INTRODUCTION

Presently, floriculture is a fast emerging major venture in the world, especially as a potential money-spinner for many third world countries. World floriculture industry is worth US$25 billion today and is expected to grow to US$40 billion by the turn of the century. Cut flowers occupy the major share of the market, followed by plants and bulbs. Floriculture products are sold fresh and dried flowers and foliage, besides bouquets, flower baskets and arranged flowers. This trade is likely to increase further in coming years as a result of fast development in the tourism and hotel industry. Many flowers and ornamental plants grown for domestic as well as for export market. Today floriculture has emerged as a lucrative profession with a much higher potential for return per unit area than other horticultural crops. Earlier, the profession of production of ornamental plants and their trade once considered a gardeners activity is now fast becoming an important commercial venture.

In India, floriculture is being viewed as high growth industries. Commercial floriculture is becoming important from export angle. The liberalization of industrial and trade policies in July 1991 paved the way for development of export oriented production of cut flowers. Economic aspects of ornamental horticulture are as important as the aesthetic ones. The floricultural products of commercial importance, mainly consist of cut flowers (fresh), dried flowers, live plants, dried plants, bulbs and tubers.

The cut flowers constitute 45% share of the total world trade in floricultural products. The most common modern flowers sold as cut flowers are Rose, Carnation, Gladioli, Tulips, Tuberose, Lilies, Liatris, Orchids, Bird-of-Paradise, Chrysanthemum (standard type), Antirrhinum and Gypshopylla whereas loose flowers are Marigold, Crossandra, Jasmine, Rose (Rosa indica, R. damascena, and R. bourboniana) and Annual Chrysanthemum. The use of cut flowers in home decoration has become an integral part of living in human society. Beside the exquisite cut flowers of rose, carnation, gladiolus and tuberose, which are preferred for bouquets and flowers arrangements, there is considerable demand for loose flowers.
for making garlands, for floral decorations and for offering at religious and social functions. Flowers like marigold, jasmine, tuberose, gladiolus and chrysanthemum are mainly used for these purposes. In South India, ladies have delightful custom of using flowers for their hairs.

Flowers and plants have become an integral part of the human life. Besides their aesthetic importance they are useful in improving the quality of life, landscaping and beautification of outdoors and indoors. Floriculture is also an important agri-business with potential for export trade.

According to Bailey (1930), botanically tuberose belongs to the division- Spermatophyta, sub-division- Angiosperms, class- Monocotyledons, order- Liliflora, family- Amaryllidaceae, genus- Polianthes and species- Tuberosa.

The tuberose (Polianthes tuberosa Linn.) is a native of Mexico from where it spread to the different parts of the world during 16th century. The name tuberose is derived form tuberosa, the plant being a tuberous hyacinth as distinguished from bulbous hyacinth. The name, therefore is tuber-ose, not tuberose. It is a half hardy, bulbous perennial perpetuating itself through the bulblets. The roots are fibrous and shallow. The leaves are long, narrow, linear, grass- like, light green, lanceolate and arise in rosette. Nearly 3000 plant species are bulbous in nature, of these around 150 have been brought into cultivation.

Tuberose occupies a very selective and special position in Indian ornamental bulbous plant due to its lovely pretty flowers, elegance and pleasantly sweet fragrance. In our country of diverse cultures and languages, tuberose is known as’Gulashabba’ in Hindi ; ‘Rajnigandha ‘ in Bengali; Gulashbo’ in Punjabi ; ‘Gulcheri’ in Marathi ; ‘Verusampenga’ in Telgu; ‘Sungandraj ‘ in Kannada and Tamil and ‘Rajnigandha’ in Sanskrit. Waxy white flowering spikes of single as well as double- flowered tuberose impregnate the atmosphere with their sweet lingering
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fragrance and are in great demand for making floral arrangements and bouquets in metropolitan cities of India. Flowers have central place in many of the Indian cultural and religious practices. Religious worship does not take place without offering of flowers. Occasions such as marriages and even welcoming someone, calls for an offer of flower.

We are inheritors of a long tradition of floriculture. Flowers have been an essential ingredient of our social life. In past a special group of people used to be intrusted with the task of nursing floriculture (Pillay, 1993). The flowers are widely used for table decoration and floral ornaments. Most artistic garlands are prepared by harvesting individual flowers in Coimbatore and other southern parts of the country, bouquets and button holes. The long flower stalk is excellent for table decoration. White flowers of the tuberose can be coloured by dissolving chemical dyes in vase water viz. Bromocresol green and Bromophenol blue which will impart different shades of colour depending upon the concentration of the chemical used (Arora, 1992).

The area under flower cultivation in India during 1998-99 was reported to be around 73971ha. with an estimated production of 459163 tonnes of loose flowers and 115.6 million cut flowers. The volume of trade in the domestic markets is estimated to be around Rs. 500 crore. Flower trade especially in Delhi and other metropolitan cities, has grown manifolds during the last decade. India’s share in world export of flowers is negligible with just about Rs. 96.6 crore export earnings in 1998-99 (Economic survey, 2000-2001).

The tuberose flowers have a funnel shaped perianth and are fragrant waxy white, about 25 mm long, single or double and borne in a spike. The terminal flower spikes arising from the bulb produce flowers for a number of days and are sessile, sub-sessile, incomplete, hermaphrodite and epigenous. Stamens are six in number, anthers dorsi- fixed in the middle, ovary 3 locular and ovules numerous. The fruit type is capsule and seeds are numerous with fleshy endosperm.
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There are three types of tuberose in cultivation, single with one row of corolla segments, semi-double bearing flower with two to three rows of segment and double having more than three rows of corolla segments. Appreciable variation in the morphological character of plant including the flower have been recorded in the population of single and double types, careful selection of better clumps may be useful in obtaining improved varieties in the two types (Sadhu and Bose, 1973).

Tuberose is cultivated on large scale in France, Italy, South Africa, North Carolina, USA and in many tropical and subtropical areas, including India. Cultivation is confined in plains of various states viz. in West Bengal it is grown on large scale in the districts of Midnapur and Nadia. Some nationalized banks provide loan to the farmers of this area for its cultivation. It is also grown around the cities of Bangalore in Karnataka, Pune and Thane in Maharastra and Coimbatore in Tamilnadu (Sadhu and Das, 1978; Mukhopadhyay and Bankar, 1981). Its cultivation is getting popularity in North India around Varanasi, Kanpur and Lucknow. Where it blooms from July to October during first cropping year and blooms profusely throughout the year except December and January months in subsequent years. It grows well during April - December at average temperature 30°C. Tuberose has got very good export potentiality than ever before because it is now more popular in Europe and it doesn't flower during winter months in temperate countries (Sadhu and Bose, 1973; Mitra et al., 1979). Tuberose is gaining high commercial importance and paying enterprise as the demand for flower and flower stalk is also fast increasing (Patil et al., 1980; Sadhu and Das, 1978).

The tuberose grows in wide range of soil and climatic conditions but it thrives best in warm and humid climate. Temperature above 40°C reduces the size of spike and the quality of flowers. Very low temperature and frost also damage the plants and flowers as well. The optimum temperature range is being 20°C - 30°C. Tuberose grows equally well in sunny situation as well as in partial shade.
The tuberose are planted in March - April in the plains and in May - June in the hills. The flowering period is summer and rainy season in northern plains when no other flower is available in the market. After flowering is over and leaves are dried, the tubers are dug - out and stored in a cool, dry and shady place (Dohare, 1984).

The bulbs remain dormant during winter, if temperature is low, however dormancy can be broken by dipping bulbs in 4 per cent thiourea solution for an hour. Ethylene chlorohydrin can also be used for breaking the dormancy.

The tuberose normally begins flowering in 90- 95 days after planting. The flower stands long distance transportation and occupies deserving place in flower market (Desai, 1957). The flower stalk is 75 - 100 cm long bearing many flowers of white colour with lower pinkish margin. The flowers remain fresh for days together and fill the atmosphere with sweet pleasant fragrance (Dohare, 1984).

The vase life varies from 10-15 days depending upon environment and change of water. The species remain fresh for longer period, if kept in a 4 per cent sugar solution.

The flowers are good source of essential oil which is mostly preferred in preparation of perfumes and cosmetics. Pure absolute of tuberose is perhaps the most expensive.

Named cultivars are few, except a double petalled cultivar, often called "Pearl" by nurserymen. There are two varieties evolved recently known as "Rajat" having white margin in single type and "Dhawal" having golden margin in double type. These varieties can also be planted for attractive foliage and flowers.

The single flowered tuberose is cultivated commercially and is often called "Rajanigandha" which is more fragrant than its double and semi double form.

Improved cultural practices offer considerable scope to raise its flower yield and "concrete" content. It is a hardy crop tolerating relatively ill-drained conditions and poor soil (Nambisan and Krishnan, 1983). The research work related to improve the yield and quality of produce for better production is to be done. The quantum of work done is of primary nature and scientific aspects like plant growth regulators / substances application, concentration and duration in tuberose is yet to be emphasized. The information available in this regard is inadequate to exploit this crop in Varanasi conditions.

The use of plant growth regulators (PGRs)/ substances / hormones has been found to be a great significance in the commercial cultivation of many ornamental crops. Till about 60 years ago, it is believed that science has evolved only two major discoveries in the field of agriculture, i.e. the chemical manure and laws of Mendalian inheritance. But now the use of plant hormones or substances supposed to be the third achievement. A large number of PGRs have been isolated and synthesized in today’s world, which are being used for many purposes in the field of agriculture. In our country, their use is very limited but in many western countries they are creating many excitement in the field of agriculture especially in horticulture. Gibberelic acid (GA) and indole-3- acetic acid (IAA) are very important PGRs and are widely used in horticulture.

Gibberelic acid is one of the most important growth regulators. One of the main plant responses to gibberellins is shoot elongation. It works as stimulator of growth. Growth is stimulated in the younger internodes and tissues and frequently the length of the individual internode remains unchanged. The application of GA₃ to stem produces a pronounced effect on cell division in the subapical meristem (Sadis et al., 1960). In some plants, apical dominance is enhanced when they are treated with
GA₃. Some bushy dwarf plants grow with a single stem after such treatment. GA₃ hastens flowering and helps to increase size of many fruits. It often increases the size of flowers as well as size of peduncle, pedicel and petal (Nand et al., 1973).

Indole-3- acetic acid (IAA) is a natural occurring phytohormone. It belongs to auxin group. It plays many important roles in plant physiology. The most important role of IAA is the elongation of cell by synthesizing DNA, which leads to protein synthesis and finally increase in the cell volume, thicker cell wall. Other roles of IAA are epical dominance, fruit setting, fruit thinning, formation of female flowers, morphogenesis (root initiation).

Wrinkler (1969) observed that corm yield and weight of gladioli were increased by dipping in GA₃ solution as compared to spraying IAA also increased weight of corms.

Soaking of tuberose bulbs in GA₃ at 10 mg / litre increased the number of spikes per plant without any variation in flower number on each spike. Foliar application of GA₃ at 10, 100 and 1000 mg / lit. proved effective in increasing the number of flower spikes as compared to soaking treatment. GA₃ at 100 mg / litre also increased the number of flowers on each spike, number of spikes per plant and number of flower per spike by GA₃ application (Biswas et al., 1983). The bulbs of tuberose after soaking in GA₃ at 200 ppm for 24 hours increased the plant height and length of spike (Tiwari, 1992).

Growth and development behaviour of bulbous plants is also regulated either by a single or by an interaction of several endogenous growth hormones like gibberellin, auxin, cytokinin and abscisic acid (ABA). They play a major role in directing the movement of organic metabolites and in establishing sinks (Rees, 1972).

Mukhopadhyay and Banker (1983) sprayed the tuberose plants of cv. single 40 days after planting and twice at fortnightly interval with GA₃ at 25 - 100
ppm or ethephon at 500 - 2000 ppm and observed that increasing concentrations reduced the plant height.

Now- a- days tuberose growers are taking keen interest in growing tuberose due to increased demand of their bulbs, cut flowers and essential oil. But the cultivations do not get optimum return due to the poor yield and quality of bulbs and flowers. For adequate production of bulbs, flowers and essential oil scientific knowledge of its cultivation, amount of manures and fertilizers, suitable PGRs and their concentration and duration to be used are required. It appears that very little work has so far been done on the NAA and GA₃ their concentration and duration aspect for tuberose in the country and abroad. Therefore, a systematic work on "Study the response of NAA and GA₃ on growth, flowering, bulb production and vase life of tuberose (Polianthes tuberosa ) cv. Single", was undertaken at the Horticultural Research Farm of Department of Horticulture, Udai Pratap Autonomous College, Varanasi (India) with the following objectives:

1. To find out the effect of dipping the bulbs in different concentrations and durations of NAA on growth, flowering and bulb production of tuberose cv. Single.
2. To find out the effect of dipping the bulbs in different concentration and durations of GA₃ on growth, flowering and bulb production of tuberose cv. Single.
3. To study the effect of NAA and GA₃ on longevity of tuberose cv. Single.
4. To standardize the concentration and durations of NAA and GA₃ for the economic production of tuberose cv. Single.