INFLUENCE OF BULB SIZE AND PHOSPHORUS ON GROWTH AND FLOWERING OF TUBEROSE CV SINGLE

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INFLUENCE OF BULB SIZE AND PHOSPHORUS ON GROWTH AND FLOWERING OF TUBEROSE CV SINGLE

BY

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CERTIFICATE

This is to certify that thesis entitled, ***"Influence of bulb size and phosphorus on growth and flowering of tuberose cv single"*** *submitted to the Department of Horticulture & 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* ***MD. KHALID HOSSAIN Reg. No. 00876*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

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The Author

Dedicated To

My Beloved Parents

INFLUENCE OF BULB SIZE AND PHOSPHORUS ON GROWTH AND FLOWERING OF TUBEROSE CV SINGLE

BY

MD. KHALID HOSSAIN

ABSTRACT

The experiment was conducted in the Horticultural Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from April, 2007 to January, 2008. The experiment considered with two factors; Factor A: Three Bulb size i.e. small (B_1:1-1.5 cm), medium (B_2 :> 1.5-2.0 cm) and large (B_3 :> 2.0-2.5 cm) in diameter; Factor B: Four levels of Phosphorus fertilizer i.e. F_0: 0 kg, F_1: 120 kg, F_2:140 kg, F_3:160 kg P_2O_5/ha respectively. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. In case of bulb size, B_3 produced tallest tuberose plant (55.32 cm), highest length of flower stalk (80.04 cm) and highest number of floret/spike (35.71) and B_1 gave the lowest results in all cases. In case of phosphorus fertilizer tallest tuberose plant (55.4 cm), highest length of flower stalk (74.9cm) and highest number of floret/spike (31.6) was recorded in F_2 and lowest results in control. For interaction effect the tallest tuberose plant (58.1 cm), highest length of flower stalk (81.73cm) and highest number of floret/spike (39.5) was recorded in B_3F_2. So large size bulb with 140 kg P_2O_5/ha is best for growth and flowering of tuberose.

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ABBREVIATIONS AND ACRONYMS

AEZ	Agro Ecological Zone
BARI	Bangladesh Agricultural Research Institute
CV	Cultivar
^{o}C	Degree Celsius
cm	Centimeter
DAS	Days After sowing
ed	edited
Ed.	Edition
et al.	and others
gm	Gram
Kg	Kilogram
LSD	Least Significant Difference
m	Meter
mg	Milligram
N	Nitrogen
NS	Non Significant
P^{H}	Hydrogen Ion Conc.
PPM	Parts Per million
RCBD	Randomized Complete Block Design
RH	Relative Humidity
SAU	Sher-e-Bangla Agriculture University
t	ton
t/ha	ton per hectare
Viz.	Namely
Var.	Variety

Chapter 1

Introduction

CHAPTER-I

INTRODUCTION

Among the ornamental bulbous plants tuberose (*Polianthes tuberosa L.*) is one of the most popular cut flower. Tuberose belongs to the family Amaryllidaceae. Tuberose is a native of Mexico from where it spread to the different parts of the world during the 16th century. Tuberose occupies a very selective and special position to flower loving people because of their prettiness, elegance and sweet pleasant fragrance, it has a great economic potential for cut-flowers trade and essential oil industry (Sadhu and Bose, 1973). In the orient, where 'white' goes for virtue and purity, tuberose is much adored for its color, elegance and fragrance. Tuberose occupies a prime position because of its popularity as cut-flower, loose flower as well as for its potential in perfume industry. Tuberose is extensively cultivated in many tropical and subtropical parts of the world.

The long spikes of tuberose are used as cut flowers in vase decoration and bouquets preparation, while individual floret is used for making veni, garland, button-holes or crown. Tuberose is planted in beds and borders, but can also be grown as potted plant. Tuberose has a delightful fragrance and is the source of tuberose oil. The natural flower oil of tuberose is one of the most expensive raw materials for perfume.

In Bangladesh, since last few years tuberose has become a popular cut flower for its attractive fragrance and beautiful display in the vase. Now it is one of the most

important commercial cut flowers. Tuberose has a high demand in the market and its production is highly profitable (Aditya, 1992).

There are three types of tuberose: Single with one row of corolla segment, Semi-double bearing flowers with two to three rows of corolla segment and double having more than three rows of corolla segments. The florets of the double tuberose often fall to open completely which results in the reduction of its fragrance. Single flower type is more fragrant and is widely cultivated than the other type.

There are many factors which can affect plant growth and economic cultivation of tuberose, different factors such as size of bulb and bulblet, depth of planting. The number of flowers per spike, flower quality, daughter bulb production etc. were found to be related to bulb size (Mahanta *et al.* 1998). Singh *et al.* (2004) reported that plants raised from large bulbs had the greatest plant height, number of leaves per clump, bulb and bulblet per clump, inflorescence length, spike length, spike diameter, flowers per spike, spikes per plant and showed the earliest flowering.

Phosphorus has a significant effect on spike production and floret quality. It also helps in increasing the number of leaves, bulbs, spikes and flowers (Banker and Mukhopadhyay, 1990). Length of spike and rachis increased significantly (opening of first floret and last floret) with increasing doses of P fertilizer (Amarjeet *et al.* 1996).

There is a scope of increasing flower yield, quality of flower, bulb and bulblet production of tuberose with the appropriate size of bulb and application of

fertilizer. An optimum rate of application of fertilizer will not only ensure better yield and quality of tuberose but also led to minimum loss of fertilizer.

In Bangladesh, very few studies have been done regarding the bulb size and application of phosphorus for growth, flowering, bulb and bulb let production of tuberose. So, research work is still lacking in the country.

Considering the above mentioned facts the present investigations were undertaken with the following objectives-

1. To study the growth and flowering of tuberose under different size of bulb.
2. To find out the appropriate level of phosphorus (P) for production of flower, bulb and bulb let.
3. To find out the best combination of bulb size and dose of phosphorus (P).

Chapter 2

Review of Literature

CHAPTER-II

REVIEW OF LITERATURE

Tuberose is one of the most popular cut flower in the world. Many research works have been done on various aspects of this important cut flower in different countries of the world. However, a limited research has been carried out on this flower under Bangladesh condition. A review of literature related to the effects of bulb size and application of phosphorus on growth, flower, bulb and bulb let production of tuberose is given below under the following headings.

2.1 Effect of bulb size

Generally bulb and bulb let are used as planting materials for propagating tuberose. Size of bulb used at planting has direct effects on bulb lets, bulbs and flowering of tuberose.

Kumar *et al.* 2003 studied the effect of bulb size (<1.5, 1.5-2.5 or 2.5-3.5 cm), and spacing (20 x 20, 25 x 25 and 30 x 30 cm) and planting depth (3, 6 or 9 cm) on growth and development of tuberose (*Polianthes tuberosa* cv. Single) in Unium, Meghalaya, India, during 1998 and 1999. Sprouting was delayed with the increase in bulb size, planting depth and reduction in spacing. Large bulb resulted in the earliest spike emergence (93.89 days). Spike emergence was delayed with the increase of the planting depth. Spike lengths 88.78 and 89.37 cm and rachis lengths 19.76 and 20.06 cm were greatest with medium and large bulbs. The depth of planting was inversely related to flower quality in terms of spike and rachis length.

Thus the longest spike 89.52 cm and rachis 19.48 cm were obtained with a planting depth of 9 cm. The number of flower spike decreased with a deep planting of small bulb at closer spacing. The number of floret /spike 33.70 was recorded for a spacing of 30 x 30 cm. This parameter, however, was independent of bulb size and planting depth. Increasing bulb size 2.5 cm and planting depth up to 9 cm increased bulb production. Small bulb in combination with the widest spacing resulted in the earliest bulb sprouting 8.28 days, medium bulbs with moderate planting depth 6 cm and spacing 25 x 25 cm gave higher yield of flower and bulb.

Misra *et al.* (2000) studied the to determine the effect of bulb size and spacing (10 x 30, 15 x 30, 20 x 30 and 30 x 30 cm) on growth and flowering of 2 tuberose (*P. tuberose*) cultivars (single and double) in Faizabad, Uttar Pradesh, India, during 1997-98. Bulb size significantly influenced the initiation of spikes in both cultivars. The maximum days for spike initiation by smaller bulb size was 170.8 and 222.7 days for single and double cultivars, respectively. The larger bulb size produced the highest number of spikes/plant for both cultivars. With closer spacing, the plants took a longer time to produce spikes than wider-spaced plants. The number of spikes/plant was higher in wider-spaced plants. However, a bulb size of 2.6-3.0 cm at 30x30 cm spacing was the best for both the cultivars.

Raja and Palanisamy (2000) conducted a field experiment in Coimbatore, Tamil Nadu, India, during 1997-98. Mother bulbs and fingers of tuberose (*Polianthes tuberose*) of varying sizes (extra large, large, medium and small) were planted.

Observations on days to emergence, percent emergence, vegetative growth and flower stalk characteristics and bulb yield traits were recorded. Mother bulb more than 2.5 cm in diameter performed better than fingers. The small bulb in the fingers took fewer days to emergence than larger bulbs. Plant height and number of plantlets/plant and number of leaves/plant increased with increasing size of planting materials. Mother bulb 2.5-3.0 cm took 97 days to initiate flower stalk emergence, the medium and small bulbs did not produce flowers. The number of flower stalk and flower yield/clump were higher for large mother bulbs than for large fingers. The number and weight of mother bulbs and fingers per clump were highest when large and extra large mother bulbs were used as planting material. Highest bulb weight per clump was recorded from bulbs with a diameter of 4 cm.

Raja and Palanisamy (1999) conducted in Tamil Nadu, India *P. tuberosa* cv. Single mother bulbs with a diameter 4.0 cm gave the highest percent emergence (89.0), greatest plant height (48.2 cm) at 200 days after planting, highest number of flower stems (3.1), longest flower stems (106.4 cm), and the highest flower yield per clump (131.7 g), weight of fingers per clump (64.4 g) and bulb weight per clump (161.7 g). Small mother bulbs (2.5 to 3.0 cm diameter) had the earliest flower stem emergence (96.7 days) large bulbs (3.5 to 4.0 cm diameter) gave the highest number (3.41) and heaviest (120.8 g) bulbs per clump. Medium bulbs (3.0 to 3.5 cm diameter) gave the highest number of fingers per clump (10.58).

In 2-year experiments Kumar and Singh (1998) studied *P. tuberosa* bulbs of diameter 1.5-2.0, 2.1-2.5 or 2.6-3.0 cm were planted at spacing of 20x20, 30x20 or

30x30 cm and given N at 0, 100, 200 or 300 kg/ha. Bulbs yield increased with increasing N rate and initial bulb size and with wider spacing.

Reddy *et al.* (1998) noted that the number and length of leaves 180 days after planting were greatest from bulbs 2.1-2.5 cm in diameter.

Kumar and Singh (1998) reported that bulbs of *Polianthes tuberosa* cv. Single 1.5-2.0, 2.1-2.5 or 2.6-3.0 cm in diameter were planted at spacing 20x20, 30x20 or 30x30 cm on 22 March 1991 or 15 March 1992 and given 0, 100, 200 or 300 kg N/ha as urea. The urea was applied half at planting and then as 2 top dressings 60 and 90 days later. Scope emergence was earliest from the smallest bulbs planted at the widest spacing and given the highest N rate. Cut flower yield and quality and bulb production were greatest from the largest bulbs planted at the widest spacing and given the highest N rate.

Mahanta *et al.* (1998) studied the effect of bulb size (diameter of 0.5-3.5 cm) on growth and flowering of P. tuberose in India during 1993-95. It was found that shoot emergence was delayed with increasing bulb size. Other characters (height of plant, number of leaves and shoots per clump, days to flowering, length of spike and rachis and number of florets per spike) were enhanced increasing bulb size.

In an experiment at Hissar, India, Reddy and Singh (1997) reported that the number of bulbs and weight of bulbs per plant increased with increase in bulb size used for planting. Salable bulbs per plant were greatest in the plants raised from bulbs

measuring 2.1-3.0 cm in diameter. Bulb lets were smallest on plants from the smallest bulbs, and largest on plants raised from large bulbs.

Mahanta and Paswan (1995) observed that bulbs [rhizomes] of *Polianthes tuberosa* cv. Single , 2.25-3.00 cm (D1), 1.50-2.25 cm (D2) or 0.75-1.50 cm (D3) in diameter, were planted at 20 x 20 (S1), 20 X 15 (S2) or 20 x 10 cm (S3) for cut flower production. D1bulbs showed slower shoot emergence but flowered earlier, produced taller plants, longer spikes and rachis, more leaves/plant, florets/spike and bulbs/plant, and heavier bulbs that D2 and D3. With regard to spacing, the number of leaves/plant decreased with plant density. The time to flowering was shortest with S3 and longest with S1. The highest number of spikes/m2 (58.55) and spike yield (169.18 q/ha) were obtained with the combination of D1and S3.

Sathyanarayana *et al.* (1994) studied the effect of bulb size on the flowering of *Polianthes tuberosa*. Flower spikes from large bulbs emerged and flower earlier than those from small bulbs. The numbers of spike/plant and spike/ha increased with increasing bulb size. Flower spikes from large bulbs had more florets than those from small bulbs.

Rao *et al.* (1992) conducted a field experiment at Tirupati, India. Bulbs of P. tuberose cv. Single of different sizes were planted at depths of 2, 4 or 6 cm. With large bulbs, the number of leaves , bulbs and side shoots produced per clump were higher, sprouting and flowering were earlier and flower yield per clump and per spike were higher. As planting depth increased, vegetative growth and flower yield

decreased. There was no significant interaction between planting depth and bulb size.

Rao *et al.* (1991) conducted an experiment .In their experiment they used tubers having 0.5-1.5, 1.5-2.5 or 2.5-3.5 cm in diameter were planted 2, 4 or 6 cm deep. Large tubers significantly increased flower yield and tuber yield and advanced flowering. Shallow planting resulted in higher flower yield, but generally planting depth had no marked effects on other growth and flower indices. Shallow planting of large tubers is recommended.

Patil *et al.* (1987) conducted an experiment. In their experiment they used rhizomes having 0.5-1.5, 1.5-2.5 or 2.5-3.5 cm in diameter and 15x20, 20x20 or 25x20 cm spacing and the plants were grown for three years for cut flowers. The highest yield of top quality flowers were obtained from the large rhizome planted at 15x20 cm.

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

Pathak *et al.* (1980) noted that bulb size also influences flowering. Larger bulb cause early flowering and gives higher yield of spikes and flowers.

According to Sadhu and Das (1978) the size of bulb plays an important role on growth and flowering of tuberose. It influences the sprouting of bulbs and time required is inversely proportional to size of the bulb.

Kale and Bhujbal (1972) concluded that the numbers/spike, flower quality, daughter bulb production etc. were also found to be related to bulb size.

2.2 Effect of phosphorus fertilizer

Singh *et al.* (2005) studied the effects of varying levels P_2O_5 (10, 20 and 30 g/m^2) on the growth and flowering of tuberose (*Polianthes tuberosa* cv. Single) were evaluated in trials conducted during 1998/99, in Faizabad, Uttar Pradesh, India. The bulbs were planted at a spacing of 25 x 20 cm. full dose of P was applied before planting, observations were recorded for days to sprouting, sprouts per bulb, leaves per plant, leaf length, plant height, days to spike initiation, spike length, flowering duration, florets/100 g and spikes per clump.

Pal and Biswas (2005) conducted a field experiment in Nadia, West Bengal, India, during 1999-2000 to 2000-01 to investigate the effect of P on the growth and flowering of tuberose (*P. tuberosa*) cv. Calcutta single. The application of 20 g of P_2O_5 recorded the highest plant height, leaf number and spike length, however

application of P_2O_5 20 g/m^2, improved spike weight and yield, and number of florets per spike for the first year. Application of 15 g of P_2O_5 improved plant height and leaf number in ratoon crop. However, application of P_2O_5 at 15 g/m2 improved spike length, weight and number/m2. The spike production was highest with P_2O_5 15 g/m^2, in ratoon crop. The lower doses of fertilizer produced poor quality plant and yield of flower. Thus, application of P_2O_5 at 15 g/m^2 for the first year, P_2O_5 15 g/m_2, for ratoon crop is recommended to produce good quality plant and improve yield of flower spike in the plains of West Bengal.

Singh *et al.* (2004) conducted a study with tuberose [*P. tuberosa*] cv. Double in Faizabad, Uttar Pradesh, India, during 1998-99. Here treatments consisted of 18 combinations with 3 levels (10, 20 and 30 g/m_2) of P, and a control (P_0). The various fertilizer levels had no significant effect on the vegetative as well as floral characters, except for length of spike and number of spikes per clump. The length of spike at opening of last floret and number of spikes per clump were highest (50.33 cm and 1.91, respectively) in the P_20_5 treatment over the control.

Ramesh *et al.* (2002) conducted a field experiment on tuberose (P. tuberosa) cv. Single bulbs were supplied with 0, 12, 24 or 32 g P/m2 in a field experiment conducted in Meghalaya, India during 1998-99. The number of leaves and spikes per clump, number of bulbs per clump and weight of bulb per clump increased with increasing rates of P up to 24 g/m_2. P application had no significant effects on the

rachis and spike length, number of florets per spike, durability of spike and bulb size of the crop.

Mishra *et al.* (2002) conducted an experiment in Bhubaneswar, Orissa, India, from March to December 1997 with tuberose [*Polianthes tuberosa*] cv. Single involving 3 levels of P, i.e. 0 (P0), 20 (P1) and 30 (P2) g/m^2; P application showed no appreciable effect on different growth parameters studied, but flowering attributes such as spike length, rachis length, weight of florets per spike and weight of 100 florets improved due to P application at 20 g or 30 g/m^2. Yield of flowers/ha (weight basis) also improved due to P treatments at 20 or 30 g/m^2, but yield of florets per spike (weight basis) was significantly increased at 30 g/m^2.

Amarjeet *et al.* (2000) reported that the nutrient status of *P. tuberosa* plants treated with different level P (0, 10, 20, 30 and 40 kg 0, 10 and 20 kg P/ha) was determined. The P content of leaves significantly increased with the increase in rate of P fertilizers. Bulb P content was affected by P fertilizers.

Singh *et al.* (1996) conducted field trials at Hisar, Haryana, in 1991 and 1992; P was applied at 0, 10 or 20 g P_2O_5/msuperscript. P rates had little effect on bulb yield.

Amarjeet *et al.* (1996) studied a fertilizer trial with 3 rates of P (0, 100 and 200 kg/ha) was conducted with *P. tuberosa* cv. Single on a sandy loam soil in 1991 and

1992. Application of high rates of, P delayed spike emergence and considerably prolonged the flowering period and shelf-life of florets in both years. Length of spike and rachis increased significantly in both years at both developmental stages (opening of first floret and last floret) with increasing doses of P fertilizer; increased rachis length at opening of the last floret, but not the first floret.

Gopalakrishnan *et al.* (1995) observed a trial at Akola in 1993/94; P was applied at 30, 45 or 60 kg P_2O_5/ha to tuberose grown for cut flowers. Average number of flowers/spike and flower diameter were greatest with + 60 kg P_2O_5.

Parthiban *et al.* (1992) studied that *P. tuberosa* cv. Single plants were supplied with 25, 50 or 75 kg P/ha the greatest plant height (58.93 cm) was obtained with the + 50 kg P treatment. The highest mean number of leaves (41.34) and number of side suckers/clump were obtained with the + 75 kg P treatment.

In an experiment Parthiban and Khader (1991) observed the fertilizer requirements of *Polianthes tuberosa* cv. Single, P at 25, 50 or 75 kg/ha. All the P was applied at the planting time. Application + 75 P kg/ha resulted in the highest number of spikes/plant (1.72), number of flowers/spike (39.67) and the highest flower yield (3578.6 kg/ha).

Gowda *et al.* (1991) studied about three rates of P_2O_5 (50, 75 and 100 kg) was compared for a cut-flower crop of *P. tuberosa*. All the P_2O_5 was applied as a basal

dressing. Increasing P rates resulted in a greater number of flower spikes and number of flowers/spike. The highest yield of flowers (40.20/spike), the longest spikes (81.28 cm) and the longest duration of flowering (29.75 days) were obtained with + 75 P_2O_5 kg /ha.

Bankar and Mukhopadhyay (1990) observed in field trials with this *Polianthes tuberosa* cultivar P_2O_5 was applied, at 0, 20 or 40 g/m^2. All of the P was applied before planting. Data are tabulated on plant growth and flowering parameters, and P contents of the leaves.

Chapter 3

Materials and Methods

CHAPTER-III

MATERIALS AND METHOD

This chapter deals with the materials and method that were used in execution of the experiment.

3.1 Experimental site

The location of the site in 23.77^0 N latitude and 90.34^0 E longitudes with an elevation of 8.2 meter from sea level.

3.2 Climate

The experimental site is situated in subtropical zone, characterized by heavy rainfall during the months from April to September (Kharif season) and scantly rainfall during the rest of the year (Rabi season). Information regarding average monthly the maximum and the minimum temperature, rainfall and relative humidity recorded by the weather yard, Bangladesh Metrological Department (climate division) Agargaon, during the period of study has been presented in Appendix I.

3.3 Soil

The soil of the experimental area belongs to the Modhupur Tract in Agro ecological zone (AEZ) 28. The analytical data of the soil sample collected from the experimental area were determined in the SRDI, Soil Testing Laboratory,

Khamarbari, Dhaka have been presented in Appendix - II.

The experimental site was a medium high land and P^{H} of the soil was 5.6. The Morphological characters of the soil of the experimental plots are given below-

AEZ No - 28

Soil series - Tejgaon

General soil - Non-calcarious dark grey.

3.4 Treatment of the experiment

The experiment was designed to study the effect of bulb size and phosphorus on growth, flowering, bulb and bulblet production of tuberose.

The experiment consisted of two factors, which are as follows:

Factor A = Bulb Size

B_1 : Small (1.0-1.5 cm in diameter)

B_2 : Medium (>1.5 to 2.0 cm in diameter)

B_3 : Large (>2.0 to 2.5 cm in diameter)

Factor B = Phosphorus Fertilizer

F_0 : Control

F_1 : 120 kg P_2O_5/ha

F_2 : 140 kg P_2O_5/ha

F_3 : 160 kg P_2O_5/ha

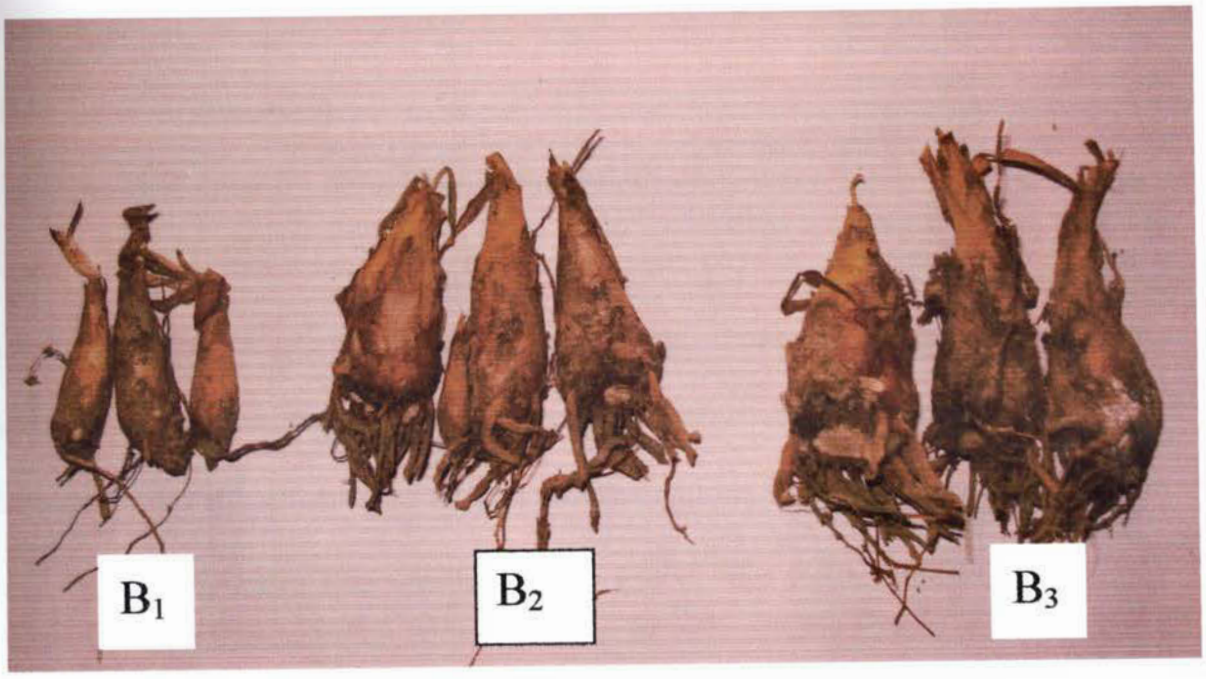


Fig 1: Different size of bulb

Factor A: Bulb size

B_1: small (1-1.5 cm in Diameter)

B_2: Medium (>1.5-2.0 cm in Diameter)

B_3: Large (>2.0-2.5cm in Diameter)

3.5 Planting materials

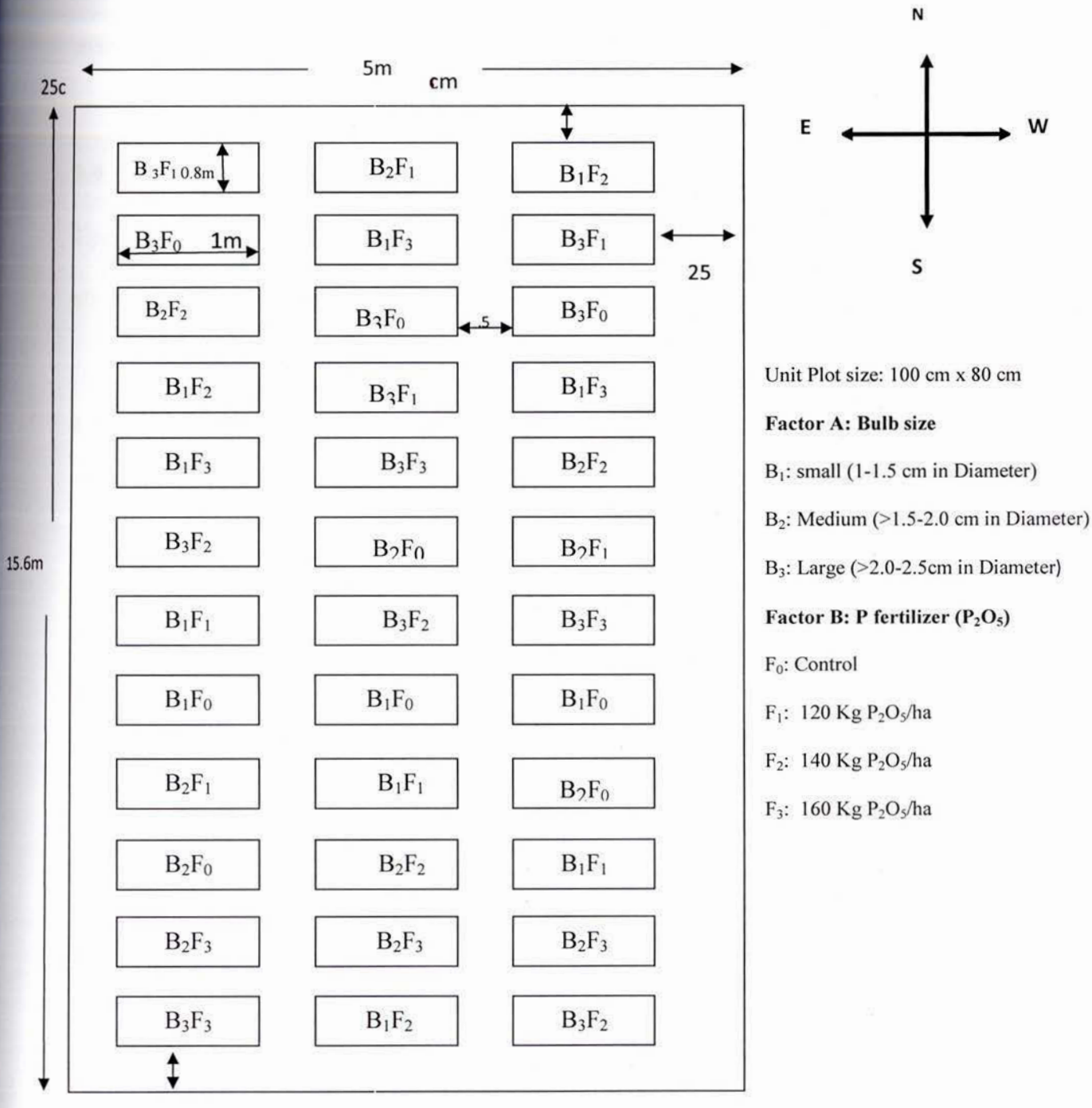
Bulbs of tuberose cv. Single were collected from Horticultural Farm, SAU, Dhaka.

3.6 Land preparation

Land was first open by ploughing in the month of January 2007 with the help of power tiller and then it kept open to sun for seven days prior to further ploughing. Afterwards it was prepared by ploughing and cross ploughing followed by laddering. The weeds and stubbles were removed after each laddering. Simultaneously the clods were broken and the soil was made into good tilth. The basal dose of manures and fertilizers were mixed into the soil during final land preparation.

3.7 Experimental design and layout

The two factors experiment was laid out in Randomized Complete Block Design (RCBD) with 3 replications. Each block was divided into 12 plots, where treatments were allotted at random. Thus, there were 36 (12 × 3) unit plots altogether in the experiment. Size of each plot was 1m x 0.8m. The distance between blocks was 0.5m and 0.5m wide drains were made between the plots. The complete layout of the experiment has been shown in fig 1.



Unit Plot size: 100 cm x 80 cm

Factor A: Bulb size

B_1: small (1-1.5 cm in Diameter)

B_2: Medium (>1.5-2.0 cm in Diameter)

B_3: Large (>2.0-2.5cm in Diameter)

Factor B: P fertilizer (P_2O_5)

F_0: Control

F_1: 120 Kg P_2O_5/ha

F_2: 140 Kg P_2O_5/ha

F_3: 160 Kg P_2O_5/ha

Fig. 2: Field layout of the two factors experiment in the Randomized Complete Block Design (RCBD).

3.8 Planting of bulbs

Bulbs were planted in 4 cm depth in furrows on 30 April 2007. Spacing was maintained 25 cm x 20 cm respectively.

3.9 Weeding and mulching

The field was weeded as and when necessary. The soil was mulched frequently after irrigation by breaking the crust for easy aeration and to conserve soil moisture.

3.10 Irrigation

The experimental plots were irrigated as and when necessary during the crop period.

3.11 Earthing up

Earthing up was done during growing period when necessary.

3.12 Staking

For staking bamboo stick was placed and spike was tide by fine rope with the stick.

3.13 Selections and tagging of plants

Ten plants from each of the plots were selected randomly for recording data for different characters.

3.14 Insect management

For controlling Aphid and borer Malathion @ 0.1% was sprayed at interval of 15 an days.

3.15 Disease management

Dithane M-45 @ 0.2% was sprayed to check the fungal infection.

3.16 Harvesting

The spikes of tuberose were harvested when the first floret in the rachis opened. Harvesting was done during 25 July to 30 September, 2007 and bulb and bulblet were harvested on 07 January, 2008.

3.17 Collection of data

3.17.1 Days required for emergence of spike

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

3.17.2 Average plant height

Plant height refers to the length of the plant from ground level up to shoot apex of the plant. It was measured at an interval of 15 days starting from 30 days after sowing (DAS) till 120 days.

3.17.3 Average number of leaves

All the leaves of ten plants were counted at an interval of 15 days starting from 30 DAS till 120 DAS.

3.17.4 Number of side shoot

It was measured at an interval of 15 days starting from 30 days after sowing (DAS) till days 120 DAS.

3.17.5 Length of flower stalk

Length of flower stalk was measured from the base to the tip of the spike.

3.17.6 Length of rachis

Length of rachis refers to the length from the axil of first floret upto the tip of the inflorescence.

3.17.7 Number of floret per spike

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

3.17.8 Weight of a single spike

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

3.17.9 Diameter of a single spike

Ten spikes were cut from randomly selected plants from each unit plot and the diameter of spikes was taken at 30 cm from the soil surface to calculate their mean.

3.17.10 Diameter of individual bulb

Ten randomly selected bulbs diameter are measured with the help of slide calipers.

3.17.11 Number of bulblet per plant

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

3.17.12 Average weight of bulblet per plant

Average weight of bulblet per plant was recorded from the mean weight of ten randomly selected sample plants.

3.17.13 Yield of bulb per hectare

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

3.17.14 Yield of bulblet per hectare

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

Statistical analysis

The recorded data on different parameters were statistically analyzed using MSTAT software to find out the significance of variation resulting from the experimental treatments. The mean for the treatments was calculated and analysis of variance for each of the characters was performed by F (variance ratio) test. Differences between the treatment means were evaluated by DMRT test at 5% probability.

Chapter 4

Results and Discussion

CHAPTER IV

RESULTS AND DISCUSSION

The present experiment was undertaken to determine the effect of bulb size and different levels of phosphorus fertilizer on growth and flowering of tuberose. The analysis of variance (ANOVA) of the data on different characters is given in Appendix III-VII. The results of the study have been presented and discussed, and possible interpretations have been given under the following headings:

4.1 Pant height (cm)

Plant height (cm) was significantly influenced by bulb size (Appendix III). Although the different bulb size showed a gradual increasing trend in plant height of tuberose start from small to large size bulb at 30, 45, 60, 75, 90, 105 and 120 DAS (Table 1). The tallest plant (55.32 cm) at 120 DAS was recorded in large size (B_3) bulb which was closely followed by medium size bulb (53.27 cm). Shortest plant (51.92 cm) at 120 DAS was recorded for small size bulb. This might be due to the fact that higher reserve food in large bulb (B_3) resulted in optimum growth and ultimately gave tallest plant in comparison to small bulb (B_1). Raja *et al.* (1999) while working with different sizes of bulbs on growth and flowering of tuberose found similar results.

In considering the plant height at 30, 45, 60, 75, 90, 105 and 120 DAS different phosphorus fertilizer does showed a statistically significant variation (Appendix III). With the increases of phosphorus level plant height of tuberose increases and represents an increasing trend (Table 1). Tallest tuberose plant (55.39 cm) at 120 DAS was recorded in F_3 (160 kg P_2O_5/ha). On the other hand the shortest tuberose plant (51.07 cm) was recorded in the plot with control condition (F_0) i.e. no phosphorus fertilizer application. The observed results are in agreement with the findings of Pal and Biswas (2005).

Interaction effect between bulb size and different level of phosphorus fertilizer showed significant variation in all the date of data recorded the plant height of tuberose (Appendix III). But tallest height of tuberose (58.17cm) at 120 DAS was recorded in large size bulb with 140 kg P_2O_5/ha phosphorus level (B_3F_2) and the shortest plant (49.70 cm) were recorded in small size bulb with no phosphorus fertilizer application (Table 2).

Table 1. Effect of bulb size and phosphorus fertilizer on plant height of tuberose

Treatments	Plant height (cm)						
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS
Bulb size							
Small	19.02 b	28.40 b	38.51 c	43.28 c	48.10 b	49.48 b	51.92 b
Medium	20.06 ab	29.46 ab	39.30 b	46.20 b	49.02 b	51.15 a	53.27 b
Large	21.24 a	30.82 a	41.48 a	47.93 a	51.63 a	52.23 a	55.32 a
$LSD_{(0.05)}$	1.35	1.52	0.62	1.04	1.40	1.60	1.64
Significance level	*	*	*	*	*	*	*
Phosphorus fertilizer level (As P_2O_5)							
0 kg/ha	18.41 c	26.79 c	36.98 c	42.50 d	46.87 c	48.96 c	51.07 b
120 kg/ha	19.71 b	29.20 b	38.59 b	45.07 c	48.61 b	50.26 b	52.16 b
140 kg/ha	20.90 a	30.86 a	41.12 a	47.39 b	50.93 a	52.13 a	55.40 a
160 kg/ha	21.40 a	31.40 a	42.36 a	48.27 a	51.92 a	52.46 a	55.39 a
$LSD_{(0.05)}$	0.99	1.12	1.44	0.77	1.04	1.19	1.22
Significance level	*	*	*	*	*	*	*

* Significant at 5% level of probability

Table 2. Interaction effect of bulb size and phosphorus fertilizer on plant height of tuberose

Bulb size × Phosphorus fertilizer (As P_2O_5)		Pant height (cm)						
		30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS
Small	0 kg/ha	17.50h	25.80e	36.13i	40.60i	45.77i	47.93f	49.70h
	120 kg/ha	18.47g	27.93c	37.77gh	43.03h	46.98h	48.46ef	51.07fg
	140 kg/ha	19.50ef	28.72c	38.88f	43.80g	48.97ef	49.85d	53.20de
	160 kg/ha	20.60cd	31.17b	41.24d	45.70f	50.69d	51.68c	53.73d
Medium	0 kg/ha	18.60cg	26.57d	36.83hi	42.97h	46.52h	49.01e	50.63g
	120 kg/ha	19.80ef	28.66c	38.10fg	45.57f	47.78g	50.98c	51.70f
	140 kg/ha	20.13de	31.00b	39.85e	47.43d	49.63e	51.75c	54.83c
	160 kg/ha	21.70b	31.61b	42.42c	48.83c	52.16c	52.87b	55.90b
Large	0 kg/ha	19.13fg	28.00c	37.98fg	43.93g	48.33fg	49.93d	52.87e
	120 kg/ha	20.87c	31.02b	39.90e	46.60e	51.07d	51.35c	53.70d
	140 kg/ha	23.07a	32.85a	44.63a	50.93a	54.18a	54.80a	58.17a
	160 kg/ha	21.90b	31.42b	43.42b	50.27b	52.92b	52.82b	56.53b
$LSD_{(0.05)}$		0.65	0.73	0.94	0.50	0.68	0.77	0.79
CV (%)		1.92	1.46	1.39	0.65	0.80	0.90	0.87

In a column means having similar letter(s) or without letter are identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

4.2 Number of leaves/plant

Bulb size significantly influenced the number of leaves/plant (Appendix IV). Different bulb size showed a gradual increasing trend in terms of number of leaves/plant of tuberose under the study considering the small to large size bulb at 30, 45, 60, 75, 90, 105 and 120 DAS (Table 3). The maximum number (15.76) of leaves/plant at 120 DAS was recorded in large size bulb (B_3) and the minimum (13.66) was recorded for small size bulb (B_1).Yadav *et al.*, (1984) and Dhua *et al.*, (1987) obtained similar results and reported that larger bulbs produced more leaves compared to smaller bulbs.

Different level of phosphorus fertilizer showed a statistically significant variation for number of leaves/plant at 30, 45, 60, 75, 90, 105 and 120 DAS under the present trial (Appendix IV). With the increases of level of phosphorus fertilizer number of leaves/plant represents an increasing trend (Table 3). The maximum (15.52) number of leaves/plant at 120 DAS was recorded at160 kg P_2O_5/ha phosphorus. On the other hand the minimum number (13.66) of leaves/plant was recorded in control condition at 120 DAS. Singh *et al.* (2005); obtained similar results.

Interaction effect was recorded between bulb size and different level of phosphorus fertilizer in all the date of data recorded in terms of leaves/plant of tuberose (Appendix IV). But maximum number (16.57) of leaves/plant at 120 DAS was recorded in large size bulb with level of phosphorus at 140 kg P_2O_5/ha and the minimum (12.73) was recorded in small size bulb (Table 4).

Table 3. Effect of bulb size and phosphorus fertilizer on leaves/plant of tuberose

Treatments	Number of leaves/Plant						
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS
Bulb size							
Small	6.11 c	8.14 b	10.15 b	10.96 b	12.04 a	12.78 a	13.66 b
Medium	8.04 b	9.44 b	10.95 ab	12.12 ab	12.85 a	13.70 a	14.80 ab
Large	9.28 a	11.16 a	12.45 a	13.12 a	13.55 a	14.02 a	15.76 a
$LSD_{(0.05)}$	0.89	1.34	1.57	1.73	1.79	1.51	1.83
Significance level	*	*	*	*	NS	NS	*
Phosphorus fertilizer level (As P_2O_5)							
0 kg/ha	7.04 b	8.07 b	9.55 c	10.61 b	12.04 b	11.74 c	13.68 b
120 kg/ha	8.51 a	9.50 a	10.88 b	11.69 b	12.85 ab	13.00 b	14.52 ab
140 kg/ha	8.31 ab	10.42 a	12.05 a	12.98 a	14.73 a	14.51 a	15.23 a
160 kg/ha	7.37 ab	10.33 a	12.24 a	12.98 a	13.55 c	14.76 a	15.52 a
$LSD_{(0.05)}$	1.35	0.99	1.16	1.28	1.33	0.73	1.35
Significance level	*	*	*	*	*	*	*

Table 4. Interaction effect of bulb size and phosphorus fertilizer on leaves/plant of tuberose

Bulb size × Phosphorus fertilizer level		Number of leaves						
		30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS
Small	0 kg/ha	6.50e	7.30fg	8.83g	10.23f	10.52ef	11.27ef	12.73ef
	120 kg/ha	6.23e	7.60fg	9.50fg	10.90f	11.27f	12.23ef	13.17ef
	140 kg/ha	6.43e	8.03fg	10.55efg	10.93ef	12.63def	13.40de	13.57df
	160 kg/ha	5.27f	9.63g	11.70fg	11.77f	13.75f	14.23f	15.17f
Medium	0 kg/ha	8.13cd	8.40de	9.32cd	10.27cd	11.42bc	11.80cd	13.67cd
	120 kg/ha	7.70d	9.00ef	10.48ef	11.37ef	11.82cde	13.47cd	14.63bc
	140 kg/ha	8.37cd	10.50cd	11.77cd	13.27bc	13.60abc	14.60abc	15.57abc
	160 kg/ha	7.97d	9.87bcd	12.23bc	13.57c	14.58abc	14.93bc	15.33abc
Large	0 kg/ha	6.50e	8.50fg	10.50de	11.33de	12.13bcd	12.17bc	14.63abc
	120 kg/ha	11.60a	12.73a	13.83 a	14.73 a	14.67 a	15.53 a	16.57 a
	140 kg/ha	10.13b	11.90ab	12.67 ab	12.80 ab	12.97 ab	13.30abc	15.77bcd
	160 kg/ha	8.87c	11.50abc	12.80a	13.60ab	14.43a	15.10ab	16.07ab
$LSD_{(0.05)}$		0.89	0.65	0.7	0.84	0.86	0.73	0.88
CV (%)		6.73	3.99	3.99	4.09	3.98	3.18	3.53

In a column means having similar letter(s) or without letter are identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

4.3 Number of side shoot

Statistically no significant variation was recorded in terms of days required for number of side shoot/plant (Appendix V). Different bulb size showed a gradual increasing trend in terms of number of side shoot/plant of tuberose under the study for small to large size bulb at 30, 45, 60, 75, 90, 105 and 120 DAS (Table 5). The maximum (4.44) number of side shoot/plant at 120 DAS was recorded in large size bulb (B_3) and the minimum (3.97) was recorded for medium size which was closely followed (4.12) by small size bulb (B_1). Rao *et al.* (1992) obtained similar results.

Different level of phosphorus fertilizer showed a statistically significant difference for number of side shoot/plant at 60, 75, and 120 DAS under the present study (Appendix V). With the increases of phosphorus fertilizer number of side shoot/plant represents an increasing trend (Table 5). The maximum (4.66) number of side shoot/plant at 120 DAS was recorded at 160 kg P_2O_5/ha (F_3). On the other hand the minimum (3.69) number of side shoot/plant was recorded in the plot with control condition i.e. no phosphorus fertilizer. The observed results are in agreement with the findings of Parthiban & Khadar (1992)

Interaction effect between bulb size and different level of phosphorus fertilizer showed significant variation in all the date of data recorded in terms of number of side shoot/plant of tuberose (Appendix V). Maximum days (4.87) required for planting to spike emergence at 120 DAS was recorded in large size bulb at 140 kg P_2O_5/ha phosphorus fertilizer level and the minimum (3.38) was recorded in small size bulb with no phosphorus fertilizer application (Table 6).

Table 5. Effect of bulb size phosphorus fertilizer on number shoot/plant of tuberose

Treatments	Number of side shoot						
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS
Bulb size							
Small	0.50 a	1.22 a	1.91a	2.46 a	2.97 a	3.54 a	3.97 a
Medium	0.66 a	1.43 a	2.14 a	2.80 a	3.22 a	3.78 a	4.23 a
Large	0.78 a	1.71 a	2.46 a	3.11 a	3.63 a	4.07 a	4.44 a
$LSD_{(0.05)}$	0.54	0.79	0.72	0.79	0.77	0.79	0.62
Significance level	NS	NS	NS	NS	NS	NS	NS
Phosphorus fertilizer level (As P_2O_5)							
0 kg/ha	0.16 b	1.09 b	1.83 b	2.26 b	2.90 b	3.33 b	3.69 c
120 kg/ha	0.57 a	1.30 ab	1.97 ab	2.51 b	3.10 ab	3.66 a	4.18 b
140 kg/ha	0.89 a	1.66 ab	2.39 a	3.20 a	3.49 a	3.97 a	4.33 ab
160 kg/ha	0.95 a	1.76 a	2.49 a	3.19 a	3.60 a	4.22 a	4.66 a
$LSD_{(0.05)}$	0.40	0.58	0.53	0.58	0.58	1.84	0.46
Significance level	*	*	*	*	*	*	*

* Significant at 5% level of probability

Table 6 . Interaction effect of bulb size and phosphorus fertilizer on number shoot/plant of tuberose

Bulb size × Phosphorus fertilizer (As P_2O_5)		Number of side shoot						
		30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS
Small	0 kg/ha	0.12e	0.92e	1.43g	1.90g	2.60f	3.03e	3.38f
	120 kg/ha	0.43de	0.95de	1.75fg	2.13g	2.77ef	3.33de	3.87de
	140 kg/ha	0.55bcd	1.30cde	2.00def	2.80cde	3.10cde	3.73cd	4.07cde
	160 kg/ha	0.68bcd	1.70abc	2.45abc	3.00bcde	3.40bcd	4.07abc	4.57ab
Medium	0 kg/ha	0.18e	0.95de	1.87ef	2.20fg	2.93def	3.40de	3.80e
	120 kg/ha	0.57 cd	1.43bc	2.00def	2.60ef	3.00def	3.57d	4.23deb
	140 kg/ha	0.77abc	1.65abc	2.37bcd	3.10bcd	3.40cd	3.80bcd	4.07de
	160 kg/ha	1.03ab	1.67abc	2.33bcd	3.30ab	3.53abc	4.33a	4.83a
Large	0 kg/ha	0.20e	1.40cd	2.20cde	2.67de	3.17cde	3.57d	3.90de
	120 kg/ha	0.63cd	1.52bc	2.17cdef	2.80cde	3.53abc	4.07abc	4.43bc
	140 kg/ha	1.10a	2.02a	2.80a	3.70a	3.97a	4.37a	4.87a
	160 kg/ha	1.10a	1.90ab	2.68ab	3.27abc	3.87ab	4.27abc	4.57ab
$LSD_{(0.05)}$		0.31	0.45	0.41	0.45	0.44	0.45	0.35
CV (%)		20.25	15.54	9.49	7.99	6.78	5.89	4.18

4.4 Days required for sowing to spike emergence

Days required for sowing to spike emergence showed statistically insignificant variation for different bulb size (Appendix VI). Different bulb size showed a gradual decreasing trend in terms of days required for sowing to spike emergence (Table 7). The lowest days (92.58) required for sowing to spike emergence was recorded in large size bulb (B_3) and the highest (95.50 days) was recorded for small size (B_1). Time required to spike emergence was found to be delayed gradually with the decrease in bulb size. Similar results were reported by Pathak *et al.*, 1980.

Different level of phosphorus fertilizer showed a statistically non significant difference for days required for sowing to spike emergence under the present trial (Appendix VI). With the increases of level of phosphorus fertilizer days required for sowing to spike emergence showed different results (Table7). The lowest (92.58 days) days required for sowing to spike emergence was recorded at 140 kg P_2O_5/ha and the highest days (95.5) required for sowing to spike emergence was recorded in the control (F_0) plot. Singh *et al.* (2005) obtained similar results.

Interaction effect was recorded between bulb size and different phosphorus fertilizer level showed significant difference in all the date of data recorded in terms of days required for sowing to spike emergence of tuberose (Appendix VI). But lowest (82.35days) days required for sowing to spike emergence was recorded in medium size bulb at 140 kg P_2O_5/ha and the highest (98.32 days) was recorded in small size bulb with 120 kg/ha fertilizer level (Table 8)

4.5 Length of flower stalk (cm)

Length of flower stalk (cm) for different bulb size showed a statistically significant variation (Appendix VI). Different bulb size (small, medium and large) showed a gradual increasing trend in terms of length of flower stalk (Table 7). The longest length of flower stalk (80.04 cm) was recorded in large size bulb (B_3) and the shortest (71.38 cm) was recorded for small size (B_1). The increased flower stalk from large bulb was probably due to the better vegetative and reproductive growth of the plant. Similar results were reported by Kumar *et al.*, (2003).

Different level of phosphorus fertilizer showed a statistically variation for length of flower stalk (cm) under the present trial (Appendix VI). With the increases of level of phosphorus fertilizer length of flower stalk performance an increasing trend (Table 7). The longest length of flower stalk (80.04 cm) was recorded in at 140 kg P_2O_5/ha. On the other hand the shortest (71.38) length of flower stalk was recorded in the plot with control condition i.e. no phosphorus fertilizer. Pal and Biswas (2005) reported similar results earlier.

Interaction effect was recorded between bulb size and different phosphorus fertilizer level showed significant difference in all the date recorded in terms of length of flower stalk of tuberose (Appendix VI). But longest (81.73 cm) length of flower stalk was recorded in large size bulb with the 140 kg P_2O_5/ha and the shortest (70.67 cm) was recorded in medium size bulb with no phosphorus fertilizer (Table 8).

Fig 3: Different Length of flower stalk (cm) in different treatments

Factor A: Bulb size

B_1: small (1-1.5 cm in Diameter)
B_2: Medium (>1.5-2.0 cm in Diameter)
B_3: Large (>2.0-2.5cm in Diameter)

Factor B: P fertilizer (P_2O_5)

F_0: Control
F_1: 120 Kg P_2O_5/ha
F_2: 140 Kg P_2O_5/ha
F_3: 160 Kg P_2O_5/ha

4.6 Length of rachis (cm)

Different bulb size showed a statistically significant variation in terms of length of rachis (Appendix VI). Different bulb size (small, medium and large) showed a gradual increasing trend in terms of length of rachis under the trial (Table 6). The longest (38.27 cm) length of rachis was recorded in large size bulb (B_3) which was closely followed (32.53 cm) by medium bulb (B_2) size and the shortest (23.00cm) was recorded for small size bulb (B_1). Better performance of the plants from larger bulbs might be due to the better growth of the plants from large bulb. Mukhopadhyay *et al* (1983) reported similar results earlier.

Different level of phosphorus fertilizer showed a statistically variation for length of rachis (cm) under the present trial (Appendix VI). With the increases of level of phosphorus fertilizer length of rachis showed an increasing trend (Table 6). The longest (34.7 cm) length of rachis was recorded at 140 kg P_2O_5/ha. On the other hand the shortest (27.62 cm) length of rachis was recorded in the plot with control condition. Similar results were not reported by Ramesh *et al.* (2002).

Interaction effect was recorded between bulb size and different phosphorus fertilizer level showed significant difference in all the date recorded in terms of length of rachis (Appendix VI). But longest (43.43 cm) length of rachis was recorded in large size bulb (B_3) with the level of phosphorus fertilizer at 140 kg P_2O_5/ha and the shortest (20cm) was recorded in small size bulb with no phosphorus fertilizer application (Table 8).

Table 7. Effect of bulb size and phosphorus fertilizer on growth and flowering of tuberose

Treatments	Days required for sowing to spike emergence	Length of flower stalk (cm)	Length of rachis (cm)	Number of floret/spike	Weight of single spike (g)	Diameter of single spike (cm)
Bulb size						
Small	95.50 a	71.38 b	23.00 b	26.50 b	53.46 c	0.66 c
Medium	93.67 a	74.99 ab	32.53 a	30.59 ab	60.64 b	0.89 b
Large	92.58 a	80.04a	38.27 a	35.71a	86.18 a	1.09 a
$LSD_{(0.05)}$	2.93	5.76	5.94	6.03	5.69	0.08
Significance level	NS	*	*	*	*	*
Phosphorus fertilizer level (As P_2O_5)						
0 kg/ha	95.50 a	71.38 b	23.00 b	26.50 b	53.46 c	0.66 c
120 kg/ha	93.67 a	74.99 ab	32.53 a	30.59 ab	60.64 b	0.89 b
140 kg/ha	92.58 a	80.04a	38.27 a	35.71a	86.18 a	1.09 a
160 kg/ha	95.50 a	71.38 b	23.00 b	26.50 b	53.46 c	0.66 c
$LSD_{(0.05)}$	2.17	3.99	4.39	2.91	8.73	0.12
Significance level	NS	*	*	*	*	*

* Significant at 5% level of probability

Table 8. Interaction effect of bulb size and phosphorus fertilizer on growth and flowering of tuberose

Bulb size × Phosphorus Fertilizer (As P_2O_5)		Days required for sowing to spike emergence	Length of flower stalk (cm)	Length of rachis (cm)	Number of floret/spike	Weight of single spike (g)	Diameter of single spike (cm)
Small	0 kg/ha	98.32a	68.83f	20.00e	23.50de	48.50g	0.56de
	200 kg/ha	95.54b	74.33cd	25.67d	30.00cd	54.67de	0.78ef
	250 kg/ha	85.95d	72.67de	24.67d	25.00ef	59.67dc	0.680f
	300 kg/ha	90.14f	70.67ef	21.67e	27.50f	51.00def	0.61f
Medium	0 kg/ha	95.84b	70.97ef	27.33d	30.11cd	62.31 d	0.97c
	200 kg/ha	93.57c	74.58cd	35.11c	31.83bc	65.36 c	0.95c
	250 kg/ha	84.25e	74.75cd	34.92c	28.00de	59.25d	0.88d
	300 kg/ha	88.58f	73.33de	32.75c	32.43bc	55.65bcd	0.76ef
Large	0 kg/ha	92.34d	69.62f	35.53bc	37.07a	87.40b	1.12b
	200 kg/ha	88.54e	77.48b	35.72bc	32.41a	93.37a	1.04bc
	250 kg/ha	82.35g	81.73a	43.43a	39.53be	82.10bc	1.15a
	300 kg/ha	85.37f	76.32bc	38.38b	33.82b	81.86bc	1.05bc
$LSD_{(0.05)}$		1.89	2.60	2.87	2.91	5.69	0.08
CV (%)		5.05	2.08	5.41	4.91	5.03	4.42

4.7 Number of floret/spike

Different bulb size showed a statistically significant variation in terms of number of floret/spike under the trial (Appendix VI). Different bulb size (small, medium and large) showed a gradual increasing trend in terms of number of floret/spike (Table 7). The maximum (35.71) number of floret/spike was recorded in large size bulb (B_3) and the minimum (26.5) number of floret/spike was recorded for small size bulb (B_1). This might be due to higher food reserve in the large bulb. The observed results are in agreement with the findings of Sathyanarayana *et al*. (1994).

Statistically significant variation was recorded for number of floret/spike for different level of phosphorus fertilizer under the trial (Appendix VI). Increases of phosphorus fertilizer the number of floret/spike showed an increasing trend (Table 7). The maximum (35.71) number of floret/spike was recorded at 140 kg P_2O_5/ha. On the other hand the minimum (26.5) number of floret/spike was recorded in the plot with control condition. Gowda *et al.* (1991); Parthiban and Khader (1991) reported similar results earlier.

Interaction effect was recorded between bulb size and different phosphorus fertilizer level showed significant differences in terms of number of floret/spike (Appendix VI). The maximum (39.53) number of floret/spike was recorded in large size bulb with the level of at 140 kgP_2O_5/ha and the minimum (23.5) was recorded in small size bulb with no phosphorus fertilizer application (Table 8).

Fig 4: Different Number of floret/spike in different treatments

Factor A: Bulb size

B_1: small (1-1.5 cm in Diameter)

B_2: Medium (>1.5-2.0 cm in Diameter)

B_3: Large (>2.0-2.5cm in Diameter)

Factor B: P fertilizer (P_2O_5)

F_0: Control

F_1: 120 Kg P_2O_5/ha

F_2: 140 Kg P_2O_5/ha

F_3: 160 Kg P_2O_5/ha

4.8 Weight of single spike (g)

Different bulb size showed a statistically significant variation in terms of weight of single spike (g) under the trial (Appendix VI). Different bulb size (small, medium and large) showed a gradual increasing trend in terms of weight of single spike (Table 7). The highest weight of single spike (86.18 g) was recorded in large size bulb (B_3) which was closely followed by medium bulb size (60.64 g) and the lowest recorded for small size bulb (53.46 g). The observed results are in agreement with the findings of Raja and Palanisamy (1999).

Statistically significant variation was recorded for weight of single spike for different level of phosphorus fertilizer under the trial (Appendix VI). Increases the level of phosphorus fertilizer the weight of single spike (g) represent an increasing trend (Table 4). The highest (86.18 g) weight of single spike was recorded at 140 kg P_2O_5/ha. On the other hand the lowest (53.46) weight of single spike was recorded in the plot with 160 kg P_2O_5/ha and without phosphorus fertilizer level. Pal and Biswas (2005) reported similar results earlier.

Interaction effect was recorded between bulb size and different phosphorus fertilizer level showed significant differences in terms of weight of single spike (Appendix VI). But highest (93.37g) weight of single spike was recorded in large size bulb with the 120 kg P_2O_5/ha and the lowest (48.50 g) was recorded in small size bulb with no phosphorus fertilizer application (Table 8).

4.9 Diameter of single spike (cm)

A statistically significant variation in terms of diameter of single spike was recorded for different bulb size (Appendix VI). Different bulb size (small, medium and large) showed a gradual increasing trend in terms of diameter of single spike (Table 7). The maximum diameter of single spike (1.09 cm) was recorded in large size bulb (B_3) and the minimum (0.67 cm) diameter of single spike was recorded for small size bulb (B_1). The observed results are in agreement with the findings of Raja and Palanisamy (1999).

Statistically significant variation was recorded for diameter of single spike for different level of phosphorus fertilizer application (Appendix VI). Increases the level of phosphorus fertilizer diameter of the single spike represent an increasing trend under the trial (Table 7). The maximum diameter of single spike (1.09cm) was recorded at 140 kgP_2O_5/ha. On the other hand the minimum (0.66 cm) diameter of single spike was recorded in the plot with control condition. Pal and Biswas (2005) reported similar results earlier.

Interaction effect was recorded between bulb size and different phosphorus fertilizer level showed significant variation in terms of diameter of single spike (Appendix VI). But maximum diameter of single spike (1.15cm) was recorded in large size bulb with at 140 kg P_2O_5/ha and the minimum (0.56 cm) was recorded in small size bulb with no phosphorus fertilizer application (Table 8).

4.10 Weight of individual bulb (g)

Weight of individual bulb showed a statistically insignificant difference for different bulb size under the present trial (Appendix VII). Bulb size like small, medium and large showed a gradual increasing trend in terms of weight of individual bulb (Table 9). The maximum weight of individual bulb (38.17 g) was recorded in large size bulb (B_3) and the minimum (33.9 g) weight of individual bulb was recorded for small size bulb (B_1). This might be due to the fact that average weight of individual bulb was higher in large bulb than the other sizes of bulb. Kale and Bhujbal (1972) reported similar results earlier.

Statistically significant variation was recorded for weight of individual bulb for different level of phosphorus fertilizer application (Appendix VII). Increases the level of phosphorus fertilizer weight of individual bulb signify an increasing trend under the trial (Table 9). The maximum weight of individual bulb (41.71g) was recorded in the level of phosphorus fertilizer at 160 kg P_2O_5/ha. On the other hand the minimum (27.01 g) weight of individual bulb was recorded in the plot with control condition. Similar results were reported by Ramesh *et al.* (2002).

Interaction effect was recorded between bulb size and different phosphorus fertilizer level showed significant differences in terms of weight of individual bulb (Appendix VII). But maximum weight of individual bulb (44.83g) was recorded in large size bulb with phosphorus fertilizer level at 120 kg P_2O_5/ha and the minimum (25.17 g) was recorded in small size bulb with no phosphorus fertilizer application (Table 10).

Table 9. Effect of bulb size phosphorus fertilizer on bulb and bulblet production of tuberose

Treatments	Weight of individual bulb (g)	Diameter of individual bulb (cm)	Number of bulblet/plant	Weight of single bulblet (g)	Yield of bulb (t/ha)	Yield of bulblet (t/ha)
Bulb size						
Small	34.06 a	1.99 a	17.07 a	1.78 a	8.47 a	11.12 a
Medium	33.90 a	2.36 a	18.21 a	1.86 a	8.51 a	11.83 a
Large	38.17 a	3.52 a	19.01 a	2.01 a	9.55 a	12.15 a
$LSD_{(0.05)}$	6.86	1.54	3.9	0.62	1.699	2.30
Significance level	NS	NS	NS	NS	NS	NS
Phosphorus fertilizer level (As P_2O_5)						
0 kg/ha	27.01 c	2.92 b	16.33 a	1.66 b	6.74 c	10.18 b
120 kg/ha	35.68 b	3.38 ab	18.32 a	1.94 ab	8.91 b	12.20 a
140 kg/ha	37.11 ab	3.46 a	18.78 a	1.99 ab	9.28 ab	12.08 a
160 kg/ha	41.71 a	3.41 ab	18.94 a	2.21 a	10.43 a	12.34 a
$LSD_{(0.05)}$	5.07	0.53	1.88	0.46	1.26	1.70
Significance level	**	*	NS	*	*	*

* Significant at 5% level of probability

Table 10. Interaction effect of bulb size and phosphorus fertilizer on bulb and bulblet production of tuberose

Bulb size × Phosphorus fertilizer (As P_2O_5)		Weight of individual bulb (g)	Diameter of individual bulb (cm)	Number of bulblet/plant	Weight of single bulblet (g)	Yield of bulb (t/ha)	Yield of bulblet (t/ha)
Small	0 kg/ha	25.17h	2.38e	15.27e	1.65d	6.29de	8.800d
	120 kg/ha	28.73gh	3.07d	16.60de	1.73abc	7.13cde	11.67bc
	140 kg/ha	38.33cd	3.25bcd	17.67bcd	2.17abc	9.59ab	11.78abc
	160 kg/ha	44.00ab	3.28bcd	18.73abcd	2.35ab	11.00a	12.23ab
Medium	0 kg/ha	25.53h	3.13cd	16.53de	1.57c	6.35e	10.58c
	120 kg/ha	33.47ef	3.25bcd	18.67abcd	1.80abc	8.37cde	11.87abc
	140 kg/ha	36.53de	3.50abc	18.40abcd	1.99ab	9.14abcd	12.33ab
	160 kg/ha	40.07bcd	3.55abc	19.23abc	2.08a	10.02abc	12.50ab
Large	0 kg/ha	30.33fd	3.25bcd	17.20cde	1.77bc	7.58cde	11.17bc
	120 kg/ha	44.83a	3.82a	19.70ab	2.27a	11.21a	13.07a
	140 kg/ha	36.47de	3.62ab	20.27a	1.80ab	9.12bcde	12.12ab
	160 kg/ha	41.07abc	3.41abcd	18.87abcd	2.20ab	10.27a	12.27ab
$LSD_{(0.05)}$		3.89	0.41	2.22	5.37	0.97	1.85
CV (%)		5.52	6.12	6.13	8.99	5.47	5.58

4.11 Number of bulblet/plant

Number of bulblet/plant showed a statistically insignificant variation for different bulb size under the present trial (Appendix VII). Bulb size (small, medium and large) showed a gradual increasing tendency in terms of number of bulblet/plant (Table 9). The maximum number of bulblet/plant (19.01) was recorded in large size bulb (B_3) which was closely followed (18.21) by medium bulb size and the minimum (17.07) number of bulblet/plant was recorded for small size bulb (B_1). Presumably, large size mother bulb planted was detrimental to the production of bulblet by number. Similar results were reported by Raja and Palanisamy (1999).

Different level of phosphorus fertilizer application showed a statistically non significant variation in terms of number of bulblet/plant (Appendix VII). The maximum number of bulblet/plant (18.94) was recorded in the level of phosphorus fertilizer 160 kg P_2O_5/ha. On the other hand the minimum (16.33) number of bulblet/plant was recorded in the plot with control condition. Similar results earlier was obsersed by Singh *et al.* (2005).

Interaction effect was recorded between bulb size and different phosphorus fertilizer level showed significant differences in terms of number of bulblet/plant (Appendix VII). The maximum (20.276) number of bulblet/plant was recorded in large size bulb with the phosphorus fertilizer level at 140 kg P_2O_5/ha and the minimum (15.267) was recorded in small size bulb with no phosphorus fertilizer application (Table 10).

4.12 Weight of single bulblet (g)

Weight of single bulblet showed a statistically insignificant variation for different bulb size (Appendix VII). Bulb size (small, medium and large) showed a gradual increasing tendency in terms of weight of single bulblet (Table 9). The highest (2.01 g) weight of single bulblet was recorded in large size bulb (B_3) which was statistically identical (1.86 g) by medium bulb size and the lowest (1.77 g) weight of single bulblet was recorded for small size bulb (B_1). The increased weight of single bulblet in large size bulb (B_3) was probably due to the stored food materials present in them during planting which contributed towards better vegetative growth and higher weight of bulblet. Misra *et al.* (1985) also reported the similar results.

Different level of phosphorus fertilizer application showed a statistically significant variation in terms of weight of single bulblet (Appendix VII). The highest (2.21 g) weight of single bulblet was recorded in level of phosphorus fertilizer at 160 kg P_2O_5/ha. On the other hand the lowest (1.66 g) weight of single bulblet was recorded in the plot with control condition (Table 9). Similar results were reported by Singh *et al.* (1996)

Interaction effect was recorded between bulb size and different phosphorus fertilizer level showed significant variation in terms of weight of single bulblet (Appendix VII). But highest (2.28 g) weight of single bulblet was recorded in large size bulb with the phosphorus fertilizer at the level of 120 kg P_2O_5/ha and the lowest (1.65 g) was recorded in small size bulb with no phosphorus fertilizer level application (Table 10).

4.13 Diameter of bulb (cm)

Diameter of bulb showed a statistically insignificant variation for different bulb size under the present trial (Appendix VII). Bulb size (small, medium and large) showed a gradual increasing tendency in terms of diameter of bulb (Table 9). The longest (3.52 cm) diameter of bulb was recorded in large size bulb (B_3) and the shortest (1.99 cm) diameter of bulb was recorded for small size bulb (B_1). Similar results were reported Raja and Palanisamy (2000).

Different level of phosphorus fertilizer application showed statistically significant variation in terms of diameter of bulb (Appendix VII). Increases the level of phosphorus fertilizer diameter of bulb suggest an increasing trend under the trial (Table 9). But the longest (3.46) diameter of bulb was recorded in the level of phosphorus fertilizer at 160 kg P_2O_5/ha which was statistically similar (3.38 cm) for 120 kg P_2O_5/ha phosphorus fertilizer level. On the other hand the shortest (2.92 cm) diameter of bulb was recorded in the plot with control condition. . The observed results are in agreement with the findings of Ramesh *et al.* (2002).

Interaction effect was recorded between bulb sizes and different phosphorus fertilizer level showed significant differences in terms of diameter of bulb under the present trial (Appendix VII). But longest (3.82 cm) diameter of bulb was recorded in large size bulb with phosphorus fertilizer level at 120 kg P_2O_5/ha and the shortest (2.383 cm) was recorded in small size bulb with no phosphorus fertilizer application (Table 10).

4.14 Yield of bulb (t/ha)

A statistically significant no variation was recorded for different bulb size in terms of yield of bulb per hectare (Appendix VII). Bulb size (small, medium and large) showed a gradual increasing trend for yield of bulb (Table 9). The highest (9.55 t/ha) yield of bulb was recorded in large size bulb (B_3) which was closely followed (8.47 t/ha) by medium bulb size and the lowest (8.50 t/ha) yield of bulb was recorded for small size bulb (B_1). The results of the present experiment are in agreement with the findings of Mukhopadhyay and Bose (1983), reported that highest yield was attained from large size of bulb.

Different level of phosphorus fertilizer application showed a statistically significant difference in terms of yield of bulb (Appendix VII). Increases the level of phosphorus fertilizer yield of bulb showed an increasing trend under the trial (Table 9). The highest (10.43 t/ha) yield of bulb was recorded in the level of phosphorus fertilizer at 160 kg P_2O_5/ha. On the other hand the lowest (6.74 t/ha) yield of bulb was recorded in the plot with control condition. Similar results were reported by Singh *et al.* (1996).

Interaction effect was recorded between bulb sizes and different phosphorus fertilizer level showed significant variation in terms of yield of bulb (Appendix VII). But highest (11.21 t/ha) yield of bulb was recorded in large size bulb with phosphorus fertilizer level at 120 kg/ha and the lowest (6.29 t/ha) was recorded in small size bulb with no phosphorus fertilizer application (Table 10).

4.15 Yield of bulblet (t/ha)

Different bulb size showed a statistically non significant variation in terms of yield of bulblet per hectare (Appendix VII). Bulb size (small, medium and large) showed a gradual increasing trend for yield of bulblet under the present trial (Table 9). The highest (12.15 t/ha) yield of bulblet was recorded in large size bulb (B_3) which was closely followed (11.83 t/ha) by medium bulb size and the lowest (11.12 t/ha) yield of bulblet was recorded for small size bulb (B_1). This might be due to higher food reserve in the large bulb. The observed results are in agreement with the findings of Raja and Palanisamy (1999)

Different level of phosphorus fertilizer showed a statistically no significant variation in terms of yield of bulblet (Appendix VII). Increases the level of phosphorus fertilizer yield of bulblet showed an increasing trend under the trial (Table 9). The highest (12.34 t/ha) yield of bulblet was recorded in level of phosphorus fertilizer at 160 kg P_2O_5/ha which was statistically similar (12.20 t/ha) for 120 kg P_2O_5/ha phosphorus fertilizer level. On the other hand the lowest (10.18 t/ha) yield of bulblet was recorded in the plot with control condition. Similar results were reported by Singh *et al.* (2005)

Interaction effect was recorded between bulb sizes and different phosphorus fertilizer level showed significant variation in terms of yield of bulblet (Appendix VII). But highest (13.07 t/ha) yield of bulblet was recorded in large size bulb with phosphorus fertilizer level at 120 kg P_2O_5/ha and the lowest (8.80 t/ha) was recorded in small size bulb with no phosphorus fertilizer application (Table 10).

Chapter 5

Summary and Conclusion

CHAPTER V

SUMMARY AND CONCLUSION

A field experiment was conducted in the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from April, 2007 to January, 2008 to study the effect of bulb size and different level of phosphorus fertilizer on growth, flowering, and yield of tuberose. The experiment considered of two factors. Factor A: Bulb size (3 levels) i.e. small (B_1:1.0-1.5 cm), medium (B_2 :> 1.5-2.0 cm) and large (B_3 :> 2.0-2.5 cm) in diameter; Factor B: Phosphorus fertilizer (4 levels) i.e.F_0: 0 kg, F_1: 120 kg, F_2:140 kg, F_3:160 kgP_2O_5/ha respectively. There were on the whole 12 (3x4) treatments combinations. The experiment was laid out in Randomized Complete Block Design. Data on growth, flowering, bulb and bulblet production of tuberose were recorded.

The tallest (55.32 cm) plant at 120 DAS was recorded in large size bulb and the shortest (51.92 cm) plant at 120 DAS was recorded for small size bulb (B_1). The tallest (55.40 cm) tuberose plant at 120 DAS was recorded in the fertilizer level of 140 kg P_2O_5/ha and the shortest (51.07 cm) tuberose plant was recorded in control condition.

Maximum number (15.76) of leaves/plant at 120 DAS was recorded in large size bulb (B_3). The longest (15.52) number of leaves/plant at 120 DAS was recorded at 160 kg P_2O_5/ha phosphorus. Maximum number (16.567) of

leaves/plant at 120 DAS was recorded in large size bulb (B_3) with level of phosphorus at 120 kg P_2O_5/ha.

The longest (4.44) number of side shoot/plant at 120 DAS was recorded in large size bulb (B_3). The maximum (4.66) number of side shoot/plant at 120 DAS was recorded at 160 kg P_2O_5/ha phosphorus fertilizer. The longest (4.87) days required for planting to spike emergence at 120 DAS was recorded in large size bulb at 120 kg P_2O_5/ha phosphorus fertilizer level.

The lowest (86.58 days) days required for sowing to spike emergence was recorded in large size bulb (B_3) and the highest (92.08 days) was recorded for small size (B_1). The lowest (84.78 days) days required for sowing to spike emergence was recorded at 140 kg P_2O_5/ha phosphorus fertilizer level and the highest (95.00 days) was recorded in control condition.

The longest (76.88 cm) length of flower stalk was recorded in the level of phosphorus fertilizer at 120 kg P_2O_5/ha which was statistically similar (74.97 cm) for 140 kg P_2O_5/ha level of phosphorus fertilizer. On the other hand the shortest (69.81cm) length of flower stalk was recorded in the plot with control condition i.e. no phosphorus fertilizer.

The longest (38.27 cm) length of rachis was recorded in large size bulb (B_3). The longest (34.7 cm) length of rachis was recorded in the level of phosphorus fertilizer at 140 kg P_2O_5/ha and the longest (43.433 cm) length of rachis was

recorded in large size bulb (B3) with the level of phosphorus fertilizer at 140 kg P_2O_5/ha.

Maximum (35.71) number of floret/spike was recorded in large size bulb (B_3) and the minimum (26.50) was recorded for small size bulb (B_1). The maximum (33.79) number of floret/spike was recorded in the level phosphorus fertilizer at 120 kg P_2O_5/ha and the minimum (28.47) number was recorded in control condition.

The maximum (38.17 g) weight of individual bulb was recorded in large size bulb (B_3) and the minimum (33.90 g) for medium size bulb (B_2). The maximum (41.71 g) weight of individual bulb was recorded in phosphorus fertilizer level at 160kg P_2O_5/ha and the minimum (27.01 g) in control condition.

The maximum (19.01) number of bulblet/plant was recorded in large size bulb (B_3) and the minimum (17.07) was recorded for small size bulb (B_1). The highest (20.27) number of bulblet/plant was recorded in the phosphorus fertilizer level at 140 kg P_2O_5/ha and the minimum (15.27) in control condition.

The highest (2.01 g) weight of single bulblet was recorded in large size bulb (B_3) and the lowest (1.78 g) for small size bulb (B_1). The highest (2.21g) weight of single bulblet was recorded in the phosphorus fertilizer level at 160 kg P_2O_5/ha and the lowest (1.66 g) in control condition.

The highest (9.55 t/ha) yield of bulb was recorded in large size bulb. The highest (10.43t/ha) yield of bulb was recorded in the level of phosphorus fertilizer at 160 kg P_2O_5/ha. The highest (11.21 t/ha) yield of bulb was recorded in large size

bulb with phosphorus fertilizer level at120 kg P_2O_5/ha and the lowest (6.29 t/ha) was recorded in small size bulb with no phosphorus fertilizer application.

The highest (12.15 t/ha) yield of bulblet was recorded in large size bulb (B_3). The highest (12.34 t/ha) yield of bulblet was recorded in level of phosphorus fertilizer at 160 kg P_2O_5/ha which was statistically similar (12.20 t/ha) for 120 kg P_2O_5/ha phosphorus fertilizer level. The highest (13.07 t/ha) yield of bulblet was recorded in large size bulb with phosphorus fertilizer level at 120 kg P_2O_5/ha and the lowest (8.80 t/ha) was recorded in small size bulb with no phosphorus fertilizer application

Large size bulb and 140 kg P_2O_5/ha phosphorus fertilizer (B_3F_3) show the highest result and there were interaction effects between bulb size and different phosphorus fertilizer level in terms of all the recorded character under present investigation. 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 adaptability and other performance.
2. Another bulb size i.e. more than 2.5cm may be included for further study for identify better performance
3. Another dose of phosphorus fertilizer may be included for further study to identify better performance.

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CHAPTER VI

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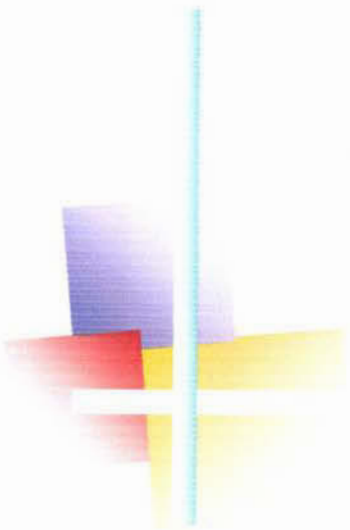

Appendices

APPENDIX

Appendix I: Monthly record of air temperature, rainfall, relative humidity and Sunshine hours during the period from April 2007 to January 2008

year	Month	Average air temperature (^{0}C)			Total rainfall (mm)	Average relative humidity (%)	Total Sunshine hours
		Maximum	Minimum	Mean			
2007	April	33.64	23.77	28.81	183	69.41	234.6
	May	33.3	24.4	28.7	290	73	241.8
	June	33.4	26.5	30.1	260	79	96.0
	July	31.4	25.8	28.6	542	81	127.1
	August	32.0	26.6	29.3	361	82	108.5
	September	32.7	26.00	29.35	514	81	144
	October	30.5	24.3	27.4	417	80	142
	November	29.7	20.1	24.9	5	65	192.20
	December	26.9	15.8	21.35	0	68	217.03
2008	January	24.6	12.5	18.7	0	66	171.01

Source: Dhaka meteorology center

Appendix II : Characteristics of horticulture farm soil is analyzed by Soil Resources Development Institute (SRDI), Khamar Bari, 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
Cropping pattern	Tuberose

Source: SRDI

B. Physical and chemical properties of the initial soil

Characteristics	Value
Partical size analysis	
% Sand	27
% Silt	43
% Clay	30
Textural Class	Silty - Clay
P^H	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

Appendix III. Analysis of variance of the data on plant height as influenced by bulb size and different levels of phosphorus on tuberose

Source of variation	Degrees of freedom	Mean square						
		Pant height (cm) at						
		30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS
Replication	2	0.77	1.87	4.22	4.39	2.30	3.72	3.82
Bulb size (A)	2	14.90*	17.63*	28.54*	66.27 *	40.11*	22.96*	35.01*
Phosphorus fertilizer (B)	3	16.02*	38.59 *	53.07*	60.11*	46.66 *	24.32 *	44.72*
Interaction (A×B)	6	1.9*	2.31*	3.35*	2.40*	2.41*	2.52*	1.43*
Error	22	0.15	0.19	0.30	0.09	0.16	0.21	0.22

* Significant at 5% level of probability

Appendix IV. Analysis of variance of the data on number of leaves/plant as influenced by bulb size and different level of phosphorus fertilizer on tuberose

Source of variation	Degrees of freedom	Mean square						
		Number of leaves						
		30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS
Replication	2	1.23	0.69	1.44	0.64	0.49	0.39	1.09
Bulb size (A)	2	56.10*	76.00*	74.01*	85.37*	48.57^{NS}	28.69^{NS}	14.94*
Phosphorus fertilizer (B)	3	2.84*	0.65*	0.16*	0.13*	0.47*	0.30*	0.41*
Interaction (A×B)	6	1.37*	2.04*	3.33*	4.97*	1.58*	1.17*	1.11*
Error	22	0.62	1.91	2.21	2.79	1.19	0.83	1.09

* Significant at 5% level of probability
NS=Non Significant

Appendix V. Analysis of variance of the data on number of side shoot/plant as influenced by bulb size and level of phosphorus fertilizer on tuberose

Source of variation	Degrees of freedom	Mean square						
		Number of side shoot						
		30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS
Replication	2	0.03	0.01	0.13	0.08	0.04	0.02	0.0142
Bulb size (A)	2	4.55^{NS}	1.51^{NS}	1.28^{NS}	1.48^{NS}	1.92^{NS}	1.8532^{NS}	1.4842^{NS}
Phosphorus fertilizer (B)	3	0.05*	0.26*	0.64*	0.62*	0.57*	0.36*	0.60*
Interaction (A×B)	6	0.14*	0.08*	0.27*	0.24*	0.30*	0.31*	0.30*
Error	22	0.02	0.02	0.04	0.063	0.03	0.031	0.06

* Significant at 5% level of probability
NS=Non Significant

Appendix VI. Analysis of variance of the data on growth and flowering as influenced by bulb size and different level of phosphorus fertilizer on tuberose

Source of variation	Degrees of freedom	Mean square					
		Days required for sowing to spike emergence	Length of flower stalk (cm)	Length of rachis (cm)	Number of floret/ spike	Weight of single spike (g)	Diameter of single spike (cm)
Replication	2	21.36	17.58	9.74	1.10	3.73	0.001
Bulb size (A)	2	92.53^{NS}	66.51*	713.49*	259.67*	3549.16*	0.57*
Phosphorus fertilizer (B)	3	203.41^{NS}	80.74*	77.05*	78.39*	173.72*	0.05*
Interaction (A×B)	6	12.60*	10.50*	11.86*	6.89*	18.62*	0.007*
Error	22	0.69	2.35	2.86	2.94	11.28	0.002

* Significant at 5% level of probability
NS=Non Significant

Appendix VII. Analysis of variance of the data on bulb and bulblet production as influenced by bulb size and different level of phosphorus fertilizer on tuberose

Source of variation	Degrees of freedom	Mean square					
		Weight of individual bulb (g)	Diameter of individual bulb (cm)	Number of bulblet/plant	Weight of single bulblet (g)	Yield of bulb (t/ha)	Yield of bulblet (t/ha)
Replication	2	1.00	0.13	4.04	0.04	0.06	0.22
Bulb size (A)	2	70.50^{NS}	0.88^{NS}	11.43^{NS}	0.08^{NS}	4.50^{NS}	3.35^{NS}
Phosphorus fertilizer (B)	3	339.62*	0.56*	13.03^{NS}	0.46*	21.40*	9.31*
Interaction (A×B)	6	58.58*	0.14*	1.51*	0.13*	3.75*	1.08*
Error	22	3.81	0.04	1.23	0.03	0.23	0.43

* Significant at 5% level of probability
NS=Non Significant