EFFECT OF BULB SIZE AND GA_3 ON VEGETATIVE AND FLORAL CHARACTERS OF TUBEROSE (*Polianthes tuberosa* L.) CVS. PRAJWAL AND CALCUTTA SINGLE

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ABSTRACT

EFFECT OF BULB SIZE AND GA_3 ON VEGETATIVE AND FLORAL CHARACTERS OF TUBEROSE (*Polianthes tuberosa* L.) CVS. PRAJWAL AND CALCUTTA SINGLE

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ABSTRACT

The present investigation to study the "Effect of bulb size and GA_3 on vegetative and floral characters of tuberose (*Polianthes tuberosa* L.) cvs. Prajwal and Calcutta Single" was carried out at the Floriculture Farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari in the year 2009-2010.

The experiment was laid out in Randomized Block Design with Factorial concept (FRBD) having twelve treatment combinations, comprising of two levels of variety (Prajwal and Calcutta Single), two levels of bulb size (1.5-2.5 cm diameter and 2.6-3.5 cm diameter) and three levels of GA_3 including control (water soaking, 50 and 100 ppm) with spacing of 40 x 30 cm. The treatments were replicated

thrice. The response of tuberose to the treatments was evaluated on the basis of growth, flowering and yield characteristics.

Among two varieties, Prajwal (V_1) significantly increased all growth, flowering, quality and yield attributes as compared to Calcutta Single. While in case of bulb size, bulbs having diameter of 2.6-3.5 cm (B_2) had significant effect on vegetative growth and superior quality and quantity production of tuberose spikes, bulbs and bulblets as compared to bulbs having diameter 1.5-2.5 cm (B_1). However, application of GA_3 at 100 ppm (G_2) had a striking influence in enhancing the growth, flowering, quality and yield characters over control (G_0).

As the economics is considered, it is clear that variety Prajwal, 2.6-3.5 cm bulb size and GA_3 at 100 ppm was found more profitable with respect to the highest net return and CBR than other treatments.

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CERTIFICATE

This is to certify that the thesis entitled "**EFFECT OF BULB SIZE AND GA_3 ON VEGETATIVE AND FLORAL CHARACTERS OF TUBEROSE (*Polianthes tuberosa* L.) CVS. PRAJWAL AND CALCUTTA SINGLE.**" submitted by **Mr. WAGH VISHAL KHUSHALRAO** in partial fulfillment of the requirements for the award of the degree of **MASTER OF SCIENCE (HORTICULTURE) in FLORICULTURE AND LANDSCAPING** of the Navsari Agricultural University is a record of bona fide research work carried out by him under my guidance and the thesis has not previously formed the basis for the award of any degree, diploma or other similar title.

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DECLARATION

This is to declare that the whole of the research work submitted in this thesis for the partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (HORTICULTURE)** in the subject of **FLORICULTURE AND LANDSCAPING** is the result of investigation done by the undersigned under the direct guidance and supervision of **Dr. S. L. Chawla,** Assistant Research Scientist (Floriculture and Landscaping), ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari and that no part of the work has been submitted for any other degree so far.

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LIST OF ABBREVIATIONS AND SYMBOLS

Sr. No.	Abbreviation	Meaning
1.	%	Per cent
2.	°C	Degree Celsius
3.	/	Per
4.	@	At the rate of
5.	CBR	Cost Benefit Ratio
6.	C.D.	Critical difference
7.	cm	Centimeter
8.	cm^2	Centimeter square
9.	C.V.	Co-efficient of variance
10.	cv.	Cultivar
11.	cvs.	Cultivars
12.	DAP	Days After Planting
13.	*et al.*	(*et alibi*) and others
14.	etc.	Etcetera
15.	Fig.	Figure
16.	FYM	Farm Yard Manure
17.	g	Gram
18.	GA_3	Gibberellic acid
19.	ha	Hectare
20.	h	Hour
21.	i.e.	That is
22.	kg	Kilogram
23.	m	Meter
24.	mg	Milligram
25.	MT	Metric tonne
26.	ml	Milliliter
27.	mm	Millimeter
28.	NS	Non-significant
29.	pH	Potential of Hydrogen Ion
30.	ppm	Part Per Million
31.	Rs	Rupee
32.	S.Em.	Standard error of mean
33.	t	Tonne
34.	*viz.*,	Namely

INTRODUCTION

I. INTRODUCTION

Flowers are one of the most important and unique gift from nature to humanity. They are the adornments of the world with their valuable aesthetic, environmental, economic and medicinal properties. These are the symbol of beauty, love and tranquility. Flowers form the soul of garden and convey the message of nature to human being. The influence of flowers in our daily life can be seen through paintings, literature, arts and crafts that are part of our culture. Flowers required in all the households and used in marriages, festivals, ceremonies and for worshipping God.

In recent years, floriculture is becoming increasingly popular not only as an essential part of good living but also as commercial enterprise with considerable potential for export and earning remunerative foreign exchange. The scope of floriculture has increased tremendously in India, which is evident by exponential increase in area from 53,000 ha (1993-94) to 1,67,000 ha (2008-09) and increase in loose flower production (2,33,000 MT in 1993 to 9,87,000 MT in 2008-2009) and also increase in cut flower production (555 million numbers in 1993-94 to 47942 million numbers in 2008-09). This has results in 8.43 % increase in export i.e. Rs 34014.42 lakhs in 2007-2008 to Rs 36881.41 lakhs in 2008-2009 (Anon., 2010).

The cut flowers like rose, gladiolus, tuberose, chrysanthemum, carnation, gerbera, orchid, anthurium, lilies etc. are commonly and frequently used for many purposes in both the local as well as the international market. Among them, tuberose is one of the most important cut flower due to its white flowers, attractive spike, delightful fragrance, ease in cultivation and wide adaptability to varying soils and agro-climatic condition. It occupies a place of pride in Indian floriculture industry for its beauty, excellent fragrance, better keeping quality and suitable for cut flower trade and essential oil industry as well.

Tuberose (*Polianthes tuberosa* L.) is a bulbous ornamental plant belongs to the family Amaryllidaceae sub order-III, the Agavaceae (Baker, 1988) and it is native of Mexico (Trueblood, 1973).

Tuberose is herbaceous perennial with fibrous roots having a bulb like tuberous root stock. It can successfully be grown in pots, beds, and borders. It is mainly propagated by bulbs. The plant has long, narrow, linear and grass like leaves. It grows with elongated spikes which produces rachis of fragrant waxy white flowers that bloom from the bottom to the top of the spike. Flowers are stalk less and funnel shaped and the spike is about 75-100cm long emerging from the centre of leaves. This crop is relatively hardy, free from attack of serious pests, diseases and can be grown even in saline and alkaline conditions.

There are four types of tuberose *viz.*, Single, Double, Semi-double and Variegated leaves. The different varieties were released in tuberose are Suvasini and Vaibhav are Double types, Shringar and Prajwal are single types, whereas, Rajatrekha and Swarnarekha are variegated leaves types.

In India, tuberose is popularly grown in West Bengal, Uttar Pradesh, Karnataka, Tamil Nadu, and Maharashtra. In Gujarat, particularly Ahmedabad, Vadodara, Surat, Navsari and Valsad districts have vast scope for the cultivation of tuberose.

Keeping in the view for the quality flower production of tuberose, it is necessary to pay attention to improved varieties, appropriate bulb size and plant growth regulators.

Among many varieties of tuberose, Prajwal is a new hybrid developed through a cross between 'Single X Double' and released from IIHR, Hesarghatta, Bangalore. It bears a single type flowers on tall stiff spikes with slightly pinkish flower buds and yields more cut as well as loose flowers than other varieties. While, Calcutta Single is also a single type variety with white flowers having petals in single whorl and a bit greenish flower buds.

Tuberose blooms profusely in the summer and monsoon. Its flowering and yield also depends on the bulb size as larger bulbs normally have more stored food than

smaller ones are capable of producing more side shoots and n turn more vegetative growth (Mukhopadhyay, 1963).

The bulbs of various sizes have a slight dormancy period due to presence of several membranous scales and certain metabolic process. GA_3 is mainly used as dormancy breaking hormone which enhances early sprouting, increase the number of sprouts in different tuber crops, reduce days to flower emergence, increase number of flowers and flower quality.

Therefore, GA_3 is becoming important and valuable in commercial bulbous flower crops for increasing production of quality flowers because it accelerates carbohydrate utilization, increases metabolic activities, active cell division and cell elongation (Jana and Biswas, 1979). A broad range effects on both morphological and physiological process can be obtained by the application of GA_3.

Almost no research work has been carried out on the use of different bulb sizes of Prajwal and Calcutta Single varieties and their treatment with GA_3 regarding the production of tuberose in Gujarat.

Therefore, it is essential to investigate the application of GA_3 to different bulb sizes of Prajwal and Calcutta Single varieties on quality and productivity of tuberose spikes, bulbs and bulblets under agro climatic condition of South Gujarat.

Keeping in view the above fact, an investigation ntitled 'Effect of bulb size and GA_3 on vegetative and floral haracters of tuberose (*Polianthes tuberosa* L.) cvs. Prajwal nd Calcutta Single' was carried out in field at Floriculture arm, ASPEE College of Horticulture & Forestry, Navsari gricultural University, Navsari during 2009-10 with the ollowing objectives:

1. To study the effect of different bulb sizes on growth and flowering of tuberose.
2. To evaluate the effect of different concentrations of GA_3 on growth and flowering of tuberose.
3. To find out the combined effect of bulb size and GA_3 on Prajwal and Calcutta Single varieties of tuberose.
4. To work out the economic feasibility of different treatments.

REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

The tuberose is an important commercial flower crop in India. In recent years, the use of growth regulators in flower crops has undergone to enhance the yield and quality by modifying and forcing the plant growth and development. The present trial was conducted to study the effect of bulb size and growth regulators on sprouting, flowering and flower yield of tuberose. Hence, the information available has been reviewed and presented under the following headings and sub headings.

2.1 EFFECT OF VARIETY

2.1.1 Effect of variety on vegetative, flowering, quality and yield characters

Bankar and Mukhopadhyay (1980) observed that commercially cv. Single was the most important in vegetative, flowering and yield parameters followed by Double and Variegated in tuberose.

Irulappan *et al.* (1980) revealed that Calcutta Single and Mexican Single gave the highest total flower yield i.e.456 and 447 flowers per clump, respectively. Whereas, the lowest yield of 43 flowers was recorded in Calcutta Semi-Double variety of tuberose.

Patil *et al.* (1987) reported maximum number of flower stalks, stalk height, flower weight and flowers per hectare was in Single cultivar of tuberose.

Niranjan and Meenakshi (1997) observed that in tuberose, among the single type hybrid Shringar recorded the highest flower yield, while hybrid Suvasini recorded the highest spike yield among the double types. Correlation studies revealed positive associations of flower yield with number of flowers/spike, flower diameter and 100 flowers weight in single types, while spike yield was positive in double types.

Kadam *et al.* (2005) reported that cv. Shringar was earlier in sprouting, flowering and recorded the highest number of leaves per plant and more vase life. While, cv. Local single recorded the longest spike and rachis, maximum number of flowers per spike and diameter of flower stalk than cultivar Shringar in tuberose.

Kumar *et al.* (2006) observed that minimum days to sprouting and maximum sprouting percentage, number of cormels per plant in cv. Shabnum, while maximum number of corms per plant, corm diameter, corms weight and corm volume in cv. Jyotsna in gladiolus.

Sharma *et al.* (2006) recorded that earliest sprouting and maximum plant height, number of leaves per plant, leaf length and width, leaf area, spike length, number of florets per spike, rachis length, floret length, number of corms per plant, weight of corms and vase life with Red Beauty cultivar of gladiolus.

Mahawer *et al.* (2008) revealed that in single flower group, cultivar Prajwal was found better for maximum spike length, number of florets per spike, size of floret and duration of flowering than other cultivars of this group.

Nazir and Raj pravin (2008) observed that cultivars Summer Sunshine and Candy Man performed better than other cultivars of gladiolus with respect to plant height, number of leaves per plant, rachis length, number of florets per spike and diameter of floret.

Srivastava *et al.* (2008) reported that cultivar Shringar performed well regarding the vegetative and floral characters during screening of tuberose cultivars under *Tarai* conditions of Uttarakhand.

Desai and Chawla (2010) conducted an experiment on varietal assessment of tuberose and observed that Prajwal was the most important variety with respect to vegetative, flowering and yield parameters than other varieties of single group.

2.1 EFFECT OF BULB SIZE

2.1.1 Days to sprouting

Rao *et al.* (1991) conducted the experiment on effect of bulb size on the growth of *Polianthes tuberosa* cv. Single and concluded that larger bulbs sprouted earlier than smaller bulbs. Similar results were also obtained by Rao *et al.* (1992) in tuberose.

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Mahanta and Paswan (1995) revealed that the maximum bulb size (2.25-3.00 cm in diameter) of *P. tuberosa* cv. Single showed slower shoot emergence but flowered earlier.

Kumar and Singh (1998) conducted an experiment on cv. Single with bulbs size 1.5-2.0, 2.1-2.5 and 2.6-3.0 cm in diameter and concluded that emergence was earliest from the smallest bulbs.

Kadam *et al.* (2005) observed that the big size bulbs (2.6-3.5 cm diameter) induced early sprouting in tuberose.

2.1.2 Sprouting percentage

Sadhu and Das (1978) observed the higher percentage of sprouting with medium and small sized bulbs.

Singh (1998) conducted an experiment on various corm sizes of gladiolus viz., large (6-6.5 cm diameter), medium (4.5-6.0 cm) and small (3.5-4.5 cm) and observed higher sprouting (99.73 %). Mother bulbs of *P. tuberosa* cv. Single with a diameter <4.0 cm also gave the highest emergence i.e. 89.0 % (Raja and Palanisamy, 1999).

2.1.3 Plant height (cm)

Mohanty *et al.* (1994) studied that plants produced from large corms were taller.

Mahanta and Paswan (1995) conducted an experiment on bulb size of *P. tuberosa* cv. Single, 2.25-3.00 cm (D_1), 1.50-2.25 cm (D_2) or 0.75-1.50 cm (D_3) in diameter and they observed that D_1 size bulbs produced taller plants.

Kalasareddi *et al.* (1997) reported that large corm produced taller plants in gladiolus cv. Snow White.

Singh (1998) recorded the maximum plant height with large corms in gladiolus cv. Sylvia.

Raja and Palanisamy (1999) reported that mother bulbs of 4.0 cm diameter produced highest plant height (48.2 cm) at 200 days after planting in tuberose.

Singh (2000) studied the influence of different grades of mother planting material on the vegetative growth and flowering and found that the largest size corm gave significantly greater height of plant in gladiolus.

Sharma and Gupta (2003) conducted the experiment on effects of corm size (3.1-3.5, 3.6-4.0, 4.1-4.5 and 4.6-5.0 cm) and they determined that plant height increased with increasing corm size.

Dilta *et al.* (2004) studied the performance of 10 gladiolus cultivars with respect to two corm sizes *viz.*, A-grade (5.00 to 6.00 cm) and B-grade (2.50 to 3.50 cm) and evaluated that A-grade corms resulted in increase plant height (5.00 to 6.00) compared to B-grade size corms (2.5 to 3.5 cm).

2.1.4 Number of leaves per plant

Rao *et al.* (1992) conducted an experiment on different bulb sizes and they noted the higher leaves with larger bulbs.

Mohanty *et al.* (1994) concluded that plants from large corms produced more leaves than those from medium or small corms.

Reddy *et al.* (1994) conducted the experiment on effect of bulb size on growth of *Polianthes tuberosa* cv. Double and concluded that plants from large bulbs had more leaves and stems than those from small bulbs.

Mahanta and Paswan (1995) observed that the maximum bulb size (2.25-3.00 cm) of *P. tuberosa* cv. Single produced maximum leaves per plant.

Reddy *et al.* (1997) recorded that the number of leaves (180 days after planting) were maximum from bulbs 2.1-2.5 cm diameter in tuberose.

Singh (1998) observed that large corms were superior in terms of number of shoots/corm among three different corm sizes in gladiolus cv. Sylvia

Sharma and Gupta (2003) conducted an experiment on effects of corm size (3.1-3.5, 3.6-4.0, 4.1-4.5 and 4.6-5.0 cm) and they determined that number of leaves per plant was increased with increasing corm size of gladiolus.

Shiraz and Maurya (2005) recorded that the largest corms produced the highest number of leaves per plant (8.79) in gladiolus.

2.1.5 Leaf area (cm^2)

Reddy *et al.* (1997) recorded that the leaf area was maximum from bulbs having large diameter in tuberose

Ramesh Kumar *et al.* (2003) recorded maximum leaf area in large size bulbs in tuberose cv. Single.

Kadam *et al.* (2005) observed that big size bulbs increased leaf area in tuberose

2.1.6 Days to spike emergence

Sathyanarayana *et al.* (1994) evaluated that flower spikes from large bulbs emerged and flowered earlier than those from small bulbs in tuberose.

Mahanta and Paswan (1995) studied with bulb sizes of *P. tuberosa* cv. Single viz., 2.25-3.00 cm (D_1), 1.50-2.25 cm (D_2) and 0.75-1.50 cm (D_3) in diameter and concluded that D_1 sized bulbs took minimum days to spikes emergence.

Kalasareddi *et al.* (1997) recorded that plants from large sized corms took less time taken for spike emergence than small corms in gladiolus cv. Snow White.

Raja and Palanisamy (1999) concluded that small mother bulbs (2.5 to 3.0 cm diameter) had the earliest flower stem emergence (96.7 days) in tuberose.

Misra *et al.* (2000) evaluated that smaller bulbs took maximum days for spike initiation in tuberose.

Ramesh Kumar *et al.* (2003) studied about the effects of bulb size (<1.5, 1.5-2.5 and 2.5-3.5 cm), in which large bulbs resulted in the earliest spike emergence (93.89 days) in tuberose.

2.1.7 Days to flowering

Rao *et al.* (1991) reported that large sized tuberose bulbs (2.5-3.5 cm diameter) produced significantly advanced flowering.

Reddy *et al.* (1994) observed that large sized bulbs flowered earlier than those from smaller sized bulbs of tuberose.

Kadam *et al.* (2005) observed that big size bulbs (2.6-3.5 cm diameter) induced early flowering in tuberose.

2.1.8 Duration of flowering (days)

Reddy *et al.* (1994) conducted the experiment on effect of bulb size on growth of *Polianthes tuberosa* cv. Double and reveled that plants from large bulbs had more duration of flowering than those from small bulbs.

Mahanta and Paswan (1995) observed that the maximum bulb size (2.25-3.00 cm in diameter) of *P. tuberosa* cv. Single produced maximum flowering duration.

Raja and Palanisamy (1999) observed that small mother bulbs (2.5 to 3.0 cm diameter) had maximum duration of flowering in tuberose.

Ramesh Kumar *et al.* (2003) studied the effects of bulb size (<1.5, 1.5-2.5 and 2.5-3.5 cm), in which large bulbs resulted in the maximum flowering duration in tuberose.

Sharma and Gupta (2003) conducted an experiment on effects of corm size (3.1-3.5, 3.6-4.0, 4.1-4.5 and 4.6-5.0 cm) and they determined that flowering duration was increased with increasing corm size of gladiolus.

2.1.9 Length of spike (cm)

Syamal *et al.* (1987) observed positive correlation between corm size and stem length. Gladiolus plants from large corms produced longer spike than those from medium or small corms (Mohanty *et al.*, 1994).

Mahanta and Paswan (1995) conducted an experiment with bulbs of *P. tuberosa* cv. Single. They found that 2.25-3.00 cm diameter bulbs produced longer spikes.

Kalasareddi *et al.* (1997) reported that plants from large corm produced longer spike than those of small ones in gladiolus cv. Snow White.

Mahanta *et al.* (1998) observed that length of spike was enhanced with increasing bulb size of tuberose.

Raja and Palanisamy (1999) concluded that longest flower stem (106.4 cm) was measured from mother bulbs with a diameter of 4.0 cm in tuberose.

Ramesh Kumar *et al.* (2003) studied the effects of various bulb sizes (<1.5, 1.5-2.5 and 2.5-3.5 cm) and observed that the spike length were greater (88.78 and 89.37 cm) with medium and large bulbs, respectively.

Sharma and Gupta (2003) conducted an experiment on effects of different corm sizes (3.1-3.5, 3.6-4.0, 4.1-4.5 and 4.6-5.0 cm) and determined that spike length increased with increasing corm size.

Shiraz and Maurya (2005) recorded longer spike (83.04 cm) from larger corms in gladiolus.

2.1.10 Rachis length (cm)

Rao *et al.* (1992) reported that large size bulbs sprouted and flowered earlier with maximum rachis length.

Sathyanarayana *et al.* (1994) observed that large size bulbs produced the highest spike length in tuberose. Similar observation was also observed by Mahanta *et al.* (1998) in tuberose.

Shrinivas and Jayashree (2002) revealed that the IIHR-2 recorded higher expression of characters such as rachis length, bud length and flower length in plants raised from small size bulbs unlike other genotypes.

2.1.11 Diameter of floret (cm)

Bhattacharjee (1981) conducted an experiment on gladiolus cv. Friendship by using corms of 3 sizes (2.5-3.5,

4-5 and 5.5-6.5 cm diameter) and concluded that flower diameter was increased with increasing corm size.

Shiraz and Maurya (2005) recorded the highest floret diameter (8.81 cm) with larger corm size in gladiolus.

Ramesh Kumar *et al.* (2003) studied the effects of bulb size (<1.5, 1.5-2.5 and 2.5-3.5 cm), in which large bulbs resulted in the highest diameter of floret in tuberose.

2.1.12 Vase life of spike (days)

Reddy *et al.* (1994) reported that tuberose cut flower lasted for 8.7 days from large sized bulbs in distilled water.

Kadam *et al.* (2005) conducted a field trial with 2 cultivars (Local Single and Shringar) and 2 bulb sizes (1.5- to 2.5-cm and 2.6- to 3.5-cm) and concluded that spike from larger bulbs had longer vase life.

2.1.13 Number of florets per spike

Sathyanarayana and Singh (1994) investigated positive correlation between large bulbs and more florets.

Mahanta and Paswan (1995) conducted an experiment with different bulb sizes of *P. tuberosa* cv. Single *viz.*, 2.5-3.0 cm (D_1), 1.50-2.25 cm (D_2) and 0.75-1.50 cm (D_3) in diameter and they observed that D_1 size gave maximum number of florets/spike.

Mahanta *et al.* (1998) observed that number of florets per spike was enhanced with increasing bulb size.

Singh (1998) recorded higher number of florets per spike from large corms than medium and small corms in gladiolus cv. Sylvia.

Sharma and Gupta (2003) conducted an experiment on effects of different corm sizes (3.1-3.5, 3.6-4.0, 4.1-4.5 and 4.6-5.0 cm) and determined that number of florets per spike increased with increasing corm size.

Dilta *et al.* (2004) studied the performance of 10 gladiolus cultivars with respect to two corm sizes *viz.*, A-grade (5.00 to 6.00 cm) and B-grade (2.50 to 3.50 cm). They evaluated that A-grade corms produced more number of florets per spike (16.95) as compared to B-grade corms (13.99).

Shiraz and Maurya (2005) recorded the highest number of florets per spike (13.44) with largest corms in gladiolus.

2.1.14 Number of spikes per plant, per plot and per hectare

Rao *et al.* (1992) concluded that large tubers 2.5-3.5 cm diameter significantly increased flower yield.

Sathyanarayana and Singh (1994) evaluated that the number of spikes per plant and spikes per ha increased with increasing bulb size of tuberose.

Singh (1998) conducted experiment on three sized gladiolus corms and found that the highest number of spikes per plant was recorded from large corms than medium and small corms.

Raja and Palanisamy (1999) reported that mother bulbs with a diameter of 4.0 cm gave highest number of spikes (3.1) in tuberose.

Misra *et al.* (2000) evaluated that the larger bulb produced the higher number of spikes/plant.

Sharma and Gupta (2003) conducted an experiment on effects of different corm sizes (3.1-3.5, 3.6-4.0, 4.1-4.5 and 4.6-5.0 cm) and determined that number of spikes per plant increased with increasing corm size. Largest corms produced the highest number of spikes per plant (2.42) in gladiolus (Shiraz and Maurya., 2005).

2.1.15 Number of bulbs and bulblets per plant, per plot and per hectare

Rao *et al.* (1991) reported that large sized tuberose bulbs (2.5-3.5 cm diameter) significantly increase the bulb yield.

Rao *et al.* (1992) reported that large sized bulbs produced maximum bulbs and bulblets per plant in tuberose. Number of bulbs and bulblets per plant increased with increase in bulb size as a planting material in tuberose (Reddy and Singh., 1997).

2.2 EFFECT OF GA_3

2.2.1 Days to sprouting

Arora *et al.* (1992) stated that 100 ppm GA_3 significantly decreased the number of days required for corm sprouting in gladiolus.

Nagaraja *et al.* (1999) reported that soaking of bulbs in GA_3 resulted in earlier plant emergence in tuberose.

Tak and Nagda (1999) revealed that GA_3 at 200 ppm enhanced sprouting of tuberose bulb and decreased the number of days required for sprouting (12.03 days) in tuberose cv. Single.

Dataram *et al.* (2001) reported that GA_3 significantly decreased the number of days required for sprouting in gladiolus. Baskaran and Misra (2007) observed that decrease in number of days required for corm sprouting in gladiolus cv. Pusa Jyostna when corms were treated with GA_3.

2.2.2 Sprouting percentage

Roychoudhuri *et al.* (1985) treated corms of gladiolus cv. Psittacinus Hybrid with GA_3 and had found increase in sprouting percentage (70 %) over control.

Pal and Chaudhury (1998) observed that soaking of gladiolus corms for 24 hrs. in GA_3 at 10 and 20 ppm increased sprouting percentage.

Nagaraja *et al.* (1999) reported that soaking of bulbs in GA_3 resulted in higher percentage of sprouting in tuberose.

Barman and Rajni (2004) stated that corm dipping with GA_3 had shown the significant increase in sprouting percentage which was much higher than control.

2.2.3 Plant height (cm)

Biswas *et al.* (1983) reported that corms dipping in GA_3 (100 ppm) increased plant height of gladiolus.

Dua *et al.* (1984) reported that GA_3 at 100 ppm as pre-planting dip of corms had increased plant height in gladiolus.

Dhua *et al.* (1987) noticed that soaking of bulbs in GA_3 at 200 ppm for 6 hrs. improved plant height (67.7 cm) in *Polianthes tubersa* L.

Mahesh and Misra (1993) noted maximum plant height with an application of 200 ppm GA_3 in gladiolus cv. Snow princes.

Nagaraja *et al.* (1999) studied the effect of growth regulators on growth of tuberose (*Polianthes tuberosa* L.) cv.

Single and obtained the highest plant hight with GA_3 500 and 1000 ppm.

Manisha *et al.* (2002) reported that bulb treatment with 150 ppm GA_3 concentration had promoted plant height in tuberose.

Ramachandrudu and Thangam (2007) observed that soaking of gladiolus corms for 24 hrs. in GA_3 (150 ppm) increased plant height (65.20 cm).

2.2.4 Number of leaves per plant

Bhattacharjee (1984) observed decrease in number of leaves with low concentration of GA_3 (10 ppm) but increase in number of leaves at higher concentration (1000 ppm) in gladiolus.

Choudhari (1987) studied the effect of GA_3 on growth and flowering of tuberose (*Polianthes tuberosa* L.) and reveled that GA_3 at 50-150 ppm increased the number of leaves per plant.

Raja and Palanisamy (2001) observed that when bulbs of tuberose soaked for 24 hours in GA_3 resulted increase in number of leaves as compared to control.

Kumar *et al.* (2002) conducted an experiment on gladiolus cv. Jester to determine the effect of GA_3 (400 ppm) and observed that maximum leaves per shoot (7.66) with dipping + spraying at 40+65+90 days after planting (DAP) treatment.

Tiwari and Singh (2002) reported that plants from bulbs treated with 150 ppm GA_3 had the maximum plant height in tuberose.

Barman and Rajni (2004) stated that corms dipping treatment with GA_3 had shown the significant increase in plant height (102.20 cm) in gladiolus.

Shah (2006) reported that soaking of corms in 15 ppm GA_3 for 12 hr enhanced number of leaves as compared to control in gladiolus cv. American Beauty.

Umrao *et al.* (2007) stated that corm soaking treatment for 24 hr with GA_3 had shown the significant increase in number of leaves per plant (6.18) in gladiolus cv. Nova Lux.

2.2.5 Leaf area (cm^2)

Mahesh and Misra (1993) observed the maximum leaf area with an application of GA_3 at 200 ppm and 500 ppm in gladiolus.

Reddy *et al.* (1997) reported that treatment with GA_3 had increased leaf are of tuberose.

Ogale *et al.* (2000) observed increase in leaf length of gladiolus cv. Happy End with 6 hrs soaking in GA_3 at 100 ppm. Leaf length is increased up to 64.6 cm where as they also found increase in leaf width with GA_3 in gladiolus cv. Apricot.

Tiwari and Singh (2002) reported that plants from bulbs treated with 150 ppm GA_3 had the greatest leaf length and leaf width of tuberose.

Barman and Rajni (2004) stated that corm dipping treatment in gladiolus with GA_3 had shown the significant increase in leaf width (2.25 cm) which was much more than control.

Shah (2006) reported that soaking of corms in 15 ppm GA_3 for 12 hrs enhanced leaf length as compared to control in gladiolus cv. American Beauty.

Ramachandrudu and Thangam (2007) observed that soaking of gladiolus corms for 24 hrs in GA_3 (150 ppm) increased leaf length (51.85 cm).

Umrao *et al.* (2007) stated that corm soaking treatment for 24 hrs with GA_3 had shown the significant increase in width of leaves (2.88 cm) in gladiolus cv. Nova Lux.

2.2.6 Days to spike emergence

Preeti Hatibarua (1997) reported that bulbs treated with GA_3 promoted the early appearance of flower spikes in tuberose.

De and Dhiman (2001) reported that pre-soaking of bulbs with higher levels of GA_3 (250 ppm) gave advance spike initiation of tuberose.

Wankhede *et al.* (2002) noticed early emergence of flower stalk when bulbs soaking in water as compared to bulb soaking in gibberellic acid in tuberose.

Barman and Rajni (2004) revealed that the application of GA_3 decreased number of days required for spike initiation in gladiolus.

Ramachandrudu and Thangam (2007) reported that soaking of corms in GA_3 for 24 hr decreased the days to spike emergence in gladiolus.

Umrao *et al.* (2007) reported that soaking of corms in GA_3 for 24 hrs decreased the days to spike emergence (76.10) in gladiolus cv. Nova Lux.

2.2.7 Days to flowering

Parmar (1992) recorded the minimum days to flowering (217.19) in plants raised from bulbs treated with GA_3 at 50 ppm as compared to control (236.97 days) in tuberose. Similar findings were also observed by Reddy *et al.* (1997) in tuberose when bulbs treated with GA_3 at 200 ppm.

Reddy *et al.* (1997) obtained early flowering in tuberose when bulbs treated with GA_3 at 200 ppm.

De and Dhiman (2001) reported that pre-soaking of tuberose bulbs with higher levels of GA_3 (200-250 ppm) produced advance flower opening.

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Tiwari and Singh (2002) reported the effects pre-planting soaking of bulbs in gibberellic acid (GA_3) at 200 ppm on flowering and yield of tuberose (*Polianthes tuberosa* L.). Bulbs soaked in GA_3 200 ppm showed earliest flowering.

Barman and Rajni (2004) noticed that the application of GA_3 decreased number of days to first flower opening in gladiolus.

Shah (2006) revealed that soaking of corms with 15 ppm GA_3 for 12 hrs decrease days required for first flower opening as compared to control in gladiolus cv. American Beauty.

Ramachandrudu and Thangam (2007) reported that soaking of gladiolus corms in GA_3 for 24 hrs decreased the days to flowering duration (15.50).

Baskaran and Misra (2007) obtained the earliest flowering with maximum duration when corm of gladiolus cv. Pusa Jyostna treated with 500 ppm GA_3.

2.2.8 Duration of flowering (days)

Singh (1999) concluded that GA_3 at 200 ppm gives maximum duration of flowering.

Kirad *et al.* (2001) reported that GA_3 at 100 ppm (dipping + spraying) increased the spike durability (22.4 days) as compared to control (14.4 days) in gladiolus. Similar result was also obtained by Singh *et al.* (2003) in tuberose.

Ramachandrudu and Thangam (2007) reported that soaking of gladiolus corms in GA_3 for 24 hrs increase flowering duration (15.50).

2.2.9 Length of spike (cm)

Roychowdhury (1989) reported that corms of gladiolus cv. Psittacinus Hybrid treated with GA_3 at 50 ppm resulting increased length of flower stalk (36.8 cm).

Tak and Nagda (1999) observed that soaking of tuberose bulbs in GA_3 200 ppm increase length of spike (103.18 cm) as compared to control.

Kumar *et al.* (2002) reported that GA_3 at 400 ppm gave the maximum spike length when dipping + spraying at 40 + 60 + 90 days after planting in gladiolus. A similar trend was also observed by Singh *et al.* (2003) with GA_3 100 ppm in tuberose.

Barman and Rajni (2004) noticed that the application of GA_3 increased spike length (64.31 cm) in gladiolus.

Panwar *et al.* (2006) noticed that dipping of bulbs in GA_3 (100 ppm) was found best for maximum spike length in tuberose.

Shah (2006) revealed that soaking of corms 15 ppm GA_3 for 12 hrs increased length of spike in gladiolus cv. American Beauty.

Ramachandrudu and Thangam (2007) reported that soaking of gladiolus corms in GA_3 for 24 hrs increased the length of spike (111.40 cm).

2.2.10 Rachis length (cm)

Nagaraja *et al.* (1999) observed that soaking of bulbs in GA_3 resulted maximum rachis length in tuberose. Similar trend was also observed by Dalal *et al.* (1999) in tuberose when bulbs treated with 40 ppm GA_3.

De and Dhiman (2001) reported that higher level of GA_3 (200-250 ppm) increased rachis length over control in tuberose. Similar results were also noted by Singh and Barad (2001) in gladiolus.

Manisha *et al.* (2002) reported that treatment with GA_3 at 150 ppm concentration had significantly increased the rachis length in tuberose.

Kumar *et al.* (2002) obtained the maximum rachis length when gladiolus corms treated and plants sprayed with 400 ppm GA_3. Likewise, Singh *et al.* (2003) also observed similar trends in tuberose when bulbs treated and plants spread with 100 ppm GA_3 at 30 days after planting.

Wankhede *et al.* (2002) recorded significant increase rachis length in tuberose with bulb soaking and foliar spray of GA_3 at 150 ppm and 200 ppm, respectively.

Panwar *et al.* (2006) noticed that dipping of tuberose bulbs in GA_3 (100 ppm) was found best for rachis length.

Umrao *et al.* (2007) stated that corm soaking treatment for 24 hrs with GA_3 had shown the significant increase in rachis length in gladiolus cv. Nova Lux.

2.2.11 Diameter of floret (cm)

Tak and Nagda (1999) observed that soaking of tuberose bulbs in 200 ppm GA_3 increase average flower diameter (3.51 cm) as compared to control. Likewise, Kirad *et al.* (2001) also obtained similar trend in gladiolus when corms treated and plants sprayed with GA_3 at 100 ppm.

Wankhede *et al.* (2002) recorded significant increase in tuberose flower diameter when bulbs soaked and fóliar sprayed with GA_3 at 150 ppm and 200 ppm, respectively.

2.2.12 Vase life of spike (days)

De and Dhiman (2001) reported that pre-soaking of bulbs with GA_3 (50-100 ppm) before planting resulted in improvement of vase life in tuberose.

Umrao *et al.* (2007) reported maximum vase life of cut spike (10.93 days) in gladiolus cv. Nova Lux when soaked in GA_3 for 24 hrs.

2.2.13 Number of florets per spike

Roychowdhury (1989) reported that corms of gladiolus cv. Psittacinus Hybrid treated with GA_3 at 100 ppm increased the number of flowers per spike (12.3) over control (10.0).

Kumar *et al.* (2002) observed the maximum number of florets per spike in GA_3 (400 ppm) dipping + spraying treatments at 40 + 60 + 90 days after planting in tuberose.

Ogale *et al.* (2000) found that soaking of corms of gladiolus cv. Happy End in GA_3 100 ppm increased number of florets (7.2) as compared to control (5.2).

Singh *et al.* (2003) reported that number of florets per spike in the main crop as well as in the ratoon crop were maximum when the bulbs were dipped in the solution of 100 ppm GA_3 for 24 hrs before planting + spraying with 100 ppm GA_3 at 30 days after planting of tuberose.

Barman and Rajni (2004) noticed that the application of GA_3 increased number of florets (13.99).

Shah (2006) revealed that soaking of corms in 15 ppm GA_3 for 12 hrs increased number of florets as compared to control in gladiolus cv. American Beauty.

2.2.14 Number of spikes per plant, per plot and per hectare

Dhua *et al.* (1987) and Preeti *et al.* (1997) obtained highest number of spikes when tuberose bulbs treated with GA_3 200 mg/l and 200 ppm, respectively.

Similar trends were also observed by Parmar (1992) and Belorkar *et al.* (1993) in tuberose by soaking bulbs in GA_3 50 ppm and 40 ppm, respectively.

De and Dhiman (2001) reported that higher levels of GA_3 (200-250 ppm) produced maximum number of spikes of tuberose. Likewise, Manisha and Syamal (2003) observed an increase in the number of spikes with an application of GA_3 at 150 ppm.

Wankhede *et al.* (2002) reported that bulb soaking treatment of GA_3 at 150 ppm had shown the significant increase in number of spikes per plant in tuberose.

Sharma *et al.* (2006) revealed that soaking of corms 200 ppm GA_3 for 24 hrs increased number of spikes as compared to control in gladiolus.

Panwar *et al.* (2006) observed that GA_3 at 100 ppm was found superior for production of more number of spikes per clump in tuberose.

Umrao *et al.* (2007) reported that soaking of corms in 50-150 ppm GA_3 for 24 hrs increase number of spike per plant (1.66) and spikes per hectare (2.77 lakh) in gladiolus cv. Nova Lux.

2.2.15 Number of bulbs and bulblets per plant, per plot and per hectare

Mukhopadhyay and Sadhu (1985) stated that GA_3 at 250 ppm increased the number bulbs considerably in the tuberose cv. Single.

Roychoudhuri *et al.* (1985) obtained maximum number of corms per plant (5.25) with hrs 50-100 ppm GA_3 soaking treatments for 6 in gladiolus cv. Psittacinus Hybrid.

Roychowdhury (1989) recorded maximum number of corms per plant (4.1) with GA_3 (100 ppm) in gladiolus cv. Psittacinus Hybrid.

Chaphale (1999) recorded significantly maximum number of bulbs when bulbs treated with GA_3 at 150 ppm in tuberose cv. Single.

Singh *et al.* (2003) observed that GA_3 at 100 ppm (dipping+ spraying) increased the number of bulbs and bulblets per plot (28.4) as compared to control (16.6). GA_3 at 50 ppm increased number of cormels per plant (17.36) as compared to control i.e. 12.29 (Barman and Rajni., 2004).

Umrao *et al.* (2007) reported an increase in number of corms (1.81) and number of cormels per plant (1.56) with GA_3 treatments for 24 hrs at 50-150 ppm in gladiolus cv. Nova Lux.

MATERIALS & METHODS

III. MATERIALS AND METHODS

The present study entitled "Effect of bulb size and GA_3 on vegetative and floral characters of tuberose (*Polianthes tuberosa* L.) cvs. Prajwal and Calcutta Single" was carried out in the year 2009-10. The details of experimental techniques, material used and criteria adopted for evaluation of treatments during the course of investigation are presented in this chapter.

3.1 Location

Navsari Agricultural University where this investigation was carried out is located on 20°57' N latitude, 75°54' E longitude and on altitude of about 10 meters above the mean sea level. This location is about 12 km away from seashore.

3.2 Experimental site

The present investigation entitled 'Effect of bulb size and GA_3 on vegetative and floral characters of tuberose (*Polianthes tuberosa* L.) cvs. Prajwal and Calcutta Single" was carried out at Plot No.13, Block-D, Floriculture Farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during 2009- 2010.

3.3 Climatic conditions

The climate of this region is typical tropical characterized by fairly hot summer, moderately cold winter

and most humid and warm monsoon. In general, monsoon insets in the second fortnight of June and end by the second fortnight of September. Pre-monsoon rains in the last week of May or first week of June are not uncommon. Most of the precipitation is received from South West monsoon, concentrating in the months of July and August. The average annual rainfall of this region approximates about 1431 mm. The winter commences from October onwards and ends by the middle of February. The temperature falls down from the beginning of November. December and January are the coldest months of the year. The summer season commences from the middle of February and ends by the first week of June. April and May are the hottest months of summer. The mean monthly meteorology data on maximum and minimum temperatures, relative humidity, rainfall and sunshine hours during the course of investigation recorded from the Meteorological Observatory of N.M. College of Agriculture, Navsari Agricultural University, Navsari are presented in Appendix-I.

3.4 Soil characteristics

The soil of Navsari Campus is black, which is very deep, rich in organic matter and potash, having good water holding capacity with fairly good drainage and reasonably suitable for tuberose cultivation.

The physical and chemical properties of soil of Plot No.-13, Block-D, Floriculture Farm, ASPEE College of

Horticulture and Forestry, Navsari are presented in Table-3.1 and 3.2.

Table-3.1: Physical properties of soil

Sr. No.	Particulars	Value (%) 0-30 cm	Texture
1	Coarse sand	0.69	
2	Fine sand	9.17	
3	Silt	24.94	Clay
4	Clay	65.20	

Table-3.2: Chemical characteristics of soil

Sr. No.	Particulars	Value	Method employed
1.	pH	7.70	Blackman's pH meter (Jackson, 1967)
2.	Total N (%)	0.052	Modified Kjeldahl's method (Jackson, 1967)
3.	Available Nitrogen (kg / ha)	160.00	Alkaline permanganate method (Jackson, 1967)
4.	Available Phosphorus (kg / ha)	40.02	Olsen *et al.* (1954)
5.	Available Potash (kg / ha)	384.50	Flame photometer (Jackson, 1967)

3.5 Experimental details

3.5.1 Site

Plot No.-13, Block-D, Floriculture Farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari.

3.5.2 Experimental design :FRBD (Randomized Block Design with Factorial concept)

3.5.3 No. of replications : 3 (Three)

3.5.4 No. of treatments : 12 (Twelve)

3.5.5 Spacing : 40 cm x 30 cm

3.5.6 Plot size : Gross : 2.8 m x 2.1m
Net : 2.0 m x 1.5 m

3.5.7 No. of plants in gross plot : 49

3.5.8 No. of plants in net plot : 25

3.5.9 Total No. of plots : 36

3.5.10 Detail of treatments

The treatments comprised of two levels of each variety and bulb size and three levels of GA_3 and their combinations are as under.

a) Varieties:

V_1 = Prajwal

V_2 = Calcutta Single

b) Bulb sizes:

B_1 = 1.5 – 2.5 cm diameter

B_2 = 2.6 – 3.5 cm diameter

$V_2B_1G_0$ $V_2B_1G_1$ $V_2B_1G_2$ $V_2B_2G_0$ $V_2B_2G_1$ $V_2B_2G_2$

$V_1B_1G_0$ $V_1B_1G_1$ $V_1B_1G_2$ $V_1B_2G_0$ $V_1B_2G_1$ $V_1B_2G_2$

Plate-I : Soking treatment of both bulb size with GA_3 including distilled water to Prajwal and Calcutta Single varieties of tuberose

c) GA_3 concentrations:

G_0 = Control (soaking in distilled water for 12 hrs.)

G_1 = 50 ppm (soaking for 12 hrs.)

G_2 = 100 ppm (soaking for 12 hrs.)

Table 3.3Treatment combinations

Sr. no.	Treatment number	Treatment combinations	Sr. no.	Treatment number	Treatment combination
1.	T_1	$V_1B_1G_0$	7.	T_7	$V_2B_1G_0$
2.	T_2	$V_1B_1G_1$	8.	T_8	$V_2B_1G_1$
3.	T_3	$V_1B_1G_2$	9.	T_9	$V_2B_1G_2$
4.	T_4	$V_1B_2G_0$	10.	T_{10}	$V_2B_2G_0$
5.	T_5	$V_1B_2G_1$	11.	T_{11}	$V_2B_2G_1$
6.	T_6	$V_1B_2G_2$	12.	T_{12}	$V_2B_2G_2$

3.6 Planting material

Bulbs of tuberose cvs. 'Prajwal' and 'Calcutta Single' of various sizes (large bulbs 2.6-3.5 cm and small bulbs 1.5-2.5 cm) were selected from the healthy and disease free planting material. Bulbs of tuberose were obtained from Floriculture Farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari.

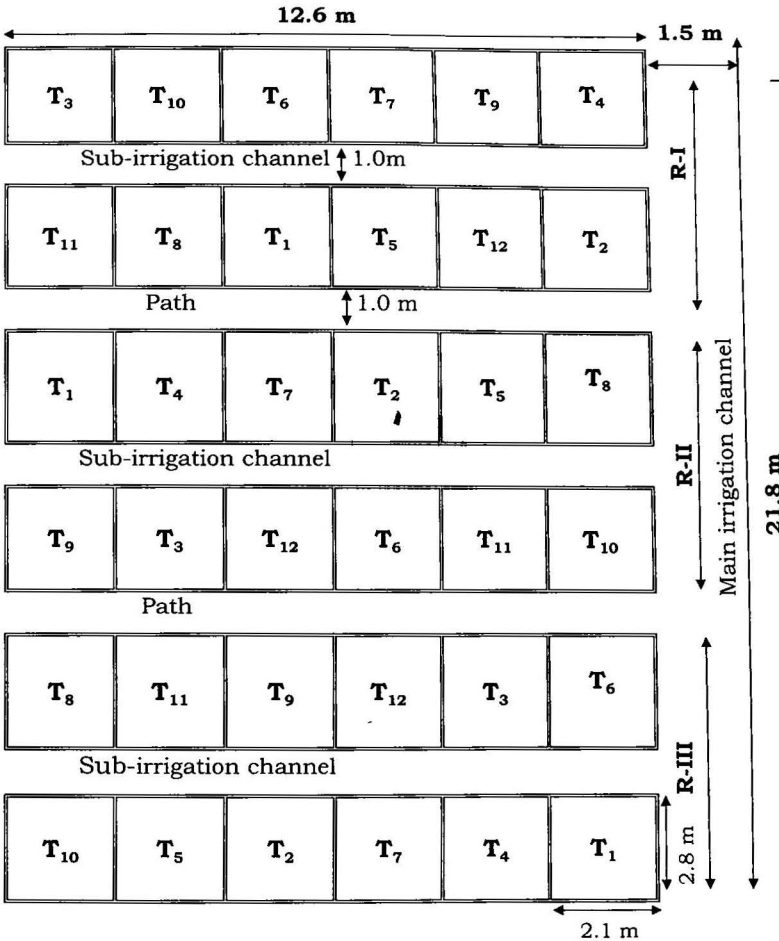


Fig.3.1 Layout of experimental field

Plate-II : General view of experimental field

3.7 Cultivation details

3.7.1 Field preparation

The field selected for experiment was ploughed once with tractor drawn mould board plough followed by planking. The well decomposed F.Y.M. @ 20 tonnes per hectare and methyl parathion dust @ 20kg per hectare were applied and again the field was ploughed by cultivator to bring the field to proper tilth. Thereafter, the layout of experiment was done with gross plot size 2.8 m x 2.1 m each with channels and path. So as to accommodate 49 plants in each plot at spacing of 40 cm row to row and 30 cm plant to plant.

3.7.2 Manure application

Well decomposed FYM was applied @ 20 t/ ha. It was uniformly incorporated into the soil at the time of preparation of field.

3.7.3 Fertilizer application

In addition to F.Y.M. application, at the time of planting 10 g nitrogen (urea), 20 g each of phosphorus (SSP) and potash (murate of potash) per square meter were also applied. These fertilizers were thoroughly mixed into the soil and plots were finally leveled. The second and third equal split dose of nitrogen (each 10 g/m^2) through urea were applied at 30th and 60th day after planting, respectively at the time of irrigation application.

3.7.4 Planting

After 12 hrs. soaking and 3 hrs. partial drying of both sized bulbs of Prajwal and Calcutta Single varieties carried for planting to the experimental site. Bulbs were planted in the field considering the randomization procedure of treatments at about 5-7 cm below the ground and soil was pressed around the bulbs so that the bulbs should not be run away by irrigation.

3.7.5 Irrigation

A light irrigation immediately after planting of bulbs in the field was given for proper establishment of bulbs. The plots were given uniform irrigation thereafter at an interval of 8 to 10 days depending on the soil moisture condition.

3.7.6 Gap filling

Gap filling was carried out as per requirements. Bulbs in the gap were planted in the plots after giving the GA_3 treatment and thus, plant population was maintained.

3.7.7 After cares

No special care was needed in this crop, however 3 to 4 hoeings were done to provide better aeration to root and weeding was regularly done to keep the experimental area clean and free from weeds.

3.8 Preparation and application of GA_3 solution

3.8.1 Preparation of GA_3 solution

50 and 100 mg GA_3 were weighed accurately on electronic weighing balance and dissolved in 50 ml 1 N NaOH separately. Then the stock solution of higher

concentration was prepared with addition of more quantity of distilled water as per required.

3.8.2 Application of Gibberellic acid (GA_3)

Bulbs were dipped in freshly prepared GA_3 solution of two different concentrations and in distilled water (control) for 12 hours then removed and dried in shade for 3 hours and carried to the experimental site for planting.

3.9 Pest and diseases

No any serious pest and diseases were observed during the experiment.

3.10 Harvesting

Harvesting of spikes was done by cutting the spikes from the base when first pair of florets opens on the spike.

3.11 Collection of experimental data

Five plants were selected at random from the net plot of each treatment and tagged for recording the observations.

The data obtained from all plots per replication under each treatment were averaged.

3.12 Observations recorded

The crop response to the treatment application under the present investigation was evaluated on the basis of growth, flowering and yield studies.

The details about the observations were recorded during the investigation are given below.

3.12.1 Vegetative growth characters

3.12.1.1 Days to sprouting

A regular watch was kept on the initiation of sprouting of bulbs. The number of days required for sprouting of bulbs was recorded carefully in each treatment.

3.12.1.2 Sprouting percentage

The number of sprouts in each treatment was recorded at 40 days after planting of bulbs and there by sprouting percentage was calculated from number of sprouted bulbs in the plot.

3.12.1.3 Plant height (cm)

The plant height of five randomly selected plants was measured from ground level to the highest growing tip of the plant with the help of meter scale. Plant height was measured at 180 days after planting in centimeter (cm) and average plant height was worked out.

3.12.1.4 Number of leaves per plant

The number of leaves was counted at 180 days after planting for each randomly selected five plants of each net plot and mean leaves per plant was calculated.

3.12.1.5 Leaf area (cm^2)

The leaf area of five randomly selected plants was measured with the help of leaf area meter. Five leaves were taken from each plant and leaf area was measured at

180 days after planting in square centimeter (cm^2) and average leaf area was worked out.

3.12.2. Flowering and quality characters

3.12.2.1 Days to spike emergence

A regular watch was kept on initiation of flower spike and number of days required for emergence of spike after planting were recorded and average was computed.

3.12.2.2 Days to flowering

Number of days required for the opening of first pair of florets to the last pair of florets on spike was counted and average was recorded.

3.12.2.3 Duration of flowering (days)

Total duration of flowering was counted from date of opening of first pair of florets to the opening of last pair of florets on the spike and the average was worked out.

3.12.2.4 Length of spike (cm)

The spike length was measured at the time of spike harvesting. It was measured uniformly for all five tagged plant from base to extreme growing tip of the main stem. A meter scale was used for this purpose and later on average was calculated.

3.12.2.5 Rachis length (cm)

The length of rachis in centimeter was measured from the point of emergence of first pair of florets to the last end of spike and average was calculated.

3.12.2.6 Diameter of floret (cm)

Lowest floret on each spike was selected randomly for this purpose. The diameter of floret was measured with the help of digital vernier calliper. This was done for all the five tagged plants and likewise for all the treatments and averages were later on calculated.

3.12.2.7 Vase life of spike (days)

First pair of florets opened spikes randomly selected from each treatment were harvested with uniform length and kept in distilled water. The water was changed after every 24 hours. The spikes were kept in flask till they showed sign of withering and days taken to withering were averaged and recorded as vase life of spike.

3.12.3 Yield characters

3.12.3.1 Number of florets per spike

Total number of fully opened florets were harvested and counted at 5 days interval during the flowering time. They summed up at the end and average was calculated.

3.12.3.2 Number of spikes per plant

The number of spikes which were harvested from time to time were summed up and the total numbers of spikes per plant were counted and recorded from selected five plants

3.12.3.3 Number of spikes per plot

After each harvesting, the number of spikes from net plot was recorded till the last harvest. The total number of spikes of different harvesting was added to obtain the overall yield of plot and average was calculated.

3.12.3.4 Number of spikes per hectare

Total number of spikes per hectare (estimated) was calculated on the basis of total number of spikes obtained from net plot.

3.12.3.5 Number of bulb and bulblets per plant

The tagged plants were dug out and counted the number of bulbs and bulblets per plant separately at the end of experiment and later on their averages were calculated.

3.12.3.6 Number of bulb and bulblets per plot

At the end of the experiment, plants from net plot area were uprooted and total number of bulbs and bulblets counted separately and then averages were calculated.

3.12.3.7 Number of bulb and bulblets per hectare

Total number of bulbs and bulblets per hectare (estimated) were calculated on the basis of total number of bulbs and bulblets obtained from net plot.

3.13 Economics

In order to evaluate the effectiveness of different treatments and to ascertain the most remunerative treatment, the expenses incurred in all cultural operations from preparation of land to harvest of the crop includes as cost of inputs viz., growth regulators, bulbs, fertilizers, irrigation etc. applied to each treatment were computed.

The gross realization worked out on the basis of mean spikes, bulbs and bulblets of each treatment

and the prevailing market price of flower. The net realization per hectare was calculated by deducting the cost of cultivation from the gross realization for each treatment and recorded accordingly. The Cost Benefit Ratio (CBR) was calculated on the basis of the formula given below:

$$\textbf{CBR} = \frac{\text{Gross realization (Rs./ha)}}{\text{Total cost of cultivation (Rs./ha)}}$$

3.14 Statistical analysis

The data of all characters studied were subjected to statistical analysis of variance technique as described by Panse and Sukhatme (1967). The method of analysis of variance for Randomized Block Design with Factorial concept (FRBD) was used. The treatment differences were tested by "F" test of significance on the basis of null hypothesis. The appropriate standard error of mean (S.Em±) was calculated in each case and the critical difference (C.D.) at five per cent level of probability was worked out to compare two treatments mean where the treatment effects were significant. The data were analyzed on a computer. The results have been depicted with the help of graphs or diagrams where necessary.

EXPERIMENTAL RESULTS

IV. EXPERIMENTAL RESULTS

The field experiment entitled "Effect of bulb size and GA_3 on vegetative and floral characters of tuberose (*Polianthes tuberosa* L.) cvs. Prajwal and Calcutta Single" was carried out during March 2009 to February 2010 at Floriculture Farm, ASPEE College of Horticulture & Forestry, Navsari Agricultural University, Navsari. The data recorded during the experiment were analyzed statistically and the results of each character are presented in this chapter. In support of tabular presentation, the graphical depictions of mean data for various plant attributes have also been included for better understanding.

4.1 VEGETATIVE CHARACTERS

The data on vegetative growth characters *viz.*, plant height, number of leaves per plant and leaf area were recorded at 180 days after planting (DAP) and sprouting percentage was recorded at 40 DAP.

4.1.1 Days to sprouting

The data pertaining to sprouting of bulbs for effect of variety, bulb size and GA_3 are presented in Table-4.1 and graphically depicted in Fig.-4.1.

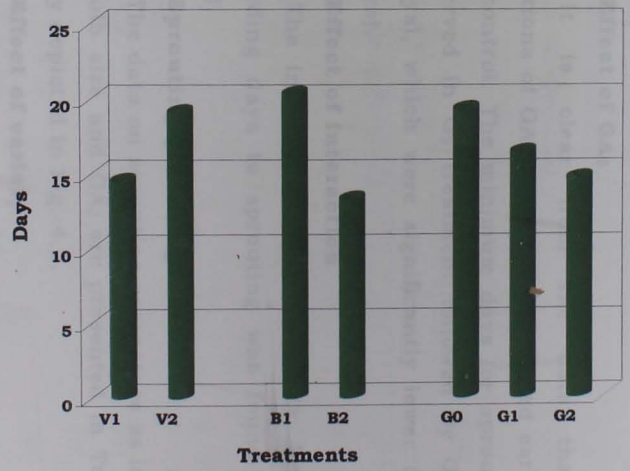
4.1.1.1 Effect of variety

The data revealed that there was significant difference in treatments of varieties with respect to days to sprouting. The significantly minimum days to sprouting

Table- 4.1: Effect of variety, bulb size and GA_3 on days to sprouting of tuberose

Treatment	Days to sprouting
Varieties (V)	
V_1 : Prajwal	14.59
V_2 : Calcutta Single	19.17
S. Em. ±	0.44
C. D. at 5 %	1.28
Bulb sizes (B)	
B_1 : 1.5 - 2.5 cm diameter	20.39
B_2 : 2.6 – 3.5 cm diameter	13.37
S. Em. ±	0.44
C. D. at 5 %	1.28
GA_3 concentrations (G)	
G_0: Water soaking (Control)	19.38
G_1: 50 ppm	16.50
G_2: 100 ppm	14.75
S. Em. ±	0.53
C. D. at 5 %	1.56
Interactions	
V x B	NS
V x G	NS
B x G	NS
V x B x G	NS
C. V. %	10.94

Fig.41: Effect of variety, bulb size and GA_3 on days to sprouting of tuberose



V1 = Prajwal,
V2 = Calcutta Single

B1 = 1.5-2.5 cm diameter
B2 = 2.6-3.5 cm diameter

G0 = Control (Water soaking)
G1 = 50 ppm GA_3
G2 = 100 ppm GA_3

(14.59) were recorded in V_1 (Prajwal) as compared to V_2 (Calcutta Single) where 19.17 days were recorded.

4.1.1.2 Effect of bulb size

A critical examination of data shows that the bulb size had significant influence on days to sprouting of bulbs. Bulb size B_2 (2.6-3.5 cm) required significantly minimum days (13.37) to sprouting as compared to B_1 (1.5-2.5 cm), whereas the maximum days (20.39) was required for sprouting.

4.1.1.3 Effect of GA_3

It is clear from the data that different concentrations of GA_3 significantly induced early sprouting over the control. The minimum days for sprouting (14.75) were observed in G_2 treatment followed by G_1 treatment (16.50 days), which were significantly lower than control (19.38 days).

4.1.1.4 Effect of interaction

The interaction effect of variety, bulb size and GA_3 regarding days to sprouting was found to be non-significant.

4.1.2 Sprouting percentage

The data on sprouting percentage as influenced by variety, bulb size and GA_3 are presented in Table-4.2 and graphically depicted in Fig.-4.2.

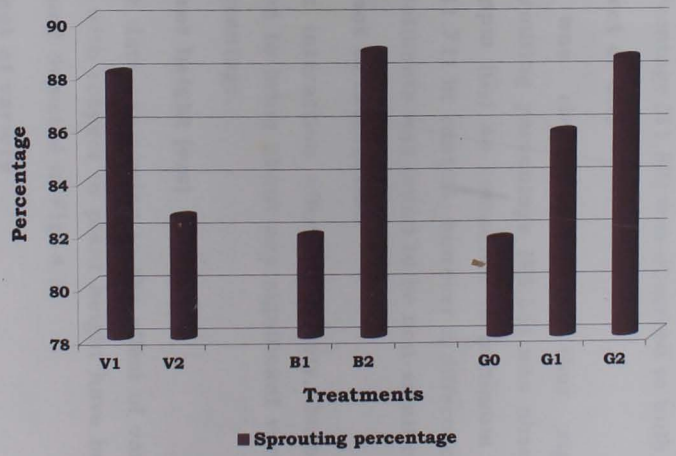
4.1.2.1 Effect of variety

The data presented in Table-4.2 showed that the significantly higher sprouting percentage (88.05) was noted in treatment V_1 (Prajwal) as compared to V_2 (Calcutta

Table- 4.2: Effect of variety, bulb size and GA_3 on sprouting percentage of tuberose

Treatment	Sprouting percentage
Varieties (V)	
V_1 : Prajwal	88.05
V_2 : Calcutta Single	82.63
S. Em. ±	1.51
C. D. at 5 %	4.43
Bulb sizes (B)	
B_1 : 1.5 - 2.5 cm diameter	81.87
B_2 : 2.6 – 3.5 cm diameter	88.82
S. Em. ±	1.51
C. D. at 5 %	4.43
GA_3 concentrations (G)	
G_0: Water soaking (Control)	81.71
G_1: 50 ppm	85.76
G_2: 100 ppm	88.55
S. Em. ±	1.85
C. D. at 5 %	5.42
Interactions	
V x B	NS
V x G	NS
B x G	NS
V x B x G	NS
C. V. %	7.51

Fig.4.2 : Effect of variety, bulb size and GA_3 on sprouting percentage per plant of tuberose



V1 = Prajwal, V2 = Calcutta Single

B1 = 1.5-2.5 cm diameter, B2 = 2.6-3.5 cm diameter

G0 = Control (Water soaking), G1 = 50 ppm GA_3, G2 = 100 ppm GA_3

Single), whereas the minimum percentage of sprouting (82.63) was recorded.

4.1.2.2 Effect of bulb size

The review of data revealed that the sprouting percentage of bulb significantly affected by the treatment of bulb size. The bulb size B_2 resulted in significantly maximum sprouting percentage (88.82), while least sprouting percentage (81.87) was observed in bulb size B_1.

4.1.2.3 Effect of GA_3

It was clearly observed that significantly maximum sprouting percentage (88.55) was observed with GA_3 at 100 ppm (G_2) as compared to minimum sprouting percentage (81.71) in control, however a difference between G_0 and G_1 treatments was found to be non-significant.

4.1.2.4 Effect of interaction

The interaction effect of variety, bulb size and GA_3 was failed to bring about any significant variance over sprouting percentage.

4.1.3 Plant height (cm)

The data concerning to the effect of variety, bulb size and GA_3 with respect to plant height have been shown in Table-4.3 and depicted in Fig.-4.3.

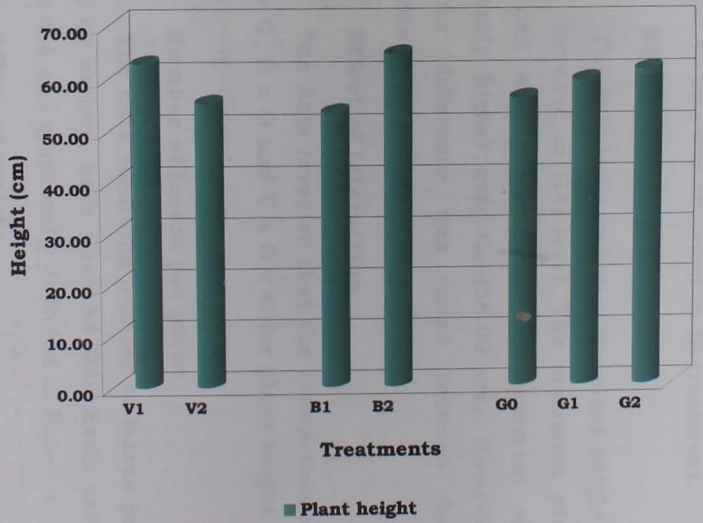
4.1.3.1 Effect of variety

The data clearly revealed that the significantly maximum plant height (62.78 cm) was found in V_1 (Prajwal),

Table- 4.3: Effect of variety, bulb size and GA_3 on plant height of tuberose

Treatment	Plant height (cm)
Varieties (V)	
V_1 : Prajwal	62.78
V_2 : Calcutta Single	55.23
S. Em. ±	1.18
C. D. at 5 %	3.47
Bulb sizes (B)	
B_1 : 1.5 - 2.5 cm diameter	53.44
B_2 : 2.6 – 3.5 cm diameter	64.57
S. Em. ±	1.18
C. D. at 5 %	3.47
GA_3 concentrations (G)	
G_0: Water soaking (Control)	56.09
G_1: 50 ppm	59.52
G_2: 100 ppm	61.40
S. Em. ±	1.45
C. D. at 5 %	4.25
Interactions	
V x B	NS
V x G	NS
B x G	NS
V x B x G	NS
C. V. %	8.51

Fig.4.3 : Effect of variety, bulb size and GA_3 on plant height of tuberose



V1 = Prajwal,
V2 = Calcutta Single

B1 = 1.5-2.5 cm diameter
B2 = 2.6-3.5 cm diameter

G0 = Control (Water soaking)
G1 = 50 ppm GA_3
G2 = 100 ppm GA_3

whereas the minimum plant height (55.23 cm) was observed in V_2 (Calcutta Single).

4.1.3.2 Effect of bulb size

It is apparent from the data that bulb size had significant effect on plant height. B_2 treatment gave maximum plant height (64.57 cm), while minimum plant height (53.44 cm) was recorded in B_1 treatment.

4.1.3.3 Effect of GA_3

The data indicated that the plant height increased with an increase in GA_3 level. The maximum plant height (61.40 cm) was recorded at G_2 treatment which was significantly higher over G_0 (56.09 cm). However, a non-significant difference was noted between G_0 and G_1 treatments.

4.1.3.4 Effect of interaction

The data revealed that the interaction effects of V x B, V x G, B x G and V x B x G for plant height was found to be non-significant.

4.1.4 Number of leaves per plant

The data regarding number of leaves per plant as affected by variety, bulb size and GA_3 levels are furnished in Table-4.4 and graphically depicted in Fig.-4.4.

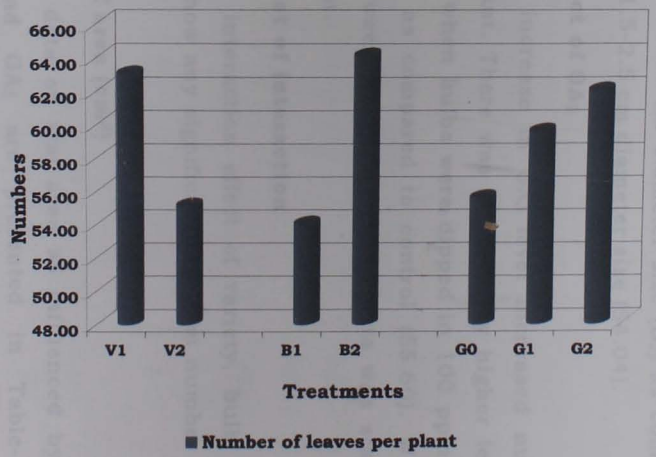
4.1.4.1 Effect of variety

It is explicit from the data that variety had significant effect on number of leaves per plant. The data indicated that V_1 (Prajwal) treatment produced the

Table- 4.4: Effect of variety, bulb size and GA_3 on number of leaves per plant of tuberose

Treatment	Number of leaves per plant
Varieties (V)	
V_1 : Prajwal	63.08
V_2 : Calcutta Single	55.14
S. Em. ±	1.41
C. D. at 5 %	4.14
Bulb sizes (B)	
B_1 : 1.5 - 2.5 cm diameter	54.04
B_2 : 2.6 – 3.5 cm diameter	64.18
S. Em. ±	1.41
C. D. at 5 %	4.14
GA_3 concentrations (G)	
G_0: Water soaking (Control)	55.60
G_1: 50 ppm	59.63
G_2: 100 ppm	62.10
S. Em. ±	1.73
C. D. at 5 %	5.07
Interactions	
V x B	NS
V x G	NS
B x G	NS
V x B x G	NS
C. V. %	10.12

Fig.4.4 : Effect of variety, bulb size and GA_3 on number of leaves per plant of tuberose



V1 = Prajwal, B1 = 1.5-2.5 cm diameter G0 = Control (Water soaking) G2 = 100 ppm GA_3

V2 = Calcutta Single B2 = 2.6-3.5 cm diameter G1 = 50 ppm GA_3

maximum number of leaves (63.08), which were 14.40 per cent higher over V_2 (Calcutta single), where the minimum number of leaves (55.14) was recorded.

4.1.4.2 Effect of bulb size

A perusal of data revealed that significantly higher number of leaves per plant (64.18) was obtained with bulbs having 2.6-3.5 cm diameter size (B_2) as compared to bulbs having 1.5-2.5 cm diameter size (54.04).

4.1.4.3 Effect of GA_3

The increase in GA_3 level increased number of leaves per plant. There was significantly higher leaves per plant (62.10) when bulbs were dipped in 100 ppm GA_3 i.e. G_2 treatment as compared to control (55.60). While, the difference between G_0 and G_1 treatments was statistically non-significant.

4.1.4.4 Effect of interaction

The interaction effect of variety, bulb size and GA_3 did not show any significant effect on number of leaves per plant.

4.1.5 Leaf area (cm^2)

The data on leaf area as influenced by variety, bulb size and GA_3 are presented in Table-4.5 and graphically depicted in Fig.-4.5.

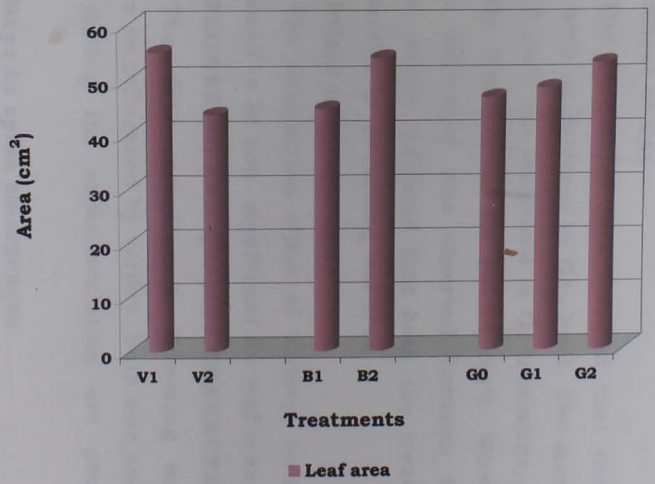
4.1.5.1 Effect of variety

It is apparent from the data that the significantly larger leaf area (55.17 cm^2) was recorded in Prajwal (V_1) as

Table- 4.5: Effect of variety, bulb size and GA_3 on leaf area of tuberose

Treatment	Leaf area (cm^2)
Varieties (V)	
V_1 : Prajwal	55.17
V_2 : Calcutta Single	43.82
S. Em. ±	1.32
C. D. at 5 %	3.89
Bulb sizes (B)	
B_1 : 1.5 - 2.5 cm diameter	44.89
B_2 : 2.6 – 3.5 cm diameter	54.10
S. Em. ±	1.32
C. D. at 5 %	3.89
GA_3 concentrations (G)	
G_0: Water soaking (Control)	46.84
G_1: 50 ppm	48.52
G_2: 100 ppm	53.13
S. Em. ±	1.62
C. D. at 5 %	4.76
Interactions	
V x B	NS
V x G	NS
B x G	NS
V x B x G	NS
C. V. %	11.36

Fig.4.5 : Effect of variety, bulb size and GA_3 on leaf area of tuberose



V1 = Prajwal, B1 = 1.5-2.5 cm diameter G0 = Control (Water soaking) G2 = 100 ppm GA_3

V2 = Calcutta Single B2 = 2.6-3.5 cm diameter G1 = 50 ppm GA_3

compared to Calcutta Single (V_2) where smaller leaf area (43.82 cm^2) was measured.

4.1.5.2 Effect of bulb size

In case of bulb size, significantly maximum leaf area (54.10 cm^2) was obtained in B_2 treatment (2.6-3.5 cm), while minimum leaf area (44.89 cm^2) was recorded in B_1 treatment.

4.1.5.3 Effect of GA_3

The perusal of data revealed that the leaf area increased with an increase in GA_3 level. The maximum leaf area (53.13 cm^2) was measured in G_2 treatment, which was significantly higher over G_0 (46.84 cm^2). Whereas, non-significant difference was observed between G_0 and G_1 treatments, which indicated that both the treatments are equally effective in increasing leaf area.

4.1.5.4 Effect of interaction

The interaction effect of variety, bulb size and GA_3 was found to be non- significant for leaf area.

4.2 FLOWERING AND QUALITY CHARACTERS

The data regarding to flowering and quality parameters as influenced by variety, bulb size and GA_3 were recorded during the experimentation are presented as under.

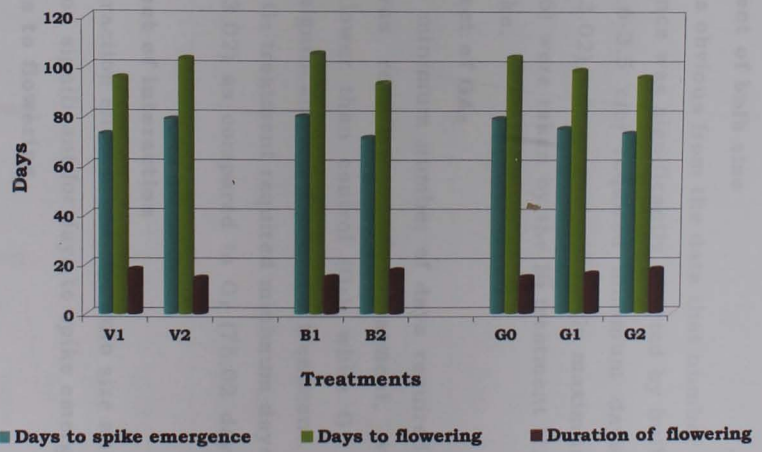
4.2.1 Days to spike emergences

The data regarding the influence of variety, bulb size and GA_3 on days to spike emergence are presented in Table-4.6 and graphically depicted in Fig.-4.6.

Table- 4.6: Effect of variety, bulb size and GA_3 on days to spike emergence of tuberose

Treatment	Days to spike emergence
Varieties (V)	
V_1 : Prajwal	72.64
V_2 : Calcutta Single	78.74
S. Em. ±	1.33
C. D. at 5 %	3.89
Bulb sizes (B)	
B_1 : 1.5 - 2.5 cm diameter	80.06
B_2 : 2.6 – 3.5 cm diameter	71.32
S. Em. ±	1.33
C. D. at 5 %	3.89
GA_3 concentrations (G)	
G_0: Water soaking (Control)	79.02
G_1: 50 ppm	75.03
G_2: 100 ppm	73.02
S. Em. ±	1.63
C. D. at 5 %	4.77
Interactions	
V x B	NS
V x G	NS
B x G	NS
V x B x G	NS
C. V. %	7.44

Fig.4.6 : Effect of variety, bulb size and GA_3 on days to spike emergence, days to flowering and duration of flowering of tuberose



V1 = Prajwal, B1 = 1.5-2.5 cm diameter G0 = Control (Water soaking) G2 = 100 ppm GA_3

V2 = Calcutta Single B2 = 2.6-3.5 cm diameter G1 = 50 ppm GA_3

4.2.1.1 Effect of variety

It is evident from the data that significantly minimum days to spike emergence (72.64 days) was recorded with Prajwal (V_1), while maximum days to spike emergence (78.74 days) was recorded with Calcutta Single (V_2).

4.2.1.2 Effect of bulb size

It is obvious from the data that number of days to spike emergence was significantly affected by bulb size. B_2 treatment (2.6-3.5 cm) required minimum days to spike emergence (73.02), whereas significantly maximum number of days (80.06) were taken by the B_1 treatment (1.5-2.5 cm) to emerge spike.

4.2.1.3 Effect of GA_3

The minimum number of days required for spike emergence was recorded at G_2 treatment, which was significantly lower than control (G_0), while G_1 treatment showed non-significant effect over G_0 treatment. The data indicate that G_2 treatment required minimum days for spike emergence (73.02) as compared to G_1 (75.02 days) and G_0 (79.02 days).

4.2.1.4 Effect of interaction

Interaction effect of variety, bulb size and GA_3 was found to be non significant for days to spike emergence.

4.2.2 Days to flowering

Data pertaining to the effect of variety, bulb size and GA_3 levels on days to flowering of tuberose have been presented in Table-4.7 and depicted graphically in Fig.-4.6.

Table- 4.7: Effect of variety, bulb size and GA_3 on days to flowering of tuberose

Treatment	Days to flowering
Varieties (V)	
V_1 : Prajwal	95.59
V_2 : Calcutta Single	103.24
S. Em. ±	1.81
C. D. at 5 %	5.31
Bulb sizes (B)	
B_1 : 1.5 - 2.5 cm diameter	105.40
B_2 : 2.6 – 3.5 cm diameter	93.43
S. Em. ±	1.81
C. D. at 5 %	5.31
GA_3 concentrations (G)	
G_0: Water soaking (Control)	103.90
G_1: 50 ppm	98.55
G_2: 100 ppm	95.80
S. Em. ±	2.22
C. D. at 5 %	6.51
Interactions	
V x B	NS
V x G	NS
B x G	NS
V x B x G	NS
C. V. %	7.73

4.2.2.1 Effect of variety

The data regarding days to flowering clearly indicated that the significantly minimum days to flowering (95.59) was observed in Prajwal (V_1), however the maximum days to flowering (103.24) was noticed in Calcutta Single (V_2).

4.2.2.2 Effect of bulb size

A perusal of data revealed that effect of different treatments of bulb size significantly influenced the days to flowering. Plants from B_2 bulb size (2.6-3.5 cm) induced advance flowering (93.43 days), while late flowering (105.40 days) was observed from B_1 bulb size i.e.1.5-2.5 cm diameter.

4.2.2.3 Effect of GA_3

A perusal of data revealed that different concentrations of GA_3 minimized the days to flowering in tuberose. Bulbs treated with 100 ppm GA_3 (G_2) took minimum days to flowering (95.80) followed by G_1 treatment (98.55 days). A significant delay in flowering was observed in control (G_0), which took maximum days (103.90).However, a non significant difference was found between G_0 and G_1 treatments.

4.2.2.4 Effect of interaction

The interaction effects of V x B, V x G, B x G and V x B x G for days to flowering was found to be non-significant.

4.2.3 Duration of flowering

The data regarding duration of flowering as affected by different variety, bulb size and GA_3 are furnished in Table-4.8 and graphically depicted in Fig.-4.6.

4.2.3.1 Effect of variety

It is evident from the data that significantly maximum duration of flowering (17.84 days) was recorded with V_1 (Prajwal), while the minimum duration of flowering (14.32 days) was recorded in V_2 (Calcutta Single).

4.2.3.2 Effect of bulb size

It is explicit from the data that treatment of bulb size showed significant influence on duration of flowering. Bulbs having 2.6-3.5 cm diameter i.e. B_2 treatment had maximum duration of flowering (17.49 days) as compared to bulbs having 1.5-2.5 cm diameter (14.68 days).

4.2.3.3 Effect of GA_3

It is clear from the data that maximum duration of flowering was recorded at G_2 treatment, which was significantly more than G_0, while G_1 treatment of GA_3 did not show any significant effect over G_0 treatment. The data explicit that maximum duration of flowering (17.70 days) was recorded in G_2 as compared to G_1 (15.97 days) and G_0 (14.58 days) treatments.

4.2.3.4 Effect of interaction

The interaction of variety, bulb size and GA_3 showed non- significant difference on duration of flowering.

Table- 4.8: Effect of variety, bulb size and GA_3 on duration of flowering of tuberose

Treatment	Duration of flowering (days)
Varieties (V)	
V_1 : Prajwal	17.84
V_2 : Calcutta Single	14.32
S. Em. ±	0.52
C. D. at 5 %	1.51
Bulb sizes (B)	
B_1 : 1.5 - 2.5 cm diameter	14.68
B_2 : 2.6 – 3.5 cm diameter	17.49
S. Em. ±	0.52
C. D. at 5 %	1.51
GA_3 concentrations (G)	
G_0: Water soaking (Control)	14.58
G_1: 50 ppm	15.97
G_2: 100 ppm	17.70
S. Em. ±	0.63
C. D. at 5 %	1.85
Interactions	
V x B	NS
V x G	NS
B x G	NS
V x B x G	NS
C. V. %	13.61

4.2.4 Length of spike (cm)

The data on spike length as affected by variety, bulb size and GA_3 are presented in Table-4.9 and graphically depicted in Fig.-4.7.

4.2.4.1 Effect of variety

It is evident from the data that significantly maximum length of spike (87.96 cm) was recorded with V_1 (Prajwal), while the minimum spike length (83.36 cm) was recorded in V_2 (Calcutta Single).

4.2.4.2 Effect of bulb size

A perusal of data revealed that bulb sizes significantly influenced the spike length. Plants from B_2 bulb size (2.6-3.5 cm) produced the longest spike (88.92 cm), whereas the shortest spike (82.40 cm) was obtained from B_1 bulb size (1.5-2.5 cm).

4.2.4.3 Effect of GA_3

It is obvious from the data that length of spike was influenced considerably as a result of application of GA_3. Among all the treatments attempted during study, a significantly maximum spike length (88.87 cm) was recorded in G_2 treatment as compared to minimum spike length (81.82 cm) in G_0 treatment. However, difference between G_0 and G_1 treatments was non-significant.

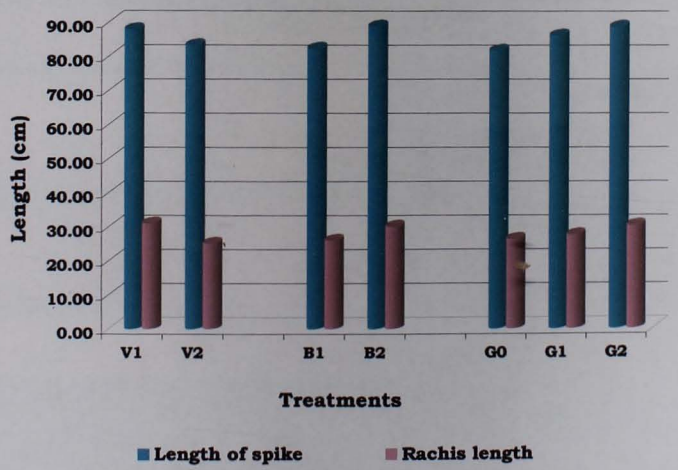
4.2.4.4 Effect of interaction

Interaction effect of variety, bulb size and GA_3 did not show any significant influence on the length of spike.

Table- 4.9: Effect of variety, bulb size and GA_3 on length of spike of tuberose

Treatment	Length of spike (cm)
Varieties (V)	
V_1 : Prajwal	87.96
V_2 : Calcutta Single	83.36
S. Em. ±	1.49
C. D. at 5 %	4.38
Bulb sizes (B)	
B_1 : 1.5 - 2.5 cm diameter	82.40
B_2 : 2.6 – 3.5 cm diameter	88.92
S. Em. ±	1.49
C. D. at 5 %	4.38
GA_3 concentrations (G)	
G_0: Water soaking (Control)	81.82
G_1: 50 ppm	86.29
G_2: 100 ppm	88.87
S. Em. ±	1.83
C. D. at 5 %	5.37
Interactions	
V x B	NS
V x G	NS
B x G	NS
V x B x G	NS
C. V. %	7.40

Fig.4.7 : Effect of variety, bulb size and GA_3 on length of spike and rachis length of tuberose



V1 = Prajwal, V2 = Calcutta Single

B1 = 1.5-2.5 cm diameter, B2 = 2.6-3.5 cm diameter

G0 = Control (Water soaking), G1 = 50 ppm GA_3, G2 = 100 ppm GA_3

Spike length of Prajwal

$V_1B_1G_0$ $V_1B_2G_1$ $V_1B_2G_2$

Spike length of Calcutta Single

$V_2B_1G_0$ $V_2B_2G_1$ $V_2B_2G_2$

Plate-III : Influence of variety, bulb size and GA_3 on spike length of tuberose

4.2.5 Rachis length (cm)

The data pertaining to rachis length as influenced by variety, bulb size and GA_3 levels are furnished in Table-4.10 and graphically depicted in Fig.-4.7.

4.2.5.1 Effect of variety

It is evident from the data that there was significant difference in rachis length due to variety. The treatment V_1 recorded significantly maximum rachis length (31.06 cm) as compared to minimum rachis length (25.22 cm) in V_2 treatment.

4.2.5.2 Effect of bulb size

The data indicated that bulb size was found to be significant for rachis length. Bulb size B_2 (2.6-3.5 cm) resulted maximum rachis length (30.18 cm), however minimum rachis length (26.10 cm) was recorded from bulb size B_1 (1.5-2.5 cm).

4.2.5.3 Effect of GA_3

It is apparent from the data that rachis length was increased with an increase in GA_3 level. The maximum rachis length of 30.38 cm was measured at G_2 treatment which was significantly higher over G_0 (26.39 cm). Whereas, a non-significant difference was observed between G_0 and G_1 treatments.

4.2.5.3 Effect of interaction

The data revealed that the interaction effects of V x B, V x G, B x G and V x B x G for rachis length was found to be non-significant.

Rachis length of Prajwal

$V_1B_1G_0$ $V_1B_2G_1$ $V_1B_2G_2$

Rachis length of Calcutta Single

$V_2B_1G_0$ $V_2B_2G_1$ $V_2B_2G_2$

Plate-IV : Influence of variety, bulb size and GA_3 on rachis length of tuberose

4.2.6 Diameter of floret (cm)

The data pertaining to diameter of floret with respect to effect of variety, bulb size and GA_3 are presented in Table-4.11 and illustrated graphically in Fig.-4.8.

4.2.6.1 Effect of variety

The data clearly indicated that there was significant difference due to variety on diameter of floret. Prajwal (V_1) recorded significantly maximum floret diameter (3.77 cm), while Calcutta Single (V_2) recorded minimum floret diameter (3.01 cm).

4.2.6.2 Effect of bulb size

The data concerning to the effect of bulb size in respect to floret diameter clearly indicated that the larger floret diameter (3.55 cm) was measured in the B_2 treatment, however significantly smaller floret diameter (3.23 cm) was measured in B_1 treatment.

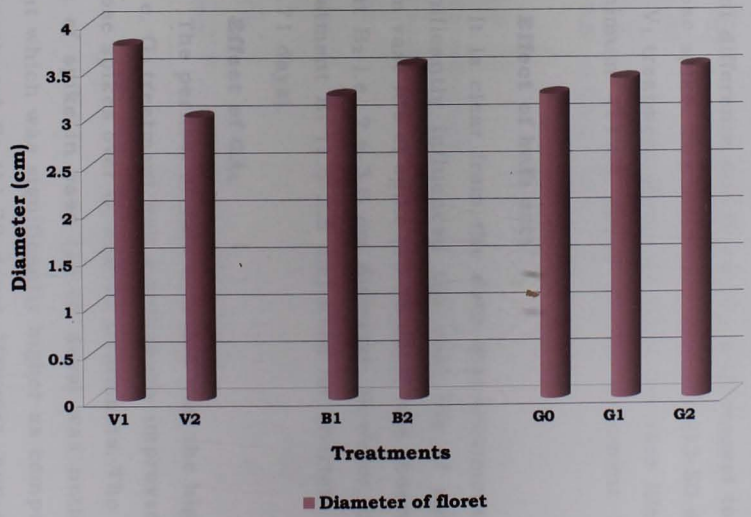
4.2.6.3 Effect of GA_3

A perusal of data revealed that the highest level of GA_3 i.e. G_2 treatment had significant influence on diameter of floret over G_0. The treatment of G_2 resulted in maximum floret diameter (3.53 cm). Whereas, minimum floret diameter (3.24 cm) was noted in control (G_0) which was at par with G_1 treatment (3.40 cm).

4.2.6.4 Effect of interaction

The effect of variety, bulb size and GA_3 on diameter of floret was found to be non-significant.

Fig.4.8 : Effect of variety, bulb size and GA_3 on diameter of floret of tuberose



V1 = Prajwal, B1 = 1.5-2.5 cm diameter G0 = Control (Water soaking) G2 = 100 ppm GA_3

V2 = Calcutta Single B2 = 2.6-3.5 cm diameter G1 = 50 ppm GA_3

4.2.7 Vase life of spike (days)

The data regarding vase life of spike as affected by variety, bulb size and GA_3 are presented in Table-4.12 and illustrated graphically in Fig.-4.9.

4.2.7.1 Effect of variety

From the data it was found that there was significant difference due to variety with respect to vase life of tuberose spike. The maximum vase life (13.50 days) was noted in V_1 treatment (Prajwal) while the vase life of spike was minimum (11.59 days) in V_2 treatment (Calcutta Single).

4.2.7.2 Effect of bulb size

It is clear from the data that treatments of bulb size significantly influenced the vase life of spikes. The maximum vase life of spike (13.38 days) was observed at the treatment B_2 i.e. 2.6-3.5 cm diameter. However, the spikes from treatment B_1 (1.5-2.5 cm) lived for shortest period in vase (11.71 days).

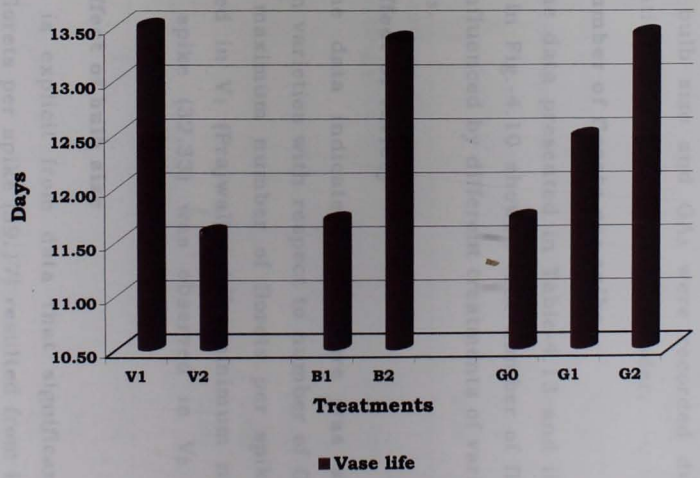
4.2.7.3 Effect of GA_3

The perusal of data revealed that the highest level of GA_3 i.e. G_2 treatment had significantly improved vase life of tuberose spikes over G_1 and G_0 treatments. The maximum duration of spike in vase (13.43 days) was noticed at G_2 treatment which was significantly higher as compared to G_1 (12.48 days) and G_0 (11.72 days). However, non-significant difference was seen between G_0 and G_1 treatments.

Table- 4.12: Effect of variety, bulb size and GA_3 on vase life of tuberose

Treatment	Vase life (days)
Varieties (V)	
V_1 : Prajwal	13.50
V_2 : Calcutta Single	11.59
S. Em. ±	0.25
C. D. at 5 %	0.73
Bulb sizes (B)	
B_1 : 1.5 - 2.5 cm diameter	11.71
B_2 : 2.6 – 3.5 cm diameter	13.38
S. Em. ±	0.25
C. D. at 5 %	0.73
GA_3 concentrations (G)	
G_0: Water soaking (Control)	11.72
G_1: 50 ppm	12.48
G_2: 100 ppm	13.43
S. Em. ±	0.31
C. D. at 5 %	0.90
Interactions	
V x B	NS
V x G	NS
B x G	NS
V x B x G	NS
C. V. %	8.46

Fig.4.9 : Effect of variety, bulb size and GA_3 on vase life of tuberose



V1 = Prajwal, V2 = Calcutta Single

B1 = 1.5-2.5 cm diameter, B2 = 2.6-3.5 cm diameter

G0 = Control (Water soaking), G1 = 50 ppm GA_3, G2 = 100 ppm GA_3

4.2.7.4 Effect of interaction

It is evident from data that vase life of spike was not influenced by the interaction of V x B, V x G, B x G and V x B x G.

4.3 YIELD CHARACTERS

The mean data on yield parameters as influenced by variety, bulb size and GA_3 were recorded during the experimentation and are presented as under.

4.3.1 Number of florets per spike

The data presented in Table-4.13 and illustrated graphically in Fig.-4.10 showed that number of florets per spike was influenced by different treatments of variety, bulb size and GA_3.

4.3.1.1 Effect of variety

The data indicated that there was significant difference in varieties with respect to number of florets per spike. The maximum number of florets per spike (41.29) was recorded in V_1 (Prajwal), while minimum number of florets per spike (32.33) was observed in V_2 (Calcutta Single).

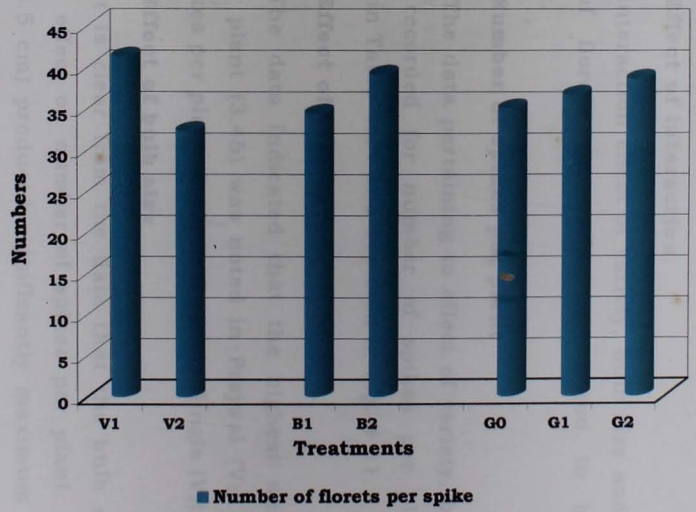
4.3.1.2 Effect of bulb size

It is explicit from data that significantly more number of florets per spike (39.17) resulted from large bulb size i.e. B_2 treatment, whereas less number of florets per spike (34.46) was obtained from small bulb size i.e. B_1 treatment.

Table- 4.13: Effect of variety, bulb size and GA_3 on number of florets per spike of tuberose

Treatment	Number of florets per spike
Varieties (V)	
V_1 : Prajwal	41.29
V_2 : Calcutta Single	32.33
S. Em. ±	0.78
C. D. at 5 %	2.28
Bulb sizes (B)	
B_1 : 1.5 - 2.5 cm diameter	34.46
B_2 : 2.6 – 3.5 cm diameter	39.17
S. Em. ±	0.78
C. D. at 5 %	2.28
GA_3 concentrations (G)	
G_0: Water soaking (Control)	35.08
G_1: 50 ppm	36.72
G_2: 100 ppm	38.63
S. Em. ±	0.95
C. D. at 5 %	2.80
Interactions	
V x B	NS
V x G	NS
B x G	NS
V x B x G	NS
C. V. %	8.97

Fig.4.10 : Effect of variety, bulb size and GA_3 on number of florets per spike of tuberose



V1 = Prajwal, V2 = Calcutta Single

B1 = 1.5-2.5 cm diameter, B2 = 2.6-3.5 cm diameter

G0 = Control (Water soaking), G1 = 50 ppm GA_3, G2 = 100 ppm GA_3

4.3.1.3 Effect of GA_3

It is obvious from the data that number of florets per spike was increased with an increase in GA_3 level. The maximum number of florets per spike (38.36) was counted at G_2 treatment which was significantly higher over G_0 (35.08). Whereas, G_0 and G_1 treatments were found to be non-significant.

4.3.1.4 Effect of interaction

Interaction effect of variety, bulb size and GA_3 on number of florets per spike was found to be non-significant.

4.3.2 Number of spikes per plant

The data pertaining to effect of variety, bulb size and GA_3 recorded for number of spikes per plant are presented in Table-4.14 and depicted in Fig.-4.11.

4.3.2.1 Effect of variety

The data indicated that the highest number of spikes per plant (3.46) was noted in Prajwal (V_1) and the lowest spikes per plant (2.42) in Calcutta Single (V_2).

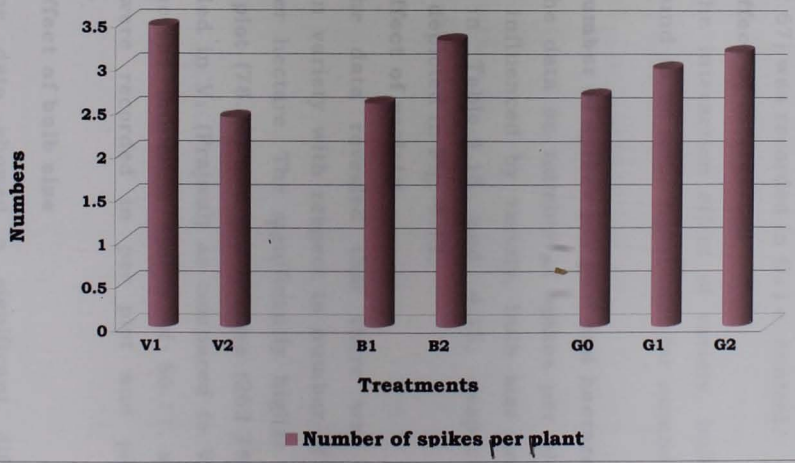
4.3.2.2 Effect of bulb size

It is clear from the data that the bulb size had significant effect on number of spikes per plant. B_2 bulb size (2.6-3.5 cm) produced significantly maximum number of spikes per plant (3.30), whereas minimum numbers of spikes per plant (2.58) was obtained from B_1 bulb size (1.5-2.5 cm).

Table- 4.14: Effect of variety, bulb size and GA_3 on number of spikes per plant of tuberose

Treatment	Number of spikes per plant
Varieties (V)	
V_1 : Prajwal	3.46
V_2 : Calcutta Single	2.42
S. Em. ±	0.06
C. D. at 5 %	0.19
Bulb sizes (B)	
B_1 : 1.5 - 2.5 cm diameter	2.58
B_2 : 2.6 – 3.5 cm diameter	3.30
S. Em. ±	0.06
C. D. at 5 %	0.19
GA_3 concentrations (G)	
G_0: Water soaking (Control)	2.67
G_1: 50 ppm	2.98
G_2: 100 ppm	3.17
S. Em. ±	0.08
C. D. at 5 %	0.23
Interactions	
V x B	NS
V x G	NS
B x G	NS
V x B x G	NS
C. V. %	9.21

Fig.4.11 : Effect of variety, bulb size and GA_3 on number of spikes per plant of tuberose



V1 = Prajwal, B1 = 1.5-2.5 cm diameter G0 = Control (Water soaking) G2 = 100 ppm GA_3

V2 = Calcutta Single B2 = 2.6-3.5 cm diameter G1 = 50 ppm GA_3

4.3.2.3 Effect of GA_3

It is apparent from the data that different levels of GA_3 had significant effect on number of spikes per plant over control. The maximum number of spikes per plant (3.17) was recorded in G_2 treatment which was at par with G_1 treatment (2.98). Whereas, minimum number of spikes per plant (2.67) was recorded in G_0 i.e. control.

4.3.2.4 Effect of interaction

The interaction effect of variety, bulb size and GA_3 was found to be non- significant for number of spikes per plant.

4.3.3 Number of spikes per plot and hectare

The data on number of spikes per plot and per hectare as influenced by variety, bulb size and GA_3 are presented in Table-4.15 and 4.16, respectively and graphically depicted in Fig.-4.12.

4.3.3.1 Effect of variety

The data revealed that there was significant difference in variety with respect to number of spikes per plot and per hectare. The significantly higher number of spikes per plot (78.83) and per hectare (262.78 thousand) were recorded in V_1 (Prajwal) as compared to V_2 (Calcutta Single), whereas minimum spikes of 56.11 and 187.04 thousand were recorded in per plot and per hectare, respectively.

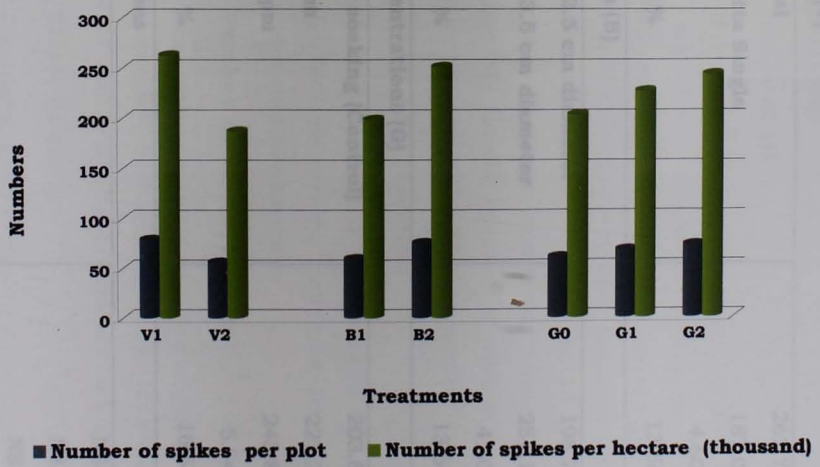
4.3.3.2 Effect of bulb size

The data showed a significant difference in number of spikes per plot and per hectare due to different

Table- 4.15: Effect of variety, bulb size and GA_3 on number of spikes per plot of tuberose

Treatment	Number of spikes per plot
Varieties (V)	
V_1 : Prajwal	78.83
V_2 : Calcutta Single	56.11
S. Em. ±	1.38
C. D. at 5 %	4.05
Bulb sizes (B)	
B_1 : 1.5 - 2.5 cm diameter	59.61
B_2 : 2.6 – 3.5 cm diameter	75.33
S. Em. ±	1.38
C. D. at 5 %	4.05
GA_3 concentrations (G)	
G_0: Water soaking (Control)	61.08
G_1: 50 ppm	68.17
G_2: 100 ppm	73.17
S. Em. ±	1.69
C. D. at 5 %	4.96
Interactions	
V x B	NS
V x G	NS
B x G	NS
V x B x G	NS
C. V. %	8.68

Fig.4.12 : Effect of variety, bulb size and GA_3 on number of spikes per plot and per hectare of tuberose



V1 = Prajwal, V2 = Calcutta Single

B1 = 1.5-2.5 cm diameter, B2 = 2.6-3.5 cm diameter

G0 = Control (Water soaking), G1 = 50 ppm GA_3, G2 = 100 ppm GA_3

Table- 4.16: Effect of variety, bulb size and GA_3 on number of spikes per hectare of tuberose

Treatment	Number of spikes per hectare (thousand)
Varieties (V)	
V_1 : Prajwal	262.78
V_2 : Calcutta Single	187.04
S. Em. ±	4.60
C. D. at 5 %	13.50
Bulb sizes (B)	
B_1 : 1.5 - 2.5 cm diameter	198.70
B_2 : 2.6 – 3.5 cm diameter	251.11
S. Em. ±	4.60
C. D. at 5 %	13.50
GA_3 concentrations (G)	
G_0: Water soaking (Control)	203.61
G_1: 50 ppm	227.22
G_2: 100 ppm	243.89
S. Em. ±	5.64
C. D. at 5 %	16.53
Interactions	
V x B	NS
V x G	NS
B x G	NS
V x B x G	NS
C. V. %	8.68

bulb sizes. The maximum number of spikes per plot (75.33) and per hectare (251.11 thousand) was obtained from bulb size B_2 (2.6-3.5cm), while bulb size B_1 (1.5-2.5 cm) produced minimum spikes per plot (59.61) and per hectare (198.70 thousand).

4.3.3.3 Effect of GA_3

It is clear from data that the different levels of GA_3 had significant effect on spikes per plot and per hectare. The maximum number of spikes per plot (73.17) and per hectare (243.89 thousand) resulted with GA_3 at 100 ppm followed by GA_3 at 50 ppm (68.17/plot and 227.22 thousand/ha.). However, treatment control (G_0) produced the significantly lowest number of spikes per plot (61.08) and spike per hectare (203.70 thousand).

4.3.3.4 Effect of interaction

The data failed to exhibit any significant interaction effect on variety, bulb size and GA_3 on yield of spikes per plot and per hectare.

4.3.4 Number of bulbs per plant

The data regarding number of bulbs per plant as affected by variety, bulb size and GA_3 levels are furnished in Table-4.17 and graphically depicted in Fig.-4.13.

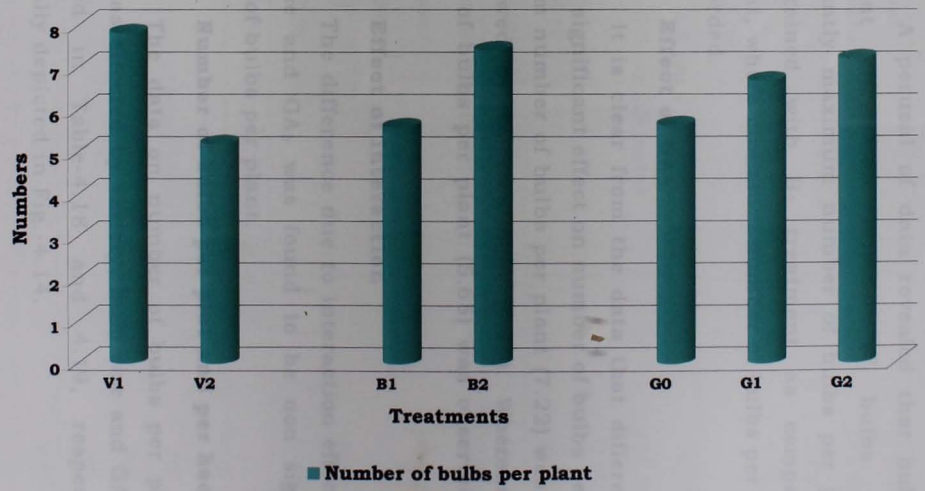
4.3.4.1 Effect of variety

The data shows significantly higher number of bulbs per plant (7.83) in V_1 treatment (Prajwal) compared to

Table- 4.17: Effect of variety, bulb size and GA_3 on number of bulbs per plant of tuberose

Treatment	Number of bulbs per plant
Varieties (V)	
V_1 : Prajwal	7.83
V_2 : Calcutta Single	5.21
S. Em. ±	0.14
C. D. at 5 %	0.42
Bulb sizes (B)	
B_1 : 1.5 - 2.5 cm diameter	5.61
B_2 : 2.6 – 3.5 cm diameter	7.43
S. Em. ±	0.14
C. D. at 5 %	0.42
GA_3 concentrations (G)	
G_0: Water soaking (Control)	5.65
G_1: 50 ppm	6.70
G_2: 100 ppm	7.22
S. Em. ±	0.18
C. D. at 5 %	0.51
Interactions	
V x B	NS
V x G	NS
B x G	NS
V x B x G	NS
C. V. %	9.39

Fig.4.13 : Effect of variety, bulb size and GA_3 on number of bulbs per plant of tuberose



V1 = Prajwal, V2 = Calcutta Single

B1 = 1.5-2.5 cm diameter, B2 = 2.6-3.5 cm diameter

G0 = Control (Water soaking), G1 = 50 ppm GA_3, G2 = 100 ppm GA_3

V_2 treatment (Calcutta Single), where lower number of bulbs per plant (5.21) was recorded.

4.3.4.2 Effect of bulb size

A perusal of data revealed that bulb size had significant effect on number of bulbs per plant. Significantly maximum number of bulbs per plant (7.43) was obtained with B_2 treatment as compared to B_1 treatment, where minimum number of bulbs per plant (5.61) was recorded.

4.3.4.3 Effect of GA_3

It is clear from the data that different levels of GA_3 had significant effect on number of bulbs per plant. The maximum number of bulbs per plant (7.22) was obtained at G_2 followed by G_1 treatment (6.70). Whereas, minimum number of bulbs per plant (5.65) was observed in control (G_0).

4.3.4.4 Effect of interaction

The difference due to interaction effect of variety, bulb size and GA_3 was found to be non significant for number of bulbs per plant.

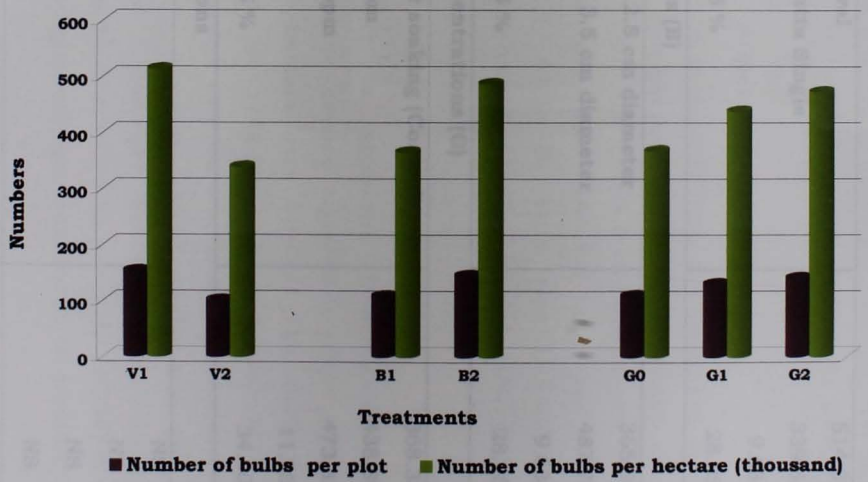
4.3.5 Number of bulbs per plot and per hectare

The data on number of bulbs per plot and per hectare as affected by variety, bulb size and GA_3 levels are presented in Table-4.18 and 4.19, respectively and graphically depicted in Fig.-4.14.

Table- 4.18: Effect of variety, bulb size and GA_3 on number of bulbs per plot of tuberose

Treatment	Number of bulbs per plot
Varieties (V)	
V_1 : Prajwal	154.22
V_2 : Calcutta Single	101.89
S. Em. ±	2.89
C. D. at 5 %	8.48
Bulb sizes (B)	
B_1 : 1.5 - 2.5 cm diameter	109.78
B_2 : 2.6 – 3.5 cm diameter	146.33
S. Em. ±	2.89
C. D. at 5 %	8.48
GA_3 concentrations (G)	
G_0: Water soaking (Control)	110.50
G_1: 50 ppm	131.67
G_2: 100 ppm	142.00
S. Em. ±	3.54
C. D. at 5 %	10.38
Interactions	
V x B	NS
V x G	NS
B x G	NS
V x B x G	NS
C. V. %	9.57

Fig.4.14 : Effect of variety, bulb size and GA_3 on number of bulbs per plot and per hectare of tuberose



V1 = Prajwal, V2 = Calcutta Single

B1 = 1.5-2.5 cm diameter, B2 = 2.6-3.5 cm diameter

G0 = Control (Water soaking), G1 = 50 ppm GA_3, G2 = 100 ppm GA_3

Table- 4.19: Effect of variety, bulb size and GA_3 on number of bulbs per hectare of tuberose

Treatment	Number of bulbs per hectare (thousand)
Varieties (V)	
V_1 : Prajwal	514.07
V_2 : Calcutta Single	339.63
S. Em. ±	9.63
C. D. at 5 %	28.25
Bulb sizes (B)	
B_1 : 1.5 - 2.5 cm diameter	365.93
B_2 : 2.6 – 3.5 cm diameter	487.78
S. Em. ±	9.63
C. D. at 5 %	28.25
GA_3 concentrations (G)	
G_0: Water soaking (Control)	368.33
G_1: 50 ppm	438.89
G_2: 100 ppm	473.33
S. Em. ±	11.80
C. D. at 5 %	34.60
Interactions	
V x B	NS
V x G	NS
B x G	NS
V x B x G	NS
C. V. %	9.57

4.3.5.1 Effect of variety

It is evident from data that significantly maximum number of bulbs per plot (154.22) and per hectare (514.07 thousand) was recorded with V_1 (Prajwal), while the minimum number of bulbs per plot (101.89) and per hectare (339.63 thousand) was recorded in V_2 treatment (Calcutta Single).

4.3.5.2 Effect of bulb size

It is explicit from the data that number of bulbs per plot and per hectare was significantly affected by bulb sizes. B_2 bulb size (2.6-3.5 cm) produced maximum number of bulbs per plot (146.33) and per hectare (487.78 thousand), while B_1 bulb size (1.5-2.5 cm) produced minimum number of bulbs per plot (109.78) and per hectare (365.93 thousand).

4.3.5.3 Effect of GA_3

It is apparent from data that all GA_3 concentration caused significant effect on bulbs per plot and per hectare over control. The maximum number of bulbs per plot (142.00) and per hectare (473.33 thousand) was recorded with G_2 treatment which was at par with G_1 treatment, whereas 131.67 bulbs per plot and 438.89 thousand bulbs per hectare were recorded. However, minimum number of bulbs per plot (110.50) and per hectare (368.33 thousand) was recorded in G_0 treatment.

4.3.5.4 Effect of interaction

The interaction effects of V x B, V x G, B x G and V x B x G for both the number of bulbs per plot and per hectare was found to be non-significant.

4.3.6 Number of bulblets per plant

The data on number of bulblets per plant as influenced by variety, bulb size and GA_3 are presented in Table-4.20 and graphically depicted in Fig.-4.15.

4.3.6.1 Effect of variety

It is explicit from the data that there was a significant difference in variety with respect to number of bulblets per plant. Significantly higher number of bulblets per plant (14.32) was recorded in V_1 (Prajwal) compared to V_2 treatment (Calcutta Single) where the least number of bulblets per plant (11.69) was recorded.

4.3.6.2 Effect of bulb size

The data pertaining to the number of bulblets per plant was significantly affected by the bulb size. Bulbs having 2.6-3.5 cm diameter (B_2) produced maximum number of bulblets per plant (14.04), while minimum number of bulblets per plant (11.97) was recorded with bulbs having 1.5-2.5 cm diameter (B_1).

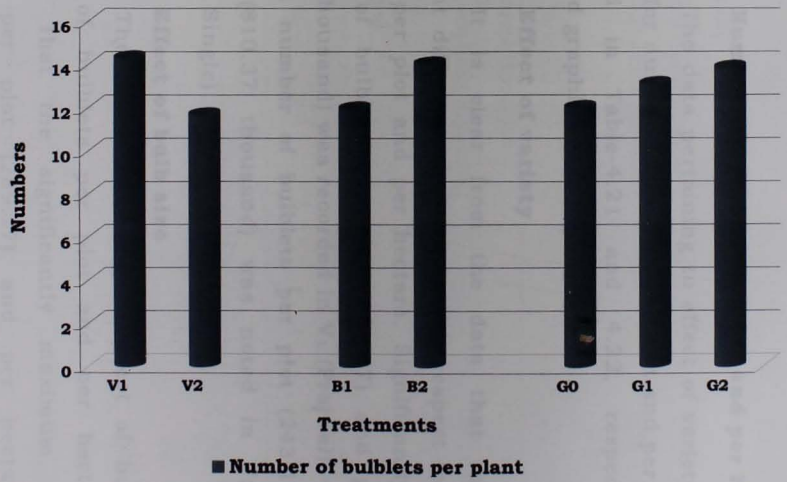
4.3.6.3 Effect of GA_3

The perusal of data revealed that the number of bulblets per plant increased with an increase in GA_3 level. The maximum number of bulblets per plant (13.87) was

Table- 4.20: Effect of variety, bulb size and GA_3 on number of bulblets per plant of tuberose

Treatment	Number of bulblets per plant
Varieties (V)	
V_1 : Prajwal	14.32
V_2 : Calcutta Single	11.69
S. Em. ±	0.39
C. D. at 5 %	1.15
Bulb sizes (B)	
B_1 : 1.5 - 2.5 cm diameter	11.97
B_2 : 2.6 – 3.5 cm diameter	14.04
S. Em. ±	0.39
C. D. at 5 %	1.15
GA_3 concentrations (G)	
G_0: Water soaking (Control)	12.03
G_1: 50 ppm	13.12
G_2: 100 ppm	13.87
S. Em. ±	0.48
C. D. at 5 %	1.41
Interactions	
V x B	NS
V x G	NS
B x G	NS
V x B x G	NS
C. V. %	12.81

Fig.4.15 : Effect of variety, bulb size and GA_3 on number of bulblets per plant of tuberose



V1 = Prajwal, V2 = Calcutta Single

B1 = 1.5-2.5 cm diameter, B2 = 2.6-3.5 cm diameter

G0 = Control (Water soaking), G1 = 50 ppm GA_3, G2 = 100 ppm GA_3

recorded at G_2 treatment, which was significantly higher over G_0 (12.03). Whereas, non-significant difference was observed between G_0 and G_1 treatments.

4.3.6.4 Effect of interaction

The interaction effect of variety, bulb size and GA_3 was found to be non-significant on number of bulblets per plant.

4.3.7 Number of bulblets per plot and per hectare

The data pertaining to effect of variety, bulb size and GA_3 for number of bulblets per plot and per hectare are presented in Table-4.21 and 4.22, respectively and illustrated graphically in Fig.-4.16.

4.3.7.1 Effect of variety

It is clear from the data that there was a significant difference in variety with respect to number of bulblets per plot and per hectare. Significantly maximum number of bulblets per plot (298.67) and per hectare (995.55 thousand) was recorded in V_1 (Prajwal), whereas the minimum number of bulblets per plot (243.11) and per hectare (810.37 thousand) was noted in V_2 treatment (Calcutta Single).

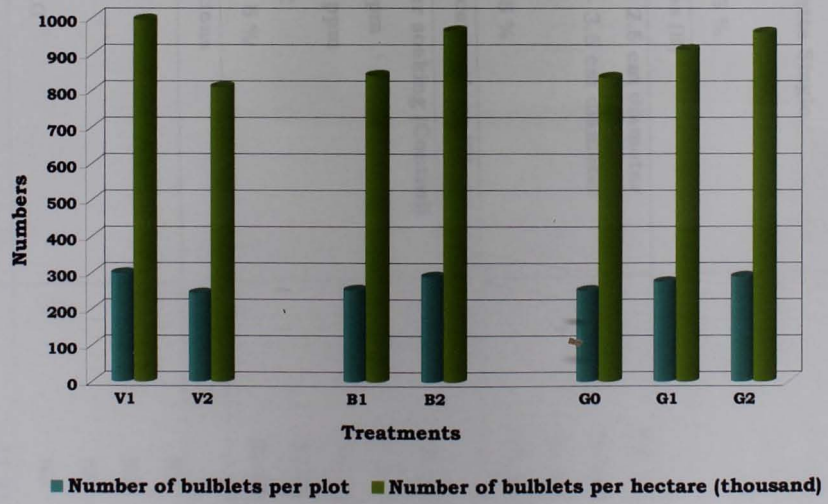
4.3.7.2 Effect of bulb size

The data concerning to effect of bulb size on number of bulblets per plot and per hectare clearly indicated that the significantly maximum number of bulblets per plot (289.17) and per hectare (963.89 thousand) was observed from bulb size having diameter 2.6-

Table- 4.21: Effect of variety, bulb size and GA_3 on number of bulblets per plot of tuberose

Treatment	Number of bulblets per plot
Varieties (V)	
V_1 : Prajwal	298.67
V_2 : Calcutta Single	243.11
S. Em. ±	7.61
C. D. at 5 %	22.31
Bulb sizes (B)	
B_1 : 1.5 - 2.5 cm diameter	252.61
B_2 : 2.6 – 3.5 cm diameter	289.17
S. Em. ±	7.61
C. D. at 5 %	22.31
GA_3 concentrations (G)	
G_0: Water soaking (Control)	251.00
G_1: 50 ppm	273.75
G_2: 100 ppm	287.92
S. Em. ±	9.32
C. D. at 5 %	27.32
Interactions	
V x B	NS
V x G	NS
B x G	NS
V x B x G	NS
C. V. %	11.91

Fig.4.16 : Effect of variety, bulb size and GA_3 on number of bulblets per plot and per hectare of tuberose



V1 = Prajwal, V2 = Calcutta Single

B1 = 1.5-2.5 cm diameter, B2 = 2.6-3.5 cm diameter

G0 = Control (Water soaking), G1 = 50 ppm GA_3, G2 = 100 ppm GA_3

Table- 4.22: Effect of variety, bulb size and GA_3 on number of bulblets per hectare of tuberose

Treatment	Number of bulblets per hectare (thousand)
Varieties (V)	
V_1 : Prajwal	995.55
V_2 : Calcutta Single	810.37
S. Em. ±	25.35
C. D. at 5 %	74.36
Bulb sizes (B)	
B_1 : 1.5 - 2.5 cm diameter	842.04
B_2 : 2.6 – 3.5 cm diameter	963.89
S. Em. ±	25.35
C. D. at 5 %	74.36
GA_3 concentrations (G)	
G_0: Water soaking (Control)	836.67
G_1: 50 ppm	912.50
G_2: 100 ppm	959.72
S. Em. ±	31.05
C. D. at 5 %	91.08
Interactions	
V x B	NS
V x G	NS
B x G	NS
V x B x G	NS
C. V. %	11.91

Treatment $V_1B_2G_2$

Treatment $V_2B_1G_0$

Plate-V : Influence of variety, bulb size and GA_3 on bulbs and bulblets production of tuberose

3.5 cm (B_2), however minimum number of bulblets per plot (252.61) and per hectare (842.04 thousand) was recorded in bulb size having diameter 1.5-2.5 cm (B_1).

4.3.7.3 Effect of GA_3

The increase in GA_3 level increased number of bulblets per plot and per hectare. There was significantly maximum number of bulblets per plot (287.92) and per hectare (959.72 thousand) when bulbs were dipped in 100 ppm GA_3 (G_2) as compared to control (G_0) where minimum bulblets (251.00 per plot and 836.67 thousand per ha.) were recorded. While, the difference between G_0 and G_1 treatments was statistically non-significant for bulblets per plot and per hectare.

4.3.7.4 Effect of interaction

The effect of variety, bulb size and GA_3 on both the number of bulblets per plot and per hectare was found to be non-significant.

4.4 Economics

The data regarding to net return and CBR as affected by different variety, bulb size and GA_3 concentration are presented in Table-4.23. The highest net return and CBR was obtained from variety Prajwal (Rs. 448969.75/ha and 1:3.01, respectively), bulbs size having diameter of 2.6-3.5 cm (Rs. 410988.29/ha and 1:2.78, respectively) and GA_3 at 100 ppm (Rs. 395127.20/ha and 1:2.71, respectively). However, the lowest net return and CBR was obtained from variety Calcutta single (Rs. 267488.45/ha and 1:2.29, respectively), bulb size having

diameter of 1.5-2.5 cm (Rs. 305469.90/ha and 1:2.53, respectively) and water soaking i.e. control (Rs. 312043.97/ha and 1:2.56, respectively).

Table 23: Economics of different treatments

Treatments	Spike yield (thousand /ha)	Bulb yield (thousand /ha)	Bulblet Yield (thousand /ha)	Total cost of cultivation (Rs./ha)	Gross realization (Rs./ha)	Net realization (Rs./ha)	CBR
Varieties (V)							
V_1:Prajwal	262.78	514.07	995.55	221807.36	670777.10	448969.75	1:3.01
V_2:Calcutta Single	187.04	339.63	810.37	204362.93	471851.38	267488.45	1:2.29
Bulb sizes (B)							
B_1:1.5-2.5 cm diameter	198.70	365.93	842.04	196992.56	502462.46	305469.90	1:2.53
B_2:2.6-5.5 cm diameter	251.11	487.78	963.89	229177.73	640166.02	410988.29	1:2.78
GA_3 concentrations (G)							
G_0:Water soaking (control)	203.61	368.33	836.67	196233.30	508277.27	312043.97	1:2.56
G_1: 50 ppm	227.22	438.89	912.50	214288.85	581804.97	367516.13	1:2.69
G_2:100 ppm	243.89	473.33	959.72	228733.29	623860.49	395127.20	1:2.71

1) Cost of GA_3 : Rs. 86.62/gm
2) Cost of NaOH : Rs. 170/lit
3) Digging cost : Rs. 0.10/bulb

4)Selling Price : a) Spike Rs. 1/spike
b) Bulb Rs. 0.60/bulb
c) Bulblet Rs. 0.10/bulblet

DISCUSSION

V. DISCUSSION

The present investigation entitled "Effect of bulb size and GA_3 on vegetative and floral characters of tuberose (*Polianthes tuberosa* L.) cvs. Prajwal and Calcutta Single" was carried out at Floriculture farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during the year 2009-2010.

The crop growth and yield are outcome of many complicated but yet related physiological and biochemical processes taking place in different parts of the plant. Tuberose is one of the most important cut flower having very high demand in the national and international market. Several enthusiastic entrepreneurs and farmers have started cultivation of tuberose on commercial scale but unimproved cultivation practices make the production uncertain. Among the different cultivation practices, selection of suitable variety, bulb size for planting and regulation of growth by use of plant growth substances have great influence on yield and quality of tuberose. The maximum yield could be obtained when the optimum conditions are provided.

The results of this experiment as given in the previous chapter are scrutinized and discussed herewith assigning suitable reason and relevant references.

5.1 EFFECT OF VARIETY

5.1.1 Vegetative Characters

It is apparent from the data that varieties significantly influenced the vegetative characters *viz.* days to sprouting and sprouting percentage (Table-4.1 and 4.2). Between the two varieties, Prajwal found superior with respect to minimum days to sprouting (14.59) and maximum sprouting percentage (88.05) compared to Calcutta Single. This could be due to the influence of genetical makeup of the variety. Similar results were also obtained by Bankar and Mukhopadhyay (1980) and Kadam *et al.* (2005) in tuberose.

The increase in plant height, number of leaves per plant and leaf area was also prejudiced by the effect of variety. Prajwal recorded maximum plant height (62.78 cm), number of leaves per plant (63.08) and leaf area (55.17 cm^2) as compared to Calcutta Single. This might be due to improved variety had a genetic potential to have better growth than others. These results are in close conformity with several workers, for example, Kadam *et al.* (2005) found same trend in tuberose and Sharma *et al.* (2006) and Nazir and Raj pravin (2008) in gladiolus. Desai and Chawla (2010) also reported the maximum vegetative growth attributes in Prajwal variety compared to other varities in an experiment of varietal assessment of tuberose at Navsari.

5.1.2 Flowering and Quality Characters

As far as the effect of varieties on various flowering characters is concerned, it was observed that

these characters *viz.* days to spike emergence, days to flowering and duration of flowering were significantly influenced (Table-4.6, 4.7 and 4.8, respectively). The data revealed that variety V_1 (Prajwal) recorded minimum days to spike emergence (72.64), days to flowering (95.59) and maximum duration of flowering (17.84 days) as compared to variety V_2 i.e. Calcutta Single. This might be due to varietal variation in their genetical make up. These findings are in consonance with the results of Bankar and Mukhopadhyay (1980) and Kadam *et al.* (2005) in tuberose. Sirvastava *et al.* (2008) also reported the maximum flowering attributes in Shringar variety compared to other varities.

The spike length, rachis length, diameter of floret and vase life also significantly varied due to variety. Significantly maximum spike length (87.96 cm), rachis length (31.06 cm), diameter of floret (3.77 cm) and vase life (13.50 days) were recorded with Prajwal (V_1) as compared to Calcutta Single (V_2). Being genetically controlled factor, the flowering and quality characters varied among the varities. The results are in accordance with the findings of Patil *et al.* (1987), Niranjan and Meenakshi (1997), Desai and Chawla (2010) in tuberose and Sharma *et al.* (2006) and Nazir and Raj pravin (2008) in gladiolus. Mahawer *et al.* (2008) also reported that cultivar Prajwal was found better for maximum spike length and size of floret than other cultivars.

5.1.3 Yield Characters

The results as reported in preceding chapter revealed that variety significantly influenced the number of florets per spike, spikes per plant, per plot and per hectare (Table 4.13, 4.14, 4.16 and 4.17, respectively). Prajwal (V_1) recorded maximum number of florets per spike (41.29), spikes per plant (3.46), per plot (78.83) and per hectare (262.78 thousand) as compared to variety Calcutta Single (V_2). The difference in these yield characters could be due to the influence of genetical makeup of the varieties. The results of present investigation are in close agreement with the observations of Irulappan *et al.* (1980) and Niranjan and Meenakshi (1997) in tuberose. Kumar *et al.* (2006) and Nazir and Raj pravin (2008) also found similar trend in gladiolus. The maximum number of flower stalks and flowers per hectare were also reported in cv. Single of tuberose (Patil *et al.*, 1987)

The data on number of bulbs and bulblets per plant, per plot and per hectare as affected by variety have been presented in Table-4.17, 4.18, 4.19, 4.20, 4.21 and 4.22, respectively. The maximum number of bulbs and bulblets per plant (7.83 and 14.32), per plot (154.22 and 289.67) and per hectare (514.07 thousand and 995.55 thousand) was obtained from Prajwal as compared to Calcutta Single. Variation in bulbs and bulblets yield was due to genetically controlled factor. This finding is close conformity with Bankar and Mukhopadhyay (1980) in

tuberose and Kumar *et al.* (2006) and Sharma *et al.* (2006) in gladiolus.

5.2 EFFECT OF BULB SIZE

5.2.1 Vegetative Characters

The results as reported in preceding chapter (Table-4.1 and 4.2) revealed that the treatment of large sized tuberose bulbs (2.6-3.5 cm) has been found superior with respect to days to sprouting (13.37) and sprouting percentage (88.81) compared to small size bulbs (1.5-2.5 cm). This may be due to the larger bulbs contain high amounts of carbohydrates which sharply decline as soon as growth start, but regain more than the loss at the end of growth period. Thus, the larger bulbs which normally have more stored food than smaller one are capable of early sprouting and more sprouting percentage (Mukhopadhyay, 1963). Mukhopadhyay *et al.* (1986), Rao *et al.* (1991), Rao *et al.* (1992) and Kadam *et al.* (2005) have also reported certain beneficial effect of large bulb size in days to sprouting in tuberose. Sadhu and Das (1978), Reddy *et al.* (1994) and Raja and Palanisamy (1999) also found the same trend with respect to sprouting percentage in tuberose.

In case of plant height, number of leaves per plant and leaf area (Table-4.3, 4.4 and 4.5, respectively), large sized bulbs recorded maximum plant height (64.57 cm), number of leaves per plant (64.18) and leaf area (54.10 cm^2) as compared to small sized bulbs. This may be due to accumulation of endogenous growth substances in larger

bulbs and the larger bulbs normally have more stored food than smaller ones, which are capable of producing more side shoots and in turn more vegetative growth because of their extra stored food. These results are in conformity with the findings of Rao *et al.* (1992) and Reddy *et al.* (1994) in tuberose. Mahanta and Paswan (1995) also recorded optimum vegetative growth of tuberose with larger sized bulbs. These findings are also consonance with Kalasareddi *et al.* (1997), Singh (1998), Singh (2000) and Sharma and Gupta (2003) observed maximum plant height, number of leaves and leaf area with increasing corm size in gladiolus.

5.2.2 Flowering and Quality Characters

The observations recorded on days to spike emergence, days to flowering and duration of flowering are presented in Table-4.6, 4.7 and 4.8, respectively. Significantly minimum number of days for spike emergence (71.32), number of days to flowering (93.43) and the maximum duration of flowering (17.49 days) was recorded under large bulbs (B_2). This might be due to sufficient number of leaves which leads to more photosynthesis and subsequently good growth, favoured early spike emergence and fewer days to flowering with maximum flowering duration. These findings are in close conformity with Rao *et al.* (1991), Reddy *et al.* (1994), Mahanta and Paswan (1995), Raja and Palanisamy (1999), Ramesh Kumar *et al.* (2003) reported that large size bulbs flowered earlier and has more duration of flowering than those from small bulbs in tuberose. Kalasareddi *et al.* (1997) also concluded that

plants from large corm took less time for spike emergence than small corms in gladiolus.

Thus, the bigger sized bulbs which have more stored food than the smaller ones produced more shoots and in turn more superior vegetative growth which contributed adequate supply of required food material, might be another reason for recording better flower emergence (Sathyanarayana *et al.*, 1994).

The spike length, rachis length, diameter of floret and vase life was also influenced by bulb sizes. The maximum spike length (88.92 cm), rachis length (30.18 cm) and diameter of floret (3.55 cm) were observed in large size bulbs (B_2) as compared to small size bulbs (B_1). The large sized bulbs have higher stored food and growth promoting substances which are responsible for healthy and robust plant growth and its ultimately enhanced floral attributes. The greater the availability of photosynthates is due to more number of leaves resulting more accumulation of sugar and amino acids etc. in the sink. Hence, spike remained fresh and took longer time for senescence (13.38 days). The results are in close agreement with the observations of Syamal *et al.* (1987), Sathyanarayana *et al.* (1994), Mahanta *et al.* (1998) and Shrinivas and Jayashree (2002) also reported beneficial effect of larger bulb size on floral and quality characters of tuberose.

Ramesh Kumar *et al.* (2003) also revealed that the large size bulbs produced the maximum floret diameter in tuberose.

5.1.3 Yield Characters

The study revealed that the B_2 bulb size significantly increased number of florets per spike as compared to B_1 bulb size (Table- 4.13). The maximum number of florets per spike (39.16) was observed under B_2 bulb size. This might be due to large sized bulbs that contain sufficient food reserve for vegetative growth and it ultimately enhanced number of florets per spike (Mukhopadhyay, 1963). The results corroborate to Sathyanarayana *et al.* (1994), Mahanta *et al.* (1998) in tuberose and Shiraz and Maurya (2005) in gladiolus. All these researchers agreed to the increase in number of florets per spike with increasing bulb sizes.

The data in Table-4.14, 4.15 and 4.16 showed that the number of spikes per plant, per plot and per hectare, respectively was significantly affected by large bulb size. The maximum number of spikes per plant (3.30), per plot (75.33) and per hectare (736.17 thousand) was obtained from B_2 bulb size as compared to B_1 bulb size. This might be due to sufficient number of leaves and more plant height which leads to more photosynthesis and subsequently good growth resulting maximum number of spikes per plant. Similar results have been recorded by Sathyanarayana *et al.* (1994), Singh (1998) and Misra *et al.* (2000) in tuberose and Shiraz and Maurya (2005) in gladiolus.

Number of bulbs and bulblets per plant, per plot and per hectare were significantly influenced by the

different bulb sizes (Tables 4.17, 4.18, 4.19, 4.20, 4.21 and 4.22, respectively). The maximum number of bulbs and bulblets per plant (7.43 and 14.04), per plot (146.33 and 289.16) and per hectare (487.77 thousand and 963.88 thousand) was recorded with the B_2 bulb size as compared to B_1 bulb size. This might be due to reserve food material present in larger bulbs which helps vigorous plant growth and it leads to more bulbs and bulblets (Bhattacharjee, 1979). Increase in number of bulbs and bulblets due to larger bulb size have been also reported by Rao *et al.* (1991), Rao *et al.* (1992).

Another study revealed that the number of bulbs and bulblets per plant increased with increase in bulb size of tuberose (Reddy and Singh., 1997).

5.1 EFFECT OF GA_3

5.1.1 Vegetative Characters

Application of GA_3 had significant influence on days to sprouting and sprouting percentage over control (Table-4.1 and 4.2, respectively). There was early sprouting with highest sprouting percentage (14.75 days and 88.81) when bulbs were soaked with 100 ppm GA_3. The soaking of bulbs in the solution of GA_3 significantly stimulated bulb sprouting since GA_3 breaks the dormancy of bulb by breaking down the reserved food material of the bulb through activating hydrolyzing enzymes resulting rapid multiplication of cells which leads to early sprouting and maximum sprouting percentage. These results are in conformity with the findings of Arora *et al.* (1992) in

gladiolus and closely related to Tak and Nagda (1999) in tuberose.

Vegetative attributes *viz.*, plant height, number of leaves per plant and leaf area varied significantly due to the application of GA_3 (Table-4.3, 4.4 and 4.5, respectively). These all are increased with increasing concentrations of GA_3. However, the maximum plant height (61.40 cm), number of leaves per plant (62.10) and leaf area (53.12 cm^2) was recorded when bulbs were dipped in the solution of GA_3 at 100 ppm. This might be due to GA_3 that promotes vegetative growth by inducing active cell division and cell elongation which increased the vegetative growth. Lockhart (1960) reported that osmotic uptake of water and nutrients by the influence of GA_3 maintain swelling force against the softening of cell wall and thereby increasing plant height. A similar findings of GA_3 with respect to vegetative attributes was also reported by Biswas *et al.* (1983), Dhua *et al.* (1987), Manisha *et al.* (2002) and Tiwari and Singh (2002) in tuberose and Dua *et al.* (1984), Mahesh and Mishra (1993) and Ramachandrudu and Thangam (2007) in gladiolus.

Choudhari (1987) reveled that GA_3 at 50-150 ppm increased the number of leaves per plant in tuberose. Likewise, the increase in leaf length and width was measured with GA_3 100 ppm in gladiolus (Ogale *et al.*, 2000).

5.3.2 Flowering and Quality Characters

The present results indicate that increasing levels of GA_3 reduced days to spike emergence and flowering but

increased duration of flowering in tuberose (Table-4.6, 4.7 and 4.8, respectively). Significantly advanced spike emergence (73.02 days) and flowering (95.80 days) was observed with GA_3 at 100 ppm. While, the maximum flowering duration (17.70 days) was observed when bulbs treated with 100 ppm GA_3 which was significantly higher than control (14.58 days). This reduction in number of days to spike emergence and flowering and maximum flowering duration might be due to GA_3 because it is quite effective in reducing the juvenile period of plants and higher capacity of cell division and elongation. This finding discussed above is closely related with Parmar (1992), Reddy *et al.* (1997), Wankhede *et al.* (2002) and Tiwari and Singh (2002) in tuberose.

Kirad *et al.* (2001) reported that GA_3 at 100 ppm increased the spike durability as compared to control in gladiolus. Similar result was also obtained by Singh *et al.* (2003) in tuberose.

The study further revealed that other flowering and quality characters *viz.*, spike length, rachis length, diameter of floret and vase life were influenced by increasing levels of GA_3. The maximum spike length (88.86 cm), rachis length (29.42 cm), diameter of floret (3.52 cm) and vase life (13.43 days) were observed with higher concentration of GA_3 i.e. 100 ppm. It may be due to the application of GA_3 which accelerates carbohydrate accumulation and increases metabolic activities which leads to more vegetative growth of plants and ultimately

production of maximum spike length, rachis length, diameter of floret and vase life of spike. Similar trend regarding these flowering and quality attributes were reported by Singh *et al.* (2003), Tak and Nagda (1999), De and Dhiman (2001) and Wankhede *et al.* (2002) in tuberose and Singh and Barad (2001), Kumar *et al.* (2002) and Ramachandrudu and Thangam (2007) in gladiolus.

Dipping of bulbs in GA_3 (100 ppm) was found best for maximum spike and rachis length in tuberose (Panwar *et al.*, 2006).

5.3.3 Yield Characters

The results as reported in preceding chapter (Table-4.13) revealed that increase in concentrations of GA_3 increase number florets per spike. The maximum number of florets per spike (38.63) was recorded when bulbs dipped in GA_3 at 100 ppm before planting which was significantly higher than control (35.08). The increase in number of florets might be due to that GA_3 treated plants produced more number of leaves with maximum leaf area which leads to the production and accumulation of more photosynthates and diverted to the sink (floret) resulting in more number of florets (Nair *et al.*, 2002). Similar trend in respect to number of florets per spike was also reported by Singh *et al.* (2003) in tuberose and Roychowdhury (1987) and Ogale *et al.* (2000) in gladiolus.

Number of spikes per plant, per plot and per hectare was significantly influenced by the application of

different levels of GA_3 in tuberose (Table-4.14, 4.15 and 4.16, respectively). The maximum number of spikes per plant (3.16), per plot (73.17) and per hectare (243.89 thousand) was recorded when the bulbs dipped in GA_3 at 100 ppm before planting. This might be due to GA_3 increased number of leaves which is essential for the production of sufficient carbohydrates in the plant and it is translocated towards the reproductive parts of the plants for the initiation of spikes. These findings are in close conformity with Panwar *et al.* (2006) in tuberose. Increase in number of spikes per plant, per plot and per hectare with GA_3 had also been reported in tuberose (Dua *et al.*, 1987, Preeti *et al.*, 1997, De and Dhiman, 2001 and Wankhede *et al.*, 2002) and in gladiolus (Sharma *et al.*, 2006 and Umrao *et al.*, 2007).

The data regarding the number of bulbs per plant, per plot and per hectare (Table-4.17, 4.18 and 4.19, respectively) and number of bulblets per plant, per plot and per hectare (Table-4.20, 4.21 and 4.22, respectively) revealed that all treatments of GA_3 significantly increased number of bulbs and bullets per plant, per plot and per hectare as compared to control. Among all treatments, GA_3 at 100 ppm recorded maximum number of bulbs and bulblets per plant (7.22 and 13.87), per plot (142.00 and 287.92) and per hectare (473.33 and 959.72 thousand) which was significantly higher over control. This increase in number of bulbs and bulblets with GA_3 might be due to its high regeneration capacity through cell elongation and cell

division which leads to more vegetative growth and growth of bulb scales segments. So, more number of bulbs and bulblets produced under GA_3 treatments. For instance, Roychowdhury (1987) reported maximum number of corms per plant (4.1) with GA_3 (100 ppm) in gladiolus. Similar trend in respect of number of bulbs and bulblets was also reported by Chaphale (1999) and Singh *et al.* (2003) in tuberose and Roychaudhari *et al.* (1985) and Umrao *et al.* (2007) in gladiolus.

5.7 Economics

The net realization in rupees per hectare and CBR (Table-4.23) was worked out from number of spikes per hectare, bulbs per hectare and bulblets per hectare by taking into consideration the prevailing price of tuberose and inputs used during the experiment. Among variety, Prajwal gave maximum net realization of Rs. 448969.75/ha with CBR of 1:3.01. With regard to bulb size, bulbs having 2.6-3.5 cm diameter recorded maximum net realization of Rs. 410988.29/ha and CBR 1:2.78. Similarly, GA_3 at 100 ppm gave maximum net realization of Rs. 395127.20/ha and CBR 1:2.71.

SUMMARY & CONCLUSION

VI. SUMMARY AND CONCLUSION

The present investigation to study the "Effect of bulb size and GA_3 on vegetative and floral characters of tuberose (*Polianthes tuberosa* L.) cvs. Prajwal and Calcutta Single" was carried out at the Floriculture Farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari in the year 2009-2010.

The experiment was laid out in a Randomized Block Design with Factorial concept (FRBD) having twelve treatments combinations of different varieties, bulb sizes and GA_3 concentrations. The treatments were replicated thrice. The response of tuberose to the treatments was evaluated on the basis of growth, flowering and yield attributes.

The salient features of the experimental findings obtained are being summarized as under:

6.1 Effect of variety

Variety had significant effect on days to sprouting, sprouting percentage, plant height, number of leaves per plant and leaf area. Prajwal sprout earlier (14.59 days) and have maximum sprouting percentage (88.05) with maximum plant height (62.78 cm), number of leaves per plant (63.08) and leaf area (55.17 cm^2). However, all the growth parameters were least under Calcutta Single.

Days to spike emergence, days to flowering, duration of flowering, spike length, rachis length, diameter

of floret and vase life also significantly influenced by Variety. V_1 (Prajwal) recorded minimum days to spike emergence (72.64) and flowering (95.59 days) and maximum duration of flowering (17.84 days) as compared to V_2 (Calcutta Single). In case of highest spike length (87.96 cm), rachis length (31.06 cm), diameter of floret (3.77 cm) and more vase life (13.50 days) also recorded in Prajwal than Calcutta Single.

The influence of variety on number of florets per spike, number of spikes, bulbs and bulblets (per plant, per plot and per hectare, respectively) was found significant. The maximum number of florets per spike (41.29), number of spikes (3.46, 78.83 and 262.78 thousand), bulbs (7.83, 154.22 and 514.07 thousand) and bulblets (14.32, 298.67 and 995.55 thousand) per plant, per plot and per hectare, respectively recorded with Prajwal (V_1).

6.2 Effect of bulb size

The effect of bulb size was found more pronounced. All vegetative attributes are significantly affected by bulb size. Least days to sprouting (13.37) as well as most sprouting percentage (88.82) was observed in B_2 bulb size (2.6-3.5 cm) than B_1 bulb size (1.5-2.5 cm). The same bulb size had a striking influence in enhancing the other vegetative attributes *viz.* plant height (64.57 cm), number of leaves per plant(64.18) and leaf area (54.10 cm^2).

The flowering attributes are also significantly affected by bulb size. Large bulb size (B_2) recorded

minimum days to spike emergence (71.32), days to flowering (93.43) and maximum duration of flowering (17.49 days) as compared to small bulb size (B_1). The highest spike length (88.92 cm), rachis length (30.18 cm), diameter of floret (3.55 cm) and vase life (13.38 days) were also observed with B_2 bulb size.

All the yield attributes were found significant with respect to bulb size. The B_2 bulb size produced maximum number of florets per spike (39.17) with highest number of spikes (3.30, 75.33 and 251.11 thousand), bulbs (7.43, 146.33 and 487.78 thousand) and bulblets (14.04, 289.17 and 963.89 thousand) per plant, per plot and per hectare, respectively.

6.3 Effect of GA_3

In the present study, influence of GA_3 was found significant with higher concentration in all vegetative growth attributes. The treatment of GA_3 at 100 ppm (G_2) recorded minimum days to sprouting (14.75) and maximum sprouting percentage (88.55), plant height (61.40 cm), number of leaves per plant (62.10) and leaf area (53.13 cm^2) as compared to control (G_0).

The influence of GA_3 on days to spike emergence, days to flowering, duration of flowering, spike length, rachis length, diameter of floret and vase life was found to be significant with higher level. The minimum days to spike emergence (73.02), days to flowering (95.80) and maximum duration of flowering (17.70 days) was observed in G_2

treatment as compared to G_0 treatment. The highest spike length (88.92 cm), rachis length (30.18 cm), diameter of floret (3.55 cm) and vase life (13.38 days) were also observed with B_2 bulb size. The maximum spike length (88.87 cm), rachis length (30.38 cm), diameter of floret (3.53 cm) and vase life (13.43 days) was observed with the same treatment of GA_3 i.e. 100 ppm (G_2).

The influence of GA_3 on number of florets per spike, number of spikes, bulbs and bulblets (per plant, per plot and per hectare, respectively) was found significant. The maximum number of florets per spike (38.63), number of spikes (3.17, 73.17 and 243.89 thousand), bulbs (7.22, 142.00 and 473.33 thousand) and bulblets (13.87, 287.92 and 959.72 thousand) per plant, per plot and per hectare, respectively recorded with GA_3 100 ppm (G_2).

6.4 Economics

As the economics is considered, it is clear that variety Prajwal, bulb size with diameter of 2.6-3.5 cm and GA_3 at 100 ppm was found most profitable and generated the highest net return (Rs. 448969.75/ha, Rs. 410988.29/ha and Rs. 395127.20/ha , respectively) with maximum CBR (1:3.10, 1:2.78 and 1:2.71, respectively).

CONCLUSION

On the basis of present investigation, it can be inferred that variety, bulb size and GA_3 play a vital role in better vegetative growth, quality and quantity production of tuberose. Tuberose variety Prajwal, bulb size with diameter

of 2.6-3.5 cm and 100 ppm GA_3 found to be the most effective in terms of vegetative traits *viz.* days to sprout, sprouting percentage, plant height, number of leaves per plant and leaf area and floral and quality traits *viz.* days to spike emergence, days to flowering, duration of flowering, length of spike, rachis length, diameter of floret and vase life. Similarly, yield characters *viz.* number of florets per spike, number of spike (per plant, per plot and per hectare), number of bulbs (per plant, per plot and per hectare) and number of bulblets (per plant, per plot and per hectare) of the same treatments found to be superior over other treatments.

Based on results summarized above and economic point of view, it can be concluded that for maximum production of spike, bulbs and bulblets of tuberose (*Polianthes tuberosa* L.) obtained with Prajwal variety, bulb size of 2.5-3.5 cm diameter and 100 ppm GA_3 under South Gujarat condition.

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* Original not seen

APPENDIX

Appendix I- Meteorological data during March 2009-February 2010.

Months	Temperature (°C)		Rainfall (mm)	Relative humidity (%)		Sunshine hours
	Max.	Min.		AM	PM	
March	35.71	19.58	0.00	82.10	29.81	8.86
April	37.66	22.93	0.00	68.67	31.87	9.14
May	34.19	26.43	0.00	77.16	55.35	8.34
June	33.16	27.52	0.00	83.80	65.40	6.07
July	29.48	25.28	1.43	91.97	82.58	2.64
August	30.70	25.98	33.91	86.52	73.97	4.07
September	32.42	25.29	6.35	88.97	66.40	5.94
October	33.90	21.49	8.00	85.06	46.97	8.47
November	32.15	19.46	2.71	76.43	42.90	8.06
December	31.23	16.28	0.71	80.00	36.39	7.32
January	30.67	15.73	0.00	70.39	37.26	7.99
February	28.01	13.93	0.00	69.82	31.54	6.97

CERTIFICATE

This is to certify that I have no objection to supply one copy of any part of this thesis at a time to any scientist through reprographic process for rendering reference services in a library or documentation centre.

Place: Navsari.

Date : 17th May 2010

(Wagh Vishal K.)