EFFECT OF SPACING AND PHOSPHORUS ON GROWTH AND FLOWERING OF GLADIOLUS

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CERTIFICATE

This is to certify that the thesis entitled **"Effect of Spacing and Phosphorus on Growth and Flowering 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 **Asma Naznin**, Registration No. **09-03756** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated: June, 2011
Place: Dhaka, Bangladesh

____

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TO

MY BELOVED PARENTS

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ABSTRACT

The study was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from October 2010 to May 2011. The experiment consisted with two factors. Factor A: Three levels of spacing: S_1: 30 cm × 20 cm; S_2: 30 cm × 25 cm and S_3: 30 cm × 30 cm and Factor B: Four levels of phosphorus: P_0: control; P_1: 100 kg; P_2: 150 kg and P_3: 200 kg P_2O_5/ha respectively. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. In case of spacing, the highest number of spike (2,77,000/ha) was recorded from S_2 and the highest yield of corm (14.91 t/ha) was recorded from S_3 and both the parameters were lowest at S_1. In case of phosphorus, the highest number of spike (2,86,000/ha) and yield of corm (15.38 t/ha) was recorded from P_2 and both the parameters were lowest at P_0. For interaction effect the highest number of spike (3,30,000/ha) and yield of corm (17.24 t/ha) was recorded from S_2P_2. The highest benefit cost ratio (2.39) was obtained from S_2P_2 and the lowest (1.11) from S_3P_0. So, the combination of 30 cm × 25 cm spacing with 150 kg P_2O_5/ha is better for growth and flowering of gladiolus.

LIST OF ABBREVIATED TERMS

ABBREVIATION	FULL NAME
AEZ	Agro-Ecological Zone
et al.	and others
BBS	Bangladesh Bureau of Statistics
cm	Centimeter
°C	Degree Celsius
DAS	Date After Seeding
etc	Etcetera
FAO	Food and Agriculture Organization
MP	Muriate of Potash
RCBD	Randomized Complete Block Design
m^2	Square meter
TSP	Triple Super Phosphate
UNDP	United Nations Development Program
SAU	Sher-e-Bangla Agricultural University

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CHAPTER I

INTRODUCTION

Gladiolus (*Gladiolus grandiflorus* L.) is an herbaceous annual flower belongs to the family Iridaceae, is one of the most popular bulbous flowering plant (Bose and Yadav, 1989). Gladiolus is now grown as a cut flower widely in Europe, particularly in Holland, Italy and Southern France (Butt, 2005). It is a very popular cut flower in Bangladesh. It was introduced from India around the year 1992 (Mollah *et al*., 2002). Gladiolus is a very colorful decorative flower which is grown in herbaceous border, bed, rockery, pot and also for cut flower (Bose and Yadav, 1989). It is popular for its attractive spikes having florets of huge forms, dazzling colors, varying sizes and long durable quality as a cut flower. Gladiolus is frequently used as cut flower in different social and religious ceremonies (Mitra, 1992). It gained popularity in many parts of the world owing to its unsurpassed beauty and economic value (Chadha and Choudhuary, 1986).

The aesthetic value of gladiolus in the daily life is increasing with the advancement of civilization for the spikes owing to its elegance and long vase life and spikes are most popular in flower arrangement and preparing bouquets (Mukhopadhyay, 1995). Scarcity of an alternative cut flower of tuberose in winter season makes an opportunity to gladiolus to be more popular in Bangladesh. It has recently become popular in Bangladesh and its demand in this country is increasing day by day. Commercial cultivation of gladiolus is gaining popularity due to export potentials and prevalence of favorable growing condition in different parts of the country.

Plant spacing is an important aspect of crop production for maximizing the yield. It helps to increase the number of leaves, branches and healthy foliage. Densely planted crop obstruct the proper growth and development. On the other hand, wider spacing ensures the basic requirements but decrease the total number of plants as well as total yield. Crop yield may be increased upto 25% by using optimum spacing (Bansal *et al*., 1995). In Bangladesh like other management practices information about spacing to be used in gladiolus cultivation is scanty.

Plants respond greatly to major essential elements like N, P and K in respect of its growth and yield (Mital *et al*., 1975; Thompson and Kelly, 1988). Fertilizer application in appropriate time, appropriate dose and proper method is the prerequisite for its cultivation. An optimum dose of application of nutrient elements will not only ensure better yield and quality of gladiolus but also lead to minimum wastage of the nutrients. There is a scope of increasing flower yield, corm and cormel production of gladiolus with the appropriate use of phosphorus.

Phosphorus is also one of the important essential macro elements for the normal growth and development of plant. The phosphorus requirements vary depending upon the nutrient content of the soil (Bose and Som, 1986). Phosphorus restricted the plant growth (Hossain, 1990). Again secondary mechanism of interference was the absorption of phosphorus from the soil through luxury consumption, increasing the tissue content without enhancing smooth biomass accumulation for the plant (Santos *et al*., 2004).

There is a scope of increasing flower yield, corm and cormel production of gladiolus with the appropriate spacing and optimum doses of phosphorus fertilizer. Considering the present situations and above facts the present investigation was undertaken with the following objectives-

i. To find out the suitable spacing for production of gladiolus;

ii. To find out the optimum level of phosphorus for production of gladiolus; and

iii. To determine the suitable combination of spacing with phosphorus for better production of gladiolus.

CHAPTER II

REVIEW OF LITERATURE

Gladiolus is one of the important cut flower in Bangladesh and as well as many countries of the world. A very few studies on the related to growth, flower, corm and cormel production have been carried out in our country as well as many other countries of the world. So the research work so far done in Bangladesh is not adequate and conclusive. Nevertheless, some of the important and informative works and research findings related to the effects of spacing and levels of phosphorus on growth, flower, corm and cormel production of gladiolus reviewed under the following headings:

2.1 Effect of spacing

Yadav and Tyagi (2007) carried out a study in the experimental field of C.S.S.S. (P.O.) College Machhra, Meerut, Uttar Pradesh, India, to determine the effect of corm size and spacing (25 × 20, 25 × 30 and 25 × 40 cm) on growth and flowering of gladiolus. It was observed that all the growth and flowering parameters increased with the increase corm size and spacing, whereas the planting of small corms advanced the sprouting of corms.

Pranav *et al*. (2005) carried out an experiment during 2000/01 and 2001/02, in Meerut, Uttar Pradesh, India to evaluate the effects of different levels of GA_3 (0, 100, 250 and 500 ppm), spacing (20 × 20, 30 × 20 and 40 × 20 cm) and planting depth on the growth, flowering and corm production parameters in gladiolus cv. Candyman. GA_3 concentration of 100 ppm, plant spacing of 30 × 20 cm and planting depth of 10 cm recorded the highest values for plant height, number of leaves per plant, length of leaf and corm production.

Shiraz and Maurya (2005) conducted an experiment to find out the effects of spacing (25 × 10, 25 × 20 or 25 × 30 cm) and corm size on the performance of gladiolus in Sobour, Bihar, India. The widest spacing (25x30 cm) resulted in the highest plant height (152.28 cm), number of leaves per plant (10.11), number of spikes per plant (2.53), spike length (87.31), number of florets per spike (14.75), floret diameter (9.35 cm), number of corms per plant (2.47) and diameter of new corm (6.00 cm), and the lowest number of days to first spike emergence (62.44) and number of days to first floret opening (72.89).

Shilini *et al*. (2004) conducted an experiment in respect of influence of spacing and corm size on growth, flowering and corm production in gladiolus cv. Deboner was conducted at Agroecology and environment Centre, Dr. P.D.K.V., Akola, Maharashtra, India during 1997. Large sized corms and wider spacing (20 × 30 cm) have recorded significantly superior results in respect of growth, flowering and corm production. Treatment combination of medium spacing (20 × 20 cm) with large corms has recorded better results in respect of growth and flowering. Wider spacing (20 × 30 cm) with larger sized corm has recorded good quality flowers and production of more cormels per plant.

Nair and Singh (2004) conducted a study to identify the most promising cultivar of gladiolus for Andamans, India and to determine the optimum spacing for cultivation of this ornamental crop. Cultivar Darshan produced the maximum number of spikes per m^2 (24.33) when plants were spaced at 25 cm × 30 cm and had the longest vase life. Pusa Suhagin recorded the maximum length of spike (73.01 cm), bigger florets (7.47 cm) but produced only 19 spikes per m^2. The number of corms and cormels produced per plant was also maximum in Pusa Suhagin. Hence, Darshan and Pusa Suhagin may be recommended as suitable cultivars for commercial cultivation in Andamans. The optimum spacing has been standardized as 25 cm × 30 cm for gladiolus cultivation in Bay Islands.

Sharma and Gupta (2003) conducted an experiment to find out the effects of corm size (3.1-3.5, 3.6-4.0, 4.1-4.5 and 4.6-5.0 cm) and spacing (10 × 40, 20 × 40, 30 × 40 and 40 × 40 cm) on the growth and flowering of gladiolus in Haryana, India during 1997-99. Plant height, number of leaves per plant, spike length, number of florets per spike and number of spike per plant increased, whereas the number of days to spike emergence and blooming decreased with increasing corm size. Increasing spacing resulted in increasing values for plant height, spike length, number of florets per spike and number of spikes per plant. The number of corms per plant, corm weight and diameter, number of cormels per plant and cormel weight per plant increased with increasing corm size and plant spacing.

Sanjib and Talukdar (2003) find out the effects of time, spacing (30 × 15, 45 × 20, 60 × 25 cm) and planting depth (2.5 and 5 cm) on the corm and corm yield of gladiolus cv. Sylvia in a field experiment conducted in Jorhat, Assam, India. Planting on 25 October resulted in the highest number of cormels produced per planted corm (1.53), size (5.61 cm) and weight of corms (47.85 g), and number and weight of small, medium and large cormels. Spacing at 45 × 20 cm resulted in the highest values for the parameters measured except for the number of medium cormels produced per cormel which was highest at 60 × 25 cm spacing. Planting depth of 2.5 cm resulted in higher number of small (18.95) and medium (8.62) cormels produced per corm, whereas planting depth of 5 cm resulted in higher size (5.12 cm) and weight of corms (41.58 g) compared to planting depth of 2.5 cm. Plant spacing and depth had no significant effects on the weight of small, medium and large cormels.

Bijimol and Singh (2001) conducted an experiment to assess the effect of spacing and nitrogen levels on flowering, flower quality and vase life of gladiolus cv. Red Beauty. Four spacings (15 × 30, 20 × 30, 25 × 30 and 30 × 30 cm) and four nitrogen rates (0, 100, 200 and 300 kg/ha) were taken. Corms planted at 25 × 30 cm and 200 kg N/ha significantly increased the diameter of spike, number of florets per spike, number of spikes per plant and number of spikes per ha and early emergence of spike under field conditions. Application of 200 kg N/ha also resulted in maximum length of spike and diameter of floret. However, early opening of flower was recorded with lower N rate (100 kg/ha), while length of floret with 300 kg N/ha. Spacing and N levels had significant effect on postharvest life of cut gladioli. Spacing 25 × 30 cm had striking effect on percent opening of florets per spike, number of open florets with drooping of minimum florets.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

2.2 Effect of phosphorus

Rajib *et al*. (2006) conducted an experiment in Meghalaya, India to study the effects of nitrogen, phosphorus and potassium (0, 10, 20, 30, 40 g/m^2 each) on the growth, flowering and corm production of gladiolus cv. Pusa Shabnum during

2004-05. Application of 40 g fertilizer/m^2 resulted in the maximum plant height (86.53 cm), leaves per plant (8.65), leaf length (54.67 cm), leaf breadth (3.31 cm), spike length (71.53 cm), rachis length (45.30 cm), florets per spike (14.00), diameter of spike (1.26 cm) and rachis (0.85 cm) and flowering duration (9.36 days) under field conditions. However, the lowest dose 10 g/m^2 produced early heading (76.12 days), first floret showing colour (88.32 days) and opening of first floret (91.62 days), while the higher doses up to 40 g/m^2 delayed flowering. Higher doses also produced maximum corm weight (42.05 g), corm diameter (4.58 cm), cormels per plant (25.45) and their weight (13.20 g), and propagation coefficient (230.56%).

Rajiv and Misra (2003) carried out an experiment to study the effects of nitrogen, phosphorus (0, 5, 10, or 20 g/m^2) and potassium on growth, flowering, and yield in gladiolus cv. Jester Gold in New Delhi, India, during 2000-01 and 2001-02. Application of 20 g P_2O_5/m^2 resulted in maximum leaves per shoot (6.0), leaf area per plant (330.83 cm2), plant height (80.6 cm), diameter of first floret on third day of opening (9.7 cm), durability of first floret (3.8 days) and whole spike (12.4 days), florets per spike (15.7), spike length (58.8 cm), rachis length (44.7 days) and useful life of the spike (7.2 days) and resulted in earliest 50% heading (95.6 days) and first floret showing colour (114.3 days).

Pimpini and Zanin (2002) in 1994-95 had grown gladiolus hybrids in 4 soil types (sandy loam, clay, sand and peat soil) and treated with 8 fertilizer treatments: N, P, K, PK, NPK, manure (L), NPK + L, and an untreated control. The best results in terms of spike length, number of florets/spike and corm production were obtained with 50 t/ha L + 250 kg/ha N + 125 kg/ha P_2O_5 + 250 kg/ha K_2O. Treatments with NPK, L and N alone also gave better results than the control. The best results were obtained on peat soil and the poorest on sandy soil.

Mallick *et al*. (2001) in Orissa, India from December 1997 to May 1998 carried out an experiment to study the effect of various rates of N, P and K on gladiolus (*Gladiolus grandiflorus*) cv. Pink Prospector. The treatments were N at 10, 20 and 30 g/m^2, 10 and 20 g P/m^2, and 10 and 20 g K/m^2. The effect of different rate of N alone on spike length was non-significant but produced the longest spike (51.10 cm). The influence of different rates of P including K alone had significant effects on spike length (51.13 and 50.48 cm, respectively). Various combinations of N, P and K interaction rates did not show any significant differences among them. Rachis length varied significantly for all the levels of fertilizer rates. None of the NPK fertilizer rates, alone or in combinations, showed any significant differences. There was a significant difference in the length of florets with various N rates, applied alone, whereas all the other treatments were non-significant. Application of NPK at 20:10:20 rates yielded the highest floral diameter (8.13 cm).

Kawarkhe *et al*. (2001) conducted a field experiment during 1995-96, 1996-97 and 1997-98 in Akola, Maharashtra, India with 4 application rates of N (0, 40, 50 and 60 g/m^2) and P (0, 10, 20 and 30 g/m^2) fertilizers on gladiolus cv. Dabonoir. The number of spikes per plant and spike length increased with the increase in application rates of N and P fertilizers. The maximum spike length was obtained with application of N at 60 g/m^2 during 1995-96 and 1997-98, which was at par with the application of N at 50 g/m^2. The length of spikes was significantly influenced by the application of P up to 20 g P/m^2. Flowering was significantly influenced by N and P application. The maximum numbers of florets per spike were produced during 1995-96 (8.87), 1996-97 (8.88) and 1997-98 (8.88) by application of 50 g N/m^2. The interaction effects of N and P were significant. The maximum numbers of spike, spike length and number of florets per spike were influenced by the application of 50 g N/m^2 and 20 g P/m^2.

Mukesh *et al*. (2001) carried out an experiment with gladiolus cv. Tropic Sea was supplied with different levels of N (40, 50 and 60 g/m^2) at 2 splits (3 and 6 leaf stages) as side dressing, P_2O_5 (10, 20 and 30 g/m^2) and K_2O at 20 g/m^2 in West Bengal, India, during 1990-93. Phosphorus at 10 g/m^2 resulted the highest spike weight, numbers of flowers per spike, flower diameter, number of open flowers at a time, size and weight of corms, and number of corms.

Anil *et al*. (2000) carried out an experiment in Haryana, India, to determine the effects of N at 0, 40, 60 and 80 g/m2 with 3 levels of P (0, 10 and 20 g P_2O_5/m^2) and K (0, 10 and 20 g K_2O/m^2) on growth, flowering and corm production in gladiolus. Growth increased with increasing N levels, but P and K did not influence growth. The tallest plants and the highest spike length and highest number of corms was recorded from K at 20 g/m^2.

Pandey *et al*. (2000) investigate the effect of different levels of N and P on the growth of gladiolus cv. Psittacinus Hybrid at Agra, India. N was applied as urea at

0, 20, 40 and 60 g/m^2 and P as superphosphate at 0, 20 and 40 g P_2O_5/m^2, in all combinations. The corms were planted in the field on a sandy loam soil in early November. There were no significant differences for most of the characters recorded (plant height, leaf length, plant neck diameter, days to colour break, rachis length and number of florets/spike). Significant differences were only seen for number of leaves/clump, which was highest for and 40 g P_2O_5/m^2.

Barma *et al*. (1998) carried out a trial to study the effect of N (0-45 g/m^2), P (0-30 g/m^2) and K (0-30 g/m^2) on enlargement and production of corms and cormels of gladiolus cv. Psittacinus Hybrid on a sandy loam soil in Nadia, India in 1990-92. The effects of N and K were much more pronounced than those of P on number, size and weight of corms and cormels. Corm number, weight and diameter were maximum (23.60/m^2, 29.92 g and 4.20 cm, respectively) at the highest K rate (30 g/m^2), followed by the highest N rate (45 g/m^2). Cormel number and weight were maximum (82.17/m^2 and 5.53 g, respectively) at the highest N rate, followed by the highest K rate.

Das *et al.* (1998) in a field experiment in 1994-96 in New Delhi found that the effect of spike removal and K application corm yield in 10 gladiolus cultivars. The corms weight/plant was higher with 200 kg K_2O/ha rather than 100 kg K_2O, but corms/plant was not affected by the K rate.

Jhon *et al*. (1997) had investigated the effects of N, P_2O_5 and K_2O (0, 50 and 100 kg/ha) on the growth of gladiolus cv. Oscar on a silty loam soil at SKUAST, Shalimar Campus, India, during 1991-93. Application of all fertilizers increased corm size, corm weight, number of cormels/plant and cormel weight. The highest dose of N (100 kg/ha) and low doses of P_2O_5 and K_2O (50 kg/ha) produced the tallest plants with the longest spikes and most florets/spike.

Mukherjee *et al*. (1994) carried out a field trial with gladiolus cv. Vink's Glory, N was applied at 40, 50 or 60 g/m^2 and P at 10, 20 or 30 g/m^2. K was applied to all plants at 20 g/m^2. P and K were applied in full before planting and N was applied in 2 split doses at the 3 and 6-leaf stages. The highest number of florets/spike and largest corms were produced with 50 g N/m^2 in 2 doses and 10-20 g P/m^2.

Chattopadhyay *et al*. (1992) planted corms of uniform size (4-4.5 cm in diameter) in a sandy loam soil at a spacing of 30 × 20 cm. A basal dressing of 10 kg cattle manure and 20 g K_2O/m^2 was applied before planting. Three rates of N (40, 50 and 60 g/m^2) and 3 rates of P_2O_5 (10, 20 and 30 g/m^2) were compared in all combinations. Half the N and all the P_2O_5 were applied before planting and the remaining N was applied at 35 days after planting. Data on plant height, flower spike length, number of flowers/spike, number of days to flower, duration of flowering and size of daughter corms produced were recorded in 3 successive years. Plant height was highest with $N_{50}P_{30}$; this treatment also resulted in longest spikes and most flowers/spike. Plants in treatments $N_{60}P_{10}$ and $N_{60}P_{30}$ flowered in the shortest time and those in treatment $N_{50}P_{20}$ were slowest to flower. The corms were smallest (though not significantly) with $N_{60}P_{20}$ and largest with $N_{50}P_{10}$.

Singh *et al*. (1990) conducted an experiment with N at 0, 20 or 40 g/m^2 and P_2O_5 at 0, 20 or 30 g/m^2. FYM at 3 kg/m^2 and 20 g K_2O/m^2 were applied in all cases. The N rate was split and applied one-half at the 3-leaf stage and the other half at the 6-leaf stage. A marked improvement in corm production was obtained with N at 40 g/m^2 or P_2O_5 at 20 g/m^2 but the combined N + P application had no significant effect on corm yield.

Gowda *et al*. (1988) reported that the highest number of spikes/plant, largest florets, maximum number of florets,/plant and highest spike were out carried with the highest N (40 g/m^2) and P (40 g/m^2) rates.

CHAPTER III

MATERIALS AND METHODS

The field experiment was conducted during the period from October 2010 to May 2011 to find out the effect of spacing and different levels of phosphorus on growth, flower, corm and cormel production 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 of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh. The location of the experimental site is situated in $23^{0}74^{/}$N latitude and $90^{0}35^{/}$E longitude.

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 the soil under the experimental plot were analyzed at the Soil testing Laboratory, SRDI, Farmgate, Dhaka and presented in Appendix I.

3.3 Weather condition of the experimental site

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

3.4 Planting materials

Corms of gladiolus (Yellow colour) were used as planting materials and they were collected from Ananda Nursery, Savar Bazar, Dhaka.

3.5 Treatment of the experiment

The experiment was carried out to find out the effects of spacing and levels of phosphorus on growth, flower, corm and cormel production of gladiolus. The experiment was considered as two factors.

Factor A: Spacing (3 levels)

i. S_1: 30 cm × 20 cm
ii. S_2: 30 cm × 25 cm
iii. S_3: 30 cm × 30 cm

Factor B: Phosphorus (4 levels)

i. P_0: 0 kg P_2O_5/ha (Control)
ii. P_1: 100 kg P_2O_5/ha
iii. P_2: 150 kg P_2O_5/ha
iv. P_3: 200 kg P_2O_5/ha

There were on the whole 12 (3 × 4) treatment combinations such as S_1P_0, S_1P_1, S_1P_2, S_1P_3, S_2P_0, S_2P_1, S_2P_2, S_2P_3, S_3P_0, S_3P_1, S_3P_2 and S_3P_3.

3.6 Experimental design and layout

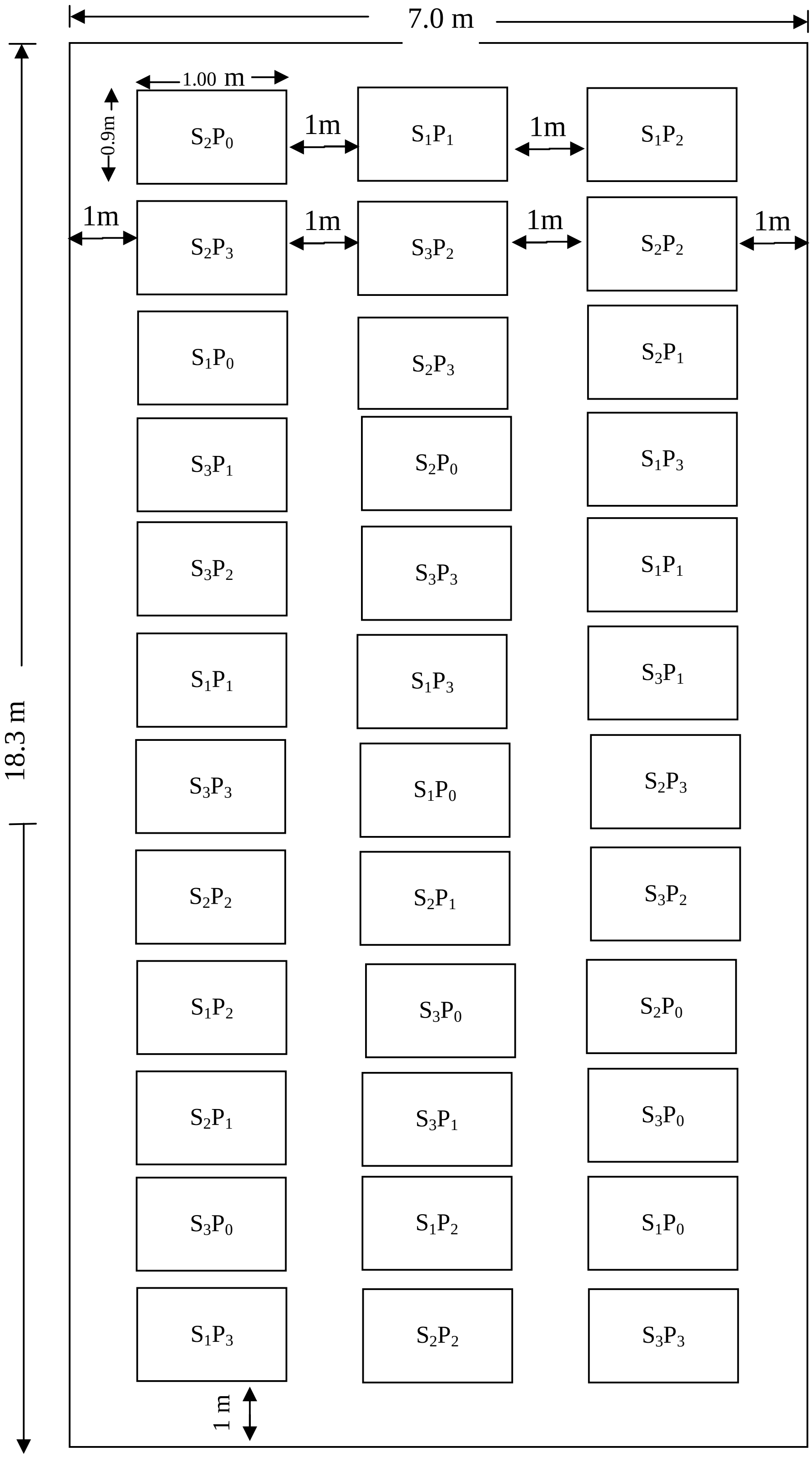
The experiment was laid out following Randomized Complete Block Design (RCBD) with three replications. An area of 18.3 m × 7.00 m was divided into three equal blocks. Each block was divided into 12 plots where 12 treatment combinations were allotted at random. There were 36 unit plots altogether in the experiment. The size of the each unit plot was 0.90 m × 1.00 m. The corms were sown with maintaining distance according to the spacing treatment. The layout of the experiment is shown in Figure 1.

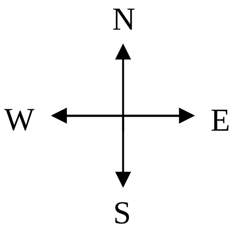
3.7 Application of manure and fertilizers

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

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

Fertilizers	Dose/ha	Application (%)			
		Basal	15 DAP	30 DAP	45 DAP
Cowdung	10 tons	100	--	--	--
Nitrogen (as urea)	200 kg	--	33.33	33.33	33.33
P_2O_5 (as TSP)	As per treatment	100	--	--	--
K_2O (as MP)	200 kg	100	--	--	--





Plot size: 0.9 m × 1.0 m
Plot spacing: 50 cm
Between replication: 1.0 m

Factor A:

Spacing

S_1: 30 cm x 20 cm

S_2: 30 cm x 25 cm

S_3: 30 cm x 30 cm

Factors A:

Level of phosphorus

P_0: 0 kg P_2O_5/ha

P_1: 100 kg P_2O_5/ha

P_2: 150 kg P_2O_5/ha

P_3: 200 kg P_2O_5/ha

Figure 1. Layout of the experimental plot

3.8 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, weeding, top dressing were accomplished for better growth and development of gladiolus seedlings.

3.8.1 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 afternoon. Further irrigation was done as when needed. Stagnant water was effectively drained out at the time of heavy rains.

3.8.2 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 emergence of seedlings whenever it is necessary. Breaking the crust of the soil was done accordingly.

3.8.3 Top dressing

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

3.9 Plant Protection

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

3.10 Data collection

Data were recorded on the following parameters from the sample plants during the course of experiment. Five plants were randomly selected from each unit plot for the collection of data.

3.10.1 Plant height

The height of plant was recorded in centimeter (cm) at 20, 30, 40, 50, 60 and 70 days after planting (DAP) in the experimental plots. The height was measured from the attachment of the ground level up to the tip of the growing point.

3.10.2 Number of leaves per plant

All the leaves of 5 plants were counted at an interval of 10 days at 20, 30, 40, 50, 60 and 70 days after planting (DAP) in the experimental plots.

3.10.3 Days required for emergence of spike

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

3.10.4 Percentage of flowering plant

It 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.

3.10.5 Length of flower stalk at harvest

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

3.10.6 Length of rachis at harvest

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

3.10.7 Number of florets per spike

All the florets of the spike were counted from 5 randomly selected plants and their mean was calculated.

3.10.8 Number of spike per plot and hectare ('000)

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

3.10.9 Diameter of individual corm

A slide calipers was used to measure the diameter of five randomly selected corm and their mean was calculated and expressed in centimeter.

3.10.10 Weight of individual corm

It was determined by weighing the corms from the five randomly selected plants and mean weight was calculated and expressed in gram.

3.10.11 Number of cormel per plant

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

3.10.12 Diameter of individual cormel

A slide calipers was used to measure the diameter of five randomly selected cormel and mean was calculated and expressed in centimeter.

3.10.13 Weight of individual cormel

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

3.10.14 Corm yield per plot and hectare

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

3.10.15 Cormel yield per plot and hectare

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

3.11 Statistical Analysis

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

3.12 Economic analysis

The cost of production was analyzed in order to find out the most economic treatment of spacing and phosphorus. All input cost were considered in computing the cost of production. The market price of spike, corm and cormel were 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 experiment was carried out to determine the effect of plant spacing and level of phosphorus on the growth and yield of gladiolus. Data on different growth parameter and yield of flower, corm and cormel was recorded. The analysis of variance (ANOVA) of the data on different growth parameter and yield of flower, corm and cormel are presented in Appendix III-VI. The results have been presented and discussed, and possible interpretations are given under the following headings:

4.1 Plant height

Gladiolus plant height showed statistically significant variation due to different plant spacing at 20, 30, 40, 50, 60 and 70 DAP (Appendix III). The longest plant (24.98 cm, 33.51 cm, 47.17 cm, 61.56 cm, 73.92 cm and 81.80 cm) was recorded from S_1 which was statistically similar (23.34 cm, 32.35 cm, 45.92 cm, 59.75 cm, 69.88 cm and 79.45 cm) with S_2 at 20, 30, 40, 50, 60 and 70 DAP, respectively. On the other hand, at the same DAP the shortest plant (19.64 cm, 20.79 cm, 38.84 cm, 52.22 cm, 60.56 cm and 72.75 cm) was measured from S_3 respectively (Figure 2). It was revealed that with the increases of spacing plant height showed decreasing trend. In case of closer spacing plant compete for light than wider spacing which helps to elongation of plant than the wider spacing. Mollah *et al.* (1995) reported that the closer spacing produced the maximum plant height (56.60 cm).

Plant height of gladiolus differed significantly due to the application of different levels of phosphorus at 20, 30, 40, 50, 60 and 70 DAP (Appendix III). At 20, 30, 40, 50, 60 and 70 DAP the longest plant (25.29 cm, 34.97 cm, 47.53 cm, 61.72 cm, 74.30 cm and 83.40 cm) was recorded from P_2 which was statistically identical (24.74 cm, 33.38 cm, 45.79 cm, 61.08 cm, 73.92 cm and 81.81 cm) with P_3 respectively. Again, the shortest plant (18.49 cm, 26.47 cm, 38.40 cm, 50.83 cm, 56.68 cm and 65.34 cm) was found from P_0 (Figure 3). Phosphorus fertilizer ensures favorable condition for the growth of gladiolus with optimum vegetative growth and the ultimate results was the tallest plant.

Statistically significant variation was recorded due to interaction effect of spacing and levels of phosphorus in terms of plant height of gladiolus at 20, 30, 40, 50, 60 and 70 DAP (Appendix III). The longest plant (29.42 cm, 38.81 cm, 53.26 cm, 67.80 cm, 86.57 cm and 90.34 cm) was recorded from S_1P_2 at 20, 30, 40, 50, 60 and 70 DAP, respectively. On the other hand, the shortest plant (17.91 cm, 26.41 cm, 37.68 cm, 50.97 cm, 54.72 cm and 65.06 cm) was recorded from S_3P_0 respectively (Table 2). It was revealed that optimum spacing and phosphorus ensured longest plant.

Table 2. Interaction effect of spacing and phosphorus on plant height of gladiolus

Treatment	Plant height (cm) at					
	20 DAP	30 DAP	40 DAP	50 DAP	60 DAP	70 DAP
S_1P_0	20.00 de	27.64 e	39.43 c	52.38 d	58.88 e	66.22 ef
S_1P_1	24.46 bc	33.68 bc	48.06 a	61.50 abc	72.47 bc	85.99 ab
S_1P_2	29.42 a	38.81 a	53.26 a	67.80 a	86.57 a	90.34 a
S_1P_3	26.03 abc	33.91 bc	47.95 a	64.56 ab	77.77 abc	84.63 abc
S_2P_0	17.97 e	26.47 e	37.72 c	51.02 d	55.70 e	65.14 f
S_2P_1	22.60 cd	32.65 cd	46.22 ab	59.81 bc	68.80 cd	83.48 abc
S_2P_2	28.02 ab	37.45 ab	51.65 a	66.17 ab	81.62 ab	87.22 ab
S_2P_3	25.17 bc	33.94 bc	48.51 a	63.92 ab	73.38 bc	82.36 bc
S_3P_0	17.91 e	26.41 e	37.68 c	50.97 d	54.72 e	65.06 f
S_3P_1	19.19 de	27.80 e	38.29 c	51.92 d	61.47 de	74.82 d
S_3P_2	18.44 e	28.66 de	38.46 c	51.20 d	55.45 e	72.65 de
S_3P_3	23.01 cd	32.30 cd	40.93 bc	54.78 cd	70.60 cd	78.45 cd
$LSD_{(0.05)}$	3.597	4.042	6.340	6.643	9.066	6.642
Level of significance	0.01	0.05	0.05	0.05	0.01	0.05
CV(%)	9.33	7.56	8.51	6.78	7.86	5.03

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

S_1: 30 cm × 20 cm
S_2: 30 cm × 25 cm
S_3: 30 cm × 30 cm

P_0: 0 kg P_2O_5/ha
P_1: 100 kg P_2O_5/ha
P_2: 150 kg P_2O_5/ha
P_3: 200 kg P_2O_5/ha

4.2 Number of leaves per plant

Statistically significant variation was observed for number of leaves per plant due to different plant spacing at 20, 30, 40, 50, 60 and 70 DAP (Appendix IV). The maximum number of leaves per plant (5.65, 8.27, 15.72, 24.00, 30.85 and 39.30) was recorded from S_1 which was statistically similar (5.37, 7.95, 14.95, 23.67, 29.40 and 35.87) with S_2 at 20, 30, 40, 50, 60 and 70 DAP, respectively. On the other hand, at the same DAP the minimum number of leaves per plant (3.93, 6.22, 13.50, 22.53, 27.68 and 30.65) was recorded from S_3 respectively (Figure 4). In case of closer spacing plant compete for light than wider spacing which helps to elongation of plant with minimum number of leaves per plant than the wider spacing.

Levels of phosphorus differed significantly for number of leaves per plant at days after planting of 20, 30, 40, 50, 60 and 70 DAP (Appendix IV). At 20, 30, 40, 50, 60 and 70 DAP the maximum number of leaves per plant (5.31, 8.09, 15.87, 22.27, 31.60 and 40.80 cm) was found from P_2 which was statistically identical (5.18, 8.08, 15.69, 23.62, 31.47 and 36.93) with P_3 respectively. Again, the minimum number of leaves per plant (4.40, 6.49, 12.49, 24.00, 24.62 and 28.40) was obtained from P_0 (Figure 5). It was revealed that with the increase of phosphorus fertilizer number of leaves increased upto a certain level than decreased. Phosphorus fertilizer ensured favorable condition for the growth of gladiolus with optimum vegetative growth with maximum number of leaves.

Interaction effect of spacing and levels of phosphorus showed statistically significant variation in terms of number of leaves per plant of gladiolus at 20, 30, 40, 50, 60 and 70 DAP (Appendix IV). The maximum number of leaves per plant (6.47, 9.40, 17.53, 24.40, 34.40 and 48.40) was observed from S_1P_2 at 20, 30, 40, 50, 60 and 70 DAP, respectively. On the other hand, the minimum number of leaves per plant (3.27, 5.73, 11.93, 20.60, 23.93 and 25.87) was found from S_2P_0 respectively (Table 3).

4.3 Days required to emergence of spike

Statistically non-significant variation was recorded for days required to emergence of spike due to different plant spacing (Appendix V). The maximum days required to emergence of spike (86.25) was recorded from S_3, while the minimum days required to emergence of spike (82.50) was observed from S_2 (Table 4). In case of closet and widest spacing plant spent extended time for vegetative growth for that reproductive growth would be delayed and the ultimate results would be maximum days for spike emergence.

Levels of phosphorus differed significantly for days required to emergence of spike (Appendix V). The maximum days required to emergence of spike (87.44) was observed from P_0 which was statistically identical (86.44) with P_3. Again, the minimum number of days required to emergence of spike (81.67) was recorded from P_2 (Table 4).

Table 3. Interaction effect of spacing and phosphorus on number of leaves per plant of gladiolus

Treatment	Number of leaves per plant at					
	20 DAP	30 DAP	40 DAP	50 DAP	60 DAP	70 DAP
S_1P_0	4.60 c	6.73 cd	12.93 efg	24.20 a	25.33 fg	29.00 fg
S_1P_1	5.73 ab	7.93 b	15.87 bc	23.27 abcd	30.87 bc	41.13 bc
S_1P_2	6.47 a	9.40 a	17.53 a	24.40 a	34.40 a	48.40 a
S_1P_3	5.80 ab	9.00 a	16.53 ab	24.27 a	32.80 ab	38.67 bcd
S_2P_0	3.27 d	5.73 d	11.93 g	20.60 e	23.93 g	25.87 g
S_2P_1	5.47 b	7.60 bc	15.07 bcd	24.00 ab	29.60 cde	37.20 cde
S_2P_2	6.20 ab	9.13 a	16.67 ab	22.93 bcd	32.93 ab	44.60 ab
S_2P_3	5.60 ab	9.00 a	16.13 ab	24.20 a	31.13 bc	35.80 cdef
S_3P_0	4.40 c	6.67 cd	12.60 fg	24.27 a	24.60 g	30.33 efg
S_3P_1	3.93 cd	6.20 d	13.60 def	22.87 c	28.20 de	32.53 defg
S_3P_2	4.20 c	6.07 d	13.40 efg	23.53 abc	27.47 ef	29.40 fg
S_3P_3	4.13 c	6.27 d	14.40 cde	22.40 d	30.47 bcd	30.33 efg
$LSD_{(0.05)}$	0.800	1.015	1.505	0.995	2.452	6.688
Level of significance	0.01	0.01	0.05	0.01	0.01	0.01
CV(%)	9.47	8.01	6.04	6.51	4.94	11.20

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

S_1: 30 cm × 20 cm
S_2: 30 cm × 25 cm
S_3: 30 cm × 30 cm

P_0: 0 kg P_2O_5/ha
P_1: 100 kg P_2O_5/ha
P_2: 150 kg P_2O_5/ha
P_3: 200 kg P_2O_5/ha

Table 4. Effect of spacing and different level of phosphorus on different growth parameter and spike yield of gladiolus

Treatment	Days required to 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)
Spacing							
S_1	84.92	76.08 b	58.15 c	31.52 c	11.28 b	20.25 b	225 b
S_2	82.50	87.95 a	72.10 a	34.59 b	14.98 a	24.92 a	277 a
S_3	86.25	84.11 a	66.60 b	36.33 a	14.36 a	23.67 a	263 a
$LSD_{(0.05)}$	--	4.784	4.193	1.197	0.722	2.301	25.56
Level of significance	NS	0.01	0.01	0.01	0.01	0.01	0.01
Level of phosphorus							
P_0	87.44 a	65.11 c	55.37 b	31.33 c	11.93 c	17.00 b	189 b
P_1	82.67 bc	83.69 b	67.37 a	32.80 b	13.33 b	23.78 a	264 a
P_2	81.67 c	92.65 a	69.63 a	36.17 a	14.53 a	25.78 a	286 a
P_3	86.44 ab	89.40 a	70.10 a	36.29 a	14.37 a	25.22 a	280 a
$LSD_{(0.05)}$	$LSD_{(0.05)}$	5.524	4.842	1.383	0.834	2.657	29.52
Level of significance	0.05	0.01	0.01	0.01	0.01	0.01	0.01
CV(%)	5.20	6.83	7.55	8.14	6.30	11.84	11.84

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

S_1: 30 cm × 20 cm
S_2: 30 cm × 25 cm
S_3: 30 cm × 30 cm

P_0: 0 kg P_2O_5/ha
P_1: 100 kg P_2O_5/ha
P_2: 150 kg P_2O_5/ha
P_3: 200 kg P_2O_5/ha

Statistically significant variation was recorded due to interaction effect of spacing and levels of phosphorus in terms of days required to emergence of spike (Appendix V). The maximum number of days required to emergence of spike (96.00) was recorded from S_1P_0, whereas the minimum days required to emergence of spike (70.00) was recorded from S_1P_2 (Table 5).

4.4 Flowering plant

Statistically significant variation was recorded for flowering plant due to different plant spacing (Appendix V). The highest flowering plant (87.95%) was recorded from S_2 which was statistically similar (84.11) with S_3, while the lowest flowering plant (76.08%) was observed from S_1 (Table 4).

Flowering plant differed significantly for levels of phosphorus (Appendix V). The highest flowering plant (92.65%) was recorded from P_2 which was statistically identical (89.40%) with P_3 and closely followed (83.69%) by P_1. Again, the lowest flowering plant (65.11%) was found from P_0 (Table 4).

Interaction effect of spacing and levels of phosphorus varied significantly in terms of flowering plant (Appendix V). The highest flowering plant (99.27%) was recorded from S_2P_2, whereas the lowest flowering plant (62.20%) was recorded from S_3P_2 (Table 5).

Table 5. Interaction effect of spacing and different level of phosphorus on different growth parameter and spike yield of gladiolus

Treatment	Days required to 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)
S_1P_0	96.00 a	65.07 g	56.70 d	31.40 cd	12.09 d	21.33 cde	237 cde
S_1P_1	87.33 b	75.92 ef	59.00 cd	33.20 c	11.14 de	18.33 de	204 de
S_1P_2	70.00 d	77.01 def	56.50 d	28.70 e	10.32 e	19.00 de	211 de
S_1P_3	86.33 b	86.34 cd	60.40 cd	32.80 c	11.55 de	22.33 bcd	248 bcd
S_2P_0	85.00 b	68.06 fg	57.40 d	32.40 cd	12.35 d	16.67 ef	185 ef
S_2P_1	74.00 cd	89.49 bc	76.50 a	28.00 e	14.79 bc	27.33 ab	304 ab
S_2P_2	86.00 b	99.27 a	78.40 a	39.70 ab	16.93 a	29.67 a	330 a
S_2P_3	85.00 b	91.97 bc	76.10 a	38.27 ab	15.87 ab	26.00 abc	289 abc
S_3P_0	81.33 bc	62.20 g	52.00 d	30.20 de	11.34 de	13.00 f	144f
S_3P_1	86.67 b	85.66 cde	66.60 bc	37.20 b	14.05 c	25.67 abc	285 abc
S_3P_2	89.00 ab	98.67 ab	74.00 ab	40.10 a	16.35 ab	28.67 a	319 a
S_3P_3	88.00 b	89.89 bc	73.80 ab	37.80 ab	15.69 ab	27.33 ab	304 ab
$LSD_{(0.05)}$	7.445	9.568	8.387	2.395	1.444	4.601	51.13
Level of significance	0.01	0.05	0.01	0.01	0.01	0.01	0.01
CV(%)	5.20	6.83	7.55	8.14	6.30	11.84	11.84

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

S_1: 30 cm × 20 cm
S_2: 30 cm × 25 cm
S_3: 30 cm × 30 cm

P_0: 0 kg P_2O_5/ha
P_1: 100 kg P_2O_5/ha
P_2: 150 kg P_2O_5/ha
P_3: 200 kg P_2O_5/ha

4.5 Length of flower stalk at harvest

Significant variation was recorded for length of flower stalk at harvest due to different plant spacing (Appendix V). The longest flowering stalk (72.10 cm) was recorded from S_2 which was closely followed (66.60 cm) by S_3, while the shortest (58.15 cm) was observed from S_1 (Table 4). It was revealed that highest plant spacing found the highest length of flowering stalk at harvest. Mollah *et al.* (1995) reported that the widest spacing (30 cm x 25 cm) produced the maximum length of spike (36.34 cm).

Length of flower stalk at harvest differed significantly for levels of phosphorus (Appendix V). The longest flowering stalk (70.10 cm) was recorded from P_3 which was statistically identical (69.63 cm and 67.37 cm) with P_2 and P_1, whereas the shortest flowering stalk (55.37 cm) was attained from P_0 (Table 4). Kawarkhe *et al*. (2001) reported that number of spikes per plant and spike length increased with the increase in application rates of P fertilizers.

Significant difference was recorded due to interaction effect of spacing and levels of phosphorus in terms of length of flower stalk at harvest (Appendix V). The longest length of flower stalk at harvest (78.40 cm) was recorded from S_2P_2, whereas the shortest flower stalk at harvest (52.00 cm) was found from S_3P_0 (Table 5).

Plate 1. Photograph showing the length of flower stalk for different plant spacing

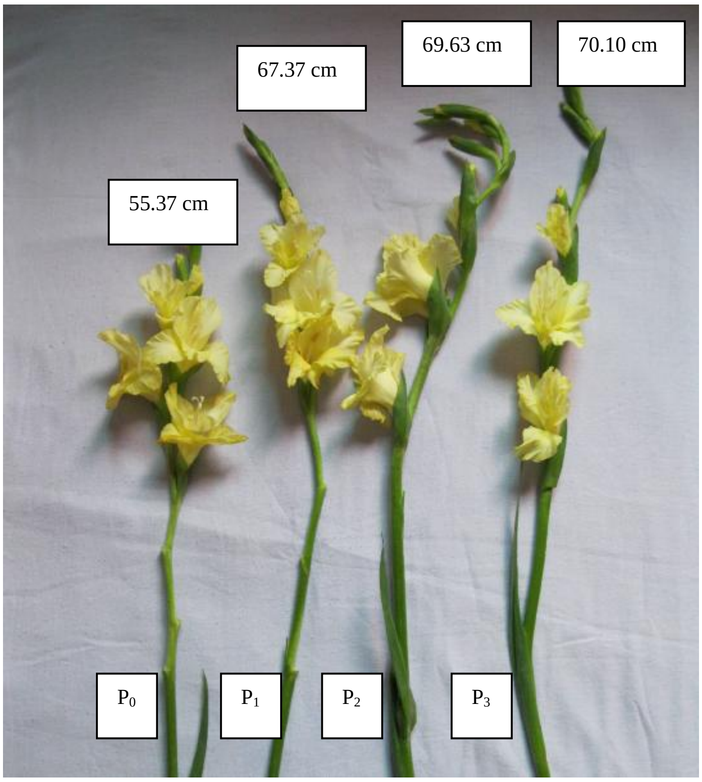


Plate 2. Photograph showing the length of flower stalk for different levels of phosphorus

4.6 Length of rachis at harvest

Statistically significant variation was recorded for length of rachis at harvest due to different plant spacing (Appendix V). The longest rachis (36.33 cm) was recorded from S_3 which was closely followed (34.59 cm) by S_2, while the shortest rachis (31.52 cm) was observed from S_1 (Table 4). It was revealed that highest plant spacing produced the highest length of rachis at harvest. In case of closer spacing it was lowest due to lowest vegetative growth. Mollah *et al.* (1995) reported that the widest spacing produced longest rachis (11.9 cm).

Levels of phosphorus differed significantly for length of rachis at harvest (Appendix V). The longest rachis (36.29 cm) was recorded from P_3 which was statistically identical (36.17 cm) with P_2 and closely followed (32.80 cm) by P_1, whereas the shortest rachis (31.33 cm) was found from P_0 (Table 4).

Statistically significant variation was recorded due to interaction effect of spacing and levels of phosphorus in terms of length of rachis at harvest (Appendix V). The longest rachis at harvest (40.10 cm) was recorded from S_3P_2, whereas the shortest rachis at harvest (28.00 cm) was recorded from S_2P_1 (Table 5).

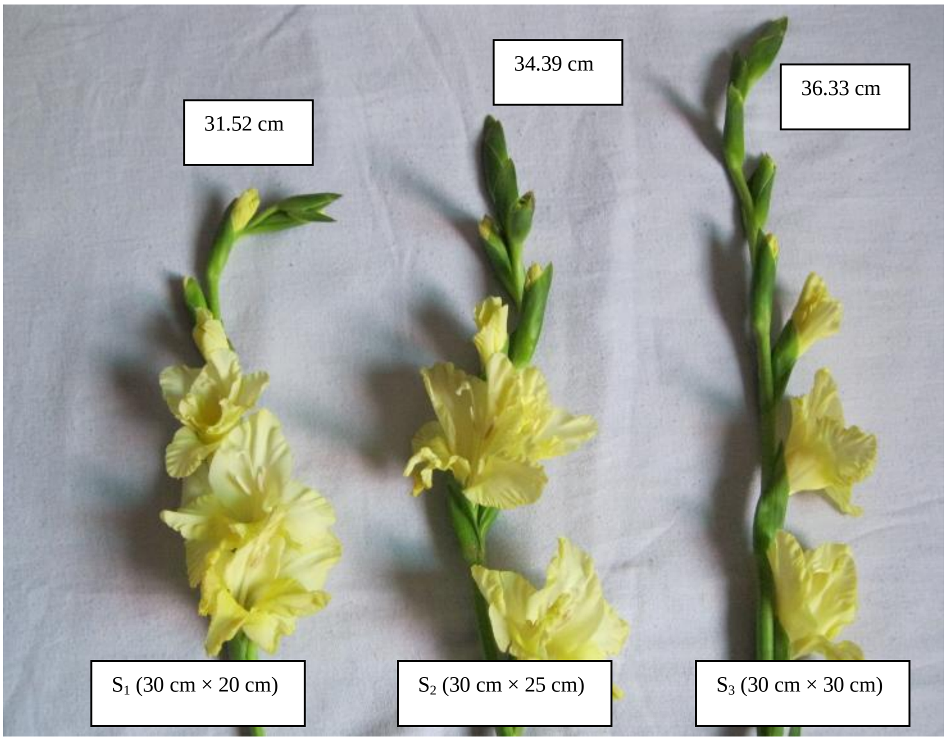


Plate 3. Photograph showing the length of rachis for different plant spacing

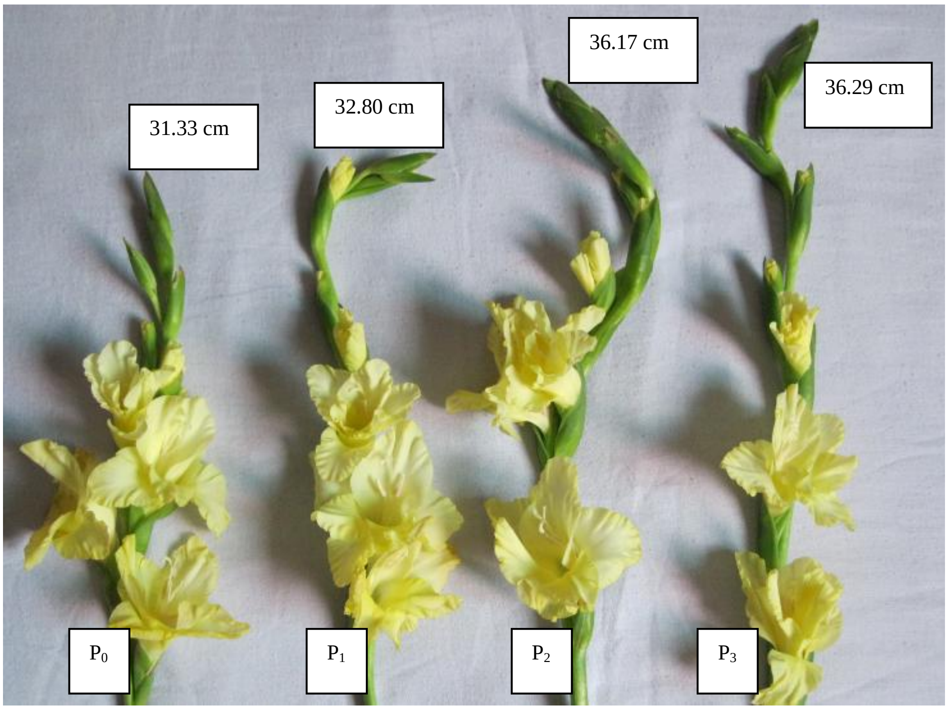


Plate 4. Photograph showing the length of rachis for different levels of phosphorus

4.7 Number of florets per spike

Florets per spike varied significantly due to different plant spacing (Appendix V). The maximum number of florets per spike (14.98) was recorded from S_2 which was statistically identical (14.36) with S_3, while the minimum number (11.28) was observed from S_1 (Table 4). It was revealed that 30 cm × 25 cm plant spacing produced the highest number of florets per spike. Nilimesh and Roychowdhury (1989) reported that higher planting density decreased the number of florets per spike and flower length.

Levels of phosphorus differed significantly for number of florets per spike (Appendix V). The maximum number of florets per spike (14.53) was recorded from P_2 which was statistically identical (14.37) with P_3 and closely followed (13.33) by P_1, whereas the minimum number of florets per spike (11.93) was found from P_0 (Table 4). Kawarkhe *et al*. (2001) reported that the maximum number of florets per spike was influenced by the application of 20 g P/m^2.

Statistically significant variation was recorded due to interaction effect of spacing and levels of phosphorus in terms of number of florets per spike (Appendix V). The maximum number of florets per spike (16.93) was recorded from S_2P_2, whereas the minimum (10.32) was recorded from S_1P_2 (Table 5).

4.8 Number of spike per plot

Statistically significant variation was recorded for number of spike per plot due to different plant spacing (Appendix V). The maximum number of spike per plot (24.92) was recorded from S_2 which was statistically identical (23.67) with S_3, while the minimum number of spike (20.25) was observed from S_1 (Table 4).

Levels of phosphorus differed significantly for number of spike per plot (Appendix V). The maximum number of spike per plot (25.78) was recorded from P_2 which was statistically identical (25.22 and 23.78) with P_3 and P_1, whereas the minimum number of spike (17.00) was found from P_0 (Table 4).

Statistically significant variation was recorded due to interaction effect of spacing and levels of phosphorus in terms of number of spike per plot (Appendix V). The maximum number of spike per plot (29.67) was recorded from S_2P_2, whereas the minimum number of spike per plot (13.00) was recorded from S_3P_0 (Table 5).

4.9 Number of spike per hectare

Statistically significant variation was recorded for number of spike per hectare due to different plant spacing (Appendix V). The maximum number of spike per hectare (277 thousand) was recorded from S_2 which was statistically identical (263 thousand) with S_3, while the minimum number (225 thousand) was observed from S_1 (Table 4). It was revealed that 30 cm × 25 cm plant spacing produced the highest number of spike per hectare. Sujata and Singh (1991) reported that growth and flowering characteristics (including cut flower yields) decreased with increasing plant density.

Levels of phosphorus differed significantly for number of spike per hectare (Appendix V). The maximum number of spike per hectare (286 thousand) was recorded from P_2 which was statistically identical (280 thousand and 264 thousand) with P_3 and P_1, whereas the minimum number of spike (189 thousand) was found from P_0 (Table 4). Singh *et al.* (1976) and Mukesh *et al.* (2001) reported that the highest level of phosphorus increased the number of spike.

Number of spike per hectare showed statistically significant variation due to interaction effect of spacing and levels of phosphorus (Appendix V). The maximum number of spike per hectare (330 thousand) was recorded from S_2P_2, whereas the minimum number of spike per hectare (144 thousand) was recorded from S_3P_0 (Table 5).

4.10 Diameter of individual corm

Significant variation was recorded for diameter of individual corm due to different plant spacing (Appendix VI). The highest diameter of corm (2.71 cm) was recorded from S_3 which was closely followed (2.44 cm) by S_2, while the lowest (1.87 cm) was found from S_1 (Table 6). It was revealed that highest plant spacing ensure highest vegetative growth and the ultimate results would be the highest diameter of individual corm.

Different levels of phosphorus differed significantly for diameter of individual corm (Appendix VI). The highest diameter of corm (2.57 cm) was recorded from P_2 which was statistically identical (2.49 cm) with P_3 and closely followed (2.22 cm) by P_1, whereas the lowest diameter (2.08 cm) was found from P_0 (Table 6).

Table 6. Effect of spacing and different level of phosphorus on different growth parameter and corm and cormel yield of gladiolus

Treatment	Diameter of individual corm (cm)	Weight of individual corm (g)	Number of cormel per plant	Diameter of individual cormel (cm)	Weight of individual cormel (g)	Yield of corm (t/ha)	Yield of cormel (t/ha)
Spacing							
S_1	1.87 c	17.19 b	18.46 b	1.18 b	12.07 b	10.57 c	8.08 b
S_2	2.44 b	26.59 a	20.09 a	1.40 a	13.05 a	13.77 b	12.12 a
S_3	2.71 a	27.54 a	19.51 ab	1.43 a	12.72 a	14.91 a	11.82 a
$LSD_{(0.05)}$	0.207	1.948	1.117	0.093	0.476	1.070	0.643
Level of significance	0.01	0.01	0.05	0.01	0.01	0.01	0.01
Level of phosphorus							
P_0	2.08 b	19.70 c	16.95 b	1.21 b	11.72 c	10.25 c	8.86 b
P_1	2.22 b	22.24 b	19.50 a	1.27 b	12.56 b	12.40 b	11.19 a
P_2	2.57 a	27.51 a	20.74 a	1.44 a	13.14 a	15.38 a	11.71 a
P_3	2.49 a	25.66 a	20.22 a	1.42 a	13.03 ab	14.30 a	10.95 a
$LSD_{(0.05)}$	0.240	2.250	1.290	0.107	0.550	1.235	0.743
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CV(%)	10.44	9.68	6.82	8.16	4.46	9.66	7.11

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

S_1: 30 cm × 20 cm
S_2: 30 cm × 25 cm
S_3: 30 cm × 30 cm

P_0: 0 kg P_2O_5/ha
P_1: 100 kg P_2O_5/ha
P_2: 150 kg P_2O_5/ha
P_3: 200 kg P_2O_5/ha

Statistically significant variation was recorded due to interaction effect of spacing and levels of phosphorus in terms of diameter of individual corm (Appendix VI). The highest diameter of individual corm (3.22 cm) was recorded from S_3P_2, whereas the lowest diameter (1.70 cm) was recorded from S_1P_3 (Table 7).

4.11 Weight of individual corm

Statistically significant variation was recorded for weight of individual corm due to different plant spacing (Appendix VI). The highest weight of corm (27.54 g) was recorded from S_3 which was statistically similar (26.59 g) by S_2, while the lowest weight (17.19 g) was observed from S_1 (Table 6). It was revealed that highest plant spacing ensure highest vegetative growth and the ultimate results would be the highest weight of individual corm.

Levels of phosphorus differed significantly for weight of individual corm (Appendix VI). The highest weight of corm (27.51 g) was recorded from P_2 which was statistically identical (25.66 g) with P_3 and closely followed (22.24 g) by P_1, whereas the lowest weight (19.70 g) was found from P_0 as (Table 6). Mukesh *et al*. (2001) reported that phosphorus at 10 g/m^2 resulted in the highest size and weight of corms, and number of corms.

Significant variation was observed due to interaction effect of spacing and levels of phosphorus in terms of weight of individual corm (Appendix VI). The highest weight of individual corm (33.80 g) was recorded from S_3P_2, whereas the lowest weight (13.92 g) was recorded from S_1P_1 (Table 7).

Table 7. Interaction effect of spacing and different level of phosphorus on different growth parameter and corm and cormel yield of gladiolus

Treatment	Diameter of individual corm (cm)	Weight of individual corm (g)	Number of cormel per plant	Diameter of individual cormel (cm)	Weight of individual cormel (g)	Yield of corm (kg/plot)	Yield of corm (t/ha)	Yield of cormel (kg/plot)	Yield of cormel (t/ha)
S_1P_0	2.23 efg	20.32 d	15.48 f	1.23 bc	11.27 f	9.14 d	10.15 d	6.70 e	7.45 e
S_1P_1	1.82 gh	13.92 e	17.72 def	1.09 c	11.71 ef	9.15 d	10.17 d	7.48 de	8.31 de
S_1P_2	1.73 h	17.53 de	18.31 cde	1.19 c	12.01 def	9.17 d	10.18 d	7.57 de	8.41 de
S_1P_3	1.70 h	17.00 de	21.12 ab	1.18 c	13.31 abc	10.62 cd	11.80 cd	7.36 de	8.17 de
S_2P_0	2.05 fgh	20.08 d	18.67 bcde	1.26 bc	12.30 cdef	9.28 d	10.31 d	7.87 de	8.74 de
S_2P_1	2.29 def	26.15 c	20.10 abcd	1.30 bc	12.96 abcd	11.87 bc	13.19 bc	11.68 abc	12.97 abc
S_2P_2	2.76 bc	31.20 ab	21.92 a	1.54 a	13.80 a	15.51 a	17.24 a	12.75 a	14.16 a
S_2P_3	2.68 bcd	28.93 bc	19.66 abcd	1.52 a	13.12 abc	12.90 b	14.34 b	11.33 bc	12.59 bc
S_3P_0	1.97 fgh	18.70d	16.70 ef	1.15 c	11.59 ef	9.23 d	10.26 d	8.48 d	9.42 d
S_3P_1	2.55 cde	26.64 c	20.67 abc	1.42 ab	13.00 abcd	12.48 bc	13.87 bc	11.05 bc	12.28 bc
S_3P_2	3.22 a	33.80 a	22.01 a	1.59 a	13.62 ab	16.86 a	18.73 a	12.17 ab	13.52 ab
S_3P_3	3.09 ab	31.03 ab	19.90 abcd	1.57 a	12.65 bcde	15.09 a	16.77 a	10.87 c	12.08 c
$LSD_{(0.05)}$	0.415	3.896	2.234	0.186	0.952	1.926	2.140	1.157	1.286
Level of significance	0.01	0.01	0.01	0.01	0.05	0.01	0.01	0.01	0.01
CV(%)	10.44	9.68	6.82	8.16	4.46	9.66	9.66	7.11	7.11

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

S_1: 30 cm × 20 cm
S_2: 30 cm × 25 cm
S_3: 30 cm × 30 cm

P_0: 0 kg P_2O_5/ha
P_1: 100 kg P_2O_5/ha
P_2: 150 kg P_2O_5/ha
P_3: 200 kg P_2O_5/ha

4.12 Number of cormel per plant

Statistically significant variation was recorded for number of cormel per plant due to different plant spacing (Appendix VI). The highest number of cormel per plant (20.09) was recorded from S_2 which was statistically similar (19.51) by S_3, while the lowest number (18.46) was observed from S_1 (Table 6). It is revealed that highest plant spacing ensure highest vegetative growth and the ultimate results would be the highest number of cormel per plant. Mollah *et al.* (1995) reported that the widest spacing (15 cm x 15 cm) produced the highest number of cormels (21.87) per plant.

Levels of phosphorus differed significantly for number of cormel per plant (Appendix VI). The highest number of cormel per plant (20.74) was recorded from P_2 which was statistically identical (20.22 and 19.50) with P_3 and P_1, whereas the lowest number (16.95) was found from P_0 (Table 6).

Statistically significant variation was recorded due to interaction effect of spacing and levels of phosphorus in terms of number of cormel per plant (Appendix VI). The highest number of cormel per plant (22.01) was recorded from S_3P_2, whereas the lowest number (15.48) was recorded from S_1P_0 (Table 7).

4.13 Diameter of individual cormel

Statistically significant variation was recorded for diameter of individual cormel due to different plant spacing (Appendix VI). The highest diameter of individual cormel (1.43 cm) was recorded from S_3 which was statistically similar (1.40 cm) by

S_2, while the lowest diameter (1.18 cm) was observed from S_1 (Table 6). It was revealed that highest plant spacing ensure highest vegetative growth and the ultimate results would be the highest diameter of individual cormel.

Levels of phosphorus differed significantly for diameter of individual cormel (Appendix VI). The highest diameter of individual cormel (1.44 cm) was recorded from P_2 which was statistically identical (1.40 cm) with P_3 and closely followed (1.27 cm) by P_1, whereas the lowest diameter (1.21 cm) was found from P_0 (Table 6).

Statistically significant variation was recorded due to interaction effect of spacing and levels of phosphorus in terms of diameter of individual cormel (Appendix VI). The highest diameter of individual cormel (1.59 cm) was recorded from S_3P_2, whereas the lowest diameter (1.09 cm) was recorded from S_1P_1 (Table 7).

4.14 Weight of individual cormel

Weight of individual cormel showed statistically significant variation due to different plant spacing (Appendix VI). The highest weight of individual cormel (13.05 g) was recorded from S_2 which was statistically similar (12.72 g) by S_3, while the lowest weight (12.07 g) was observed from S_1 (Table 6). It was revealed that highest plant spacing ensure highest vegetative growth and the ultimate results would be the highest weight of individual cormel.

Levels of phosphorus differed significantly for weight of individual cormel (Appendix VI). The highest weight of individual cormel (13.14 g) was recorded from P_2 which was statistically identical (13.03 g) with P_3 and closely followed (12.56 g) by P_1, whereas the lowest weight (11.72 g) was found from P_0 (Table 6).

Statistically significant variation was recorded due to interaction effect of spacing and levels of phosphorus in terms of weight of individual cormel (Appendix VI). The highest weight of individual cormel (13.80 g) was recorded from S_2P_2, whereas the lowest weight (11.27 g) was recorded from S_1P_0 (Table 7).

4.15 Yield of corm per plot

Significant variation was recorded for yield of corm per plot due to different plant spacing (Appendix VI). The highest yield of corm per plot (13.42 kg) was recorded from S_3 which was closely followed (12.39 kg) by S_2, while the lowest yield (9.52 kg) was found from S_1 (Figure 6).

Yield of corm per plot differed significantly for levels of phosphorus (Appendix VI). The highest yield of corm per plot (13.85 kg) was recorded from P_2 which was statistically identical (12.87 kg) with P_3 and closely followed (11.16 kg) by P_1, whereas the lowest yield (9.22 kg) was found from P_0 (Figure 7).

Interaction effect of spacing and levels of phosphorus varied significantly in terms of yield of corm per plot (Appendix VI). The highest yield of corm per plot (16.86 kg) was recorded from S_3P_2, whereas the lowest yield (9.14 kg) was recorded from S_1P_0 (Table 7).

4.16 Yield of corm per hectare

Significant variation was recorded for yield of corm per hectare due to different plant spacing (Appendix VI). The highest yield of corm per hectare (14.91 ton) was recorded from S_3 which was closely followed (13.77 ton) by S_2, while the lowest yield (10.57 ton) was observed from S_1 (Table 6). It was revealed that highest plant spacing ensure highest vegetative growth and the ultimate results would be the highest yield of corm. But Rabbani and Azad (1996) reported the highest yield of mother corm (13.17 t/ha) from the treatment combination of closest spacing (20 × 10 cm). Incalcaterra (1992) reported that increasing the planting density increased corm yield but reduced the corm quality. Sujata and Singh (1991) found that planting density had no significant effect on corm production.

Levels of phosphorus differed significantly for yield of corm per hectare (Appendix VI). The highest yield of corm per hectare (15.38 ton) was recorded from P_2 which was statistically identical (14.30 ton) with P_3 and closely followed (12.40 ton) by P_1, whereas the lowest yield (10.25 ton) was found from P_0 (Table 6). Mukesh *et al.* (2001) reported that phosphorus at 10 g/m^2 resulted in the highest size and weight of corms.

Statistically significant variation was recorded due to interaction effect of spacing and levels of phosphorus in terms of yield of corm per hectare (Appendix VI). The highest yield of corm per hectare (18.73 ton) was recorded from S_3P_2, whereas the lowest yield (10.15 ton) was recorded from S_1P_0 (Table 7).

4.17 Yield of cormel per plot

Statistically significant variation was recorded for yield of cormel per plot due to different plant spacing (Appendix VI). The highest yield of cormel per plot (10.91 kg) was recorded from S_2 which was statistically identical (10.64 kg) with S_2, while the lowest yield (7.28 kg) was observed from S_1 (Figure 8).

Levels of phosphorus differed significantly for yield of cormel per plot (Appendix VI). The highest yield of cormel per plot (10.54 kg) was recorded from P_2 which was statistically identical (10.07 kg and 9.85 kg) with P_1 and P_3 , whereas the lowest yield (7.97 kg) was found from P_0 (Figure 9).

Statistically significant variation was recorded due to interaction effect of spacing and levels of phosphorus in terms of yield of cormel per plot (Appendix VI). The highest yield of cormel per plot (12.75 kg) was found from S_2P_2, whereas the lowest yield (6.70 kg) was recorded from S_1P_0 (Table 7).

4.18 Yield of cormel per hectare

Statistically significant variation was recorded for yield of cormel per hectare due to different plant spacing (Appendix VI). The highest yield of cormel per hectare (12.12 ton) was observed from S_2 which was statistically identical (11.82 ton) with S_3, while the lowest yield (8.08 ton) was found from S_1 (Table 6). But Rabbani and Azad (1996) reported the highest yield cormel (22.36 t/ha) from the treatment combination of closest spacing (20 × 10 cm). Mukhopadhyay and Yadav (1984) reported that wider spacing produced more cormels than the closer spacing.

Levels of phosphorus differed significantly for yield of cormel per hectare (Appendix VI). The highest yield of cormel per hectare (11.71 ton) was recorded from P_2 which was statistically identical (11.19 ton and 10.95 ton) with P_3 and P_1, whereas the lowest yield (8.86 ton) was found from P_0 (Table 6).

Statistically significant variation was recorded due to interaction effect of spacing and levels of phosphorus in terms of yield of cormel per hectare (Appendix VI). The highest yield of cormel per hectare (14.16 ton) was observed from S_2P_2, whereas the lowest yield (7.45 ton) was recorded from S_1P_0 (Table 7).

4.19 Economic analysis

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

4.19.1 Gross return

The combination of plant spacing and level of phosphorus showed different value in terms of gross return under the trial (Table 8). The highest gross return (Tk. 1,423,690) was obtained from the treatment combination S_2P_2 and the second highest gross return (Tk. 1,374,360) was found in S_3P_2. The lowest gross return (Tk. 642,780) was obtained from S_3P_0.

Table 8. Cost and return of gladiolus cultivation as influenced by spacing and level of phosphorus

Treatment Combination	Cost of production (Tk./ha)	Yield of corm (t/ha)	Price of corm (Tk.)	Yield of cormel (t/ha)	Price of cormel	Number of spike/ha	Price of cut flower	Gross return (Tk./ha)	Net return (Tk./ha)	Benefit cost ratio
S_1P_0	592880	10.17	10170	8.41	50460	237	948000	1008630	415750	1.70
S_1P_1	598618	10.15	10150	8.31	49860	204	816000	876010	277392	1.46
S_1P_2	601487	10.18	10180	7.45	44700	211	844000	898880	297393	1.49
S_1P_3	604356	11.80	11800	8.17	49020	248	992000	1052820	448464	1.74
S_2P_0	586610	10.31	10310	8.74	52440	185	740000	802750	216140	1.37
S_2P_1	592348	13.19	13190	12.97	77820	304	1216000	1307010	714662	2.21
S_2P_2	595217	18.73	18730	14.16	84960	330	1320000	1423690	828473	2.39
S_2P_3	598086	14.34	14340	12.59	75540	289	1156000	1245880	647794	2.08
S_3P_0	580340	10.26	10260	9.42	56520	144	576000	642780	62440	1.11
S_3P_1	586078	13.87	13870	12.28	73680	285	1140000	1227550	641472	2.09
S_3P_2	588947	17.24	17240	13.52	81120	319	1276000	1374360	785413	2.33
S_3P_3	589308	16.77	16770	12.08	72480	304	1216000	1305250	715942	2.21

S_1: 30 cm × 20 cm
S_2: 30 cm × 25 cm
S_3: 30 cm × 30 cm

P_0: 0 kg P_2O_5/ha
P_1: 100 kg P_2O_5/ha
P_2: 150 kg P_2O_5/ha
P_3: 200 kg P_2O_5/ha

4.19.2 Net return

In case of net return, different treatment combination showed different levels of net return under the present trial (Table 8). The highest net return (Tk. 828,473) was found from the treatment combination S_2P_2 and the second highest net return (Tk. 785,413) was obtained from the combination S_3P_2. The lowest (Tk. 62,440) net return was obtained S_3P_0.

4.19.3 Benefit cost ratio

In the combination of plant spacing and different level of phosphorus highest benefit cost ratio (2.39) was noted from the combination of S_2P_2 and the second highest benefit cost ratio (2.33) was estimated from the combination of S_3P_2. The lowest benefit cost ratio (1.11) was obtained from S_3P_0 (Table 8). From economic point of view, it is apparent from the above results that the combination of S_2P_2 was more better than rest of the combination.

CHAPTER V

SUMMARY AND CONCLUSION

The field experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from October 2010 to May 2011 to find out the effect of spacing and different levels of phosphorus on growth, flower, corm and cormel production of gladiolus. The experiment was considered as two factors. Factor A: Spacing (3 levels) - S_1: 30 cm × 20 cm; S_2: 30 cm × 25 cm; and S_3: 30 cm × 30 cm; Factor B: Phosphorus (4 levels) - P_0: 0 kg P_2O_5/ha (Control); P_1: 100 kg P_2O_5/ha; P_2: 150 kg P_2O_5/ha and P_3: 200 kg P_2O_5/ha. There were total 12 (3 × 4) treatment combinations. The experiment was laid out following Randomized Complete Block Design (RCBD) with three replications.

At 20, 30, 40, 50, 60 and 70 DAP, the longest plant (24.98 cm, 33.51 cm, 47.17 cm, 61.56 cm, 73.92 cm and 81.80 cm) was recorded from S_1 and at the same DAP the shortest plant (19.64 cm, 20.79 cm, 38.84 cm, 52.22 cm, 60.56 cm and 72.75 cm) was observed from S_3, respectively. At 20, 30, 40, 50, 60 and 70 DAP the maximum number of leaves per plant (5.65, 8.27, 15.72, 24.00, 30.85 and 39.30) was recorded from S_1 and at the same DAP the minimum number of leaves per plant (3.93, 6.22, 13.50, 22.53, 27.68 and 30.65) was recorded from S_3. The maximum days required to emergence of spike (86.25) was recorded from S_3, while the minimum days required to emergence of spike (82.50) was observed from S_2. The highest flowering plant (87.95%) was recorded from S_2, while the lowest flowering plant (76.08%) was observed from S_1. The longest flowering stalk (72.10 cm) was recorded from S_2, while the shortest (58.15 cm) was observed from S_1. The longest rachis (36.33 cm) was recorded from S_3, while the shortest rachis (31.52 cm) was observed from S_1. The maximum number of florets per spike (14.98) was recorded from S_2, while the minimum number (11.28) was observed from S_1. The maximum number of spike per hectare (277 thousand) was recorded from S_2, while the minimum number (225 thousand) from S_1. The highest diameter of corm (2.71 cm) was recorded from S_3, while the lowest (1.87 cm) was found from S_1. The highest weight of corm (27.54 g) was recorded from S_3, while the lowest weight (17.19 g) was observed from S_1. The highest diameter of individual cormel (1.43 cm) was recorded from S_3, while the lowest diameter (1.18 cm) was observed from S_1. The highest yield of corm per hectare (14.91 ton) was recorded from S_3, while the lowest yield (10.57 ton) was observed from S_1. The highest yield of cormel per hectare (12.12 ton) was observed from S_2, while the lowest yield (8.08 ton) was found from S_1.

At 20, 30, 40, 50, 60 and 70 DAP the maximum number of leaves per plant (5.31, 8.09, 15.87, 22.27, 31.60 and 40.80 cm) was found from P_2 and the minimum number of leaves per plant (4.40, 6.49, 12.49, 24.00, 24.62 and 28.40) was obtained from P_0. At 20, 30, 40, 50, 60 and 70 DAP the longest plant (25.29 cm, 34.97 cm, 47.53 cm, 61.72 cm, 74.30 cm and 83.40 cm) was recorded from P_2 again, the shortest plant (18.49 cm, 26.47 cm, 38.40 cm, 50.83 cm, 56.68 cm and 65.34 cm) was found from P_0. The maximum days required to emergence of spike (87.44) was observed from P_0 again, the minimum number of days required to emergence of spike (81.67) was recorded from P_2. The highest flowering plant (92.65%) was recorded from P_2 again, the lowest flowering plant (65.11%) was found from P_0. The longest flowering stalk (70.10 cm) was recorded from P_3, whereas the shortest flowering stalk (55.37 cm) was attained from P_0. The longest rachis (36.29 cm) was recorded from P_3, whereas the shortest rachis (31.33 cm) was found from P_0. The maximum number of florets per spike (14.53) was recorded from P_3, whereas the minimum number of florets per spike (11.93) was found from P_0. The maximum number of spike per hectare (286 thousand) was recorded from P_2, while the minimum number (189 thousand) from P_0. The highest diameter of corm (2.57 cm) was recorded from P_2, whereas the lowest diameter (2.08 cm) was found from P_0. The highest weight of corm (27.51 g) was recorded from P_2, whereas the lowest weight (19.70 g) was found from P_0. The highest diameter of individual cormel (1.44 cm) was recorded from P_2, whereas the lowest diameter (1.21 cm) was found from P_0. The highest yield of corm per hectare (15.38 ton) was recorded from P_2, whereas the lowest yield (10.25 ton) was found from P_0. The highest yield of cormel per hectare (11.71 ton) was recorded from P_2, whereas the lowest yield (8.86 ton) was found from P_0.

At 20, 30, 40, 50, 60 and 70 DAP the longest plant (29.42 cm, 38.81 cm, 53.26 cm, 67.80 cm, 86.57 cm and 90.34 cm) was recorded from S_1P_2 and the shortest plant (17.91 cm, 26.41 cm, 37.68 cm, 50.97 cm, 54.72 cm and 65.06 cm) was recorded from S_3P_0. The maximum number of leaves per plant (6.47, 9.40, 17.53, 24.40, 34.40 and 48.40) was observed from S_1P_2 and the minimum number of leaves per plant (3.27, 5.73, 11.93, 20.60, 23.93 and 25.87) was found from S_2P_0. The maximum number of days required to emergence of spike (96.00) was recorded from S_1P_0, whereas the minimum days required to emergence of spike (70.00) was recorded from S_1P_2. The highest flowering plant (99.27%) was recorded from S_2P_2, whereas the lowest flowering plant (62.20%) was recorded from S_1P_0. The longest flower stalk at harvest

(78.40 cm) was recorded from S_2P_2, whereas the shortest (52.00 cm) was found from S_3P_0. The longest length of rachis at harvest (40.10 cm) was recorded from S_3P_2, whereas the shortest length of rachis at harvest (28.00 cm) was recorded from S_2P_1. The maximum number of florets per spike (16.93) was recorded from S_2P_2, whereas the minimum (10.32) was recorded from S_1P_2. The maximum number of spike per hectare (330 thousand) was recorded from S_2P_2, while the minimum number (144 thousand) from S_3P_0. The highest diameter of individual corm (3.22 cm) was recorded from S_3P_2 whereas the lowest diameter (1.70 cm) was recorded from S_1P_3. The highest weight of individual corm (33.80 g) was recorded from S_3P_2, whereas the lowest weight (13.92 g) was recorded from S_1P_1. The highest diameter of individual cormel (1.59 cm) was recorded from S_3P_2, whereas the lowest diameter (1.09 cm) was recorded from S_1P_1. The highest yield of corm per hectare (18.73 ton) was recorded from S_3P_2, whereas the lowest yield (10.15 ton) was recorded from S_1P_0. The highest yield of cormel per hectare (14.16 ton) was observed from S_2P_2, whereas the lowest yield (7.45 ton) was recorded from S_1P_0.

The highest gross return (Tk. 1,423,690) was obtained from the treatment combination S_2P_2 and the lowest gross return (Tk. 642,780) was obtained from S_3P_0. The highest net return (Tk. 828,473) was found from the treatment combination S_2P_2 and the lowest (Tk. 62,440) net return was obtained S_3P_0. In the combination of plant spacing and different level of phosphorus highest benefit cost ratio (2.39) was noted from the combination of S_2P_2 and the lowest benefit cost ratio (1.11) was obtained from S_3P_0.

It is apparent from the above findings that the combination of S_2P_2 was more profitable than rest of the combination.

Conclusion:

From the results of present study it may be concluded that-

1. Other combinations of spacing may be used in future trial.

2. Further studies at different agro-ecological zone of Bangladesh are needed for final conclusion.

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