EFFECT OF SPACING AND POTASSIUM ON GROWTH AND FLOWERING OF GLADIOLUS

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This is to certify that the thesis entitled ***"Effect of Spacing and Potassium on Growth and Flowering of Gladiolus"*** *submitted to the Department of Horticulture and Postharvest Technology, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE in HORTICULTURE****, embodies the result of a piece of bona fide research work carried out by* ***Fahmida Islam****, Registration No.* ***031169*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

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TO

MY BELOVED PARENTS

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ABSTRACT

The study was conducted at the Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from November, 2007 to June, 2008. The experiment consisted with two factors. Factor A: Three levels of spacing: S_1: 15 × 10; S_2: 20 × 10 and S_3: 25 × 10 cm^2 and Factor B: Five levels of potassium: K_0: 0 kg (Control); K_1: 90 kg; K_2: 120 kg; K_3: 150 kg and K_4: 180 kg K_2O/ha, respectively. The experiment was laid out with Randomized Complete Block Design with three replications. In case of spacing the highest flowering plant (91.07%), thousand number of spike (761.48), number of cormel per plant (23.47), highest yield of corm (17.08 t/ha) and yield of cormel (13.83 t/ha) were recorded from S_2 while all the above parameters were lowest at S_1. In case of potassium, the highest flowering plant (94.00%), thousand number of spike (790.12), number of cormel per plant (23.43), highest yield of corm (16.23 t/ha) and yield of cormel (13.09 t/ha) were recorded from K_3 and lowest from K_0. For interaction effect the highest flowering plant (96.67%), thousand number of spike (844.44), number of cormel per plant (25.60), highest yield of corm (18.66 t/ha) and yield of cormel (14.92 t/ha) were recorded from S_1K_3 and the lowest from S_1K_0. The highest benefit cost ratio (2.43) was obtained from S_2K_3 and the lowest (1.31) from S_1K_0. So, 20 cm ×10 cm spacing with 150 kg K_2O/ha were best for growth and flowering of gladiolus.

LIST OF ABBREVIATED TERMS

FULL NAME	ABBREVIATION
Agro-Ecological Zone	AEZ
and others	*et al.*
Bangladesh Bureau of Statistics	BBS
Centimeter	cm
Degree Celsius	°C
Date After Seeding	DAS
Etcetera	etc
Food and Agriculture Organization	FAO
Gram	g
Hectare	ha
Hour	hr
Kilogram	kg
Meter	m
Millimeter	mm
Month	Mo
Muriate of Potash	MP
Number	no.
Percent	%
Randomized Complete Block Design	RCBD
Square meter	m^2
Triple Super Phosphate	TSP
United Nations Development Program	UNDP

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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 and occupying fourth place in international cut flower trade (Bose and Yadav, 1989). It is also known as the Sword Lily, due to its sword shaped leaves. Gladiolus seems to be originated in South Africa and its development started only at the beginning of the 18^{th} century.

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.

Spacing and fertilizer management influence the production and quality of gladiolus flower as well as its corm and cormels (Khanna and Gill, 1983). Reports indicated that growth and flowering in gladiolus are affected by various factors of which spacing and fertilizer management is one of the main factors (Mohanty, 1994). Optimum plant spacing ensures judicious use of natural resources and makes the intercultural operations easier and 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.

Plant spacing is an important aspect of crop production for maximizing the yield. It helps 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).

Gladiolus responds greatly to major essential elements like N, P and K in respect of its growth and yield (Mital *et al.*, 1975; Singh *et al.*, 1976; Thompson and Kelly, 1988). Fertilizer plays a vital role in proper growth and development of Gladiolus. Fertilizer application in appropriate time, appropriate dose and proper method is the prerequisite for its cultivation (Islam, 2003). Potassium is also one of the important essential macro elements for growth and development of plant. Gladiolus requires about 3 to 4 percent potassium in the leaves on a dry weight basis for the best yield and quality. Potassium deficiency results in shortening of spike length, reduction in the number of florets, general yellowing of older leaves and yellowing between the veins of younger leaves (Woltz, 1972).

The potassium requirements vary depending upon the nutrient content of the soil (Bose and Som, 1986). It is also essential for cell organization, hydration and cell permeability.

It is an essential element of chloroplast. It helps photosynthesis by maintaining iron supply and increases the body substrates. Potassium improves root system of plant, so that the roots can absorb the minerals and irons from soil solution efficiently, resulting with higher yield. Potassium progressively increases the yield (Obreza and Vavrina, 1993) but an adequate supply is essential for vegetative growth, and desirable yield (Yoshizawa and Roan, 1981). Excessive application is not only uneconomical but also induces physiological disorder.

There is a scope of increasing flower yield, quality of flower, corm and cormel production of gladiolus with the appropriate spacing and optimum doses of potassium fertilizer. An optimum dose of application of nutrient elements will not only ensure better yield and quality of gladiolus but also led to minimum wastage of the applied nutrients. Considering the present situations and above facts the present investigation was undertaken with the following objectives-

i. to study the growth, flowering, flower yield and also corm and cormel production of gladiolus for different spacing ,
ii. to find out the optimum level of potassium for the production of gladiolus ,
iii. to determine the growth and flowering performance of gladiolus under different combination of spacing and potassium and
iv. to determine the optimum combination of spacing and potassium in consideration of benefit cost ratio.

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 potassium on growth, flower, corm and cormel production of gladiolus reviewed under the following headings-

2.1 Effect of spacing on growth and yield of gladiolus

Yadav and Tyagi (2007) carried out a study in the experimental field of 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 corm size and spacing, whereas the planting of small corms advanced the sprouting of corms.

A study was carried out by Pranav *et al.* (2005) 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 greatest 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).

A study was conducted by Shalini *et al.* (2004) 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, 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 were determined in a field experiment conducted 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.

The effects of planting date spacing (30 × 15, 45 × 20, 60 × 25 cm) and depth (2.5 and 5 cm) on the corm and corm yield of gladiolus cv. Sylvia were determined in a field experiment conducted in Jorhat, Assam, India by Sanjib and Talukdar (2003). 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.

An experiment was conducted by Bijimol and Singh (2001) 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 00 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 treatment combination of closet spacing (20 × 10 cm).

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

Mollah *et al.* (1995) studied the effect of cormel size and spacing on growth and flower and corm of gladiolus in Bangladesh. They reported that the widest spacing (15 cm x 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 gladioulus cv. Victor Borge in Italy. Gladiolus cormels (<2 or 2.0-2.5 cm circumference) were planted at the densities of 400, 600 or 800 per square meter. It was reported that corms for cut flower production and propagating mater. I 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 materied.

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

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

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

Borrelli (1984) 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 distance on the production of gladiolus corm. They planted 100, 150 or 200 corms per square meter and found that optimum size corms could be obtained from the highest planting density. They also observed that cormel production was not affected by planting density.

Grabowska (1980) 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) investigated 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, 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 potassium on growth and yield of gladiolus

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 N/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 of nitrogen i.e. 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 of nitrogen up to 40 g/m^2 delayed flowering. Higher doses of nitrogen (40 g/m^2) 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%).

The experiment was carried out by Rajiv and Misra (2003) to study the effects of nitrogen (0, 20, 40, 60, or 80 g/m^2), phosphorus (0, 5, 10, or 20 g/m^2) and potassium (0, 15, 20, or 25 g/m^2) on growth, flowering, and yield in Gladiolus cv. Jester Gold in New Delhi, India, during 2000-01 and 2001-02. Application of 60 g N/m^2 resulted in maximum leaves per shoot (6.0), leaf area per plant (330.83 cm^2), 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). N at 20 g/m^2 resulted in earliest 50% heading (95.6 days) and first floret showing colour (114.3 days), while 40 g N/m^2 resulted in earliest 50% sprouting (7.9 days). Higher dose of nitrogen (80 g/m^2) resulted in maximum corms per plant (1.8), corm size (5.3 cm), corm weight (44.8 g), cormel weight (5.0 g), cormels per plant (19.3), and propagation coefficient (315.2%).

Pimpini and Zanin (2002) in 1994-95 was grown Gladiolus hybridus in 4 soil types (sandy loam, clay, sand and peaty 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.

A field experiment was conducted by Mallick *et al.* (2001) in Orissa, India from December 1997 to May 1998 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).

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 (10, 20 and 30 g/m^2), in a field experiment in West Bengal, India, during 1990-93. Potassium at 20 g/m^2 resulted in 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.

A field experiment was conducted by Anil *et al.* (2000) in Haryana, India, to determine the effects of N at 0, 40, 60 and 80 g/m^2 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.

An trial was carried out by Barma *et al.* (1998) 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 greatest (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 greatest (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, the effect of spike removal and K application corm yield in 10 gladiolus cultivars was examined. 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.

A 3 year field study was undertaken to investigate 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 by Jhon *et al.* (1997). 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 20 g K/m^2.

Corms of uniform size (4-4.5 cm in diameter) were planted 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 by Chattopadhyay *et al.* (1992). Three rates of N (40, 50 and 60 g/m^2) and 3 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 being applied before planting and the remaining N 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 greatest with $N_{50}K_{20}$; this treatment also resulted in longest spikes and most flowers/spike. Plants in treatments $N_{60}K_{20}$ 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 $N_{60}K_{20}$ and largest with $N_{50}K_{20}$.

Gowda *et al.* (1988) carried out in studies with this cv. grown for cut flowers, the plants received N and P, each at 20, 30 or 40 g/m2; K at 20 g/m^2 was applied as a basal dressing. A high number of spikes/plant, a large florets diameter (9 cm), the highest number of florets/plant (14.6) and the greatest spike length (89.7 cm) were obtained with the highest N and K rates.

Singh *et al.* (1976) reported that flower yield of tuberose depends upon the dose of nitrogen, phosphorus and potash. They recommended a dose of 80 kg nitrogen, 60 kg phosphorus and 40 kg potash per hectare, respectively under Uttar Pradesh. India conditions to have a optimum flower yield. According to them potash increased the yield of fresh flowers through increasing the number of spike. Number and weight of flower per hill and also the weight of flowers per spike.

Woltz (1973) reported that gladiolus required about 3 to 4 per cent potassium in the leaves on a dry (weight Basis for the best yield and quality of flowers. Potassium deficiency results in shortening of spike length, reduction in the number of florets, general yellowing of elder leaves and yellowing between the veins of younger leaves. In case of severe deficiency the older leaves show marginal leaf burn.

Skalska (1970) also reported that significant increase in weight of corms and cormels of gladiolus when split application of K was applied. Pandey and Jaukari (1970) reported that the application of 90 kg K resulted in the highest yield of corm and improved its quality.

Trials in North Carolina on a sandy loam soil showed increase in corm yields and length of spikes of gladiolus following side dressings of potassium but no response of N. Mn or Fe fertilizers was recorded. Application of 55 kg available K/ha was recommended when the plants began to send up flower spikes (Jenkins, 1961).

Higher levels of potassium were effective to production greater number of flowers and large flower size in gladiolus (Lemeni and Lemeni, 1965). Kosugi and Kondo (1961) reported improvement in flowering of gladiolus by using high dose of potassium.

El-Gamassy (1958) conducted an experiment to study the relative effect of various fertilizer elements on growth, flowering, corm and cormels production of gladiolus. It found that application of potassium before flowering resulted better yield of best quality flowers and corms.

CHAPTER III

MATERIALS AND METHODS

The field experiment was conducted during the period from November 2007 to June 2008 to find out the effect of spacing and potassium 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 Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh. The location of the experimental site is situated in $23^{0}74^{\prime}$N latitude and $90^{0}35^{\prime}$E longitude (Anon., 1989).

3.2 Characteristics of soil

The experimental soil belongs to the Modhupur Tract (UNDP, 1988) under AEZ No. 28. The selected experimental plot was medium high land and the soil series was Tejgaon (FAO, 1988). The characteristics of the soil under the experimental plot were analyzed in the SRDI, Soil testing Laboratory, 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 monsoon or the winter season from November to February and the pre-monsoon period or hot season from March to April and the monsoon period from May to October (Edris *et al.*, 1979). Meteorological data related to the temperature, relative humidity, rainfalls and sunshine during the period of the experiment was collected from the Bangladesh Meteorological Department, Sher-e-Bangla Nagar, Dhaka and presented in Appendix II.

3.4 Planting materials

Cormels of gladiolus 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 potassium on growth, flower, corm and cormel production of gladiolus. The experiment considered as two factors.

Factor A: Spacing (Three levels)

i. S_1: 15 cm × 10 cm
ii. S_2: 20 cm × 10 cm
iii. S_3: 25 cm × 10 cm

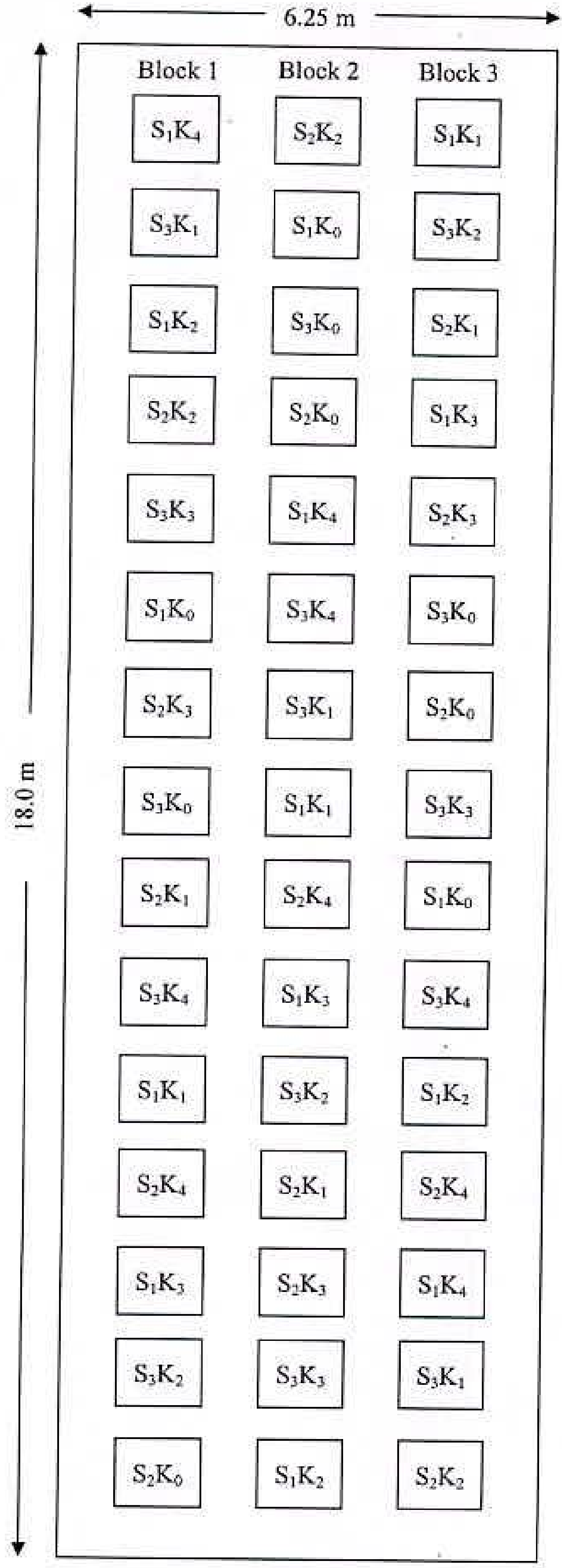
Factor B: Potassium (Five levels)

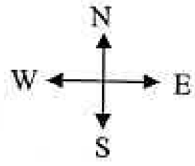
i. K_0: 0 kg K_2O/ha (Control)
ii. K_1: 90 kg K_2O/ha
iii. K_2: 120 kg K_2O/ha
iv. K_3: 150 kg K_2O/ha
v. K_4: 180 kg K_2O/ha

There were on the whole 15 (3 × 5) treatment combinations such as S_1K_0, S_1K_1, S_1K_2, S_1K_3, S_1K_4, S_2K_0, S_2K_1, S_2K_2, S_2K_3, S_2K_4, S_3K_0, S_3K_1, S_3K_2, S_3K_3 and S_3K_4.

3.6 Experimental design and layout

The experiment was laid out following Randomized Complete Block Design (RCBD) with three replications. An area of 18.0 m × 6.25 m was divided into three equal blocks. Each block was divided into 15 plots where 15 treatment combinations were allotted at random. There were 45 unit plots altogether in the experiment. The size of the each unit plot was 0.75 m × 0.60 m. The cormels were sown with maintaining distance according to the spacing treatment. The layout of the experiment is shown in Figure 1.





Plot size = 0.75 m × 0.60 m

Plot spacing = 0.5 m

Between replication= 0.75 m

Factor A:

S_1: 15 cm × 10 cm

S_2: 20 cm × 10 cm

S_3: 25 cm × 10 cm

Factor B:

K_0: 0 kg K_2O/ha

K_1: 90 kg K_2O/ha

K_2: 120 kg K_2O/ha

K_3: 150 kg K_2O/ha

K_4: 180 kg K_2O/ha

Figure 1. Layout of the experimental field

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. MP was applied according to the level of treatment. Urea was applied in three equal installments at 15, 30 and 45 days after planting cormels. Well-rotten cowdung also applied during final land preparation. The following amount of manures and fertilizers were used which shown as tabular form recommended by BARI, 2002.

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

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

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 was 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 evening. Further irrigation was done and 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 when needed.

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 nitrogen fertilizer.

3.9 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.

3.10 Data collection

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

3.10.1 Plant height

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

3.10.2 Number of leaves per plant

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

3.10.3 Days required for 50% emergence of spike

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

3.10.4 Days required for 80% emergence of spike

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

3.10.5 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.

3.10.6 Length of flower stock at harvest

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

3.10.7 Length of rachis at harvest

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

3.10.8 Number of spikelet per spike

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

3.10.9 Number of spike/ha ('000)

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

3.10.10 Individual corm thickness

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

3.10.11 Individual corm weight

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

3.10.12 Individual corm diameter

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

3.10.13 Number of cormel per plant

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

3.10.14 Weight of cormel

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

3.10.15 Diameter of cormel

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

3.10.16 Corm yield per hectare

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

3.10.17 Cormel yield per hectare

Total cormel yield per plot was recorded by adding the total harvested corm in a plot and expressed in kilogram and 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 different levels of potassium on flowering, corm and cormel production of gladiolus. The mean values of all the recorded characters were calculated and analysis of variance was performing by the 'F' (variance ratio) test. The significance of the difference among the individual and treatment combinations means was estimated by the Duncan's Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

3.12 Economic analysis

The cost of production was analyzed in order to find out the most economic treatment of spacing and potassium. 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 experiment was carried out to determine the effect of plant spacing and level of potassium 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-V. The results have been presented and discussed, and possible interpretations are given under the following headings:

4.1 Plant height

Plant height showed statistically significant variation due to different plant spacings at 30, 45, 60 and 75 DAP (Appendix III) in gladiolus. At the different days after planting (DAP) the highest plant height (39.25 cm, 57.07 cm, 64.74 cm and 73.98 cm) was recorded from S_1 (15 cm × 10 cm) which was statistically similar (37.56 cm, 55.59 cm, 62.51 cm and 68.78 cm) with S_2 (20 cm × 10 cm) at 30, 45, 60 and 75 DAP, respectively. On the other hand, at the same DAP the lowest plant height (35.50 cm, 54.48 cm, 59.80 cm and 66.89 cm) was observed from S_3 (25 cm × 10 cm), 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 closer spacing helps to elongation of plant than the wider spacing. Mollah *et al.* (1995) reported that the widest spacing (15 cm x 15 cm) produced the maximum plant height (56.60 cm).

Plant height of gladiolus differed significantly due to the application of different levels of potassium at days after planting of 30, 45, 60 and 75 (Appendix III). At 30, 45, 60 and 75 DAP the highest plant height (42.22 cm, 60.55 cm 67.32 cm and 75.24 cm) was recorded from K_3 (150 kg K_2O/ha) which was statistically identical (40.58, 58.56 cm, 65.71 cm

Plate-1: Experimental field of Gladiolus to evaluate the effect of spacing and potassium on growth and flowering of gladiolus

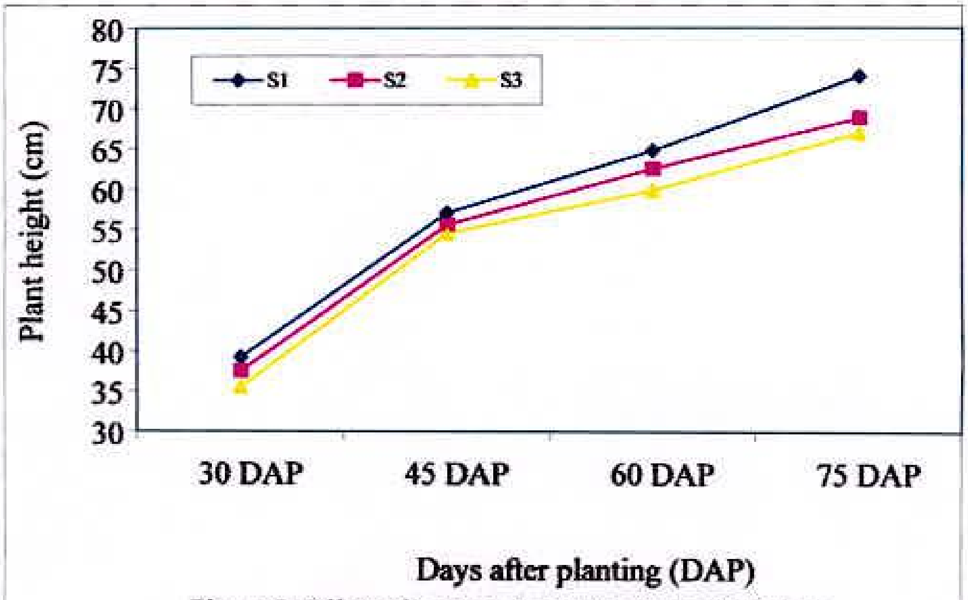


Figure 2. Effect of spacing on plant height of gladiolus

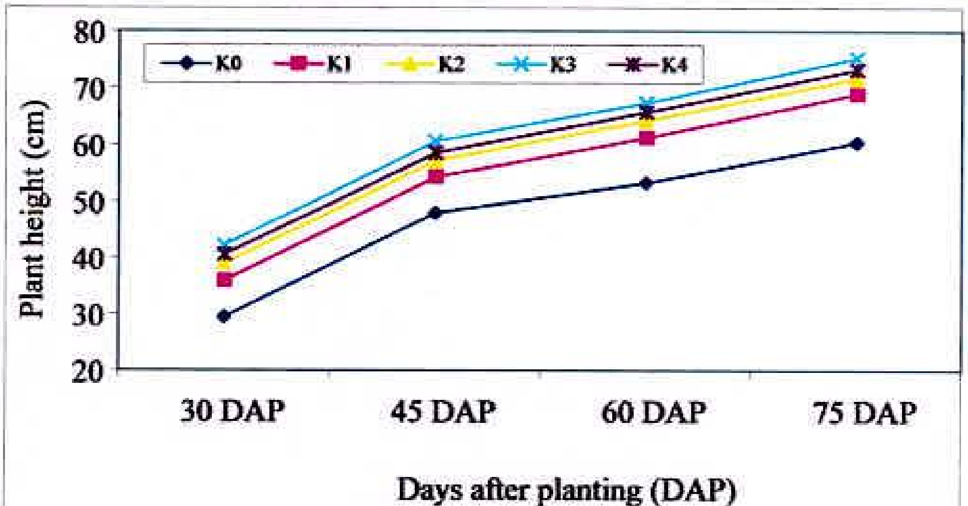


Figure 3. Effect of potassium on plant height of gladiolus

and 73.19 cm) to K_4 (180 kg K_2O/ha), respectively. Again, the lowest (29.47 cm, 48.00 cm, 53.31 cm and 60.41 cm) was found from K_0 as 0 kg K_2O/ha which was closely followed (35.98 cm, 54.31 cm, 61.24 cm and 68.95 cm) by K_1 (90 kg K_2O/ha) for same DAP, respectively (Figure 3). It was revealed that with the increase of potassium plant height increase upto a certain level than decreases. Potassium fertilizer ensures favorable condition for the growth of gladiolus with optimum vegetative growth and the ultimate results was the tallest plant. Anil *et al.* (2000) reported tallest plants from K at 20 g/m^2.

Statistically significant variation was recorded due to interaction effect of spacing and different levels of potassium in terms of plant height of gladiolus at 30, 45, 60 and 75 DAP (Appendix III). The highest plant height (43.78 cm, 61.01 cm and 69.25 cm) was recorded from S_2K_3 (20 cm × 10 cm plant spacing + 150 kg K_2O/ha) at 30, 45 and 60 DAP, respectively where as (77.09 cm) was recorded from S_1K_3 (15 cm × 10 cm plant spacing + 150 kg K_2O/ha) at 75 DAP. On the other hand, the lowest plant height (24.06 cm, 42.30 cm, 48.11 cm and 55.31 cm) was recorded from S_3K_0 (25 cm × 10 cm plant spacing + 0 kg K_2O/ha) at 30, 45, 60 and 75 DAP, respectively (Table 2). It was revealed that optimum spacing and potassium ensures highest plant height.

4.2 Number of leaves per plant

Number of leaves per plant of gladiolus varied significantly due to different plant spacings at 30, 45, 60 and 75 DAP (Appendix III). At the different days after planting (DAP) the maximum number of leaves per plant (3.13, 6.39, 9.63 and 11.81) was found from S_2 (20 cm × 10 cm) which was closely followed (2.96, 5.49, 8.85 and 10.99) by S_3 (25 cm × 10 cm) at 30, 45, 60 and 75 DAP, respectively. Again, at the same DAP the minimum number of leaves per plant (2.63, 4.79, 7.55 and 9.27) was recorded from S_1 (15 cm × 10 cm), respectively (Figure 4). It is revealed that 20 cm × 10 cm plant spacing ensures maximum

Table 2. Interaction effect of spacing and potassium on plant height and number of leaves per plant of gladiolus

Treatment	Plant height (cm) at				Number of leaves per plant at			
	30 DAP	45 DAP	60 DAP	75 DAP	30 DAP	45 DAP	60 DAP	75 DAP
S_1K_0	36.76 bc	53.01 e	61.94 bc	70.06 bcd	2.47 gh	4.47 hi	7.20 f	8.67 g
S_1K_1	36.54 bc	55.35 cde	62.50 bc	71.86 abcd	2.47 gh	4.60 ghi	7.27 ef	8.93 fg
S_1K_2	39.49 abc	58.14 abc	65.10 ab	74.65 ab	2.60 fg	4.87 gh	7.53 ef	9.40 efg
S_1K_3	41.99 ab	60.08 ab	67.28 ab	77.09 a	2.80 efg	5.07 fg	7.87 ef	9.73 e
S_1K_4	41.47 ab	58.77 abc	66.89 ab	76.22 a	2.80 efg	4.93 gh	7.87 ef	9.60 ef
S_2K_0	27.58 d	48.68 f	49.87 d	55.85 e	2.43 gh	5.73 de	8.00 e	9.93 e
S_2K_1	36.48 bc	53.70 de	62.18 bc	68.49 cd	3.03 cde	6.20 cd	9.60 bc	11.70 c
S_2K_2	38.47 abc	55.85 bcde	64.12 abc	70.30 bcd	3.17 bcd	6.40 bc	9.87 abc	12.10 bc
S_2K_3	43.78 a	61.01 a	69.25 a	75.87 a	3.57 a	6.87 a	10.47 a	12.83 a
S_2K_4	41.51 ab	58.74 abc	67.12 ab	73.39 abc	3.43 ab	6.73 ab	10.20 ab	12.50 ab
S_3K_0	24.06 d	42.30 g	48.11 d	55.31 e	2.13 h	4.33 i	7.40 ef	9.40 efg
S_3K_1	34.93 c	53.86 de	59.02 c	66.50 d	2.93 def	5.47 ef	8.80 d	10.93 d
S_3K_2	38.85 abc	57.51 abcd	63.30 abc	69.94 bcd	3.20 bcd	5.80 de	9.27 cd	11.40 cd
S_3K_3	40.89 ab	60.57 a	65.45 ab	72.75 abc	3.33 abc	6.07 cd	9.53 bc	11.73 c
S_3K_4	38.75 abc	58.18 abc	63.13 bc	69.97 bcd	3.20 bcd	5.80 de	9.27 cd	11.47 cd
$LSD_{(0.05)}$	4.90	3.82	5.18	4.84	0.32	0.43	0.66	0.69
Level of significance	0.05	0.01	0.01	0.05	0.01	0.05	0.05	0.05
CV(%)	7.84	9.11	5.97	8.14	6.68	5.71	10.59	8.89

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

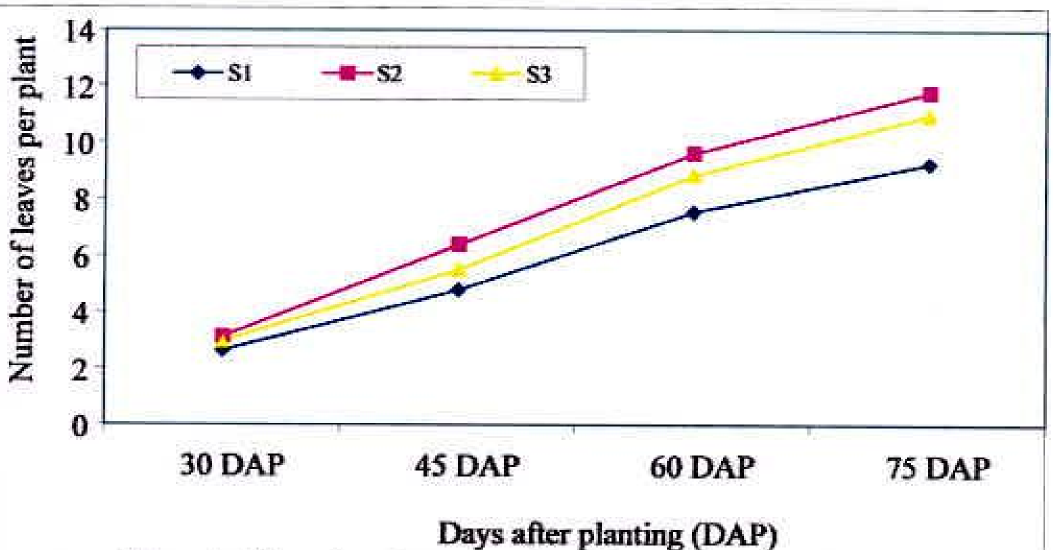


Figure 4. Effect of spacing on number of leaves per plant of gladiolus

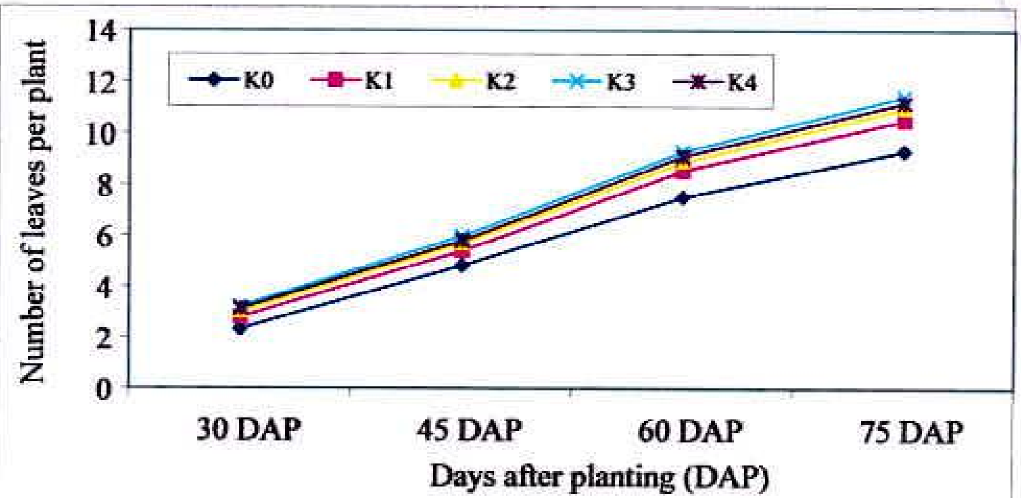


Figure 5. Effect of potassium on number of leaves per plant of gladiolus

number of leaves per plant. In case of closer spacing plant compete for light than closer spacing helps to elongation of plant with minimum number of leaves per plant than the wider spacing.

Number of leaves per plant of gladiolus differed significantly due to the application of different levels of potassium at 30, 45, 60 and 75 DAP (Appendix III). At the same days after planting (DAP) the maximum number of leaves per plant (3.23, 6.00, 9.29 and 11.43) was obtained from K_3 (150 kg K_2O/ha) which was statistically similar (3.14, 5.82, 9.11 and 11.19) with K_4 (180 kg K_2O/ha), respectively. On the other hand the lowest (2.34, 4.84, 7.53 and 9.33) was found from K_0 as 0 kg K_2O/ha which was closely followed (2.81, 5.42, 8.56 and 10.52) by K_1 (90 kg K_2O/ha) for the same DAP, respectively (Figure 5). It was revealed that with the increase of potassium number of leaves per plant increase upto a certain level than decreases. Potassium fertilizer ensures favorable condition for the growth of gladiolus with optimum vegetative growth and the ultimate results was the maximum number of leaves per plant.

Interaction effect of spacing and levels of potassium showed statistically significant variation for number of leaves per plant of gladiolus at 30, 45, 60 and 75 DAP (Appendix III). The highest number of leaves per plant (3.57, 6.87, 10.47 and 12.83) was found from S_2K_3 (20 cm × 10 cm plant spacing + 150 kg K_2O/ha) at 30, 45, 60 and 75 DAP, respectively. Again, the lowest number of leaves per plant (2.13 and 4.33) was observed from S_3K_0 (25 cm × 10 cm plant spacing + 0 kg K_2O/ha) at 30 and 45 DAP, respectively and at 60 and 75 DAP the lowest number of leaves per plant (7.20 and 8.67) was recorded from S_1K_0 (Table 2). It was revealed that optimum spacing and potassium ensures highest number of leaves per plant and in any deviation it showed the lowest value.

4.3 Days required to 50% emergence of spike

Days required for 50% emergence of spike of gladiolus varied significantly due to different plant spacings (Appendix IV). The maximum days required for 50% emergence of spike (81.47) were recorded from S_3 (25 cm × 10 cm) which was statistically identical (79.73) with S_1 (15 cm × 10 cm) and the minimum days required for 50% emergence of spike (76.67) was observed from S_2 (20 cm × 10 cm) plant spacing (Table 3). It was revealed that S_2 (20 cm × 10 cm) plant spacing produced 50% spike with minimum days. In case of closer and wider spacing plant spent extended time for vegetative growth for that reproductive growth would be delayed and the ultimate results would be maximum days for 50% spike emergence.

Significant variation was recorded for days required for 50% emergence of spike of gladiolus due to the application of different levels of potassium (Appendix IV). The maximum days required for 80% emergence of spike (94.00) was obtained from K_0 (0 kg K_2O/ha) which was statistically similar (92.78 and 91.67) with K_1 (90 kg K_2O/ha) and K_2 (120 kg K_2O/ha). On the other hand, the minimum (89.00) was found from K_3 (150 kg K_2O/ha) which was statistically identical (90.22) with K_4 as 180 kg K_2O/ha (Table 3). It was revealed that with the increase of potassium days required for 50% emergence of spike decreases upto a certain level then increases with the increase of potassium level. Potassium fertilizer ensures favorable condition for the growth of gladiolus with optimum vegetative growth then reproductive growth and the ultimate results was the minimum days required for 80% emergence of spike at the optimum level.

Statistically significant variation for days required for 50% emergence of spike was recorded for the interaction effect of spacing and levels of potassium showed (Appendix IV). The maximum days required for 50% emergence of spike (85.00) was observed from

Table 3. Effect of spacing and different level of potassium on different growth parameter and spike yield of gladiolus

Treatment	Days required to 50% emergence of spike	Flowering plant (%)	Length of flower stalk at harvest (cm)	Length of rachis at harvest (cm)	Number of spikelets per spike	Yield of spike per hectare (number)
Spacing						
S_1	79.73 a	88.07 b	59.29 b	31.40 b	12.97 c	656.30 b
S_2	76.67 b	91.07 a	66.50 a	35.30 a	15.02 a	761.48 a
S_3	81.47 a	90.20 a	66.90 a	35.49 a	14.25 b	745.19 a
$LSD_{(0.05)}$	2.18	1.92	2.09	1.11	0.56	22.90
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01
Level of potassium						
K_0	82.78 a	81.89 d	54.99 d	29.00 d	11.94 c	607.41 d
K_1	80.44 ab	88.56 c	63.46 c	33.64 c	13.63 b	686.42 c
K_2	79.22 bc	91.33 b	66.05 bc	35.14 b	14.59 a	733.33 b
K_3	76.33 c	94.00 a	68.94 a	36.66 a	15.21 a	790.12 a
K_4	77.67 bc	93.11 ab	67.71 ab	35.87 ab	15.04 a	787.65 a
$LSD_{(0.05)}$	2.82	2.47	2.70	1.43	0.72	29.57
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01
CV(%)	13.69	12.86	9.36	6.36	5.32	8.25

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

Table 4. Interaction effect of spacing and different level of potassium on different growth parameter and spike yield of gladiolus

Treatment	Days required to 50% emergence of spike	Flowering plant (%)	Length of flower stalk at harvest (cm)	Length of rachis at harvest (cm)	Number of spikelets per spike	Yield of spike per hectare (number)
S_1K_0	85.00 a	85.33 gh	54.85 fg	28.71 i	12.16 fg	577.78 g
S_1K_1	82.00 abc	85.67 fgh	57.36 efg	30.36 ghi	12.23 fg	614.81 fg
S_1K_2	79.33 bcd	88.67 efg	59.74 def	31.96 fgh	13.10 def	666.67 ef
S_1K_3	75.33 de	90.00 defg	62.59 cd	33.19 def	13.70 de	711.11 de
S_1K_4	77.00 cde	90.67 bcde	61.91 cde	32.78 efg	13.67 de	711.11 de
S_2K_0	79.67 abcd	81.33 hi	54.07 g	28.71 i	12.43 efg	666.67 ef
S_2K_1	78.33 bcde	90.33 cdef	66.28 bc	34.97 cde	14.48 cd	711.11 de
S_2K_2	76.67 cde	92.00 abcde	68.31 ab	36.16 bc	15.32 abc	755.56 cd
S_2K_3	73.67 e	96.67 a	73.08 a	38.97 a	16.63 a	844.44 a
S_2K_4	75.00 de	95.00 abc	70.76 ab	37.67 abc	16.25 ab	829.63 ab
S_3K_0	83.67 ab	79.00 i	56.05 fg	29.59 hi	11.23 g	577.78 g
S_3K_1	81.00 abc	89.67 defg	66.72 bc	35.58 bcd	14.17 cd	733.33 cd
S_3K_2	81.67 abc	93.33 abcde	70.10 ab	37.31 abc	15.37 abc	777.78 bc
S_3K_3	80.00 abcd	95.33 ab	71.16 ab	37.81 ab	15.30 abc	814.81 ab
S_3K_4	81.00 abc	93.67 abcd	70.45 ab	37.16 abc	15.19 bc	822.22 ab
$LSD_{(0.05)}$	4.88	4.29	4.68	2.48	1.25	51.21
Level of significance	0.05	0.01	0.05	0.05	0.05	0.05
CV(%)	13.69	12.86	9.36	6.36	5.32	8.25

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

S_1K_0 (15 cm × 10 cm plant spacing + 0 kg K_2O/ha) and the minimum days required for 50% emergence of spike (73.67) was recorded from S_2K_3 (20 cm × 10 cm plant spacing + 150 kg K_2O/ha) (Table 4). It was revealed that optimum spacing and potassium ensures early flowering.

4.4 Days required to 80% emergence of spike

Statistically significant variation was recorded for days required for 80% emergence of spike due to different plant spacings (Appendix IV). The maximum days required for 80% emergence of spike (93.13) were recorded from S_3 (25 cm × 10 cm) which was statistically identical (91.87) with S_1 (15 cm × 10 cm). Again, the minimum days required for 80% emergence of spike (89.60) was found from S_2 as 20 cm × 10 cm plant spacing (Table 3). It was revealed that 20 cm × 10 cm plant spacing produced 80% spike with minimum days. In case of closer and wider spacing plant spent extended time for vegetative growth for that reproductive growth would be delayed and the ultimate results would be maximum days for 80% spike emergence. Grabowska (1980) reported that high planting density delayed flowering

Different levels of potassium showed significant differences for days required for 80% emergence of spike of gladiolus (Appendix IV). The maximum days required for 80% emergence of spike (82.78) was found from K_0 (0 kg K_2O/ha) which was statistically similar (80.44) with K_1 (90 kg K_2O/ha). On the other hand, the minimum (76.33) was obtained from K_3 (150 kg K_2O/ha) which was statistically identical (77.67) with K_4 as 180 kg K_2O/ha (Table 3). It was revealed that with the increase of potassium days required for 80% emergence of spike decreases upto a certain level than increases. Potassium fertilizer ensures favorable condition for the growth of gladiolus and the ultimate results was the minimum days required for 80% emergence of spike at the optimum level.

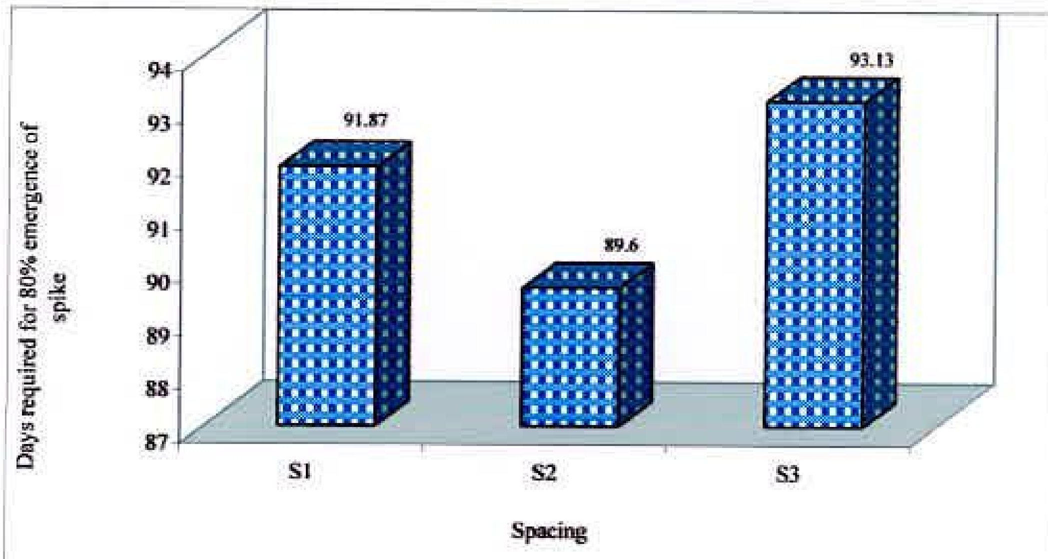


Figure 6. Effect of spacing size on days required for 80% emergence of spike of gladiolus

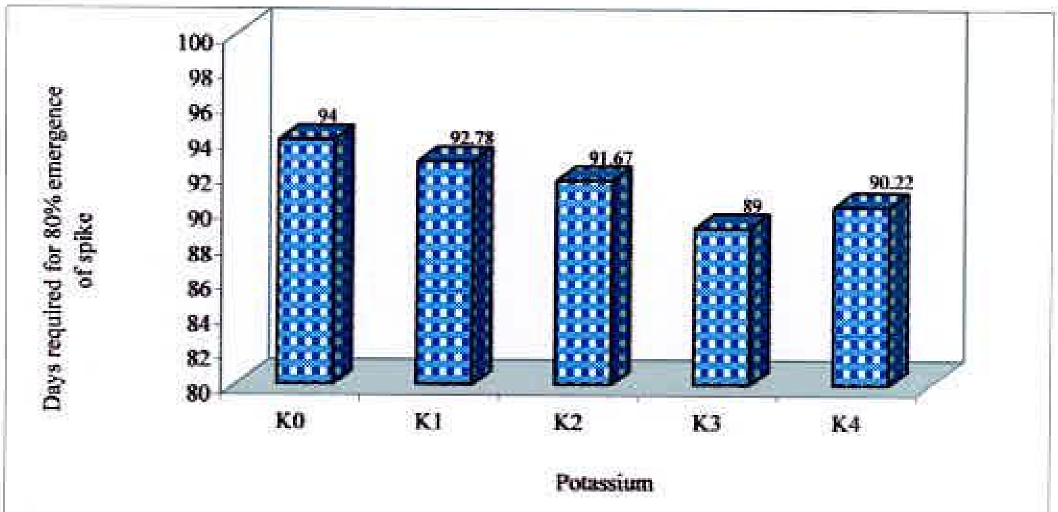


Figure 7. Effect of potassium on days required for 80% emergence of spike of gladiolus

Spacing and levels of potassium showed significant interaction effect for days required for 80% emergence of spike (Appendix IV). The maximum days required for 80% emergence of spike (85.00) was observed from S_1K_0 (15 cm × 10 cm plant spacing + 0 kg K_2O/ha) and the minimum days required for 80% emergence of spike (73.67) was recorded from S_2K_3 (20 cm × 10 cm plant spacing + 150 kg K_2O/ha) (Table 4). It was revealed that optimum spacing and potassium ensures early flowering.

4.5 Flowering plant

Flowering plant of gladiolus showed statistically significant variation due to different plant spacings (Appendix IV). The highest flowering plants (91.07%) were recorded from S_2 (20 cm × 10 cm) which was statistically identical (90.20%) with S_3 (25 cm × 10 cm). Again, the lowest flowering plant (88.07%) was observed from S_1 as 15 cm × 10 cm (Table 3). It is revealed that 20 cm × 10 cm plant spacing reported the minimum flowering plant. In case of closer spacing lowest flowering would be found due to highest lodging plant whereas in wider spacing it would be due to maximum vegetative growth. Mollah *et al.* (1995) reported that the widest spacing (15 cm × 15 cm) produced the maximum percentage of flowering plant (54.60).

Flowering plant of gladiolus differed significantly due to the application of different levels of potassium (Appendix IV). The highest flowering plant (94.00%) was obtained from K_3 (150 kg K_2O/ha) which was statistically identical (93.11%) with K_4 (180 kg K_2O/ha). On the other hand, the lowest (81.89%) was found from K_0 (0 kg K_2O/ha) which was closely followed (88.56%) with K_1 as 90 kg K_2O/ha (Table 3). It was revealed that with the increase of potassium flowering of plant increases then decreases. Potassium fertilizer ensures favorable condition for the growth of gladiolus with optimum vegetative and reproductive growth and the ultimate results was the maximum flowering plant.

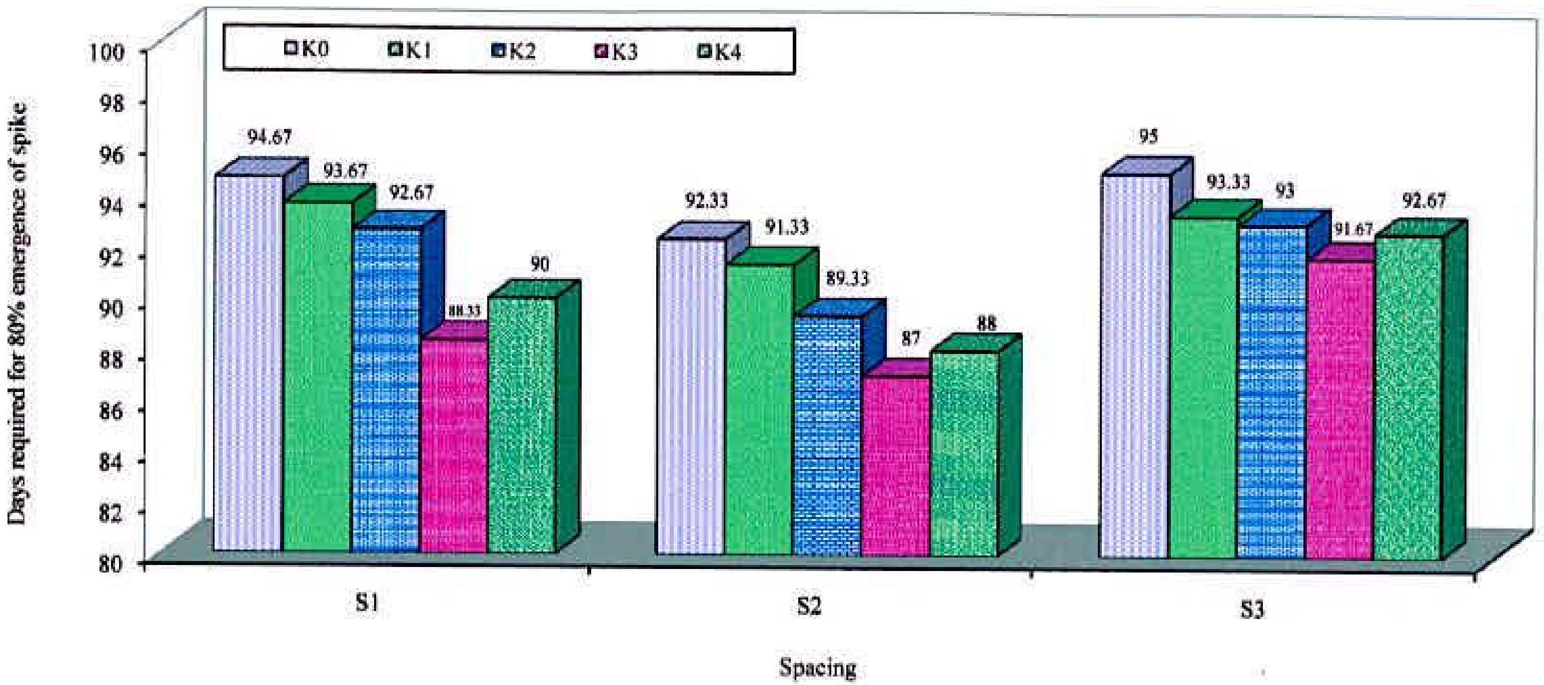


Figure 8. Interaction effect of spacing and potassium on days required for 80% emergence of spike of gladiolus

Spacing and different levels of potassium showed statistically significant variation due to the interaction effect in consideration of flowering plant (Appendix IV). The highest flowering plant (96.67%) was observed from S_2K_3 (20 cm × 10 cm plant spacing + 150 kg K_2O/ha) and the lowest (79.00%) was recorded from S_3K_0 (25 cm × 10 cm plant spacing + 0 kg K_2O/ha) (Table 4). It was revealed that optimum spacing and potassium ensured maximum flowering of plant due to optimum vegetative and reproductive growth.

4.6 Length of flower stalk at harvest

Length of flowering stalk at harvest varied significantly due to different plant spacings (Appendix IV). The highest length of flowering stalk at harvest (66.90 cm) was recorded from S_3 (25 cm × 10 cm) which was statistically identical (66.50 cm) with S_2 (20 cm × 10 cm) and the lowest length of flowering stalk at harvest (59.29 cm) was found from S_1 as 15 cm × 10 cm (Table 3 and Plate 1). It was revealed that highest plant spacing reported the highest length of flowering stalk at harvest. In case of closer spacing it was lowest due to minimum vegetative growth. Mollah *et al.* (1995) reported that the widest spacing (15 cm x 15 cm) produced the maximum length of spike (36.34 cm).

Length of flower stalk at harvest of gladiolus differed significantly due to the application of different levels of potassium (Appendix IV). The highest length of flowering stalk at harvest (68.94 cm) was recorded from K_3 (150 kg K_2O/ha) which was statistically identical (67.71 cm) with K_4 (180 kg K_2O/ha). On the other hand, the lowest (54.99 cm) was obtained from K_0 (0 kg K_2O/ha) which was closely followed (63.46 cm) by K_1 as 90 kg K_2O/ha (Table 3 and Plate 2). It was revealed that with the increase of potassium length of flower stalk per plant increases upto a certain level then decreases with the increase of potassium. Potassium fertilizer ensures favorable condition for the growth of gladiolus with optimum

Plate-2: Effect of spacing on length of flower stalk at harvest

Plate-3: Effect of potassium on length of flower stalk at harvest vegetative growth and the ultimate results was the maximum length of flowering stalk at harvest. Anil *et al.* (2000) reported the highest spike length from K at 20 g/m^2.

Statistically significant variation was recorded due to the interaction effect of spacing and different levels of potassium for length of flowering stalk at harvest (Appendix IV). The highest length of flowering stalk at harvest (73.08 cm) was obtained from S_2K_3 (20 cm × 10 cm plant spacing + 150 kg K_2O/ha) and the lowest (54.07 cm) was recorded from S_2K_0 (20 cm × 10 cm plant spacing + 0 kg K_2O/ha) (Table 4). It was revealed that optimum spacing and potassium ensured maximum vegetative growth with highest length of flower stalk per plant.

4.7 Length of rachis at harvest

Different plant spacings showed statistically significant variation for the length of rachis at harvest (Appendix IV). The highest length of rachis at harvest (35.49 cm) was recorded from S_3 (25 cm × 10 cm) which was statistically identical (35.30 cm) with S_2 (20 cm × 10 cm). Again, the lowest length of rachis at harvest (31.40 cm) was observed from S_1 as 15 cm × 10 cm (Table 3 and Plate 3). 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 (15 cm x 15 cm) produced longest rachis (11.9 cm).

Length of rachis at harvest of gladiolus differed significantly due to the application of different levels of potassium (Appendix IV). The highest length of rachis at harvest (36.66 cm) was recorded from K_3 (150 kg K_2O/ha) which was statistically identical (35.87 cm) with K_4 (180 kg K_2O/ha). On the other hand, the lowest (29.00 cm) was found from K_0 (0 kg K_2O/ha) which was closely followed (33.64 cm) by K_1 as 90 kg K_2O/ha (Table 3 and Plate 4). It was revealed that with the increase of potassium length of rachis per plant

Plate-4: Effect of spacing on length of rachis at harvest

Plate- 5: Effect of potassium on length of rachis at harvest increases up to a certain level then decreases. Potassium fertilizer ensures favorable condition for the growth of gladiolus with optimum vegetative growth and the ultimate results was the maximum length of rachis at harvest. Mallick *et al.* (2001) reported that rachis length varied significantly for all the levels of fertilizer rates.

Interaction effect of spacing and levels of potassium showed statistically significant variation for length of rachis at harvest (Appendix IV). The highest length of rachis at harvest (38.97 cm) was observed from S_2K_3 (20 cm × 10 cm plant spacing + 150 kg K_2O/ha) and the lowest (28.71 cm) was recorded from S_1K_0 (15 cm × 10 cm plant spacing + 0 kg K_2O/ha) (Table 4). It was revealed that optimum spacing and potassium ensured maximum vegetative growth with highest length of rachis per plant.

4.8 Number of spikelets per spike

Number of spikelets per spike showed significant differences due to different plant spacings (Appendix IV). The highest number of spikelets per spike (15.02) was obtained from S_2 (20 cm × 10 cm) which was closely followed (14.25) by S_3 (25 cm × 10 cm) and the lowest number of spikelets per spike (12.97) was observed from S_1 as 15 cm × 10 cm (Table 3 and Plate 5). It was revealed that 20 cm × 10 cm plant spacing produced the highest number of spikelets per spike. In case of closer spacing it was lowest due to lowest vegetative growth. Nilimesh and Roychowdhury (1989) reported that higher planting density decreased the number of florets per spike and flower length.

Number of spikelets per spike of gladiolus differed significantly due to the application of different levels of potassium (Appendix IV). The highest number of spikelets per spike (15.21) was observed from K_3 (150 kg K_2O/ha) which was statistically identical (15.04 and 14.59) with K_4 (180 kg K_2O/ha) and K_2 (120 kg K_2O/ha). Again, the lowest (11.94) was recorded from K_0 (0 kg K_2O/ha) which was closely followed (13.63) by K_1 as 90 kg

Plate-6: Effect of spacing on the number of spikelet per spike at harvest

Plate-7: Effect of potassium on the number of spikelet per spike at harvest

K_2O/ha (Table 3 and Plate 6). It was revealed that with the increase of potassium number of spikelets per spike increases up to a certain level then decreases. Potassium fertilizer ensures favorable condition for the growth of gladiolus with optimum vegetative growth and the ultimate results was the maximum number of spikelets per spike.

Interaction effect of spacing and different levels of potassium showed statistically significant variation for number of spikelets per spike (Appendix IV). The highest number of spikelets per spike (16.63) was observed from S_2K_3 (20 cm × 10 cm plant spacing + 150 kg K_2O/ha) and the lowest (11.23) was found from S_3K_0 (25 cm × 10 cm plant spacing + 0 kg K_2O/ha) (Table 4). It was revealed that optimum spacing and potassium ensured maximum vegetative growth with the maximum number of spikelets per spike.

4.9 Number of spike per hectare

Number of spike per hectare differs significantly due to different plant spacings (Appendix IV). The highest thousand number of spike per hectare (761.48) was recorded from S_2 (20 cm × 10 cm) which was statistically similar (745.19) with S_3 (25 cm × 10 cm) and the lowest thousand numbers of spikes per hectare (656.30) was obtained from S_1 as 15 cm × 10 cm (Table 3). It was revealed that 20 cm × 10 cm plant spacing produced the highest number of spike per hectare. In case of closer spacing it was lowest due to lowest vegetative growth. Sujata and Singh (1991) reported that growth and flowering characteristics (including cut flower yields) decreased with increasing plant density.

Due to the application of different levels of potassium statistically significant variation was recorded from number of spike per hectare of gladiolus (Appendix IV). The highest number spike per hectare (790.12) was found from K_3 (150 kg K_2O/ha) which was statistically identical (787.65) with K_4 (180 kg K_2O/ha). On the other hand, the lowest (607.41) was recorded from K_0 (0 kg K_2O/ha) which was closely followed (686.42) by K_1

as 90 kg K_2O/ha (Table 3). It was revealed that with the increase of potassium number of spike per hectare increases upto a certain level then decreases. Potassium fertilizer ensures favorable condition for the growth of gladiolus with optimum vegetative growth and the ultimate results was the maximum number of spike per hectare. Chattopadhyay *et al.* (1992) reported that longest spikes with $N_{50}K_{20}$.

A statistically significant variation was recorded from the interaction effect of spacing and different levels of potassium for number of spike per hectare (Appendix IV). The highest number of spike per hectare (844.44) was obtained from S_2K_3 (20 cm × 10 cm plant spacing + 150 kg K_2O/ha) and the lowest (577.78) was recorded from S_3K_0 (25 cm × 10 cm plant spacing + 0 kg K_2O/ha) (Table 4). It was revealed that optimum spacing and potassium ensured maximum vegetative growth with the maximum number of spike per hectare.

4.10 Thickness of individual corm

Different plant spacings showed statistically significant differences in consideration of thickness of individual corm (Appendix V). The highest thickness of individual corm (6.91 cm) was recorded from S_2 (20 cm × 10 cm) which was statistically identical (6.69 cm) with S_3 (25 cm × 10 cm). On the other hand the lowest thickness of individual corm (5.97 cm) was recorded from S_1 as 15 cm × 10 cm (Table 5). It was revealed that highest plant spacing ensure highest vegetative growth and the ultimate results would be the highest thickness of individual corm. In case of closer spacing it was lowest due to lowest vegetative growth.

Thickness of individual corm of gladiolus differed significantly due to the application of different levels of potassium (Appendix V). The highest thickness of individual corm (7.15 cm) was recorded from K_3 (150 kg K_2O/ha) which was statistically identical (7.05

cm) with K_4 (180 kg K_2O/ha). On the other hand, the lowest (5.35 cm) was found from K_0 (0 kg K_2O/ha) which was closely followed (6.35 cm) by K_1 as 90 kg K_2O/ha (Table 5). It was revealed that with the increase of potassium thickness of individual corm increases upto a certain level then decreases. Potassium fertilizer ensures favorable condition for the growth of gladiolus with optimum vegetative growth and the ultimate results was the maximum thickness of individual corm.

Interaction effect of spacing and levels of potassium showed statistically significant variation for thickness of individual corm (Appendix V). The highest thickness of individual corm (7.72 cm) was observed from S_2K_3 (20 cm × 10 cm plant spacing + 150 kg K_2O/ha) and the lowest (4.97 cm) was recorded from S_3K_0 (25 cm × 10 cm plant spacing + 0 kg K_2O/ha) (Table 6). It was revealed that optimum spacing and potassium ensured maximum vegetative growth with highest thickness of individual corm.

4.11 Weight of individual corm

Weight of individual corm varied significantly due to different plant spacings (Appendix V). The highest weight of individual corm (28.67 g) was recorded from S_2 (20 cm × 10 cm) which was statistically identical (28.54 g) with S_3 (25 cm × 10 cm) and the lowest weight of individual corm (25.33 g) was found from S_1 as 15 cm × 10 cm (Table 5). It was revealed that highest plant spacing ensure highest vegetative growth and the ultimate results would be the highest weight of individual corm. In case of closer spacing it was lowest due to lowest vegetative growth.

Weight of individual corm of gladiolus differed significantly due to the application of different levels of potassium (Appendix V). The highest weight of individual corm (30.04 g) was found from K_3 (150 kg K_2O/ha) which was statistically identical (29.79 g) with K_4 (180 kg K_2O/ha). Again, the lowest (22.87 g) was obtained from K_0 (0 kg K_2O/ha) which

Table 5. Effect of spacing and different level of potassium on different growth parameter and corm and cormel yield of gladiolus

Treatment	Thickness of individual corm (cm)	Weight of individual corm (g)	Diameter of individual corm (cm)	Weight of individual cormel (g)	Diameter of individual cormel (cm)	Yield of corm (t/ha)	Yield of cormel (t/ha)
Spacing							
S_1	5.97 b	25.33 b	1.65 c	11.81 c	1.16 c	13.04 c	10.64 c
S_2	6.91 a	28.67 a	2.11 a	14.07 a	1.43 a	17.08 a	13.83 a
S_3	6.69 a	28.54 a	1.99 b	13.48 b	1.32 b	15.45 b	12.18 b
$LSD_{(0.05)}$	0.33	1.07	0.08	0.57	0.04	0.52	0.44
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Level of potassium							
K_0	5.35 c	22.87 d	1.56 d	10.77 d	1.10 c	13.20 d	10.68 d
K_1	6.35 b	26.42 c	1.86 c	12.77 c	1.25 b	15.00 c	11.89 c
K_2	6.72 ab	28.46 b	1.99 b	13.52 b	1.29 b	15.44 bc	12.44 bc
K_3	7.15 a	30.04 a	2.11 a	14.32 a	1.44 a	16.10 ab	13.00 ab
K_4	7.05 a	29.79 ab	2.07 ab	14.22 ab	1.42 a	16.23 a	13.09 a
$LSD_{(0.05)}$	0.42	1.38	0.11	0.73	0.06	0.68	0.58
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CV(%)	6.79	5.22	6.02	5.82	5.12	8.63	6.92

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

Table 6. Interaction effect of spacing and different level of potassium on different growth parameters and corm and cormel yield of gladiolus

Treatment	Thickness of individual corm (cm)	Weight of individual corm (g)	Diameter of individual corm (cm)	Weight of individual cormel (g)	Diameter of individual cormel (cm)	Yield of corm (t/ha)	Yield of cormel (t/ha)
S_1K_0	5.59 fgh	23.38 de	1.44 g	10.76 fg	1.02 f	12.18 i	9.99 gh
S_1K_1	5.66 fgh	24.03 de	1.58 fg	11.18 fg	1.09 f	12.57 hi	10.33 fgh
S_1K_2	5.92 efg	25.70 cd	1.67 ef	11.78 ef	1.13 f	12.96 ghi	10.59 fgh
S_1K_3	6.30 defg	26.77 bc	1.80 de	12.64 de	1.27 e	13.51 fgh	11.03 efg
S_1K_4	6.38 def	26.78 bc	1.76 def	12.70 de	1.27 e	13.99 fg	11.28 ef
S_2K_0	5.49 gh	23.23 de	1.81 de	11.30 fg	1.25 e	14.39 ef	12.37 cd
S_2K_1	6.74 bcd	27.43 bc	2.05 bc	13.81 bcd	1.36 cde	17.07 bc	13.36 bc
S_2K_2	7.03 abcd	29.31 ab	2.12 abc	14.30 abc	1.41 bcd	17.22 bc	13.73 b
S_2K_3	7.72 a	31.80 a	2.33 a	15.55 a	1.57 a	18.66 a	14.79 a
S_2K_4	7.56 ab	31.58 a	2.26 ab	15.39 a	1.54 a	18.07 ab	14.92 a
S_3K_0	4.97 h	22.00 e	1.43 g	10.26 g	1.03 f	13.03 ghi	9.67 h
S_3K_1	6.65 cde	27.80 bc	1.95 cd	13.31 cd	1.30 de	15.34 de	11.98 de
S_3K_2	7.21 abc	30.35 a	2.18 ab	14.49 abc	1.34 de	16.13 cd	13.01 bcd
S_3K_3	7.42 abc	31.53 a	2.20 ab	14.75 ab	1.49 ab	16.13 cd	13.19 bc
S_3K_4	7.22 abc	31.00 a	2.18 ab	14.57 abc	1.46 abc	16.63 c	13.07 bcd
$LSD_{(0.05)}$	0.74	2.40	0.19	1.27	0.10	1.17	1.00
Level of significance	0.05	0.05	0.05	0.05	0.05	0.05	0.05
CV(%)	6.79	5.22	6.02	5.82	5.12	8.63	6.92

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

was closely followed (26.42 g) by K_1 as 90 kg K_2O/ha (Table 5). It was revealed that with the increase of potassium weight of individual corm increases upto a certain level then decreases. Potassium fertilizer ensures favorable condition for the growth of gladiolus with optimum vegetative growth and the ultimate results was the maximum weight of individual corm.

Interaction effect of spacing and levels of potassium showed statistically significant variation for weight of individual corm (Appendix V). The highest weight of individual corm (31.80 g) was recorded from S_2K_3 (20 cm × 10 cm plant spacing + 150 kg K_2O/ha) and the lowest (22.00 g) was recorded from S_3K_0 (25 cm × 10 cm plant spacing + 0 kg K_2O/ha) (Table 6). It was revealed that optimum spacing and potassium ensured maximum vegetative growth with highest weight of individual corm.

4.12 Diameter of individual corm

Statistically significant variation was recorded for diameter of individual corm due to different plant spacings (Appendix V). The highest diameter of individual corm (2.11 cm) was found from S_2 (20 cm × 10 cm) which was closely followed (1.99 cm) with S_3 (25 cm × 10 cm). Again, the lowest diameter of individual corm (1.65 cm) was recorded from S_1 as 15 cm × 10 cm (Table 5). It was revealed that highest plant spacing ensure highest vegetative growth and the ultimate results would be the highest diameter of individual corm. In case of closer spacing it was lowest due to lowest vegetative growth.

Diameter of individual corm of gladiolus differed significantly due to the application of different levels of potassium (Appendix V). The highest diameter of individual corm (2.11 cm) was obtained from K_3 (150 kg K_2O/ha) which was statistically identical (2.07 cm) with K_4 (180 kg K_2O/ha). On the other hand, the lowest (1.56 cm) was recorded from K_0 (0 kg K_2O/ha) which was closely followed (1.86 cm) by K_1 as 90 kg K_2O/ha (Table 5). It was revealed that with the increase of potassium diameter of individual corm increases upto a certain level then decreases. Potassium fertilizer ensures favorable condition for the growth of gladiolus with optimum vegetative growth and the ultimate results was the maximum diameter of individual corm.

Spacing and different levels of potassium showed statistically significant interaction effect for diameter of individual corm (Appendix V). The highest diameter of individual corm (2.33 cm) was found from S_2K_3 (20 cm × 10 cm plant spacing + 150 kg K_2O/ha) and the lowest (1.43 cm) was recorded from S_3K_0 (25 cm × 10 cm plant spacing + 0 kg K_2O/ha) (Table 6). It was revealed that optimum spacing and potassium ensured maximum vegetative growth with highest diameter of individual corm.

4.13 Number of cormel per plant

Number of cormel per plant varied significantly due to different plant spacings (Appendix V). The highest number of cormel per plant (23.47) was recorded from S_2 (20 cm × 10 cm) which was statistically identical (22.85) with S_3 (25 cm × 10 cm). On the other hand the lowest number of cormel per plant (19.15) was found from S_1 as 15 cm × 10 cm (Figure 9). It is revealed that highest plant spacing ensure highest vegetative growth and the ultimate results would be the highest number of cormel per plant. In case of closer spacing it was lowest due to lowest vegetative growth. Mollah *et al.* (1995) reported that the widest spacing (15 cm x 15 cm) produced the highest number of cormels (21.87) per plant.

Number of cormel per plant of gladiolus differed significantly due to the application of different levels of potassium (Appendix V). The highest number of cormel per plant (23.43) was recorded from K_3 (150 kg K_2O/ha) which was statistically identical (22.88) with K_4 (180 kg K_2O/ha). On the other hand, the lowest (18.88) was observed from K_0 (0 kg K_2O/ha) which was closely followed (21.53) by K_1 as 90 kg K_2O/ha (Figure 10).

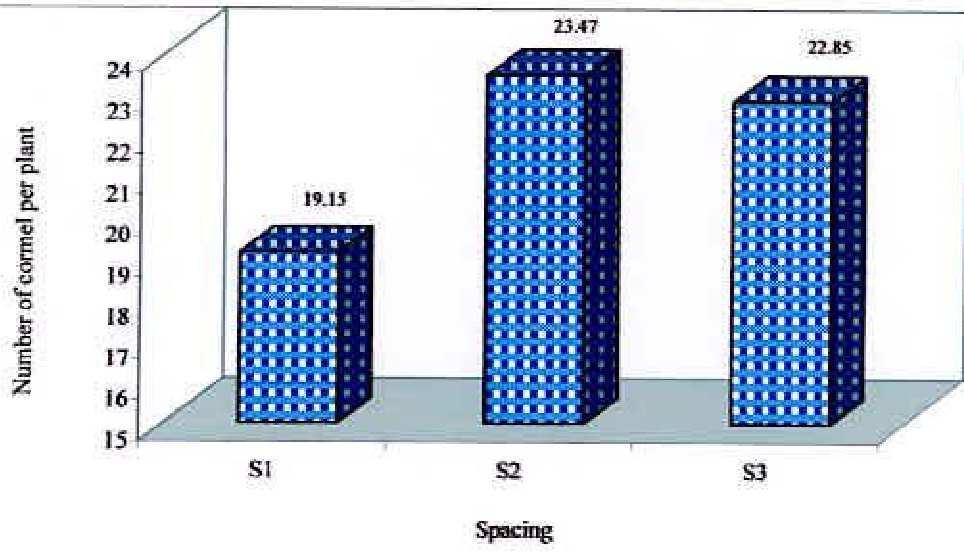


Figure 9. Effect of spacing on number of cormel per plant of gladiolus

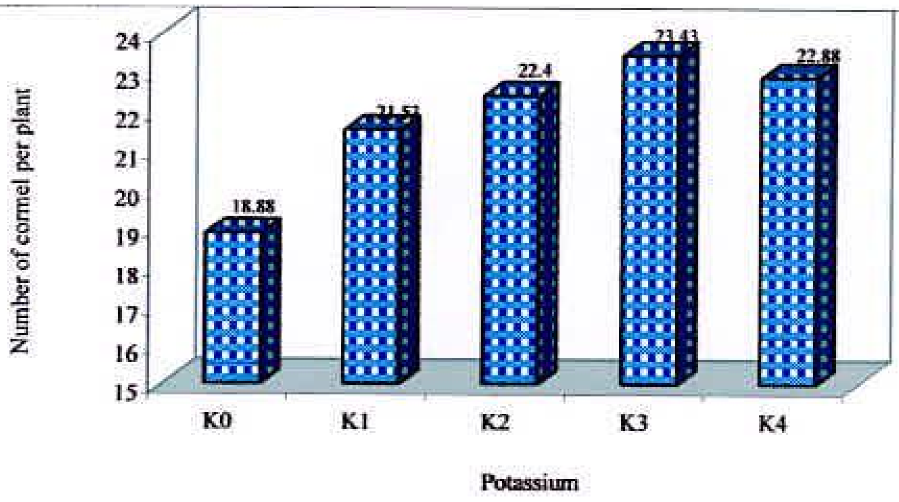


Figure 10. Effect of potassium on number of cormel per plant of gladiolus

It was revealed that with the increase of potassium number of cormel per plant increases upto a certain level then decreases. Potassium fertilizer ensures favorable condition for the growth of gladiolus with optimum vegetative growth and the ultimate results was the maximum number of cormel per plant.

Interaction effect of spacing and different levels of potassium showed statistically significant variation for number of cormel per plant (Appendix V). The highest number of cormel per plant (25.60) was recorded from S_2K_3 (20 cm × 10 cm plant spacing + 150 kg K_2O/ha) and the lowest (17.52) was recorded from S_1K_0 (15 cm × 10 cm plant spacing + 0 kg K_2O/ha) (Figure 11). It was revealed that optimum spacing and potassium ensured maximum vegetative growth with highest number of cormel per plant.

4.14 Weight of individual cormel

Significant variation was recorded in consideration of weight of individual cormel due to different plant spacings (Appendix V). The highest weight of individual cormel (14.07 g) was found from S_2 (20 cm × 10 cm) which was closely followed (13.48 g) with S_3 (25 cm × 10 cm) and the lowest weight of individual cormel (11.81 g) was observed from S_1 as 15 cm × 10 cm (Table 5). It was revealed that highest plant spacing ensure highest vegetative growth and the ultimate results would be the highest weight of individual cormel. In case of closer spacing it was lowest due to lowest vegetative growth.

Weight of individual cormel of gladiolus showed statistically significant variation due to the application of different levels of potassium (Appendix V). The highest weight of individual cormel (14.32 g) was recorded from K_3 (150 kg K_2O/ha) which was statistically identical (14.22 g) with K_4 (180 kg K_2O/ha). Again, the lowest (10.77 g) was obtained from K_0 (0 kg K_2O/ha) which was closely followed (12.77 g) by K_1 as 90 kg K_2O/ha (Table 5). It is revealed that with the increase of potassium weight of individual cormel

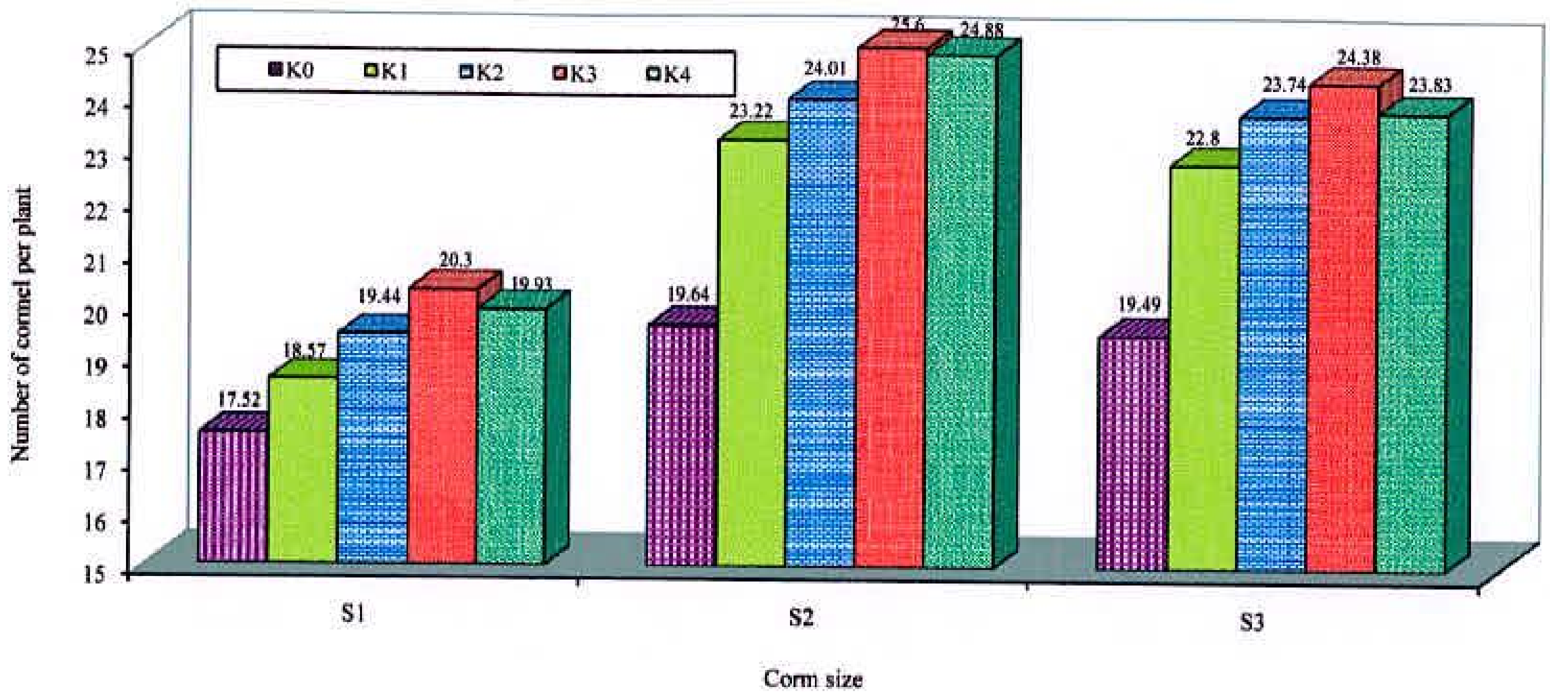


Figure 11. Interaction effect of spacing and potassium on number of cormel per plant of gladiolus

increases upto a certain level then decreases. Potassium fertilizer ensures favorable condition for the growth of gladiolus with optimum vegetative growth and the ultimate results was the maximum weight of individual cormel.

Interaction effect of spacing and different levels of potassium showed statistically significant variation for weight of individual cormel (Appendix V). The highest weight of individual cormel (15.55 g) was recorded from S_2K_3 (20 cm × 10 cm plant spacing + 150 kg K_2O/ha) and the lowest (10.26 g) was recorded from S_3K_0 (25 cm × 10 cm plant spacing + 0 kg K_2O/ha) (Table 6). It was revealed that optimum spacing and potassium ensured maximum vegetative growth with highest weight of individual cormel.

4.15 Diameter of individual cormel

Diameter of individual cormel varied significantly due to different plant spacings (Appendix V). The highest diameter of individual cormel (1.43 cm) was found from S_2 (20 cm × 10 cm) which was closely followed (1.32 cm) with S_3 (25 cm × 10 cm). On the other hand the lowest diameter of individual cormel (1.16 cm) was recorded from S_1 as 15 cm × 10 cm (Table 5). It was revealed that highest plant spacing ensure highest vegetative growth and the ultimate results would be the highest diameter of individual cormel. In case of closer spacing it was lowest due to lowest vegetative growth.

Diameter of individual cormel of gladiolus differed significantly due to the application of different levels of potassium (Appendix V). The highest diameter of individual cormel (1.44 cm) was recorded from K_3 (150 kg K_2O/ha) which was statistically identical (1.42 cm) with K_4 (180 kg K_2O/ha). Again, the lowest (1.10 cm) was observed from K_0 (0 kg K_2O/ha) which was closely followed (1.25 cm) by K_1 as 90 kg K_2O/ha (Table 5). It was revealed that with the increase of potassium diameter of individual cormel increases upto a certain level then decreases. Potassium fertilizer ensures favorable condition for the growth of gladiolus with optimum vegetative growth and the ultimate results was the maximum diameter of individual cormel.

Interaction effect of spacing and different levels of potassium showed statistically significant variation for diameter of individual cormel (Appendix V). The highest diameter of individual cormel (1.57 cm) was found from S_2K_3 (20 cm × 10 cm plant spacing + 150 kg K_2O/ha) and the lowest (1.02 cm) was recorded from S_1K_0 (15 cm × 10 cm plant spacing + 0 kg K_2O/ha) (Table 6). It was revealed that optimum spacing and potassium ensured maximum vegetative growth with highest diameter of individual cormel.

4.16 Yield of corm

Statistically significant variation was recorded from yield of corm due to different plant spacings (Appendix V). The highest yield of corm (17.08 t/ha) was obtained from S_2 (20 cm × 10 cm) which was closely followed (15.45 t/ha) with S_3 (25 cm × 10 cm) and the lowest yield of corm (13.04 t/ha) was found from S_1 as 15 cm × 10 cm (Table 5). It was revealed that highest plant spacing ensure highest vegetative growth and the ultimate results would be the highest yield of corm. In case of closer spacing it was lowest due to lowest vegetative growth. But Rabbani and Azad (1996) reported the highest yield of mother corm (13.17 t/ha) from the treatment combination of closet 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.

Due to the application of different levels of potassium yield of corm of gladiolus differed significantly (Appendix V). The highest yield of corm (16.23 t/ha) was obtained from K_4 (180 kg K_2O/ha) which was statistically identical (16.10 t/ha) with K_3 (150 kg K_2O/ha). On the other hand, the lowest (13.20 t/ha) was found from K_0 (0 kg K_2O/ha) which was closely followed (15.00 t/ha) by K_1 as 90 kg K_2O/ha (Table 5). It was revealed that with the increase of potassium yield of corm increases. Potassium fertilizer ensures favorable condition for the growth of gladiolus with optimum vegetative growth and the ultimate results was the maximum yield of corm. Anil *et al.* (2000) reported highest number of corms from K at 20 g/m^2.

Interaction effect of spacing and different levels of potassium showed statistically significant variation for yield of corm (Appendix V). The highest yield of corm (18.66 t/ha) was recorded from S_2K_3 (20 cm × 10 cm plant spacing + 150 kg K_2O/ha) and the lowest (12.18 t/ha) was observed from S_1K_0 (15 cm × 10 cm plant spacing + 0 kg K_2O/ha) (Table 6). It was revealed that optimum spacing and potassium ensured maximum vegetative growth with highest yield of corm.

4.17 Yield of cormel

Yield of cormel varied significantly due to different plant spacings (Appendix V). The highest yield of cormel (13.83 t/ha) was observed from S_2 (20 cm × 10 cm) which was closely followed (12.18 t/ha) with S_3 (25 cm × 10 cm) and the lowest yield of cormel (10.64 t/ha) was recorded from S_1 as 15 cm × 10 cm (Table 5). It was revealed that highest plant spacing ensure highest vegetative growth and the ultimate results would be the highest yield of cormel. In case of closer spacing it was lowest due to lowest vegetative growth. But Rabbani and Azad (1996) reported the highest yield cormel (22.36 t/ha) from the treatment combination of closet spacing (20 × 10 cm). Mukhopadhyay and Yadav (1984) reported that wider spacing produced more cormels than the closer spacing.

Yield of cormel of gladiolus differed significantly due to the application of different levels of potassium (Appendix V). The highest yield of cormel (13.09 t/ha) was recorded from K_4 (180 kg K_2O/ha) which was statistically identical (13.00 t/ha) with K_3 (150 kg K_2O/ha).

Again, the lowest (10.68 t/ha) was found from K_0 (0 kg K_2O/ha) which was closely followed (11.89 t/ha) by K_1 as 90 kg K_2O/ha (Table 5). It was revealed that with the increase of potassium yield of cormel increases. Potassium fertilizer ensures favorable condition for the growth of gladiolus with optimum vegetative growth and the ultimate results was the maximum yield of cormel.

Statistically significant variation was recorded for the interaction effect of spacing and different levels of potassium in consideration of yield of gladiolus cormel (Appendix V). The highest yield of cormel (14.92 t/ha) was recorded from S_2K_4 (20 cm × 10 cm plant spacing + 180 kg K_2O/ha) and the lowest (9.67 t/ha) was observed from S_3K_0 (25 cm × 10 cm plant spacing + 0 kg K_2O/ha) (Table 6). It was revealed that optimum spacing and potassium ensured maximum vegetative growth with highest yield of cormel.

4.18 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 was considered as per market rate. The economic analysis presented under the following headings-

4.18.1 Gross return

The combination of plant spacing and level of potassium showed different gross return under the trial. The highest gross return (Tk. 1,112,040) was obtained from the treatment combination S_2K_3 (20 cm × 10 cm plant spacing + 150 kg K_2O/ha) and the second highest gross return (Tk. 1,093,550) was found in S_2K_4 (20 cm × 10 cm plant spacing + 180 kg K_2O/ha). The lowest gross return (Tk. 755,140) was obtained from S_1K_0 (15 cm × 10 cm plant spacing + 0 kg K_2O/ha).

Table 7. Cost and return of gladiolus cultivation as influenced by spacing and level of potassium

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 cut flower	Price of cut flower	Gross return (Tk./ha)	Net return (Tk./ha)	Benefit cost ratio
S_1K_0	327251	12.18	97440	9.99	79920	577.78	577780	755140	427889	1.31
S_1K_1	318175	12.57	100560	10.33	82640	614.81	614810	798010	479835	1.51
S_1K_2	321424	12.96	103680	10.59	84720	666.67	666670	855070	533646	1.66
S_1K_3	324673	13.51	108080	11.03	88240	711.11	711110	907430	582757	1.79
S_1K_4	327923	13.99	111920	11.28	90240	711.11	711110	913270	585347	1.79
S_2K_0	308427	14.39	115120	12.37	98960	666.67	666670	880750	572323	1.86
S_2K_1	318175	17.07	136560	13.36	106880	711.11	711110	954550	636375	2.00
S_2K_2	321424	17.22	137760	13.73	109840	755.56	755560	1003160	681736	2.12
S_2K_3	324673	18.66	149280	14.79	118320	844.44	844440	1112040	787367	**2.43**
S_2K_4	327923	18.07	144560	14.92	119360	829.63	829630	1093550	765627	2.33
S_3K_0	308427	13.03	104240	9.67	77360	577.78	577780	759380	450953	1.46
S_3K_1	318175	15.34	122720	11.98	95840	733.33	733330	951890	633715	1.99
S_3K_2	321424	16.13	129040	13.01	104080	777.78	777780	1010900	689476	2.15
S_3K_3	324673	16.13	129040	13.19	105520	814.81	814810	1049370	724697	2.23
S_3K_4	327923	16.63	133040	13.07	104560	822.22	822220	1059820	731897	2.23

4.18.2 Net return

In case of net return different treatment combination showed different levels of net return. The highest net return (Tk. 787,367) was found from the treatment combination S_2K_3 and the second highest net return (Tk. 765,627) was obtained from the combination S_2K_4. The lowest (Tk. 427,889) net return was obtained S_1K_0.

4.18.3 Benefit cost ratio

In the combination of plant spacing and different level of potassium highest benefit cost ratio (2.43) was noted from the combination of S_2K_3 and the second highest benefit cost ratio (2.33) was estimated from the combination of S_2K_4. The lowest benefit cost ratio (1.31) was obtained from S_1K_0 (Table 7). From economic point of view, it is apparent from the above results that the combination of S_2K_3 was more profitable than rest of the combination.

CHAPTER V

SUMMARY AND CONCLUSION

The study was conducted at the Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from November, 2007 to June, 2008 to find out the effect of spacing and potassium on growth, flower, corm and cormel production of gladiolus. The experiment considered as two factors. Factor A: Spacing (Three levels) such as: S_1: 15 cm × 10 cm; S_2: 20 cm × 10 cm and S_3: 25 cm × 10 cm and Factor B: Potassium (Five levels) such as: K_0: 0 kg (Control); K_1: 90 kg; K_2: 120 kg; K_3: 150 kg and K_4: 180 kg K_2O/ha, respectively. The experiment was laid out following Randomized Complete Block Design (RCBD) with three replications.

The highest thousand number of spike per hectare (761.48) was recorded from S_2 and the lowest (656.30) was obtained from S_1. The highest weight of individual corm (28.67 g) was recorded from S_2 and the lowest (25.33 g) was found from S_1. The highest number of cormel per plant (23.47) was recorded from S_2 and the lowest (19.15) was found from S_1. The highest weight of individual cormel (14.07 g) was found from S_2 and the lowest (11.81 g) was observed from S_1. The highest diameter of individual cormel (1.43 cm) was found from S_2 and the lowest (1.16 cm) was recorded from S_1. The highest yield of corm (17.08 t/ha) was obtained from S_2 and the lowest (13.04 t/ha) was found from S_1. The highest yield of cormel (13.83 t/ha) was observed from S_2 and the lowest (10.64 t/ha) was recorded from S_1.

The highest flowering plant (94.00%) was obtained from K_3 and the lowest (81.89%) was recorded from K_0. The highest length of flowering stalk at harvest (68.94 cm) was recorded from K_3 and the lowest (54.99 cm) was obtained from K_0. The highest length of flowering stalk at harvest (73.08 cm) was obtained from S_2K_3 and the lowest (54.07 cm) was recorded from S_2K_0. The highest length of rachis at harvest (36.66 cm) was recorded from K_3 and the lowest (29.00 cm) was found from K_0. The highest number spike per hectare (790.12) was found from K_3 and the lowest (607.41) was recorded from K_0. The highest weight of individual corm (30.04 g) was found from K_3 again, the lowest (22.87 g) was obtained from K_0. The highest number of cormel per plant (23.43) was recorded from K_3 and the lowest (18.88) was observed from K_0. The highest weight of individual cormel (14.32 g) was recorded from K_3 again, the lowest (10.77 g) was obtained from K_0. The highest diameter of individual cormel (1.44 cm) was recorded from K_3 and the lowest (1.10 cm) was observed from K_0. The highest yield of corm (16.23 t/ha) was obtained from K_4 and the lowest (13.20 t/ha) was found from K_0. The highest yield of cormel (13.09 t/ha) was recorded from K_4 again, the lowest (10.68 t/ha) was found from K_0.

The highest flowering plant (96.67%) was observed from S_2K_3 and the lowest (79.00%) was recorded from S_3K_0. The highest number of spike per hectare (844.44) was obtained from S_2K_3 and the lowest (577.78) was recorded from S_3K_0. The highest weight of individual corm (31.80 g) was recorded from S_2K_3 and the lowest (22.00 g) was recorded from S_3K_0. The highest number of cormel per plant (25.60) was recorded from S_2K_3 and the lowest (17.52) was recorded from S_1K_0. The highest weight of individual cormel (15.55 g) was recorded from S_2K_3 and the lowest (10.26 g) was recorded from S_3K_0. The highest diameter of individual cormel (1.57 cm) was found from S_2K_3 and the lowest (1.02 cm) was recorded from S_1K_0. The highest yield of corm (18.66 t/ha) was recorded from S_2K_3 and the lowest (12.18 t/ha) was observed from S_1K_0. The highest yield of cormel (14.92 t/ha) was recorded from S_2K_4 and the lowest (9.67 t/ha) was observed from S_3K_0.

The highest gross return (Tk. 1,112,040) was obtained from the treatment combination S_2K_3 and the lowest gross return (Tk. 755,140) was obtained from S_1K_0. The highest net return (Tk. 787,367) was found from the treatment combination S_2K_3 and the lowest (Tk. 427,889) net return was obtained S_1K_0. The highest benefit cost ratio (2.43) was noted from the combination of S_2K_3 and the lowest benefit cost ratio (1.31) was obtained from S_1K_0. From economic point of view, it is apparent from the above results that the combination of S_2K_3 was more profitable than rest of the combination.

Conclusion:

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

1. Such study is needed in different agro-ecological zones (AEZ) of Bangladesh for regional compliance and other performance.
2. Another experiment may be carried out with another plant spacing for maximizing highest benefit.
3. Potassium fertilizer had significant influence on the growth and yield of gladiolus. So, further study in needed to specify the level.

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APPENDICES

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

A. Morphological characteristics of the experimental field

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

B. Physical and chemical properties of the initial soil

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

Source: SRDI

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

Month	*Air temperature (°c)		*Relative humidity (%)	*Rain fall (mm) (total)	*Sunshine (hr)
	Maximum	Minimum			
November, 2007	25.82	16.04	78	00	6.8
December, 2007	22.4	13.5	74	00	6.3
January, 2008	24.5	12.4	68	00	5.7
February, 2008	27.1	16.7	67	30	6.7
March, 2008	31.4	19.6	54	11	8.2
April, 2008	33.6	23.6	69	163	6.4
May, 2008	34.7	25.9	70	185	7.8
June, 2008	34.5	26.8	76	213	7.1

* Monthly average,

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

Appendix III. Analysis of variance of the data on plant height and number of leaves per plant of gladiolus as influenced by spacing and different level of potassium

Source of variation	Degrees of freedom	Mean square							
		Plant height (cm) at				Number of leaves per plant at			
		30 DAP	45 DAP	60 DAP	75 DAP	30 DAP	45 DAP	60 DAP	75 DAP
Replication	2	2.466	4.349	6.083	1.122	0.006	0.014	0.131	0.058
Spacing (A)	2	53.081**	25.245*	91.862**	201.754**	0.972**	9.643**	16.595**	25.318**
Potassium (B)	4	226.360**	214.164**	275.360**	299.977**	1.114**	1.822**	4.344**	6.180**
Interaction (A×B)	8	23.269*	17.387**	29.432**	23.815*	0.129**	0.184*	0.477**	0.449*
Error	28	8.609	5.241	9.606	8.388	0.038	0.069	0.159	0.173

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

Appendix IV. Analysis of variance of the data on different growth parameter and spike yield of gladiolus as influenced by spacing and different level of potassium

Source of variation	Degrees of freedom	Mean square							
		Days required to 50% emergence of spike	Days required to 80% emergence of spike	Lodging plant (%)	Flowering plant (%)	Length of flower stalk at harvest (cm)	Length of rachis at harvest (cm)	Number of spikelets per spike	Yield of spike per hectare (number)
Replication	2	8.089	10.467	0.726	0.422	5.497	1.270	1.095	208.505
Spacing (A)	2	88.622**	48.067**	10.990**	35.756**	274.899**	79.763**	16.066**	48076.82**
Potassium (B)	4	55.978**	35.522**	4.653**	213.944**	278.032**	83.128**	16.307**	52812.07**
Interaction (A×B)	8	16.094*	32.289**	2.464**	20.894**	18.235*	5.724*	1.524*	2507.544*
Error	28	8.541	5.705	0.612	6.589	7.843	2.205	0.562	937.488

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

Appendix V. Analysis of variance of the data on different growth parameter and corm and cormel yield of gladiolus as influenced by spacing and different level of potassium

Source of variation	Degrees of freedom	Mean square							
		Thickness of individual 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 (t/ha)	Yield of cormel (t/ha)
Replication	2	0.109	4.390	0.002	0.116	0.936	0.002	0.027	0.106
Spacing (A)	2	3.663**	53.572**	0.861**	81.802**	20.506**	0.277**	61.924**	38.179**
Potassium (B)	4	4.760**	79.202**	0.435**	28.700**	19.004**	0.176**	13.433**	8.778**
Interaction (A×B)	8	0.509*	5.904*	0.035*	5.389*	1.373*	0.107*	1.163*	0.994*
Error	28	0.196	2.062	0.013	0.744	0.582	0.004	0.496	0.361

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

Appendix VI. Production cost of gladiolus per hectare

A. Input cost

Treatment	Labour cost	Ploughing cost	Corm Cost	Irrigation Cost	Insecticides	Pesticides	Manure and fertilizers				Sub Total (A)
							Cowdung	Urea	TSP	MP	
S_1K_0	30000.00	10000.00	63250.00	5000.00	4000.00	3000.00	30000.00	3000.00	16000.00	0.00	164250.00
S_1K_1	30000.00	10000.00	63250.00	5000.00	4000.00	3000.00	30000.00	3000.00	16000.00	8100.00	172350.00
S_1K_2	30000.00	10000.00	63250.00	5000.00	4000.00	3000.00	30000.00	3000.00	16000.00	10800.00	175050.00
S_1K_3	30000.00	10000.00	63250.00	5000.00	4000.00	3000.00	30000.00	3000.00	16000.00	13500.00	177750.00
S_1K_4	30000.00	10000.00	63250.00	5000.00	4000.00	3000.00	30000.00	3000.00	16000.00	16200.00	180450.00
S_2K_0	30000.00	10000.00	63250.00	5000.00	4000.00	3000.00	30000.00	3000.00	16000.00	0.00	164250.00
S_2K_1	30000.00	10000.00	63250.00	5000.00	4000.00	3000.00	30000.00	3000.00	16000.00	8100.00	172350.00
S_2K_2	30000.00	10000.00	63250.00	5000.00	4000.00	3000.00	30000.00	3000.00	16000.00	10800.00	175050.00
S_2K_3	30000.00	10000.00	63250.00	5000.00	4000.00	3000.00	30000.00	3000.00	16000.00	13500.00	177750.00
S_2K_4	30000.00	10000.00	63250.00	5000.00	4000.00	3000.00	30000.00	3000.00	16000.00	16200.00	180450.00
S_3K_0	30000.00	10000.00	63250.00	5000.00	4000.00	3000.00	30000.00	3000.00	16000.00	0.00	164250.00
S_3K_1	30000.00	10000.00	63250.00	5000.00	4000.00	3000.00	30000.00	3000.00	16000.00	8100.00	172350.00
S_3K_2	30000.00	10000.00	63250.00	5000.00	4000.00	3000.00	30000.00	3000.00	16000.00	10800.00	175050.00
S_3K_3	30000.00	10000.00	63250.00	5000.00	4000.00	3000.00	30000.00	3000.00	16000.00	13500.00	177750.00
S_3K_4	30000.00	10000.00	63250.00	5000.00	4000.00	3000.00	30000.00	3000.00	16000.00	16200.00	180450.00

Appendix VI. Contd.

B. Overhead cost

Treatment	Cost of lease of land for 12 months (13% of value of land Tk. 8,00000/year	Miscellaneous cost (Tk. 5% of the input cost)	Interest on running capital for 12 months (Tk. 13% of cost/year	Sub total (Tk) (B)	Total cost of production (Tk./ha) [Input cost (A)+ overhead cost (B)]
S_1K_0	104000	21353	37648	163001	327251
S_1K_1	104000	22406	19419	145825	318175
S_1K_2	104000	22757	19617	146374	321424
S_1K_3	104000	23108	19816	146923	324673
S_1K_4	104000	23459	20014	147473	327923
S_2K_0	104000	21353	18824	144177	308427
S_2K_1	104000	22406	19419	145825	318175
S_2K_2	104000	22757	19617	146374	321424
S_2K_3	104000	23108	19816	146923	324673
S_2K_4	104000	23459	20014	147473	327923
S_3K_0	104000	21353	18824	144177	308427
S_3K_1	104000	22406	19419	145825	318175
S_3K_2	104000	22757	19617	146374	321424
S_3K_3	104000	23108	19816	146923	324673
S_3K_4	104000	23459	20014	147473	327923