RESPONSE OF TUBEROSE TO ORGANIC MANURES AND GA_3

SALMA SULTANA

DEPARTMENT OF HORTICULTURE

SHER- E–BANGLA AGRICULTURAL UNIVERSITY

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SALMA SULTANA

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Approved by:

Prof. Md. Ruhul Amin	**Prof. Dr. Md. Ismail Hossain**
Department ofHorticulture	Department of Horticulture
SAU, Dhaka-1207	SAU, Dhaka-1207
Supervisor	**Co-supervisor**

Prof. Dr. A. F. M. Jamal Uddin
Chairman
Examination Committee

DEPARTMENT OF HORTICULTURE
Sher-e-Bangla Agricultural University
Sher-e--Bangla Nagar, Dhaka-1207

Memo No: SAU/HORT/…… Dated:……

CERTIFICATE

*This is to certify that that thesis entitled, "**Response of tuberose to organic manures and GA_3**" submitted to the Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** in **HORTICULTURE,** embodies the result of a result of a piece of bona fide research work carried out by **SALMA SULTANA**, **Reg. no. 08-03168** 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, has been availed of during the course of this investigation has duly been acknowledged.

Dated- June, 2014**Prof. Md. Ruhul Amin**
Department of Horticulture
Sher-e-Bangla Agricultural University
Dhaka, Bangladesh
Supervisor

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Place: SAU, Dhaka

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ABSTRACT

The study was conducted at Horticultural Farm of Sher-e-Bangla Agricultural University, Dhaka during the period from April2013 to March 2014. The experiment had two factors. Factor A: Three levels of organic manure; M_0 - Control, M_1 - Cowdung: 30 t/ha and M_2 - Poultry litter: 20 t/ha; Factor B: Four levels of gibberellic acid; G_0 - Control, G_1- 100 ppm, G_2 - 200 ppm and G_3– 300 ppm respectively. The experiment was laid out on Randomized Complete Block Design with three replications. Application of organic manure with different concentration of GA_3 showed significant variations on most of the parameters. In case of organic manure, the highest yield of spike (3,22,000/ha) and bulb (19.95t/ha) was recorded from M_2 and the lowest spike (2,64,500/ha) and bulb (15.78t/ha) from M_0.In case of GA_3, the highest yield of spike (3,09,100/ha) and bulb (18.86t/ha) was found from G_2 and the lowest spike (2,69,500/ha) and bulb (15.70t/ha) from G_0.For combined effect the highest yield of spike (3,50,000 /ha) and bulb (21.72t/ha) was found from M_2G_2 and the lowest spike (2,50,300/ha) and bulb (15.17t/ha) from M_0G_0.The highest benefit cost ratio (2.22) was noted from M_2G_2 and the lowest (1.41) from M_0G_0. So, application of poultry litterat 20 t/ha with GA_3at 200 ppm was found suitable for growth, flowering and yield of tuberose.

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ABBREVIATIONS AND ACRONYMS

%	:	Percentage
@	:	At the Rate of
Abstr.	:	Abstract
AEZ	:	Agro-ecological Zone
Agric.	:	Agriculture
BARC	:	Bangladesh Agricultural Research Council
BARI	:	Bangladesh Agricultural Research Institute
BAU	:	Bangladesh Agricultural University
BBS	:	Bangladesh Bureau of Statistics
BCR	:	Benefit Cost Ratio
cm.	:	Centimeter
cv.	:	Cultivar
DAS	:	Day After Sowing
et al.	:	et alii (and others)
FAO	:	Food and Agriculture Organization
Fig.	:	Figure
FW	:	Fresh weight
FYM	:	Farm Yard Manure
G	:	Gram
Hort.	:	Horticulture
i.e.	:	That is
J.	:	Journal

K	:	Potassium
Kg	:	Kilogram
LSD	:	Least Significant Difference
M	:	Meter
MOP	:	Murate of Potash
N	:	Nitrogen
NS	:	Non-significant
^{O}C	:	Degree Celsius
P	:	Phosphorus
RCBD	:	Randomized Complete Block Design
Sci.	:	Science
Soc.	:	Society
T	:	Tonne
ton/ha	:	Ton per hectare
Tk.	:	Taka
TSP	:	Triple Super Phosphate
UK	:	United Kingdom
UNDP	:	United Nations Development Program
Viz.	:	Namely

CHAPTER I

INTRODUCTION

Tuberose (*Polianthestuberosa* L.) is one of the most popular cut flower of tropical and sub-tropical areas. Tuberose belongs to the family Amaryllidaceae, produces attractive, elegant and fragrant white flowers. Tuberose is a half hardy, bulbous perennial multiplying itself through the bulblets, roots are mainly adventitious and shallow, the leaves are long, narrow, linear, grass like, green and arise in rosette. Planting during April- March is suitable for single variety.

The Tuberose is a night-blooming plant native to Mexico, today it is found in many parts of the world, although predominantly in the southern hemisphere. By the late 19th century, notable quantities of Tuberose were under cultivation in Grasse, France, where the absolute of the flowers was extracted. Besides France, the plants are currently cultivated in Morocco, Egypt, India and Bangladesh.

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. 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.The flowers remain fresh for quite a long time and stand long distance transportation and fill a useful place in the flower market (Patel *et al.* 2006). It is used as vase decoration, bouquets, making veni, garland, button-holes or crown and frequently used during marriage or religious ceremonies. The long flower spikes of tuberose are excellent as cut flowers for table decoration when arranged in bowls and vases. The natural flower oil of tuberose remains today as one of the most expensive of the perfumes raw materials.

In Bangladesh, for the last few years, tuberose has become a popular cutflower for its attractive fragrance and beautiful display in the vase. Tuberose has high demand in the market and its production is highly profitable. In Bangladesh, its commercial cultivation was introduced during 1980 by some pioneer and innovative farmers at Panishara union of Jhikorgachathana under Jessore district near the Benapol border. But the production in Bangladesh is not sufficient for the high market demand (Baksh*et al.*1993).

Plant growth and economic cultivation of tuberose are affected by many factors among them fertilizer is important one. Tuberose is a gross feeder and requires a large quantity of NPK, both in the form of organic and inorganic fertilizers (Singh *et al*. 1976). Fertilizers have great influence on growth, flower and bulb production in tuberose (Kumar *et al.*2004; Yadav*et al*. 1985). Effect of NPK on tuberose production has been reported by several authors of different geographical region (Sultana *et al.*2006; Rajwal and Singh, 2006; Mukhopadhyay and Banker, 1986; Yadav*et al*. 1985;Nanjan*et al*. 1980;Singh *el al*. 1976;Cirrito, 1975).

Organic manures are used to prevent or improve the negative stresses effects in plants and yield decreasing. It is material to decrease soil salinity, increase the organic matter, improve the soil structure and increase water and air permeability by root developing in soil (Ikram*et al.*2012). It is one of the best used fertilizers.

Normal plant growth and development are regulated by naturally produced chemicals or phytohormones. Their role can be substituted by application of Plant Growth Regulator (PGR). These are becoming extremely important and valuable ion the commercial control of crop growth in both agriculture and horticulture. The potential use of PGR such asGA_3in flower production has created considerable scientific interest in recent years (Padaganur*et al.*2005; Singh *et al.*2003).

There is a scope of increasing flower yield and improve the quality of flower of tuberose with the application of $GA_3$and organic manure. An optimum level ofapplication of GA_3will not only ensure better yield and quality of tuberose as well as minimum wastage of GA_3(Dalal*et al.*1991).

In Bangladesh, a few studies were done regarding the organic manure and $GA_3$for growth and flower production of tuberose. So, research information under Bangladesh condition is scanty.

Considering the present situations and above facts the present investigation was undertaken with the following objectives-

i. To find the suitable organic manure on the growth, flowering and yield of tuberose.

ii. To determine the optimum level of $GA_3$for the growth, flowering and yield of tuberose.

iii. To determine the best combination of organic manure with GA_3 for better growth, flowering and yield of tuberose.

CHAPTER II

REVIEW OF LITERATURE

Tuberose is one of the important cut flower in Bangladesh and as well as many countries of the world. A very few studies on the related to growth, flower, and bulb production due to standard level of organic manure andGA_3 have been carried out in our country as well as many other countries of the world. So, the research work so far done in Bangladesh is not adequate and conclusive. A review of literature related to the performance of tuberose in response to organic manures and GA_3 is given below under the following headings.

2.1 Effect of organic manures

Optimum organic manure is one of the most important and uncontroversial factors for maximizing the yield of a crop. The results of the researchers relating to organic manure of tuberose are reviewed.

Ikram*et al.* (2012) conducted a study was carried out in the agro-metrological conditions of Rawalpindi, Pakistan. Different potting media were used in different combinations to check their effect on the morphological parameters as well as on the vase life of the tuberose. The different treatments included the combinations of FYM, poultry manure, sand, leaf compost and coconut coir in equivalent ratio. The data was analyzed statistically which showed significant effect of media combinations over control values. Maximum plant spread, number of leaves and vase life was recorded in sand+FYM. Coconut coir + FYM contributed to the maximum values of plant height, leaf area and spike length.

Maximum plantlets were counted for sand+poultry manure. The highest values of floral diameter, number of flowers per spike and shelf life were observed in sand+leaf compost. These findings lead toward better quality cut flower production with maximum vase life.

Bahadoran*et al.* (2011) conducted a research was conducted to investigate the effect of poultry litter (PL) on vegetative growth and flower characteristics of tuberose (*Polianthestuberosa* L.). The experiment was carried out as a completely randomized design with nine treatments (each treatment with 4 replications): 29.0 (T_1), 31.5 (T_2), 34.0 (T_3), 36.5 (T_4), 39.0 (T_5), 41.5 (T_6), 44.0 (T_7), 46.5 (T_8) and 49.0 g (T_9) PL in the soil mixture per pot (equivalent to 116, 126, 136, 146, 156, 166, 176, 186 and 196 g m–2 in field) along with control. Results indicated that PL increased the height of flowering stem at T_4, T_5, T_6 and T_7; flower diameter at T_8; diameter of flowering stem at T_7; fresh weight of flowering stem at T_3, T_4, T_5, T_6, T_7 and T_8; fresh and dry weight of bulblet at T_4 and shoot at T_2; chlorophyll content at T_3, T_4, T_5 and T_6; bulblet diameter at T_6; number of floret per inflorescence at T_6 and T_9; number of bulblet at T_4; but had no effect on the length of flower, leaf area and root fresh and dry weight. Overall, adding PL had positive effect on tuberose growth and flowering and is recommended for using in the soil mixture of tuberose. To our knowledge this is the first report on using PL in the soil mixture of tuberose. Further investigations are needed to clarify how PL works on this bulbous plant.

Kabir*et al.* (2011) conducted a field experiment was conducted at the farmer's field of Sutiakhali, MymensinghSadarUpazilla, Mymensingh, during the period from April, 2009 to March, 2010 to investigate the effect of organic fertilizers along with half chemical fertilizers on the growth, bulb and flower yield of tuberose cv. single. The experiment consisted of four different sources of fertilizers viz., (i) recommended chemical fertilizers @ 400, 300, 300 and 100 kg ha^{-1} of urea, TSP, MP and gypsum, respectively; (ii) vermicompost @ 5 t ha^{-1}

along with half of chemical fertilizers; (iii) poultry litter @ 20 t ha^{-1} along with half of chemical fertilizers and (iv) cowdung @ 20 t ha^{-1} along with half of chemical fertilizers. The experiment was laid out in a randomized complete block design with three replications. Results revealed that plant height, leaf number $plant^{-1}$, leaf length and breadth and number of side shoots $plant^{-1}$, bulb production $plant^{-1}$, bulb length, bulb diameter and bulb yield both per plant and per hectare, rachis length, spike length and diameter, number of florets $spike^{-1}$ and flower yield both per spike and per hectare were greater in organic fertilizers along with half chemical fertilizers than absolute use of chemical fertilizers. The highest bulb and flower yield both per plant and per hectare were recorded in poultry manures followed by cowdung. The bulb and flower yields were higher in poultry manures might be due to increased side shoots number, bulb size and flowers $plant^{-1}$. In contrast, the lowest bulb and flower yields were recorded in chemical fertilizers due to production of fewer side bulb and flowers plant.

Yadav (2007) conducted an experiment in Bikaner, Rajasthan, India, to study the effect of N (0, 10 and 20 g) and P (0, 6 and 12 g) fertilizers on the growth and flowering of tuberose cv. Shringar. Plant height, number of leaves per plant, number of flowers per spike, length of spike, length of rachis, number of spike per plot and weight of flower per spike were remarkably increased with N and P application, alone and in combination. However, N and P fertilizers did not have any significant effect on the flower length. Plant height (35.50 cm), number of leaves (34.40) per plant, number of flowers (37.50) per spike, length of spike (49.40 cm), length of rachis (20.80 cm), number of spike per plot (33.90) and weight of flower (109.50 g) per spike were higher with combination of 20 g N and 12 g P per plot.

Patel *et al*. (2006) conducted a multifactor experiment on tuberose cv. Single at Instructional Farm of ASPEE College of Horticulture and Forestry, NavsariAgriculturalUniversity, Navsari, India, during 2002-04. The treatments

comprised four levels of nitrogen (100, 200, 300 and 400 kg N/ha), three levels of phosphorus (100, 150 and 200 kg P/ha) and three spacings i.e. 30x20, 30x30, and 30x45 cm, in a randomized block design with factorial concept replicated thrice. The results revealed that for higher yield of spikes and bulbs tuberose could be planted at a closer spacing of 30x20 cm and fertilized with 400 kg nitrogen and 200 kg phosphorus per hectare. Spikes/plant was found to be higher under wider spacing (30x45 cm). Application of nitrogen at 400 kg/ha recorded significantly the highest values of vegetative and floral characters. The effect of phosphorus was non significant on vegetative characters while floral characters viz., rachis length and number of florets/spike were found significant. Bulb yield in terms of clump weight (t/ha) was also found significant and 200 kg P/ha recorded the higher values.

Rajwal and Singh (2006) studied the effects of various N rates (100, 125 and 150 kg/ha) on the performance of *P.tuberosa* (cv. Double) in Muzaffarnagar, Uttar Pradesh, India, during 2002-03. The application of 150 kg N/ha resulted in the lowest number of days to the sprouting of bulbs (9.04) and greatest number of sprouts per bulb after 120 days (5.52), number of leaves per bulb after 120 days (44.45), length of the longest leaf (56.27 cm), plant height after 120 days (53.07 cm), number of clumps per bulb (3.80), number of flowers per spike (29.87), spike length (80.47 cm), rachis length (21.50 cm), spike diameter (0.82), weight of the largest bulb per clump (25.19 g) and diameter of the largest bulb per clump (3.12 cm). The number of days to the opening of flowers was lowest (89.67) for 125 kg N/ha. The highest number of bulblets per clump was recorded for 100 kg N/ha (17.50).

Sultana *et al*. (2006) conducted a field trial on tuberose at the Floriculture field of Horticultural Research Centre, BARI, Joydebpur, Gazipur, Bangladesh during thesummer seasons of 2003 and 2004 to observe the response of tuberose (cv. single) to different nutrient elements. Nutrients were 4 levels of nitrogen (0, 100,

200 and 300 kg/ha), 3 levels of phosphorus (0, 45 and 90 kg P/ha) and 3 levels of potassium (0, 80 and 160 kg K/ha) along with a blanket dose of 10 t/ha cowdung. The experiment was laid out in a randomized complete block design replicated 3 times. The application of NPK significantly influenced the growth, flowering and flower quality of tuberose. All the parameters except plant height were the highest with 200 kg N, 45 kg P and 80 kg K/ha along with 10 t/ha cowdung. Plant height was highest with 300 kg N, 45 kg P and 80 kg K/ha along with 10 t/ha cowdung.

Kumar *et al*. (2004) conducted a pot culture experiment in sandy loam soil to evaluate the effect of N (0, 50, 100, 150, 200 and 250 ppm) and Zn (0, 2.5, 5.0, 7.5 and 10.0 ppm) on spike length, bulb production and nutrient content of tuberose cv. Double. Spike length increased significantly with the application of N. The maximum spike length (56.7 cm) was recorded at 200 ppm N level which was at par with 150 ppm N. Zinc application also increased the spike length significantly and the maximum spike length (58.2 cm) was observed with 10 ppm Zn level. The application of N and Zn significantly increased the bulb production (number of bulbs, average weight of bulb and yield of bulbs per plant). Leaf N and Zn content increased with increasing rates of their application. Leaf P content decreased with N and Zn application but K remained unaffected. The application of 100-150 ppm N along with 7.5 ppm Zn was observed optimum for tuberose cultivation. Approximately 1.70% N and 45 ppm Zn content in leaf at spike emergence stage were associated with good spike length and better bulb production.

Salminen*et al.* (2001) showed the effect of plant growth in tuberose with the application of digested poultry slaughterhouse waste as nitrogen source, gave the higher yield.

Singh *et al*. (2001) evaluate the nutrient status of *Polianthestuberosa* plants treated with different N, P and K levels (0, 10, 20, 30 and 40 kg N/ha; 0, 10 and

20 kg P/ha; and 0, 10 and 20 kg K/ha). The N, P and K contents of leaves significantly increased with the increase in rate of N, P and K fertilizers, respectively. Leaf P and K concentrations decreased with increasing N fertilizer rate. N, P and K contents in leaves were higher than those in bulbs (rhizomes). Bulb N increased with increasing rates of all fertilizers. Bulb P content was affected by N and P fertilizers, but not by K fertilizer. Bulb K content also increased with increasing rates of all fertilizers.

At the Horticulture Farm, Bangladesh Agricultural University, Mymensingh, Rahman (2000) carried out an experiment and found that plant height of tuberose was significantly influenced by the application of cowdung. The highest plant height (75.28 cm.) at 100 days was obtained from the highest dose of cowdung (100 t/ha).

Baksh*et al*. (1993) in Jessore region investigated that July to August was peak period for tuberose yield and January to March was lean period. But during first year, tuberose yielded highest in January- February. Considering total yield, double stick was major about 69% in first year followed by 59% and 58% during second and third year respectively.

Bankar and Mukhopadhyay (1990) evaluated the effect of NPK on growth and flowering of tuberose cv. double. N was applied @ 0, 5, 10, 15, g/m^2 P_2O_5 @ 0, 20 or 40 g/ m^2 and K_2O @ 0, 20 or 40 g/ m^2. One half of N and all of P and were applied before planting, the remaining N was applied as a top dressing before flower emergence. Data were tabulated on plant growth and flowering parameters and NPK contents of the leaves, N application advanced flowering and improved growth. The highest number of flower spikes/ m^2 (20.0) was obtained with the highest N rate. Fertilization of tuberose with N: P_2O_5 : K_2O at 20:20:20 g/ m^2 was recommended.

Yadav*et al*. (1985) carried out a three year investigation on nutrient requirements of tuberose in West Bengal, India. In their experiments, 300 kg nitrogen in two

splits and 20 kg phosphorus per hectare per year proved to be the most effective in improving the plant growth and flowering. He found that with best agronomic practices in “single” tuberose about 5 lakh flower spikes and/or 10.5 tons of loose flowers can be obtained per hectare under Nadia District of West Bengal.

Nambisan and Krishran (1983) reported that the requirement of manures and fertilizers for tuberose vary with climatic conditions and soil types. During the preparation of soil, a basal application of leaf mould, farmyard manure or cattle manure at the rate of 20 to 50 t/ha depending on climatic conditions and soil type should be done to ensure better growth and flowering of tuberose. He recorded from an experiment with tuberose cv. “single” a flower yield of 12000 kg/ha, by using FYM alone and application of nitrogen and phosphorus fertilizers increased yield to 20951 kg/ha under South Indian condition.

Nanjan*et al*. (1980) studied the effects of nitrogen, phosphorus and potash on the production of tuberose cv. Single in a neutral clay soil having high amount of potassium. They recommended a nutrient combination of 200 kg nitrogen, 60 kg phosphorus and 50 kg potash/ha is soils low in potassium.

Bhattacharjee*et al*. (2010) carried out an experiment in an alkaline and nitrogen deficient soil, application of 20 kg N, 40 kg P_2O_5 and 20 kg K_2O over a basal dose of 2.5 kg of FYM/m^2 was recommended per year. Full dose of P_2O_5 and K_2O and half dose of N were to be applied as basal dressing; while the remaining half dose of N was applied 20 days after planting.

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

Cirrito (1975) reported from application of 200 kg nitrogen, 400 kg phosphorus and 600 kg potash per hectare increased the weights of both saleable and individual bulbs of tuberose.

2.2 Effect of GA_3

Padaganur*et al.*(2005) conducted plant growth regulators- GA_3, paclobutrazol and maleic hydrazide were tried at three different concentrations in tuberose (cv. Single) to evaluate and arrive at the best concentration that aids in realising higher flower production in tuberose. GA_3 increased the plant height, number of leaves, number of shoots and leaf area, whereas maleic hydrazide and paclobutrazol reduced all these parameters compared to control. Flowering was enhanced by GA_3. Spraying GA_3 at 150 ppm, paclobutrazol at 1500 ppm followed by maleic hydrazide 1000 ppm at 30 and 60 days after planting is ideal to realize higher flower spike yield, whereas spraying GA_3 at 150 ppm has realized maximum loose flower yield.

Singh *et al.* (2003) conducted an experiment in Meerut, Uttar Pradesh, India, during 1997-98 on tuberose (*Polianthestuberosa*L.) cv. Double. The treatment comprised of water dipping in GA_3, IAA and NAA and dipping + spraying GA_3, IAA and NAA. The number of flowers, flower length and longevity of the whole spike were highest for bulbs dipped in 100 ppm GA_3 at 30 days after planting. Spike length and rachis length were also highest in bulbs dipped and sprayed with 100 ppm GA_3. GA_3 at 100 ppm (dipping + spraying) increased the number (24.4), weight (90.52 g), diameter (4.20 cm) and yield (305.25 ton/ha).

Manisha*et al.*(2002) studied tuberose (*Polianthestuberosa*L.) cv. Single in Varanasi, Uttar Pradesh, India during 1999-2000. Treatments comprised of a control and foliar sprays of GA_3(100. 150, 200 ppm) at 40, 60 and 80 days after planting. Treatment with GA_3at all concentrations promoted the height of all plants and increased the number of leaves per plant being maximum (55.50 cm and 15.99) with 150 ppm GA_3application. GA_3 at all concentrations significantly increased the number of spikes per plant, number of flowers per spikes and per hectare yield. All these characters were maximum in plants applied with GA_3at 150 ppm. Applications of GA_3at all concentrations significantly increased the

flower spike and rachis. Among the 3 concentrations of GA_3used 150 ppm was found the most superior.

Naggar*et al.* (2002) conducted an experiment to identify the effects of GA_3(0, 100, 200 and 300 ppm) and nitrogen fertilizer (0, 15, 30 and 50 kg/feddan as ammonium nitrate) on tuberose (*Polianthestuberosa*L.) cv. Double in Alexandria, Egypt, during the summer season of 2000 and 2001. The roots were soaked in $GA_3$for 24 hours before planting. N fertilizer was applied as a side dressing once in one month after planting and twice within the following 42 days. The application of 200 ppm GA_3+ 30 kg N/feddar resulted flowering (109.3 days) and the greatest average plant height (99.34 cm), number of leaves per plants (51.85), leaf dry weight (14.88 g), number of spikes per plant (4.94), number of florets per spike (29.91),flower duration (18.28 days),number of bulb and bulblet per clump (28.74 and 42.45), fresh and dry weights of bulb and bulblet per clump (121.72 g and 8.67 g) and total chlorophyll content (229.87 mg/100 g leaf fresh weight). The highest average floret dry weight (4.47 g) was obtained with 100 ppm GA_3 + 30 Kg N/feddan,whreas the highest N content (3.92%) was obtained with 300 ppm GA_3 + 30 Kg N/feddan. The contribution ratio of soil N decreased with increasing N fertilizer rate but increased with increasing GA_3 rate.

Tiwari and Singh (2002) conducted an experiment to identify the effects of bulb size, i. e. large (> 1.5 cm in diameter), medium (1.0-1.5 cm), small (<1.0 cm) and preplanting soaking in GA_3 (50, 100, 150, 200, 250 ppm) on growth, flowering and yield of tuberose (*Polianthestuberosa*L.) in Kanpur, Uttar Pradesh, India during 1992-93. Plants raised from large bulbs had the greatest weight, clump weight, bulb and bulblet per clump, inflorescence length, spike length, flower length, spike diameter, flowers per spike and spikes per plant and showed earliest flowering. Similar result were recorded for plants from bulbs treated with

200 ppm GA_3. Large soaked in 200 ppm GA_3 showed significant increase in growth, flowering and bulb production.

Wankhade*et al.* (2002a) conducted an experiment during 2000-2001 at the College of Agriculture, Nagpur, Maharashtra, India to study the effect of GA_3 treatment (soaking of bulbs in 0, 50, 100 and 200 ppm as main treatments and foliar spraying of 0, 100, 150 and 200 ppm as sub-treatment) on P tuberose. Higher concentration of bulb soaking treatment at 150 ppm, floret showed significant increase in diameter and length of fully opened floret, length of rachis, diameter of spike, weight of floret per spike, number of spikes and fresh weight of bulbs.

Wankhade*et al.* (2002b) conducted an experiment during 2000-2001 to study the effect of gibberellic acid with bulb soaking treatment and foliar spray on growth, flowering and yield of tuberose (*Polianthestuberosa*L.). Data indicated the higher concentration of GA_3 as afoliar spray showed significant increase in plant height, number of leaves, number of floret per spike and number of spikes per plant under study. Early sprouting, early emergence of flower stalk and early opening of the first pair of florets were recorded by bulb soaking in water and foliar spraying of water and of these with control treatment combinations.

Yang *et al.* (2002) in a green house experiment on *Polianthestuberosa*bulbs were treated with GA_3(40 and 80 ppm) at 4^o c for 30 days or at 30^o c for 15 days before planting. Bulbs were planted in October, November and December. The tubers treated with low temperature combined with GA_3increased the flowering rate. The highest flowering rate was over 95% with an average of spike 62%.

In a trail by Sanap*et al.* (2000) at Pune, tuberose plants were spraying with 100, 200 or 300 ppm CCC Chlormequat 40, 55 and 70 days after planting. Flower yield was highest (27.5 t/ha) when 150 ppm $GA_3$was used.

Dalal*et al.* (1999) conducted a field experiment to study the influence of N application rate (0, 50, 60 and 70 kg/ha) and GA_3 concentration (0, 10, 20 or 40 ppm) on flower quality of *Polianthestuberosa.* The optimum N application rate was 70 kg/ha; rachis length, flower stalk length, flower weight and vase life were 30.68 cm, 88.87 cm, 89.14 g/plant and 12.74 days. The optimum concentration of GA_3 was 40 ppm; rachis length, flower stalk length, flower weight and vase life were 30.93 cm, 91.06 cm, 106.14 g/plant and 12.94 days. The interaction between N and $GA_3$was significant only inrespect of weight of flowers per plant.

Devendra*et al.* (1999) in an experiment on*Polianthestuberosa* L. cv. Single, bulbous were treated with GA_3 (100 or 200 ppm), Cycocl (2000 or 4000 ppm) and Ethrel (1000 or 2000 ppm). Two methods of application were used bulbs were dipped in solution for 24 hrs or plants were treated with foliar application at 40 days after transplanting. GA_3 at 200 ppm enhanced bulb sprouting, decreasing the number of days required for sprouting from 20.83 in the control to 12.03. Foliar application of 200 ppm GA_3 also significantly increased plant height (65.65 cm), flower spike length (103.96 cm), flower diameter (3.67), floret number per spike (38.03) and fresh flower yield (12.26 t/ha) compared to other treatments and the control.

Nagaraja*et al.* (1999) studied an experiment to investigate the effects of growth regulators on the growth and flowering of tuberose (*Polianthestuberosa*L.) cv. Single. The tuberose bulbs were soaked for 24 hrs in solution of GA_3, Ethrel or BA each at 100, 500, 1000 and 1500 ppm and then planted in a RCBD. All treatments influenced growth and flowering characteristics. All treatments resulted in earlier plant emergence, a higher percentage of sprouting and earlier flowering compared to the control with GA_3 at 500 and 1500 ppm being particularly effective. Plant height was greatest with GA_3 at 500 and 100 ppm while ethrel at all concentrations reduced plant height compared to the control. The number of spikes per plant and florets per spike were enhanced by GA_3at

500 and 1500 ppm. Length of flowering was greatest with ethrel at 1000 ppm. All GA_3treatments and ethrel at 100 ppm increased bulb number whereas all other ethrel and all BA treatments reduced bulb number.

Singh (1999) studied an experiment to investigate the effects of GA_3 (100 and 200 ppm), ethephon (200 and 400 ppm) and kinetin (50 and 100 ppm) on the growth, flowering and yield of tuberose (*Polianthestuberosa*L.) cv. Double. The PGR was applied as foliar sprays 40 days after planting. The second application was conducted 3 weeks after the initial spraying. All PGR improved the performance of tuberose compared with the control. GA_3 at 200 ppm produced the tallest plants (35.87 cm) with the highest number of leaves per plant (27.41), spike length (63.17 cm), number of florets per spike (35.99) and floret weight per plant (52.16 g).

Preeti*et al.* (1997) observed a field experiment during 1993-94 at Biswanath College of Agriculture, Sonitpur, Assam, India to study the effects of per-planting treatment of bulbs of Tuberose (*Polianthestuberosa*L.) cv. Singlewith GA_3 (50, 100 and 200 ppm), Ethrel (100, 200 and 400 ppm) or thiourae (1 and 2%)on growth. Compared with the control, treatment of bulbs with GA_3, Ethrel or thiourea prompted the early appearance of flower spikes and promoted the number of flower spikes but reduced the number of bulbs produced/plants. Treatment with GA_3 at 200 ppm produced the highest number of floret/spike.

Tuberose (*Polianthestuberosa*L.) plants treated with GA_3 at 200 ppm were found early flower. Plants treated PGR were late to complete their first flowering. Application of GA_3, BA and phosphon increased spike length, while CCC and B-9 reduced spike length. In GA_3 treated plants, all the nodes of the rachis portion had florets (Reddy *et al.*, 1997).

Dhua*et al.* (1987) reported that Tuberose (*Polianthestuberosa*L.) is an important cut flower crop. Using rhizomes with soaking GA_3(200 ppm) for 6 hrs improved plant growth and increase theyield of spikes and flowers.

Mukkhopadhay and Banker (1983) spraying the plant of Tuberose (*Polianthestuberosa*L.) cv. Single 40 days after planting and twice at fortnightly interval with GA_3 at 25- 100 ppm or Ethephon at 500 to 2000 ppm and observed that increasing concentration reduced the plant height. GA_3 increased the spike length and flower/spike. Duration of flowering in the field was improved with GA_3 at 100 ppm.

Pathak*et al.* (1980) found that soaking of bulb in GA_3, Ethrel, Kinetin and Thiourea solutions before planting improved the growth and flowering of tuberose. Among the different chemicals used GA_3 and thiourea proved more effective than others. Thiourea promoted plant height and leaf number while GA_3 improved flowering. GA_3 at 200 ppm caused earliest flowering and gave the maximum yield of spikes and flowers.

CHAPTER III

MATERIALS AND METHODS

The field experiment was conducted during the period from April 2013 to March 2014 to find out the performance of tuberose in response to organic manures and GA_3. The materials and methods that were used for conducting the experiment are presented in this chapter under the following headings:

3.1 Experimental site

The experiment was conducted at the Horticultural Farm of Sher-e-BanglaAgricultural University, Sher-e-Bangla Nagar, Dhaka. The location of the study site is situated in 23°74′N latitude and 90°35′E longitude.

3.2 Characteristics of soil

The experimental soil belongs to the Modhupur Tract under AEZ No. 28 (UNDP 1988). The selected experimental plot was medium high land and the soil series was Tejgaon (FAO 1988). The components of the soil were analyzed in the SRDI, Soil testing Laboratory, Farmgate, Dhaka and presented in Appendix I.

3.3 Weather condition of the experimental site

The climate of experimental site was under the subtropical, characterized by three distinct seasons, the monsoon or the winter season from November to

February and the pre-monsoon period or hot season from March to April and the monsoon period from May to October. Meteorological data related to the temperature, relative humidity, rainfalls and sunshine during the period of the experiment was collected from the Bangladesh Meteorological Department, Sher-e-Bangla Nagar, Dhaka and presented in Appendix II.

3.4 Planting materials

Bulbs of tuberose were used as planting materials and they were collected from Bangladesh Agricultural Research Institute (BARI),Gazipur.

3.5 Treatment of the experiment

The experiment had two factors.

Factor A: Organic manures: 3 levels

i. M_0 = Control - No Organic manures

ii. M_1 = Cowdung - 30 t/ha

iii. M_2 = Poultry litter 20 t /ha

Factor B:GA_3: 4 levels

i.G_0 = Control - Water spray

ii. G_1 = GA_3– 100 ppm

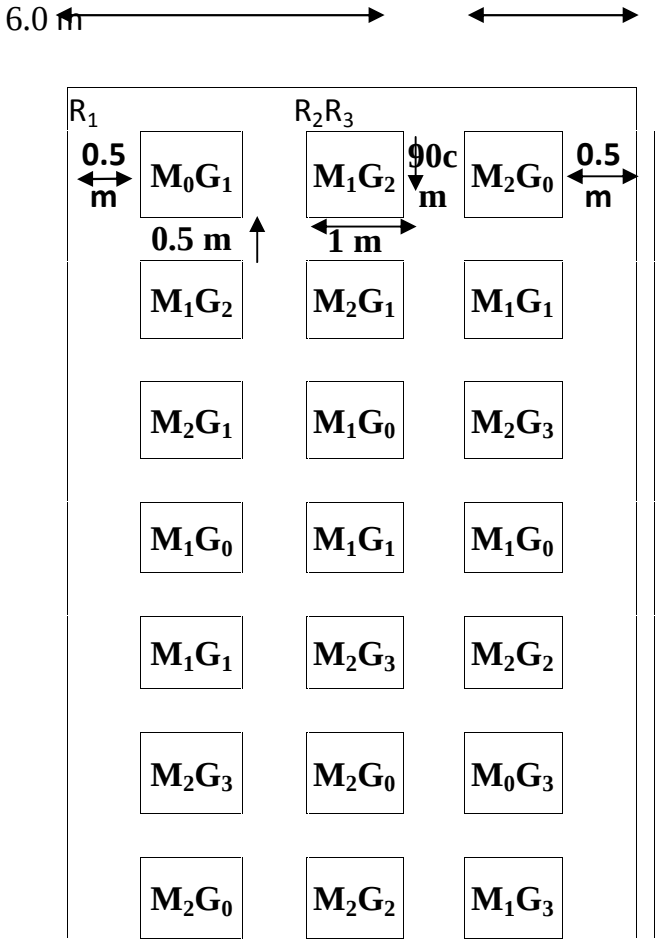
iii. G_2=GA_3– 200 ppm

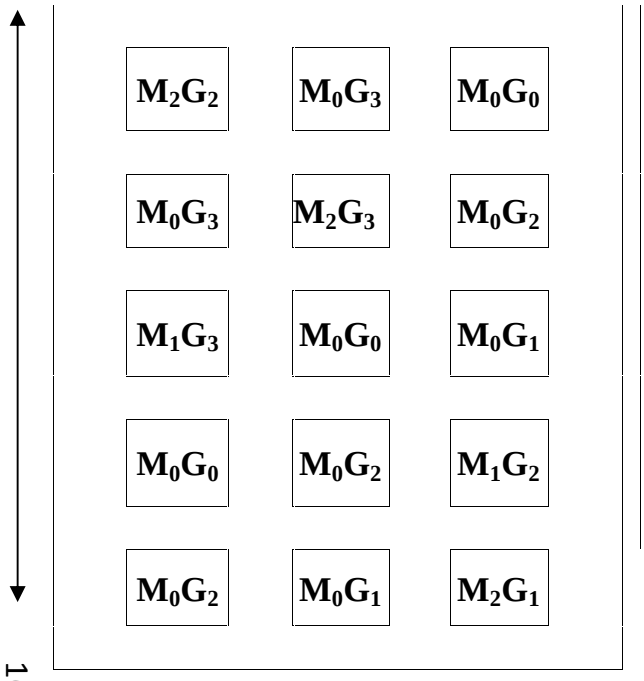
iv. G_3= GA_3– 300 ppm

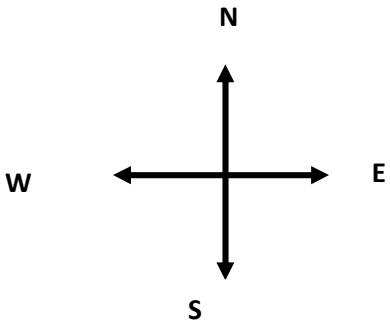
There were 12 (3 x 4) treatment combinations such as M_0G_0,M_0G_1,M_0G_2,M_0G_3,M_1G_0,M_1G_1,M_1G_2,M_1G_3,M_2G_0,M_2G_1,M_2G_2 andM_2G_3.

3.6 Experimental design and layout

The experiment was laid out following Randomized Complete Block (RCB) Design with three replications. An area of 16.8 m x 6.0 m was divided into three equal blocks and each block was divided into 12 plots for distribution 12 treatment randomly. There were 36 unit plots, the size of each was 1.0 m x 0.90 m with a plant spacing 30 x 20 cm. Two adjacent unit plots and block will be separated by0.5 m and 1.0 m space, respectively. The layout of the experiment is shown in Figure 1.







Plot size: 1.0 m x 0.9 m
Spacing: 30 cm x 20 cm
Spacing between plot: 50 cm
Spacing between replication:1 m

ure 1: Field layout of the two factors experimer

Factors: A
M_0 : Control
M_1 : Cowdung (30 t/ha)
M_2 : Poultry Manure (20 t/ha)

Factor:B
G_0 = Control (water spray)
G_1 = GA_3(100 ppm)
G_2 = GA_3(200 ppm)
G_3= GA_3(300 ppm)

3.7 Land preparation

The experimental plot was opened in the first w tiller and left exposed to the sun for a week. harrowed, ploughed and cross-ploughed several obtain good tilth. Weeds and stubbles were desirable filth of soil.

3.8 Manures

Well-decomposed cowdungand poultry manure were also applied during final land preparation as per treatment (Nambishan and Krisran, 1983). The following amount of manures and fertilizers were used which shown as tabular form:

Table 1: Dose and method of application of organic manures in tuberose field

Manures	Dose/ha	During land preparation	Dose/plot
Cowdung	30 t/ha	All	3 kg
Poultry litter	20 t/ha	All	2 kg

3.9 Planting of bulblet

The experimental plot was partitioned into unit plots in accordance with the experimental design mentioned in Figure 1. The bulbs were planted on 21 April, 2013 with a distance on 30 cm x 20 cm and the number of bulb/plot was 20.

3.10 Preparation of Gibberellic acid (GA_3) and Control solution

GA_3in different concentrations viz. 0, 100, 200 and 300 ppm were prepared following the procedure mentioned below and spraying was done using hand sprayer. Spraying was done 40 days, 50 days, 60 days after transplanting. 1000 ppm stock solution of $GA_3$was prepared by dissolving 1 g of GA_3 in a small quantity of ethanol prior to dilution with distilled water in one litre of volumetric flask. The stock solution was used to prepare the required concentration for different treatment i.e. 100 ml of this stock solution was diluted in 1 litre of distilled water to get 100 ppmGA_3solution.In a similar way 200 and 300 ppm concentrations were made. An adhesive Tween-20 @ 0.1% was added to each solution including the control as a wetting agent. Control plots were treated only with distilled water.

3.11 Intercultural operation

When the seedlings started to emerge in the beds it was always kept under careful observation. After emergence of seedlings, various intercultural operations, weeding, top dressing was accomplished for better growth and development of tuberose seedlings.

3.11.1 Irrigation and drainage

Over-head irrigation was provided with a watering can to the plots once immediately after germination in every alternate day in the evening. Further irrigation was done when needed. Stagnant water was effectively drained out at the time of heavy rains.

3.11.2 Weeding

Weeding was done to keep the plots free from weeds, easy aeration of soil, which ultimately ensured better growth and development. The newly emerged weeds were uprooted carefully after complete emergence of seedlings whenever it is necessary. Breaking the crust of the soil was done when needed and it was done for 2 times at 30 DAP and 50 DAP.

3.11.3 Mulching

The soil was mulched frequently after irrigation by breaking the crust for easy aeration and to conserve soil moistur

3.11.4Top Dressing

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

3. 11.5Earthing up

Earthing up was done during growing period when necessary.

3.11.6 Staking

For staking bamboo stick was placed and spike was tied with the rope.

3.11.7 Selection and tagging of plants

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

3.11.8 Plant Protection

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

3.11.9 Harvesting

The spikes of tuberose were harvested when the first floret in the rachis opened. Harvesting was done during 5August to 10 September, 2013 and bulbs were harvested on 20 March, 2014.

3.12 Data collection

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

3.12.1 Plant height

The height of plant was recorded in centimeter (cm) at 30, 45, 60, 75 and 90 days after planting in the experimental plots. The height was measured from the ground level up to the tip of the growing point of the plant.

3.12.2 Number of leaves per plant

All the leaves of ten plants were counted at an interval of 15 days at 30, 45, 60, 75 and 90 days after planting in the experimental plots.

3.12.3 Number of side shoot

It was measured at an interval of 15 days at 30, 45, 60, 75 and 90 days after planting in the experimental plots.

3.12.4 Percentage of flowering plant

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

3.12.5 Length of spike at harvest

Length of spike refers to the length from the side shoot of first floret up to the tip of the inflorescence in centimeter.

3.12.6 Diameter of the spike

Diameter of the spike was used to measure the diameter of the spike and expressed in centimeter and mean of 10 spikes was calculated.

3.12.7 Weight of the single spike

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

3.12.8 Length of rachis at harvest

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

3.12.9 Number of floret per spike

It was measured at harvesting time in the experimental plots.

3.12.10 Number of spike per hectare

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

3.12.11 Individual bulb weight

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

3.12.12 Individual bulb diameter

A slide calipers was used to measure the diameter of the bulb and expressed in centimeter and mean of 10 bulbs was calculated.

3.12.13Bulb yield per plot and hectare

Total bulb yield per plot was recorded by adding the total harvested bulb in a plot and expressed in kilogram and converting the yield of tuberose bulb per plot to per hectare and expressed in ton per hectare.

3.12.14Bulblet yield per plot and hectare

Total bulblet yield per plot was recorded by adding the total harvested bulb in a plot and expressed in kilogram and converting the yield of tuberose bulblet per plot to per hectare and expressed in ton per hectare.

3.13 Statistical Analysis

The experimental data obtained for different parameters were statistically analyzed.The mean values of all the recorded characters were calculated and analysis of variance was performed by 'F' (variance ratio) test.

The significance of the difference among the individual and treatment combinations means was estimated by the Duncan's Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

3.14 Economic analysis

The cost of production was analyzed in order to find out the most economic treatment of nutrient sources and mulching. All input cost were considered in computing the cost of production. The market price of spike, bulb and bulblet was considered for estimating the return. The benefit cost ratio (BCR) was calculated as follows:

$$\text{Benefit cost ratio} = \frac{\text{Gross return per hectare (Tk.)}}{\text{Total cost of production per hectare (Tk.)}}$$

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was carried out to find out the influences of organic manures andGA_3on growth and yield of tuberose. The analysis of variance (ANOVA) of the data on different growth parameter and yield of flower and bulb are presented in Appendix III-VII. The results have been presented and discussed, and possible interpretations given under the following headings:

4.1 Plant height

Plant height of tuberose showed statistically significant differences due to different organic manure at 30, 45, 60, 75 and 90 DAP (Appendix III). At the different days after planting (DAP) the tallest plant (20.2 cm, 30.5 cm, 45.8 cm, 53.2 and 58.8 cm) was recorded from M_2at 30, 45, 60, 75 and 90 DAP, respectively which was statistically similar (18.8 cm, 25.7 cm, 42.3 cm, 50.0 cm and 54.3 cm) with M_1 at same DAP, again, at the same DAP the shortest plant (12.5 cm, 20.0 cm, 27.5 cm, 30.8 cm and 35.2 cm) was recorded from M_0 , respectively (Figure 2). Tuberose is a gross feeder and requires a large quantity of organic manure (Singh *et al.*1976). Organic manure has great influence on growth in tuberose (Yadav*et al.* 1985). Similar findings have also been obtained by Rahman (2000) and Bhattacharjee*et al*. (1979).

Plant height of tuberose differed significantly due to the application of different concentration of GA_3at days after planting of 30, 45, 60, 75 and 90 (Appendix III). At 30, 45, 60, 75 and 90 DAP the tallest plant (45.5 cm, 47.9 cm, 50.8 cm, 52.0 cm and 54.5 cm) was found from G_2whereas, the shortest plant (15.8 cm, 17.6cm, 19.7 cm, 20.5 cm and 21.9 cm) was observed from G_0 for the same DAP,

respectively (Figure 3).The observed results are in agreement with the findings of Nagaraja*et al.* (1999) and Wankhade*et al.* (2002a).

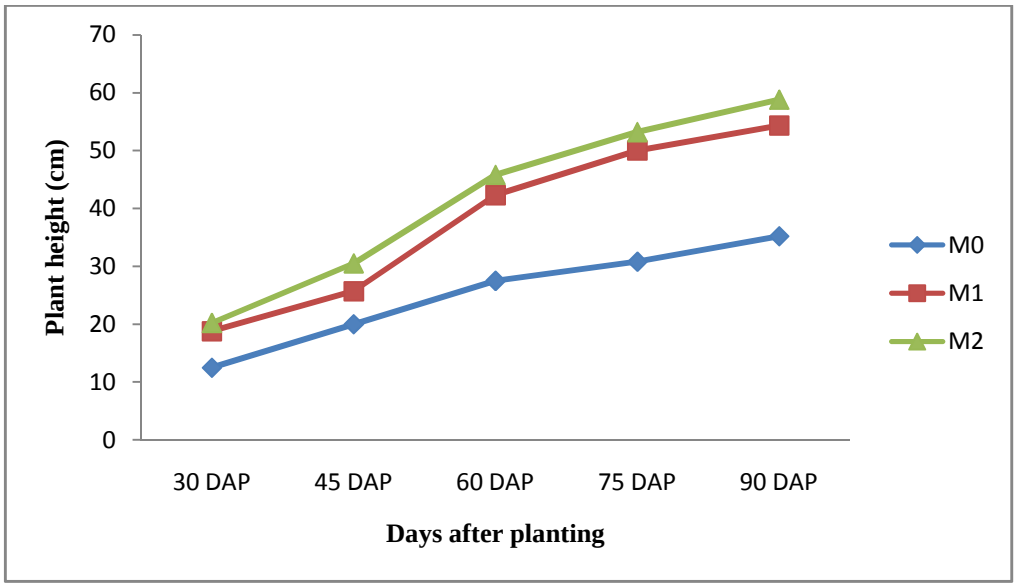


Figure 2: Effect of Organic manure on plant height of tuberose

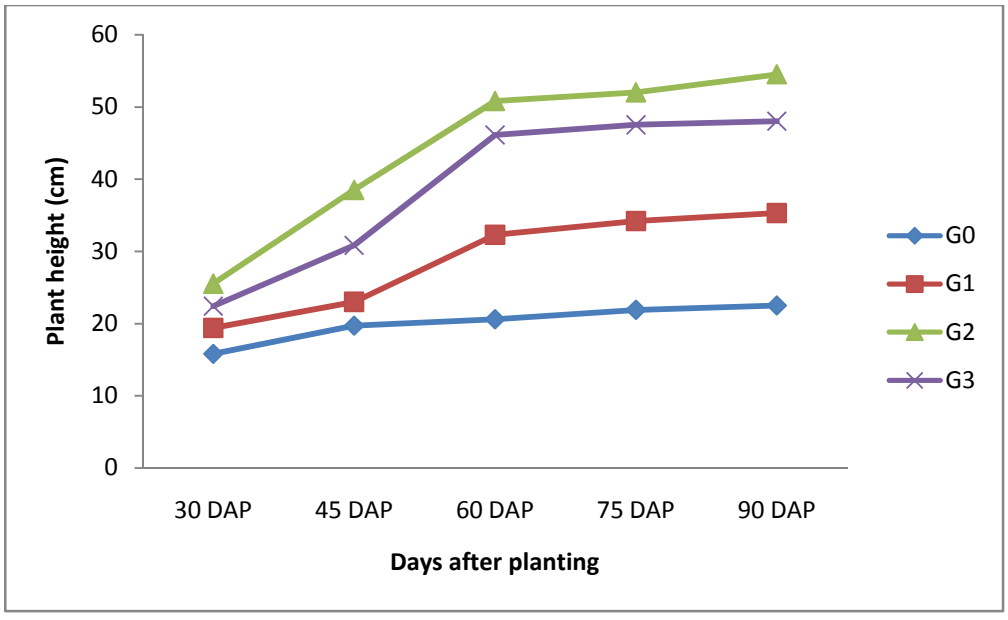


Figure 3: Effect of GA_3on plant height of tuberose

M_0: Control: No organic manure G_0: Control: Water spray
M_1: Cowdung 30 t/ha G_1: GA_3 100 ppm
M_2: Poultry litter 20 t/ha G_2: GA_3 200 ppm
G_3: GA_3 300 ppm

Table 2. Combined effect of organic manure and GA_3 on plant height of tuberose

Treatment	Plant height (cm) at				
	30DAP	45 DAP	60 DAP	75 DAP	90 DAP
M_0G_0	17.0 f	34.6 g	41.3 c	43.3 d	46.97 f
M_0G_1	18.6 de	38.6 b-e	46.0 bc	55.0 b-d	53.19 de
M_0G_2	18.6 de	38.6 b-e	46.3 bc	55.0 b-d	53.59 de
M_0G_3	18.0 ef	36.0 fg	45.6 bc	55.0 b-d	48.40 d
M_1G_0	19.0 c-e	36.3 e-g	45.0 bc	55.6 bc	52.89 de
M_1G_1	19.6 b-d	38.6 b-e	47.0 bc	55.0 b-d	55.05 cd
M_1G_2	19.6 b-d	36.6 d-g	44.3 c	52.0 cd	55.72 bc
M_1G_3	19.0 c-e	37.6 c-f	45.0 bc	52.6 cd	54.15 cd
M_2G_0	20.0 bc	39.0 b-d	45.3 bc	56.3 b	55.47 c
M_2G_1	20.3 b	40.0 bc	47.0 bc	56.6 b	60.61 b
M_2G_2	22.6 a	44.0 a	47.0 a	55.0 a	60.73 a
M_2G_3	20.6 b	40.3 bc	48.0 b	56.3 b	57.47 bc
$LSD_{(0.05)}$	1.1	2.1	3.0	3.4	1.75
Level of significance	0.05	0.05	0.05	0.05	0.05
CV(%)	3.4	3.3	3.9	3.7	3.02

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

M_0: Control: No organic manure G_0: Control: Water spray

M_1: Cowdung 30 t/ha G_1: GA_3 100 ppm
M_2: Poultry litter 20 t/haG_2: GA_3 200 ppm
G_3: GA_3 300 ppm

Significant variation was recorded due to interaction effect of organic manure and GA_3in terms of plant height of tuberose at 30, 45, 60, 75 and 90 DAP (Appendix III). The tallest plant (22.6 cm, 44.0 cm, 47.0 cm, 55.0 cm and 60.73 cm) was observed from M_2G_2 at 30, 45, 60, 75 and 90 DAP, respectively whereas the shortest plant (17.0 cm, 34.6 cm, 41.3 cm, 43.3 cm and 46.97 cm) was recorded from M_0G_0 at 30, 45, 60, 75 and 90 DAP, respectively (Table 2). It was revealed that M_2G_2 ensure maximum vegetative growth by ensuring organicmanure immediate after germination that lead to the development of plants and the ultimate results was the highest plant height of tuberose.

4.2 Number of leaves per plant

Statistically significant differences was recorded for number of leaves per plant of tuberose application of organic manure at 30, 45, 60, 75 and 90 DAP (Appendix IV). At 30, 45, 60, 75 and 90 DAP the highest number of leaves per plant (3.05, 6.03, 9.43, 11.41 and 13.58) was found from M_2. At the same DAP the lowest number of leaves per plant (2.59, 5.01, 7.71, 9.45 and 11.30) was observed from M_0 (Figure 4).

Different concentration of $GA_3$was significantly on number of leaves per plant of tuberose at 30, 45, 60, 75 and 90 DAP (Appendix VI). At 30, 45, 60, 75 and 90 DAP the highest number of leaves per plant (3.04, 6.73, 9.00, 10.99 and 12.03)

was recorded from G_2 whereas, the lowest number of leaves per plant (2.47, 5.23, 7.10, 8.50 and 9.33) was found from G_0 as no GA_3 i.e. control for the same DAP, respectively (Figure 5). The results of the experiment comply with the findings of Wankhade*et al.* (2002b).

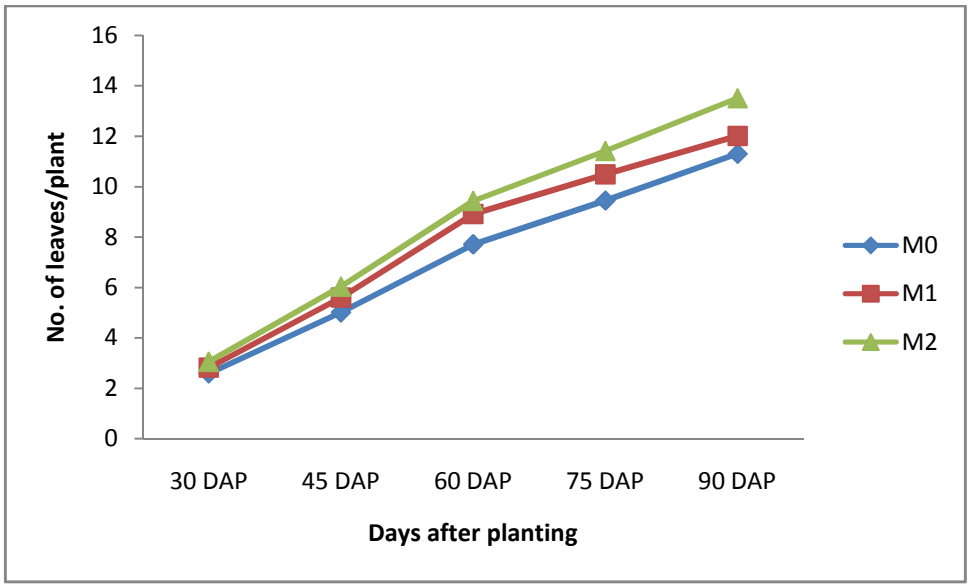


Figure 4: Effect of Organic manure on number of leaves/plant of tuberose

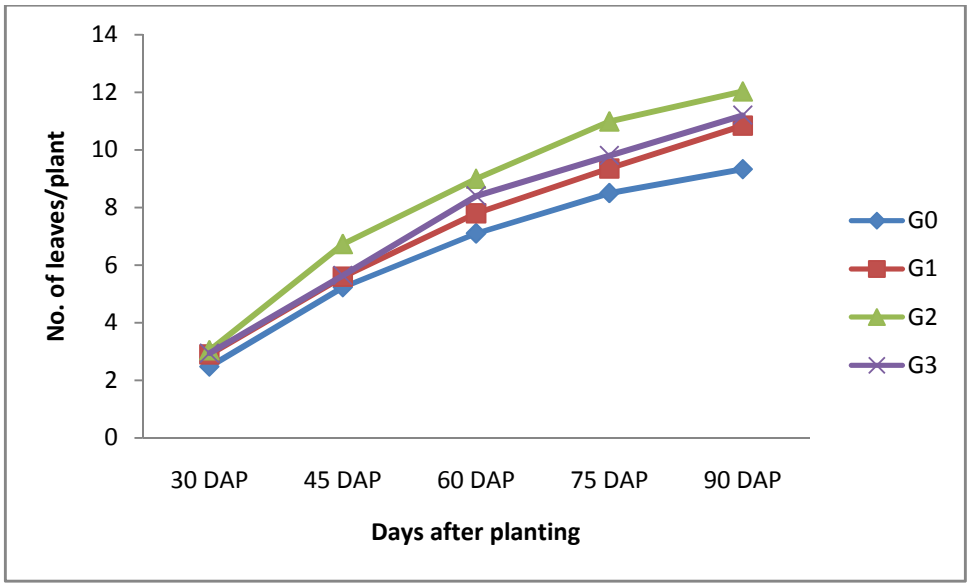


Figure 5: Effect of GA_3 on number of leaves/plant of tuberose

M_0: Control: No organic manure G_0: Control:Water spray
M_1: Cowdung 30 t/ha G_1: GA_3 100 ppm
M_2: Poultry litter 20 t/haG_2: GA_3 200 ppm
G_3: GA_3 300 ppm

Table 3. Combined effect of organic manure and GA_3on number of leaves oftuberose

Treatment	Number of leaves at				
	30DAP	45 DAP	60 DAP	75 DAP	90 DAP
M_0G_0	4.3	5.3 g	9.3 g	14.3 f	15.41 i
M_0G_1	4.6	6.3 ef	10.0 fg	14.6 ef	17.93 f
M_0G_2	5.3	6.3 ef	10.3 ef	15.3 d-f	17.31 f
M_0G_3	4.3	6.0 f	10.3 ef	15.3 d-f	18.70 g
M_1G_0	4.6	6.6 de	10.6 d-f	15.6 d-f	19.59 e
M_1G_1	5.3	7.0 cd	11.3 cd	16.0 c-e	19.88 e
M_1G_2	5.3	7.0 cd	11.3 cd	15.6 c-f	23.11 c

M_1G_3	5.6	7.0 cd	11.0 c-e	15.6 d-f	16.11 h
M_2G_0	5.6	7.0 cd	11.0 c-e	16.3 b-d	21.05 d
M_2G_1	6.0	7.6 b	11.6 bc	17.0 bc	24.92 b
M_2G_2	6.3	8.6 a	13.0 a	19.0 a	26.25 a
M_2G_3	5.6	7.3 bc	12.3 ab	17.3 b	23.40 c
$LSD_{(0.05)}$	2.9	0.363	0.8	1.2	0.65
Level of significance	NS	0.05	0.05	0.05	0.05
CV(%)	4.4	4.11	4.4	4.4	4.14

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

M_0: Control: No organic manure
M_1: Cowdung 30 t/ha
M_2: Poultry litter 20 t/ha

G_0: Control: Water spray
G_1: GA_3 100 ppm
G_2: GA_3 200 ppm
G_3: GA_3 300 ppm

Significant variation was recorded due to combined effect of organic manure and GA_3 in terms of number of leaves per plant of tuberose at 30, 45, 60, 75 and 90 DAP (Appendix IV). The highest number of leaves per plant (6.3, 8.6, 13.0, 19.0 and 26.25) was attained from M_2G_2 at 30, 45, 60, 75 and 90 DAP, respectively whereas the lowest number of leaves per plant (4.3, 5.3, 9.3, 14.3 and 15.41) was found from M_0G_0 at 30, 45, 60, 75 and 90 DAP, respectively (Table 3).

4. 3 Number of side shoot

A significant variation was observed in terms of days required for number of side shoot/plant (Appendix V). Different organic manure showed a gradual increasing trend in terms of number of side shoot/plant of tuberose under the study for control to poultry litter at 30, 45, 60, 75 and 90 DAP (Figure 6). The maximum (5.57) required for number of side shoot/plant at 90 DAP was required from M_2 and the minimum (4.76) was obtained from M_0.

Different concentration of GA_3 showed a statistically significant difference on number of side shoot/plant at 30, 45, 60, 75 and 90 DAP under the present study (Appendix V). The maximum (5.23) number of side shoot/plant at 90 DAP was recorded from G_2. On the other hand, the minimum (4.01) number of side shoot/plant was observed G_0(Figure 7).

Interaction effect between organic manure and GA_3showed no significant variation in all the data of value recorded in terms of number of side shoot/plant of tuberose (Appendix V). But the maximum (5.58) required at 90 DAP was found M_2G_2 and the minimum (4.42) was recorded from M_0G_0 (Table 4).

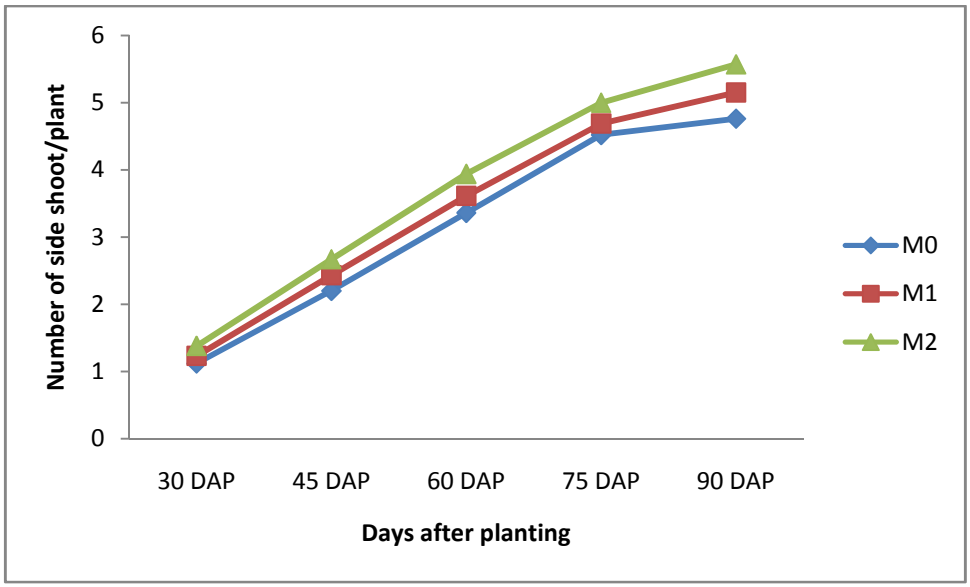


Figure 6: Effect of Organic manure on number of side shoot/plant of tuberose

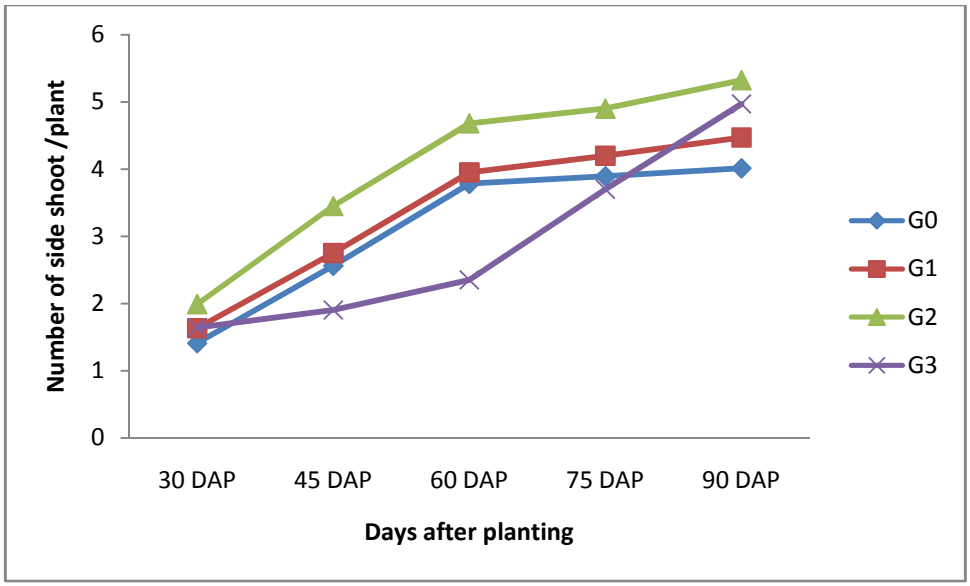


Figure 7: Effect of GA_3on number of side shoot/plant of tuberose

M_0: Control: No organic manure
M_1: Cowdung 30 t/ha
M_2: Poultry litter 20 t/ha
G_0: Control: Water spray
G_1: GA_3 100 ppm
G_2: GA_3 200 ppm
G_3: GA_3 300 ppm

Table 4. Combined effect of organic manure and GA_3on number of side shoot oftuberose

Treatment	Number of side shoot at				
	30DAP	45 DAP	60 DAP	75 DAP	90 DAP
M_0G_0	0.89	1.67	2.03	3.38	4.42
M_0G_1	0.97	1.44	2.52	3.67	4.73
M_0G_2	1.09	1.57	2.77	3.85	4.88

M_0G_3	1.08	1.62	2.76	3.80	4.92
M_1G_0	1.18	1.57	2.71	3.92	4.97
M_1G_1	1.20	1.87	2.97	4.03	4.13
M_1G_2	1.25	1.83	2.95	4.09	4.11
M_1G_3	1.14	1.96	3.09	4.22	5.25
M_2G_0	1.20	1.99	3.28	4.38	5.45
M_2G_1	1.23	2.07	3.34	4.62	5.48
M_2G_2	1.35	2.36	3.57	4.98	5.58
M_2G_3	1.25	2.23	3.49	4.90	5.30
$LSD_{(0.05)}$	---	---	---	---	---
Level of significance	NS	NS	NS	NS	NS
CV(%)	6.23	6.79	6.83	5.68	5.04

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

M_0: Control: No organic manure G_0: Control: Water spray
M_1: Cowdung 30 t/ha G_1: GA_3 100 ppm
M_2: Poultry litter 20 t/ha G_2: GA_3 200 ppm
G_3: GA_3 300 ppm

Table 5. Main effect of organic manure and different concentration GA_3 on growth parameter of tuberose

Treatment	Flowering plant (%)	Length of spike	Diameter of single Spike (cm)	Weight of single spike (g)	Length of rachis	Number of floret per spike
Organic manure						
M_0	81.11 c	71.5 c	0.7 b	36.98 c	26.76 b	37.32 c
M_1	88.76 b	75.0 b	0.7 b	41.35 b	26.74 b	41.90 b
M_2	91.44 a	82.6 a	0.8 a	46.40 a	30.23 a	49.04 a
$LSD_{(0.05)}$	22.156	3.3	0.03	1.251	1.164	1.503
Level of significance	0.05	0.05	0.05	0.05	0.05	0.05
Gibberellic acid (GA_3)						
G_0	78.00c	76.0	0.8	38.05 d	24.27c	37.75 d
G_1	89.33 b	76.6	0.8	42.30 b	29.83b	43.76 b
G_2	92.56 a	76.7	0.8	44.47 a	31.11 a	46.19 a
G_3	87.92 b	76.3	0.8	39.83 c	29.43 b	40.32 c
$LSD_{(0.05)}$	2.783	---	---	1.770	1.502	2.125
Level of Significance	0.05	NS	NS	0.05	0.05	0.05
CV(%)	7.31	9.5	3.13	4.38	4.76	7.7

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

M_0: Control: No organic manure
M_1: Cowdung 30 t/ha
M_2: Poultry litter 20 t/ha
G_3: GA_3 300 ppm

G_0: Control: Water spray
G_1: GA_3 100 ppm
G_2: GA_3 200 ppm

Table 6. Combined effect of organic manure and GA_3on growth parameter of tuberose

Treatment	Flowering plant(%)	Length of spike (cm)	Diameter of single Spike (cm)	Weight of single spike (g)	Length of rachis (cm)	Number of floret per spike
M_0G_0	71.00g	70.0 c	0.68	33.93 i	21.56g	30.0
M_0G_1	85.67de	73.0 bc	0.76	35.43 h	24.66f	32.0
M_0G_2	86.90 d	74.0 bc	0.75	39.67 f	27.64 de	34.0
M_0G_3	81.00ef	72.0 bc	0.71	3700 g	26.58ef	33.0
M_1G_0	80.00f	73.0 bc	0.73	37.90 g	26.96 e	34.0
M_1G_1	92.00bc	75.0 bc	0.79	39.60 f	30.31 a-d	36.6
M_1G_2	93.67ab	76.0 b	0.81	43.91 d	31.16 a-c	41.3
M_1G_3	92.56 bc	75.0 bc	0.78	42.70 e	29.66 c-e	36.0
M_2G_0	88.33 cd	75.0 bc	0.81	42.33 e	29.97 b-d	35.3
M_2G_1	95.00ab	80.0 ab	0.86	44.47 c	32.18 ab	44.0
M_2G_2	98.33a	82.0 a	0.86	49.83 a	33.20 a	45.3
M_2G_3	93.83ab	76.0 b	0.83	47.20 b	31.11 a-c	43.3
$LSD_{(0.05)}$	4.820	2.073	---	0.897	2.602	---
Level of significance	0.05	0.05	NS	0.05	0.05	NS
CV(%)	7.31	9.5	3.13	4.38	4.76	7.7

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

M_0: Control: No organic manure
M_1: Cowdung 30 t/ha
M_2: Poultry litter 20 t/ha
G_0: Control: Water spray
G_1: GA_3 100 ppm
G_2: GA_3 200 ppm
G_3: GA_3 300 ppm

4.4 Flowering plant

Flowering plant of tuberose varied significantly for the application of organic manure (Appendix VI). The highest flowering plant (91.44 %) was observed in M_2. The lowest flowering plant (81.11 %) was obtained from M_0 (Table 5). It was revealed that M_2 produced maximum flowering plant compare to other organic manure that used under this experiment. Organic sources have great influence flower production in tuberose (Yadav*et al*. 1985).

Different concentration of GA_3 differed significantly for flowering plant of tuberose (Appendix VI). The highest flowering plant (92.56 %) was found from G_2 whereas, the lowest flowering plant (78.00 %) was recorded from G_0 i.e. control condition (Table 5). Tuberose plants treated with GA_3 at 200 ppm were found early flowering (Naggar*et al.* 2002; Tiwari and Singh, 2002; Yang *et al.*2002; Sanap*et al.*2000; Reddy *et al.*1997).

Combined effect of organic manure and GA_3showed significant variation in terms of flowering plant of tuberose (Appendix VI). The maximum flowering plant (98.33 %) was found from M_2G_2 whereas, the minimum flowering plant (71.00 %) was recorded from M_0G_0 (Table 6).

4. 5 Length of spike

The length of spike varied significantly due to the effect of application of organic manure (Appendix VI). The highest spike length (82.6 cm) was observed from M_2. One the other hand, the shortest spike (71.5 cm) was recorded from M_0

(Table 5). The results also agreed with the findings of Kabir*et al.* (2011) who concluded that the increased spike length was due to use of poultry litter.

Different concentration of GA_3 showed no statistically variation on spike length under the present trial (Appendix VI). The maximum spike length (76.7 cm) was recorded from G_2. One the other hand, the minimum spike length (76.0 cm) was recorded from G_0 (Table 5). Singh (1999) reported similar results in tuberose plant.

Interaction effect of organic manure and GA_3 showed significant difference on spike length of tuberose (Appendix VI). The longest spike (82.0 cm) was recorded from M_2G_2 and the shortest spike (70.0 cm) was obtained from M_0G_0 (Table 6).

4.6 Diameter of single spike

A statistically significant variation in terms of diameter of single spike was recorded on different organic manure (Appendix VI). The maximum diameter of single spike (0.8 cm) was recorded in M_2 and the minimum diameter of single spike (0.7) was recorded in M_0 and M_1 (Table 5). The poultry litter was showed the highest diameter of single spike but cowdung and control was showed similar result.The present results are in agreement thefindings ofBahadoran*et al.*(2011).

Statistically non-significant variation was recorded for diameter of single spike for different concentration of GA_3 application (Appendix VI). The diameter of single spike (0.8 cm) was recorded in all concentration of GA_3 (Table 5).The present results are in agreement thefindings of Mukhopandhay and Bankar (1983).

Interaction effect between organic manure and GA_3 showed no significant variation in terms of diameter of single spike (Appendix VI). But, the maximum

diameter of single spike (0.86) was recorded in M_2G_2 and M_2G_1.One the other hand, the minimum diameter of single spike (0.68 cm) was recorded in M_0G_0 (Table 6).

4.7 Weight of single spike

Different organic manure showed a statistically significant variation in terms of weight of single spike under the trial (Appendix VI). The highest weight of single spike (46.40 g) was recorded from M_2 and M_0 performed the lowest (36.98 g) weight of single spike (Table 5). The poultry litter was showed the highest weight of single spike and control was showed lowest result.The present results are in agreement thefindings ofSalminen*et al.*(2001).

Statistically significant variation was recorded for weight of single spike for different concentration of GA_3 under the trial (Appendix VI). Increases of concentration of GA_3 weight of single spike represent an increasing trend. The highest weight of single spike (44.47 g) was recorded from G_2 and G_0 performed the lowest (38.05 g) weight of single spike (Table 5).

Interaction effect between organic manure and GA_3 showed significant variation in terms of weight of single spike (Appendix VI). The maximum weight of single spike (49.83 g) was observed from M_2G_2 and the minimum weight of single spike (33.93 g) was recorded from M_0G_0 (Table 6).

4.8 Length of rachis at harvest

Statistically significant difference was found on length of rachis at harvest for the application of organic manure (Appendix VI). The highest length of rachis at

harvest (30.23 cm) was recorded from M_2 which was statistically identical (29.14 cm) to M_1 while the lowest length of rachis at harvest (26.76 cm) was recorded from M_0 (Table 5). Yadav (2007) reported that length of rachis was remarkably increased with organic and poultry litter application, alone and in combination.

Length of rachis at harvest of tuberose varied significantly for different concentration of GA_3 (Appendix VI). The highest length of rachis at harvest (31.11 cm) was found from G_2 whereas, the lowest length of rachis at harvest (24.27 cm) was found from G_0 as (Table 5). Manisha*et al.* (2002) found similar results.

Length of rachis at harvest of tuberose showed significant variation due to combined effect of organic manure and GA_3 (Appendix VI). The maximum length of rachis at harvest (33.20 cm) was recorded from the treatment combined of M_2G_2 whereas, the minimum length of rachis at harvest (21.56 cm) was recorded from M_0G_0 (Table 6).


26.75
29.14
30.23

M_0M_1 M_2

Plate 1: Different length of rachis (cm) in response to organic manures

Factors: A: Organic manure

M_0 : Control(no organic manure)

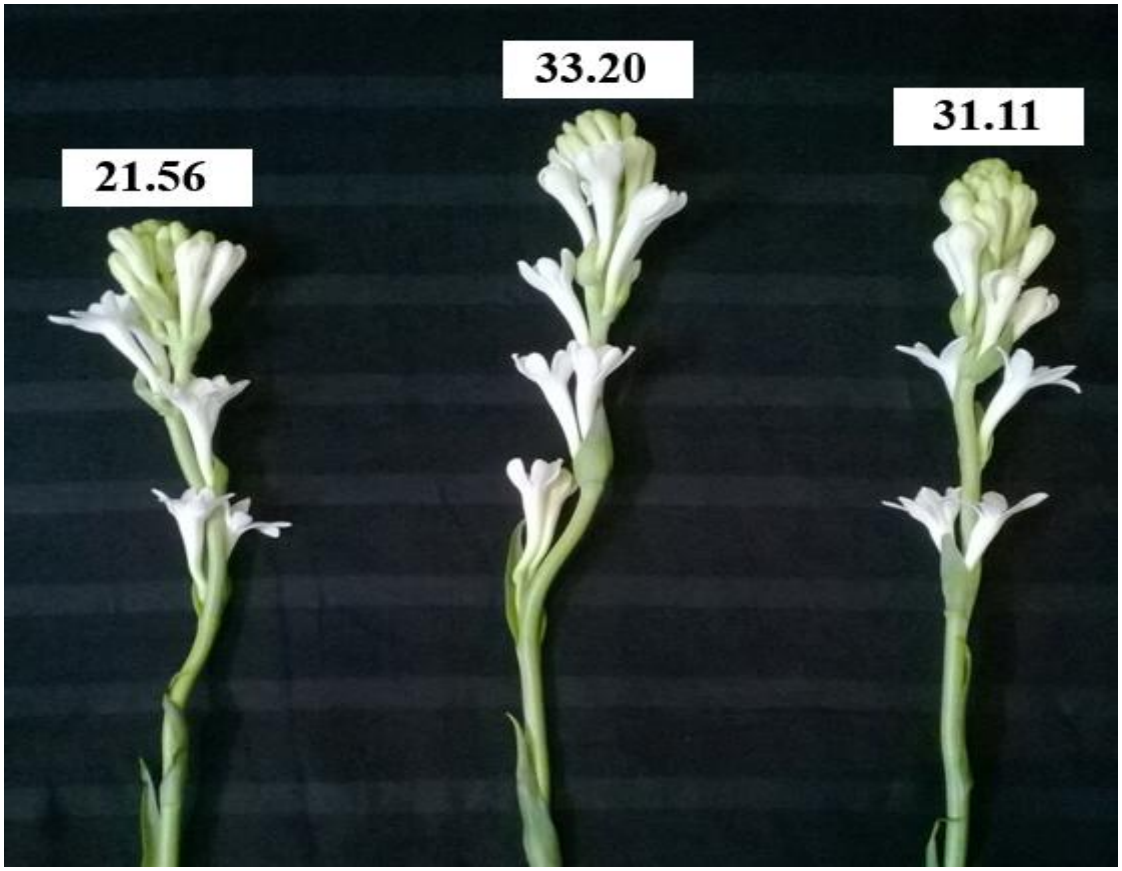
M_1 : Cowdung (30 t/ha)

M_2 : Poultry Manure (20 t/ha)

G_0G_1 G_2 G_3

Plate 2: Different length of rachis (cm) in response to different concentrationofGA_3

Factor:B: GA_3
G_0 = Control (water spray)
G_1 = GA_3(100 ppm)
G_2 = GA_3(200 ppm)
G_3= GA_3(300 ppm)



M_0G_0 M_2G_2 M_2G_3

Plate 3: Combined effect of organic manure and GA_3 on the length of rachis (cm)

Factors: A: Organic manure
M_0 : Control (no organic manure)
M_1 : Cowdung (30 t/ha)
M_2 : Poultry Manure (20 t/ha)

Factor:B: GA_3
G_0 = Control (water spray)
G_1 = GA_3(100 ppm)
G_2 = GA_3(200 ppm)
G_3= GA_3(300 ppm)

4.9 Number of floret per spike

Significant difference was recorded on number of floret per spike due to the application of organic manure (Appendix VI). The highest number of floret per spike (49.04) was performed by M_2 and the lowest number of floret per spike (37.32) was found from M_0 (Table 5). Yadav (2007) reported that number of spike per plot was remarkably increased with N and P application, alone and in combination.

Different concentration of GA_3 differed significantly on number of floret per spike of tuberose (Appendix VI). The highest number of floret per spike (46.19) was found from G_2 and the lowest number of floret per spike (37.75) was recorded from G_0 (Table 5).Preeti*et al.*(1997) found similar results.

Non-significant variation was recorded due to combined effect of organic manure and GA_3 in terms of number of floret per spike of tuberose (Appendix VI). The maximum number of floret per spike (45.30) was found from M_2G_2 whereas, the minimum number of floret per spike (30.00) was recorded from M_0G_0 (Table 6).

4. 10 Number of spike per hectare (‘000)

A statisticallysignificant variation in terms of number of spike in thousand per hectare was recorded for application of organic manure (Appendix VII) but, the maximum number of spike per hectare (322.5) was recorded from M_2 and the minimum number of spike per hectare (264.5) was recorded from M_0 (Table 7).

Statistically significant was recorded on number of spike in thousand per hectare for different concentration of GA_3 application (Appendix VII). Increases of concentration of GA_3 number of spike per hectare represent an increasing trend under the investigation. The maximum number of spike per hectare (309.1) was recorded from G_2. The minimum number of spike per hectare (269.5) was recorded from G_0 (Table 7). The present results are in agreement thefindings ofDhua*et al.*(2001) and Pathak*et al.*(1980).

Interaction between organic manure and GA_3 showed significant variation in terms of number of spike in thousand per hectare (Appendix VII). The maximum number of spike per hectare (350.0) was recorded from M_2G_2. The minimum number of spike per hectare (250.3) was recorded from M_0G_0 (Table 8).

Table 7. Main effect of organic manure and different concentration GA_3on growth parameter of tuberose

Treatment	Number of spike per hectare (‘000)	Diameter of single bulb (cm)	Weight of single bulb (g)	Yield of bulb (kg/plot)	Yield of bulblet (kg/plot)	Yield of bulb (t/ha)	Yield of bulblet (t/ha)
Organic manure							
M_0	264.5c	3.29 c	37.52 c	0.11 c	0.15 c	10.78 c	11.28 c
M_1	281.4b	3.62 b	41.64 b	0.17 b	0.22 b	12.37 b	13.92 b

M_2	322.5 a	3.82 a	45.48 a	0.21 a	0.25 a	14.95 a	15.38 a
$LSD_{(0.05)}$	26.77	0.053	1.141	0.031	0.023	1.012	1.348
Level of significan-ce	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Gibberellic acid (GA_3)							
G_0	269.5 d	3.43 d	38.81 d	0.15 c	0.11 c	10.70d	11.62 c
G_1	292.9 b	3.60 bc	42.32 ab	0.27 b	0.23 a	11.65c	13.21 a
G_2	309.1 a	3.68 a	43.79 a	0.31 a	0.25 a	15.86 a	13.60 a
G_3	286.3 c	3.55 cd	41.00 bc	0.25 b	0.16 b	14.59 b	12.59 b
$LSD_{(0.05)}$	30.92	0.078	1.614	0.033	0.023	0.27	0.785
Level of significan-ce	0.05	0.05	0.05	0.05	0.05	0.05	0.05
CV(%)	9.9	2.22	4.06	11.52	12.04	11.52	12.04

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

M_0: Control: No organic manure G_0: Control: Water spray
M_1: Cowdung 30 t/ha G_1: GA_3 100 ppm
M_2: Poultry litter 20 t/haG_2: GA_3 200 ppm
G_3: $GA_3$300 ppm

Table 8.Combined effect of organic manure and GA_3on yield parameter of tuberose

Treatment	Number of spike per hectare (‘000)	Diameter of single bulb (cm)	Weight of single bulb (g)	Yield of bulb (kg/plot)	Yield of bulblet (kg/plot)	Yield of bulb (t/ha)	Yield of bulblet (t/ha)

M_0G_0	250.3 l	3.11	35.59 g	0.10 f	0.22 e	15.17 k	11.00e
M_0G_1	270.3 i	3.32	38.17 f	0.23 de	0.36 d	16.33 i	17.95d
M_0G_2	278.6 g	3.43	39.69 e	0.26 c-e	0.38 cd	17.28 g	18.67cd
M_0G_3	258.6 j	3.21	35.95g	0.19 e	0.34d	16.5 h	17.20 d
M_1G_0	258.3 k	3.52	38.29 f	0.19 e	0.38 cd	15.78 j	19.22cd
M_1G_1	278.3 h	3.67	42.67 d	0.21b-d	0.45 bc	17.28 g	22.76a-c
M_1G_2	298.6 e	3.69	44.09 c	0.21 b-d	0.46 bc	17.59 f	22.90a-c
M_1G_3	290.3 f	3.67	42.56 d	0.20 b-d	0.40 cd	18.84 d	22.60a-c
M_2G_0	300 d	3.63	39.65 e	0.15c-e	0.45bc	18.33 e	20.24b-d
M_2G_1	330 b	3.85	46.12 b	0.26 ab	0.49 ab	19.33 c	22.67 ab
M_2G_2	350 a	3.93	47.59 a	0.31 a	0.54 a	21.72 a	26.95a
M_2G_3	310 c	3.75	44.37 c	0.23 a-c	0.46bc	20.43 b	24.46a-c
$LSD_{(0.05)}$	5.35	---	0.746	0.092	0.075	4.336	4.067
Level of significan-ce	0.05	NS	0.05	0.05	0.05	0.05	0.05
CV(%)	9.9	2.22	4.06	11.52	12.04	11.52	12.04

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

M_0: Control: No organic manure
M_1: Cowdung 30 t/ha
M_2: Poultry litter 20 t/ha
G_0: Control: Water spray
G_1: GA_3 100 ppm
G_2: GA_3 200 ppm
G_3: GA_3 300 ppm

4.11 Diameter of single bulb

Statistically significant difference was found on diameter of single bulb for the application of organic manure (Appendix VII). The highest diameter of single bulb (3.82 cm) was found from M_2 while, the lowest diameter of individual bulb (3.29 cm) was observed from M_0 (Table 7).

Different concentration of GA_3 differed significantly on diameter of single bulb of tuberose (Appendix VII). The highest diameter of single bulb (3.68 cm) was found from G_2 whereas, the lowest diameter of single bulb (3.43 cm) was observed from G_0 as no GA_3 i.e. control (Table 7).

Non-significant variation was recorded due to combined effect of organic manure and GA_3in terms of diameter of single bulb of tuberose (Appendix VII). But, the maximum diameter of single bulb (3.93 cm) was recorded from the treatment combination of M_2G_2 whereas, the minimum diameter of single bulb (3.11) was recorded from M_0G_0 (Table 8).

4.12 Weight of single bulb

Weight of single bulb showed statistically significant differed due to the application of organic manure (Appendix VII). The highest weight of single bulb (45.48 g) was observed in M_2 and the lowest weight of single bulb (37.52 g) was found from M_0 (Table 7).

Different concentration of GA_3 differed significantly on the weight of single bulb of tuberose (Appendix VII). The highest weight of single bulb (43.79 g) was observed in G_2 whereas, the lowest weight of single bulb (38.81 g) was found from G_0 as no GA_3 i.e. control (Table 7).

Combined effect of organic manure and GA_3 varied significantly in terms of weight of single bulb of tuberose (Appendix VII). The maximum weight of single bulb (47.59 g) was observed in M_2G_2 whereas, the minimum weight of single bulb (35.59 g) was observed from M_0G_0 (Table 8).

4.13 Yield of bulb per plot

Yield of bulb per plot varied significantly for the application of organic manure (Appendix VII). The highest yield of bulb per plot (0.21 kg) was observed in M_2 and the lowest yield of bulb per plot (0.11 kg) was found from M_0 (Table 7). Singh *et al*.(2001) reported that poultry litter contents in leaves were higher than those in bulbs (rhizomes).

Concentration of GA_3differed significantly on yield of bulb per plot of tuberose (Appendix VII). The highest yield of bulb per plot (0.38 kg) was recorded from G_2 whereas, the lowest yield of bulb per plot (0.15 kg) was observed from G_0 (Table 7).The present results are in agreement thefindings ofDevendra*et al*.(1991).

Significant difference was recorded due to interaction effect of organic manure and GA_3 in terms of yield of bulb per plot of tuberose (Appendix VII). The maximum yield of bulb per plot (0.31 kg) was found from M_2G_2whereas, the minimum yield of bulb per plot (0.10 kg) was recorded from M_0G_0 (Table 8).

4.14 Yield of bulblet per plot

Application of organic manure varied significantly on yield of bulblet per plot for the (Appendix VII). The highest yield of bulblet per plot (0.25 kg) was obtained from M_2 while, the lowest yield of bulblet per plot (0.15 kg) was recorded from M_0 (Table 7).

Statistically significant variation was found on yield of bulblet per plot of tuberose due to use of GA_3(Appendix VII). The highest yield of bulblet per plot (0.25 kg) was found from G_2 which was statistically similar (0.23 kg) to G_1 whereas, the lowest yield of bulblet per plot (0.11 kg) was found from G_0 (Table 7).

Variation was recorded due to combined effect of organic manure and GA_3 in terms of yield of bulblet per plot of tuberose (Appendix VII). The maximum yield of bulblet per plot (0.54 kg) was observed from the treatment of M_2G_2 whereas, the minimum yield of bulblet per plot (0.22 kg) was observed from M_0G_0 (Table 8).

4.15 Yield of bulb per hectare

Yield of bulb per hectare showed statistically significant difference for the application of organic manure (Appendix VII). The highest yield of bulb per hectare (14.95 ton) was recorded from $M_2$and the lowest yield of bulb per hectare (11.78 ton) was recorded from M_0 (Table 7).

Significant difference was found concentration of GA_3 on yield of bulb per hectare of tuberose (Appendix VII). The highest yield of bulb per hectare (15.86 ton) was observed from G_2 whereas, the lowest yield of bulb per hectare (10.70 ton) was attained from G_0 (Table 7).

Combined effect of organic manure and GA_3varied significantly on terms of yield of bulb per hectare of tuberose (Appendix VII). The maximum yield of bulb per hectare (21.72 ton) was observed from M_2G_2 whereas, the minimum yield of bulb per hectare (15.17 ton) was recorded from M_0G_0 (Table 8).

4.16 Yield of bulblet per hectare

Significant difference was recorded on yield of bulblet per hectare due to the application of organic manure (Appendix VII). The highest yield of bulbletper hectare (15.38 ton) was found from $G_2$and the lowest yield of bulblet per hectare (11.28 ton) was recorded from G_0 (Table 7).

Yield of bulblet per hectare of tuberose showed significance variation for different concentration of GA_3 (Appendix VII). The highest yield of bulblet per hectare (13.60 ton) was found from G_2 whereas, the lowest yield of bulblet per hectare (11.62 ton) was found from G_0 (Table 7).

Statistically significant variation was recorded due to combined effect of organic manure and GA_3 in terms of yield of bulblet per hectare of tuberose (AppendixVII). The maximum yield of bulblet per hectare (26.95 ton) was observed from M_2G_2 whereas, the minimum yield of bulblet per hectare (11.00 ton) was observed from M_0G_0 (Table 8).

4.17 Economic analysis

Input costs for land preparation, seed cost, organic manure, GA_3, irrigation and manpower required for all the operations from planting to harvesting of tuberose flower, bulb and bulblet were recorded for unit plot and converted into cost per hectare. Price of tuberose flower, bulb and bulblet was considered as per market rate. The economic analysis presented under the following headings-

4.17.1 Gross return

The combination of organic manure and GA_3showed different gross return. The highest gross return (Tk. 3,85,195) was obtained from M_2G_2 and the second highest gross return (Tk. 3,60,665) was found in M_2G_1. The lowest gross return (Tk.2,70,970) was obtained from M_0G_0 (Table 9).

4.17.2 Net return

In case of net return different treatment combination showed different concentration of net return. The highest net return (Tk.2,15,195) was found from

M_2G_2 and the second highest net return (Tk. 1,95,665) was obtained from M_2G_1.The lowest (Tk. 1,20,970) net return was obtained M_0G_0 (Table-9).

4.17.3 Benefit cost ratio

In the combination of organic manure and GA_3, highest benefit cost ratio (2.22) was noted from M_2G_2 and the second highest benefit cost ratio (2.14) was estimated from M_2G_1. The lowest benefit cost ratio (1.41) was obtained from M_0G_0 (Table 9). From economic point of view, it was apparent from the above results that the combination of M_2G_2 was more profitable than rest of the combination.

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the Horticultural Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207 during the period from April, 2013 to March, 2014 to find out the performance of tuberose in response to organic manures andGA_3. The experiment had two factors. Factor A: Organic manure: 3 levels; M_0 - Control: No organic manure, M_1 - Cowdung: 30 t/ha and M_2 - Poultry litter: 20 t/ha; Factor B:GA_3: 4 levels; G_0 - Control: Water spray, G_1-GA_3: 100 ppm, G_2 - GA_3: 200 ppm and G_3– GA_3: 300 ppm. The experiment was laid out following Randomized Complete Block(RCB) Design with three replications. Data on different growth parameter and yield of flower, bulb and bulblet were recorded and significant variation was recorded for different treatment.

In case of organic manure, at 30, 45, 60, 75 and 90 DAP, the tallest plant (20.2 cm, 30.5 cm, 45.8 cm, 53.2 cm and 58.8 cm) was observed from M_2 again the shortest plant (12.5 cm, 20.0 cm, 27.5 cm, 30.8 cm and 35.2 cm) was recorded from M_0.At 30, 45, 60, 75 and 90 DAP the highest number of leaves per plant (3.05, 6.03, 9.43, 11.41 and 15.81) was found from M_2 again the lowest number of leaves per plant (2.59, 5.01, 7.71, 9.45 and 11.30) was observed from M_0. The maximum (16.84) required for number of side shoot/plant was required from M_2

and the minimum (15.02) was obtained from M_0. The highest flowering plant (91.44 %) was observed in M_2 and the lowest flowering plant (81.11 %) was obtained from M_0.The highest spike length (82.6 cm) was observed from M_2 while the shortest spike (71.5 cm) was recorded from M_0. The maximum diameter of single spike (0.8 cm) was recorded in M_2 and the minimum diameter of single spike (0.7 cm) was recorded in M_0 and M_1.The highest weight of single spike (46.40 g) was recorded from M_2 and M_0 performed the lowest (36.98 g) weight of single spike. The highest length of rachis at harvest (36.23 cm) was recorded from M_2 while the lowest length (32.76 cm) was recorded from M_0.The highest number of floret per spike (49.04) was performed by M_2 and the lowest number of floret per spike (37.32) was found from M_0. The maximum number of spike per hectare (3,22,000) was recorded from M_2 and the minimum number of spike per hectare (2,64,500) was recorded from M_0.The highest diameter of single bulb (3.82 cm) was found from M_2 while, the lowest diameter of individual bulb (3.29 cm) was observed from M_0.The highest weight of individual bulb (45.48 g) was observed from M_2 while the lowest weight (37.52 g) was found from M_0.The highest yield of bulb per plot (0.21 kg) was observed in M_2 and the lowest yield of bulb per plot (0.11 kg) was found from M_0.The highest yield of bulblet per plot (0.45 kg) was obtained from M_2 while, the lowest yield of bulblet per plot (0.35 kg) was recorded from M_0.The highest yield of bulb per hectare (19.95 ton) was recorded from M_2 while the lowest yield (15.78 ton) was recorded from M_0. The highest yield of bulblet per hectare (22.38 ton) was found from M_2 while the lowest yield (17.28 ton) was recorded from M_0.

In case of concentration of GA_3, at 30, 45, 60, 75 and 90 DAP the tallest plant (45.5 cm, 47.9 cm, 50.8 cm, 52.0 cm and 54.5 cm) was found from G_2 whereas, the shortest plant (15.8 cm, 17.6cm, 19.7 cm, 20.5 cm and 21.9 cm) was observed from G_0. At 30, 45, 60, 75 and 90 DAP the highest number of leaves

per plant (3.04, 5.73, 9.00, 10.99 and 12.03) was recorded from G_2 whereas, the lowest number (2.47, 5.23, 8.10, 9.39 and 10.33) was found from G_0. The maximum (17.84) number of side shoot/plant was recorded from G_2 and the minimum (14.04) number of side shoot/plant was observed G_0.The highest flowering plant (92.56 %) was found from G_2whereas, the lowest flowering plant (78.00 %) was recorded from G_0.The maximum spike length (76.7 cm) was recorded from G_2 and the minimum spike length (76.0 cm) was recorded from G_0.The highest weight of single spike (44.47 g) was recorded from G_2 and G_0 performed the lowest (38.05 g) weight of single spike. The highest length of rachis at harvest (37.11 cm) was found from G_2 whereas, the lowest (30.27 cm) was found from G_0.The highest number of floret per spike (46.19) was found from G_2 and the lowest number of floret per spike (37.75) was recorded from G_0.The highest yield of spike per hectare (3,09,000) was observed from G_2 and the lowest yield (2,69,500) was observed from G_0.The highest diameter of single bulb (3.68 cm) was found from G_2 whereas, the lowest diameter of single bulb (3.43 cm) was observed from G_0.The highest weight of single bulb (43.79 g) was observed in G_2 whereas, the lowest weight of single bulb (38.81 g) was found from G_0.The highest yield of bulb per plot (0.31 kg) was recorded from G_2 whereas, the lowest yield of bulb per plot (0.15 kg) was observed from G_0.The highest yield of bulblet per plot (0.45 kg) was found from G_2 whereas, the lowest yield of bulblet per plot (0.31 kg) was found from G_0.The highest yield of bulb per hectare (18.86 ton) was observed from G_2whereas, the lowest yield of bulb per hectare (15.70 ton) was attained from G_0.The highest yield of bulblet per hectare (22.60 ton) was found from G_2 whereas, the lowest (15.62 ton) was found from G_0.

In case of combined effect of organic manure and GA_3, at 30, 45, 60, 75 and 90 DAP the tallest plant (22.6 cm, 44.0 cm, 47.0 cm, 55.0 cm and 60.73 cm) was observed from M_2G_2 whereas, the shortest plant (17.0 cm, 34.6 cm, 41.3 cm,

43.3 cm and 46.97 cm) was recorded from M_0G_0. At 30, 45, 60, 75 and 90 DAP the highest number of leaves per plant (6.3, 8.6, 13.0, 19.0 and 26.25) was attained from M_2G_2, whereas, the lowest number of leaves per plant (4.3, 5.3, 9.3, 14.3 and 15.41) was found from M_0G_0.The maximum number of side shoot (16.58) required at was found M_2G_2 and the minimum (12.92) was recorded from M_0G_0.The maximum flowering plant (98.33%) was found from M_2G_2 whereas,the minimum flowering plant (71.00%) was observed from M_0G_0.

The longest spike (82.0 cm) was recorded from M_2G_2 and the shortest spike (70.0 cm) was obtained from M_0G_0.The maximum diameter of single spike (0.86) was recorded in $M_2G_2$and the minimum diameter of single spike (0.68 cm) was recorded in M_0G_0.The maximum weight of single spike (49.83 g) was observed from M_2G_2 and the minimum weight of single spike (33.93 g) was recorded from M_0G_0.The maximum length of rachis at harvest (37.20 cm) was recorded from M_2G_2whereas, the minimum length of rachis at harvest (25.56 cm) was recorded from M_0G_0. The maximum number of floret per spike (45.30) was found from M_2G_2whereas, the minimum number of floret per spike (30.00) was recorded from M_0G_0.The maximum number of spike per hectare (3,50,000) was recorded from $M_2G_2$and the minimum number of spike per hectare (2,50,300) was recorded from M_0G_0.The maximum diameter of single bulb (3.93 cm) was recorded from the treatment combination of M_2G_2whereas, the minimum diameter of single bulb (3.11) was recorded from M_0G_0.The maximum weight of single bulb (47.59 g) was observed in M_2G_2 whereas, the minimum weight of single bulb (35.59 g) was observed from M_0G_0.The maximum yield of bulb per plot (0.31 kg) was found from M_2G_2whereas, the minimum yield of bulb per plot (0.10 kg) was recorded from M_0G_0.The maximum yield of bulblet per plot (0.54 kg) was observed from the treatment of M_2G_2 whereas, the minimum yield of bulblet per plot (0.22 kg) was observed from M_0G_0.The maximum yield of bulb per hectare (21.72 ton) was observed in M_2G_2whereas, the minimum (15.17 ton)

was recorded from M_0G_0. The maximum yield of bulblet per hectare (26.95 ton) was observed from M_2G_2 whereas, the minimum yield (11.00 ton) was observed from M_0G_0.

The combination of organic manure and GA_3 the highest gross return (Tk. 3,85,195.00) was obtained from M_2G_2 and the lowest gross return (Tk. 2,70,970.00) was obtained from $M_0G_{0.}$ The highest net return (Tk. 2,15,195.00) was found from M_2G_2 and the lowest (Tk. 1,20,970.00) net return was obtained $M_0G_{0.}$ In the combination of organic manure and GA_3highest benefit cost ratio (2.22) was noted from M_0G_0 and the lowest benefit cost ratio (1.41) was obtained from $M_0G_{0.}$

Conclusion

Poultry litter20 t/ha with 200 ppm GA_3exhibited the highest result. So, it may be concluded that poultry litter and 200 ppm GA_3 application is the best considering the growth, flowering, bulb and bulblet production of tuberose.Other organic manure and growth regulators may be used for further study to get best results.

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LIST OF PLATES

Plate 4: Gibberellic acid

Plate 5 : Field view of tuberose experiment

Plate 6: Flower of tuberose

APPENDICES

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

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Horticulture Garden, SAU, Dhaka

AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping Pattern	Fallow- Tuberose

B. Physical and chemical properties of the initial soil

Characteristics	**Value**
%Sand	27
%Silt	43

%clay	30
Textural class	Silty-clay
pH	6.1
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.077
Available P (ppm)	20.00
Exchangeable K (mel 1 00 g soil)	0.10
Available S (ppm)	45

Source : SRDI, 2013

Appendix II.Monthly record of air temperature, rainfall, relative humidity, soil temperature and sunshine of the experimentalsite during the period from April 2013 to January 2014

Month	Average air temperature (°C)			Average relative humidity (%)	Total rainfall (mm)	Total Sunshine per day (hrs)
	Maximum	Minimum	Mean			
April, 2013	33.7	23.8	28.81	69	185	7.8
May, 2013	36.7	20.3	28.5	70	205	7.7
June, 2013	35.4	22.5	28.95	80	577	4.2
July, 2013	36.0	24.6	30.3	83	563	3.1
August, 2013	36.0	23.6	29.8	81	319	4.0
September,2013	34.8	24.4	29.6	81	279	4.4
October, 2013	34.8	18.0	26.4	77	227	5.8
November, 2013	29.7	20.1	24.9	65	5	6.4
December, 2013	26.9	15.8	21.35	68	0	7.0
January, 2014	24.6	12.5	18.7	66	0	5.5

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

Appendix III. Analysis of variance of the data on plant height of tuberose as influenced by organic manure and GA_3

Source of variation	Degrees of freedom	Mean square				
		Plant height (cm) at				
		30 DAP	45 DAP	60DAP	75 DAP	90 DAP
Replication	2	1.863	2.164	4.224	0.302	0.264
Organic manure (A)	2	43.346*	56.761**	95.643**	95.362*	224.794*
Growth Regulator (B)	3	84.086**	81.107**	128.127**	71.901*	73.655*
Interaction (AxB)	6	3.407**	13.26**	15.03**	11.60*	3.660*
Error	22	0.452	1.61	3.35	4.23	2.752

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

Appendix IV. Analysis of variance of the data on Number of leaves of tuberose as influenced by organic manure and GA_3

Source of variation	Degrees of freedom	Mean square				
		Number of leaves				
		30 DAP	45 DAP	60DAP	75 DAP	90 DAP
Replication	2	0.005	0.128	0.058	0.269	8.337
Organic manure (A)	2	0.429**	0.323*	1.087**	3.480**	771.500*
Growth Regulator (B)	3	0.794**	3.980**	11.576**	14.424**	149.357*
Interaction (AxB)	6	0.083^{NS}	1.574**	1.743**	3.694**	10.350*
Error	22	0.055	0.046	0.241	0.505	5.722

* *: Significant at 0.01 level of probability *: Significant at 0.05 level of probability
NS: Non-significant

Appendix V. Analysis of variance of the data on Number of side shoot of tuberose as influenced by organic manure and GA_3

Source of variation	Degrees	Mean square

	of freedom	Number of side shoot				
		30 DAP	45 DAP	60DAP	75 DAP	90 DAP
Replication	2	0.008	0.612	0.401	0.737	0.136
Organic manure (A)	2	3.909*	8.810*	12.801*	6.418*	8.048*
Growth Regulator (B)	3	0.268*	13.934*	9.808*	7.435*	10.310*
Interaction (AxB)	6	0.087^{NS}	0.679^{NS}	0.368^{NS}	0.081^{NS}	0.252^{NS}
Error	22	0.185	0.350	0.481	0.522	0.591

*: Significant at 0.05 level of probability NS: Non-significant

Appendix VI. Analysis of variance of the data on growth parameter of tuberose as influenced by organic manure and GA_3

Source of variation	Degrees of freedom	Mean square						
		Flowering-plant (%)	Length of flower stalk at harvest (cm)	Length of spike	Diameter of single Spike (cm)	Weight of single spike (g)	Length of rachis	Number of floret per spike
Replication	2	3.934	4.042	0.147	0.0001	8.000	0.143	0.001
Organic manure (A)	2	266.883**	292.491*	200.952*	0.017*	279.054*	61.398**	631.212*
Growth Regulator (B)	3	430.933**	34.832*	3.892^{NS}	0.001^{NS}	62.880*	47.212**	100.080*
Interaction (AxB)	6	37.518**	14.981*	10.50*	0.0001^{NS}	40.515*	6.758*	6.407^{NS}
Error	22	8.306	5.173	5.38*	0.001	3.412	2.421	4.576

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

Appendix VII. Analysis of variance of the data on growth parameter of tuberose as influenced by organic manure and GA_3

Source of variation	Degrees of freedom	Mean square						
		Number of spike per hectare (‘000)	Diameter of single bulb (cm)	Weight of single bulb (g)	Yield of bulb (kg/plot)	Yield of bulblet (kg/plot)	Yield of bulb (t/ha)	Yield of bulblet (t/ha)
Replication	2	15662.25	0.020	12.433	0.0001	0.001	0.07	0.084

Organic manure (A)	2	55892.7*	1.305*	285.135*	0.082**	0.041**	18.12**	24.583**
Growth Regulator (B)	3	75.00*	0.081*	34.395*	0.034**	0.026**	0.33**	25.527*
Interaction (AxB)	6	375.00*	0.003^{NS}	0.641*	0.008**	0.007**	21.103**	17.441**
Error	22	5675.159	0.006	2.839	0.003	0.002	6.720	5.913

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

Appendix VIII. Agro-Ecological Zone of Bangladesh

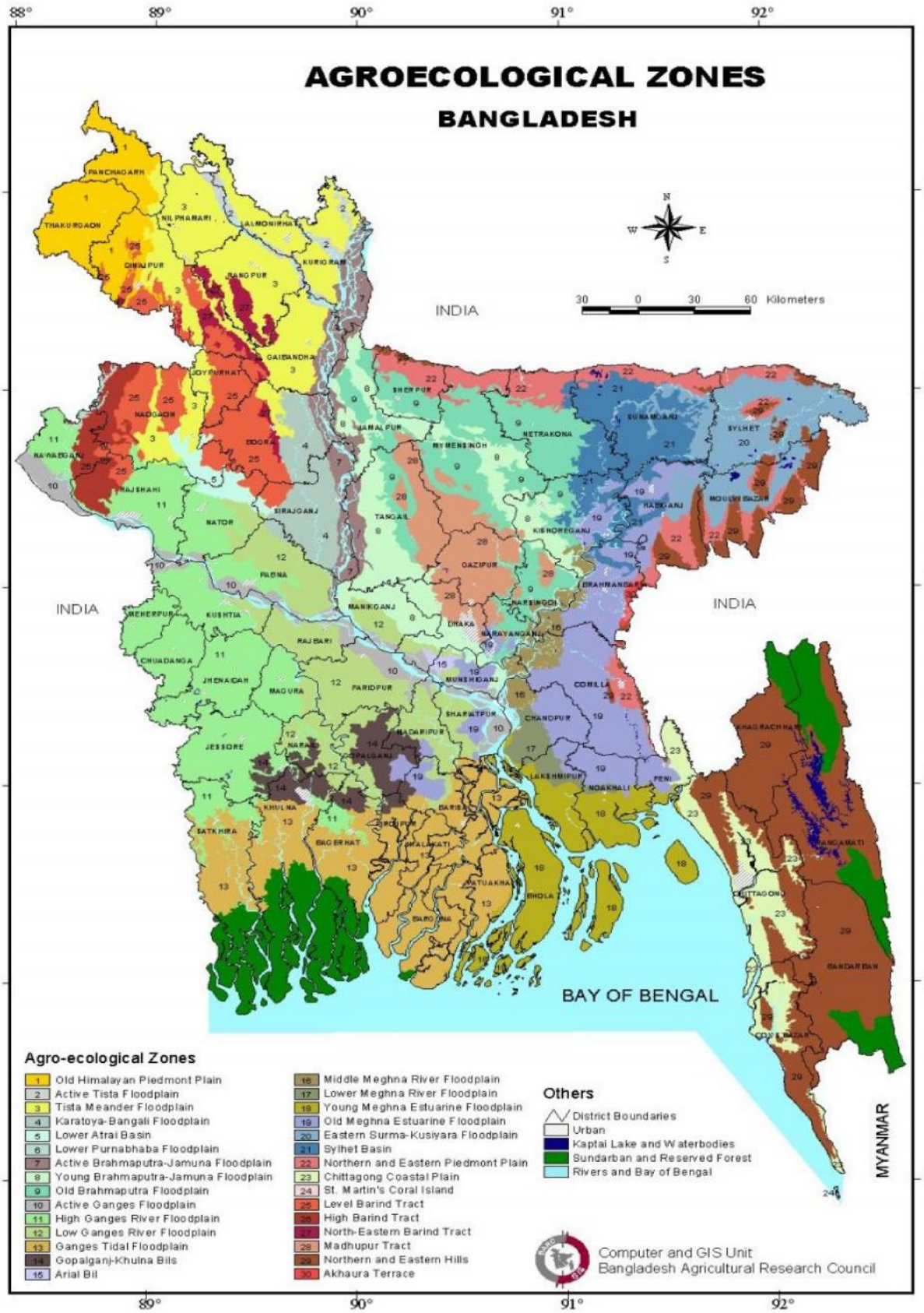
AGROECOLOGICAL ZONES
BANGLADESH
INDIA
INDIA
INDIA
MYANMAR
BAY OF BENGAL
30 0 30 60 Kilometers
Agro-ecological Zones
1 Old Himalayan Piedmont Plain
2 Active Tista Floodplain
3 Tista Meander Floodplain
4 Karatoya-Bangali Floodplain
5 Lower Atrai Basin
6 Lower Purnabhaba Floodplain
7 Active Brahmaputra-Jamuna Floodplain
8 Young Brahmaputra-Jamuna Floodplain
9 Old Brahmaputra Floodplain
10 Active Ganges Floodplain
11 High Ganges River Floodplain
12 Low Ganges River Floodplain
13 Ganges Tidal Floodplain
14 Gopalganj-Khulna Bils
15 Arial Bil
16 Middle Meghna River Floodplain
17 Lower Meghna River Floodplain
19 Young Meghna Estuarine Floodplain
19 Old Meghna Estuarine Floodplain
20 Eastern Surma-Kusiyara Floodplain
21 Sylhet Basin
22 Northern and Eastern Piedmont Plain
23 Chittagong Coastal Plain
24 St. Martin's Coral Island
25 Level Barind Tract
26 High Barind Tract
27 North-Eastern Barind Tract
28 Madhupur Tract
29 Northern and Eastern Hills
30 Akhaura Terrace
Others
District Boundaries
Urban
Kaptai Lake and Waterbodies
Sundarban and Reserved Forest
Rivers and Bay of Bengal
Computer and GIS Unit
Bangladesh Agricultural Research Council

Table 9. Cost and return of tuberose cultivation as influenced by organic manure and GA_3

Treatment	Cost of production (Tk./ha)	Yield of bulb (t/ha)	Price of bulb (Tk.)	Yield of Bulblet (t/ha)	Price of bulblet (Tk.)	Tuberose (1000)	Price of cut flower (Tk.)	Gross return (Tk./ha)	Net return (Tk./ha)	Benefit cost ratio
M_0G_0	1,50,000	15.17	1,51,70	11.00	5,500	250.3	2,50,300	2,70,970	1,20,970	1.41
M_0G_1	1,53,000	16.33	1,63,30	17.95	8,975	270.3	2,70,300	2,95,605	1,40,605	1.51
M_0G_2	1,56,000	17.28	1,72,80	18.67	9,335	278.6	2,78,600	3,05,215	1,45,215	1.51
M_0G_3	1,59,000	16.5	1,65,00	17.20	8,600	258.6	2,58,600	2,83,700	1,18,700	1.62
M_1G_0	1,80,000	15.78	1,57,80	19.22	9,610	258.3	2,58,300	2,83,690	1,03,690	1.88
M_1G_1	1,83,000	17.28	1,72,80	22.76	11,380	278.3	2,78,300	3,06,960	1,21,960	1.86
M_1G_2	1,86,000	17.59	1,75,90	22.90	11,450	298.6	2,98,600	3,27,640	1,37,640	1.92
M_1G_3	1,89,000	18.84	1,88,40	22.60	11,300	290.3	2,90,300	3,20,440	1,25,440	1.94
M_2G_0	1,60,000	18.33	1,83,30	20.24	10,120	300.0	3,00,000	3,28,450	1,68,450	2.01
M_2G_1	1,63,000	19.33	1,93,30	22.67	11,335	330.0	3,30,300	3,60,665	1,95,665	2.14
M_2G_2	1,66,000	21.72	2,17,20	26.95	13,475	350.0	3,50,000	3,85,195	2,15,195	2.22
M_2G_3	1,69,000	20.43	2,04,30	24.46	12,230	310.0	3,10,000	3,42,660	1,67,660	1.98

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

M_0: Control: No organic manure
G_0: Control: Water spray
M_1: Cowdung 30 t/ha G_1: GA_3 100 ppm
M_2: Poultry litter 20 t/ha G_2: GA_3 200 ppm
G_3: GA_3 300 ppm