EFFECT OF BULB SIZE AND POTASSIUM ON THE GROWTH FLOWER AND BULB PRODUCTION OF TUBEROSE

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Dedicated to
My
Beloved Parents

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*This is to certify that the thesis entitled, "EFFECT OF BULB SIZE AND POTASSIUM ON THE GROWTH, FLOWER AND BULB PRODUCTION OF TUBEROSE submitted to the Department of Horticulture and Postharvest Technology , Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE in HORTICULTURE** embodies the result of a piece of bona-fide research work carried out by **Maleka Khayrunnessa, Registration No. 02622** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

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ABSTRACT

An experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka during the period from May 2007 to April 2008, to study the effect of different sizes of bulb and potassium on the growth flower and bulb yield of tuberose. The experiment consisted with two factors, Factor A: three sizes of bulb viz, B_1: Small bulb (1.0 - 1.5 cm); B_2: Medium bulb (1.6 - 2.0 cm) and B_3: Large bulb (2.1 - 2.6 cm) in diameter respectively and Factor B: four levels of potassium viz., K0: 0 kg (control); K_1: 120 kg; K_2: 140 kg and K_3: 160 kg K_2O /ha respectively. The experiment was conducted in a Randomized Complete Block Design with three replications. Bulb size and potassium fertilizer significantly influenced the growth and yield of tuberose. In case of bulb size, B_3 gave the highest (8.8 t/ha) yield and B_1 gave the lowest (7.04 t/ha). In case of potassium, K_2 gave the highest yield (8.63 t/ha) and K_0 gave the lowest (7.30 t/ha). For combined effect B_3K_3 gave the highest (8.71t/ha) yield and B_1K_0 gave the lowest (7.17 t/ha). So, large bulb size with 160 kg K_2O/ha was best for growth, flower and bulb yield of tuberose.

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ABBREVIATIONS AND ACRONYMS

DAP	= Days After Planting
N	= Nitrogen
P	= Phosphorus
K	= Potassium
RH	= Relative Humidity
et al.	= and others
Viz.	= Namely

CHAPTER I

INTRODUCTION

Tuberose (*Polianthes tuberosa* L.) belonging to the family Amaryllidacaae, produce attractive, elegant and fragrant white flowers. It occupies a very selective and special position to flower loving people because of its prettiness, elegance and sweet pleasant fragrance. It has a great economic potential for cut flower trade and essential oil industry (Sadhu and Bose, 1973). Flowers remain fresh for quite a long time and stand distance transportation and fill a useful place in the flower market (Desai, 1957).

Long spikes of tuberose are used for vase decoration and bouquet preparation and the florets for making artistic garlands, ornaments and buttonhole use. Flowers emit a delightful fragrance and are the source of tuberose oil. Natural flower oil of tuberose is one of the most expensive perfumer's raw materials.

Tuberose is a native of Mexico from where it spread to the different parts of the world during 16 th century. How and when the tuberose found its entrance to India, Cylon and elsewhere in the Orient is probably is probably an unanswerable question (Yadav and Maity, et al 1984). Now a day, it is cultivated on large scale in France, Italy, South Africa, USA and in many tropical and sub-tropical areas, including India even Bangladesh.

There are many factors which can affect the plant growth and economic cultivation of tuberose. Bulb size is one of the prime major importance factors among of all the cultural factors which greatly influence the

growth, bulbing and flower production. For economic production and good yield, bulb size is so important to be determined. In case of very small size of bulb, there is actually loss of land, labor and energy. When plants are grown by large size bulb, enhance to vigorous growth, long spikes, large number of florets per spike, delay senescence and to achieve the maximum bulb and yield.. Developmental process also depends on size of bulb. Small sized bulbs produce the shortest spike and rachis, minimum florets per spike, contribute lower yield of bulb and flowers. Sometimes from small size bulb, flowering may early before the completion of full vegetative growth, often senescence starts earlier (Vandor Valk & Timmer, 1974). In case of tuberose, number of flower spikes per plant and bulb production increases with large sized bulbs (Mukhopdahyay *et al.*1986). However, there are reports that the maximum production of bulbs can be achieved from higher large sized bulb (Cirrito and Zizzo, 1980).

Application of potassium fertilizer has been found to influence the growth and flowering of tuberose (Bose and Yadav, 1998). Mukhopdahyay and Banker (1983) applied different levels of potassium in tuberose plants and observed that higher levels of potassium fertilzer increased spike length and number of flower per spike. Duration of flower in the field was improved through using potassium fertilizer.

In Bangladesh, its commercial cultivation was introduced during 1980 by some pioneer and innovative farmers at Panishara union of Jhikorgacha thana under Jessore district. Due to multi use, it holds a high demand in the market and its production is appreciable (Aditya, 1992).Although tuberose is now cultivation in the country, very little knowledge of production technology is hand to the growers (Ahmed, 1985).

In Bangladesh, a little work has been done in respect of bulb size and use of potassium for tuberose cultivation. So, research work is so lack about the production technique of tuberose. Considering the facts, such research is very important for the greater interest of the scientist as well as the growers of our country.

The present study is, therefore, undertaken with the following objectives:

1. to find out the optimum size of bulb of tuberose for achieving the maximum growth, flower and bulb yield.
2. To find out the optimum level of potassium for maximizing the growth, flower and bulb yield of tuberose
3. To determine the suitable combination of bulb size and level of potassium for ensuring the growth, flower and bulb production of tuberose.

CHAPTER II

REVIEW OF LITERATURE

Tuberose (*Polianthes tuberose* L.) is one of the most popular cut flower of the world as well as Bangladesh and received much attention to the researchers of different countries including Bangladesh. Like many other cut flowers; the growth, bulb and flower yield of tuberose are influenced by bulb size and potassium fertilizer. A number of factors like temperature, soil moisture are involved with the absorption of potassium fertilizer and bulb emergence which ultimately influence the growth and yield of a crop. Bulb of tuberose is also known to be a heavy absorber of soil moisture as well as potassium fertilizer. There is a little or no combined research work to the effect of bulb size and potassium on growth and yield of bulb and flower in Bangladesh. The literature related to the present study is reviewed in this chapter.

2.1 Influence of potassium on growth, bulb and flower yield of tuberose

Singh *et al.* (2005) studied the effect of varying levels of N (10, 20 and 30 g/m2), $P_2 0_5$ (10, 20 and 30 g/m2) and $K_2 0$ (10 and 20 g/m^2) on the growth and flowering of tuberose (*Polianthes tuberosa* cv. Single) were valuated in trails conducted during 1998/99, in Faizabad, Uttar Pradesh, India. The bulbs applied before planting, and the remaining half dose of N was applied at the time of spike initiation. Observations were recorded for days to sprouting, sprouts per bulb, leaves per plant, leaf length days to spike initiation, spike length flowering duration, florets/100 g and spikes per clump.

A field experiment was conducted by Pal and Biswas (2005) in Nadia, West Bengal, India, during 1999-2000 to 2000-01 to investigate the effect of N.P and K on the growth the flowering of tuberose (*Polianthes. tuberosa*)cv. Calcutta Single. The application of 20 g each of N, P_2O_5 and K_20/m2 recorded the highest plant height, leaf number and spike length, however application of N, P_2O_5 and K_20 at 20, 15 and 20g/m2, respectively, improved spike weight and yield, and number of florets per spike for the first year. Application of 15g each of N, P_20_5 and K_20/m^2 improved plant height and leaf number in ratoon crop. However, application of N and P_20_5 each at $15g/m^2$ and K_20 at $20g/m^2$ improved spike length, weight and number/m^2. The spike production was highest weight and number /m^2 .The spike production was highest with N, P_20_5 and K_20 at 20, 15 and$15g/m^2$, respectively, in ratoon crop. The lower doses of fertilizer produced poor quality plant and yield of flower. Thus, application of N and K_20 at 15.15 and 20 g/m2 and P_20_5 at $15g/m^2$ for the first year, and N, P_20_5 and K_20 at 15, 15 and $20/m^2$ and 205 at $15g/m^2$,respectively for ratoon crop recommended to produce good quality plant and improve yield of flower spike in the plains of West Bengal.

Singh and Sangama (2000) studied the N, P and K uptake by *Polianthes tuberosa* cv. Single conducted in Bapatla, Andhra Pardesh, India. Treatments consisted of 3 intrarow spacing (10(SI), 20 (S2) and 30 (S3) cm), Keeping a constant interrow spacing of 30 cm; and / or 4 NPK application rates (100 kg N+ 50 kg P_20_5 + 50 kg K_20 /ha (F1). 175 kg N+ 75 kg P_20_5 + 75 kg K_20/ha (F2), 250kg N + 100 kg P_20_5+ 100kg K_20/ha (F3), and 325 kg N + 125kg P_20_5 + 125 kg K_20/ha (F4), F4,S3 and its combinations resulted in the highest N , P and K uptake , both at 50% flowering stage and harvesting stage.

The N, P and K uptake by *Polianthes tuberosa* cv. Single was studied in an experiment conducted by Mohanty *et al.*, (1999) in Bapatla, Andhra Pradesh, India. Treatments consisted of 3 intrarow spacing (10 (S_1). 20 (S_2) and 30 (S_3) cm), keeping a constant interrow spacing of 30 cm; and /or 4 NPK application rates (100kg N +50kg $P_2 0_5$ +50 kg $K_2 0$/ha (F_1), 175 kg N+ 75kg $P_2 0_5$ + 75 g $K_2 0$/ha (F_2), 250 kg N + 100 kg $P_2 0_5$ + 100 kg $K_2 0$/ha (F_3), and 325 kg N +125 kg $P_2 0_5$ + 125 kg $K_2 0$/ha (F_4). F_4, S3 and its combination resulted in the highest N,P and K uptake, both at 50% flowering stage and harvesting stage.

In a 2-year trial by Amarjeet and Godara (1998) at Hisar, India, N was applied at 0,100,200,300 or 400 kg/ha and P and K each at 0,100 or 200 kg/ha to tuberose cv. Single. Total flower yield increased with increasing N rate reaching 8.20 and 9.48 t/ha in 1991 and 1992, respectively, at the highest N rate, Increasing P rate also increased flower yield but K application had only a slight effect.

Amarjeet and Godara (1998) explained from their 2-year trail at Hisar, N was applied at 0, 100,200,300 or 400 kg/ha and P and K each at 0,100 or 200 kg/ha to tuberose cv. Single flower yield increased with increasing N rate reaching 8.20 and 9.48 t/ha in 1991 and 192, respectively, at the highest N rate. Increasing P rate also increased flower yield but K application had only a slight effect.

Bankar (1998) studied in 2-year field trials , plants received N at 0, 5, 10, 15 or 20 g/m^2, and $P_2 0_5$ and $K_2 0$ each at 0, 20 or 40 g/m^2, giving 45 treatments altogether. Data are tabulated on plant height number of leaves /plant , days to spike emergence , number of spikes/plant , spike length, rachis length, number of spikes/plant , spike length, rachis length, number of flowers/spike, duration of

flowering, and number and weight of bulbs/plant. N improved vegetative growth, flowering and bulb production in the first year. P and K improved vegetative growth, flowering and bulb production in the first year. P and K increased spike number, rachis length and duration of flowering only in the second year (the ratoon crop crop). The optimum fertilizer application rate was determined as 15 g N + 40 g $P_2 0_5$ + 40 g $K_2 0$/m2.

Patel *et al.* (1997) conducted with three spacing (45 × 45 cm, 45 × 30 cm or 45 × 15 cm) and 4 fertilizer rates (5 kg organic manure/ m2 or NPK at 100+50+0, 200+100+50 or 300+ 200+100 kg/ha) were compared in trials in Navsari, Gujarat, India , in 1992-95 with Polianthes tuberosa (cv. Double) grown for cut flower. Neither plant height nor leaf width was affected by the different spacing or fertilizer treatments. Leaf number was highest with the widest spacing and highest NPK fertilizer rate. The field of flower spikes/plant was similar in all treatments but the yield/ha was highest at the closest spacing (1 047 530 spikes/ha). Flower spike length and the number of florets/spike were highest and the closest spacing with the highest NPK rate. The highest cost benefit ratios were obtained with the closest spacing (45 cm ×15cm) and the highest NPK rate or organic manure.

An experiment was conducted by Bhuyan *et al.*(1996) at Jorhat, Assam, India, during 1992 and 1993 to study the effect of applying K at 0 - 120 g $K_2 0$/m2 on growth, flowering and bulb production in tuberose for cut flowers. The number and weight of spikes, floret size, shelf- life and vase –life increased as K rate increased up to 60 g/m2. Bulb production was also greatest with 60 g $K_2 0$/ m2.

Singh *et al.* (1996), in trials at Hisar, Haryana, in 1991 and 1992, N was applied at 0,10,20,30,40 g/msuperscript 2,P at 0,10 or 20 g $P_2 0_5$ /msuperscript 2 and K at 0,10 or 20 g $K_2 0$ /msuperscript 2. Bulb yields increased as N rate increased up to 30 g/plant. P and K rates had little effect on bulb yield. There was a significant interaction between N and P.

Amarjeet *et al.* (1996) studied with 5 rates of N (0,100,200,300 and 400 gk/ha) and 3 rates each of P and K (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 N, P and K 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 development stages (opening of first floret and last floret) with increasing doses of N and P fertilizer, increasing K application increased rachis length at opening of the last floret but not the first floret.

An experiment was conducted by Bhuyan *et al.* (1996) at Jorhat, Assam, India, during 1992 and 1993 to study the effect of applying K at 0-120 g $K_2 0$/ m2 on growth flowering and bulb production in tuberose for cut flowers. The number and weight of spikes, floret size shelf-life and vase – life increased as K rate increased up to 60 g/m2. Bulb production was also greater with 60 g /m 2.

Amarjeet and Godara (1995) in plots of *Polianthes tuberosa* cv. Single received N fertilizer at 0,100,200,300 or 400 kg/ha and P and K fertilizer each at 0,100 or 200 kg/ha. Increasing rates of N, P and K increased the number of leaves per plant and plant height significantly. Increasing rates of N and P reduced the number of days for sprouting of rhizomes but K had no significant effect.

Parthiban *et al.*(1992) worked on *Polianthes tuberosa* cv. Single plants were supplied with 50, 75,100 or 125 kg N/ha, 25, 50,75kg P/ha and 37.5, 62.5 or 87.5 kg k/ha . The greatest plant height (58.93 cm) was obtained with the 125 kg N + 50 kg/ha + 62.5 kg K/ha treatment combination. The highest mean number of leaves (41.34) and number of side suckers/clump were obtained with the 100 kg N + 75 kg P + 62.5 kg K/ha treatment combination.

Gowda *et al.*(1991) carried out an experiment at the farm under Horticulture Division , University of Agriculture, Banglore, India, with three rates of N application (100, 150 and 200 kg /ha), 3 of $P_2 0_5$ (50, 75 and 100 kg) and 3 of K20 (100 , 125 and 150 kg) were compared for a cut-flower crop of *Polianthes tuberosa* L. grown at a spacing of 30 X 30 cm. All the $P_2 0_5$ and $K_2 0$ and half the N were applied as a basal dressing ; the remaining N was applied as a top dressing 30 days after planting. Increasing N significantly increased plant height. Both N and K20 significantly influenced the number of days required for flower spike emergence. Increasing P and $K_2 0$ 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 (29.75days) were obtained with 200 kg N + 75 kg $P_2 0_5$ + 125 kg $K_2 0$/ha .

Parthiban and Khader (1991) studied in an experiment aimed at determining the fertilizer requirements of *Polianthes tuberosa* cv. Single. N was applied at 50, 75,100 kg, P at 25,50 or 75 kg and K at 37.5, 62.5 or 87.5 kg/ha. All the P and K were applied with half the N at planting. The remaining N was applied 45 days later. Application of 100 kg N + 75 Kg P + 62.5 kg K/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) worked with three rates of N (100,150 and 200 kg/ha), 3 of $P_2 0_5$ (50,75 and 100kg) and 3 of $K_2 0$ (100,125 and 150 kg) were compared for a cut-flower crop of *Polianthes tuberosa* grown at a spacing of 30 X30 cm. All the $P_2 0_5$ and $K_2 0$ and half the N were applied as a basal dressing ; the remaining N was applied as a top dressing 30 days after planting .Increasing N significantly increased plant height. Both N and $K_2 0$ significantly influenced the number of increased plant height. Both N and $K_2 0$ significantly influenced the number of days required for flower spike emergence. Increasing P and K20 rates resulted in a greater number of flower spike and number of flowers/spike. The highest flowering (29.75 days) were obtained with 200 kg N +75 kg $P_2 0_5$ +125 kg $K_2 0$/ha.

Bankar and Mokhopadhyay (1990) in field trails with *Polianthes tuberosa* cultivar, N was applied at 0,5,10,15 or 20 g/m2, P205 at 0,20 or 40 g/m^2 and K20 at 0,20 or 40 g/m2. One –half on the N and all of the P and K were applied before planting; the remaining N was applied as a top dressing at flower emergence. Data are tabulated on plant growth and flowering parameters, and NPK contents of the leaves. N application advanced flowering and improved growth. Leaf N content was positively correlated but leaf P and K contents were negatively correlated with number of flower spikes. The highest number of flower spike/ m^2 (20.09) was obtained from 20 g/m^2 of K_2O.

2.2 Effect of bulb size on the growth, bulb and flower yield of tuberose

Bulbs of tuberose cv. Single 1.5-2.0, 2.1-2.5 or 2.6-3.0 cm in diameter were planted as spacing of 20 X20, 30 X20 or 30 X30 cm by Sunil and Singh (1998) 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. Emergence was earliest from the smallest bulbs planted at the widest spacing and given the highest N rate. Cut flower field and quality and bulb production were greatest from the largest bulbs planted at the widest spacing and given the highest N rate.

Kumar *et al.*(2003) studied the effect of bulb size (<1.5, 1.5 – 2.5 or 2.5 – 3.5 cm in diameter), spacing (20 x20, 25 x 25, 30 x 30 cm) and planting depth (3, 6 or 9 cm) on growth and development of tuberose (*polianthes tuberosa* L. 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). Spike emergence was delayed with the increase of the planting depth. Spike length 88.78 and 89.37 cm and rachis lengths 19.76 and 20.06 cm were greatest with the medium and large size bulbs. The depth of planting was inversely related to flower quality in terms of spike and rachis length. Thus, the longest length of spike 89.52 cm and rachis length 19.48 cm were obtained with a planting depth with of 9 cm. The number of flower spike decreased with deep planting of small size of bulb at closer spacing. The number of floret/spike increased with the increase of spacing. Thus the highest number of florets/spike (33.70) was recorded from the spacing of 30.30 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 sprouting8.28 days, medium bulbs with moderate planting depth 6 cm and spacing 25 x 25 cm gave higher yield of flower and bulb.

Field experiments were conducted by Misra *et al.*(2000) to determine the effect of bulb size spacing on plant growth and flowering of two tuberose (*Polianthes tuberosa* L.) cultivars (Single and Double) in Faizabad, Uttar Pradesh, India, during 1997 – 1998. 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. The spike length and number of florets decreased in closer spaced-plants. However, a bulb size of 2.60 – 3.00 cm at 30 x30 cm spacing was the best for both the cultivars.

Raja and Palanisamy (2000) conducted an experiment in Coimbatore, Tamil Nadu, India, during 1997 – 1998. Mother bulbs and fingers of tuberose (*Polianthes tuberosa*) of varing 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 larger bulbs. Plant height and number of plantlets/plant and number of leaves/ plant increased with increasing size

of planting materials. Mother bulbs 2.5 – 3.0 cm took 97 days to initiate flower stalk emergence, the medium and small sizes of bulbs did not produce flowers. The number of flower stalk, flower weight/ stalk, length of flower stalks and flower yield/clump were higher for large mother bulbs than for large finger.

Raja and Palanisamy (1999) conducted a field experiment Tamil Nadu, India, on *Polianthes tuberose* cv. Single, mother bulb with a diameter <4.0 cm. It gave the highest percent emergence (89.0), greatest plant height (48.2 cm) at 200 days after planting, highest number of flower stalk (3.1), longest flower stalk (106.4 cm) and 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 – 3.0 cm in diameter) had the earliest flower stalk emergence (96.7 days). Large bulbs (3.5- 4.0 cm in diameter) gave the highest number (3.41) and the heaviest (120.8 g) bulbs per clump. Medium bulbs (3.0 – 3.5 cm in diameter) gave the highest number of fingers per clump (10.58).

Patil *et al.*(1987), conducted an experiment, they used rhizomes having 1.5 -2.5, 2.6 – 3.0 cm diameter15 x 20, 20 x 20 and 25 x 20 cm spacing and the plants are grown for three years for cut flowers. The highest yield of top quality flowers were obtained from the large rhizome planted at 15 x 20 cm.

Yadav *et al.*(1984), Dhua *et al.*(1987) found that number of leaves per plant also showed gradual increase with the increase in bulb size up to a certain level.

Larger bulbs were found to take more time for sprouting (Yadav *et al.*1984). This might be due to the presence of more layers of membranous scales, which interfered the exchange of gases and inhibited metabolic process (Kamerbeek, 1962).

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 in tuberose cv.Single for a period of three years and recorded that plant with large size bulbs (3.1- 3.5 cm in diameter) 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 (30.10 ton/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 bulbs cause early flowering and gives higher yields of spikes and flowers.

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

Kale and Bhujbal (1972); Ramaswamy and Chokalingam (1977) concluded that the numbers of flowers/ spike, flower quality, daughter bulb production etc. were also found to be related to the bulb.

CHAPTER III

MATERIALS AND METHODS

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

3.1 Experimental site

The experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from May 2007 to April 2008. The site is situated between $23^0 74'$ N latitude and $90^0 35'$ E longitude with an elevation of 8.2 m from sea level (Anonymous, 1989).

3.2 Climate

The experimental area is situated in the subtropical zone, characterized by heavy rainfall during Kharif season (April to September), and scanty in Rabi season (October to March). Rabi season is characterized by plenty of sunshine. Information regarding average monthly maximum and minimum temperature, rainfall and relative humidity, soil temperature as recorded by the Dhaka meteorology centre, Agagoan, Dhaka, during the period of study have been presented in Appendix I.

3.3 Soil

The soil of the experimental area was non-calcarious dark grey and belongs to the Madhupur Tract (UNDP, 1988) under AEZ 28. The selected plot was medium high land and soil series was Tejgoan (FAO, 1988) with a pH of 5.6. The analytical data of the soil sample collected from the experimental area were analyzed in the SRDI, Soil Testing

Laboratory, Khamarbari, Dhaka and details of the soil characteristics are presented in Appendix II.

3.4 Treatments of the experiment

The experiment was designed to study the effect of different sizes of bulbs and different levels of potassium on growth, flower and bulb yield of tuberose. The experiment consisted of two factors which are as follows:

Factor A: Bulb size (three size)

i) B_1 : Small bulb (1.0-1.5 cm in diameter)

ii) B_2 : Medium bulb (1.6- 2.0 cm in diameter)

iii) B_3 : Large bulb (2.1-2.6 cm in diameter)

Factor B: Potassium used as K_2O (four levels)

i) K_0 : 0 kg K_2O /ha (control; no K_2O /ha was used)

ii) K_1 : 120 kg K_2O /ha

iii) K_2 : 140 kg K_2O /ha

iv) K_3 : 160 kg K_2O /ha

There were altogether 12 treatment combinations such as: B_1K_0, B_1K_1, B_1K_2, B_1K_3, B_2K_0, B_2K_1, B_2K_2, B_2K_3, B_3K_0, B_3K_1, B_3K_2 and B_3K_3.

3.5 Experimental design and layout

The two-factor experiment was laid out following Randomized Complete Block Design (RCBD) with three replications. Total area (159.9 m^2) of the experimental land was divided into three equal blocks. Each block was divided in to 12 plots where 12 treatments were allotted at random.

B_1

B_2

B_3

Plate No 1. Different size of bulb

B_1=Small bulb (1.0-1.5 cm in diameter)
B_2= medium bulb (1.6-2.0 cm in diameter)
B_3= Large bulb (2.1-2.6 cm in diameter)

Thus, there were 36 (12 ×3) unit plots altogether in the experiment. The size of each plot was 1.4 ×1 m. The distance between blocks and between plots was kept respectively 1 and 0.5 m. Spacing of the bulbs were 25 x 20 cm and 28 bulbs were planted at each plot.

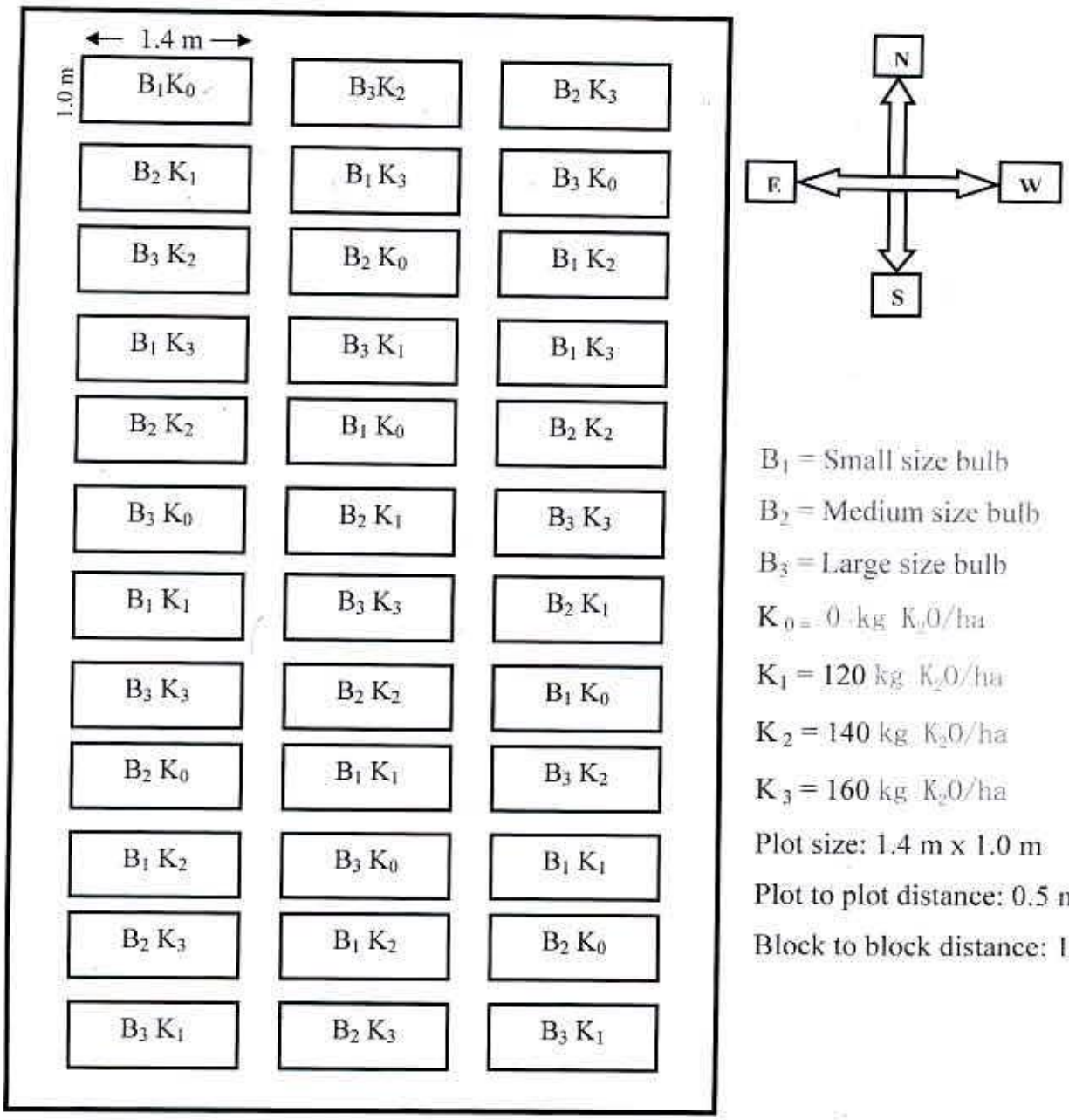

Figure 1. Field layout of the two factors experiment in the Randomized Complete Block Design (RCBD)

3.6 Land preparation

The land which was selected to conduct the experiment was opened on 15 April, 2007 with the help of a power tiller and then it was kept open to sun for 7 days prior to further ploughing. Afterwards it was prepared by ploughing and cross ploughing followed by laddering. Deep ploughing was done to have a good tilth, which was necessary for getting better yield of this crop. The weeds and stubbles were removed after each laddering. Simultaneously the clods were broken and the soil was made until good tilth.

3.7 Application of manures and fertilizer

The following doses of manures and fertilizers were used for tuberose production.

Manures/fertilizer	Doses per hectare
Cowdung	15 ton
Urea	260 kg
Triple Super Phosphate (TSP)	200 kg
Muriate of Potash (MP) as K_2O	As per treatment

The entire amount of cowdung, TSP and half of urea were applied during final land preparation. The applied manures were mixed properly with the soil in the plot using a spade. The rest urea and MP were used as equal four top dressing. First top dressing was done 30 days after emergence of bulbs. Second and third were done after 30 days of first and second top

dressing respectively. The last top dressing was done during first blooming of the 25% plants in each plot.

3. 8 Collection and planting of bulbs

The bulbs of tuberose were used in the experiment. The bulbs were collected from Barisal Nursery, Saver, Dhaka.

The bulbs were planted in the field on 5 May 2007. The bulbs were planted in raised bed placing upright and hole was made for each bulb up to the neck of bulbs at a distance of 20 cm, along the row spaced at a distance of 25 cm. Only one bulb was placed in each hole and covered with loose soil.

3.9 Intercultural operations

3.9.1 Weeding

Plots were kept from weeds by regular weeding. The weeds were eradicated very carefully with roots were done as per necessity.

3.9.2 Irrigation and drainage

Irrigation and drainage were done as necessity.

3.9.3. Pest management

Mole cricket, field cricket and cutworm attacks were a problem during seedling stage for tuberose cultivation. As a preventive measure against the insect pest, Dursban 20 EC was applied @ 0.2% at 15 days interval for three times starting from 20 days after emergence of bulb.

3.9.4 Diseases management

The crop was healthy and disease free and no fungicide were used.

3.9.5 Selections and tagging of plants and spikes

Ten plants from each plot were selected randomly for recording plant height, number of leaves per plant, number of side shoot per plant, number to days to first flowering, weight of bulb. Ten spikes from each plot were labeled with details of date of first flowering and after opening of basal floret to each spike. Spikes were labeled again with date for recording duration of flowering on plant. Ten spikes of each plot were selected randomly for three times for throughout the season for recording the length of spike, length of rachis, number of florets per spike and weight of spike.

3.10 Harvesting

The spikes were harvested when the basal floret opened and data were recorded for number spike per hectare and yield per hectare.

3.11 Data collection

Data on the following parameters were recorded from the sample plants during the course of experiment. Ten plants were sampled randomly from each unit plot for the collection of per plant data. The whole plot was harvested to record per plot data.

Data were collected on different growth and yield component and yield. The plants in the outer rows and at the extreme end of the middle rows were excluded from the random selection to avoid the border effect. The following observations were made regarding plant growth, yield and yield attributes as affected by different sizes bulbs and levels of potassium.
The following parameters were recorded.

3.11.1 Plant height

Plant height was measured in centimeter (cm) by a meter scale at 25, 50, 75, 100 and 125 DAP from the point of attachment of the leaves to the bulb (ground level) up to the tip of the longest leaf.

3.11.2 Number of leaves per plant

Number of leaves per plant of ten random selected plants were counted at 25, 50, 75, 100 and 125 DAP. All the leaves of each plant were counted separately. Only the smallest young leaves at the growing point of the plant were excluded from the counting and the average number was recorded.

3.11.3 Length of leaf

Leaves were made detached by a sharp knife of ten random selected plants were measured at 25,50, 75, 100 and 125 DAP with a meter scale top to beneath of the leaf and average was taken in centimeter.

3.11.4 Number of side shoots per plant

Number of side shoot per plant was taken from ten random sample plants at 25, 50, 75, 100 and 125 DAP and average was recorded. Side shoot refers to those plants, which developed from the mother bulb, all the green shoot above the soil surface and adjoined to the mother plant were counted as side shoot.

3.11.5 Length of spike

The average length of spike was measured from ten random selected plants in centimeter with the help of a meter scale from the basal (cutting)

end of the spike to the last point of the tippest floret of the spike in each treatment.

3.11.6 Length of spike

The average length of spike which produced from side shoot was measured from ten random selected plants in centimeter with the help of a meter scale from the basal (cutting) end of the spike to the last point of the tippest floret of the spike in each treatment.

3.11.7 Diameter of spike

Diameter of spike from ten selected plants were measured with the help of a slide calipers after harvest and expressed in centimeter. Mean diameter was taken from top, middle and bottom portion of the harvested spikes.

3.11.8 Length of rachis

Immediately after harvest, the length of rachis which raised from mother bulbs was measured with the help of a meter scale from ten random selected plants and mean was expressed in centimeter. Length of rachis refers to the length from the basal floret to the tip of the last floret.

3.11.9 Length of rachis

After harvest, the length of rachis which produced from side shoots were measured with the help of a meter scale from ten random selected plants and mean was expressed in centimeter which raised from mother bulb.

3.11.10 Number of florets per spike

At harvest, the number of florets per spike was counted and average was recorded which only produced from mother bulbs.

3.11.11 Number of florets per spike

The total number of florets per spikes was counted which produced from side shoots and average was recorded.

3.11.12 Weight of single spike)

After harvested spikes from ten selected plants were weighed and average was considered as weight of single spike which expressed in gram (g).

3.11.13 Number of spikes per hectare

Total number of spikes was counted from ten selected plants at each unit ($1.4m^2$) area of plot and was converted the total number of spikes per hectare.

3.11.14 Number of bulb lets per plant

Number of bulb lets per plant was counted from ten random selected plants and their average was recorded.

3.11.15 Weight of individual bulb

After colleted bulbs from ten selected plants were weighed and average was considered as weight of individual bulb which expressed in gram (g).

3.11.16 Yield of bulbs per hectare

The yield of bulbs per hectare was calculated in ton by converting the total yield of bulbs per plot.

3.11.17 Yield of flowers per hectare

The yield of flowers per hectare was calculated in ton by converting the total yield of flowers per plot.

3.12 Statistical analysis

The data collected from the experimental plots were statistically analyzed. The mean value for all the treatments was calculated and the analysis of variance for most of the characters was accomplished by F variance test. The significance of difference between pair of means was tested by the Duncan's Multiple Range Test (DMRT) test at 5% probability (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to investigate the effect of different bulb size and different levels of potassium on the growth, flower and bulb production of tuberose. The analysis of variances for different characters has been presented in Appendices IV and V. Data on different parameters was analyzed statistically and the results have been presented in Tables 1 to 10, plate 1 to 3 and Figures 1 to 13. Results of the present study have been presented and discussed in this chapter under the following headings.

4.1 Effect of bulb size and potassium on growth, flower and bulb production of tuberose

4.1.1 Plant height

The plant height was recorded at different stages of growth i.e. 25, 50, 75, 100 and 125 days after planting (DAP). The plant height varied significantly due to sowing of different size of bulbs (Fig. 2 and Appendix III). During the period of plant growth stage, the longest plant was observed in large size of bulb (B_3) followed by medium (B_2) and small size of bulb (B_1) respectively. It was found that, the plant height gradually increased at all observations. However, at 125 DAP, the longest plant (64.69 cm) was obtained from B_3 which was statistically similar to B_2 (62.24 cm) and the shortest plant (56.01 cm) was obtained from small size of bulb (B_1).

The plant height varied also significantly due to application of different levels of potassium. The plant height of tuberose increased linearly with the increasing level of potassium (Fig. 3 and Appendix III). At 125 DAP, the longest plant (65.12 cm) was obtained from the large size of bulb (B_3) and the shortest plant (55.42cm) was obtained from the small size of bulb.

The plant height was significantly influenced by the combined effect of different bulb size and different levels of potassium. The tallest plant (68.87 cm) was obtained from the treatment combination of B_3K_3 (large sized bulb and 160 kg K_2O/ ha) while the shortest (52.60 cm) was found from B_1K_0. (Table 1and Appendix III). Parthiban *et al.*(1992) worked on *Polianthes tuberosa* cv. Single , and they observed that the longest plant height (58.93 cm) was obtained with the 125 kg N + 50 kg/ha + 62.5 kg K/ha treatment combination.

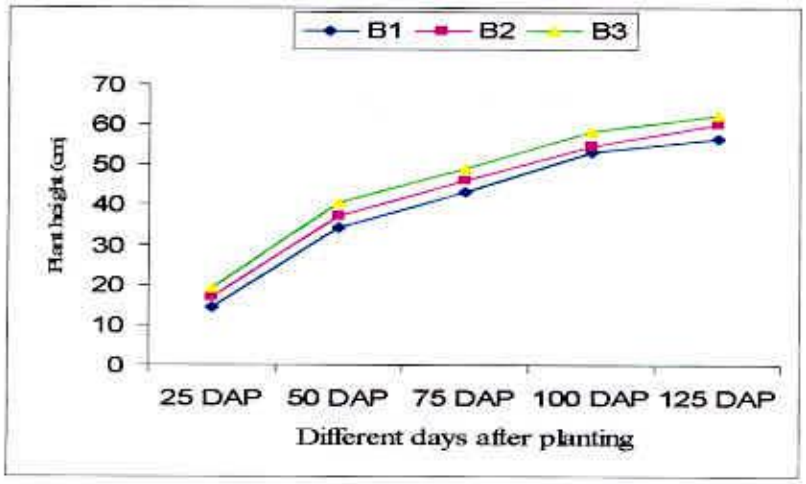

Figure 2. Effect of bulb size on plant height of tuberose

B_1 : Small bulb (1.0-1.5 cm in diameter)

B_2 : Medium bulb (1.6- 2.0 cm in diameter)

B_3 : Large bulb (2.1-2.6 cm in diameter)

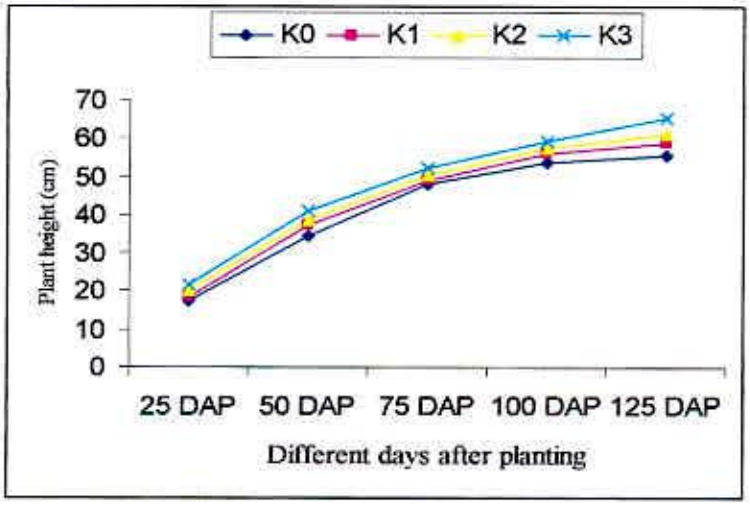

Figure 3. Effect of potassium on plant height of tuberose

K_0 : 0 kg K_2O /ha (control; no K_2O /ha was used)

K_1 : 120 kg K_2O /ha

K_2 : 140 kg K_2O /ha

K_3 : 160 kg K_2O /ha

Table 1. Combined effect of bulb size and potassium on plant height of tuberose

Treatment	25 DAP	50 DAP	75 DAP	100 DAP	125 DAP
B_1K_0	11.33f	31.21i	41.86bc	49.3d	52.60g
B_1K_1	13.78e	33.97h	44.58bc	59.98abc	53.62fg
B_1K_2	16.04d	35.83fg	44.95bc	51.52bcd	57.79e
B_1K_3	16.97d	36.93f	44.89bc	52.55bcd	60.05d
B_2K_0	18.71c	34.22gh	46.56abc	50.75cd	54.92f
B_2K_1	19.64c	39.29e	39.22c	54.18bcd	62.79c
B_2K_2	20c	40.85de	50.31ab	56.04abcd	64.8bc
B_2K_3	22.63ab	42.58cd	47.73abc	57.23abcd	66.45b
B_3K_0	23.47a	39.24e	46.43abc	54.34bcd	58.72dc
B_3K_1	21.43b	43.03bc	47.09abc	58.03abcd	64.64bc
B_3K_2	21.37b	44.74b	49.02abc	61.22ab	66.53b
B_3K_3	22.27ab	49.23a	56.5a	65.46a	68.87a
CV (%)	4.13	2.64	11.72	9.21	1.93
LSD(0.05)	1.33	1.75	9.25	8.72	1.99

DAP: Days after planting

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

4.1.2 Number of leaves per plant (mother bulb)

Planting of different bulb size significantly influenced on number of leaves per plant at different days after planting except 25 DAP (Fig. 4 and Appendix IV). At 25 DAP, the maximum number of leaves (7.42) per plant was produced by large sized bulb which was identical toB_2 (6.34) while the minimum number of leaves (5.32) was obtained from the small sized bulb. However, at 50 DAP, the highest number of leaves (11.03) per plant was found from large sized bulb and the lowest number of leaves (7.04) per plant was obtained from the smallest size of bulb which was statistically similar to B_2 (8.78). However, at 125 DAT, the maximum number of leaves (31.20) was produced by use of large sized bulbs and minimum number of leaves (24.85) per plant was recorded from the small size of bulbs. Yadav *et al.* (1984), Dhua *et al.*(1987) found that number of leaves per plant also showed gradual increase with the increase in bulb size up to a certain level.

Significant variation was found in case of number of leaves per plant due to application of different levels of potassium at different days after planting. (Fig. 5 and Appendix IV). The number of leaves increased with the advancement of time. The maximum number of leaves (10.23) per plant was recorded from K_3 and the minimum (7.38) was from control condition at 50 DAP. At 75 DAP, the large sized bulb produced the maximum number of leaves (18.12) which were identical to K_2 (17.12) and K_1 (16.17) while the minimum number of leaves (13.54) per plant was counted from control treatment. The maximum number of leaves (24.66) per plant was recorded from K_3 and the minimum (21.48) was from control condition at100 DAP. At 125 DAP, K_3 (160 kg K_2O /ha) produced the maximum number of leaves (30.00.) which were identical to

K_2 (28.57) while the minimum number of leaves (25.46) per plant was counted from K_0 (where the plots did not receive fertilizer) which was statistically similar (27.51) to K_1.Such response may be accounted for the physiochemical and biological improvement occurred in the soil including favorable temperature and moisture regimes, nutrient availability. The higher number of leaves per plant achieved on account of large size of bulbs. Amarjeet and Godara (1995) worked on *Polianthes tuberosa* cv. Single and they stated that K had no significant effect on number of leaves per plant. The present study did not support to their findings.

The number of leaves per plant was significantly influenced by the combined effect of different bulb size and different levels of potassium with the advancement of time. (Table 2 and Appendix IV). However, at 125 DAP; the highest number of leaves (33.98) per plant was recorded from the treatment combination B_3K_3. The lowest number of leaves (23.62) per plant was observed from B_1K_0 where small sized bulb and lower level of potassium were used. The highest mean number of leaves (41.34) was obtained by Parthiban *et al.*(1992) with 100 kg N + 75 kg P + 62.5 kg K/ha treatment combination.

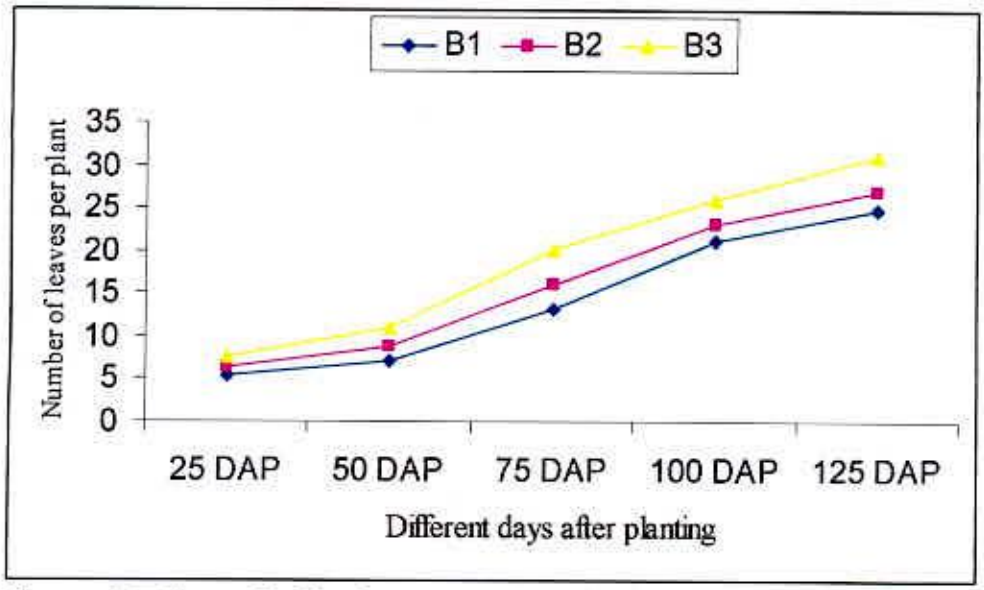

Figure 4. Effect of bulb size on number of leaves of tuberose

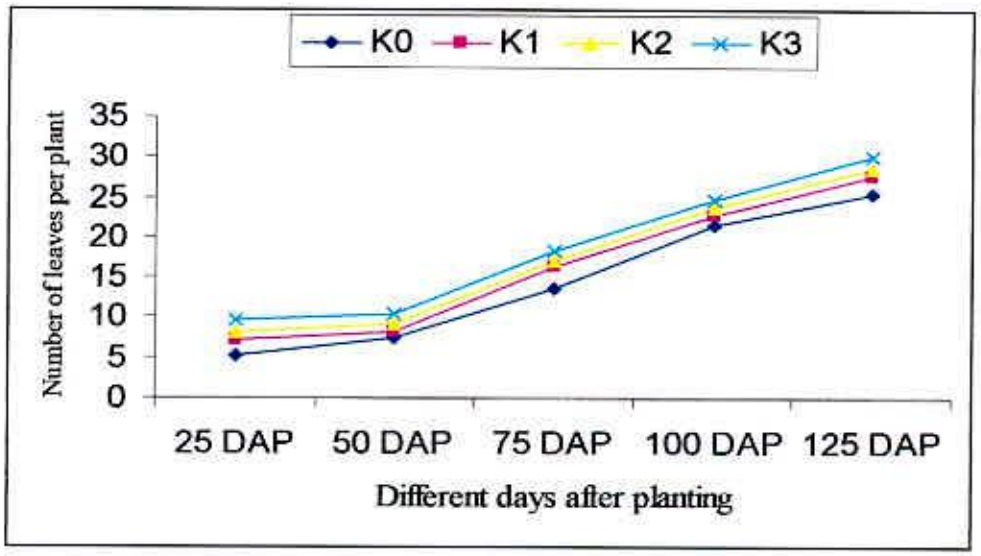

Figure 5. Effect of potassium on number of leaves of tuberose

Table 2. Combined effects of bulb size and potassium on number of leaves per plant of tuberose

Treatment	25 DAP	50 DAP	75 DAP	100 DAP	125 DAP
B_1K_0	4.617d	6.34j	12.15g	19.93h	23.62h
B_1K_1	5.077cd	6.61ij	12.95efg	20.93gh	24.62gh
B_1K_2	5.947bcd	7.397ghi	14.17def	22.22ef	24.83fgh
B_1K3	5.647bcd	7.82gh	14.71de	23.63cd	26.35ef
B_2K_0	5.053cd	6.943hij	12.62fg	21.47fg	25.8efg
B_2K_1	5.84bcd	8.147fg	15.94cd	21.94efg	26.4ef
B_2K_2	6.903abc	9.747de	16.85c	22.93de	28.55cd
B_2K3	7.567ab	10.31cd	17.45c	23.95bcd	29.68c
B_3K_0	6.103bcd	8.883ef	15.84cd	23.05de	26.97de
B_3K_1	6.997abc	11.19bc	19.6b	24.37bc	31.5b
B_3K_2	7.737ab	11.5b	20.35b	25.05b	32.35b
B_3K_3	8.88a	12.57a	22.21a	26.4a	33.98a
CV (%)	9.25	6.36	6.38	2.72	3.35
LSD(0.05)	1.33	1.75	9.25	8.72	1.99

DAP: Days after planting

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

4.1.3 Length of leaf

A significant variation was found due to use of different size of bulbs at 25, 50, 75, 100 and 125 days after planting (Fig. 6 and Appendix V). The longest leaf (21.82) was obtained from the large sized bulb which was similar to B_2 (18.79 cm) while the lowest (13.97 cm) was found from small sized bulb at 25 DAP. At 50 DAP; large sized bulb gave the longest (43.32 cm) length of leaf while small size bulb produced the shortest (33.84 cm) length of leaf. At 75 DAP, the longest leaf length (52.97 cm) was produced by large sized bulb and the shortest (44.13 cm) was found from small size of bulb which was similar to B_2 (44.38 cm). However, 125 DAP, the longest leaf (69.38 cm) was recorded from B_3 and the shortest (55.35 cm) from B_1.

Due to application of different levels of potassium showed significant variation on length of leaf at 25, 50, 75, 100 and 125 DAP (Fig. 7 and Appendix V). However, at 125 DAP, the higher level of potassium (160 kg K_2O/ ha) produced the longest leaf (66.95 cm) which was statistically similar to K_2 (64.43 cm) and the treatment F_0 gave the shortest leaf (56.75 cm) which was identical to K_1 (60.25 cm). Singh *et al.* (2005) studied the effect of varying levels of N (10, 20 and 30 g/m2), P_2O_5 (10, 20 and 30 g/m2) and K_2O (10 and 20 g/m^2) on the growth and flowering of tuberose (*Polianthes tuberosa* cv. Single), they found that leaf length was not significantly influenced with the application of potassium fertilizer.

Due to the combined effect of different size of bulb and different levels of potassium showed significant variation on length of leaf (Table 3 and

Appendix V). At 125 DAS, the maximum length of leaf (76.46 cm) was recorded from B_3K_3 (large sized bulb and 160 kg K_2O/ha) whereas, the minimum (52.14 cm) was obtained from treatment combination of B_1K_0.

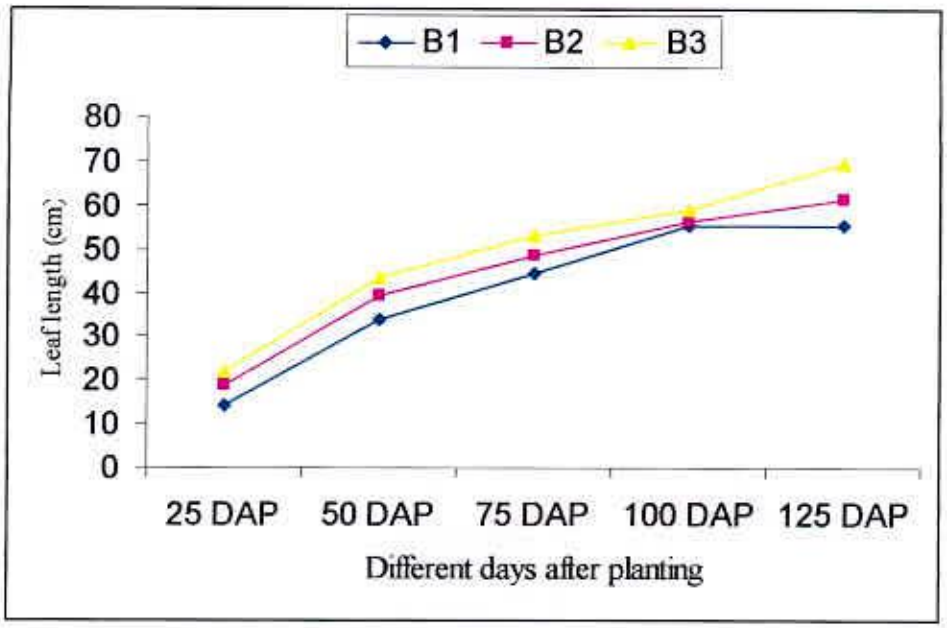

Figure 6. Effect of bulb size on leaf length of tuberose

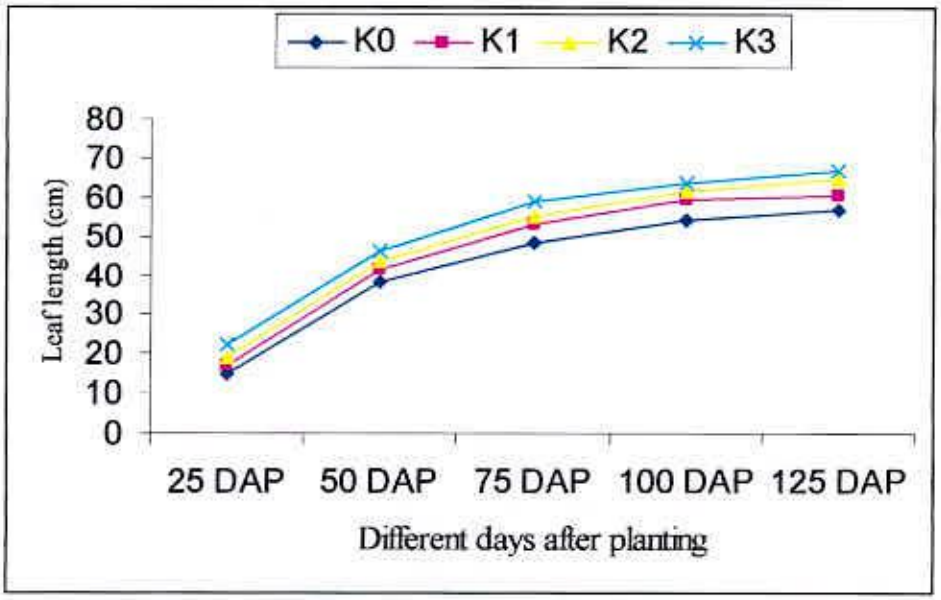

Figure 7. Effect of potassium on length of tuberose

Table 3. Combined effects of bulb size and potassium on leaf length of tuberose

Treatment	25 DAP	50 DAP	75 DAP	100 DAP	125 DAP
B_1K_0	10.95f	30.89h	41.32i	48.88f	52.14i
B_1K_1	13.1e	33.36g	43.71h	49.62f	53.9hi
B_1K_2	15.54d	35.23f	44.9gh	53.02e	56.89fg
B_1K3	16.27d	35.87f	46.57fg	54.51de	58.48f
B_2K_0	15.36d	33.38g	43.32hi	50.49f	54.94gh
B_2K_1	18.32c	36.25f	48.6ef	53.42de	60.82e
B_2K_2	19.45c	38.6e	49.68de	55.72d	64.53cd
B_2K3	22.03b	40.82d	51.92c	58.15c	65.9c
B_3K_0	19.15c	38.63e	46.13g	54.65de	63.18d
B_3K_1	21.38b	43.09c	51.74cd	60.42b	66.02c
B_3K_2	22.33b	44.78b	54.87b	62.14b	71.87b
B_3K_3	24.42a	46.79a	59.14a	65.28a	76.46a
CV (%)	4.86	2.37	2.6	2.31	2.21
LSD(0.05)	1.49	1.53	2.13	2.17	2.32

DAP: Days after planting

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

4.1.4 Number side shoots per plant

The number of side shoot varied significantly due to use of different size of bulbs at different days after planting (Fig. 8 and Appendix VI). At 25 DAP, the highest number of side shoot (6.78) was recorded from the large sized bulb which was similar (5.68) to medium size bulb (B_2) while the lowest number of side shoots (3.58) per plant was found from small sized bulb. Large bulb size gave the maximum (7.42) number of side shoots per plant and the minimum (4.22) was noted from small (B_1) size of bulb at 50 DAP. At 75 DAP, the maximum number of side shoots (8.80) was performed by large sized bulb whereas, the minimum (4.59) was found from small size of bulb. The maximum number of side shoots per plant (11.32) was recorded from large size of bulb which was similar (9.85) to medium (B_2) size of bulb at 100 DAP. The lowest number of side shoots (7.92) was obtained from small size of bulb (B_1). At 125 DAP, the highest number of side shoot (11.80) was obtained from B_3 and the lowest (8.41) was found from B_1 treatment.

Application of different levels of potassium showed significant variation on number of side shoots per plant at 25, 50, 75, 100 and 125 DAS (Fig. 9 and Appendix VI). However, at 125 DAS, the higher level of potassium (160 kg K_2O/ ha) produced the maximum number of shoots (11.13) and the lowest number of shoots (8.82) was counted from control treatment where the plot did not receive potassium, Raja and Palanisamy (2000) recorded, the number of side shoot varied due application of potassium fertilizer. The present investigation supports their statement.

The number of side shoot per plant was also varied due to the combined effect of different size of bulb and different levels of potassium (Table 4 and Appendix VI). The maximum number of side shoots (13.52) was recorded from B_3K_3 (large sized bulb and 160 kg K_2O/ha) whereas, the minimum (7.26) was obtained from treatment combination of B_1K_0 at125 DAP.

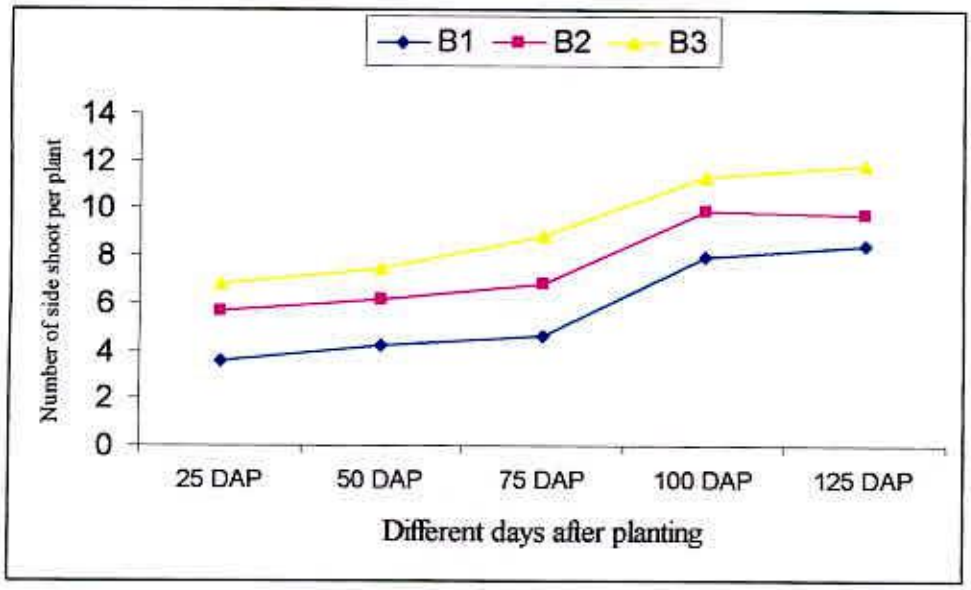

Figure 8. Effect of bulb size on number of side shoot per plant of tuberose

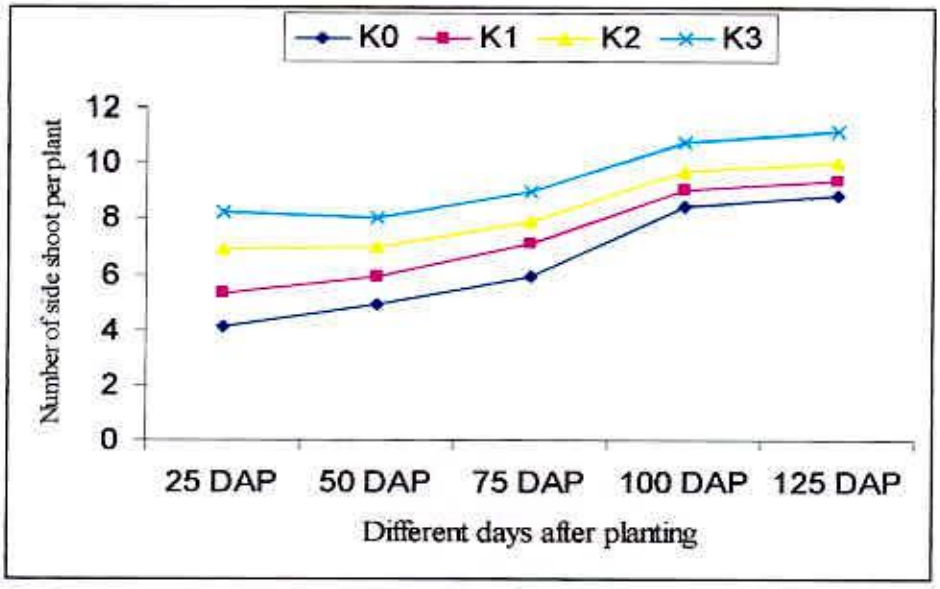

Figure 9. Effect of potassium on number of side shoot per plant of tuberose

Table 4. Combined effects of bulb size and potassium on number of side shoot per plant of tuberose

Treatment	25DAP	50 DAP	75 DAP	100 DAP	125 DAP
B_1K_0	2.123f	3.15g	3.527h	6.957g	7.26g
B_1K_1	3.41e	4.12f	4.627g	7.587fg	8.32f
B_1K_2	4.16de	4.713e	5.02fg	8.29ef	8.88ef
B_1K3	4.643d	4.927e	5.22f	8.88e	9.187e
B_2K_0	4.587d	4.24f	4.87fg	8.49e	8.633ef
B_2K_1	5.113d	5.4d	5.87e	10.12d	10.19d
B_2K_2	6.12c	6.307c	7.41d	10.22cd	10.37d
B_2K3	6.913bc	7.027b	8.68b	10.6cd	10.67cd
B_3K_0	4.983d	5.42d	7.973c	9.897d	10.57cd
B_3K_1	7.36b	7.027b	8.593b	10.96bc	11.14c
B_3K_2	8.3a	8.52ab	8.853b	11.51b	12.29b
B_3K_3	9.07a	9.36a	9.78a	12.9a	13.52a
CV(%)	9.74	3.96	3.69	4.39	3.97
LSD(0.05)	0.92	0.38	0.42	0.72	0.68

DAP: Days after planting

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

4.1.5 Length of spike (mother bulb)

The length of spike showed significant differences due to use of different size of bulbs (Table 5 and Appendix VII). Different sizes of bulb has been shown in plate 1. However, the longest length of spike (75.11 cm) was obtained from the large sized bulb which was similar to B_2 (70.95 cm) while the shortest (64.02 cm) was recorded from small sized bulb.Bankar (1988) studied in 2-year field trials, plants received N at 0, 5, 10, 15 or 20 g/m2, and P_20_5 and K_20 each at 0, 20, or 40 gm2, length of spike increased with the higher level of potassium fertilizer.

Application of different levels of potassium showed significant variation on length of spike (Table 6, plate 2 and Appendix VII). However, the higher level of potassium (160 kg K_2O/ ha) produced the longest length of spike (74.79 cm) and the shortest length of spike (65.22 cm) was recorded from control treatment.

Due to the combined effect of different size of bulb and different levels of potassium showed significant variation on length of spike of mother bulb (Table 7 and Appendix VII).The longest length of spike (78.69 cm) was recorded from B_3K_3 (large sized bulb and 160 kg K_2O/ha) whereas, the treatment combination of B_1K_0 produced the minimum (59.49 cm) length of spike.

4.1.6 Length of spike (side shoot)

The length of spike of side shoot varied significantly due to planting of different size of bulbs at different days after sowing (Table 5 and Appendix VII). The large sized bulbs produced he longest length of spike (63.77 cm) while the small sized bulbs showed the shortest (55.40

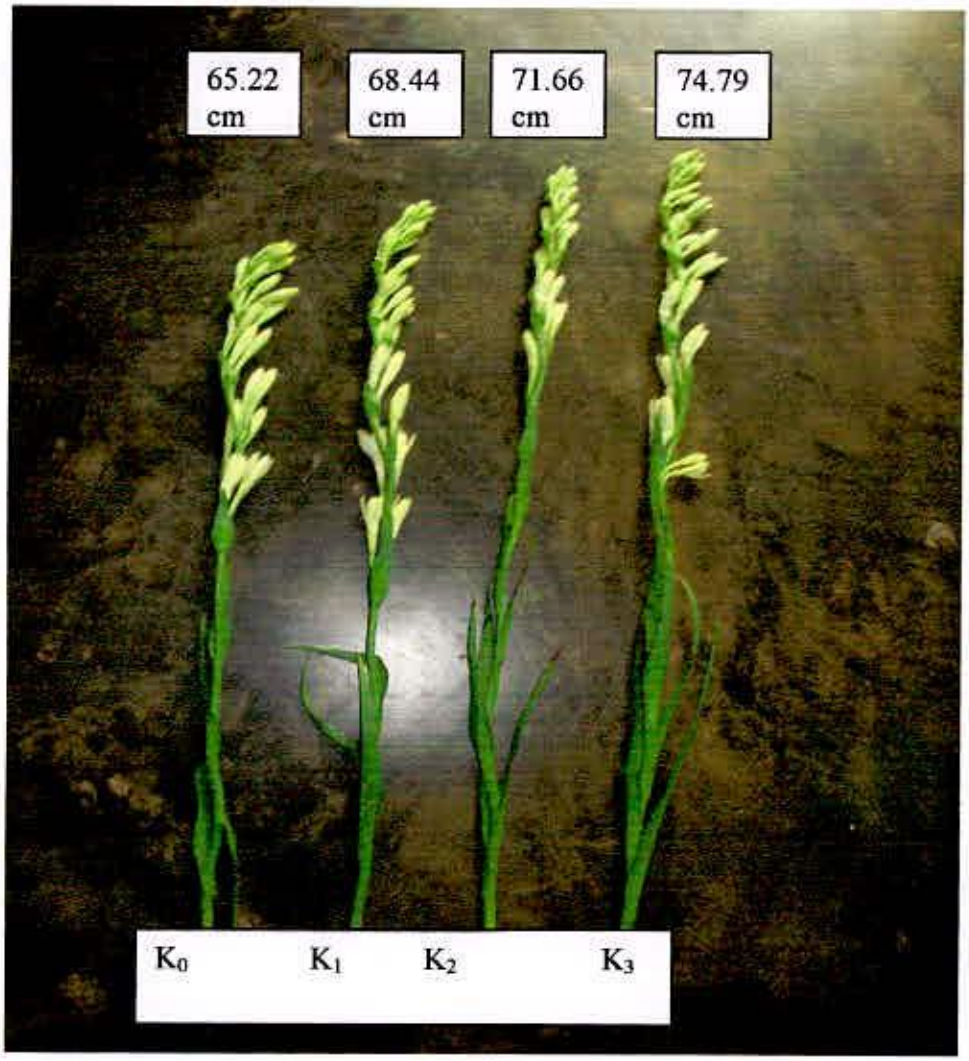

Plate 2. Effect of potassium on length of spike of tuberose

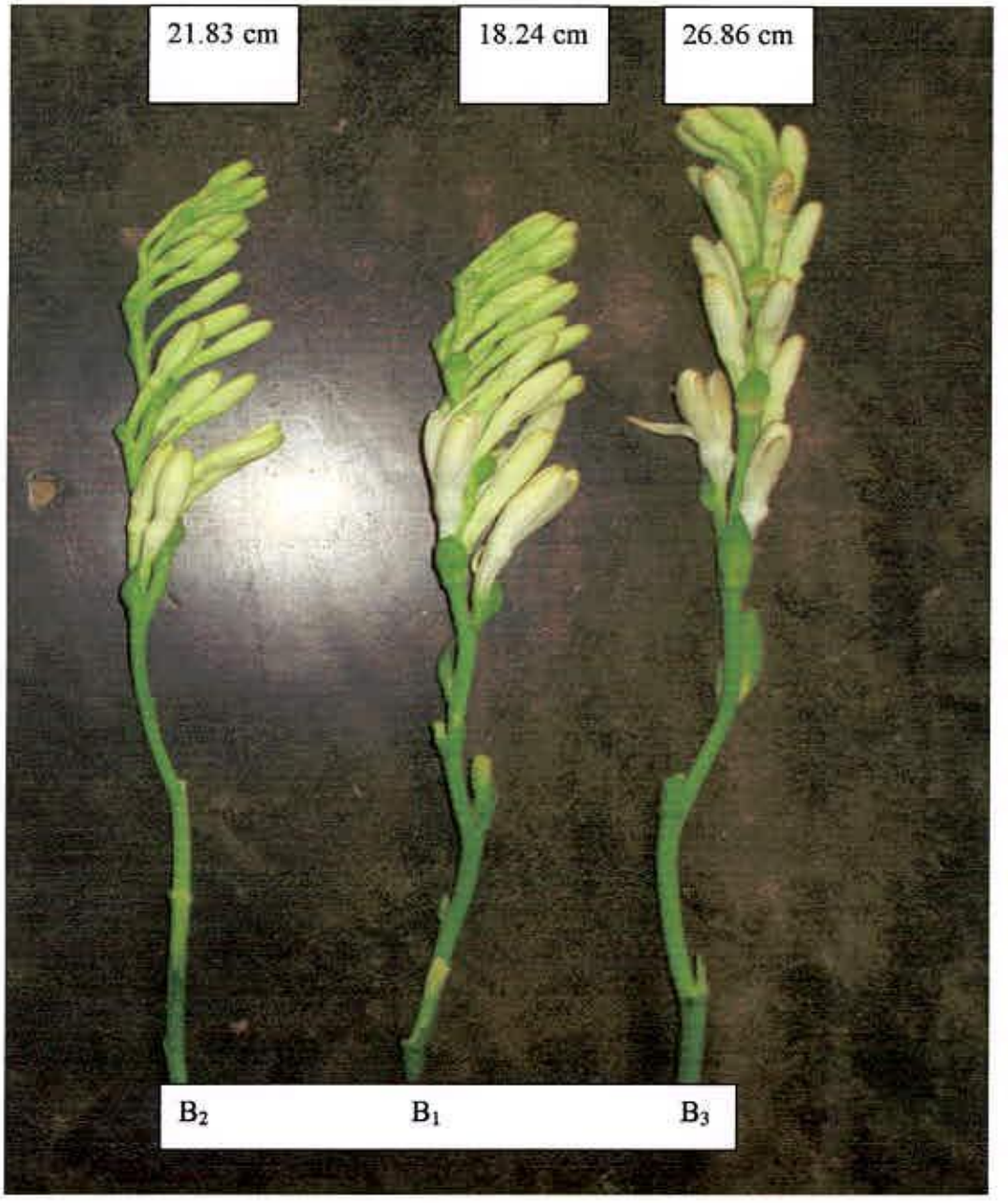

Plate 3. Effect of bulb size on length of rachis of tuberose produced from mother bulb

cm) length of spike which was similar to B2 (57.42 cm). Patel *et al.* (1997) also found similar trends of result.

Application of different levels of potassium showed significant variation on length of spike (Table 6 and Appendix VII). However, the higher level of potassium (160 kg K_2O/ ha) produced the longest length of spike (63.22 cm) and the shortest length of spike (54.11 cm) was recorded from control treatment where the plot did not receive potassium fertilizer.

A significant variation was observed due to combined effect of different size of bulbs and different levels of potassium on length of spike of side shoot (Table 7 and Appendix VII). However, the longest length of spike (72.13 cm) was obtained from B_3K_3 (large sized bulb and 160 kg K_2O/ha) while the treatment combination of B_1K_0 gave the shortest length of spike (52.07 cm) of side shoot.

4.1.7 Diameter of spike

Diameter of spike did not show the significant differences due to use of different size of bulbs (Table 5 and Appendix VII). The highest diameter spike (0.87 cm) was obtained from the large sized bulb while the lowest (0.78 cm) was recorded from small sized bulbs.

There was no significant variation on diameter of spike due to application of different levels of potassium (Table 6 and Appendix VII). However, the higher level of potassium F_3 (160 kg K_2O/ ha) produced the highest diameter of spike (0.85 cm) and the shortest length of spike (0.78 cm) was recorded from control treatment.

Combined effect of different size of bulbs and different levels of potassium showed significant variation on diameter of spike (Table 7 and Appendix VII). The maximum diameter of spike (0.89 cm) was recorded from B_3K_3 (large sized bulb and 160 kg K_2O/ha) whereas, the minimum (0.67 cm) was recorded from the treatment combination of B_1K_0.

4.1.8 Length of rachis (mother bulb)

A significant variation was found on length of rachis of mother bulb due to use of different size of bulbs (Table 5,plate 3 and Appendix VII). The large sized bulb produced the longest length of rachis (26.86 cm) from mother bulb and the shortest (18.24 cm) was recorded from small sized bulbs. The present study supports the findings of Singh *et al.* (2005).

Different levels of potassium showed significant variation on length of rachis (Table 6 and Appendix VII). The higher level of potassium (160 kg K_2O/ ha) produced the highest length of rachis (25.96 cm) and the shortest length of rachis (18.49 cm) was recorded from control treatment.

There was a significant variation on length of rachis of mother bulb due to combined effect of different size of bulbs and different levels of potassium (Table 7 and Appendix VII). The longest length of rachis (30.39 cm) was recorded from the treatment combination of B_3K_3 (large sized bulb and 160 kg K_2O/ha) whereas, the minimum (15.62 cm) was recorded from the treatment combination of B_1K_0 (small sized bulb with no fertilizer).

4.1.9 Length of rachis (side shoot)

Length of rachis showed significant differences due to use of different size of bulbs (Table 5 and Appendix VII). The highest length of rachis (16.77 cm) was obtained from the large sized bulb while the shortest (12.06 cm) was recorded from small sized bulbs which were similar to B_2 (13.40 cm). Bankar (1988) noted that large size bulb produced the maximum length of rachis.

Application of different levels of potassium showed significant variation on length of rachis (Table 6 and Appendix VII). However, the higher level of potassium (160 kg K_2O/ ha) produced the longest rachis (16.43 cm) and the shortest length of spike (11.50 cm) was recorded from control treatment.

Combined effect of different size of bulbs and different levels of potassium showed significant variation on length of rachis from side shoot (Table 7 and Appendix VII). The maximum length of rachis from side shoot (19.67 cm) was recorded from B_3K_3 (large sized bulb and 160 kg K_2O/ha) whereas, the minimum (10.23 cm) was recorded from the treatment combination of B_1K_0.

4.1.10 Number of florets per spike (mother bulb)

A significant variation was found on number of florets per spike (mother bulb) due to use of different size of bulbs (Table 5 and Appendix VII). The large sized mother bulb produced the highest number of florets per spike (36.59) and the shortest (24.08) was recorded from small sized mother bulbs. Yadav, *et al.*(1984) found the maximum

number of florets per spike from large size bulb which support to the present trial.

A significant variation was found on number of florets per spike due to application of different levels of potassium (Table 6 and Appendix VII). The higher level of potassium (160 kg K_2O/ ha) produced the highest number of florets per spike (35.06) and the lowest number of florets per spike (23.61) was recorded from control condition.

Significant variation was observed on number of florets per spike produced from mother bulb due to combined effect of different size of bulbs and different levels of potassium (Table 7 and Appendix VII). The highest number of florets per spike (44.19) was counted from the treatment combination of B_3K_3 (large sized bulb and 160 kg K_2O/ha) while the minimum (20.72) was recorded from B_1K_0 (small sized bulb with no fertilizer).

4.1.11 Number of florets per spike (side shoot)

Number of florets per spike (side shoot) showed significant differences due to use of different size of bulbs (Table 8 and Appendix VIII). The highest number of florets (26.80) per spike (produced from side shoot) was obtained from the large sized bulb while the lowest (18.10) was noted from small sized bulbs.

Application of different levels of potassium showed significant variation on number of florets per spike (Table 9 and Appendix VIII). However, the higher level of potassium (160 kg K_2O/ ha) produced the maximum

number of florets per spike (26.33) and the minimum number of florets per spike (18.59) was counted from control treatment.

Combined effect of different size of bulbs and different levels of potassium showed significant variation on number of florets per spike which produced from side shoot (Table 11 and Appendix VIII). The maximum number of florets per spike (33.72) was recorded from B_3K_3 (large sized bulb and 160 kg K_2O/ha) whereas, the minimum (16.37) was recorded from the treatment combination of B_1K_0.

4.1.12 Weight of single spike (g)

A significant variation was found on weight of single spike due to use of different size of bulbs (Table 8 and Appendix VIII). The large sized bulb produced the highest weight of single spike (43.9 g) and the lowest (35.12 g) was recorded from small sized mother bulbs. Raja and Palanisamy (1999) stated that large size bulb produced the highest weight of single spike. The present study agreed with their findings.

A significant variation was found on weight of single spike due to application of different levels of potassium (Table 9 and Appendix VIII). The higher level of potassium (160 kg K_2O/ ha) produced the highest weight of single spike (43.35 g) and the lowest weight of single spike (33.17 g) was recorded from control condition.

Significant variation was observed on weight of single spike due to combined effect of different size of bulbs and different levels of potassium (Table 10 and Appendix VIII). The highest weight of single spike (43.65 g) was noted from the treatment combination of B_3K_3 (large

sized bulb and 160 kg K_2O/ha) while the minimum (34.14 g) was recorded from B_1K_0 (small sized bulb with no fertilizer).

4.1.13 Number of spikes per hectare (000')

Number of number of spikes per hectare ('000') showed significant differences due to use of different size of bulbs (Table 8 and Appendix VIII).The highest number of bulbs (281.05) per hectare in thousand was obtained from the large sized bulb while the lowest (240.03) was noted from small sized bulbs.

Application of different levels of potassium showed significant variation on number of bulbs per hectare (Table 9 and Appendix VIII). However, the higher level of potassium (160 kg K_2O/ ha) produced the maximum number of bulbs per hectare (360.85) and the minimum number of florets per spike (236.15) was counted from control treatment. Similar trends of result were obtained by Bankar and Mokhopadhyay (1990).

Combined effect of different size of bulbs and different levels of potassium showed significant variation on number of bulbs per hectare in thousand (Table 10 and Appendix VIII). The maximum number of bulbs per hectare (320.95) was recorded from B_3K_3 (large sized bulb and 160 kg K_2O/ha) whereas, the minimum (238.09) was recorded from the treatment combination of B_1F_0. Gowda *et al.*(1991) noted that the highest yield of flowers (40.20/spikes) were obtained with 200 kg N+75 kg P_2O_5+125 kg K_2O/ha .

4.1.14 Number of bulblets per plant

A significant variation was found on number of bulb lets per plant due to use of different size of bulbs (Table 8 and Appendix VIII). The large sized bulb produced the highest number of bulb lets per plant (22.02) and the lowest (15.42) was recorded from small sized bulbs.

A significant variation was found on number of bulb lets per plant due to application of different levels of potassium (Table 9 and Appendix VIII). The higher level of potassium (160 kg K_2O/ ha) produced the highest number of bulb lets per plant (20.46) and the lowest number of bulb lets per plant (17.82) was recorded from control condition.

Significant variation was observed on number of bulb lets per plant due to combined effect of different size of bulbs and different levels of potassium (Table 10 and Appendix VIII). The highest number of bulb lets per plant (24.67) was noted from the treatment combination of B_3K_3 (large sized bulb and 160 kg K_2O/ha) while the minimum (14.97) was recorded from B_1K_0 (small sized bulb and where no fertilizer applied).

4.1.15 Weight of individual bulb

Weight of individual bulb showed significant differences due to use of different size of bulbs (Table 8 and Appendix VIII). The maximum weight of bulb (44.00 g) was obtained from the large sized bulb while the small sized bulbs produced the minimum (35.23 g) small sized bulbs. Kale and Bhujbal (1972); Ramaswamy and Chokalingam (1977) concluded that the numbers of flowers/ spike, flower quality, daughter bulb production etc. were also found to be related to the size of bulb.

Application of different levels of potassium showed significant variation on of weight of bulbs per hill (Table 9 and Appendix VIII). However, the higher level of potassium (160 kg K_2O/ ha) produced the maximum weight of bulb (43.18 g) and the minimum weight of bulb (36.52 g) was recorded from control treatment.

Combined effect of different size of bulbs and different levels of potassium showed significant variation on weight of individual bulb (Table 11 and Appendix VIII). The maximum weight of bulbs (43.59 g) was recorded from B_3K_3 (large sized bulb and 160 kg K_2O/ha) which was similar to B_3K_2 (43.05 g) whereas, the minimum (35.87 g) was recorded from the treatment combination of B_1K_0.

Table 5. Effect of bulb size on length of spike, length of spike (side shoot), diameter of spike, length of rachis (mother bulb), length of rachis (side shoot) and number of florets /spike (mother bulb) of tuberose

Treatment(s)	Length of spike(mother bulb) (cm)	Length of spike(side shoot) (cm)	Diameter of spike(cm)	Length of rachis (mother bulb) (cm)	Length of rachis (side shoot) (cm)	Number of florets /spike(mother bulb)
B_1	64.02b	55.40 b	0.78a	18.24c	12.06b	24.08c
B_2	70.95a	57.42b	0.86a	21.83b	13.4b	28.56b
B_3	75.11a	63.77a	0.87a	26.86a	16.77a	36.59a
CV (%)	2.38	1.58	6.48	4.06	3.13	3.32
LSD (0.05).	5.85	3.28	0.19	3.18	1.55	3.47

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

Table 6. Effect of potassium on length of spike , length of spike(side Shoot), diameter of spike, length of rachis mother bulb , length of rachis side shoot and number of florets /spike(mother bulb) of tuberose

Treatment(s)	Length of spike(mother bulb) (cm)	Length of spike (side shoot) (cm)	Diameter of spike (cm)	Length of rachis (mother bulb) (cm)	Length of rachis (side shoot) (cm)	Number of florets /spike(mother bulb)
K_0	65.22d	54.11c	0.78a	18.49c	11.50d	23.61d
K_1	68.44c	58.34b	0.82a	21.31b	13.56c	28.6c
K_2	71.66b	59.87b	0.83a	23.48b	14.81b	31.7b
K_3	74.79a	63.22a	0.85a	25.96a	16.43a	35.06a
CV (%)	2.38	1.58	6.48	4.06	3.13	3.32
LSD (0.05).	2.42	2.42	0.14	2.35	1.15	2.26

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

Table 7. Combined effects of bulb size and potassium on length of spike, length of spike (side shoot), diameter of spike, length of rachis (mother bulb), length of rachis side shoot and number of florets /spike (mother bulb) of tuberose

Treatment (s)	Length of spike(mother bulb) (cm)	Length of spike(side shoot) (cm)	Diameter of spike (cm)	Length of rachis (mother bulb) (cm)	Length of rachis (side shoot) (cm)	Number of florets /spike(mother bulb)
B_1K_0	59.49e	52.07i	0.67e	15.62h	10.23i	20.72i
B_1K_1	62.11e	54.77gh	0.73de	16.68g	11.22h	22.85h
B_1K_2	65.01d	56.77ef	0.884a	18.89f	12.52g	25.38g
B_1K_3	69.46c	58.28de	0.78cd	21.77de	14.24e	27.38f
B_2K_0	65.72d	54.15h	0.79bcd	17.35g	11.08h	20.85i
B_2K_1	67.62cd	58.01de	0.86abc	20.93e	13.29fg	28.09ef
B_2K_2	74.25b	58.27de	0.86abc	23.32d	13.86ef	31.67d
B_2K_3	76.22ab	59.24d	0.883a	25.72c	15.38d	33.62c
B_3K_0	70.46c	56.12fg	0.87abc	22.5de	13.2fg	29.27e
B_3K_1	75.59b	62.25c	0.87abc	26.32c	16.17c	34.87c
B_3K_2	75.72b	64.58b	0.86abc	28.23b	18.05b	38.04b
B_3K_3	78.69a	72.13a	0.89a	30.39a	19.67a	44.19a
CV (%)	2.38	1.58	6.48	4.06	3.13	3.32
LSD(0.05)	2.82	1.58	0.09	1.53	0.75	1.67

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

Table 8. Effect of bulb size on number of florets per spike, weight of single spike, number of spike ,number of bulbs and weight of bulb of tuberose

Treatment	Number of florets/spike(side shoot)	Weight of single spike (g)	Number of spike/ ha (000')	Number of bulblets/plant)	Weight of individual bulb(g)
B_1	18.10c	35.12c	240.03c	15.42b	35.23 c
B_2	21.49b	40.03b	275.65b	19.43ab	41.22b
B_3	26.8a	43.96a	281.05a	22.02a	44.ooa
CV (%)	2.56	4.9	7.84	9.64	3.61
LSD	1.99	3.90	5.52	6.42	3.03

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

Table 9. Effect of potassium on number of florets per spike, weight of single spike, number of spike, number of bulb and weight of bulb of tuberose

Treatment	Number of florets/spike(side shoot)	Weight of single spike (g)	Number of spike/ ha (000')	Number of bulblets/plant	Weight of individual bulb(g)
K_0	18.59d	33.17d	236.15d	17.82d	36.52d
K_1	20.55c	36.93c	260.72c	18.61c	38.ooc
K_2	23.04b	39.26b	309.24b	18.93b	42.10b
K_3	26.33a	43.35a	360.85a	20.46a	43.18a
CV (%)	2.56	4.9	7.84	9.64	3.61
LSD (0.05)	1.47	3.01	4.78	1.02	1.03

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

Table 10. **Effect of bulb size on yield of bulb and flower yield per hectare in tuberose**

Treatment	Bulb yield (t/ha)	Flower yield (t/ha)
B_1	7.04 c	8.42 c
B_2	8.13 b	9.83 b
B_3	8.80 a	12.35 a
CV (%)	8.83	7.04
LSD (0.005)	0.082	1.36

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

Table 11. Effect of potassium on yield of bulb and flower yield per hectare in tuberose

Treatment	Bulb yield (t/ha)	Flower yield (t/ha)
K_0	7.30c	7.83c
K_1	7.57c	9.74c
K_2	8.01b	12.63b
K_3	8.63a	15.64a
Cv (%)	8.30	7.04
LSD (0.005)	0.339	2.09

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

4.1.16 Yield of bulb per hectare

A significant variation was found on yield of bulb per hectare due to use of different size of bulbs (Table10 and Appendix VIII). The large sized bulb produced the highest yield of bulb (8.8 t/ha) and the lowest (7.04 t/ha) was recorded from small sized bulbs.

A significant variation was found on yield of bulb per plant due to application of different levels of potassium (Table 10 and Appendix VIII). The highest yield (8.63 t/ha) was obtained from the higher level of potassium (160 kg K_2O/ ha) and the control treatment performed the lowest (7.30 ton) yield of bulb per hectare. The present findings agreed to the results of Amarjeet and Godara (1998).

A significant variation was observed on yield of bulb per hectare due to combined effect of different size of bulbs and different levels of potassium (Table 11 and Appendix VIII). The highest yield (8.71 ton/ha) was noted from the treatment combination of B_3K_3 (large sized bulb and 160 kg K_2O/ha) which was statistically similar to B_3K_2 (8.61 t/ha) and the minimum (7.17 t/ha) was recorded from B_1K_0. Amarjeet and Godara (1998)

Table 12. Combined effects of bulb size and potassium on number of florets per spike, weight of single spike, number of spike, number of bulbs, weight of bulb, yield of flower and yield of bulb of tuberose

Treatment	Number of florets per spike(side shoot)	Weight of single spike(g)	Number of spike/ ha (000')	Weight of individual bulb (g)	Number of bulblet/plant	Yield of flower (t/ha)	Yield of bulb (t/ha)
B_1K_0	16.37i	34.14e	238.09f	35.87gh	14.97gh	8.12 fs	7.17 j
B_1K_1	17.12hi	36.02d	250.37f	36.61fg	15.47fg	9.02 ef	7.32 i
B_1K_2	18.76g	37.19c	274.63bcd	38.71cde	19.23cde	10.28 d	7.74 h
B_1K_3	20.16f	39.23bc	300.40g	39.25h	22.2abc	12.03 bc	7.85 g
B_2K_0	17.66hi	36.60d	255.90abc	38.87abc	13.0h	9.43 de	7.83 g
B_2K_1	20.3f	38.48c	268.18ef	39.61efg	16.67efg	10.32 d	7.77 h
B_2K_2	22.86d	39.64c	292.44de	41.66def	18.73def	11.58c	7.92 f
B_2K_3	25.12c	41.69bc	318.25cd	42.20bcd	20.13bcd	13.33a	8.44 c
B_3K_0	21.73e	38.56d	258.60de	40.26def	18.67def	10.09d	8.05 e
B_3K_1	24.22c	40.44bc	270.88bcd	41.00abcd	21.33abcd	10.98d	8.20 d
B_3K_2	27.5b	41.61ab	295.14ab	43.05ab	23.40ab	12.24b	8.61 b
B_3K_3	33.72a	43.65a	320.95a	43.59a	24.67a	13.99a	8.71 a
CV (%)			7.84	9.64	3.61	7.04	8.30
LSD(0.05)	0.96	2.12	5.60	3.09	7.17	1.02	0.056

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

4.1.17 Yield of flower per hectare

Yield of flower per hectare showed significant differences due to planting of different size of bulbs (Fig. 12 and Appendix VIII).The highest yield of flower (12.35t/ha) was obtained from the large sized bulb while the lowest (8.42 t/ha) was noted from small sized bulbs. Pathak *et al.* (1980) noted that bulb size also influences flowering. Larger bulbs cause early flowering and gives higher yields of spikes and flowers. This statement also support to the present investigation. Patil *et al.* (1987) reported from his findings that larger size of bulbs performed the highest yield.

Application of different levels of potassium showed significant variation on yield of flower of tuberose per hectare (Fig. 13 and Appendix VIII). However, the higher level of potassium (160 kg K_2O/ ha) produced the maximum flower yield (15.64 t/ha) and the minimum (7.83 t/ha) was counted from control treatment.

Combined effect of different size of bulbs and different levels of potassium showed significant variation on yield of flower per hectare (Table 11 and Appendix VIII). The maximum yield of flower (13.99 t/ha) recorded from B_3K_3 (large sized bulb and 160 kg K_2O/ha) whereas, the minimum (8.12 t/ha) was recorded from the treatment combination of B_1K_0. Yadav, *et al.*(1984) noted also recorded similar trends of results.

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka Bangladesh, to evaluate the effect of bulb size of tuberose and different levels of potassium on the growth, bulb and flower yield of tuberose during the period from May 2007 to April 2008. The experiment consisted of three bulb size viz.,B_1 (small size bulb; 1.0-1.5 cm in diameter) ,B_2 (medium size bulb; 1.6-2.0 cm in diameter) ,B_3 (large size bulb; 2.1-2.6 cm in diameter) and different levels of potassium viz., K_0 (no K_2O/ha ;control), K_1 (120 kg K_2O/ha), K_2 (140 kg K_2O/ha) and K_3 (160 kg K_2O/ha).

The maximum number of side shoot per plant (11.8), length of spike which produced from mother bulb (75.11 cm), length of spike which produced from side shoot (63.77 cm), diameter of spike (0.87 cm), length of rachis which produced from mother bulb (26.86 cm), length of rachis which produced from side shoot (16.77 cm), number of florets per spike which produced from mother bulb (36.59), number of florets per spike which produced from side shoot (26.80), weight of single spike (43.96 g), number of spikes (281.05)per hectare ('000), number of blublets per plant (22.02), weight of individual bulb (44.00 g), yield of bulb (8.80 t/ha) and yield of flowers (12.35 t/ha) was recorded from the large size bulb treatment which was significantly superior to all other treatments and the minimum result was performed by small size of bulbs in all above parameters.

Application of different levels of potassium treatments showed a significant effect on plant height, number of leaves (at all dates of observation), length of leaf, maximum number of side shoot per plant, length of spike which produced from mother bulb , length of spike which produced from side shoot , diameter of spike, length of rachis which produced from mother bulb, length of rachis which produced from side shoot, number of florets per spike which produced from mother bulb , number of florets per spike which produced from side shoot , weight of single spike , number of spikes per hectare ('000), number of blublets per plant , weight of individual bulb, yield of bulb(t/ha) and yield of flowers (t/ha) was recorded from the higher level of potassium (160 kg K_2O) which was significantly superior to all other treatments and the minimum result was noted from control condition.

Combined effects different sizes of bulb and levels of potassium had significant influenced on plant height at all other dates of observations. Large size bulb (2.1-2.5 cm in diameter) with higher level potassium (160kg K_2O/ha) showed the highest plant height (68.87 cm) while the lowest height (52.60 cm) was observed from the treatment combination of B_1K_0 (small size bulb and no potassium fertilizer) at 150 DAP. The combined effect of different sizes of bulb and levels of potassium showed significant variation on number of leaves per plant at 105 days after planting. The maximum number of leaves per plant (33.98) was observed from large size bulb (2.1-2.5 cm in diameter) with higher level potassium (160kg K_2O/ha) and the minimum number of leaves per plant (23.62) was recorded from B_1K_0.

The longest length of rachis which produced from side shoot (19.67 cm) was obtained from the treatment combination of large size bulb (2.1- 2.5

cm in diameter) with higher level of potassium (160 kg K_2O) while the B_1K_0 treatment gave the shortest (10.23 cm). Treatment combination of B_3K_3 performed the highest number of florets per spike (33.72) and B_1K_0 treatment gave the lowest (16.37) which produced from side shoot. The highest weight of single spike (43.65 g) was weighted from the treatment combination of B_3K_3 and the lowest (34.14 g) was found from B_1K_0. Treatment combination of B_3K_3 performed the highest number of blublets per plant (24.67) whereas, the lowest number of bulblets (14.97) was counted from B_1K_0, The highest yield of bulb (8.71 t/ha) was obtained from the treatment combination of B_3K_3 and the lowest (7.17t/ha) was found from B_1K_0. Treatment combination of B_3K_3 gave the highest yield of flowers (13.99t/ha) while B_1K_0 showed the lowest yield (8.12t/ha).

Conclusion and suggestions

It may be concluded that the results obtained from present investigation, large size (2.1 – 2.5 cm in diameter) bulb with 160 kg K_2O/ha is the suitable combination for maximum growth of plant, bulb and flower production. However, such type of study further may be conducted on similar as well as different soil and climatic situation before final recommendation to the tuberose growers.

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

- Such study is needed in different agro-ecological zones (AEZ) of Bangladesh for regional competence and other performance
- Another experiment may be carried out with other size of bulb for maximizing the highest benefit

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APPENDICES

Appendix I. Soil analysis data of the experimental plot

Mechanical analysis

Constituents	Percentage (%)
Sand	28.0
Silt	42.5
Clay	29.5
Textural classification	Silty - clay

Chemical analysis

Soil properties/constituents	Values
P^H	6.5
Organic carbon	0.84%
Total nitrogen	0.08%
Available P	18 ppm
Available K	45 ppm
Available S	8 ppm

Source: SRDI, Khamarbari, Farmgate, Dhaka, Bangladesh

Appendix II. Monthly records of air temperature, relative humidity, rainfall and sunshine during the period from May 2007 to April 2008

Year	Month	** Air temperature (^{0}C)			** Soil temp. at different depth			**Relative humidity (%)	*Rainfall (mm)	**Sunshine (Hours)
		Max.	Min.	Mean	5 cm	10 cm	20 cm			
2007	May	33.7	25.0	29.35	25.4	25.0	24.9	74.1	288	240.0
	June	33.2	26.5	29.85	20.6	19.8	19.0	80.2	358	98.02
	July	31.4	25.4	28.4	20.4	21.2	21.4	81.3	542	134.8
	August	32.4	26.8	29.6	22.2	22.4	22.0	82.4	402	110.8
	September	32.2	32.8	32.5	23.4	23.8	23.2	81.7	381	148.4
	October	30.2	30.4	30.3	22.8	23.6	23.0	77.80	401	142.2
	November	28.78	18.54	23.76	25.4	25.9	26.2	71.53	83.1	235.0
	December	25.32	14.40	19.86	21.4	22.0	22.5	67.06	0.00	219.4
2008	January	21.77	10.17	15.97	17.5	16.9	18.3	83.65	Trace	165.6
	February	26.77	15.49	21.13	21.1	21.6	21.4	75.21	27.10	229.2
	March	27.95	18.11	23.03	24.1	24.5	24.3	75.39	114.00	199.3
	April	33.74	23.57	28.65	24.5	24.0	23.6	76.04	81.00	242.4

*Monthly total, ** Monthly average

Source: Dhaka meteorology centre, Agargoan, Dhaka.

Appendix III. Analysis of variance of different characters of tuberose

Sources of variation	Degree of freedom	Mean of sum of square				
		Plant height (cm)				
		25 DAP	50 DAP	75 DAP	100 DAP	125 DAP
Block	2	322.125	8.106	7.405	18.590	254.382
Factor-A (bulb size)	2	299.461^{NS}	203.251**	596.829**	823.663**	724.240**
Factor-B (potassium)	3	130.663^{NS}	148.43**	429.210**	487.236**	465.12**
Interaction (A × B)	6	9.801^{NS}	8.506*	36.598**	18.987**	17.128**
Error	22	0.576	2.124	4.542	3.310	5.170

** = Significant at 1% level

* = Significant at 5% level

NS = Non significant

Appendix IV. Analysis of variance of different characters of tuberose

Sources of variation	Degree of freedom	Mean of sum of square				
		Number of leaves (cm)				
		25 DAP	50 DAP	75 DAP	100 DAP	125 DAP
Block	2	7.324	0.414	1.241	0.107	4.547
Factor-A (bulb size)	2	17.509**	11.620**	12.247**	14.985**	15.618**
Factor-B (potassium)	3	9.616**	8.954**	8.555**	8.303**	9.7658**
Interaction (A × B)	6	0.210**	0.254**	0.822*	0.231**	0.225*
Error	22	0.784	0.089	0.341	0.075	0.192

** = Significant at 1% level

* = Significant at 5% level

Appendix V. Analysis of variance of different characters of tuberose

Sources of variation	Degree of freedom	Mean of sum of square				
		Length of leaf (cm)				
		25 DAP	50 DAP	75 DAP	100 DAP	125 DAP
Block	2	9.478	1.024	1.341	0.210	3.014
Factor-A(bulb size)	2	11.452**	16.245*	14.321**	15.125**	13.412**
Factor-B (potassium)	3	8.258**	5.365**	9.964*	9.358**	98.369**
Interaction (A × B)	6	0.348**	0.7.252*	0.758**	0.453*	0.435*
Error	22	0.484	0.076	0.571	0.086	0.462

** = Significant at 1% level

* = Significant at 5% level

Appendix.V1. Analysis of variance of different characters of tuberose

Sources of variation	Degree of freedom	Mean of sum of square				
		Number of side shoots per plant (cm)				
		25 DAP	50 DAP	75 DAP	100 DAP	125 DAP
Block	2	6.248	1.024	13.124	0..015	5.210
Factor-A(bulb size)	2	12.509**	14.023*	15.146**	17.253**	15.045**
Factor-B (potassium)	3	8.661**	7.354**	7.542**	7.354**	6.676**
Interaction (A × B)	6	0.2421**	0.273**	0.952*	0.712**	0.458*
Error	22	0.674	0.429	0.536	0.258	0.435

** = Significant at 1% level

* = Significant at 5% level

Appendix VII. Analysis of variance of different characters of tuberose

Sources of variation	Degree of freedom	Means square					
		Length of spike (mother bulb) (cm)	Length of spike (side shoot)(cm)	Diameter of spike (cm)	Length of rachis (mother bulb)(cm)	Length of rachis (side shoot)(cm)	Number of florets/spike (mother bulb)
Block	2	1.654	0.729	0.037	0.0107	0.725	0.070
Factor-A (bulb size)	2	804.315**	23.003**	10.246*	4.125**	1053.123**	8.249**
Factor-B (potassium)	3	808.442**	6.015*	8.459^{NS}	3.478**	749.135**	341.65**
Interaction (A × B)	6	193.633**	0.707**	0.098**	0.214**	50.604**	0.054*
Error	22	5.124	0.164	0.052	0.702	0.266	0.574

** = Significant at 1% level

* = Significant at 5% level

NS = Non significant

Appendix VIII. Analysis of variance of different characters of tuberose

Sources of variation	Degree of freedom	Means square						
		Number of florets/spike (side shoot)	Weight of single spike(g)	Number of bulbs/ha ('000')	Number of bulblets /plant	Weight of individual bulb (g)	Yield of bulb (t/ha)	Yield of flower (t/ha)
Block	2	0.047	0.097	0.169	0.004	0.155	0.089	0.784
Factor-A (bulb size)	3	4.521*	8.498**	2.146**	0.133*	76.268**	87.235**	77.354**
Factor-B (potassium)	3	7.025**	2.186**	1.586**	0.819**	65.128**	38.147**	40.854**
Interaction (A × B)	9	0.147**	0.492**	0.157*	0.564**	6.243**	2.221*	23.524*
Error	30	0.739	0.542	1.881	0.123	0.684	0.973	0.574

** = Significant at 1% level

* = Significant at 5% level