EFFECT OF PHOSPHORUS ON GROWTH AND YIELD OF GLADIOLUS (*Gladiolus grandiflora* L.)

A Thesis

By

Student no. MS- 110803

Session : 2011 - 2012

MASTER OF SCIENCE (MS)

IN

HORTICULTURE

AGROTECHNOLOGY DISCIPLINE

KHULNA UNIVERSITY, KHULNA

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FINAL ORAL EXAMINATION OF THE MS Thesis

The undersigned certify that they have read and recommended to the Agrotechnology Discipline for acceptance, an MS Thesis Entitled:

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Submitted By

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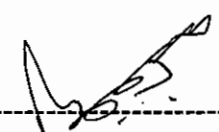
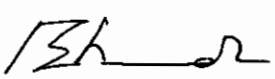
In Partial Fulfillment of the Requirements for the Degree of

MASTER OF SCIENCE IN HORTICULTURE

PROF. MD. YAMIN KABIR
Supervisor



PROF. DR. MD. ABDUL MANNAN
Co-Supervisor



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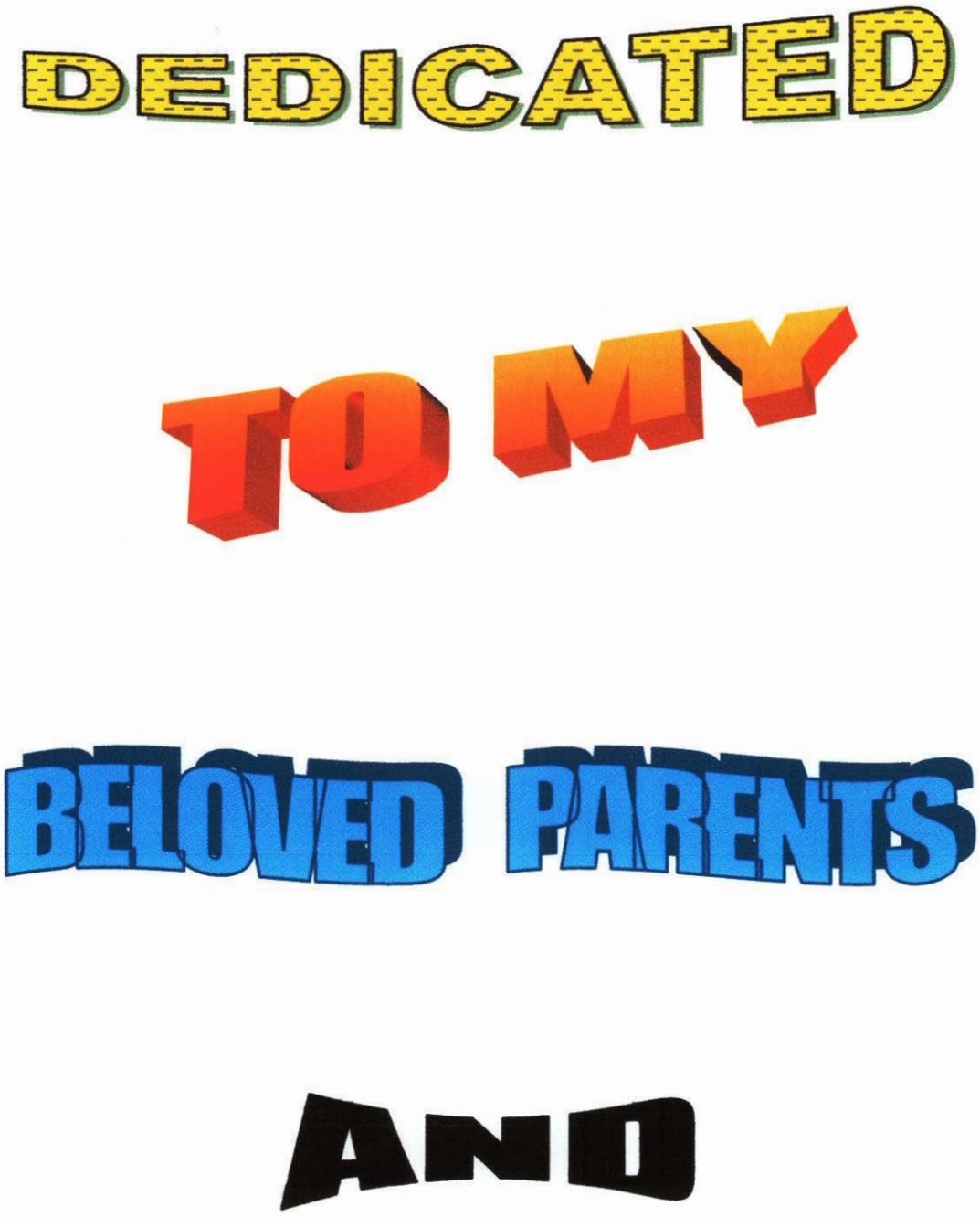
DEDICATED
TO MY
BELOVED PARENTS
AND
SISTER

ACKNOWLEGDEMENT

All praises are due to almighty God, who kindly enabled the author to complete the research work and the thesis successfully.

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The author.

ABSTRACT

An experiment was conducted to investigate the effect of phosphorus and variety on growth, flowering, corm and cormel production of gladiolus during the period from November 2012 to April 2013. The object of the experiment was to determine the optimum level of nutrient for higher yield of flowers, corms and cormels production of gladiolus. The experiment included for four levels of phosphorus and three varieties of gladiolus. The experiment was laid out in the Randomized Complete Block Design with three replication. The results of the experiment revealed that the application of phosphorus influenced growth, flowering, corm and cormels yield of gladiolus. The highest yield of spike (81111/ha) was obtained from the 450 kgP/ha and variety White Queen (77917) and the lowest (69444/ha) at the control treatment and variety Kolmilota produced lowest (75000 t/ha). The highest yield of corm (5.24 t/ha) and cormel (2.58 t/ha) were found from 450 kgP/ha and 300 kgP/ha, respectively while the lowest yield of corm (5.11 t/ha) and cormel (1.86 t/ha) at control treatment. The variety White Queen produced the highest yield (5.25 t/ha) of corm and Kolmilota produced the highest cormel (2.43 t/ha) and the lowest yield of corm (5.13 t/ha) for Red Beauty and cormel (2.08 t/ha) for komlilota. The economic analysis showed that the highest net return TK (685228) and the Benefit Cost Ratio (2.12) were obtained from the 450 kg/ha. And variety White Queen gave the highest net return TK (644826) and the Benefit Cost Ratio (2.05).

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ABBREVIATIONS

AEZ	: Agro-ecological Zone
ANOVA	: Analysis of Variance
BCR	: Benefit Cost Ratio
DAP	: Days After Planting
EC	: Emulcifia ble Concentrate
Kg	: Kilogram
LSD	: Least Significant Difference
RCBD	: Randomized Complete Block Design
t/ha	: Ton per Hectare
viz	: Namely

CHAPTER I

INTRODUCTION

Bangladesh is located in a sub-tropical climatic zone and her climatic condition is suitable for gladiolus production. Gladiolus (*Gladiolus grandiflora* L.) is one of the most important cut flowers and occupies fourth place in international cut flower trade (Bose and Yadav, 1989). It belongs to the family Iridaceae. It is a bulbous ornamental plant and considered as queen among bulbous flower (Anonymous, 1972). Gladiolus is believed to be originated in South Africa and its development started only during the beginning of the 18^{th} century. It has been cultivated since the Greek period (Randhawa and Mukhopadhyay, 1986). But in Indian subcontinent, its cultivation started only in the 19^{th} Century. Gladiolus has magnificent inflorescence with various color which made it attractive for use in herbaceous border, bedding, rockeries, pot and as cut flower.

The name "Gladiolus'' was derived from Latin word gladius because of its sword like leaves. Gladiolus used as cut flower in different social and religious ceremonies (Mitra, 1992). There is an increasing demand for its attractive spikes having florets of huge forms, dazzling colors and varying sizes. Gladiolus spikes are most popular in flower arrangement and preparing high class bouquets. Gladiolus cormels responded better to heavy doses of fertilizers compared to corms (Mukhopadhaya, 1995).

It has recently become popular in Bangladesh and its demand in this country is increasing day by day. But its commercial production is still at the initial stage in this country due to lack of information regarding its cultivation technology. However, its production is mainly concentrated in few districts such as Jessore, Jhenaidha, Satkhira, Dhaka, Mymenshingh, Cox's Bazar, Chittagong and Rangpur. Due to lack of technology, high yielding variety and experiences, they can't produce high number of flowers and corm.

Phosphorus is essential for plant growth. It requires small amount for optimum growth and reproduction than N and K (Khasawneth *et al.* 1980). Phosphorus is found in DNA, RNA, and phospholipid that form all cell membranes (Leicester and Klickstein, 1952). Phosphorus is a vital component of DNA, the genetic "memory unit" of all living things. It is also a component of RNA, the compound that read the DNA code to build proteins and other compound that essential for plant structure, seed yield and genetic transfer (Griffith, 1999).

Phosphorus is one of the most important element for plant growth and metabolism. It plays a key roles in many plant processes such as energy metabolism, the synthesis of nucleic acids and membranes, photosynthesis, respiration, nitrogen fixation and energy regulation (Duff *et al.*, 1994).

The amount of phosphorus required by gladiolus is only about one-tenth the nitrogen expressed in terms of foliar analysis. Phosphorus in the corm is readily utilized by the new plant and this source of supply is very important. This element is later freely translocated throughout the plant and new tissue is well supplied from older tissue. It enhances the root development, helps in flowering and corm development, increases the diseases resistance and prevents wilting. Plant can grow quickly and vigorously, it induces strength of stalk that helps to prevent lodging, it is important for cell division, fat, enzyme and co-enzyme function and synthesis of nucleoprotein molecule. Phosphorus is mobile element in plant. Phosphorus availability is controlled by three primary factors: soil pH, organic matter and proper placement. Soil pH values below 5.5 and between 7.5 and 8.5 limit phosphate availability to plants, which may cause deficiency symptoms. An exception is found when the soils are allowed to become very acid (pH 4.5) in which case P may be leached out by rainfall.

Organic matter maintenance is an important factor in controlling phosphorus availability. Mineralization of organic matter provides a significant portion of P for crops. P is placed two inches below the corm of row plants providing a ready source of P for young seedlings. (www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_053254.pd).

The symptoms of phosphorus deficiency are dark green foliage and purple coloration in the lower leaves. Ripening and development are slow. Drying of the tip of the lower leaves. Delaying flowering and leaf shape become distorted and limited root growth. When it applied higher doses it shown toxic effect as it reduces vegetative growth, professed root growth and pre-mature flowering of crops.

P fixation is a perennial problems in areas of clay-bearing soil having high iron and aluminum contents. If the application be high doses the micronutrients Zn, Fe and Co and macronutrient N deficiency occur. In acidic condition Fe, Mn and Al fixed with soil particles. This problem is meeting by liming and proper placement of source materials. In sandy soil of lower iron and aluminum content the phosphorus problem is not so serious. http://fshs.org/proceedings-o/1956-vol-69/347-351%20(WOLTZ).pdf

Phosphorus is a very crucial element for gladiolus and only judicious application can attain maximum flower, corm and cormel yield. We don't have so many works on phosphorus only. Most of the works are focused to identify the effect of (N, P, K) on gladiolus growth and yield. Therefore, the present investigation was undertaken with the following objectives:

a. To study the growth and yield of gladiolus as influenced by phosphorus.

b. To find out the suitable dose of phosphorus for better yield of flower, corm and cormel of gladiolus.

c. To find out the suitable variety for better yield of gladiolus.

CHAPYER-II

REVIEW OF LITERATURE

Effects of different fertilizer treatments on the plant growth, flowering, and corm and cormel production of gladiolus have been studied in various parts of the world. But a few studies have been done on gladiolus crop under the agro ecological condition of Bangladesh. However the following review includes relevant work carried out in different parts of the world on the gladiolus production.

Effect of phosphorus of growth and yield on gladiolus

Phosphorus is an important element for increasing gladiolus production. It has pronounced effect on the no. of flower, no. of corm and cormel production that progressively increase the quality and yield of gladiolus.

Gladiolus is known as queen of the bulbous plants is very popular as a cut flower, both with the consumer and the florist alike because of its many spike forms, color combinations, an advantage in every floral arrangement (Bushman, 1990). Modern Gladiolus an important cut flower, considered to have been bred originally from only six species (Lewis *et al.* 1972).

Gladiolus grows from corms, which consist of one or more buds. Once planted the buds on the corm develop into leaves and flowering spikes. At the same time as the leaves and spikes are extending, a new corm forms at the base of the leaves while at the union of the parent and daughter corm, stolon grow out, terminating in cormels which are used for propagation (Bushman, 1990).

Besides their intangible aesthetic value, gladiolus can contribute to the economy of Pakistan by earning and saving valuable foreign exchange. Coetzee (2002) stated that the Netherlands earns more from South African flowers than South Africa earns from its

gold. To boost its economical production, it is very important to evaluate cultivars with desired characteristics that are adoptable to particular climatic conditions.

Safiullah and Ahmad (2001) evaluated ten Dutch hybrid cultivars of gladiolus : Blad Jack, My Love, T512, Deciso, Spic and Span, Mary housley, Njova lux, Her majesty, Rose Delight and Trader Horn for their performance in terms of floral characters, corm and cormlels production and recommended Deciso, Trader horn, T512, Blad jackp, Rose delight, Nova lux and Mary housley for general cultivation. Ahmad *et al*. (2002) studied on the introduction and evaluation of ten exotic gladiolus cultivars namely, Wine and Roges, Wing's sensation, Red beauty, Oscar, Praha, City light, Green wood packer, Priscilla and Victor borge for their performance and recommended Wine and Roges, Red beauty, Blue Isle, Victor broge and City light for general cultivation due to their performance.

Kem *et al.* (2003) conducted an experiment and recommended Oscar and Melody for general cultivation similarly Kamble *et al.* (2004) worked on the performance of gladiolus cultivars: Summer sunshine, Sylvia, Trust, Majic, Vendanapoli, American beauty, Melody, Snow white and Yellow cup.

Ram *et al.* (2005) evaluated the performance of 8 gladiolus cultivars, i.e. American beauty, Nova lux, White prosperity, Sylvia, Peter pears, Jester gold, and Picardy, under sodic soil conditions. White prosperity recorded the highest number of corms (1.79) and cormlets per plant (32.25).

Rao and Janakiram (2006) studied on the performance of gladiolus cultivars and found that plant height, spike length and rachis length were maximum in Dhiraj while Maximum floret size was recorded in Kumkum whereas the maximum number of florets per spike in Dhiraj.

Chopde *et al.* (2012) evaluated eight varieties of gladiolus for flower and corm production and inferred that varieties Psittacinus Hybrid and Phule Tejas were superior in respect of quantitative yield of spikes and corms, whereas for quality production of spikes and corms, the varieties Phule Ganesh, Pink Perfection, Monte Alto and Phule Neelrekha were found better than the other varieties of gladiolus.

Bawaja *et al.* (2001) studied the effect of N (0, 50,150 and 200kg/ha) and P (0, 30, 60 and 90 kg/ha) on the growth and flowering of gladiolus at Kandaghate, Himachal Prodesh, India. The tallest plant and longest spikes were recorded at 200kg N/ha with 60kg P/ha.

Narendra and Singh (2006) carried an experiment to study the effect of sulfosalicylic acid on membrane stability and vase life of flowers. All the vase solution such as STS (silver thiosulphate) (1.0 mM), sucrose (4%) and sulphosalicilic acid 100 ppm significantly enhanced the quality of the cut flower. Sulphosalicilic acid phosphorus + sucrose significantly improve membrane stability in cut flower and prolong the vase life of the cut flower from 4.80 to 12.00 days.

Zubair *et al.* (2006) conducted an experiment on the vegetative growth of gladiolus in response to phosphorus under the soil and climatic condition of Peshawar at the agriculture research farm, Department of Horticulture, NWFP Agriculture University, Peshawar, Pakistan. Eight cultivar of gladiolus namely, deciso, hongkong, jessica, jester ruffted, madonna, peters pears, rose supreme and white friendship were given phosphorus at 0, 100, and 200kg/ha. Sprouting spike emergence, first floret and full spike opening were early in year-1 (2003 - 2004). The maximum number of plant per corm was observed in the year-1 and year-2 (2004 - 2005). The time and phosphorus interaction significantly influenced plant height whereas the plant emergence (sprouting), days to spike emergence, days to first floret and full spike opening were not affected

significantly. Cultivars showed significant difference in all vegetative characteristic studied. Phosphorus level did not influence vegetative growth.

Niengboi and Singh (2005) conducted an experiment in Imphal, Manipur, India to evaluate the effect of N (30, 60 and 90 kg/ha) and P (30 and 60 kg/ha) on growth and flowering of gladiolus cv. Green Bay. Data were recorded for plant height, leaf area, days to first floret opening, floret life, no of floret per spike, spike length and longevity of intake spike. All parameters increased with increasing levels of both N and P.

Sharma *et al.* (2003) conducted an experiment in Hisar, Haryana, India on production of gladiolus supplemented with N (200, 300 and 400 kg/ha) and P fertilizers (100, 200 and 300 kg/ha). The tallest plant with the highest no. on leaves were obtained with 400kg N and 100kg P/ha. N and P rates did not significantly affected days to spike emergence, flowering and flowering duration. On the other hand, spike length increased all the treatments. Application of N (up to 400kg/ha) and P (up to 200 kg/ha) increased the floret size and no. of floret per spike. The rates of N and P had significant effects on the corm size and cormel production but did not significant effect on the corms produced per plant. The higher rates of P were more effective in improving the yield and quality of cormel and corms. The plants supplemented with 400kg N and 300kg P/ha produced the highest no. of cormel and corm size.

Sehrawat *et al.* (2003) conducted an experiment in Hisar, Haryana, India to study the effect of N, P and K rates for the cultivation of gladiolus cv. Happy End. Four N rates (0, 20, 40, 60 g/m^2), three P rates (0, 15 and 30 g/m^2) and two rate of K (0 and 10 g/m^2) were used. The average leaf number per plant and plant height were the highest with 60 N, 30 P and 15 K per m^2. The corm production, duration of flowering, spike and rachis length and no of florets were increase with the application of 40 N, 15 P and 15 K per m^2.

Kumar *et al.* (2003) conducted an experiment in Kanpur, Uttar Prodesh, India to investigate the effect of N (0, 20, 30 or 40 g/m²) and P (10, 20 or 30 g/m²) on growth, flowering and yield of gladiolus cv. Sylvia and found that application of N 30, P 30 g/m² resulted in maximum plant height (86.65 cm), (86.65 cm), florets / spike (15.60cm), spike length (75.70 cm) and rachis length (50.45 cm), leaf length (55.05 cm), leaf width (2.79 cm), floret length (8.95 cm) corm per plant (1.50) and weight of cormel per plant (54.30 g). However, corm size (6.16 cm), cormel weight per plant (40.20 g) floret width (8.53 cm) and propagation co-efficient (305.36%) were significantly maximum with higher doses of N 40, P 30 g/m². Earliest flowering (74.0 days) was recorded with N 20, P 30 g/m² doses. Durability of first floret (2.94 days) and whole spike (11.12 days) was significantly increased with N 30, P 20 g/m².

Singh and Bijimol (2002) conducted an experiment on effect of fertilizer on gladiolus production in Pantanagar, on the effect of N (0, 25, 50 and 75 g/m²), P (20 and 30 g/m²), and K (0 and 20 g/m²) or the N, P and K content of the leaves of gladiolus cv. Sylvia. It was observed that N, P and K content in leaves of gladiolus increased with increasing rates of N, P and K fertilizers. N and K application resulted in the increasing the leaf P content although the increase was not significant. Leaf K content increased significantly with the application of N and K fertilizers. The effect of P and K content of the leaves were not significant.

Kawarkhe *et al.* (2001) conducted an experiment in Akola, Mahsarastra, India to study the effect of N and K on growth and flowering of gladiolus cv. Dabonoir. It was found that the no. of spikes per plant and spike length increased with the application of N and P at the rate of 0, 40, 50 and 60 g/m² and 0, 10, 20 and 30 g/m², respectively. The maximum spike length was recorded with application of N at 60 g/m². Chand and Bhattacharjee

(2001) observed that the P requirement, varied from (50 -300) kg/ha. But satisfactory result obtained from 200 kg/ha for gladiolus production.

Kumar *et al.* (2006) conducted an experiment in Meghalaya, India, to study the effects of N, P and K(0, 10, 20,30, 40, g/m² each) on the growth, flowering and corm production of gladiolus cv. Pusa Shabnum. Application of 40 g N/m² 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 (0.8 cm) and flowering duration (9.36 days) under field conditions. However, the lowest dose of N i. e. 10g/m² produced early heading (76.62 days), first floret showing color (88.32 days) and opening of first floret (91.62 days), while the higher doses of N up to 40 g/m² delayed flowering. Higher doses of N (40 g/m²) also produced maximum corm weight (42.05 g), corm diameter (4.58 cm), cormels per plant (25.45) and their weight (13.20g) and propagation co efficient (230.56%).

Debnath *et al.* (2004) conducted an experiment at Bhuvaneswar, Orissa, India to evaluate the effects of varying doses of N (0, 20, 30 and 40 g/m²) and K (0,10,20 and 30 g/m²) and a constant dose of P (40 g/m²) on the growth and flowering of gladiolus (Gladiolus grandiflorus) cv. Red Beauty. Combined application of N at (40g/m²) and K at 30 g/m² recoreded the highest values for plant height (59.97 cm), leaves per plant (10.67), leaf area (87.90 cm), spike length (67.79 cm) and no of florets per spike (13.40).

Gowda *et al.* (1991) conducted an experiment in Khandaghate, Himachal Pradesh, India to study the effect of N (0, 50, 100, 150 and 200 kg/ha) and P (0, 30, 60 and 90 kg/ha) rates on the growth and flowering of gladiolus cv. Happy End and found that the interaction effect of N and P was significant only for plant height and spike length. The tallest plants were obtained from 150 or 200 kg N/ha with 60 or 20 kg P /ha. The longest spikes were recorded for 200 and 150 kg N /ha with 600 kg P/ha. He also observed that P

application significantly increased plant height, spike length and no. of florets. The tallest plants were obtained with 90 kg P/ha. Spike length did not significant vary between 30 and 90 kg P/ha. Phosphorus at 60 kg /ha resulted in the greatest spike length and no. of florets/spike.

Singh *et al.* (1999) worked on gladiolus corm production in Delhi, India and reported that improve cormel and corm production were obtained from N at 40 g/m² or P at 20g/m² but the combined N+P application had no significant effect on corm yield.

Barma *et al.* (1998) carried out an experiment to study the effect of N (0-45 g/m²), P (0-30 g/m²), and K (0-30 g/m²) on enlargement and production of corms and cormels of gladiolus cv. Psittacinus Hybrid on a sandy loam soil in Nadia, India. The effect of N and K were much more pronounced than those of P on n umber, size, and weight of corms and cormels. Corm number, weight and diameter were greatest at the highest N rate (45 g/m²). Cormel number and weight (87.12 and 5.53 g/m²) were greatest at the highest N rate, followed by the highest K rate.

Waly *et al.* (2001) conducted an experiment in Egypt to study the effects of 1.5 potassium sulphate per liter, applied as foliar fertilizer 2, 4 or 6 times on the growth, flowering, corm and cormel productivity and chemical constituents of *Gladiolus grandiflorus* cv. Peter Pears. Spraying sulphate fertilizer six times significantly increased plant height, no of leaves per plant, fresh and dry weight s of leaves , no of florets per spike, flower spike, fresh weight and length , no of cormels per plant and fresh and dry weight of corm and cormels over the other treatments. N, P, K and Na content of the leaves, corms and cormels of the crops were higher with six spray treatments with potassium sulphate. Six spray of potassium sulphate also resulted in the highest N, P and K uptake, and reduced N : K ratio. Generally gladiolus plants spread six times with

potassium sulphate recorded the highest vegetative growth, flowering, and corm and cormels productivity.

Higher rate of nitrogen delayed the time of flowering and increased the spike length, weight and size of the corms and number of cormels, whereas higher rates of phosphorus and potash tended to improve flower quality, cormel growth and corm production in cv. Friendship (Bhattacharjee. 1981).

In our country most of the farmer those who are cultivate the tuberose, rose and other one. But they do not know about scientific cultivation of gladiolus and its outcome. A gladiolus stick normally sold at taka (5-15) in variable market condition whereas a tuberose is taking (2-2.5). So the gladiolus production is more profitable and required only 65 days to flower initiation. Flower cultivation is more profitable than any other crop specially gladiolus. I want to acknowledge the farmer those who don't know this cultivation through make a gladiolus based flower garden in our locality. Although there are no much available work in this field especially in our country so I choose this research works to make available and enriched this field.

CHAPTER-III

MATERIALS AND METHODS

The present experiment was carried out at the Prof Purnendu Gain Field Laboratory of Agrotechnology Discipline of Khulna University during the period from November 2012 to April 2013 to investigate the effects of phosphorus on growth, flowering, corm and cormel production of gladiolus varieties. The materials and methods followed in conducting the present experiment have been described as follow.

3.1 Soil of experimental site

The soil of experimental site was medium high and belongs to Ganges flood plain. The texture of soil was silt loam and pH was 6.5. The land was well drained with good irrigation facilities that are good for gladiolus production. The characteristic of the soil of farm was analyzed in the lab of Soil Science of Khulna University have been present in Appendix I. The critical value of soil pH was 7; whereas experimental soil value was 6.5. The critical values of nitrogen, phosphorus and potassium were 0.12%, 10ppm and 0.2ppm; whereas experimental soil values were 0.07%, 5ppm and 0.2ppm, respectively.

3.2 Characteristics of gladiolus varieties used in this experiment

White Queen : The plant height is 60.11 cm, leaf breadth 3.28 cm, rachis length 42.8 cm, no. of florets per plant 13.29, diameter of corms and cormels are 4.76 cm and 1.00 cm respectively and days required to 80% emergence is 12.22.

Red Beauty : The height of the plant is 54.28 cm, leaf breadth 2.67 cm, rachis length 42.1 cm, no. of florets per plant 9.5, diameter of corms and cormels are 4.14 cm and 1.25 cm respectively and days required to 80% emergence is 12.34.

Kolmilota : The plant height is 54.7 cm, leaf breadth 2.67 cm, rachis length 40.75 cm, no. of florets per plant 11.25, diameter of corms and cormels are 3.9 cm and 1.2 cm respectively and days required to 80% emergence is 13.21.

3.3 Climate

The experimental area is under the sub-tropical climate characterized by to distinct seasons, the winter season from November to February and the summer season from March to April (Edris *et al.* 1979).

3.4 Treatment of the experiment

The experiment included following treatments:

Phosphorus levels (P)	**Varieties (V)**
P_1 = 00 kg P/ha	V_1 = White Queen
P_2= 150 kg P/ha	V_2 = Red Beauty
P_3= 300 kg P/ha	V_3 = Kolmilota
P_4= 450 kg P/ha	

3.5 Experimental design and layout

The 2- factor experiment consisted of four levels of phosphorus and three varieties of gladiolus was laid out in the Randomized Complete Block Design (RCBD) with three replications. At first the whole experimental area was marked with the measuring tape and rope. The total experimental area was divided into three equal blocks, representing the replications. The total numbers of plots were 36. The size of each unit of plot was (1.8m ×1m). The distance between two adjacent blocks and plots were 1m and 0.5m, respectively. Total area of experimental plot was 72 m². There were 12 plots in each block and area of each plot was 1.8m².

3.6 Land preparation

The selected land for experiment was first opened with a power tiller on 10 Oct. 2012 and it was kept open to the sun for 2 weeks prior to next ploughing. The land was ploughed with spade and large clods were breaking up for making a good tilth. All the stables and weeds were removed from the land. The basal dose of manure was applied to the land,

during the land preparation and incorporated with soil. Irrigation channel were made around the experimental land.

3.7 Manure and fertilizers

10 kg well rotten cow dung, half from 300 kg nitrogen and 250 kg potassium were applied during final land preparation. Phosphorus also applied during final land preparation but it was applied in four doses as treatment P_1=00 kg, P_2= 150 kg, P_3= 300 kg, P_4= 450 kg per ha. And rest of nitrogen was applied at 5^{th} leaves stage of gladiolus.

3.8 Planting materials used for the experiment

The corms of gladiolus collected from Godhkali of Jessore district and used for the present study.

3.9 Corm soaking

Before planting, corms were soaked in 0.1% Bavistin solution for five minutes and air dried to avoid rotting of corm in the field.

3.10 Planting of corms

Corms were planted at 7cm depth in furrows on 29 Nov, 2012. Corm to corm distance was 25cm and row to row distance was 30cm. There were four rows and every row contain six plants. So total number of plants were 24.

3.11 Other intercultural operation

3.11.1 Gap filling

At the time of planting, few corms were planted in the border of the experimental plots for gap filling. A few corms were damaged after planting. The seedlings were transplanted from the border seedlings to gap with a mass of soil with root to minimize the transplanting shock.

3.11.2 Weeding and mulching

Weeding was done two times. Mulching was done after each irrigation by breaking the crust for proper aeration and to conserve the soil moisture.

3.11.3 Irrigation

Irrigation was done every weeks in my experimental field.

3.11.4 Earthing up

During the crop period, earthing up was done twice. The first and second earthing up were done at 25 and 50 days after planting, respectively.

3.11.5 Staking

Every plant was staked with strong bamboo stakes to avoid lodging of the plant.

3.11.6 Diseases and pest management

The experimental plants were not infected or infested by any organisms.

3.12 Harvesting of flowers, corms and cormels

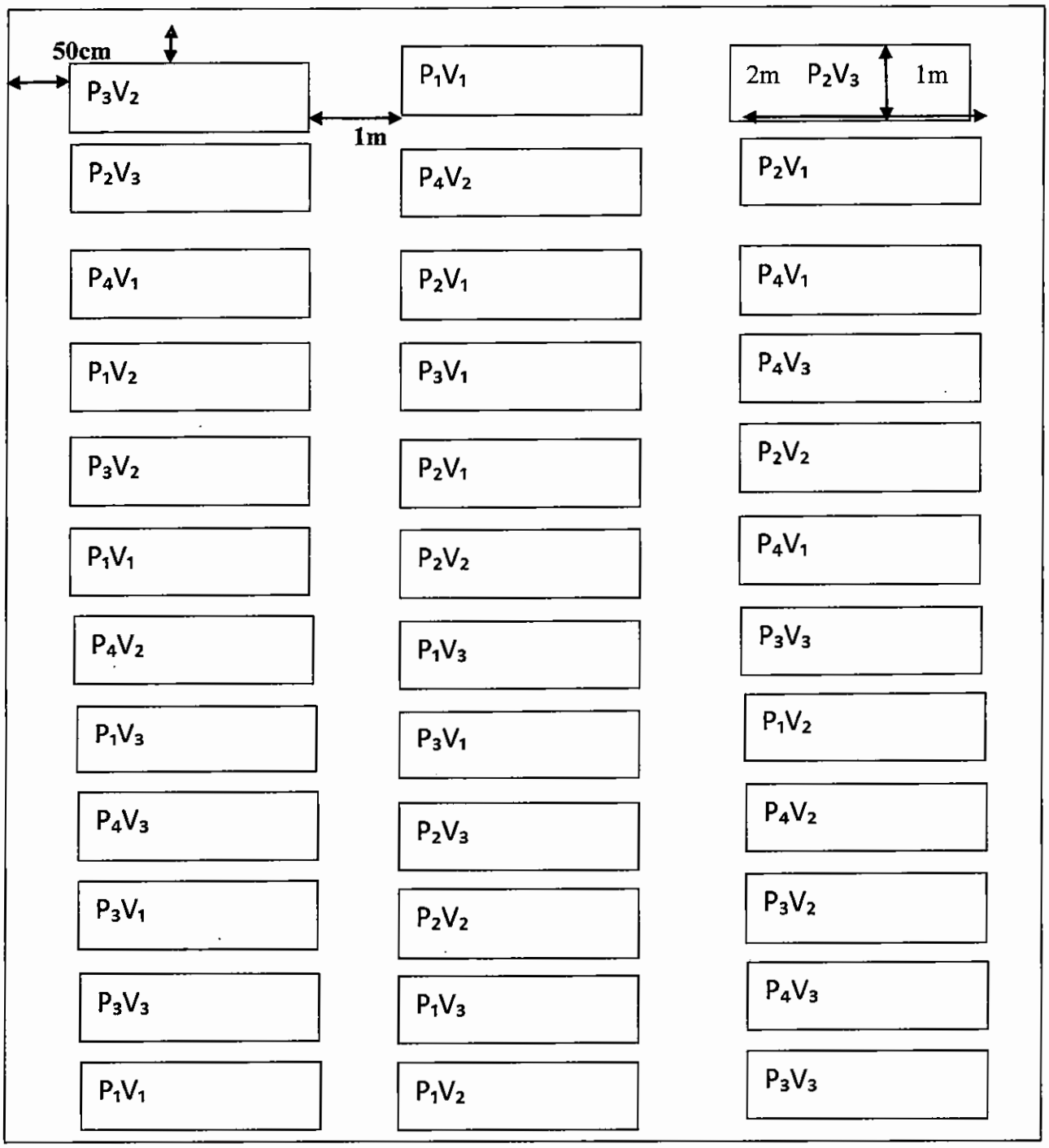
The spikes of gladiolus were harvested when the basal florets showed colors. Corm and cormels were harvested after two months of spike harvest, when the leaves turn into yellow color. The harvested corms and cormels were cured for 7 days under shade and then data were recorded.

3.13 Collections of data

Data were collected from 8 plants randomly selected from each plot. All the growth parameter data were recorded at an interval of 15 days starting at 35 Days After Planting (DAP) till 65 DAP. The following parameters are measured:

3.13.1 Days required to 80% emergence

It was achieved by recording the time taken to complete 80% emergence of spike from each plot



P_1=00 k g /ha P_2= 150 kg/ha P_3= 300 kg /ha P_4= 450kg/ha

V_1= Kolmilota V_2= Red Beauty V_3= White Queen

Fig: Field layout of the experiment

3.13.2 Plant height

Plant height refers to the length of the plant from ground level to tip of the leaf. Height of 8 randomly selected plants of each plot was measured and mean was calculated.

3.13.3 Number of leaves per plant

Number of leaves per plant was recorded by counting all the leaves from 8 randomly selected plants and the mean was calculated.

3.13.4 Number of tiller per hill

Number of tillers per plant was recorded by counting all the leaves from 8 randomly selected plants and the mean was calculated.

3.13.5 Days required to first spike initiation

It was recorded by counting the days from planting to first visible spike initiation of plants from each plot.

3.13.6 Days required to first bud break

It was recorded by counting the days taken for color formation of 1-2 florets of the lower portion of spike from each plot.

3.13.7 Spike length at harvest

Length of spike was measured from the base of the spike to the tip of the spike (cm).

3.13.8 Rachis length at harvest

It was measured from the axils of the floret up to the tip of the inflorescence (cm).

3.13.9 Length of leaves at harvest

The length of leaves of 8 randomly selected plants was measured and mean was calculated (cm).

3.13.10 Number of florets per spike

All the florets of the spike were counted from 8 randomly selected plants and then the mean was calculated.

3.13.11 Percentage of flowering plant

It was calculated by counting the number of plants bearing flowers in each plot divided by the number of plants emerged and converted to percentage.

3.13.12 Number of spike per plot

Number of spike of gladiolus harvested per plot was recorded and mean was calculated.

3.13.13 Number of spike per hectare

Number of spike per ha was calculated by counting the number of spikes per plot.

3.13.14 Number of cormel per plant

It was calculated from the number of cormels obtain from 8 randomly selected plants from each plot divided by 8 plants.

3.13. 15 Weight of corm (g)

It was recorded by weighing the corms collected from 8 randomly selected plants from each plot and the mean was calculated.

3.13.16 Diameter of corm (cm)

A slide calipers was used to measure the diameter of corm.

3.13. 17 Weight of corm per plot (g)

Weight of corm per plot was measured by using electric balance.

3.13.18 Weight of cormel per plant (g)

It was recorded by weighing the cormels collected from 8 randomly selected plants from each plot and the mean was calculated.

3.13.19 Diameter of cormel (cm)

A slide calipers was used to measure the diameter of cormel.

3.13.20 Weight of cormel per plot (kg)

Weight of cormel per plot was measured by using electric balance.

3.13.21 Yield of corm (t\ha)

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

3.13.22 Yield of cormel (t\ha)

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

3.14 Statistical analyses

The recorded data for various characters were statistically analyzed by using MSTAT computer package programme. The analysis of variance for each of the character under study was performed by F test. The significance of differences among the treatment means were evaluated by least significance difference (LSD) test.

3.15 Economic analysis

The cost of production was analyzed in order to find out the most profitable treatment of phosphorus. All the non-material and material input costs and interests on fixed and running capital were considered for computing the cost of production. The interests were calculated for six months. The value of land per ha was considered to be TK. 5,55,000.00. The price of seed corms and cormels were TK. 100.00/kg and 50.00/kg, respectively.

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

CHAPTER IV

RESULTS AND DISCUSSION

This chapter comprises the presentation and discussion of the results obtained from the experiment. The growth and yield components were influenced by phosphorus. Data on different parameters were analyzed and the results have been presented in Tables and Figures. The results of each parameter have been presented, discussed and possible interpretations have been made in this chapter. The analysis of variance (ANOVA) for different characters studied with their sources of variation and corresponding degrees of freedom have been shown in Appendix IV.

4.1 Days required to 80% emergence

Time required for 80% emergence of new gladiolus plant from corm varied significantly with different doses of phosphorus but not with different varieties. The phosphorus level 300kg P/ha required minimum (11.67 days) and maximum (13.56 days) were required for control level for 80 % emergence (Table 1). Deswal *et al.* (1983) reported on their experiment that optimum level of phosphorus is shown the minimum days to maximum emergence of gladiolus. For varieties minimum (12.58 days) and maximum (13.25 days) were counted for 80% emergence of gladiolus plant for White Queen and Kolmilota, respectively (Table 2).

4.2 Plant height

Plant height is an important growth contributing characteristics of gladiolus. The data on plant height were recorded periodically at 35, 50 and 65 days after planting. The results showed that the plant height gradually increased with the time and reached at 65 peak at DAP. The different level of phosphorus were significant only 35 DAP and rest two DAP were not significant and varieties were not significant in respect of plant height. The plant height was maximum (52.88 cm) at 300kg P/ha at 65 DAP while minimum (48.82 cm) at

450 kg P/ha (Table 1). Bawaja (2003) reported that the plant height increased with the increased level of phosphorus. Rabi (1981) also reported the plant height increased with the level of phosphorus. The maximum plant height (52.37 cm) was obtained from the variety White Queen and minimum (49.02 cm) from Red Beauty at 65 DAP (Table 2).

4.3 Number of leaves per plant

The data on number of leaves per plant were taken periodically at 35, 50 and 65 days after planting. The leaf number was gradually increased with the time and reached at the peak at 65 DAP and was statistically significant for varieties only at 35 DAP but not for phosphorus levels. The maximum no. of leaves (8.10) was produced from the treatment 450 kg P/ha while minimum (7.43) at control treatment with 65 DAP (Table 1). The varieties Red Beauty produced the highest (8.37) and White Queen the lowest (7.40) number of leaves at 65 DAP (Table 2).

4.4 Leaf breadth

The plant those are most vigorous give the high leaf width and its gives the high productivity. Leaves breadth increased gradually and reached at peak at 65 DAP and was statistically significant with varieties for all DAP but for phosphorus only at 35 DAP. The highest breadth (3.62 cm) of leaves was recorded at 65 DAP at treatment of 150 kg P/ha and lowest (2.37 cm) at 00 kg P/ha (Table 3). The maximum leaf breadth (3.64 cm) and minimum (2.30 cm) produced from varieties White Queen and Red Beauty, respectively at 65 DAP (Table 4).

Table 1. The effect of phosphorus on the days required to 80% emergence, length of leaves (cm), number of leaves per plant of gladiolus

Level of phosphorus (kg/ha)	Days required to 80% emergence	Number of leaves per plant			Plant height (cm)		
		35 DAP	50 DAP	65 DAP	35 DAP	50 DAP	65 DAP
00	13.56	3.24	5.06	7.43	22.80	37.37	48.82
150	13.33	3.36	5.28	8.10	23.97	39.62	50.85
300	11.67	3.52	5.68	7.88	28.16	42.12	52.87
450	12.78	3.37	5.51	8.10	23.54	38.10	48.34
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS

NS = Non significant

4.5 Number of tiller per hill

Number of tiller did not differ significantly both at varieties and phosphorus levels at different DAP. The highest no. of tillers per hill was (1.45) from the treatment 450 kg P/ha on the other hand the lowest no. of tillers (1.22) from 150 kg P/ha (Table 3). The variety Kolmilota produced the best (1.40) and Red Beauty was low (1.24) (Table 4).

Table 2. The effect of varieties on the days required to 80% emergence, length of leaves (cm), number of leaves per plant of gladiolus

Varieties	Days required to 80% emergence	Number of leaves per plant			Plant height (cm)		
		35 DAP	50DAP	65 DAP	35 DAP	50 DAP	65 DAP
Kolmilota	13.25	2.88	5.12	7.85	22.08	38.52	49.27
Red Beauty	12.66	3.25	5.52	8.37	22.32	38.16	49.02
White Queen	12.58	3.99	5.52	7.40	29.46	41.22	52.37
LSD(0.05)	NS	NS	NS	NS	NS	NS	NS

NS = Non significant

4.6 Days required to first spike initiation

Days required to first spike initiation varied significantly for varieties but not for different phosphorus levels. Highest P level (450 kg) required maximum time (72 days) whereas control required minimum (70 days) to initiate first spike (Table 5). It was found that the highest treatment prolonged the vegetative growth and delayed the spike initiation. Bijimol and Singh (2001) reported that increased level of phosphors delayed the spike initiation. The effect of different treatments was significant in respect of first spike initiation. Richardson *et al.* (2009) also reported that the increased level of phosphorus delayed the spike initiation. The variety White Queen took the lowest time (63.66 days) and Kolmilota required the highest time (78.50 days) (Table 6).

Table 3. The effect of phosphorus on the leaves breadth (cm) and number of tiller of gladiolus varieties

Level of phosphorus	Leaves breadth (cm)			Number of tiller		
	35DAP	50 DAP	65 DAP	35DAP	50 DAP	65 DAP
00	1.34	2.98	2.37	1.21	1.34	1.34
150	1.72	2.07	3.62	1.11	1.22	1.22
300	2.72	2.18	2.45	1.20	1.35	1.35
450	1.50	2.99	2.41	1.30	1.45	1.45
LSD (0.05)	0.67	NS	NS	NS	NS	NS

NS = Non significant

4.7 Days required to first bud break

Number of days required to appear first bud differed significantly for different varieties but not for phosphorus. The maximum period (80.67 days) was required to bud break by 450 kg P/ha while the minimum (77.33 days) was at 150 kg P/ha (Table 5). Maximum time (87.08 days) required for Kolmilota and minimum (71.08 days) for White Queen (Table 6).

Table 4. The effect of varieties on the leaves breadth (cm) and number of tiller of gladiolus varieties

Varieties	Leaves breadth(cm)			Number of tiller		
	35DAP	50 DAP	65 DAP	35DAP	50 DAP	65 DAP
Kolmilota	1.46	2.00	2.45	1.18	1.40	1.40
Red Beauty	1.41	2.91	2.30	1.17	1.24	1.24
White Queen	2.84	2.27	3.64	1.27	1.39	1.39
LSD(0.05)	NS	NS	NS	NS	NS	NS

NS = Non significant

4.8 Length of spike at harvest

Length of spike at harvest is varied significantly for varieties but not for phosphorus level. Control treatment produced the maximum length of spike (85.23 cm) while the minimum (83.30cm) at 150 kg P/ha (Table 5). Bhattacharjee (1981) reported that the Length of spike increased with the increased level of phosphorus. Singh and Sujatha (1998) also reported the same reported. The varieties White Queen produced the highest spike length (97.07 cm) and Kolmilota the lowest (75.87 cm) (Table 6).

4.9 Total number of plant per plot

Different doses of phosphorus and varieties were not significant on the parameter total number of plant per plot. The maximum number of plant (21.67) per plot was produced with the treatment 300 kg P/ha while the minimum (20.00) was at 00 kg P/ha (Table 5). The maximum number of plant (21.16) per plot were produced from both Kolmilota and White Queen and the minimum (20.83) from Red Beauty (Table 8).

Table 5. The effect of phosphorus on days required to first spike initiation, days required to first bud break, length of rachis at harvest, length of spike at harvest, number of florets per plant, (%) flowering plant per plot and total number of plant per plot of gladiolus varieties

Level of phosphorus (kg/ha)	Days required to first spike initiation	Days required to first bud break	Length of rachis at harvest	Length of spike at harvest	No. of florets per spike	(%) Flowering plant per plot	Total number of plant per plot
00	70.000	80.333	27.744	85.233	8.952	57.870	20.000
150	70.444	77.333	28.733	83.303	9.610	67.600	21.444
300	71.667	79.556	30.536	83.713	9.331	62.511	21.667
450	72.000	80.667	30.848	83.772	9.492	68.158	21.111
LSD(0.05)	NS	NS	NS	NS	2.649	NS	NS

NS = Non significant

4.10 Length of rachis at harvest

The length of rachis was not significantly influenced by the application of phosphorus but with different varieties. The highest rachis length (30.848cm) was produced from the treatment 450 kg P/ha. And the minimum rachis length (27.744cm) was from control level (Table 5). Bawaja (2003) reported that the length of rachis increased with the increased level of phosphorus. The rachis length of gladiolus was enhanced by the application of increased level of phosphorus. Similar effect of phosphorus was found by Roy *et al.* (1995). The highest rachis length (34.096 cm) was produced by White Queen and lowest (26.858cm) for Kolmilota (Table 6).

Table 6. The effect of varieties on days required to first spike initiation, days required to first bud break, length of rachis at harvest, length of spike at harvest, number of florets per plant, (%) flowering plant per plot and total number of plant per plot of gladiolus varieties

Varieties	Days required to first spike initiation	Days required to first bud break	Length of rachis at harvest	Length of spike at harvest	No. of florets per spike	(%) Flowering plant per plot	Total number of plant per plot
Kolmilota	78.500	87.083	26.858	75.879	8.640	63.629	21.167
Red Beauty	70.917	80.250	27.442	79.067	8.873	63.547	20.833
White Queen	63.667	71.083	34.096	97.071	10.526	64.928	21.167
LSD(0.05)	NS	NS	11.08	NS	NS	NS	NS

NS = Non significant

4.11 Number of florets per spike

Number of florets per spike varied significantly for different level of phosphorus but not for varieties. The maximum no. of florets (9.610) was found with the treatment 150 kg P/ha while the minimum was (8.952) at 00 kg P/ha (Table 5). Bijimol and Singh (2001) reported that the maximum no. of florets per spike was found at highest phosphorus level. Shah *et al.* (1984) and Gowda *et al.* (1987) found that the maximum level of phosphorus increased the no. of florets per spike. The variety White Queen yields the maximum spike (10.526) and Kolmilota the minimum (8.640) (Table 6).

Table 7. The effect of phosphorus on the number of spike per plot, number of cormels per hill, weight of cormels per hill(g), diameter of cormels (cm) , weight of corm per plant (g) and diameter of corm (cm) of gladiolus varieties

Level of phosphorus (kg/ha)	Number of spike per plot	Number of cormels per hill	Weight of cormels per hill(g)	Diameter of cormels (cm)	Weight of corm per plant (g)	Diameter of corm (cm)	Yield of cormel per plot (kg)	Yield of corm per plot (kg)
00	13.77	13.10	16.91	0.74	43.32	3.72	0.27	1.03
150	16.22	15.66	15.47	0.70	42.70	3.74	0.28	1.01
300	15.00	12.63	21.43	0.77	43.16	3.75	0.82	1.03
450	16.00	13.23	21.11	0.96	43.87	3.67	0.33	1.04
LSD(0.05)	NS	NS	NS	0.32	NS	NS	NS	NS

NS = Non significant

4.12 Percentage of flowering plant

The percentage of flowering plant per plot was not significant both with varieties and phosphorus levels effect on phosphorus. The maximum percentage (68.15) flowers was found at 450 kg P/ha while the minimum (57.87) at 00 kg P/ha (Table 5). Gandaharan and Gopinath (2000) reported that the phosphorus increased the no. of flowering plant in field. Atta- Alla *et al.* (2003) gets satisfactory results on percentage of flowering plants in phosphorus. The variety White Queen produced the maximum percentage (64.92) and Red Beauty produced minimum (63.54) (Table 6).

Table 8. The effect of varieties on the number of spike per plot, number of cormels per hill, weight of cormels per hill(g), diameter of cormels (cm), weight of corm per plant (g) and diameter of corm (cm) of gladiolus

Varieties	Number of spike per plot	Number of cormels per hill	Weight of cormels per hill(g)	Diameter of cormels (cm)	Weight of corm per plant (g)	Diameter of corm (cm)	Yield of cormel per plot (kg)	Yield of corm per plot (kg)
Kolmilota	14.91	14.75	20.27	0.74	42.94	3.74	0.84	1.02
Red Beauty	15.25	13.08	18.57	0.90	42.95	3.41	0.38	1.02
White Queen	15.58	13.11	17.35	0.74	43.90	4.00	0.25	1.04
LSD(0.05)	NS	NS	NS	NS	NS	NS	NS	NS

NS = Non significant

4.13 Number of spike per plot

The effect of phosphorus on number of spike per plot was not significant and the same for the varieties. The maximum no. of spikes (16.22) was found with the treatment 150 kg P/ha while the minimum was (13.77) at control treatment (Table 7). Singh (1998) observed that the phosphorus increased the no. of spike per plot among the other elements. White Queen variety produced the highest (15.58) spike per plot and Kolmilota the lowest (14.91) (Table 8).

4.14 Number of spike per hectare

The number of spike per hectare was not differed significantly both at different levels of phosphorus and varieties at different DAP. The maximum no. of spikes (81.11) was counted with the treatment 150 kg P/ha while the minimum (69.44) was at control treatment (table 14). The increased level of phosphorus increased the spike said by Singh and Bijimol (2003). The variety White Queen produced the highest number (77.91) of spike and Kolmilota the lowest (75.00) (table 15).

4.15 Number of cormels per plant

The effect of phosphorus and varieties on number of cormels per plant were not significant. The maximum no. of cormels (15.66) was found from 150 P/kg while the minimum (12.63) at control treatment (Table 7). Waly *et al.* (2001) and Kumar *et al.* (2006) reported that the increased phosphorus level produced the maximum no. of cormels per plant similar results were found by The varieties Red Beauty produced the maximum number of cormels per plant (14.77) and Kolmilota produced minimum (13.11) (Table 8).

4.16 Weight of cormels per plant (g)

The average weight of cormels per plant was not significant for phosphorus and varieties. The maximum weight of cormels (21.43 g) was found with the treatment 300 kg P/ha while the minimum (15.47 g) was at 150 kg P/ha (Table 7). Sujatha *et al.* (1990) observed that the highest doses of phosphorus was more effective in improving the weight of cormels per plant. Kolmilota yielded the highest (20.27 g) cormel weight and White Queen the lowest (17.35 g) (Table 8).

4.17 Weight of corm per plant (g)

The weight of corm per plant was not significant for both varieties and phosphorus levels. The maximum weight of corm (43.87 g) was found with the treatment 450 kg P/ha while the minimum (42.70 g) was at 150 kg P/ha (Table 7). Kumar and Chattopadhyay (2001) observed that phosphorus improved the weight of corm per plant. Pimpini and Zanin (2002) also found the similar result. The varieties White Queen produced the maximum (43.90 g) corm weight and Kolmilota the minimum (42.94 g) (Table 8).

4.18 Diameter of corm (cm)

Different doses of phosphorus and varieties were not significant on the parameter diameter of corm. The maximum diameter (3.75 cm) of corm was produced with the treatment 300 kg P/ha while the minimum (3.67 cm) was at 450 kg P/ha (Table 7). The maximum corm diameter (4.00 cm) was produced from White Queen and the minimum (3.41 cm) from Red Beauty (Table 8).

4.19 Diameter of cormels (cm)

The average diameter of cormels was significantly on phosphorus but not for varieties. The maximum average diameter of cormels (0.96 cm) was found from the treatment 450 kg P/ha while the minimum (0.70 cm) was at 300 kg P/ha (Table 7). The maximun diameter of cormels (0.90 cm) was produced from Red Beauty and Kolmilota produced the minimum (0.74 cm) (Table 8).

4.20 Yield of corm per plot (kg)

The corm yield per plot showed not significant responses based on phosphorus and varieties. The maximum yield of corm (1.04 kg) was found with the treatment 450 kg P/ha while the minimum (1.01 kg) was at 150 kg P/ha (Table 7). Deo and Dubey (2005) reported that the corm yield per plot of gladiolus increased with increased of phosphorus. The maximum corm per plot (1.04 kg) was produced from White Queen and the minimum (1.02 kg) from Kolmilota (Table 8).

4.21 Yield of cormel per plot (kg)

The cormel yield per plot showed non significant effect by phosphorus levels and varieties. The maximum yield of cormel (1.08 kg) was found with the treatment 300 kg P/ha while the minimum (0.27 kg) was at 00 kg P/ha (Table 7). The variety Kolmilota produced the maximum cormel (1.08 kg) per plot and minimum from White Queen (0.25 kg) (Table 8).

4.22 Yield of corm (t/ha)

Yield of corm per hectare did not differ both in different level of phosphorus and varieties at different DAP. The maximum yield of corm (5.24 t/ha) was found from the treatment 450 kg P/ha while the minimum (5.11 t/ha) was at 150 kg P/ha (table 14). Kathiresan and Venkatesha (2002) highest dose of phosphorus increased the yield of corm. Godse *et al.* (2006) and Das. (1998) the result revealed that yield of corm was increased with increased in phosphorus. The maximum corm yield (5.25 t/ha) was produced by White Queen and Red Beauty produced the minimum (5.13 t/ha) (table 15).

4.23 Yield of cormel (t/ha)

Phosphorus of various levels and varieties both were not significant on the yield of cormel per hectare. The maximum yield of cormel (2.53 t/ha) was found with the treatment 450 kg P/ha while the minimum (1.86 t/ha) was at 150 kg P/ha (table 14). Kolmilota produced the maximum cormel (2.43 t/ha) and White Queen the minimum (2.08 t/ha) (table 15).

4.24 Interaction effect of phosphorus and varieties on various characters of gladiolus

The interaction of different phosphorus levels and varieties have been reported in five different tables (9, 10, 11, 12 and 13) and (Appendix IV). Days required to 80 % emergence was significant effect on phosphorus and varieties but rest of all parameter were non significant on phosphorus and varieties. The minimum days (11.33) required to 80% emergence was recorded from P_3V_3 and P_2V_1, the maximum length of leaves (57.06 cm) was reported from P_3V_3, the maximum number of leaves per plant (8.77) was counted from P_3V_3 (Table 11). The maximum leaves breadth (2.90 cm) at P_2V_3 and the maximum number of tiller (1.59) at P_3V_1 (Table 12). The minimum days required to first spike initiation (63.00) at P_2V_3, the minimum days required to first bud break (71.33) at P_4V_3, the maximum length of rachis at harvest (36.31 cm) at P_3V_3, the maximum length of spike at harvest (101.70 cm) at P_1V_3, the maximum number of florets per plant(11.09) at P_2V_3, the maximum flowering (%) plant per plot (72.21) at P_4V_3 and the maximum total number of plant per plot (22.66) was produced from P_3V_2 (Table 13). The maximum number of spike per plot (17.33) at P_4V_3, the maximum number of cormels per hill (21.25) at P_2V_3, the maximum weight of cormels per hill (27.77 g) at P_3V_1, the maximum diameter of cormels (0.94 cm) at P_4V_1, the maximum weight of corm per plant (45.66 g) at P_1V_3 and the maximum diameter of corm (4.12 cm) at P_2V_2 (Table 14).

Table 9. The interaction effect of phosphorus and varieties on the days required to 80% emergence, length of leaves (cm), number of leaves per plant of Gladiolus

Treatments	Number of leaves per plant			Plant height (cm)		
	35DAP	50 DAP	65 DAP	35DAP	50 DAP	65 DAP
P_1V_1	13.66	3.0	5.88	7.99	22.00	40.75
P_2V_1	14.66	2.83	5.38	8.00	22.89	40.17
P_3V_1	11.33	2.83	5.25	7.62	22.99	38.77
P_4V_1	13.33	2.87	5.63	7.79	20.44	34.39
P_1V_2	13.66	3.10	6.33	8.40	21.29	35.70
P_2V_2	12.33	2.83	5.25	8.00	18.93	35.71
P_3V_2	12.33	3.54	7.13	8.77	26.33	41.16
P_4V_2	12.33	3.54	6.13	8.25	22.72	40.10
P_1V_3	13.33	3.62	5.25	5.89	25.11	35.66
P_2V_3	13.00	4.41	6.50	8.21	30.08	42.96
P_3V_3	11.33	4.20	6.45	7.25	35.18	46.40
P_4V_3	12.66	3.71	5.63	8.25	27.47	39.82
LSD(0.05)	1.07	NS	NS	NS	NS	NS

NS = Non significant

P_1=00 k g /ha P_2= 150 kg/ha P_3= 300 kg /ha P_4= 450kg/ha

V_1= Kolmilota V_2= Red Beauty V_3= White Queen

Table 10. The interaction effect of phosphorus and varieties on the leaves breadth (cm) and number of tiller of gladiolus

Treatments	Number of tiller			Length breadth (cm)		
	35DAP	50 DAP	65 DAP	35DAP	50 DAP	65 DAP
P_1V_1	1.23	1.43	1.43	1.23	2.16	2.49
P_2V_1	1.06	1.10	1.10	1.76	2.07	2.68
P_3V_1	1.27	1.59	1.59	1.46	1.98	2.43
P_4V_1	1.15	1.47	1.47	1.41	1.77	2.21
p_1V_2	1.11	1.17	1.17	1.21	1.72	2.12
P_2V_2	1.1	1.25	1.25	1.34	1.79	2.28
P_3V_2	1.13	1.14	1.14	1.64	2.04	2.41
P_4V_2	1.36	1.40	1.40	1.45	2.07	2.38
P_1V_3	1.29	1.43	1.43	1.59	2.06	2.50
P_2V_3	1.19	1.30	1.30	2.07	2.36	3.90
P_3V_3	1.19	1.33	1.33	2.08	2.53	2.50
P_4V_3	1.40	1.50	1.50	1.64	2.12	2.66
LSD(0.05)	NS	NS	NS	NS	NS	NS

NS = Non significant

P_1=00 k g /ha P_2= 150 kg/ha P_3= 300 kg /ha P_4= 450kg/ha

V_1= Kolmilota V_2= Red Beauty V_3= White Queen

Table 11. The interaction effect of phosphorus and varieties on days required to first spike initiation, days required to first bud break, length of rachis at harvest, length of spike at harvest, number of florets per plant, flowering (%)plant per plot and total number of plant per plot of gladiolus

Treatments	Days required to first spike initiation	Days required to first bud break	Length of rachis at harvest	Length of spike at harvest	No. of florets per plant	(%) Flowering plant per plot	Total number of plant per plot
P_1V_1	77.00	88.33	20.00	75.33	7.13	54.16	21.33
P_2V_1	81.66	90.00	31.10	87.27	9.10	70.85	20.66
P_3V_1	76.66	82.66	22.75	68.25	8.08	58.36	20.33
P_4V_1	87.66	87.33	33.583	72.65	10.24	71.10	22.33
P_1V_2	68.66	78.66	27.00	78.66	8.66	59.72	18.66
P_2V_2	66.66	75.00	23.50	70.80	8.63	66.66	21.66
P_3V_2	74.33	84.00	32.54	82.13	9.75	66.66	22.66
P_4V_2	74.00	83.33	26.70	84.66	8.44	61.10	20.33
P_1V_3	64.33	74.00	36.23	101.70	11.07	59.72	20.00
P_2V_3	63.00	67.00	31.60	91.83	11.09	65.28	22.00
P_3V_3	64.00	72.00	36.31	100.57	10.15	62.50	22.00
P_4V_3	63.00	71.33	32.24	93.99	9.79	72.21	20.00
LSD(0.05)	NS	NS	NS	NS	NS	NS	NS

NS = Non significant

P_1=00 k g /ha P_2= 150 kg/ha P_3= 300 kg /ha P_4= 450kg/ha

V_1= Kolmilota V_2= Red Beauty V_3= White Queen

Table 12. The interaction effect of phosphorus and varieties on the number of spike per plot, number of cormels per hill, weight of cormels per hill(g), diameter of cormels (cm), weight of corm per plant (g) and diameter of corm (cm) of gladiolus

Treatments	Number of spike per plot	Number of cormels per hill	Weight of cormels per hill(g)	Diameter of cormels (cm)	Weight of corm per plant (g)	Diameter of corm (cm)
P_1V_1	12.66	17.2	15.34	0.58	41.63	3.77
P_2V_1	17.00	13.09	14.26	0.61	42.46	3.73
P_3V_1	14.00	13.26	27.77	0.82	42.33	3.69
P_4V_1	16.00	15.47	23.70	0.94	45.33	3.80
P_1V_2	14.33	10.35	18.05	0.92	45.66	3.20
P_2V_2	16.00	12.63	14.47	0.78	41.30	3.37
P_3V_2	16.00	12.43	20.92	0.85	43.50	3.52
P_4V_2	14.66	16.91	20.87	1.05	41.33	3.56
P_1V_3	14.33	11.69	17.35	0.72	42.66	4.18
P_2V_3	15.66	21.23	17.68	0.70	44.33	4.12
P_3V_3	15.00	12.20	15.61	0.65	43.66	4.06
P_4V_3	17.33	7.33	18.76	0.88	44.97	3.67
LSD(0.05)	NS	NS	NS	NS	NS	NS

NS = Non significant

P_1=00 k g /ha P_2= 150 kg/ha P_3= 300 kg /ha P_4= 450kg/ha

V_1= Kolmilota V_2= Red Beauty V_3= White Queen

Table 13. The interaction effect of phosphorus and varieties on the number of spike per ha, yield of corm per ha(t/ha), yield of cormel per ha(t/ha)of gladiolus

Treatments	Number of spike per ha('000)	Yield of corm per ha(t/ha)	Yield of cormel per ha(t/ha)
P_1V_1	65.00	4.93	1.83
P_2V_1	85.00	5.10	1.70
P_3V_1	70.00	5.10	3.33
P_4V_1	80.00	5.43	2.84
P_1V_2	71.66	5.46	2.22
P_2V_2	80.00	4.90	1.73
P_3V_2	80.00	5.23	2.53
P_4V_2	73.33	4.93	2.50
P_1V_3	71.66	5.13	2.07
P_2V_3	78.33	5.33	2.14
P_3V_3	75.00	5.20	1.87
P_4V_3	85.66	5.36	2.24
LSD(0.05)	NS	NS	NS

NS = Non significant

P_1=00 k g /ha P_2= 150 kg/ha P_3= 300 kg /ha P_4= 450kg/ha

V_1= Kolmilota V_2= Red Beauty V_3= White Queen

4.25 Economic analysis

The details of economic analysis have been shown in (Table 13 and 14) and in (Appendix 5). Cost and Return analysis in details were done according to the procedure of Alam *et al.* (1989). Materials, non-materials and overhead cost including harvest of spikes, corm and cormels were recorded for all the treatment of unit plot basis and calculated per ha. The total cost of production ranged between TK. 614660 to 603590 per ha. Among the treatment, the variation was due to the cost of doses of phosphorus. The highest cost of production (TK. 614660) was involved with the 450 kg P/ha treatment. And the cost of production (TK. 608510) was involved with the all varieties. This might be to the fact that cost of production varied with the phosphorus level which resulted cost of production. The gross return for phosphorus ranged from TK. 1175552 to 1299888 per ha. Gross return was the total income through sell of spikes, corm and cormels. The highest gross return (TK. 1299888) was obtained from the treatment 450 kg P/ha and the lowest (TK. 1175552) from control treatment 00 kg P/ha. The highest gross return (TK. 1253336) was obtained from the White Queen and the lowest (TK. 1235700) from variety Red Beauty. The Benefit Cost Ratio (BCR) was found to be the highest (2.12) in the treatment 450 kg P/ha. On the other hand, the lowest Benefit Cost Ratio (BCR) (1.95) was obtained from the 00 kg P/ha control treatment. The Benefit Cost Ratio (BCR) was found to be the highest (2.05) in variety White Queen and the lowest Benefit Cost Ratio (BCR) (2.03) was obtained from the Red Beauty.

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Table 14. The effect of phosphorus on the growth, flowering, corm, cormel yield and economic return of gladiolus

Level of phophorus (Kg/ha)	Number of spike ('000/ha)	Yield of corm(t/ha)	Yield of cormel (t/ha)	Price of spike (TK/ha)	Price of corm (TK/ha)	Price of cormel (TK/ha)	Gross return (TK/ha)	Total cost of production	Net return	Benefit Cost Ratio
00	69.44	5.17	2.04	555552	517800	102200	1175552	603590	571962	1.95
150	81.11	5.11	1.86	648888	511100	93050	1253038	607280	645758	2.06
300	75.00	5.17	2.57	600000	517800	128900	1246700	608510	638190	2.05
450	80.00	5.24	2.53	640000	524400	126600	1299888	614660	685228	2.12

Spike price @ TK 8/piece
Corm price @ TK 100/kg
Cormel price @ TK 50/kg

Table 15. The effect of varieties on the growth, flowering, corm, cormel yield and economic return of gladiolus

Varieties	Number of spike ('000'/ha)	Yield of corm(t/ha)	Yield of cormel (t/ha)	Price of spike (TK/ha)	Price of corm (TK/ha)	Price of cormel (TK/ha)	Gross return (TK/ha)	Total cost of production	Net return	Benefit Cost Ratio
Kolmilota	75.00	5.15	2.43	600000	515200	121500	1236700	608510	628190	2.03
Red Beauty	76.25	5.13	2.24	610000	513300	112400	1235700	608510	627190	2.03
White Queen	77.91	5.25	2.08	623336	525800	104200	1253336	608510	644826	2.05

Spike price @ TK 8/piece
Corm price @ TK 100/kg
Cormel price @ TK 50/kg

CHAPTER V

SUMMARY

An experiment was conducted to find out the effect of phosphorus of growth, flowering, corm and cormel yield of gladiolus at the Professor Purnnendu Gain Field Laboratory of Agrotechnology discipline of Khulna University, during the period of October 2012 to April 2013. The double factor experiment consist of four levels of phosphorus viz, 00 kg P/ha, 150kg P/ha, 300 kg P/ha, 450 kg P/ha and three gladiolus varieties named Kolmilota, Red Beauty and White Queen.

The double factor experiment was laid out in the Randomized Complete Block Design (RCBD) with three replications. The size of unit plot was 2m ×1m. The plot was supplied with 10 kg of well decomposed cow dung are uniformly incorporated with soil. The total amount of phosphorus and potassium were applied to the soil as per treatment during final land preparation. Nitrogen was applied in two equal splits doses Days After Planting (DAP). Corms were planted on 29 November, 2012 having spacing 25cm × 30cm. Corm and cormels were harvested at 15 Jun 2013. Eight plants from each plot were randomly selected and identified with tag for data collection. The flower, corm and cormel yield was recorded from all plants to each plot. Data were recorded for days required to 80% emergence, plant height, number of leaves and tillers per hill, days required for first spike initiation, days required for first bud break, spike length, number of florets per spike, percentage of flowering plant, number of spike per plot, no. of spike per ha, no. of cormel per plant, weight of corm per plant, yield of cormel per plot, yield of corm per plot, yield of corms per ha and yield of cormels per ha. The collected data were statistically analyzed and results have been summarized as follows:

The results of the experiment revealed that the time required for 80% emergence of new gladiolus plant from corm varied significantly with different doses of phosphorus but not with different varieties. The phosphorus level 300kg P/ha required minimum (11.66 days) and maximum (13.55 days) were required for control level for 80 % emergence. For varieties minimum (12.58 days) and maximum (13.25 days) were counted for 80% emergence of gladiolus plant for White Queen and Kolmilota, respectively.

The different level of phosphorus were significant only 35 DAP and rest two DAP were not significant and varieties were not significant in respect of plant height. The plant height was maximum (52.87 cm) at 300kg P/ha at 65 DAP while minimum (48.82 cm) at 450 kg P/ha. The maximum plant height (52.37 cm) was obtained from the variety White Queen and minimum (49.02 cm) from Red Beauty at 65 DAP.Number of tiller did not differ significantly both at varieties and phosphorus levels at different DAP. The highest no. of tillers per hill was (1.45) from the treatment 450 kg P/ha on the other hand the lowest no. of tillers (1.22) from 150 kg P/ha. The variety Kolmilota produced the best (1.40) and Red Beauty was low (1.24). Days required to first spike initiation varied significantly for varieties but not for different phosphorus levels. Highest P level (450 kg) required maximum time (72 days) whereas control required minimum (70 days) to initiate first spike. The variety White Queen took the lowest time (63.66 days) and Kolmilota required the highest time (78.50 days). Number of days required to appear first bud differed significantly for different varieties but not for phosphorus. The maximum period (80.66 days) was required to bud break by 450 kg P/ha while the minimum (77.33 days) was at 150 kg P/ha. Maximum time (87.08 days) required for Kolmilota and minimum (71.08 days) for White Queen. Length of spike at harvest is varied significantly for varieties but not for phosphorus level. Control treatment produced the maximum length of spike (85.23cm) while the minimum (83.30cm) at 150 kg P/ha. The varieties White Queen produced the highest spike length (97.07 cm) and Kolmilota the lowest (75.87 cm). The length of rachis was not significantly influenced by the application of phosphorus but with different varieties. The highest rachis length (30.84 cm) was produced from the treatment 450 kg P/ha. And the minimum rachis length (27.74 cm) was from control level. The highest rachis length (34.09 cm) was produced by White Queen and lowest (26.85 cm) for Kolmilota. Number of florets per spike varied significantly for different level of phosphorus but not for varieties. The maximum no. of florets (9.61) was found with the treatment 150 kg P/ha while the minimum was (8.95) at 00 kg P/ha. The variety White Queen yields the maximum spike (10.52) and Kolmilota the minimum (8.64).

The percentage of flowering plant per plot was not significant both with varieties and phosphorus levels effect on phosphorus. The maximum percentage (68.15) flowers was found at 450 kg P/ha while the minimum (57.87) at 00 kg P/ha . The variety White Queen produced the maximum percentage (64.92) and Red Beauty produced minimum (63.54).

The effect of phosphorus on number of spike per plot was not significant and the same for the varieties. The maximum no. of spikes (16.22) was found with the treatment 150 kg P/ha while the minimum was (13.77) at control treatment. White Queen variety produced the highest (15.58) spike per plot and Kolmilota the lowest (14.91). The number of spike per hectare was not differed significantly both at different levels of phosphorus and varieties at different DAP. The maximum no. of spikes (81.11) was counted with the treatment 150 kg P/ha while the minimum (69.44) was at control treatment. The variety White Queen produced the highest number (77.91) of spike and Kolmilota the lowest (75.00). The average weight of cormels per plant was not significant for phosphorus and varieties. The maximum weight of cormels (21.43 g) was found with the treatment 300 kg P/ha while the minimum (15.47 g) was at 150 kg P/ha. Kolmilota yielded the highest (20.27 g) cormel weight and White Queen the lowest (17.35 g). The weight of corm per plant was not significant for both varieties and phosphorus levels. The maximum weight of corm (43.87 g) was found with the treatment 450 kg P/ha while the minimum (42.70 g) was at 150 kg P/ha. The varieties White Queen produced the maximum (43.90 g) corm weight and Kolmilota the minimum (42.94 g). Different doses of phosphorus and varieties were not significant on the parameter diameter of corm. The maximum diameter (3.75 cm) of corm was produced with the treatment 300 kg P/ha while the minimum (3.67 cm) was at 450 kg P/ha. The maximum corm diameter (4.00 cm) was produced from White Queen and the minimum (3.41 cm) from Red Beauty. The corm yield per plot showed not significant responses based on phosphorus and varieties. The maximum yield of corm (1.04 kg) was found with the treatment 450 kg P/ha while the minimum (1.01 kg) was at 150 kg P/ha. The maximum corm per plot (1.04 kg) was produced from White Queen and the minimum (1.02 kg) from Kolmilota.

The cormel yield per plot showed non significant effect by phosphorus levels and varieties. The maximum yield of cormel (1.08 kg) was found with the treatment 300 kg P/ha while the minimum (0.27 kg) was at 00 kg P/ha. The variety Kolmilota produced the maximum cormel (1.08 kg) per plot and minimum from White Queen (0.25 kg). Yield of corm per hectare did not differ both in different level of phosphorus and varieties at different DAP. The maximum yield of corm (5.24 t/ha) was found from the treatment 450 kg P/ha while the minimum (5.11 t/ha) was at 150 kg P/ha. The maximum corm yield (5.25 t/ha) was produced by White Queen and Red Beauty produced the minimum (5.13 t/ha). Phosphorus of various levels and varieties both were not significant on the yield of cormel per hectare. The maximum yield of cormel (2.53 t/ha) was found with the treatment 450 kg P/ha while the minimum (1.86 t/ha) was at 150 kg P/ha. Kolmilota produced the maximum cormel (2.43 t/ha) and White Queen the minimum (2.08 t/ha).

In economic analysis it was observed that the highest net return (TK.685228) and Benefit Cost Ratio (2.12) were obtained from the 450 kg P/ha treatment and White Queen produced the highest net return (TK. 644826) and benefit cost ratio (2.05).

conclusion

Considering the all parameter of gladiolus under the field condition we can concluded that the analyzed data of gladiolus maximum were not significant for phosphorus and varieties but numerically showed that:

- ✓ The phosphorus level 450 kg/ha and White Queen took the better results under farm condition of Agrotechnology Discipline of Khulna University is mostly accepted
- ✓ However, further study is needed at farmer's field to recommend the practice for use of national level

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APPENDICES

Appendix I. Data of soil chemical analysis of the experimental plot.

Soil properties	Examined Values	Critical values
Soil pH	6.5	7.00
Total nitrogen	0.07%	0.12%
Phosphorus available	5 ppm	10 ppm
Potassium	0.01 ppm	0.2 ppm

Source: Soil Testing Laboratory of Khulna University.

Appendix II. Weather data of temperature, relative humidity, rainfall and sunshine during the period of study in the experimental site (November 2012 to April 2013)

Year	Month	Air temperature			Relative humidity (%)	Rainfall (mm)	Sunshine
		Max.	Min.	Average			
2012	October	25.55	15.56	23.26	82.50	0.00	160.51
	November	25.33	14.45	22.45	82.05	0.20	151.80
	December	24.87	11.67	16.87	82.98	0.00	129.44
2013	January	23.41	10.87	17.47	80.90	0.00	111.56
	February	25.65	15.76	19.51	84.87	0.00	149.56
	March	25.98	17.93	20.82	86.65	76.87	234.54
	April	29.98	22.70	24.84	87.23	86.97	200.34

Appendix III. The effect of phosphorus and varieties on the plant height, number of spike per ha, yield of corm t/ha and yield of cormel t/ha of gladiolus

Level of phosphorus (kg/ha)	Plant height (cm)			Number of spike per ha (000)	Yield of corm (t/ha)	Yield of cormel (t/ha)
	35 DAP	50 DAP	65 DAP			
00	22.80	37.37	48.82	69.44	5.17	1.03
150	23.97	39.62	50.85	81.11	5.11	1.01
300	28.16	42.12	52.87	75.00	5.17	1.03
450	23.54	38.10	48.34	80.00	5.24	1.04
Varieties						
Kolmilota	22.08	38.52	49.27	75.00	5.14	1.02
Red Beauty	22.32	38.16	49.02	76.25	5.13	1.02
White Queen	29.46	41.22	52.37	77.91	5.25	1.04

Appendix IV. Analysis of Variance (ANOVA) for different parameters under study as influenced by phosphorus and varieties of gladiolus

Source of variation	Degree of freedom	Mean sum of squares			
		Days required to 80% emergence of plant	Plant height		
			35 DAP	50 DAP	65 DAP
Replication	2	0.52 NS	0.01 NS	0.76 NS	0.63 NS
Factor (A)	2	0.51 NS	8.94 NS	1.26 NS	2.07 NS
Factor (B)	3	0.53 NS	2.21 NS	1.50 NS	1.93 NS
AB	6	0.54 NS	0.77 NS	1.38 NS	0.65 NS
Error	22				

NS= Non significant

Appendix IV. Continued

Source of variation	Degree of freedom	Weight of corm per plant(g)	Diameter of corm (cm)	Number of cormel per hill	Weight of cormel per hill	Number of spike per ha	Corm yield per plot	Cormel yield per plot	Yield of corm (t/ha)	Yield of cormel (t/ha)
Replication	2	0.15 NS	0.94 NS	2.38 NS	0.22 NS	0.17 NS	0.17 NS	0.54 NS	0.16 NS	0.23 NS
Factor (A)	2	0.58 NS	6.26 NS	0.26 NS	0.67 NS	0.14 NS	0.47 NS	0.54 NS	0.56 NS	0.64 NS
Factor (B)	3	0.33 NS	0.06 NS	0.39 NS	2.13 NS	1.49 NS	0.24 NS	0.47 NS	0.25 NS	2.06 NS
AB	6	1.71 NS	0.70 NS	1.41 NS	1.06 NS	0.51 NS	1.47 NS	0.68 NS	1.72 NS	1.09 NS
Error	22									

NS= Non significant

Appendix IV. Continued

Source of variation	Degree of freedom	Leaves breadth (cm) at			Number of leaves at			Number of tiller/hill	Number of plant/plot	First spike initiation
		35 DAP	50 DAP	65 DAP	35 DAP	50 DAP	65 DAP			
Replication	2	0.77 NS	1.02 NS	0.23 NS	2.79 NS	0.385 NS	2.12 NS	1.37 NS	0.50 NS	1.28 NS
Factor (A)	2	7.79 NS	4.97 *	5.35 *	17.47 NS	1.31 NS	2.32 NS	1.28 NS	0.07 NS	16.63 NS
Factor (B)	3	3.63 *	0.96 NS	1.70 NS	0.56 NS	1.38 NS	0.72 NS	1.12 NS	0.79 NS	0.20 NS
AB	6	0.82 NS	1.43 NS	1.25 NS	1.61 NS	0.95 NS	1.28 NS	0.74 NS	0.76 NS	0.66 NS
Error	22									

*= Significant at 5% level
NS= Non significant

Appendix V. Cost of production of gladiolus per ha

A. a. Input cost of phosphorus (TK/ha)

Level of phosphorus (kg/ha)	Labour cost	Ploughing cost	Seed cost	Pesticide cost	Cow dung cost	Urea cost	TSP cost	MOP cost	Sub total input cost(A)	Miscellaneous (5%) of total input cost	Total running capital of input cost
00	54000	4000	480000	1000	12000	6300	000	6300	563600	7000	570600
150	54000	4000	480000	1000	12000	6300	3600	6300	567200	7000	574200
300	54000	4000	480000	1000	12000	6300	4800	6300	568400	7000	575400
450	54000	4000	480000	1000	12000	6300	10800	6300	574400	7000	581400

A. b. Input cost of varieties (TK/ha)

Varieties	Labour cost	Ploughing cost	Seed cost	Pesticide cost	Cow dung cost	Urea cost	TSP cost	MOP cost	Sub total input cost(A)	Miscellaneous (5%) of total input cost	Total running capital of input cost
Kolmilota	54000	4000	480000	1000	12000	6300	4800	6300	568400	7000	575400
Red beauty	54000	4000	480000	1000	12000	6300	4800	6300	568400	7000	575400
White Queen	54000	4000	480000	1000	12000	6300	4800	6300	568400	7000	575400

Labour cost @ TK. 300/day
Ploughing @ TK. 500/bigha
Corm (seed) @ TK. 4/piece

Cowdung @ TK. 1.5/kg
Urea @ TK. 21/kg
TSP @ TK. 24/kg
MOP @ TK. 24/kg