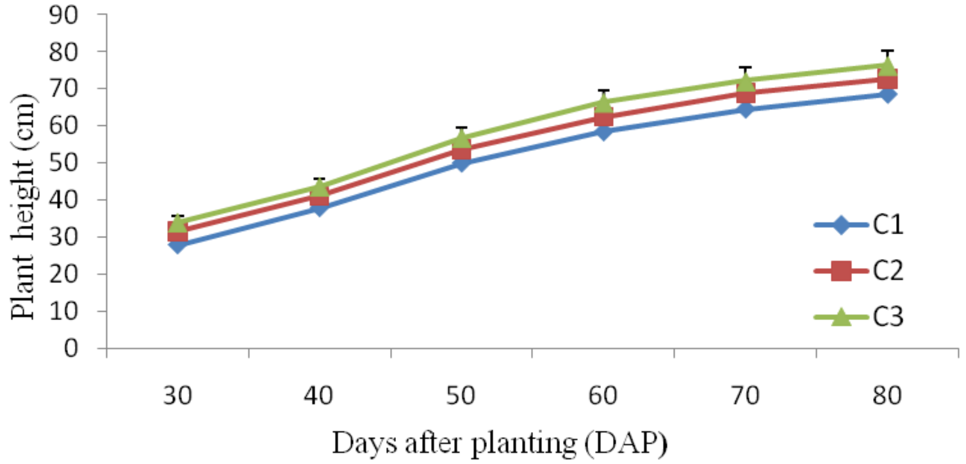


Fig. 3. Effect of different corm size on plant height at different days after planting

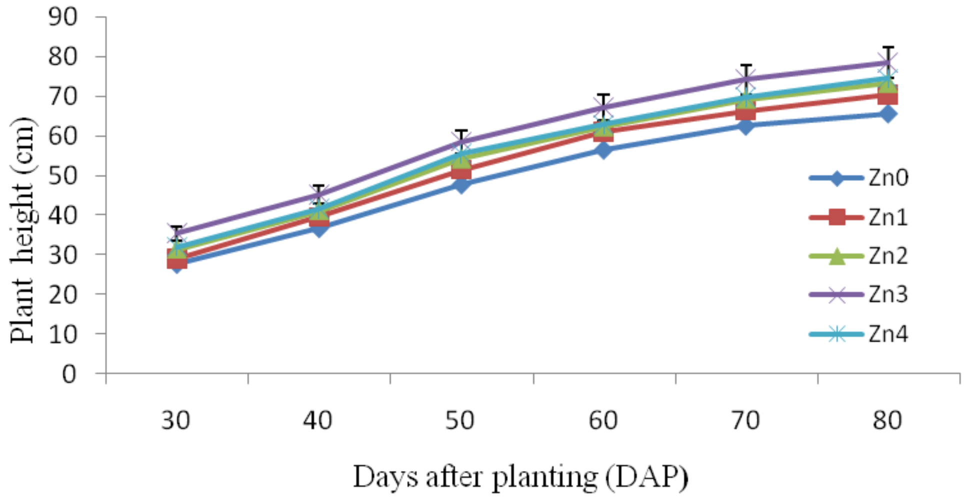


Fig. 4. Effect of different levels of zinc on plant height at different days after planting

Table1. Interaction effect of corm size and zinc on plant height at different days after planting of gladiolus

Treatment	Plant height (cm) at different days after planting (DAP)					
	30 DAP	40 DAP	50 DAP	60 DAP	70 DAP	80 DAP
C_1Zn_0	26.58 f	36.01 e	45.20 h	53.85 f	59.83 g	64.25 g
C_1Zn_1	25.99 f	37.56 e	49.94 efgh	58.50 def	64.81 defg	69.57 defg
C_1Zn_2	28,37 def	38.62 de	51.87 defg	61.09 de	66.10 def	70.16 defg
C_1Zn_3	29.43 def	39.08 de	52.06 cdefg	61.19 de	66.90 def	70.69 defg
C_1Zn_4	29.43 def	38.72 e	51.17 defg	57.78 ef	64.66defg	68.51efg
C_2Zn_0	27.40 ef	36.92 de	49.38 fgh	57.46 ef	64.05 efg	65.79 g
C_2Zn_1	30.12 cdef	39.25 bcd	51.86 defg	60.63 de	66.66 def	70.14 defg
C_2Zn_2	32.42 bcd	42.40 b	55.36 bcde	63.88bcde	70.36 bcde	74.77 cde
C_2Zn_3	36.05 b	46.29 cde	57.43 bc	67.97 abc	73.83 bc	78.97bc
C_2Zn_4	31.97 bcdef	40.35 e	54.39 cdef	61.92 cde	69.25cdef	73.42cdef
C_3Zn_0	29.23 def	37.37 e	48.76 gh	58.20 def	63.74 fg	66.78fg
C_3Zn_1	30.86 cdef	40.41 cde	52.57 cdefg	61.47 de	67.55 def	71.11defg
C_3Zn_2	32.57 bcd	43.68 bc	55.68 bcd	64.97 bcd	70.92bcd	76.08bcd
C_3Zn_3	42.05 a	50.61 a	67.70 a	72.53 a	82.76 a	85.91a
C_3Zn_4	34.80 bc	45.91 b	59.83 b	69.28 ab	75.34b	81.72ab
$LSD_{(0.05)}$	4.231	3.802	4.852	5.845	5.469	6.124
CV(%)	8.12	5.56	5.42	5.63	4.78	5.05

C_1: Small size corm (11-20 g)
C_2: Medium size corm (21-30 g)
C_3: Large size corm (31-40 g)

Zn_0: 0 kg Zn/ha
Zn_1: 1 kg Zn/ha
Zn_2: 2 kg Zn/ha
Zn_3: 3 kg Zn/ha
Zn_4: 4 kg Zn/ha

In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

4.2 Number of leaves per plant

Significant variation was recorded in terms of number of leaves per plant at different corm size (Appendix V). At harvest, the highest number of leaves per plant (11.27) was recorded from large corm while the lowest number of leaves (8.95) was obtained from small corm (Fig. 5). Generally large size corm ensure the nutrient element adequately which is the ultimate result in increased number of leaves. Mohanty *et al.* (1994), Gowda (1987) and Bhat *et al.* (2009) reported the same findings.

The effect of different levels of zinc was found significant variation on number of leaves per plant (Appendix V). At harvest, the highest number of leaves per plant (11.08) was recorded from Zn_3 and the lowest number of leaves (7.90) was found from Zn_0 (Fig. 6). Similar results were reported by Katiyar *et al.* (2012).

Number of leaves per plant showed significant variation due to interaction effect of corm size and zinc. Interaction effect revealed that large corm treated with 3kg zinc produced highest number of leaves per plant (14.67) at harvest while the lowest number (7.20) was recorded in the combination of small corm with control treatment (Table 2).

4.3 Days required for 50% emergence of spike

Days required for 50% emergence of spike varied significantly for different corm size (Appendix VI).The maximum (82.87) days required for 50% emergence of spike was recorded from small corm while the minimum (79.00) was obtained from large corm (Table 3). Large size corm initially helps the plant for growth and development with supplying storage nutrients in the corm which is the ultimate result of minimum days for 50% emergence of spike.

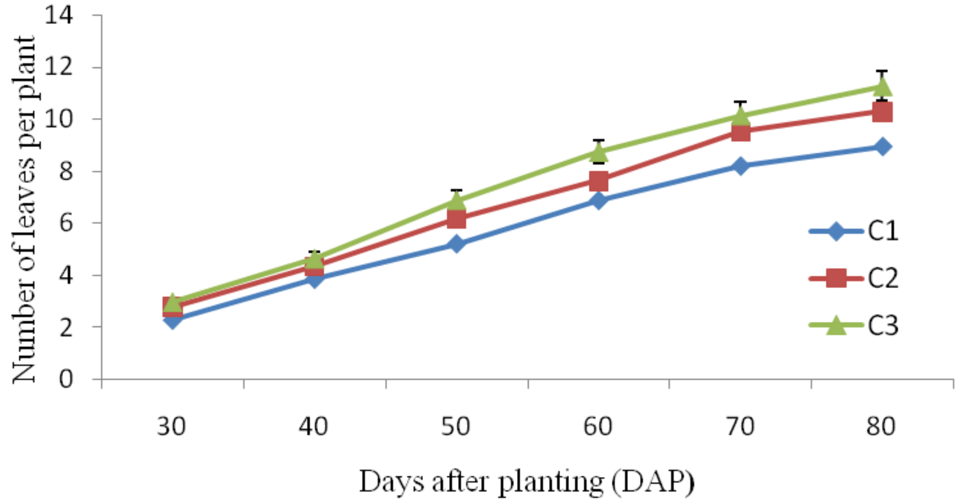


Fig. 5. Effect of different corm size on number of leaves per plant at different days after planting

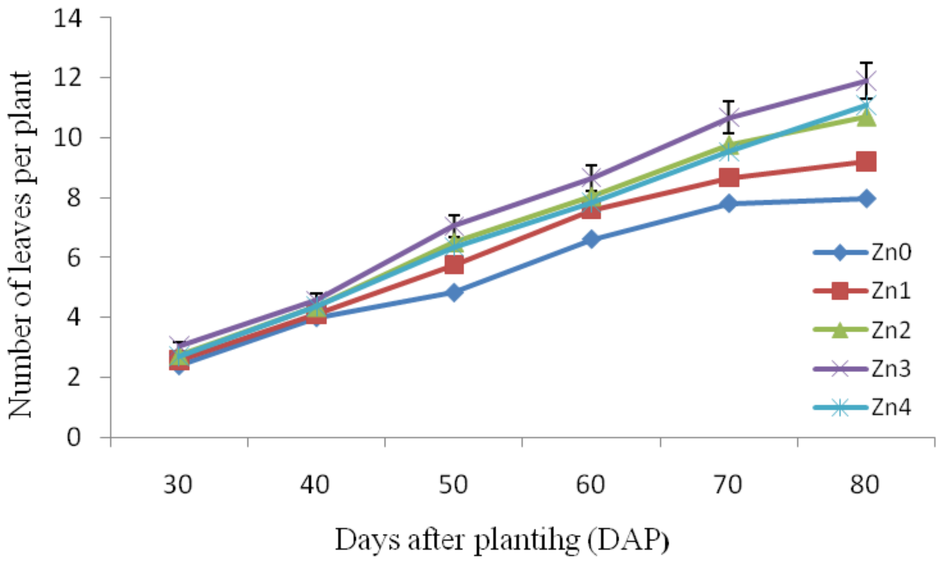


Fig. 6. Effect of different levels of zinc on number of leaves per plant at different days after planting

Table 2. Interaction effect of corm size and zinc on number of leaves per plant at different days after planting of gladiolus

In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

Treatment	Number of leaves per plant at different days after planting (DAP)					
	30 DAP	40 DAP	50 DAP	60 DAP	70 DAP	80 DAP
C_1Zn_0	2.10 h	3.54 e	4.40 g	6.33 g	7.30 f	7.20 g
C_1Zn_1	2.23 gh	3.73 de	5.00 fg	6.60 g	7.70 f	8.50 ef
C_1Zn_2	2.30 fgh	3.86 cde	5.23efg	7.00 fg	7.93 f	8.60 ef
C_1Zn_3	2.66 de	4.20 bcd	6.06 cde	8.00 cde	9.93 cd	10.40 cd
C_1Zn_4	2.16 h	3.96 cde	5.43 def	6.50 g	8.13 ef	9.36 de
C_2Zn_0	2.60 def	3.90 cde	4.86 fg	6.40 g	7.90 f	7.66 f
C_2Zn_1	2.63 def	4.16 bcd	6.06 cde	7.63 def	9.03 de	9.53 cde
C_2Zn_2	2.90 cd	4.33 bc	6.66 bc	7.73 def	9.86 cd	10.80 cd
C_2Zn_3	3.06 bc	4.96 a	6.90 bc	8.70 bc	11.20 b	12.53 b
C_2Zn_4	2.70 de	4.33 bc	6.40 bc	7.63 def	9.63 d	10.93 c
C_3Zn_0	2.50 efg	4.13 bcd	5.23 efg	7.10 efg	8.20 ef	8.33 ef
C_3Zn_1	2.76 cde	4.33 bc	6.23 cd	8.16 cd	9.10 de	9.53 cde
C_3Zn_2	2.63 def	4.50 b	6.76 bc	8.36 cd	9.50 d	10.90 c
C_3Zn_3	3.80 a	5.20 a	9.00 a	10.70 a	13.10 a	14.67 a
C_3Zn_4	3.23 b	5.06 a	7.23 b	9.36 b	10.80 bc	12.93 b
$LSD_{(0.05)}$	0.303	0.432	0.844	0.846	0.561	1.31
CV (%)	6.72	6.03	8.28	6.53	6.25	7.70

C_1: Small size corm (11-20 g)
C_2: Medium size corm (21-30 g)
C_3: Large size corm (31-40 g)

Zn_0: 0 kg Zn/ha
Zn_1: 1 kg Zn/ha
Zn_2: 2 kg Zn/ha
Zn_3: 3 kg Zn/ha
Zn_4: 4 kg Zn/ha

Application of different levels of zinc was showed statistically significant variation in terms of days required for 50% emergence of spike (Appendix VI). The maximum days (83.33) required for 50% emergence of spike was recorded from Zn_0 where the minimum days (79.44) was found from Zn_3 (Table 3).

Interaction effect showed significant variation on days required for 50% emergence of spike (Appendix VI). Interaction effect showed that small corm with control treatment required maximum days (84.67) for 50% emergence of spike while the minimum days (74.33) required for 50% emergence of spike was recorded from large corm treated with 3kg zinc (Table 4).

4.4 Days required for 80% emergence of spike

Significant variation was recorded due to different corm size for days required for 80% emergence of spike (Appendix VI). The maximum days (95.87) required for 80% emergence of spike was recorded from small corm and the minimum days (90.00) was found from large corm (Table 3). Large size corm initially helps the plant for growth and development with supplying storage nutrients in the corm which is the ultimate result of minimum days for 80% emergence of spike. Similar findings were also found by Bhat *et al*. (2009).

The effect of different levels of zinc was found significant differences for days required for 80% emergence of spike (Appendix VI). The maximum days (95.67) required for 80% emergence of spike was recorded from Zn_0 where the minimum days (91.78) was obtained from Zn_3 (Table 3).

Corm size and zinc showed significant variation due to interaction effect for days required for 80% emergence of spike of gladiolus (Appendix VI).The maximum days (97.67) required for 80% emergence of spike was recorded from small corm with control treatment while the minimum days (85.33) was obtained from large corm treated with zinc at 3kg/ha (Table 4).

4.5 Percentage of flowering plant

Percentage of flowering plants of gladiolus showed significant variation due to various sizes of corm (Appendix VI). The highest flowering plant (91.87 %) was found from large corm while the lowest flowering plant (81.27%) was recorded from small corm (Table 3). Similar results were also reported by Uddin *et al*. (2002), Singh and Singh (1998), Mollah *et al*. (1995) and Ko *et al*. (1994).

Application of different levels of zinc showed significant differences on percentage of flowering plants of gladiolus (Appendix VI). The highest flowering plant (91.89%) was found from Zn_3 while the lowest flowering plant (81.44%) was recorded from Zn_0 (Table 3).

Interaction effect showed significant variation on percentage of flowering plants of gladiolus (Appendix VI). The highest percentage of flowering plant (99.00%) was recorded from large corm treated with zinc at 3kg/ha while the lowest plant (79.33%) was found from the combination of small corm with control treatment (Table 4).

4.6 Length of spike at harvest

Length of spike varied significantly for different sizes of corm. (Appendix VI). At harvest, the maximum length of spike (69.30 cm) was recorded from large corm and the minimum (60.80cm) was found from small corm (Table 3). This might be due to the higher amount of stored food material from large corm. Similar results were also reported by Dod *et al.* (1989) and Bhattacharjee (1981).

Application of different levels of zinc showed significant variation on spike length of gladiolus (Appendix VI). The maximum length of spike at harvest (69.46 cm) was recorded from Zn_3 where the minimum (60.78) was recorded from Zn_0 (Table 3). Similar results were also reported by Katiyar *et al.*, (2012).

Table 3. Effect of corm size and zinc on different growth and flowering parameters and spike yield of gladiolus

Treatment	Days required to 50% emergence of spike	Days required to 80% emergence of spike	Flowering plant (%)	Length of flower stalk at harvest (cm)	Length of rachis at harvest (cm)	Number of florets per spike	Number of spike per plot	Number of spike per hectare ('000)
Corm size								
C_1	82.87 a	95.87 a	81.27 b	60.80 c	31.32 c	11.59 c	18.87 c	251.6 c
C_2	80.01 b	93.01 b	88.53 a	65.32 b	34.18 b	14.23 b	20.40 b	272.0 b
C_3	79.00 b	90.00 c	91.87 a	69.30 a	36.31 a	15.89 a	21.80 a	290.7 a
$LSD_{(0.05)}$	1.986	1.986	3.471	2.169	1.714	0.762	0.804	10.72
Levels of zinc								
Zn_0	83.33 a	95.67 a	81.44 b	60.78 c	31.47 c	11.11 d	17.89 c	238.5 c
Zn_1	81.67 ab	94.00 ab	84.33 b	64.03 b	33.16 bc	12.97 c	20.00 b	266.7 b
Zn_2	80.36 bc	92.69 bc	89.44 a	66.33 b	33.98 b	14.99 b	20.89 b	278.5 b
Zn_3	78.33 c	90.67 c	91.89 a	69.46 a	36.30 a	16.07 a	22.33 a	297.8 a
Zn_4	79.44 bc	91.78 bc	89.00 a	65.10 b	34.77 ab	14.37 b	20.67 b	275.6 b
$LSD_{(0.05)}$	2.564	2.564	4.481	2.800	2.213	0.983	1.038	13.84
CV(%)	5.29	5.86	5.32	4.45	6.75	7.33	5.28	5.28

C_1: Small size corm (11-20 g)
C_2: Medium size corm (21-30 g)
C_3: Large size corm (31-40 g)

Zn_0: 0 kg Zn/ha
Zn_1: 1 kg Zn/ha
Zn_2: 2 kg Zn/ha
Zn_3: 3 kg Zn/ha
Zn_4: 4 kg Zn/ha

In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

Interaction effect showed significant differences on length of flower stalk of gladiolus (Appendix VI). At harvest, the maximum length of spike (76.49 cm) was recorded from large corm treated with zinc at 3kg/ha while the minimum (57.40 cm) was found from small corm with control treatment (Table 4).

4.7 Length of rachis at harvest

Statistically significant variation was recorded due to different sizes of corm on length of rachis of gladiolus (Appendix VI). At harvest, the maximum length of rachis (36.31 cm) was obtained from large corm and the minimum was (31.32 cm) found from small corm (Table 3). This might be due to the higher amount of stored food material in the large corm which resulted in better vegetative and reproductive growth of the plant. Similar findings were found by Mollah *et al.* (1995).

Length of rachis differed significantly for different levels of zinc (Appendix VI). At harvest, the maximum length of rachis (36.30 cm) was recorded from Zn_3 and the minimum length (31.47 cm) was recorded from Zn_0 (Table 3). Similar results were found by Reddy, *et al.* (2009).

Interaction effect showed significant variation on length of rachis (Appendix VI). At harvest, the maximum length of rachis (40.11 cm) was recorded from large size corm treated with zinc at 3kg/ha while the minimum (30.42 cm) was recorded from small corm with control treatment (Table 4).

4.8 Number of floret per spike

Number of floret per spike was showed significant differences due to different sizes of corm (Appendix VI). The highest number of floret per spike (15.89) was found from large corm while the lowest (11.59) was recorded from small corm (Table 3). Similar results were also reported by Bhat *et al.* (2009), Singh K. P. (2000), Kalasareddi *et al.* (1997) and Ko *et al.* (1994).

Fig. 7. Influence of corm size on spike length of gladiolus

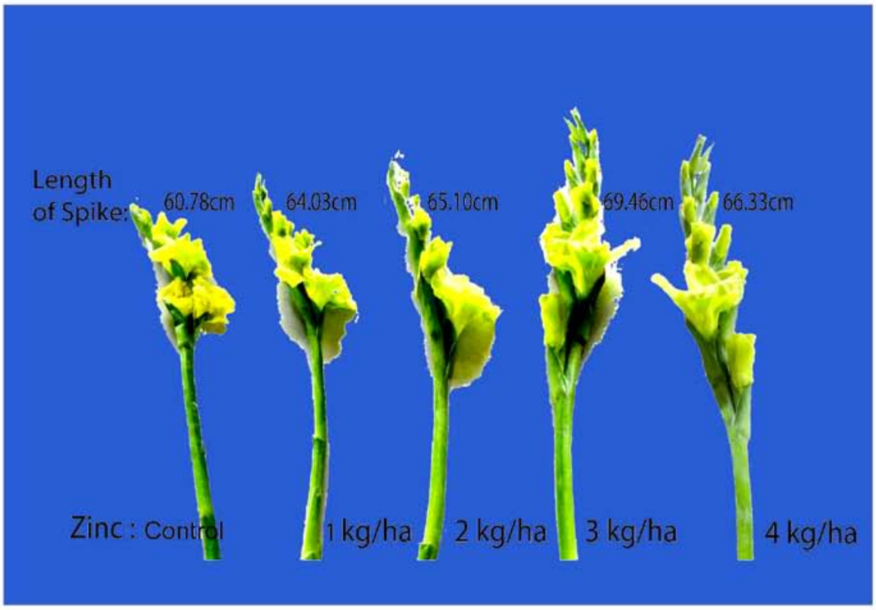


Fig. 8. Influence of zinc on spike length of gladiolus

Significant variation was observed for number of floret per spike of gladiolus for application of different levels of zinc (Appendix VI). The highest number of floret per spike (16.07) was obtained from Zn_3 while the lowest (11.11) was recorded from Zn_0 (Table 3). Similar results were found by Reddy, *et al* (2009).

Number of floret per spike varied significantly for interaction effect of corm size and zinc (Appendix VI). The highest number of floret per spike (19.43) was obtained from large size corm treated with zinc at 3kg/ha while the lowest (10.43) was recorded from small corm with control treatment (Table 4).

4.9 Number of spike per plot

Statistically significant variation was observed due to different corm size on number of spike per plot in gladiolus (Appendix VI). The highest number of spike per plot (21.80) was found from large corm and the lowest (18.87) was recorded from small corm (Table 3).

Application of different levels of zinc varied significantly for number of spike per plot in gladiolus (Appendix VI). The highest number of spike per plot (22.33) was obtained from Zn_3 while the lowest (17.89) was recorded from Zn_0 (Table 3).

Interaction effect showed significant differences on number of spike per plot of gladiolus (Appendix VI). The highest number of spike per plot (25.33) was recorded from large corm treated with zinc at 3kg/ha while the lowest (17.33) was obtained from small corm with control treatment (Table 4)**.**

4.10 Number of spike/ ha (‘000)

Statistically significant variation was obtained due to different corm size on number of spike in thousand per hectare of gladiolus (Appendix VI). The highest number of spike (290.7/ha) was found from large corm while the lowest (251.6/ha) was recorded from small corm (Table 3). Kalasareddi *et al*. (1997) reported large corm increased number of spike

Number of spike in thousand per hectare of gladiolus differed significantly for the application of different levels of zinc (Appendix VI). The highest number of spike (297.8 /ha) was obtained from Zn_3 while the lowest (238.5/ha) was recorded from Zn_0 (Table 3).

Corm size and zinc showed significant variation on number of spike in thousand per hectare of gladiolus for the interaction effect (Appendix VI). The highest (337.8/ha) number of spike was recorded from large corm treated with zinc at 3kg/ha while the minimum (231.1/ha) was found from small corm with control treatment (Table 4).

4.11 Individual corm thickness

Significant difference was observed due to different corm size on individual corm thickness of gladiolus (Appendix VII). The maximum individual corm thickness (7.04 cm) was recorded from large corm while the minimum thickness (6.09 cm) was found from small corm (Table 5). This might be due to the higher amount of stored food materials in the large corm which resulted in better vegetative and reproductive growth of the plant. Similar findings were found by Mollah *et al.* (1995).

Application of different levels of zinc showed significant variation on individual corm thickness of gladiolus (Appendix VII). The maximum individual corm thickness (7.16 cm) was recorded from Zn_3 while the minimum (5.99 cm) was recorded from Zn_0 (Table 5).

Interaction effect showed significant variation on individual corm thickness of gladiolus (Appendix VII). The maximum (8.57 cm) individual corm thickness was recorded from large corm treated with zinc at 3kg/ha while the minimum (5.49 cm) was obtained from small corm with control treatment (Table 6).

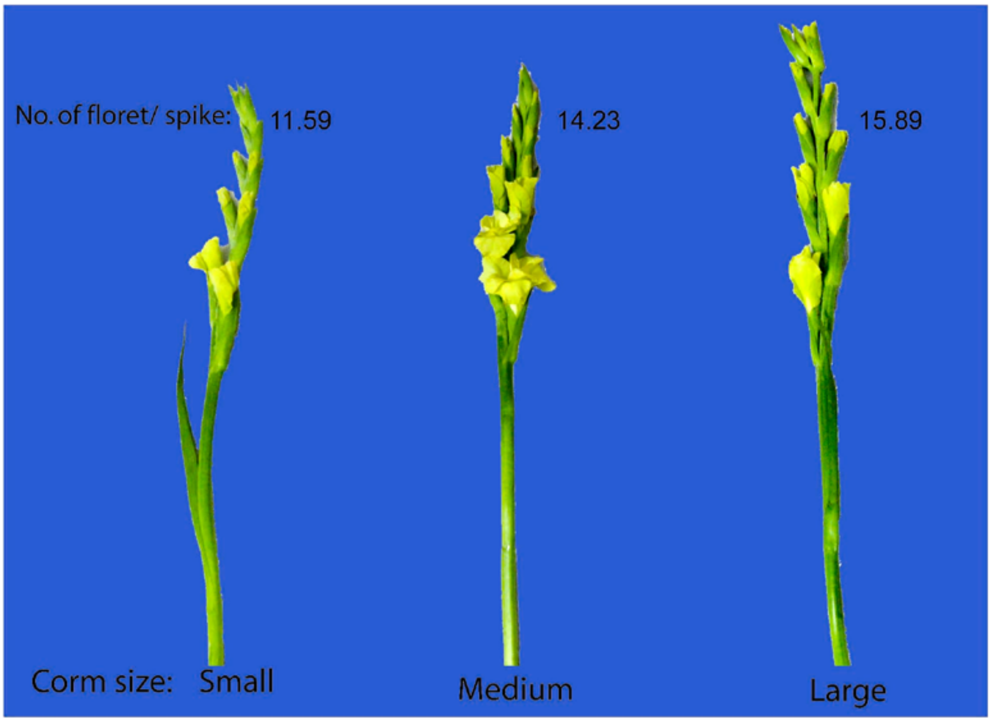


Fig. 11. Influence of corm size on number of floret/spike of gladiolus

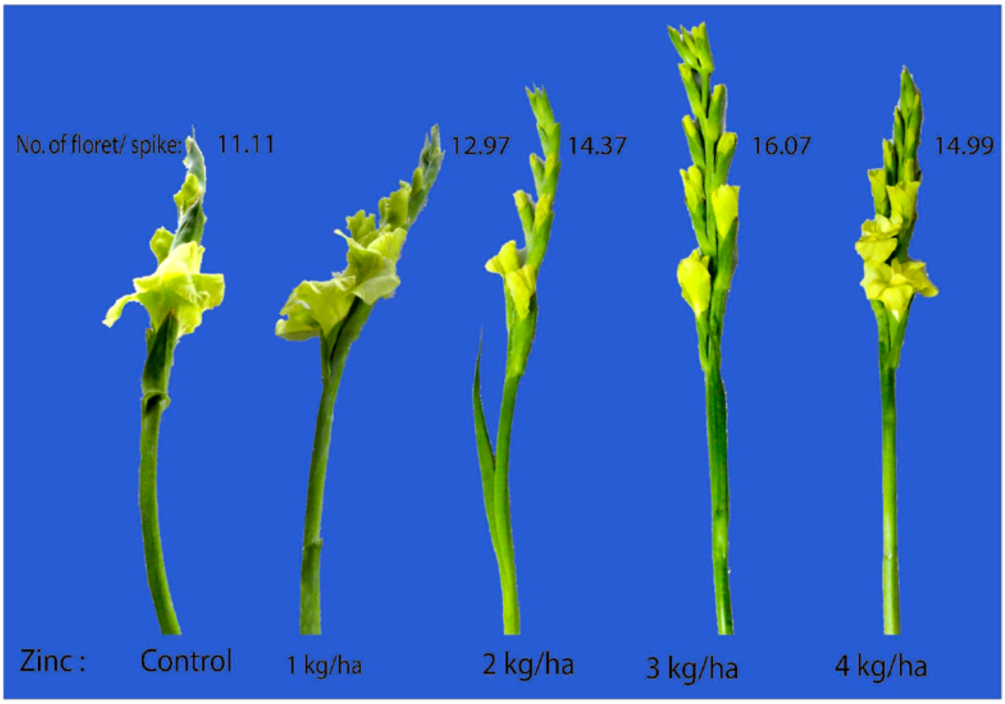


Fig.12. Influence of zinc on number of floret/spike of gladiolus

Table 4. Interaction effect of corm size and zinc on different growth and flowering parameters and spike yield of gladiolus

Treatment	Days required to 50% emergence of spike	Days required to 80% emergence of spike	Flowering plant (%)	Length of spike at harvest(cm)	Length of rachis at harvest (cm)	Number of florets per spike	Number of spike per plot	Number of spike per hectare (‘000)
C_1Zn_0	84.67 a	97.67 a	79.33 f	57.40 f	30.42 f	10.43 f	17.33 i	231.1 i
C_1Zn_1	83.33 abc	93.67 abcde	80.00 f	59.85 ef	30.70 ef	11.37 f	18.33 ghi	244.4 ghi
C_1Zn_2	83.00 abc	96.00 abc	81.33 ef	60.70 def	31.04 ef	11.43 f	19.67 defgh	262.2 defgh
C_1Zn_3	82.67 abc	96.33 ab	84.00 def	64.81 cde	32.52d ef	13.68 de	20.00 defg	266.7 defg
C_1Zn_4	80.67 abcd	95.67 abc	81.67 def	61.26 def	31.90 ef	11.03 f	19.00 efghi	253.3 efghi
C_2Zn_0	84.00 ab	97.00 ab	80.67 ef	61.01 def	30.74 ef	10.68 f	17.67 hi	235.6 hi
C_2Zn_1	81.67 abc	94.67 abcd	85.67 cdef	63.35 cde	32.99d ef	13.56 de	19.67 defgh	262.2 defgh
C_2Zn_2	79.40 bcd	92.40 bcde	90.33 bcd	66.12 bcd	35.04 bcde	15.12 cd	21.00 cde	280.0 cde
C_2Zn_3	76.00 de	89.00 ef	96.67 ab	71.21 b	38.11 abc	17.33 b	23.33 b	311.1 b
C_2Zn_4	79.00 bcde	92.00 bcde	89.33 bcde	64.89 cde	34.04 cdef	14.45 cd	20.33 defg	271.1 defg
C_3Zn_0	83.33 abc	94.33 abcd	84.33 def	63.93 cde	32.64 def	12.21 ef	18.67 fghi	248.9 fghi
C_3Zn_1	80.00 abcd	91.00 cde	86.00 cdef	67.48 bc	33.96 cdef	14.00 de	20.67 def	275.6 def
C_3Zn_2	78.67 cde	89.67 def	94.00 abc	68.05 bc	36.47 abcd	16.17 bc	21.67 bcd	288.9 bcd
C_3Zn_3	74.33 e	85.33 f	99.00 a	76.49 a	40.11 a	19.43 a	25.33 a	337.8 a
C_3Zn_4	78.67 cde	89.67 def	96.00 ab	70.58 b	38.37 ab	17.63 b	22.67 bc	302.3 bc
$LSD_{(0.05)}$	4.441	4.441	7.762	4.851	3.833	1.704	1.798	23.97
CV(%)	5.29	5.86	5.32	4.45	6.75	7.33	5.28	5.28

In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

C_1: Small size corm (11-20 g)
C_2: Medium size corm (21-30 g)
C_3: Large size corm (31-40 g)

Zn_0: 0 kg Zn/ha
Zn_1: 1 kg Zn/ha
Zn_2: 2 kg Zn/ha
Zn_3: 3 kg Zn/ha
Zn4: 4 kg Zn/ha

4.12 Individual Corm Weight

Individual corm weight varied significantly due to different sizes of corm (Appendix VII). The highest individual corm weight (25.14 g) was found from large corm while the lowest (21.19 g) was recorded from small corm (Table 5). Similar results were also reported by Bhat *et al* (2009).

Application of different levels of zinc showed significant variation on individual corm weight (Appendix VII). The highest individual corm weight (26.26 g) was found from Zn_3 and the minimum (19.54 g) was recorded from Zn_0 (Table 5). Singh *et al.* (2012) reported large corm influenced individual weight of corm.

Corm size and zinc showed significant differences on individual corm weight due to the interaction effect. (Appendix VII). The highest individual corm weight (30.27 g) was recorded from large size corm treated with zinc at 3 kg/ha while the minimum (18.23 g) was recorded from small corm with control treatment (Table 6).

4.13 Individual Corm diameter

Significant variation was recorded in individual corm diameter for different corm size (Appendix VII).The maximum (2.25 cm) individual corm diameter was recorded from large size corm while the minimum (1.85 cm) was obtained from small corm (Table 5).

Application of different levels of zinc was showed significant variation on individual corm diameter of gladiolus (Appendix VII). The maximum (2.38 cm) individual corm diameter was recorded from Zn_3. On the other hand the minimum (1.66 cm) was recorded from Zn_0 under present trail (Table 5). Singh *et al.* (2012) reported large corm influenced individual corm diameter of gladiolus.

Interaction effect showed significant variation on individual corm diameter (Appendix VII).The maximum (2.67 cm) individual corm diameter was

Table 5. Effect of corm size and zinc on corm characters and yield of gladiolus

Treatment	Thickness of corm (cm)	Weight of individual corm (g)	Diameter of individual corm (cm)	Yield of corm (kg/plot)	Yield of corm (t/ha)
		(g)	(cm)		
Corm size					
C_1	6.09 c	21.19 c	1.85 c		0.94 c
C_2	6.53 b	23.53 b	2.03 b		1.02 b
C_3	7.04 a	25.14 a	2.25 a		1.17 a
$LSD_{(0.05)}$	0.278	1.071	0.066		0.052
Levels of zinc					
Zn_0	5.99 c	19.54 d	1.66 d		0.86 d
Zn_1	6.35 b	22.17 c	1.80 c		0.98 cd
Zn_2	6.58 b	24.17 b	2.21 b		1.08b c
Zn_3	7.16 a	26.26 a	2.38 a		1.23 a
Zn_4	6.67 b	24.29 b	2.19 b		1.07 b
$LSD_{(0.05)}$	0.360	1.383	0.086		0.068
CV(%)	5.70	6.15	4.48		6.64

In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

C_1: Small size corm (11-20 g)
C_2: Medium size corm (21-30 g)
C_3: Large size corm (31-40 g)

Zn_0: 0 kg Zn/ha
Zn_1: 1 kg Zn/ha
Zn_2: 2 kg Zn/ha
Zn_3: 3 kg Zn/ha
Zn_4: 4 kg Zn/ha

C_1Zn_0	5.49 e	18.23j	1.37 j	0.77 h	10.31 h
C_1Zn_1	5.95 de	20.36 hij	1.83 hi	0.95 efg	12.84 efg
C_1Zn_2	6.29 cd	22.44 efgh	1.91 gh	0.96 efg	12.89 efg
C_1Zn_3	6.62 bcd	23.20 defg	2.28 cd	1.01 ef	13.53 ef
C_1Zn_4	6.08 de	21.73 fghi	1.88 ghi	0.86 gh	11.50 gh
C_2Zn_0	6.01 de	19.18 ij	1.48 j	0.89 fgh	11.92 fgh
C_2Zn_1	6.32 cd	21.51 fghi	1.86 hi	1.01 ef	13.57 ef
C_2Zn_2	6.55 bcd	24.13 cdef	2.20 fg	1.08 de	14.46 de
C_2Zn_3	6.96 bc	28.15 ab	2.56 ab	1.26 bc	16.80 bc
C_2Zn_4	6.81 bc	24.67 cde	2.25 de	1.00 ef	13.33 ef
C_3Zn_0	6.46 bcd	21.22 ghi	2.12 ef	0.92 fg	12.31 fg
C_3Zn_1	6.45 bcd	22.57 defgh	1.72 i	0.96 efg	12.90 efg
C_3Zn_2	6.59 bcd	25.19 cd	2.31 cd	1.15 cd	15.40 cd
C_3Zn_3	8.57 a	30.27 a	2.67 a	1.47 a	19.69 a
C_3Zn_4	7.12 b	26.47 bc	2.43 bc	1.35 b	18.03 b
$LSD_{(0.05)}$	0.623	2.395	0.149	0.118	1.550
CV(%)	5.70	6.15	4.48	6.64	6.64

Table 6. Interaction effect of corm size and zinc on corm characters and corm yield of gladiolus

In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

recorded from large corm treated with zinc at 3kg/ha while the minimum (1.37 cm) was obtained from small corm with control treatment (Table 6).

C_1: Small size corm (11-20 g)
C_2: Medium size corm (21-30 g)
C_3: Large size corm (31-40 g)

Zn_0: 0 kg Zn/ha
Zn_1: 1 kg Zn/ha
Zn_2: 2 kg Zn/ha
Zn_3: 3 kg Zn/ha
Zn_4: 4 kg Zn/ha

4.14 Number of cormel per plant

Number of cormel per plant of gladiolus varied significantly for different sizes of corm (Appendix VII). The highest (25.25) number of cormel per plant was recorded from large corm while the lowest (20.27) was obtained from small corm (Table 7). The result is in an agreement with the findings of Joshi *et al*. (2011), Mollah *et al.* (1995) and Bhat *et al*. (2009).

Number of cormel per plant of gladiolus showed significant variation on number of cormel per plant of gladiolus due to different levels of zinc application (Appendix VII). The highest number of cormel per plant (26.29) was found from Zn_3 and the lowest (19.56) was recorded from Zn_0 (Table 7).

Interaction effect showed significant variation on number of cormel per plant (Appendix VII).The highest (29.07) number of cormel per plant was recorded from large size corm treated with zinc at 3kg/ha while the lowest (17.67) was obtained from small corm with control treatment (Table 8).

4.15 Weight of cormel

Significant variation was observed on individual weight of cormel of gladiolus for different sizes of corm (Appendix VII). The maximum individual corm weight (14.59 g) was recorded from large corm while the minimum weight (11.86 g) was recorded from small corm (Table 7). Similar results were also reported by Bhat *et al* (2009).

Application of different levels of zinc showed significant variation on individual weight of cormel (Appendix VII). The highest individual weight of cormel (14.51 g) was found from Zn_3 while the minimum weight (11.95 g) was recorded from Zn_0 (Table 7).

Corm size and zinc showed significant variation on individual weight of cormel for their interaction effect (Appendix VII). The highest (17.21 g) individual weight of cormel was recorded from large corm treated with zinc at 3kg/ha while the minimum weight (11.12 g) was found from small corm with control treatment (Table 8).

4.16 Diameter of cormel

Diameter of cormel varied significantly for different size of corm. (Appendix VII).The maximum individual cormel diameter (1.53 cm) was recorded from large corm while the minimum (1.26 cm) was recorded from small size corm (Table 7).

Statistically significant differences was observed at different levels of zinc on individual cormel diameter (Appendix VII). The maximum individual cormel diameter (1.55 cm) was recorded from Zn_3 and the minimum (1.23 cm) was obtained from Zn_0 (Table 7).

Corm size and zinc significantly affect on individual corm diameter for their interaction effect. (Appendix VII). The maximum individual cormel diameter (1.76 cm) was recorded from large corm treated with zinc at 3kg/ha while the minimum (1.17 cm) was recorded from small corm with control treatment (Table 8).

Yield

4.17 Corm yield per plot

Different sizes of corm showed significant variation on corm yield per plot (Appendix VII). The highest corm yield (1.17 kg /plot) was recorded from large corm while the lowest (0.94 kg/plot) was recorded from small corm (Table 5). Similar results were also reported by Bhat *et al.* (2009).

Application of different levels of zinc was showed significant variation on corm yield per plot (Appendix VII). The highest corm yield (1.23 kg/plot) was

Table 7. Effect of corm size and zinc on cormel characters and cormel yield of gladiolus

Treatment	Number of cormel per plant	Weight of individual cormel (g)	Diameter of individual cormel (cm)	Yield of cormel (kg/plot)
Corm size				
C_1	20.27 c	11.86 c	1.26 c	0.80 c
C_2	23.81 b	13.31 b	1.37 b	0.89 b
C_3	25.25 a	14.59 a	1.53 a	1.07 a
$LSD_{(0.05)}$	0.949	0.791	0.078	0.052
Levels of zinc				
Zn_0	19.56 d	11.95 c	1.23 d	0.80 c
Zn_1	21.47 c	12.71 bc	1.31 cd	0.87 b
Zn_2	23.84 b	13.63 ab	1.39 bc	0.93 b
Zn_3	26.29 a	14.51 a	1.55 a	1.06 a
Zn_4	24.40 b	13.46 ab	1.44 b	0.93 b
$LSD_{(0.05)}$	1.225	1.021	0.101	0.068
CV(%)	5.49	7.98	7.43	7.32

In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

C_1: Small size corm (11-20 g)
C_2: Medium size corm (21-30 g)
C_3: Large size corm (31-40 g)

Zn_0: 0 kg Zn/ha
Zn_1: 1 kg Zn/ha
Zn_2: 2 kg Zn/ha
Zn_3: 3 kg Zn/ha
Zn_4: 4 kg Zn/ha

Table 8. Interaction effect of corm size and zinc on cormel characters and cormel yield of gladiolus

Treatment	Number of cormel per plant	Weight of individual cormel (g)	Diameter of individual cormel (cm)	Yield of cormel (kg/plot)	Yield of cormel (t/ha)
C_1Zn_0	17.67 f	11.12 e	1.17 e	0.67 g	8.95 g
C_1Zn_1	19.27 ef	11.63 de	1.26 de	0.72 fg	9.69 fg
C_1Zn_2	20.67 e	12.14 cde	1.25 de	0.76 efg	10.13 efg
C_1Zn_3	23.33 bcd	12.64 cde	1.29 de	0.86 de	11.44 de
C_1Zn_4	20.40 e	11.76 cde	1.26 de	0.85 def	11.31 def
C_2Zn_0	19.80 ef	11.47 de	1.22 de	0.84 def	11.21 def
C_2Zn_1	21.40 cde	12.71 cde	1.29 de	0.91 d	12.21 d
C_2Zn_2	23.60 bc	13.74 bc	1.40 cd	0.92 d	12.28 d
C_2Zn_3	29.13 a	15.20 b	1.60 ab	1.08 bc	14.49 c
C_2Zn_4	25.13 b	13.41 bcd	1.40 cd	0.87 de	11.62 de
C_3Zn_0	21.20 de	12.74 cde	1.32 de	0.88 de	11.70 de
C_3Zn_1	23.73 b	12.78 cde	1.38 cd	0.87 de	11.64 de
C_3Zn_2	24.60 b	15.00 b	1.53 bc	1.05 c	14.04 c
C_3Zn_3	29.07 a	17.21 a	1.76 a	1.34 a	17.96 a
C_3Zn_4	27.67 a	15.21 b	1.65 ab	1.20 b	16.04 b
$LSD_{(0.05)}$	2.122	1.769	0.175	0.118	1.508
CV(%)	5.49	7.98	7.43	7.32	7.32

In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

C_1: Small size corm (11-20 g)
C_2: Medium size corm (21-30 g)
C_3: Large size corm (31-40 g)

Zn_0: 0 kg Zn/ha
Zn_1: 1 kg Zn/ha
Zn_2: 2 kg Zn/ha
Zn_3: 3 kg Zn/ha
Zn_4: 4 kg Zn/ha

recorded from Zn_3 while the lowest (0.86 kg/plot) was recorded from Zn_0 (Table 5). Similar results were also reported by Halder *et al.* (2007).

Corm yield per plot of gladiolus varied significantly due to the interaction effect of corm size and zinc (Appendix VII). The highest corm yield (1.47 kg/plot) was recorded from large corm treated with zinc at 3kg/ha while the lowest (0.77 kg/plot) was recorded from small corm with control treatment (Table 6).

4.18 Corm yield per hectare

Significant variation was recorded in terms of corm yield per hectare for different corm size (Appendix VII). The highest corm yield (15.67 t/ha) was recorded from large corm while the lowest (12.54 t/ha) was recorded from small corm (Fig.13). Similar findings were also reported by Bhat *et al.* (2009).

Corm yield per hectare varied significantly due to application of different levels of zinc (Appendix VII). The highest corm yield (16.44 t/ha) was recorded from Zn_3 where the lowest (11.51 t/ha) was recorded from Zn_0 (Fig. 14). Similar results were also reported by Halder *et al.* (2007).

Interaction effect showed significant variation on corm yield per hectare of gladiolus (Appendix VI). The highest corm yield (19.69 t/ha) was recorded from while the lowest (10.31t/ha) was recorded from small corm with control treatment (Table 6).

4.19 Cormel yield per plot

Different sizes of corm showed significant variation on cormel yield per plot (Appendix VII). The highest cormel yield (1.07 kg/plot) was recorded from large size corm while the lowest (0.80 kg/plot) was recorded from small size corm (Table 7).

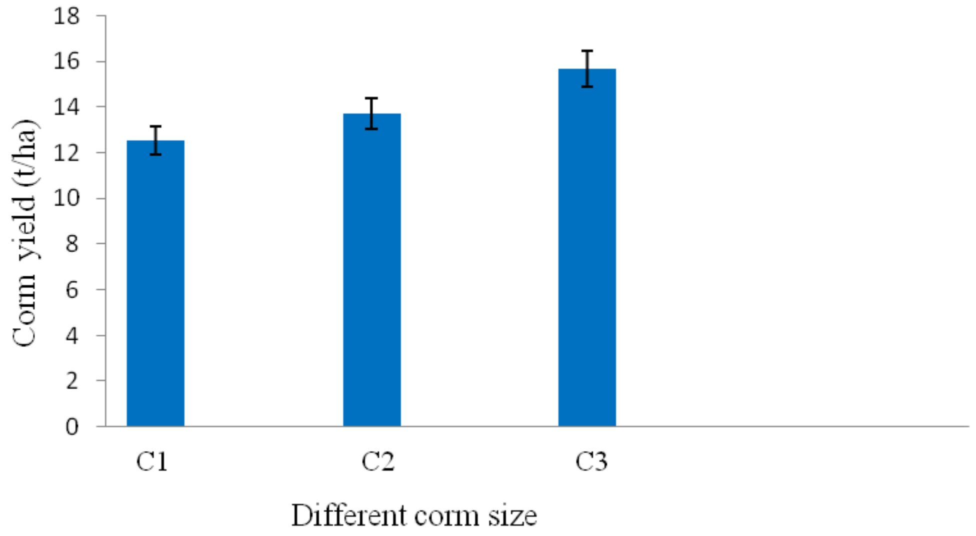


Fig. 13. Effect of different corm size on corm yield of gladiolus

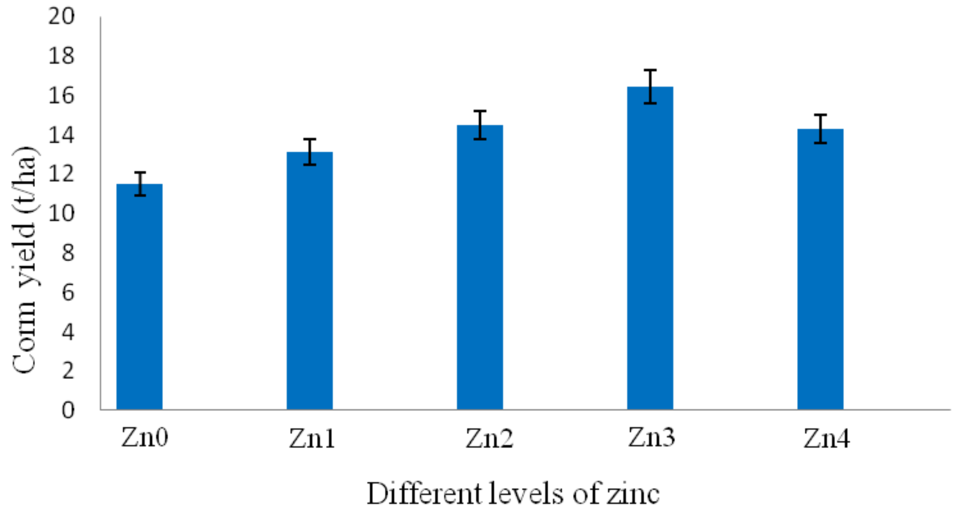


Fig. 14. Effect of different levels of zinc on corm yield of gladiolus

Application of different levels of zinc was showed significant variation on cormel yield per plot (Appendix VII). The highest cormel yield (1.06 kg/plot) was recorded from Zn_3 while the lowest (0.80kg/plot) was recorded from Zn_0 (Table 7). Similar results were also reported by Halder *et al.* (2007).

Interaction effect showed significant variation on cormel yield per plot of gladiolus (Appendix VII). The highest cormel yield (1.34 kg/plot) was recorded from large size corm treated with zinc at 3kg/ha while the lowest (0.67 kg/plot) was recorded from small corm with control treatment (Table 8).

4.20 Cormel yield per hectare

Significant variation was recorded for different corm sizes on cormel yield per hectare (Appendix VII). The highest cormel yield (14.27 t/ha) was recorded from large size corm while the lowest (10.76 t/ha) was recorded from small size corm (Fig.15).

Application of different levels of zinc was showed significant variation on cormel yield per hectare (Appendix VII). The highest cormel yield (14.19 t/ha) was recorded from Zn_3 and the lowest (10.70 t/ha) was recorded from Zn_0 (Fig. 16). Similar results were also reported by Halder *et al.* (2007).

Corm size and zinc showed significant variation on cormel yield per hectare of gladiolus for the interaction effect (Appendix VII). The highest cormel yield (17.96 t/ha) was recorded from large size corm treated with zinc at 3kg/ha. On the other hand the lowest (8.95 t/ha) was found from small corm with control treatment (Table 8).

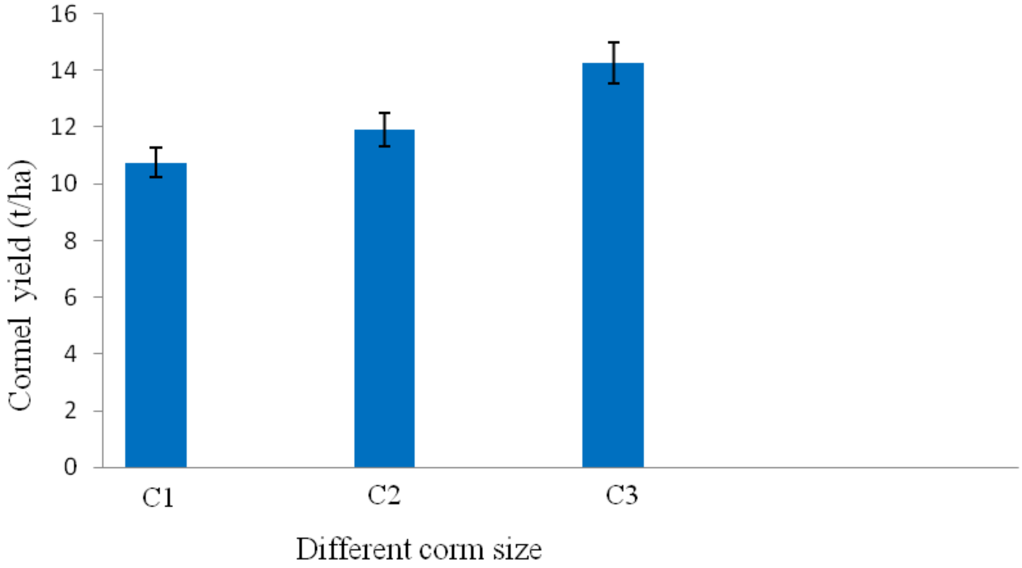


Fig. 15. Effect of different corm size on cormel yield of gladiolus

4.21 Economic analysis

The economic analysis was calculated to find out the gross and net return and the benefit cost ratio in the experiment and presented under the following headings-

4.21.1 Gross return

In the combination of corm size and different levels of zinc the highest gross return (Tk 845850) was obtained from the treatment combination of large corm and zinc with 3kg/ha and the second highest gross return (Tk 764180) was obtained in medium corm and zinc at 3kg/ha. The lowest gross return (Tk 558470) was found from medium corm with no zinc fertilizer (Table 9).

4.21.2 Net return

In case of net return different treatment combination showed different types of net return. In the combination of corm size and different levels of zinc the highest net return (Tk 545861) was obtained from the treatment combination of large corm and zinc with 3kg/ha and the second highest net return (Tk 470575) was found in medium corm and zinc at 4kg/ha. The lowest net return (Tk 265249) was obtained from medium corm with no zinc fertilizer (Table 9).

4.21.3 Benefit cost ratio

In the combination of corm size and different levels of zinc the highest benefit cost ratio (2.82) was attained from the treatment combination of large corm treated with 3kg zinc and the second highest benefit cost ratio (2.60) was obtained in medium corm treated with zinc at 3kg/ha. The lowest benefit cost ratio (1.90) was obtained from medium corm with control treatment (Table 9).

Table 9. Effect of corm size and zinc on economic point of view showing gross return, net return and BCR

Treatment Combination	Cost of production (Tk./ha)	Yield of corm (t/ha)	Price of corm (Tk.)	Yield of cormel (t/ha)	Price of cormel	Yield of spike	Price of cut flower	Gross return (Tk./ha)	Net return (Tk./ha)	Benefit cost ratio
C_1Zn_0	286837	10.31	59600	8.95	45760	231.11	462220	567580	280743	1.98
C_1Zn_1	286965	12.84	64450	9.69	45240	244.44	488880	598570	311605	2.08
C_1Zn_2	287092	12.89	67650	10.13	44840	262.22	524440	636930	349838	2.22
C_1Zn_3	287220	13.53	64200	11.44	40520	266.67	533340	638060	350840	2.23
C_1Zn_4	287348	11.50	57500	11.31	38760	253.33	506660	602920	315612	2.01
C_2Zn_0	293221	11.92	51550	8.95	35800	235.56	471120	558470	265249	1.90
C_2Zn_1	293349	13.57	67850	12.21	48840	262.22	524440	641130	347781	2.18
C_2Zn_2	293477	14.46	72300	12.28	49120	280.00	560000	681420	348343	2.32
C_2Zn_3	293605	16.80	84000	14.49	57960	311.11	622220	764180	470575	2.60
C_2Zn_4	293732	13.33	66650	11.62	46480	271.11	542220	655350	361618	2.23
C_3Zn_0	299606	12.31	61550	11.70	46800	248.89	497780	606130	306524	2.02
C_3Zn_1	299734	12.90	64500	11.64	46560	275.56	551120	662180	362446	2.21
C_3Zn_2	299861	15.40	77000	14.04	56160	288.89	577780	710940	411079	2.37
C_3Zn_3	299989	19.69	98450	17.96	71840	337.78	675560	845850	545861	2.82
C_3Zn_4	300117	18.03	90150	16.04	64160	302.22	604440	758750	458633	2.53

Price of corm @ Tk.=5000\t and cormel Tk.=4000\t
Price of cut flower @ Tk.=2\spike

CHAPTER V

SUMMERY AND CONCLUSION

The field experiment was conducted in the Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from November, 2011 to June, 2012 to find out the influence of corm size and different levels of zinc on growth, flowering, corm and cormel production of gladiolus. The experiment was consisted with two factors. Factor A: Three levels of corm size i.e. C_1: Small size corm (11-20 g); C_2: Medium size corm (21-30 g) and C_3: Large size corm (31-40 g) and Factor B: Five levels of zinc as Zn_0: 0 kg/ha (control), Zn_1: 1 kg/ha, Zn_2: 2 kg/ha, Zn_3: 3 kg/ha and Zn_4: 4 kg/ha. There were on the whole 15 treatments combination. The experiment was laid out in a factorial (two factors) Randomized Complete Block Design (RCBD) with three replications. Data were collected on growth characters, yield contributing characters and yield of gladiolus.

The effect of different corm sizes on morphological characters such as plant height, number of leaves per plant was significant at different growth stages of 30, 40, 50, 60, 70 and 80 days after planting. At harvest, the highest plant height (76.32 cm) and number of leaves per plant (11.27) was recorded from large corm. On the other hand, the lowest plant height (68.64 cm) and number of leaves (8.95) was obtained from large corm.

There were significant differences in floral characters such as days required for 50% emergence of spike, days required for 50% emergence of spike, percentage of flowering plant, length of spike, length of rachis, number of floret per spike, number of spike per plot and number of spike/ha (“000) due to different sizes of corm. The minimum days (79.00 and 90.00) required for 50% and 80% emergence of spike respectively, highest flowering plant (91.87 %), maximum spike length (69.30 cm), maximum rachis length (36.31 cm), highest number of floret per spike (15.89), highest number of spike per plot (21.80), highest number of spike (290700 /ha) were recorded from large corm.

On the other hand, the maximum days (82.87 and 95.87) required for 50% and 80% emergence of spike respectively, lowest flowering plant (81.27%), minimum spike length (60.80cm), minimum rachis length (31.32), lowest number of floret per spike (11.59), lowest number of spike per plot (18.87), lowest number of spike (251600/ha) were obtained from small corm.

Corm and cormel characters and yield such as individual corm thickness, individual corm weight, individual corm diameter, number of cormel per plant, weight of cormel, diameter of cormel, corm yield per plot, corm yield per hectare, cormel yield per plot and cormel yield per hectare were significantly influenced by different sizes of corm. The maximum individual corm thickness (7.04 cm), highest individual corm weight (25.14 g), maximum individual corm diameter (2.25 cm), highest number of cormel per plant (25.25), highest individual cormel weight (14.19 g), maximum individual cormel diameter (1.53 cm), highest corm yield (1.17 kg/plot and15.67 t/ha) and highest cormel yield (1.07 kg/plot and 14.27 t/ha) were recorded from large corm. On the other hand, The minimum individual corm thickness (6.09 cm), lowest individual corm weight (21.19 g), minimum individual corm diameter (1.85 cm), lowest number of cormel per plant (20.27), lowest individual cormel weight (11.86 g), minimum individual cormel diameter (1.26 cm), lowest corm yield (0.94 kg/plot and 12.54 t/ha) and lowest cormel yield (0.80 kg/plot and 10.76 t/ha) were obtained from small corm.

The effect of different levels of zinc on morphological characters such as plant height, number of leaves per plant was significant at different growth stages of 30, 40, 50, 60, 70 and 80 days after planting. At harvest, the highest plant height (78.52 cm) and number of leaves per plant (11.08) was recorded from Zn_3. On the other hand, the lowest plant height (65.61 cm) and number of leaves (7.90) was recorded from Zn_0.

There were significant differences in floral characters such as days required for 50% emergence of spike, days required for 50% emergence of spike, percentage of flowering plant, length of spike, length of rachis, number of floret per spike, number of spike per plot and number of spike/ha (“000) due to different levels of zinc. The minimum days (79.44 and 91.78) required for 50% and 80% emergence of spike respectively, highest flowering plant (91.89 %), maximum spike length (69.46 cm), maximum rachis length (36.30 cm), highest number of floret per spike (16.07), highest number of spike per plot (22.33), highest number of spike (297800 /ha) were recorded from Zn_3. On the other hand, the maximum days (83.33 and 95.67) required for 50% and 80% emergence of spike respectively, lowest flowering plant (81.44%), minimum spike length (60.78cm), minimum rachis length (31.47), lowest number of floret per spike (11.11), lowest number of spike per plot (17.89), lowest number of spike (238500/ha) were obtained from Zn_0.

Corm and cormel characters and yield such as individual corm thickness, individual corm weight, individual corm diameter, number of cormel per plant, weight of cormel, diameter of cormel, corm yield per plot, corm yield per hectare, cormel yield per plot and cormel yield per hectare were significantly influenced by different levels of zinc. The maximum individual corm thickness (7.16 cm), highest individual corm weight (26.26 g), maximum individual corm diameter (2.38 cm), highest number of cormel per plant (26.29), highest individual cormel weight (14.51 g), maximum individual cormel diameter (1.55 cm), highest corm yield (1.23 kg/plot and 16.44 t/ha) and highest cormel yield (1.06 kg/plot and 14.19 t/ha) were recorded from Zn_3. On the other hand, The minimum individual corm thickness (5.99 cm), lowest individual corm weight (19.54 g), minimum individual corm diameter (1.66 cm), lowest number of cormel per plant (19.56), lowest individual cormel weight (11.95 g), minimum individual cormel diameter (1.23 cm), lowest corm yield (0.86 kg/plot and 11.51 t/ha) and lowest cormel yield (0.80 kg/plot and 10.70 t/ha) were obtained from Zn_0.

The interaction effect of corm size and different levels of zinc on morphological characters such as plant height, number of leaves per plant was significant. At harvest, the highest plant height (85.91cm) and number of leaves per plant (12.93) was recorded from large corm treated with zinc at 3kg/ha. On the other hand, the lowest plant height (64.25 cm) and number of leaves (7.20) was found from small corm with control treatment.

There were significant differences in floral characters such as days required for 50% emergence of spike, days required for 50% emergence of spike, percentage of flowering plant, length of spike, length of rachis, number of floret per spike, number of spike per plot and number of spike/ha (“000) due to interaction effect of corm size and different levels of zinc. The minimum days (74.33 and 85.33) required for 50% and 80% emergence of spike respectively, highest flowering plant (99.00 %), maximum spike length (76.49cm), maximum rachis length (40.11cm), highest number of floret per spike (19.43), highest number of spike per plot (25.33), highest number of spike (337800/ha) were recorded from large corm treated with zinc at 3kg/ha. On the other hand, the maximum days (84.67 and 97.67) required for 50% and 80% emergence of spike respectively, lowest flowering plant (79.33%), minimum spike length (57.40cm), minimum rachis length (30.42), lowest number of floret per spike (10.43), lowest number of spike per plot (17.33), lowest number of spike (231100/ha) were obtained from small corm with control treatment.

Corm and cormel characters and yield such as individual corm thickness, individual corm weight, individual corm diameter, number of cormel per plant, weight of cormel, diameter of cormel, corm yield per plot, corm yield per hectare, cormel yield per plot and cormel yield per hectare were significantly influenced by interaction effect of corm size and different levels of zinc.

The maximum individual corm thickness (8.57 cm), highest individual corm weight (30.27g), maximum individual corm diameter (2.67 cm), highest number of cormel per plant (29.07), highest individual cormel weight (17.21 g), maximum individual cormel diameter (1.76 cm), highest corm yield (1.47 kg/plot and19.69 t/ha) and highest cormel yield (1.34 kg/plot and 17.96 t/ha) were recorded from large corm treated with zinc at 3kg/ha. On the other hand, the minimum individual corm thickness (5.49 cm), lowest individual corm weight (18.23 g), minimum individual corm diameter (1.37 cm), lowest number of cormel per plant (17.67), lowest individual cormel weight (11.12 g), minimum individual cormel diameter (1.17 cm), lowest corm yield (0.77 kg/plot and 10.31 t/ha) and lowest cormel yield (0.67 kg/plot and 8.95t/ha) were obtained from small corm with control treatment. The highest benefit cost ratio (2.82) was attained from large corm treated with zinc at 3kg/ha and the lowest (1.90) was obtained from the treatment combination of medium corm with control treatment.

CONCLUSION

Considering the above discussion it may be concluded that

1. In the experiment, large size corm was more effective than small corm.
2. Better performance was observed for application of 3kg zinc per hectare.
3. The treatment under the study, large size corm with 3kg/ha zinc is best for growth, flowering and yield of gladiolus.
4. Considering the situation of the present experiment, further studies might be conducted in different agro-ecological zones (AEZ) of Bangladesh for regional adaptability and other performances.

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APPENDICES

Appendix I. Characteristics of the soil of experimental field analyzed by Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

A. Morphological characteristics of the soil of experimental field

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

B. Physical and chemical properties of the initial soil

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

Source: SRDI, 2012

Appendix II. Monthly record of air temperature, rainfall, relative humidity, rainfall and Sunshine of the experimental site during the period from October 2012 to March 2013

Month (2012)	*Air temperature (ºc)		*Relative humidity (%)	*Rainfall (mm)	*Sunshine (hr)
	Maximum	Minimum			
October, 2012	24.32	17.22	75	13	7.2
November, 2012	25.82	16.04	78	00	6.8
December, 2012	22.40	13.50	74	00	6.3
January, 2013	24.50	12.40	68	00	5.7
February, 2013	27.10	16.70	67	30	6.7
March. 2013	31.40	19.60	54	11	8.2

* Monthly average,
Source: Bangladesh Meteorological Department (Climate & weather division) Agargoan, Dhaka – 1212

Appendix III. Name of fertilizers and manure used in gladiolus production and their nutrient composition (%)

Fertilizer	**Nutrient**	**%**
Urea	N	46
TSP	P_2O_5	48
	P	21.12
MP	K_2O	60
	K	49.8
ZnO	Zn	78
Cowdung	N	0.5-1.5
	P	0.4-0.8
	K	0.5-1.9

Source :Fertilizer Recommendation Guide-2012, BARC

Appendix IV. Analysis of variance of the data on plant height of gladiolus as influenced by corm size and zinc

Source of variation	Degrees of freedom	Mean square					
		Plant height (cm) at different days after planting (DAP)					
		30 DAP	40 DAP	50 DAP	60 DAP	70 DAP	80 DAP
Replication	2	1.426	4.968	6.695	0.889	3.562	3.580
Corm size (A)	2	134.472**	117.734**	170.344**	175.048**	214.390**	221.635**
Level of zinc (B)	4	81.236**	84.946**	150.292**	134.153**	170.297**	209.434**
Interaction (A×B)	8	15.936*	17.435**	25.990**	29.316**	27.981*	31.940*
Error	28	6.400	5.168	8.416	12.215	10.692	13.408

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

Appendix V. Analysis of variance of the data on number of leaves per plant of gladiolus as influenced by corm size and zinc

Source of variation	Degrees of freedom	Mean square					
		Number of leaves per plant at different days after planting (DAP)					
		30 DAP	40 DAP	50 DAP	60 DAP	70 DAP	80 DAP
Replication	2	0.001	0.043	0.035	0.039	0.024	0.532
Corm size (A)	2	1.901**	2.358**	10.489**	13.068**	14.752**	20.346**
Level of zinc (B)	4	0.493**	0.448**	6.375**	5.056**	10.706**	22.164**
Interaction (A×B)	8	0.311**	0.425**	1.233**	1.916**	3.801**	5.022**
Error	28	0.033	0.067	0.255	0.256	0.338	0.614

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

Appendix VI. Analysis of variance of the data on different growth parameter and spike yield of gladiolus as influenced by corm size and zinc

Source of variation	Degrees of freedom	Mean square							
		Days required to 50% emergence of spike	Days required to 80% emergence of spike	Flowering plant (%)	Length of flower stalk at harvest (cm)	Length of rachis at harvest (cm)	Number of florets per spike	Number of spike per plot	Number of spike per hectare ('000)
Replication	2	0.779	7.660	2.463	0.132	146.173	0.176	1.851	0.007
Corm size (A)	2	129.099**	271.295**	94.288**	70.528**	5740.246**	3.393**	59.203**	0.588**
Level of zinc (B)	4	34.061**	90.838**	29.201**	33.189**	4201.481**	1.673**	58.303**	0.831**
Interaction (A×B)	8	15.321*	19.765*	11.733*	6.799*	960.000**	0.850**	12.655**	0.182**
Error	28	7.050	8.411	5.252	1.038	205.432	0.139	2.051	0.008

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

Appendix VII. Analysis of variance of the data on different growth parameter, corm and cormel yield of gladiolus as influenced by corm size and zinc

Source of variation	Degrees of freedom	Mean square									
		Thickness of corm (cm)	Weight of individual corm (g)	Diameter of individual corm (cm)	Number of cormel per plant	Weight of individual cormel (g)	Diameter of individual cormel (cm)	Yield of corm (kg/plot)	Yield of cormel (kg/plot)	Yield of corm (t/ha)	Yield of cormel (t/ha)
Replication	2	0.174	0.381	0.004	0.002	0.000	0.321	0.065	6.489	0.822	2.854
Corm size (A)	2	98.798**	28.037**	0.278**	0.211**	0.271**	37.496**	48.197**	440.689**	32.289**	180.868**
Level of zinc (B)	4	62.198**	8.465**	0.132**	0.167**	0.083**	29.750**	14.753**	161.111**	23.633**	52.823**
Interaction (A×B)	8	9.737**	4.366**	0.024**	0.054**	0.061**	9.592*	10.819**	38.244**	5.400**	13.656**
Error	28	1.610	1.119	0.011	0.005	0.005	0.859	0.813	21.537	1.156	8.511

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

Appendix VIII. Per hectare production cost of gladiolus

A. Input cost

Treatment Combination	Labour cost	Ploughing cost	Corm Cost	Irrigation Cost	Insecticides	Zinc	Manure and fertilizers				Sub Total (A)
							Cowdung	Urea	TSP	MP	
C_1Zn_0	30000.00	15000.00	35000.00	12000.00	9000.00	0.00	20000.00	1600.00	6500.00	3500.00	132600.00
C_1Zn_1	30000.00	15000.00	35000.00	12000.00	9000.00	100.00	20000.00	1600.00	6500.00	3500.00	132700.00
C_1Zn_2	30000.00	15000.00	35000.00	12000.00	9000.00	200.00	20000.00	1600.00	6500.00	3500.00	132800.00
C_1Zn_3	30000.00	15000.00	35000.00	12000.00	9000.00	300.00	20000.00	1600.00	6500.00	3500.00	132900.00
C_1Zn_4	30000.00	15000.00	35000.00	12000.00	9000.00	400.00	20000.00	1600.00	6500.00	3500.00	133000.00
C_2Zn_0	30000.00	15000.00	40000.00	12000.00	9000.00	0.00	20000.00	1600.00	6500.00	3500.00	137600.00
C_2Zn_1	30000.00	15000.00	40000.00	12000.00	9000.00	100.00	20000.00	1600.00	6500.00	3500.00	137700.00
C_2Zn_2	30000.00	15000.00	40000.00	12000.00	9000.00	200.00	20000.00	1600.00	6500.00	3500.00	137800.00
C_2Zn_3	30000.00	15000.00	40000.00	12000.00	9000.00	300.00	20000.00	1600.00	6500.00	3500.00	137900.00
C_2Zn_4	30000.00	15000.00	40000.00	12000.00	9000.00	400.00	20000.00	1600.00	6500.00	3500.00	138000.00
C_3Zn_0	30000.00	15000.00	45000.00	12000.00	9000.00	0.00	20000.00	1600.00	6500.00	3500.00	142600.00
C_3Zn_1	30000.00	15000.00	45000.00	12000.00	9000.00	100.00	20000.00	1600.00	6500.00	3500.00	142700.00
C_3Zn_2	30000.00	15000.00	45000.00	12000.00	9000.00	200.00	20000.00	1600.00	6500.00	3500.00	142800.00
C_3Zn_3	30000.00	15000.00	45000.00	12000.00	9000.00	300.00	20000.00	1600.00	6500.00	3500.00	142900.00
C_3Zn_4	30000.00	15000.00	45000.00	12000.00	9000.00	400.00	20000.00	1600.00	6500.00	3500.00	143000.00

Appendix VIII.Contd.

B. Overhead cost (Tk./ha)

Treatment Combination	Cost of lease of land for 6 months (13% of value of land Tk. 8,00000/year)	Miscellaneous cost (Tk. 5% of the input cost)	Interest on running capital for 12 months (Tk. 13% of cost/year)	Sub total (Tk) (B)	Total cost of production (Tk./ha) [Input cost (A)+ overhead cost (B)]
C_1Zn_0	104000	17238	32999	154237	286837
C_1Zn_1	104000	17251	33014	154265	286965
C_1Zn_2	104000	17264	33028	154292	287092
C_1Zn_3	104000	17277	33043	154320	287220
C_1Zn_4	104000	17290	33058	154348	287348
C_2Zn_0	104000	17888	33733	155621	293221
C_2Zn_1	104000	17901	33748	155649	293349
C_2Zn_2	104000	17914	33763	155677	293477
C_2Zn_3	104000	17927	33778	155705	293605
C_2Zn_4	104000	17940	33792	155732	293732
C_3Zn_0	104000	18538	34468	157006	299606
C_3Zn_1	104000	18551	34483	157034	299734
C_3Zn_2	104000	18564	34497	157061	299861
C_3Zn_3	104000	18577	34512	157089	299989
C_3Zn_4	104000	18590	34527	157117	300117

Appendix IX. Map showing the experimental sites under study