EFFECTS OF NITROGEN LEVELS AND GIBBERELLIC ACID ON GROWTH & FLOWERING OF TUBEROSE (*Polianthes tuberosa*, Linn)

THESIS

Submitted to the
Punjabrao Krishi Vidyapeeth, Akola
in partial fulfilment of the requirements
for the Degree of

MASTER OF SCIENCE

IN

AGRICULTURE
(HORTICULTURE)

BY

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1992

DECLARATION OF STUDENT

I hereby declare that the experimental work and its interpretation of the thesis entitled "Effect of nitrogen levels and gibberellic acid on growth and flowering of tuberose" or part there-of has not been submitted for any other degree or diploma of any University, nor the data have been derived from any thesis/publication of any University or scientific organisation. The sources of material used and all assistance received during the course of investigation have been duly acknowledged.

Date : 6.6.92

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Enrolment No. J/353.

CERTIFICATE

This is to certify that the thesis entitled, "EFFECT OF NITROGEN LEVELS AND GIBBERELLIC ACID ON GROWTH AND FLOWERING OF TUBEROSE (Polianthes tuberosa, Linn)" submitted on partial fulfilment of the requirement for the degree of Master of Science in Agriculture of the Punjabrao Krishi Vidyapeeth, Akola is a record of bonafide research work carried out by Shri. Sudhir Rajaram Dalal under my guidance and supervision. The subject of thesis has been approved by the student's advisory committee.

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ACKNOWLEDGEMENT

It gives me immense pleasure to express my esteem and profound sense of gratitude to Shri. P.V. Belorkar, Assistant Professor, Dept. of Horticulture, College of Agriculture, Nagpur and Chairman of the Advisory Committee for suggesting the research problem and for thought provoking discussion, valuable and constructive suggestions and critisms during the course of this investigation. His fatherly guidance and encouragement sustained me all along and helped me greatly in M.Sc.(Agril.) studies and research project.

I also feel immense pleasure in expressing my humble and deepest sense of gratitude to the members of Advisory committee, Shri. B.N. Patil, Reader in Horticulture, Shri. T.K. Shende, Assistant Professor, Department of Agiculture Economics.

I am greatfully acknowledge my indebtness to Dr. T.R. Bagde, Professor of Horticulture, College of Agriculture, Nagpur for providing necessary facilities and his valuable contribution towards the completion of this investigation.

I am highly obliged to Dr. V.Y. Bhagwat, Associate Dean, College of Agriculture, Nagpur for providing necessary facilities during the course of present investigation.

I wish to express my sincere thanks to all the staff members of Horitculture section for making this research work successful.

I shall fail in my duties if I do not place on record my deepest sense of gratitude to my parents Shri. Rajaram B. Dalal and Smt. Indirabai R. Dalal whose silent presence has always guided my efforts.

No words of gratitude can equate the tremendous encouragement and love that has been bestowed on me by brother-in-law Pandharinath N. Sorte, elder sister Sau Bharti P. Sorte, elder brother Arvind, Younger Nandu and Nitin and younger sister Manju and other relatives for the great inspiration during the entire period of my education without which it would not have been possible for me to come out with this valued investigation.

Last but not least, I wish to acknowledge and express my sincere thanks to my dear and near Yogesh, Vithal, Dhananjay, Miss. Shalini, Satish Prasad, Nana, Avi, Suresh, Shripad, Atul, Siraj, Ganesh, Kishore, Ajay who proved me to be immensely helpful during the course of my entire studies.

I am also thankful to New Vidarbha Computer Institute for composing of this thesis.

PLACE : NAGPUR

DATE : 6-6-92

(S.R. DALAL)

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LIST OF ABBREVIATIONS

@	:	At the rate of
CD	:	Critical difference
cm	:	Centimetre
cm^2	:	Centimetre square
°C	:	degree centigrade
et.al.	:	et alia (and associates)
fig	:	figure
g	:	gram
ha	:	hectare
i.e.	:	that is
kg	:	kilogram
m	:	metre
m^2	:	metre square
NS	:	Non significant
/	:	Per
%	:	per cent
q	:	quintal
SEm ±	:	standard error of means
Sig	:	Significant

CHAPTER I

INTRODUCTION

India has rich heritage of ornamental horticulture. Flowers have been associated with our social life since ancient time and are used for devine purposes. Just a few flowers in the living room or on a desk will turn a dull day into filled with warmth and sunshine. On joyful occasions flowers seem to have a close affinity with happiness. This is perhaps one of the reason we use them so lavishly at gala events, like carnivals weddings, festivals, offering to god and also as ladies ornaments. Their tranquility and sweetness brings comfort to millions. In a different context, millions of people grow flowers for the pure joy of witnessing the annual, renewal of plant life a miracle which never falls and brightens homes and gardens with blooms. Thus growing flowers has become a part of our daily life.

According to an earlier survey made by the Indian Council of Agricultural Research it is revealed that about 10,500 ton of cut flowers, worth Rs. 9.26 crores are sold annually in the market of metropoliton cities like Bombay, Madras, Calcutta and Delhi (Vishnu Swarup, 1967). Preliminary survey made by the Department of Horticulture Punjabrao krishi Vidyapeeth, Akola during the year 1974 has also indicated that, there is heavy demand for flowers in most of cities and towns of Vidarbha region. This indicates better future for flower cultivation in this region.

Bulbous plants constitute one of the most important group of ornamental horticulture. Beauty, fragrance, colour of their bloom, the super excellence of their flowers for interior decorations, their symbolic values and medicinal aspects have been responsible for enduring their cultivation to garden lovers.

Bulbous plants have great commercial value. In Netherland, tulip cultivation is a national industry. In India, cut flower industry, however, is not yet so developed as in foreign countries like U.S.A., U.K., Japan and France. In India flower cultivation has been confined largely to the fields around major cities and pilgrimage centres to meet their day to day requirement.

Tuberose (Polianthes tuberosa, linn) is popularly known as Rajnigandha or Nishigandha. Tuberose is a native of Mexico. It has been cultivated from remote time and it belongs to family Amarllidaceae. It is grown on large scale in France, Italy and other tropical and subtropical areas, including India.

Tuberose though grown throughout India in plains, it blooms profusely during summer and rains. (Sandhu and Bose, 1973). Tuberose also grows well in warm and humid climate. Optimum temperature requirement ranges from 20 to 30° C. In sunny situation as well as in partial shade, tuberose grows equally well (Sandhu and Bose, 1973).

Tuberose is widely grown for its beautiful waxy white flowers having sweet pleasant, lingering fragrance, which remains fresh for eight to ten days. The blooms are mainly used for garlands, bouquets, cut fowers, decoration, ornaments for bridal make up, button holes etc.

Tuberose flowers and bulbs have got various medicinal uses (Sharga, 1977). Tuberose bulbs are used as a remedy for gonorrhoea. Tuberose is used for medicinal purposes and in perfume industry (Trueblood, 1974). Tuberose flowers are also a good source of essential oils which are utilised in preperation of various cosmetics and perfumes.

Some essential oils (Sapojenine like hecogenin and tigogenin) are also extracted from the tubes/bulbs (Chopra <u>et</u>.<u>al</u>., 1969).

Sharga (1977) reported that single flowered variety is most suitable for the extraction of essential oils and oil content varies from 0.08 to 0.10 percent. Double flowered variety has less essential oil content and therefore it is cultivated for cut flower trade.

Nutrition and growth regulator plays very important and remarkable influence on growth, flowering and yield of various crops.

Therefore the present investigation 'Effects of Nitrogen levels and Gibberellic acid on growth and flowering of tuberose' was undertaken at main garden of Agriculture College, Nagpur during 1991-92 with the following objectives.

1) To compare the different dose of Nitrogen and Gibberellic acid on growth and yield of tuberose.

2) To compute the suitable dose of nitrogen and growth regulator (GA_3) on growth and yield of tuberose.

3) To study the interaction effects of different doses of nitrogen and gibberellic acid on growth and yield of tuberose.

CHAPTER II

REVIEW OF LITERATURE

Application of fetilizers and use of growth regulators, plays an important role, influencing growth, flowering and yield behaviour of various crops.

The review of research work carried out so far on these aspects in respect of tuberose and related crops is presented under approximate heads in this chapter.

1. EFFECT OF FERTILIZERS ON GROWTH, FLOWERING AND YIELD :-

Stuart (1949) reported that in green house and field test at Betville that the nutrient requirements of optimum size gladiolus corms is low and that any soil of moderate fertility can be used to produce quality flowers and large size corns without fetilization. Best results have been obtained from corms fertilized only at flowering time. Fertilizers applied in the rows before planting delayed flowering and decreased flower and corm yield.

Stuart and Meclellan (1950) stated that in Florida the highest flower production in gladiolus was obtained when 800 lb/acre of 5:10:5 NPK fertilizers were applied in the row before planting and 400 lb/acre of the same fertilizers in each of two side dressings. These treatments also produced the highest yield of corms.

Waltz (1954) observed in gladiolus that, autumn planted corms were benefitted more from high nitrogen ratios in complete fertilizer applications than did large corms, but rotting caused by fusarium was increased by high nitrogen ratio. Increased application were more beneficial to spring planted than to autumn planted corms.

Mantrova (1957) reported that gladiolus responded most readily to nitrogen nutrition especially when this was applied as side dressing during the development of the second and fifth leaf. Complete fertilizers in the early stages of development, depressed growth but become effective after fifth leaf stage and the response of plants to NPK improved throughout the growth period.

Kosugi (1960) observed that gladiolus corms planted in sand, when applied with 3 levels of nitrogen and two levels of potassium and phosporus showed no significant difference in percentage of flowering, height of plants, number of leaves and number of florets. Early flowering occured in plants receiving the higher amount of nitrogen and phosporus. The flowering was delayed where no nitrogen was given. Nitrogen deficiency was noted in plants receiving little or no nitrogen and poor root development in those receiving high nitrogen. The fresh weight of new corms increased with increasing nitrogen levels but the number of cormels was greater at low nitrogen and decreased markedly at the highest nitrogen level.

Wilsle (1961) reported that soil fertility affects maturity, high phosporus hastens and high nitrogen delays it.

Sasso (1962) reported that when ammonium nitrate was applied at the rate of 20, 40 or 60 Kg per hectare, the stalk length and stalk diameter were increased in Dahlia though it was not significantly superior.

Garibaldi (1964) reported that, in gladiolus, the number of inflorescences per corm was slightly increased by NPK and combinations of these elements. When K was applied alone, the height of the inflorescence was reduced but N and P had opposite effect. The number of flowers per spike was slightly increased by all treatments.

Joiner et.al. (1964) observed that, application of nitrogen resulted in production of large size bulbs with more number of bulblets in Amaryllis. They also observed that, application of higher level of phosphorus produce larger size of bulbs.

Lemeni and lemeni (1965) reported in gladiolus that, highest rate of mineral fertilization, viz. 400 kg ammonium nitrate, 600 kg super phospate and 300 kg muriate of potash per hectare resulted in the greatest plant height, flower number per plant and flower size.

Sakalska (1968) reported in gladiolus that, the best results were obtained in weight of corms and cormels and the proportion of corms by application of 75 kg ammonium sulphate, 10 kg super phosphate and 10 kg muriate of potash per 100 sq. m.

Cirrito (1972) observed best results in tuberose bulb production, by applying 24 kg nitrogen + 24 kg phosphate and 30 kg muriate of potash per hectare.

Sandhu and Bose (1973) observed satisfactory growth in tuberose by applying 6 g of urea + 16 g of super phosphate + 16 g of muriate of potash per sq. metre area.

Jana et.al. (1974) found that high nitrogen and phosphorus, proved very effective in increasing the number of leaves, number of branches and number of flowers in dahlia and tuberose.

Rahman and Mitra (1974) reported that, application of 50 lb N per acre in dahlia resulted in maximum shoot length, leaf number, branch number and flower number and 75 lb/acre resulted in the largest weight and number of root tubers, the earliest appearance of flower buds and the shortest time to flower.

Cirrito (1975) observed that, number of saleable bulbs and individual bulb weight were greatest where 20 + 40 + 60 kg NPK per 1000 sq. metre applied at planting in tuberose.

Rikhter (1976) reported that the highest bulb yield was produced by 120 kg N per hectare in narcissus cultivars.

Singh et.al. (1976) reported that, a dressing of 120 kg nitrogen increased the yield of flowers by 6.4 and 14.1 % over 80 and 40 kg N per hectare in tuberose.

Hetman (1977) observed highest yield in tulip by applying 120 kg nitrogen, 60 kg P_2O_5 and 20 kg K_2O per hectare. He also observed increased plant height by applying 120 kg N + 60 kg P_2O_5 and 20 kg K_2O per ha.

Misra and Negi (1977) observed in gladiolus that, with every increase in dose of nitrogen there was progressive increase in weight of the corms and cormels. Best results were obtained with 20 g nitrogen which was followed by 15 and 10 g of nitrogen per sq. metre.

Shoushan et.al. (1978) were reported that N, NP, NPK, NK were applied to amaryllis. All treatments increased bulb weight, bulb size and encouraged bulblet production, but the treatments containing k were the most effective.

Mitra et.al. (1979) observed earliest flowering and highest number of flowers per spike by applying 75 kg N per hectare in case of tuberose.

Motilal et.al. (1979) reported, delayed spike emergence and number of buds per spike by applying area (25-100 g/m^2) P_2O_5 (100-300 g/m^2) and K_2O (100-300) g/m^2). They also reported that flower spikes were tallest (126.5 cm) by applying 25 kg urea + 100 g P_2O_5 and 100 g K_2O in gladiolus.

Allurwar (1980) observed in tuberose that, application of 200 kg nitrogen per hectare produced more number of leaves, more number of total bulblets, dry weight of bulb and bulblets at harvest.

Jana and Bose (1980) reported that, maximum yield of bulbs and flowers were obtained from plots receiving 20 g nitrogen, 40 g P_2D_5 and 20 g K_2O/sq.metre in Hippeastrum.

Nanjan et.al. (1980) observed highest flower production and economic returns in tuberose by applying 200 kg nitrogen + 60 kg phosphorus per hectare.

Bhattacharjee (1981) observed increasing level of nitrogen advanced the time of flowering and greatly increased flower spike length, corm weight, size as well as number of cormels per plant by application of basal dose of NPK. Increasing level of each treatment resulted in increasing flower spike quality, corm growth and cormel production in gladiolus cv. friendship.

Haider et.al. (1981) reported increased nitrogen uptake under enhanced nitrogen application, 20 kg N per hectare being most effective for growth, flowering corm and cormel yield in gladiolus.

Bhattcharjee and Yadav (1982), reported highest NPK rates (20:40:40 of NPK per sq.metre) give■ best results as regards leaf length and number, bulb weight and diameter, bulblet weight and diameter, days to flower, number of flower stalks, flower length of flower stalk, flower diameter, flower length and flowering duration in hippeastrum.

Deswal et.al (1983) reported that the gladiolus plant receiving higher rate of nitrogen was tallest and produced greatest number of florests per spike and corms per plant.

Deswal and Patil (1983) reported that vase life in gladiolus was longest in spikes from plants receiving only nitrogen 100 kg/hectare.

Jagtap (1983) reported increased fresh weight of leaves, increased total number of flowers, rooted bulblets, yield of rachis and accumulation of dry matter in bulblets in tuberose with the application of 40:30:20 kg NPK/ha.

Shah <u>et</u>.<u>al</u>. (1984) observed that application of nitrogen at the rate of 24 g per plot though delayed the flowering but greatly increased growth of the plants, number of leaves per plant, spike length and number of florets per plant, spike length and number of florets per spike. However corm weight and number of corms per plot were found highest in medium dose of nitrogen (18 g per plot) and low dose of phosphorus (18 g/plot). The number of cormels and cormel weight per plot was highest under low dose of N and P (12 g NP per plot).

Borelli (1984) reported increase in number of flowering shoots, corms and cormels by increasing the levels of nitrogen. However, there was decline in spike quality, corm and cormel size in gladiolus.

Bankar and Mukhopadhyay (1985) noted that, the height of plant, number of leaves and yield of spike increased significantly by application of 25 g and 35 g N per plot as compared to control.

Potti and Arora (1986) reported that the application of 60:20:20 g NPK/m^2 was found to be beneficial for the production of flowers as well as corm and cormels in gladiolus.

Mugge et.al. (1987) reported that, increasing fertilizer rates upto 180 kg nitrogen per hectare increased cut flower yield of offset bulbs in tulip.

Gowda et.al. (1988) reported, more number of spikes per plot, more number of florates per plot (14.6) and greater length of spike (89.79 cm) by application of 40 g N + 40 g P/m^2 in gladiolus.

Sidhu and Arora (1989) noted that, spike length of gladiolus plant is increased by application of 20 g nitrogen per sq. metre.

Bankar and Mukhopadhyay (1990) reported that, nitrogen application advanced the flowering and improved growth in tuberose. The highest number of spikes per sq.metre (20.09) was obtained with the highest nitrogen rate (20 g per m^2) in tuberose.

2. EFFECT OF GROWTH REGULATOR ON GROWTH, FLOWERING AND YIELD :-

Paleg (1961) reported activity of GA, increasing germination of seeds in barley due to the production of reducing sugar from the starch as a result of increase in water soluble amylolytic activity of endosperm, the higher concentration of GA causing inhibition in the sugar production.

Mathur and Sharma (1969) reported that, application of GA_3 in dahlia accelerated flowering of plants in inductive day lengths. The critical day length was not affected by GA_3 treatment.

Winkler (1969) observed in gladiolus that corm yields were only increased by dipping, in contrast to spraying and dusting of GA. GA treatment increased the weight of cormels.

Syrtanova and Rachimbaev (1973) reported that the content of free gibberellin like substances increased and the inhibitor disappeared during intensive bulb growth. Growth phases of the tulip bulbs were accompanied by changes in the activities of endogenous GA and these activities were associated with transformation of the bound gibberellin like substances into free gibberellin like substances and with the translocation of GA from the storage scales to the flower stalk.

Laiche and Box (1973) reported that in easter lily GA treatment alone stimulated growth by hastening shoot emergence.

Tsukamoto (1974) reported that soaking of gladiolus corms in a 20 ppm benzyladenine solution for 24 hours followed 3 days later by resoaking in a GA solution at 100 ppm, resulted in dormancy breaking and in good shoot and root growth after sprouting.

Lin and Wilkins (1975) reported that in _Lilum longforum_, shoot emergence from non-cooled bulbs was increased by injection of GA_3. Neither GA_3 nor GA_7 enhanced flowering of cooled bulbs and GA_3 increased stem elongation.

Mugge and Richter (1975) observed in tulip that, dipping of bulbs in a mixture of IAA, GA and kinetin improved the propagation coefficient than leaf spray of the same mixture.

Rudnicki (1976) observed in tulip that, the injection of 10 mg GA_3 into the bulb stimulated sprouting, growth of floral stalks and flowering.

Sebanek _et_._al_. (1976) reported that flowering was advanced by 3-4 days and flower size was significantly increased in tulip and hyacinth by application of Benzyladenine + gibberellic acid.

Gordon and Ress (1977) reported that gibberellic acid (1 to 100 ppm) reduced the number and weight of bulbils produced in twin-scaled narcissus.

Eldabh <u>et</u>.<u>al</u>. (1978) observed no effect on flower production by treating the bulb of tulip with 1000 ppm GA for 24 hours.

Saniewski (1978) reported that, GA stimulated early growth of the leaves and flower stalks of chilled bulbs, when applied at 0.5 and 2.0 % concentration in lanolin paste to the basal plate in muscari comosum mill.

Bragt and Gelder (1979) reported that GA_3 (1 mg in 0.5 ml water) treated bulbs, flowers 10 days earlier than the control and have heavier daughter bulb in tulip.

Tymoszvk <u>et</u>.<u>al</u>. (1979) reported that, GA_3 at 50, 100, 1000 and 5000 ppm concentration accelerated growth and flowering in hyacinth.

Bose <u>et</u>.<u>al</u>. (1980) reported that soaking of Hippeastrum hyacinth bulbs for 24 hours in GA_3 (10-1000 ppm) increased bulb weight and flower diameter, GA_3 at 10, 100 or 1000 mg per litre increased bulblet production on the treated plants. GA_3 (10-1000 ppm) increased flower number and size.

Talia and stellacci (1980) reported that, treating the base of the bulbs with 100 ppm GA for a week before planting improved earliness by a few days and enhanced flower quality.

Auge (1982) reported that, dipping of tulip bulbs in GA (500 or 200 mg/lit) reduced emergence (both concentration) GA treated plants has 75-80 % flowering and flowered 10 days earlier than untreated.

Auge (1982) reported that gladiolus corms soaked in GA (as Berlex at 0.5 lit) or sprayed with 2g/litre berlex helped in early sprouting and flowering by ten days.

EL-Meligy (1982) reported that in gladiolus Cv.eurovision cormels stored at 5° C for 100 days were soaked for 24 hours in solution of GA_3 at 0-500 ppm. Some cormels were then subjected to gamma irradiation at 500 or 1000 rad. The controls were soaked in water without irradiation. Soaking in GA_3 at 500 ppm + irradiation at 1000 rad gave a cormel yield 1.5 times greater than the control.

Jana and Biswas (1982) reported, early maturity (97 days) by soaking the tuberose bulb in GA_3 solution for 24 hours at 10 to 1000 ppm and maximum number of flowers per spike by treating the bulb of tuberose with 1000 ppm B-nine.

Biswas et.al. (1983) reported that in case of tuberose, bulbs treated with GA_3, leaves appeared between 27 and 45 days depending upon concentration. GA_3 at 1000 mg/lit reduced the height of plant. The number of flower spikes per plant was increased by GA_3 treatment. Considerably, large number of spikes obtained by GA_3 at 10 mg/liter. GA_3 at 100 mg/lit also increased the number of flower on each spike.

Singh et.al. (1983) reported that, 4 ppm GA proved to be best for average number, length and fresh weight of leaves, number, length and fresh weigh of roots, diameter and fresh weight of bulbs and yield per hectare in onion.

Thomas et.al. (1983) reported that, GA_3 as foliar spray at 5 and 10 ppm hastened flowering but 10 ppm caused flower abnormalities and 30 and 100 ppm increase flower number in cyclamen.

Wanjo and Waithaka (1983) reported that, corms of *Liatris spictata* were soaked in solutions of 50, 100, 250 or 500 mg GA_3 per litre for 15 hours at 23° C. Other corms were stored in polythene bags at 3 to 5° C for 4 or 8 weeks and some of these were also soaked in 250 mg GA_3 per litre before or after cold treatment. The combined effect of GA_3 and cold treatment led to earlier flowering and more inflorescence per plant.

Bhattacharjee (1984) observed that, GA_3 at 10 and 100 ppm as a foliar spray increase vegatative growth, improved corm size and weight, induced more cormel production, stimulated flower stalk and rachis length, accelerated floret size and number per spike and lengthened the life of spike. Increased the number of flowers per spike in gladiolus.

Bhattacharjee (1984) reported that, application of GA_3 as a foliar spray at 10, 100 & 1000 ppm showed appreciable stem elongation. GA_3 at 10 and 100 ppm induced 4-5 days early flowering. Number of flowers per plant at all concentration was more in Dahlia.

Dua <u>et</u>.<u>al</u>. (1984) reported the maximum number of corm and cormel production, resulted from GA_3 spray or preplanting dip at 100 ppm. Spraying increased plant height, number of leaves and shoot per plant, improved spike quality (in terms of number and size of flowers) in gladiolus.

Mukhopadhyay and Sadhu (1985) reported that, soaking of tuberose in GA_3 solution tend to increase the number of leaves, improved the rachis length at all concentrations. (10, 100, 250 and 500 ppm).

Lopez and Lopez (1985) reported that, soaking of bulbs of Liatris spictata at 270 or 450 ppm GA for 16 hours delayed sprouting from 14 days to 7 days. It also hastened flowering and increased inflorescence production but had no effect on cut flower quality.

Tjia (1986) reported that, tubers of Lantedschia elliottiana (used primarily for cut flowers but of interest as a pot plant) were treatd with GA_3, GA_{4+7} dips at 50 or 100 mg per litre for 30 minutes, increased the percentage of flowering. GA_{4+7} treated plants, flowered earlier than untreated plants.

Corr and Widmer (1987) reported that soaking rhizomes of Lantedeschia elliotiana in 500 p.p m GA_3 solution for 10 minutes increased the number of flowering shoots and flowers per shoot.

Roychaudhary (1989) reported that the corms of gladiolus were soaked for 6 hours in GA_3 (50 or 100 p.p.m.) before planting and planted at 25 or 33 corms per sq.metre. The higher planting density increased plant height, flower stalk length and yield of corms per unit area but decreased the number of florets per spike and flower length and diameter irrespective of growth regulator treatment.

CHAPTER III

MATERIALS AND METHODS

The present study "Effects of Nitrogen levels and gibberellic acid on growth and flowering of tuberose (Polianthes tuberosa, Linn.)" was carried out in main garden, College of Agriculture, Nagpur during Kharif and Rabi season of 1991.

CLIMATE AND WEATHER CONDITIONS :-

Nagpur, a district place in Maharashtra State comes under sub-tropical belt 321 metres above mean sea level. It is geographically situated at 21.10° N latitude and 79.10° E longitude. During the period of crop duration that is from July 1991 to February 1992 the maximum temperature ranged from 22.5° C to 35.4° C and the minimum temperature ranged from 8.0° C to 25.4° C. The relative humidity during the period varied from 55 % to 88 %. The weekly observations on important weather parameters recorded in Agro-meteorological observatory, Department of Agronomy, College of Agriculture, Nagpur during the course of investigation are presented in appendix-I.

SOIL :-

The land under the experiment was fairly uniform with a gentle slope. The soil was black. The plot was ploughed and brought to fine tilth. It was weed free at the time of planting of bulbs.

The soil analysis at 0-30 cm depth is given below.

Chemical Composition of Soil

Particulars	Percentage	Analytical method used
1. Total N	0.059	Modified Kjeldahl's method (A.O.A.C. 1955)
2. Available P	22.4 kg/ha	Olsen's method (Jackson, 1967)
3. Available K	672 kg/ha	Flame photometer (Jackson, 1967)
4. Organic Carbon	0.59 %	Walkley and Black (Jackson, 1967)
5. P^H	8.05	Backman's Gas Electrode P^H meter (Jackson, 1967)

EXPERIMENTAL DETAILS :-

The experiment includes two factors viz, various levels of nitrogen and different concentrations of gibberellic acid. These two factors were studied in split plot design.

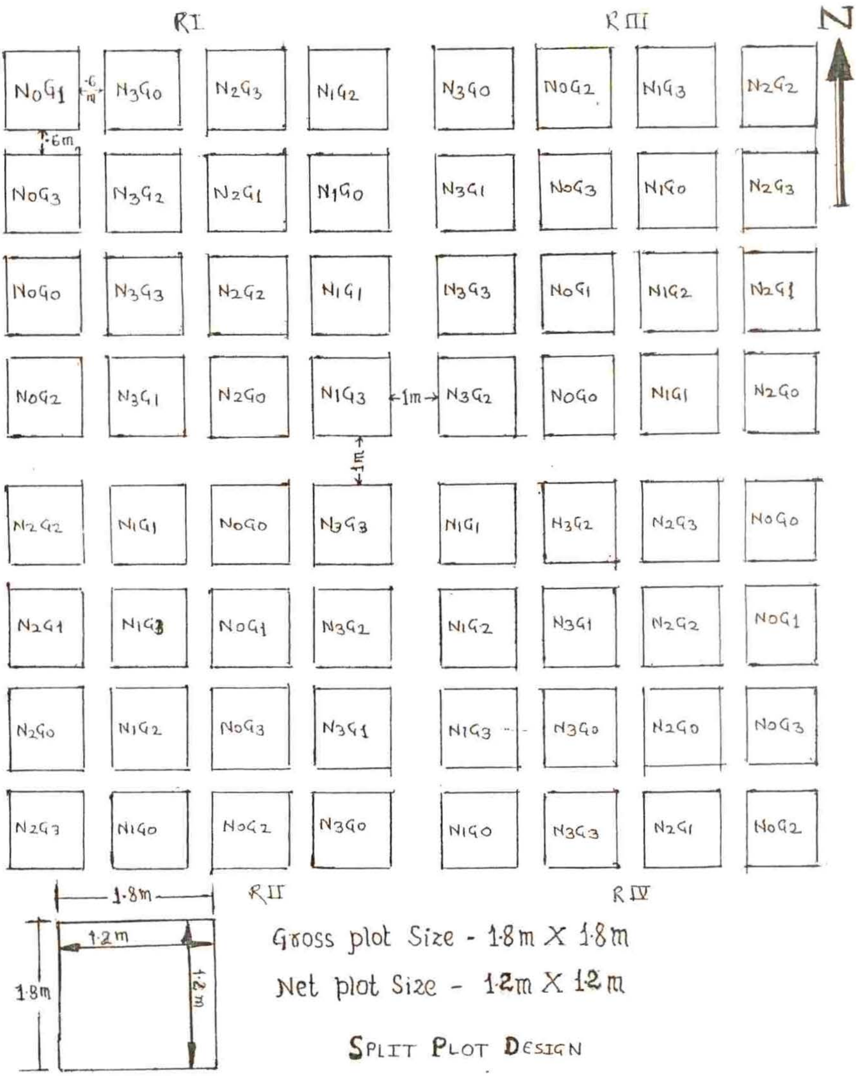


FIG. 1 PLAN OF LAYOUT

The details of the experiment were as under :-

1. Design of the experiment —— Split plot design.
2. Replications —— 4 (four)
3. Treatments :-

   a) **Main treatments** —— Nitrogen levels

   i) N_0 - 0 kg Nitrogen per ha.

   ii) N_1 - 50 kg Nitrogen per ha.

   iii) N_2 - 60 kg Nitrogen per ha.

   iv) N_3 - 70 kg Nitrogen per ha.

   b) **Sub treatments** —— Gibberellic acid.

   i) G_0 - 0 ppm

   ii) G_1 - 10 ppm

   iii) G_2 - 20 ppm

   iv) G_3 - 40 ppm

4. Gross plot size —— 207.36 sq.m.
5. Net plot size —— 92.16 sq.m.
6. Total experimental area —— 299.52 sq.m.
7. Distance between two plots —— 0.60 m.
8. Distance between two replications —— 1.00 m
9. Spacing —— 0.30 x 0.30 m
10. Season —— Kharif/Rabi
11. Variety —— Single
12. Date of planting —— 04.07.1991.

SELECTION OF PLANTING MATERIAL AND PLANTING :-

From previous plantation of tuberose, the plants were uprooted by digging fork. The bulbs were separated and washed with water, so as to remove all soil particles.

Disease free bulbs were selected for plantation. All the leaves emerging from the neck of the bulbs were trimmed off. The individual bulbs weighing 25 to 30 g were selected for planting. Selected bulbs were treated with different concentrations of GA_3, as per treatment. The stock solution of 1000 ppm of gibberellic acid was prepared by dissolving 1 g of substance one litre of distilled water. To facilate dissolution of chemicals, the chemical were first dissolved in little quantity of ethyle alcohol. From this stock solution the required strength and quantity of growth regulator was made up to volume. Bulbs were soaked for 24 hours in each treatment of GA_3. After 24 hours, bulbs were taken out from solution and were allowed to dry in shade for half an hour. For control treatment bulbs were soaked in distilled water. The bulbs were then planted at 5 cm deep at a spacing of 30 x 30 cm in flat beds.

FERTILIZER APPLICATION :-

The land was prepared to fine tilth. Plots were marked leaving irrigation channels FYM @ 5 kg/sq.m. was applied and properly mixed in the soil.

Urea (46.4 % N) single super phosphate (16 % P_2O_5) and muriate of potash (60 % K_2O) were used as a source of nitrogen, phosphoric acid and potassium respectively. As per treatments, fertilizer quantities of fertilizers were calculated, half dose of nitrogen, full dose of phosphorus and potassium were applied as a basal dose at the time of planting. The remaining half dose of nitrogen was applied 30 days after planting. P and K applied at the rate of 20 and 30 kg per ha. respectively.

IRRIGATION :-

Immediately after planting first irrigation was given, followed by second irrigation on the fourth day after planting. Subsequent irrigations were given as and when required.

INTERCULTURE OPERATIONS AND PLANT PROTECTION MEASURES :-

Plot was kept free from weeds by necessary weedings. Eight weedings were given at twenty five days interval from planting. In order to protect the crop from infestation of white ants BHC 10 % dust was applied at the time of land preparation. The malathion 10 CC in 10 litres of water sprayed on 12^{th} September and on 4^{th} October to protect the crop against thrips damage.

PICKING OF FLOWERS :-

The first picking of flowers was done on 8^{th} October, 1991. Subsequent pickings were done at an interval of 7-8 days. In all 12 pickings were undertaken throughout the flowering period. Last picking was done on 20^{th} January 1992.

HARVESTING OF FLOWER STALK :-

The harvesting of flower stalk was done when last picking of flowers was completed.

The observational plants uprooted by a fork, and flower stalks were seperated by giving a cut just above the top of the bulbs. The rooted and unrooted bulblets were separated and washed with water for recording observations.

OBSERVATIONS :-

The details of pre harvest and post harvest observations were recorded as given below.

A> PRE-HARVEST OBSERVATIONS :-

1) Number of leaves per hill.
2) Number of days required for emergence of flower stalk form planting.
3) Number of days required from emergence of flower stalk to harvest.
4) Number of days required for harvesting of flower stalk from planting.

B> POST-HARVEST OBSERVATIONS :-

1) Average number of leaves per hill.
2) Average number of rachis per hill per hectare.
3) Average length of rachins per hill.
4) Average length of flower stalk (excluding rachis) per hill.
5) Average number of flowers per rachis.
6) Average weight of flowers per rachis per plot per hectare.
7) Average number of unrooted bulblets per hill.
8) Average number of rooted bulblets per hill.
9) Vase life of rachis in days.

POST-HARVEST OBSERVATIONS :-

NUMBER OF LEAVES PER HILL :-

Number of leaves per hill at the time of harvest were counted.

NUMBER OF RACHIS PER HILL PER HECTARE :-

Number of rachis per hill per hectare were recorded at the time of harvest.

LENGTH OF RACHIS PER HILL :-

Length of rachis from the base of lower most flower bud to the base of upper most flower bud was measured and recorded in centimetre.

LENGTH OF FLOWER STALK PER HILL :-

Length of flower stalk was measured from just above the bulb to the base of upper most flower.

NUMBER OF FLOWERS PER RACHIS :-

Number of flowers were recorded by counting the flowers on a rachis.

PRE-HARVEST OBSERVATIONS :-

NUMBER OF LEAVES PER PLANT :-

First observation was taken 30 days after planting and at the interval of 15 days there after. In all six observations were recorded.

NUMBER OF DAYS REQUIRED FOR EMERGENCE OF FLOWER STALK FROM PLANTING :-

Number of days required for emergence of flower stalk from planting were counted from the date of planting upto emergence of flower stalk.

NUMBER OF DAYS REQUIRED FROM EMERGENCE OF FLOWER STALK TO HARVEST :-

Number of days required for harvesting from emergence of flower stalk were counted from the date of emergence of flower stalk to harvesting of flower stalk.

NUMBER OF DAYS REQUIRED FOR HARVESTING OF FLOWER STALK FROM PLANTING :-

Number of days required for harvesting from planting were counted from the date of planting to harvest of flower stalk.

POST-HARVEST OBSERVATIONS :-

NUMBER OF LEAVES PER HILL :-

Number of leaves per hill at the time of harvest were counted.

NUMBER OF RACHIS PER HILL PER HECTARE :-

Number of rachis per hill per hectare were recorded at the time of harvest.

LENGTH OF RACHIS PER HILL :-

Length of rachis from the base of lower most flower bud to the base of upper most flower bud was measured and recorded in centimetre.

LENGTH OF FLOWER STALK PER HILL :-

Length of flower stalk was measured from just above the bulb to the base of upper most flower.

NUMBER OF FLOWERS PER RACHIS :-

Number of flowers were recorded by counting the flowers on a rachis.

AVERAGE WEIGHT OF FLOWERS PER HILL(g) PER PLOT (kg) AND PER HECTARE (quintals) :-

The average yield of flowers per plot per hectare were counted from the yield of flowers per hill.

NUMBER OF ROOTED AND UNROOTED BULBLETS :-

Total number of unrooted and rooted bulblets were counted separately.

VASE LIFE OF RACHIS IN DAYS :-

The stalks having same number of flowers and [redacted] of same age are selected and kept in vase containing distilled water. Then days were counted till the opening of upper most flower bud.

STASTICAL ANALYSIS :-

Standard method of analysis known as 'Analysis of Variance' was used for statstical analysis (Panse and Sukhame 1978). The critical difference (C.D.) was worked out at 5 per cent level of significancefor the treatment comparisions where the 'f' test revealed significant. The treatment effects are presented by preparing the tables of means of important effects with the appropriate standard error means (SEM) and C.D. values.

CHAPTER IV

EXPERIMENTAL FINDINGS

PRE-HARVEST OBSERVAITONS :-

4.1 AVERAGE NUMBER OF LEAVES PER HILL :-

The average number of leaves as influenced by different treatments were recorded periodically at 15 days interval till harvest and presented in Table 1 to 6 and illustrated in Fig. 2.

EFFECT OF NITROGEN LEVELS :-

The data recorded in table 1 to 6 revealed that N_3 level of Nitrogen recorded significantly more number of leaves at 30, 45, 60 and 105 days after planting followed by N_2 , N_1 and N_0 treatment. However, N_2 and N_1 were at par with each other at 45 days after planting but N_2 was significantly superior over N_1 and N_0 at 30, 60, 90 and 105 days after planting.

However, at 75 days after planting the results were found to be non significant.

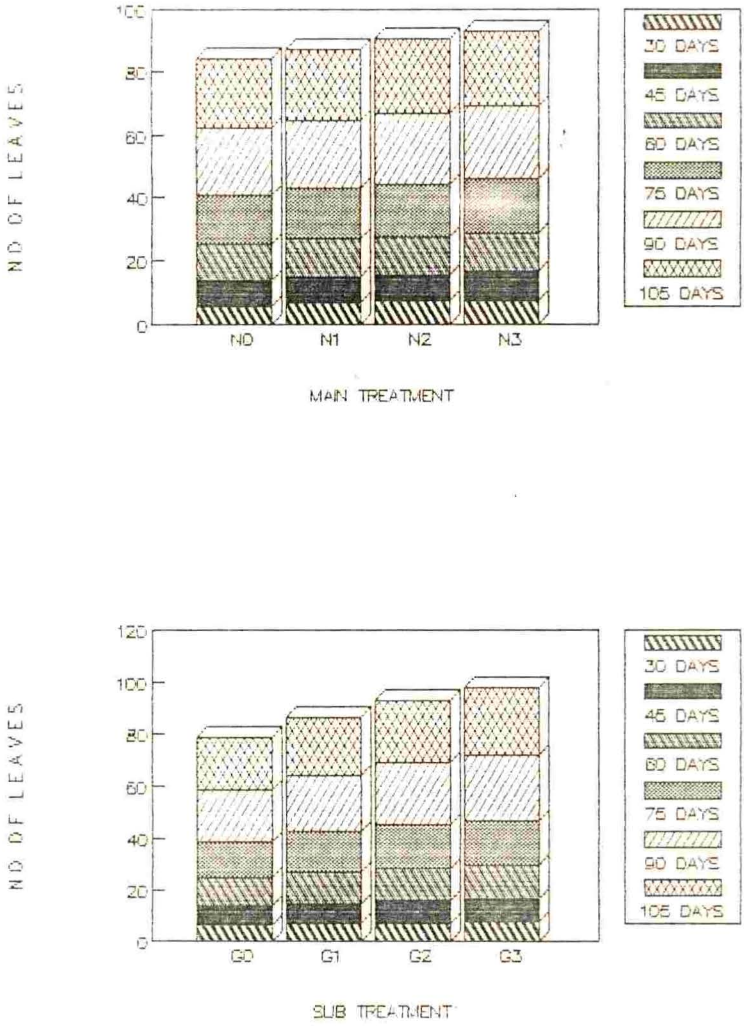


FIG 2. AVERAGE NUMBER OF LEAVES PER HILL.

Table 1: Data showing average number of leaves at 30 days after planting.

Main	Sub Treatments G_0	G_1	G_2	G_3	Mean
N_0	4.80	5.65	6.15	6.30	5.72
N_1	6.20	6.60	6.70	6.70	6.55
N_2	6.95	7.05	7.40	7.40	7.20
N_3	7.15	7.45	7.45	8.15	7.55
Mean	6.27	6.68	6.92	7.13	

Treatment	Nitrogen Level	GA	Interaction
'F' test	Sig	Sig	N.S.
S.E.(M)±	0.08	0.09	0.18
CD at 5%	0.26	0.26	-

Table 2: Data showing average number of leaves at 45 daysafter planting.

Main	Sub Treatments G_0	G_1	G_2	G_3	Mean
N_0	6.65	7.50	8.30	8.45	7.72
N_1	7.05	7.85	8.25	8.95	8.02
N_2	7.05	7.85	8.35	9.35	8.15
N_3	7.70	8.25	9.45	9.70	8.77
Mean	7.11	7.86	8.58	9.11	

Treatment	Nitrogen Level	GA	Interaction
'F' test	Sig	Sig	N.S.
S.E.(M)±	0.11	0.09	0.19
CD at 5%	0.35	0.27	0.55

Table 3: Data showing average number of leaves at 60 days after planting.

Main	Sub Treatments G_0	G_1	G_2	G_3	Mean
N_0	10.25	11.65	12.50	12.65	11.76
N_1	11.12	11.92	12.55	12.90	12.12
N_2	11.65	12.07	12.70	13.00	12.35
N_3	11.70	12.50	12.70	13.37	12.56
Mean	11.18	12.03	12.61	12.98	

Treatment	Nitrogen Level	GA	Interaction
'F' test	Sig	Sig	Sig
S.E.(M)±	0.06	0.08	0.16
CD at 5%	-	-	-

Table 4: Data showing average number of leaves at 75 days after planting.

Main	Sub Treatments G_0	G_1	G_2	G_3	Mean
N_0	13.50	15.40	16.70	17.60	15.80
N_1	14.05	15.95	17.50	18.15	16.41
N_2	14.10	16.30	17.70	18.40	16.62
N_3	15.05	16.80	17.85	18.00	16.92
Mean	14.17	16.11	17.43	18.04	

Treatment	Nitrogen Level	GA	Interaction
'F' test	NS	NS	NS
S.E.(M)±	1.12	0.62	1.25
CD at 5%	0.19	0.23	0.46

Table 5: Data showing average number of leaves at 90 days after planting.

Main	Sub Treatments G_0	G_1	G_2	G_3	Mean
N_0	18.40	20.70	22.60	24.30	21.50
N_1	19.15	20.50	22.70	24.25	21.65
N_2	20.50	21.80	23.80	24.85	22.74
N_3	21.10	22.65	24.40	25.85	23.50
Mean	19.78	21.41	23.38	24.81	

Treatment	Nitrogen Level	GA	Interaction
'F' test	Sig	Sig	Sig
S.E.(M)±	0.11	0.09	0.17
CD at 5%	0.35	0.25	0.50

Table 6: Data showing average number of leaves at 105 days after planting.

Main	Sub Treatments G_0	G_1	G_2	G_3	Mean
N_0	19.35	21.45	23.30	23.75	21.96
N_1	20.55	21.75	23.35	25.15	22.67
N_2	20.95	22.30	24.45	25.85	23.38
N_3	21.85	23.20	24.30	26.25	23.90
Mean	20.67	22.17	23.85	25.25	

Treatment	Nitrogen Level	GA	Interaction
'F' test	Sig	Sig	Sig
S.E.(M)±	0.11	0.07	0.13
CD at 5%	0.36	0.19	0.38

EFFECT OF GIBBERELLIC ACID :-

G_3 produced maximum average number of leaves than all other treatments followed by G_2, G_1 and G_0 at all the observations. G_3 produced significantly more average number of leaves at 45, 60, 90 and 105 days after planting. However, G_3 was at par with G_2 at 30 days after planting. The results were non significant at 75 days after planting.

EFFECT OF INTERACTION :-

The interaction effects of different combinations were found to be non significant at 30 and 75 days after planting.

The interaction effects were significant at 45, 60, 90 and 105 days after planting. The data revealed that treatment combination N_3G_3 was significantly superior over all other treatment combination at 90 and 105 days after planting followed by N_2G_3 and N_3G_2 at 90 days and N_2G_3, N_1G_3 at 105 days after planting but at par with N_3G_2 and N_2G_3 at 45 days after planting. At 60 days after planting N_3G_3 was at par with N_2G_3.

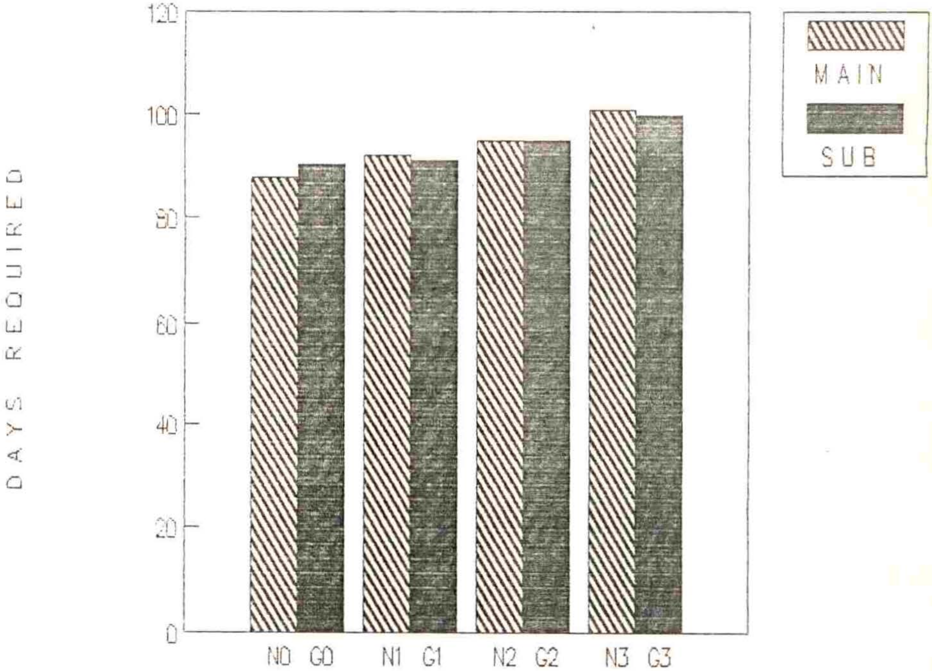


FIG 3. AVERAGE NUMBER OF DAYS REQUIRED FOR EMERGENCE OF FLOWER STALK.

4.2 AVERAGE NUMBER OF DAYS REQUIRED FOR EMERGENCE OF FLOWER STALK :-

The data in respect of average number of days required for emergence of flower stalk from planting time as influenced by different treatments were recorded and presented in table 7 and illustrated in fig. 3.

Table 7 : Data showing average number of days required for emergence of flower stalk from planting.

Main Treatments	Sub treatment				
	G_0	G_1	G_2	G_3	Mean
N_0	88.35	84.55	88.85	88.90	87.66
N_1	87.60	88.45	92.35	99.25	91.91
N_2	92.10	90.35	95.40	101.45	94.82
N_3	92.25	99.90	102.50	108.00	100.66
Mean	90.07	90.81	94.77	99.40	

Treatment	Nitrogen level	GA	Interaction
'F' test	Sig	Sig	N.S.
S.E. (M) ±	0.86	0.81	1.62
CD at 5%	2.74	2.33	—

EFFECT OF NITROGEN LEVELS :-

The data indicated that increasing dose of Nitrogen delays emergence of flower stalk. N_3 level of nitrogen recorded maximum average number of days for emergence of flower stalk. The result was significant to all other nitrogen levels followed by N_2, N_1 and N_0 level.

EFFECT OF GIBBERELLIC ACID :-

G_3 concentration recorded significant result in respect of average number of days required for emergence of flower stalk, followed by G_2, G_1 and G_0 concentration. However, G_1 and G_0 were at par with each other.

EFFECT OF INTERACTION :-

Interaction effects were found to be non significant.

4.3 AVERAGE NUMBER OF DAYS REQUIRED FROM EMERGENCE OF FLOWER STALK TO HARVEST :-

The data in respect of average number of days required from emergence of flower stalk to harvest as influenced by different treatments were recorded and presented in table 8 and illustrated in fig. 4.

Plate 1 : Growth and flowering of tuberose N_3G_3 (70 kg N/ha + 40 ppm GA)

Plate 2 : Growth and flowering of tuberose N_0G_0 (control)

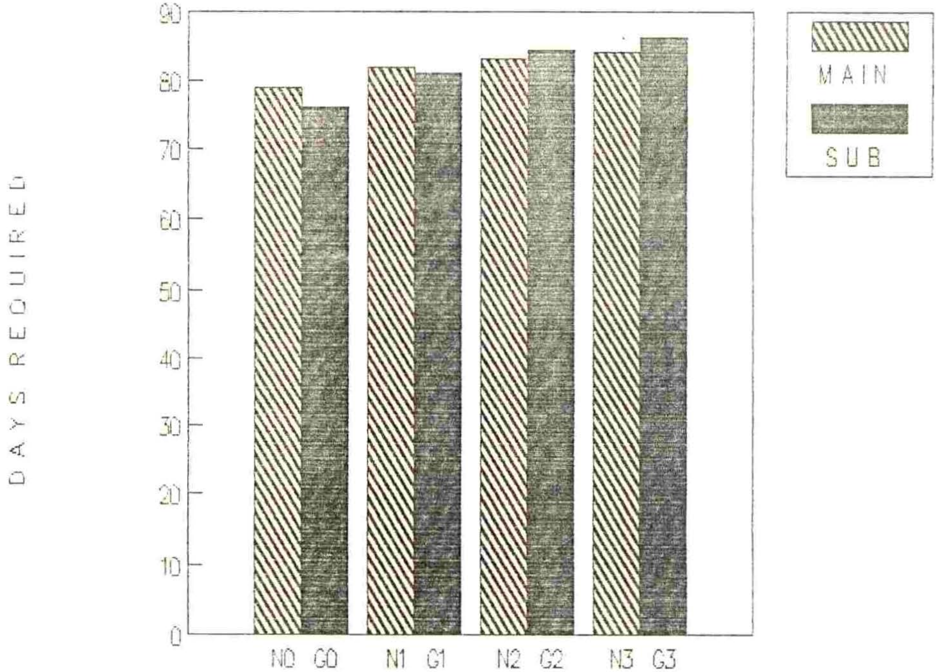


FIG 4. AVERAGE NUMBER OF DAYS REQUIRED FROM EMERGENCE OF FLOWER STALK TO HARVEST.

Table 8 : Data showing average number of days required from emergence of flower stalk to harvest.

Main Treatments	Sub treatments				
	G_0	G_1	G_2	G_3	Mean
N_0	72.90	78.00	82.20	82.20	78.82
N_1	74.65	79.95	84.85	87.35	81.70
N_2	76.70	81.70	85.15	88.85	83.10
N_3	79.47	84.25	85.90	86.50	84.03
Mean	75.93	80.97	84.52	86.22	

Treatments	Nitrogen level	GA	Interaction
'F' test	Sig	Sig	N.S.
S.E. (M) ±	0.92	0.99	1.99
CD at 5%	2.94	2.86	--

EFFECT OF NITROGEN LEVELS :-

N_3 level of nitrogen recorded maximum average number of days from emergence of flower stalk to harvest but it was at par with N_2 and N_1 level. However, N_1 and N_0 level were also at par with each other.

EFFECT OF GIBBERELLIC ACID :-

G_3 concentration recorded maximum average number of days from emergence of flower stalk to harvest but it

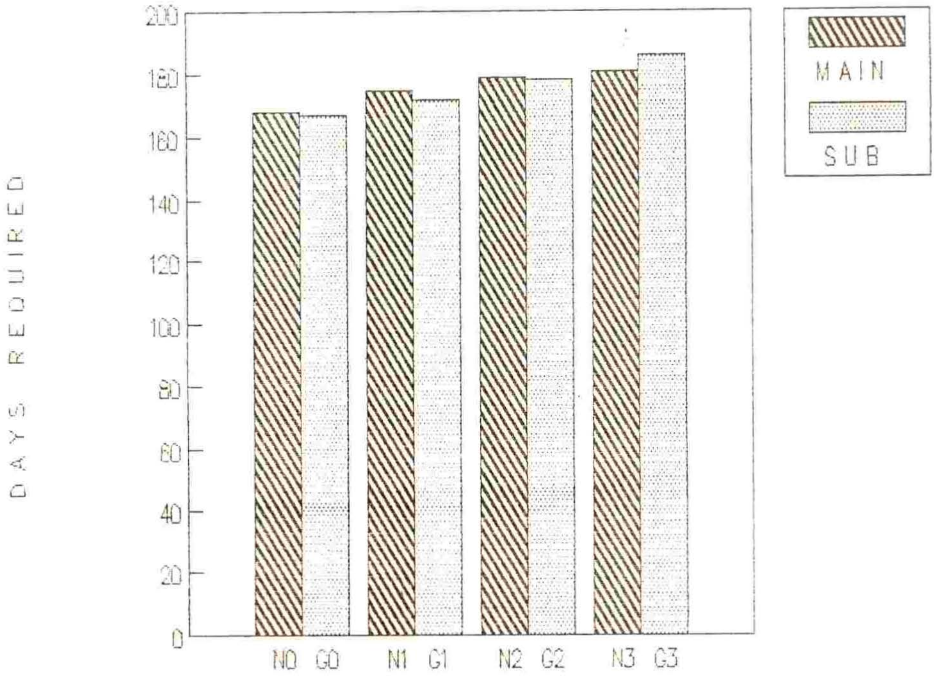


FIG 5. AVERAGE NUMBER OF DAYS REQUIRED FOR HARVESTING OF FLOWER STALK FROM PLANTING.

was at par with G_2 concentration. However, G_3 and G_2 concentration were significantly superior to rest of the GA concentrations.

EFFECTS OF INTERACTION :-

The interaction effects were found to be non significant.

4.4 AVERAGE NUMBER OF DAYS REQUIRED FOR HARVESTING OF FLOWER STALK FROM PLANTING :-

The average number of days required for harvesting of flower stalk from planting as influenced by different treatments were recorded and presented in Table 9 and illustrated in Fig. 5.

Table 9 : Data showing average number of days required for harvesting of flower stalk from planting.

Main Treatments	Sub treatments				
	G_0	G_1	G_2	G_3	Mean
N_0	163.00	164.50	170.70	176.25	168.61
N_1	164.30	170.15	175.50	188.10	174.51
N_2	171.57	174.60	181.30	187.95	178.85
N_3	170.15	177.90	184.70	190.20	180.73
Mean	167.25	171.78	178.05	185.62	

Treatments	Nitrogen level	GA	Interaction
'F' test	Sig	Sig	N.S.
S.E. (M) ±	1.068	0.81	1.62
CD at 5%	3.42	2.33	—

EFFECT OF NITROGEN LEVELS :-

The data recorded, indicates that increasing dose of nitrogen delays harvesting of flower stalk.

N_3 level recorded maximum days for harvesting of flower stalk, significantly superior over rest of the treatment except N_2 level. Both were at par with each other.

EFFECT OF GIBBERELLIC ACID :-

Higher concentration G_3 recorded significant result over all other concentrations in respect of period of harvesting of flower stalk followed by G_2, G_1 and G_0 concentrations.

EFFECTS OF INTERACTION :-

Interaction effects were found to be non significant.

POST HARVEST OBSERVATIONS :-

4.5 AVERAGE NUMBER OF LEAVES PER HILL AT HARVEST :-

The average number of leaves per hill at harvest as influenced by different treatments were recorded and presented in Table 10 and illustrated in Fig. 6.

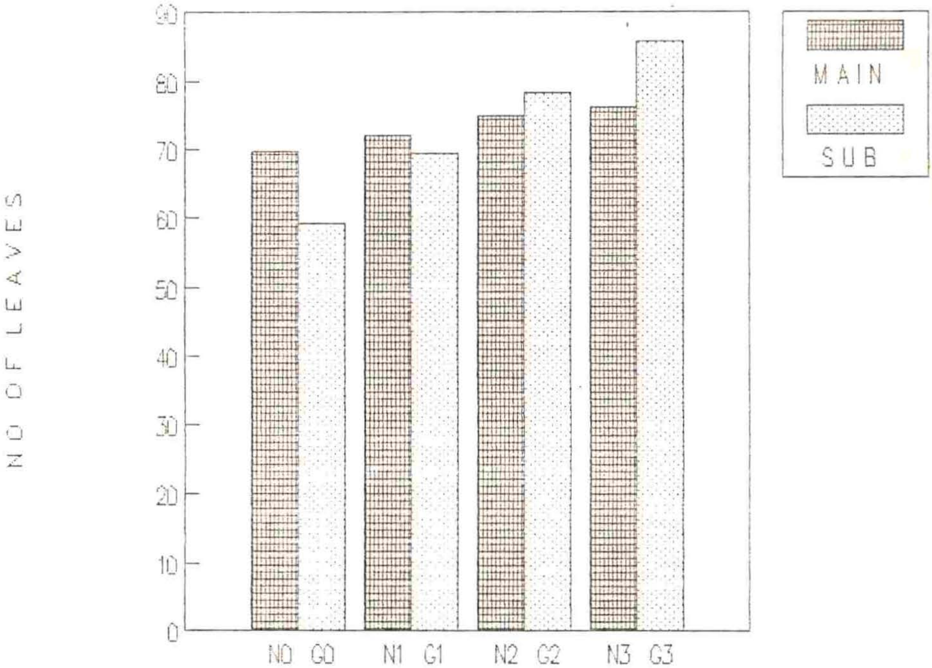


FIG 6. AVERAGE NUMBER OF LEAVES PER HILL AT HARVEST

Table 10 : Data showing average number of leaves per hill at harvest.

Main Treatments	Sub treatments				
	G_0	G_1	G_2	G_3	Mean
N_0	55.50	62.90	81.60	78.55	69.63
N_1	55.15	67.15	79.10	87.10	72.12
N_2	65.65	73.40	77.15	83.60	74.95
N_3	60.85	74.85	75.85	93.15	76.17
Mean	59.28	69.57	78.42	85.60	

Treatments	Nitrogen level	GA	Interaction
'F' test	Sig.	Sig.	N.S.
S.E. (M) ±	1.12	0.96	1.93
CD at 5%	3.57	2.77	5.53

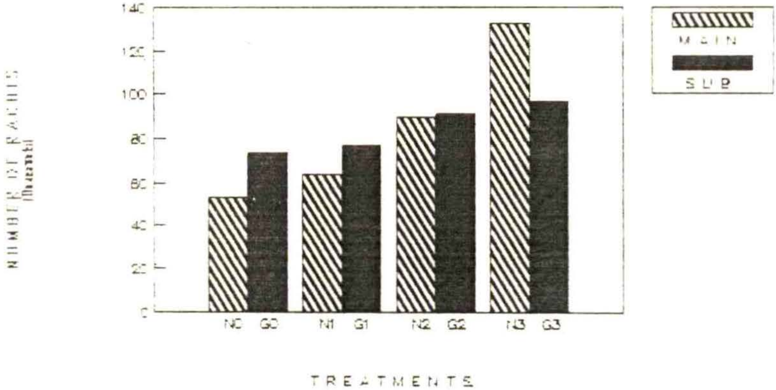
EFFECT OF NITROGEN LEVELS :-

Increasing level of nitrogen recorded increase in average number of leaves.

N_3 level recorded significant result over all other treatments except N_2 being at par. However, N_1 and N_2 were also at par with each other.

EFFECT OF GIBBERELLIC ACID :-

G_3 concentration recorded significantly more number of leaves than all other treatments followed by G_2, G_1 and G_0.



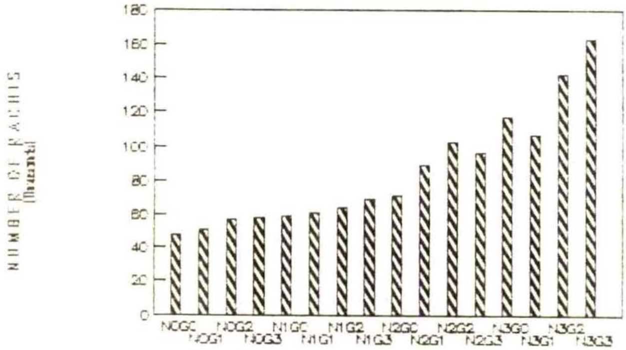


FIG 7. NUMBER OF RACHIS PER HECTARE.

EFFECTS OF INTERACTION :-

Treatment combination N_3G_3 recorded significantly more number of leaves followed by N_1G_3 and N_2G_3. However, N_1G_3 and N_2G_3 were at par with each other.

4.6 AVERAGE NUMBER OF RACHIS PER HILL AND PER HECTARE :-

The average number of rachis per hill and per hectare as influenced by different treatments were recorded and presented in Table 11 and Table 12 respectively and illustrated in Fig. 7.

Table 11 : Data showing average number of rachis per hill.

Main Treatments	Sub treatments				
	G_0	G_1	G_2	G_3	Mean
N_0	1.0	1.0	1.0	1.0	1.0
N_1	1.0	1.0	1.0	1.0	1.0
N_2	1.0	1.25	1.45	1.35	1.26
N_3	1.65	1.50	2.0	2.30	1.86
Mean	1.16	1.18	1.36	1.41	

Treatments	Nitrogen level	GA	Interaction
'F' test	Sig	Sig	N.S.
S.E. (M) ±	0.04	0.03	0.06
CD at 5%	0.13	0.09	0.18

Table 12 : Data showing average number of rachis per hectare.

Main Treatments	Sub treatments				
	G_0	G_1	G_2	G_3	Mean
N_0	47777.78	51111.11	56666.66	57777.78	53333.33
N_1	58888.89	61111.11	64444.44	68888.89	63333.33
N_2	71111.11	88888.89	103111.11	96000.00	89777.78
N_3	117333.33	106666.67	142222.22	163555.56	132444.45
Mean	73777.78	76944.45	91611.10	96555.55	

Treatment	Nitrogen Level	GA	Interaction
'F' test	Sig	Sig	Sig
SE(M)±	4744.44	4041.33	8333.33
CD at 5%	15597.22	12436.00	25000.00

EFFECT OF NITROGEN LEVELS :-

N_3 level of nitrogen produced maximum number of rachis per hill and per hectare which was significantly superior to all other treatments, except N_2 level. However, N_2 level was significantly superior to N_1 and N_0 level.

EFFECT OF GIBBERELLIC ACID :-

G_3 concentration of GA recorded highly significant result over all other GA concentrations, followed by G_2, G_1 and G_0.

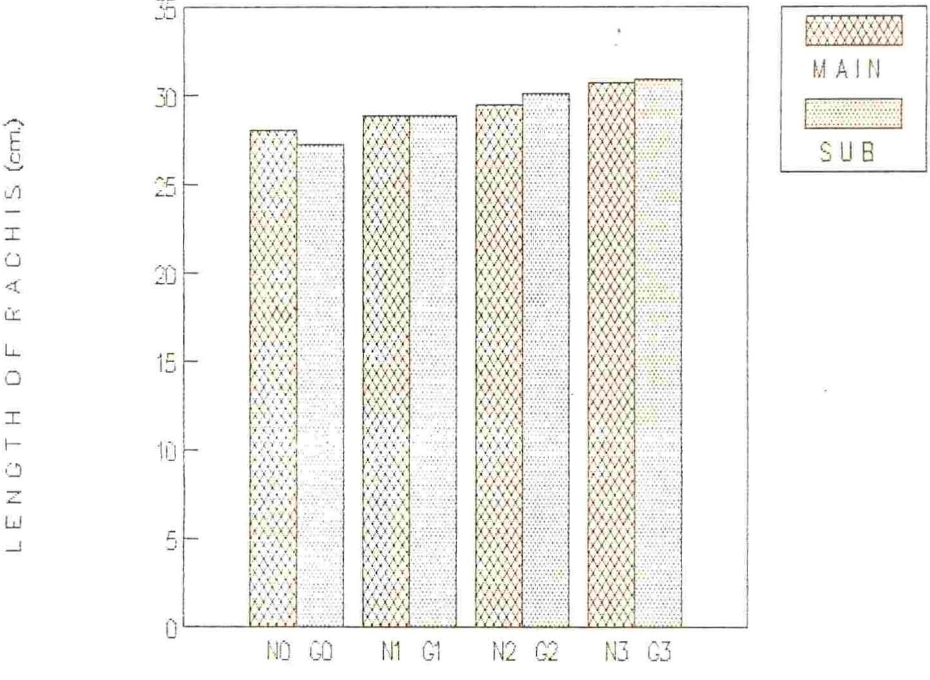


FIG 8. AVERAGE LENGTH OF RACHIS PER HILL (cm.).

EFFECT OF INTERACTION :-

N_3G_3 combination recorded significant results over all other treatment combination followed by N_2G_3, N_0G_3 and N_1G_3.

4.7 AVERAGE LENGTH OF RACHIS PER HILL :-

The data in respect of the average length of rachis per hill as influenced by different treatments were recorded and presented in Table 13 and illustrated in Figure. 8.

Table 13 : Data showing average length of rachis per hill (cm).

Main Treatments	Sub treatments				
	G_0	G_1	G_2	G_3	Mean
N_0	26.54	27.73	28.42	29.67	28.09
N_1	27.07	27.95	29.73	30.72	28.87
N_2	27.36	29.14	30.04	31.14	29.42
N_3	27.98	30.66	31.88	32.20	30.68
Mean	27.24	28.87	30.03	30.93	

Treatments	Nitrogen level	GA	Interaction
'F' test	Sig	Sig	N.S.
S.E. (M) ±	0.34	0.16	0.32
CD at 5%	1.11	0.47	—

EFFECT OF NITROGEN LEVEL :-

N_3 level of nitrogen produced significantly superior result as compared to all other nitrogen levels in respect of average length of rachis per hill, followed by N_2, N_1 and N_0 level. However, N_2 level was significantly superior over N_0 level, being at par with N_1 level.

EFFECT OF GIBBERELLIC ACID :-

G_3 concentration of GA produced significantly superior result as compared to all other GA concentration followed by G_2, G_1 and G_0 concentrations. G_2 concentration was also significantly superior to G_1 and G_0 concentration.

EFFECT OF INTERACTION:-

Interaction effects were found to be non significant.

4.8 AVERAGE LENGTH OF FLOWER STALK (EXCLUDING RACHIS) PER HILL :-

The data in respect of average length of flower stalk (excluding rachis) per hill as influenced by different treatments were recorded and presented in Table 14 and illustrated in Fig. 9.

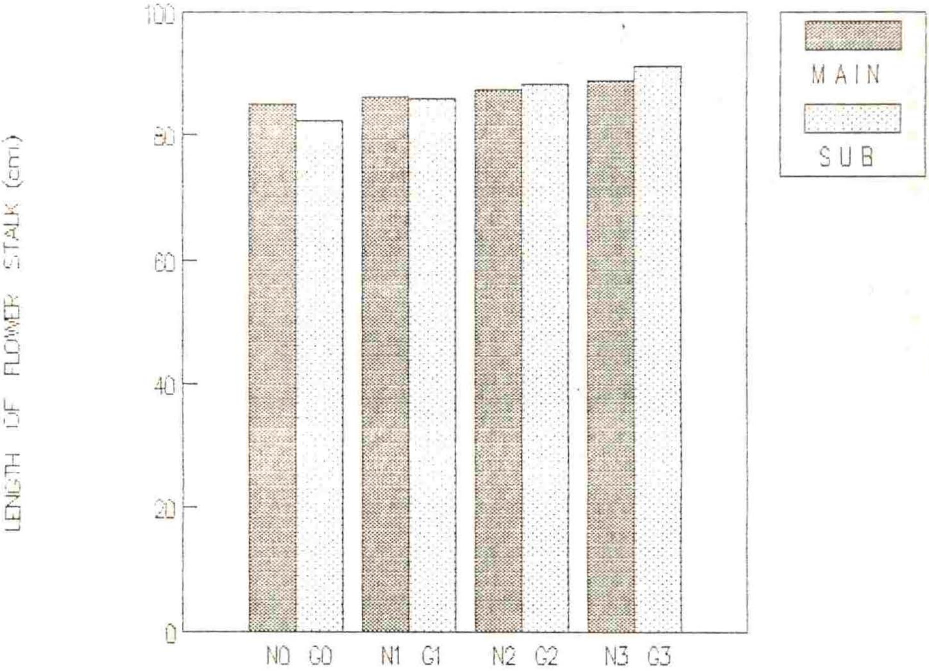


FIG 9. AVERAGE LENGTH OF FLOWER STALK (EXCLUDING RACHIS) PER HILL (cm.).

Table 14 : Data showing average length of flower stalk (cm)

Main Treatments	Sub treatments				
	G_0	G_1	G_2	G_3	Mean
N_0	81.40	85.28	86.32	87.41	85.10
N_1	81.39	85.74	87.75	90.63	86.37
N_2	82.73	86.30	88.06	92.94	87.50
N_3	84.55	86.46	90.87	93.36	88.78
Mean	82.51	85.94	88.25	91.06	

Treatments	Nitrogen level	GA	Interaction
'F' test	Sig	Sig	N.S.
S.E. (M) ±	0.92	0.39	0.78
CD at 5%	2.95	1.12	—

EFFECT OF NITROGEN LEVELS :-

N_3, N_2 and N_1 levels of nitrogen recorded significant results over N_0, being at par with each other. However, N_2, N_1 and N_0 were at par with each other.

EFFECT OF GIBBERELLIC ACID :-

G_3 concentration of GA recorded highly significant result followed by G_2, G_1 and G_0. G_2 and G_1 were also significantly superior to G_0 concentration.

EFFECT OF INTERACTION :-

Interaction effects were found to be non significant.

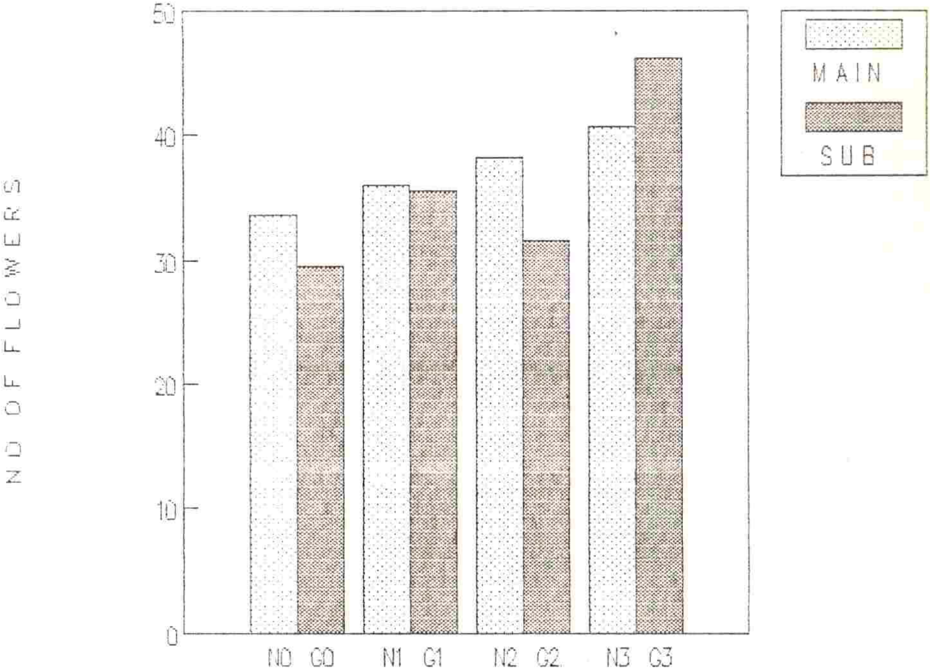


FIG 10. AVERAGE NUMBER OF FLOWERS PER STALK.

4.9 AVERAGE NUMBER OF FLOWERS PER STALK :-

The data in respect of average number of flowers per stalk as influenced by different treatments were recorded and presented in Table 15 and illustrated in Fig. 10.

Table 15 : Data showing average number of flowers per stalk.

Main Treatments	Sub treatments				
	G_0	G_1	G_2	G_3	Mean
N_0	27.40	32.05	35.45	40.05	33.73
N_1	28.20	35.90	36.00	44.10	36.05
N_2	29.80	35.90	38.85	48.05	38.15
N_3	31.65	38.20	40.15	52.60	40.65
Mean	29.26	35.51	37.61	46.20	

Treatments	Nitrogen level	GA	Interaction
'F' test	Sig	Sig	N.S.
S.E. (M) ±	0.07	0.09	0.19
CD at 5%	0.21	0.27	0.54

EFFECT OF NITROGEN LEVEL :-

N_3 level of nitrogen produced maximum flowers per stalk. The result was highly significant over all other nitrogen levels followed by N_2, N_1 and N_0 levels. However, N_2 and N_1 were also significantly superior over N_0.

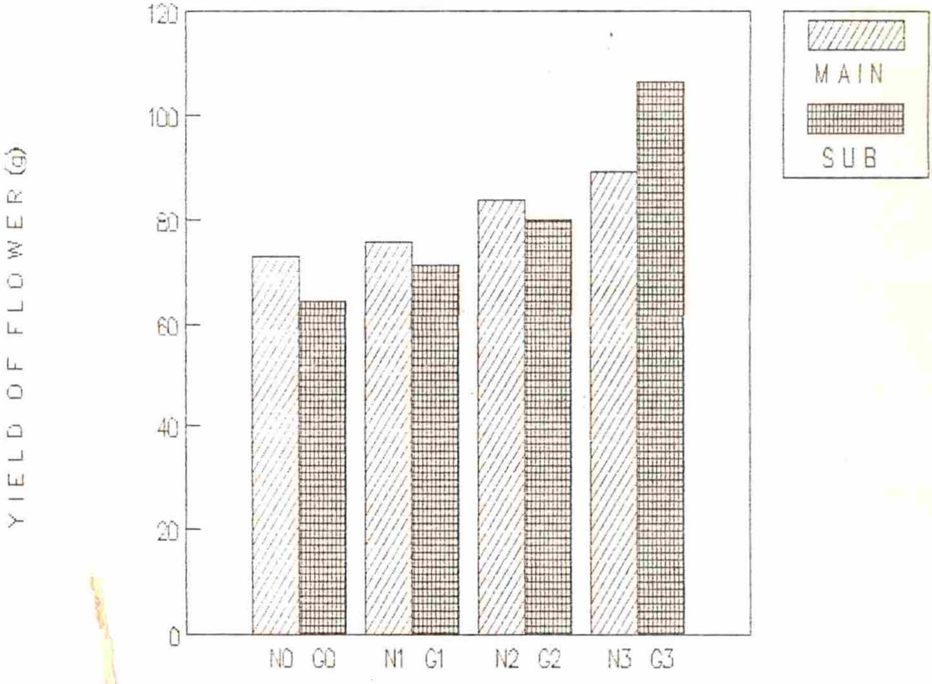


FIG 11. AVERAGE YIELD OF FLOWERS PER PLANT IN GRAM.

EFFECT OF GIBBERELLIC ACID :-

G_3 concentration of GA recorded highly significant results as compared to all other GA concentrations followed by G_2, G_1 and G_0.

EFFECT OF INTERACTION :-

N_3G_3 recorded significant results as compared to all other treatment combination followed by N_2G_3, N_1G_3 and N_3G_2 combinations.

4.10 AVERAGE YIELD OF FLOWERS PER PLANT IN GRAM :-

The data in respect of flower yield per plant as influenced by different treatments were recorded and presented in Table 16 and illustrated in Fig. 11.

Table 16 : Data showing average yield of flowers per plant (g).

Main Treatments	Sub treatments				
	G_0	G_1	G_2	G_3	Mean
N_0	62.67	66.94	67.85	95.84	73.32
N_1	64.21	69.06	70.11	99.79	75.79
N_2	65.25	69.74	87.58	113.40	83.99
N_3	66.14	79.71	95.16	115.56	89.14
Mean	64.56	71.36	80.17	106.14	

Treatments	Nitrogen level	GA	Interaction
'F' test	Sig	Sig	N.S.
S.E. (M) ±	1.47	1.29	2.57
CD at 5%	4.69	3.70	7.39

EFFECT OF NITROGEN :-

N_3 level of nitrogen recorded significantly superior results followed by N_2, N_1 and N_0 level. N_2 and N_1 were also significantly superior to N_0 level. Minimum yield was recorded by N_0 level.

EFFECT OF GIBBERELLIC ACID :-

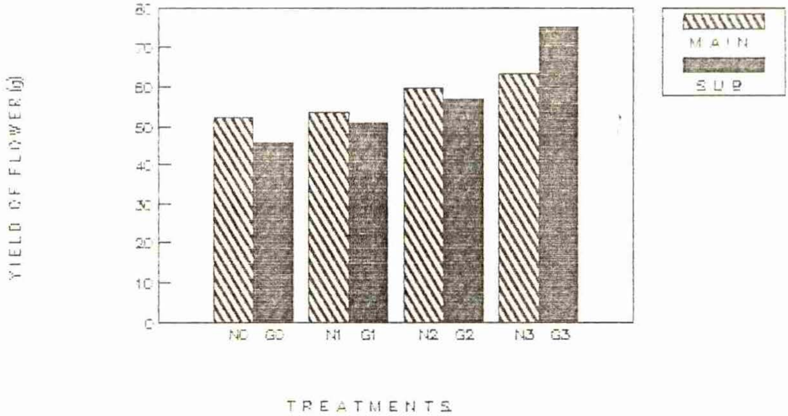
G_3 concentration of GA recorded highly significant results as compared to rest of the GA concentrations. However, G_2 and G_1 were also highly significant over G_0 concentration. Minimum yield was recorded by G_0 concentration.

EFFECT OF INTERACTION :-

N_3G_3 and N_2G_3 recorded significanly superior results over all other treatment combinations being at par with each other. However, N_1G_3 and N_0G_3 were at par with each other. Minimum yield was recorded by N_0G_0 combination.

4.11 AVERAGE YIELD OF FLOWERS PER PLOT AND PER HECTARE IN QUINTALS :-

The data in respect of yield of flowers as influenced by different treatments were recorded an presented in Table 17 and 18 and illustrated in Fig. 12.



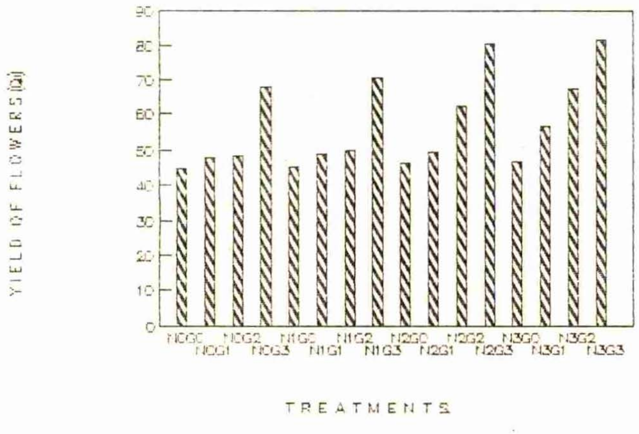


FIG 12. AVERAGE YIELD OF FLOWERS PER HECTARE IN QUINTALS.

EFFECT OF NITROGEN :-

N_3 recorded significantly superior yield (63.10 q/ha) as compared to rest of the nitrogen levels. Similarly N_2 level was also significantly superior to N_1 and N_0 level. However, N_1 and N_0 levels were at par with each other.

EFFECT OF GIBBERELLIC ACID :-

G_3 concentration of GA produced significantly superior yield (75.21 q/ha) as compared to rest of the GA concentration. Similarly, G_2 and G_1 were also significantly superior over G_0 concentration. G_2 was also significantly superior over G_1.

EFFECT OF INTERACTION :-

N_3G_3 and N_2G_3 combinations recorded significantly superior yield (81.77 q/ha and 80.44 q/ha respectively) over all other treatment combinations, being at par with each other. However, next in order were N_1G_3 and N_0G_3 being at par with each other. N_0G_0 recorded lowest yield per hectare.

4.12 AVERAGE NUMBER OF ROOTED BULBLETS PER HILL :-

The data in respect of average number of rooted bulblets as influenced by different treatments were recorded and presented in Table 19 and illustrated in Fig. 13.

Table 17 : Data showing average yield of flowers per plot in kilogram.

Main Treatments	Sub treatments				
	G_0	G_1	G_2	G_3	Mean
N_0	1.00	1.07	1.08	1.53	1.17
N_1	1.02	1.10	1.12	1.59	1.20
N_2	1.04	1.11	1.40	1.81	1.34
N_3	1.05	1.27	1.52	1.84	1.42
Mean	1.02	1.13	1.28	1.69	

Treatments	Nitrogen level	GA	Interaction
'F' test	Sig	Sig	N.S.
S.E. (M) ±	0.02	0.03	0.05
CD at 5%	0.07	0.08	0.15

Table 18 : Data showing average yield of flowers per hectare in quintal

Main Treatments	Sub treatments				
	G_0	G_1	G_2	G_3	Mean
N_0	44.44	47.55	48.00	68.00	51.99
N_1	45.33	48.88	49.77	70.66	53.66
N_2	46.22	49.33	62.22	80.44	59.55
N_3	46.66	56.44	67.55	81.77	63.10
Mean	45.66	50.55	56.88	75.21	

Treatments	Nitrogen level	GA	Interaction
'F' test	Sig	Sig	N.S.
S.E. (M) ±	1.19	1.40	2.18
CD at 5%	3.41	4.48	6.25

EFFECT OF NITROGEN :-

N_3 recorded significantly superior yield (63.10 q/ha) as compared to rest of the nitrogen levels. Similarly N_2 level was also significantly superior to N_1 and N_0 level. However, N_1 and N_0 levels were at par with each other.

EFFECT OF GIBBERELLIC ACID :-

G_3 concentration of GA produced significantly superior yield (75.21 q/ha) as compared to rest of the GA concentration. Similarly, G_2 and G_1 were also significantly superior over G_0 concentration. G_2 was also significantly superior over G_1.

EFFECT OF INTERACTION :-

N_3G_3 and N_2G_3 combinations recorded significantly superior yield (81.77 q/ha and 80.44 q/ha respectively) over all other treatment combinations, being at par with each other. However, next in order were N_1G_3 and N_0G_3 being at par with each other. N_0G_0 recorded lowest yield per hectare.

4.12 AVERAGE NUMBER OF ROOTED BULBLETS PER HILL :-

The data in respect of average number of rooted bulblets as influenced by different treatments were recorded and presented in Table 19 and illustrated in Fig. 13.

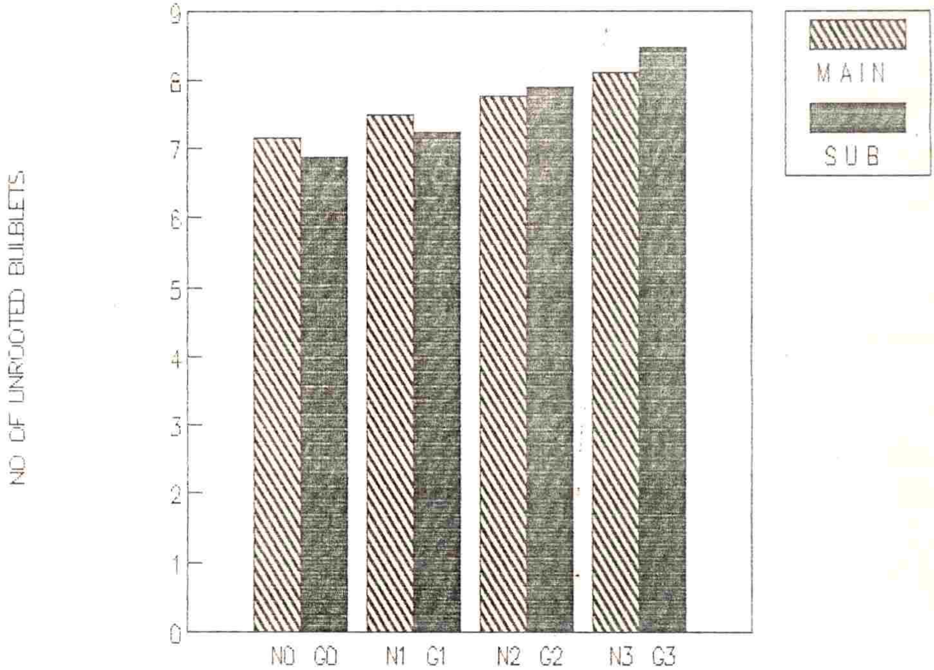


FIG 13. AVERAGE NUMBER OF ROOTED BULBLETS PER HILL.

Table 19 : Data showing average number of rooted bulblets per hill.

Main Treatments	Sub treatments				
	G_0	G_1	G_2	G_3	Mean
N_0	6.75	6.85	6.95	8.05	7.15
N_1	6.75	7.10	7.85	8.30	7.50
N_2	6.95	7.50	8.25	8.30	7.75
N_3	7.10	7.55	8.55	9.25	8.11
Mean	6.88	7.25	7.90	8.47	

Treatments	Nitrogen level	GA	Interaction
'F' test	Sig	Sig	N.S.
S.E. (M ±)	0.22	0.24	0.49
CD at 5%	0.72	0.70	—

EFFECT OF NITROGEN :-

N_3 level of nitrogen recorded significantly more yield of average number of rooted bulblets per hill followed by N_2, N_1 and N_0 level. However, N_2, N_1 and N_0 were at par with each other.

EFFECT OF GIBBERELLIC ACID :-

G_3 concentration of GA recorded significant result over G_1 and G_0 being at par with G_2 concentration.

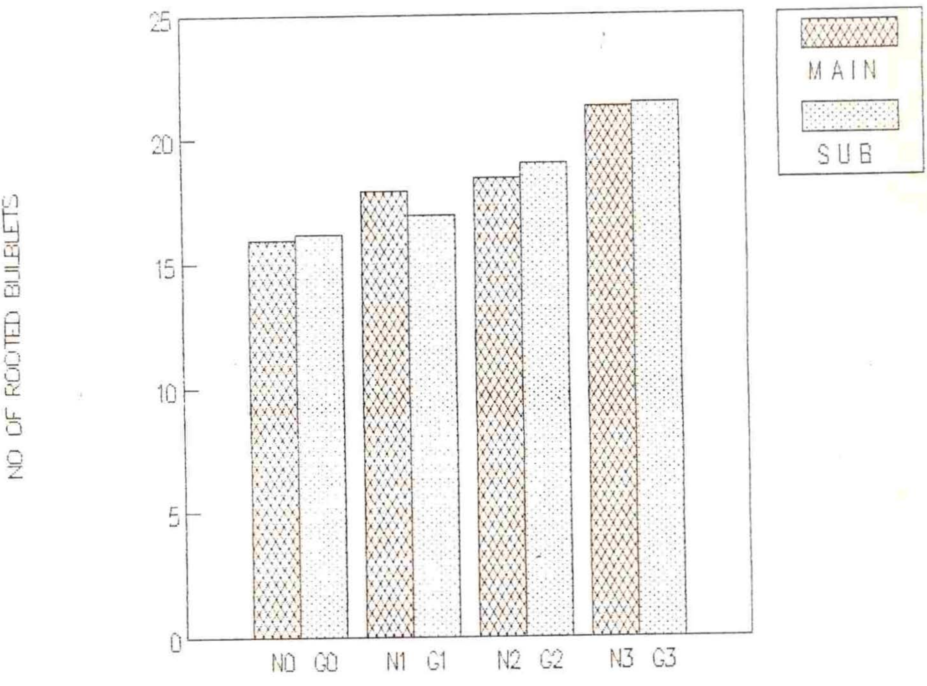


FIG 14. AVERAGE NUMBER OF UNROOTED BULBLETS PER HILL.

EFFECT OF INTERACTION :-

Interaction effects were found to be non significant.

4.13 AVERAGE NUMBER OF UNROTTED BULBLETS PER HILL :-

The data in respect of average number of unrooted bulblets produced as influenced by different treatments were recorded and presented in Table 20, and illustrated in Fig. 14.

Table 20 : Data showing average number of unrooted bulblets per hill.

Main Treatments	Sub treatments				
	G_0	G_1	G_2	G_3	Mean
N_0	14.10	14.92	16.40	18.50	15.98
N_1	14.35	17.15	19.55	20.70	17.93
N_2	17.10	15.45	16.70	24.42	18.41
N_3	19.05	20.55	23.40	21.94	21.23
Mean	16.15	17.01	19.01	21.39	

Treatments	Nitrogen level	GA	Interaction
'F' test	Sig	Sig	N.S.
S.E. (M) ±	0.30	0.55	1.10
CD at 5%	0.97	1.58	—

EFFECT OF NITROGEN :-

N_3 level of nitrogen produced significantly superior results as compared to rest of the treatments followed by N_2, N_1 and N_0 level. However, N_2 and N_1 level were at par with each other. N_0 level recorded lowest average number of unrooted bulblets per hill.

EFFECT OF GIBBERELLIC ACID :-

G_3 concentration recorded significantly superior yield of unrooted bulblets over all other treatments. G_2 concentration recorded significantly more yield over G_1 and G_2 concentration.

EFFECT OF INTERACTION :-

Interaction effects were found to be non significant.

4.14 AVERAGE VASE LIFE PERIOD OF CUT FLOWERS IN DAYS :-

The data in respect of average vase life period of harvested spike as influenced by different treatments were recorded and presented in Table 21, and illustrated in Fig. 15.

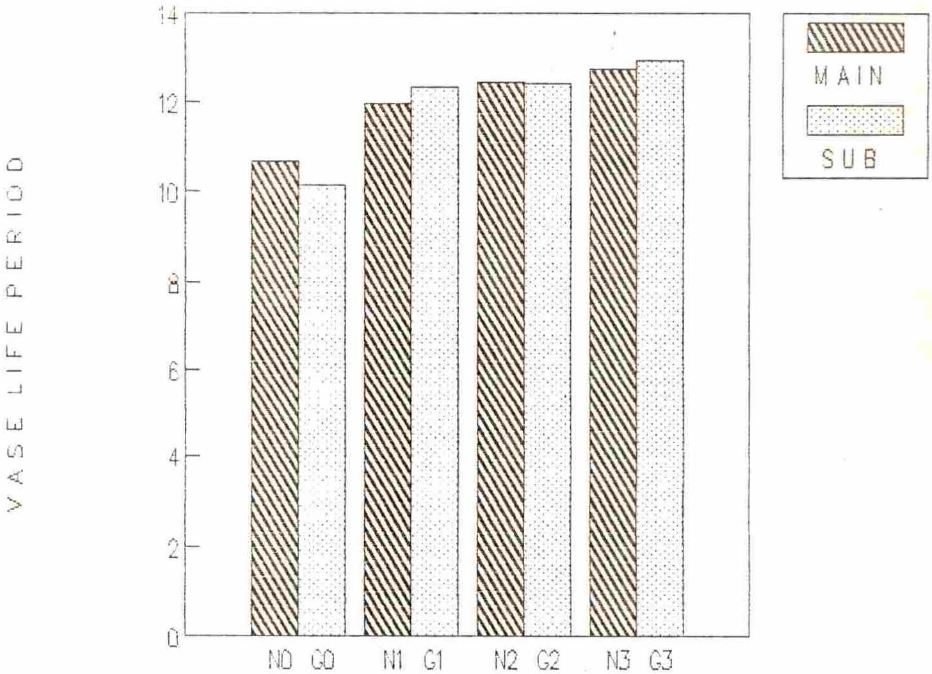


FIG 15. AVERAGE VASE LIFE PERIOD OF CUT FLOWERS IN DAYS.

Table 21 : Data showing average vase life period of cut flowers (spike) in days.

Main Treatments	Sub treatments				
	G_0	G_1	G_2	G_3	Mean
N_0	8.99	11.55	10.22	11.77	10.63
N_1	9.41	12.15	12.90	13.30	11.94
N_2	10.55	12.80	13.12	13.30	12.44
N_3	11.55	12.72	13.30	13.40	12.74
Mean	10.12	12.30	12.38	12.94	

Treatments	Nitrogen level	GA	Interaction
'F' test	Sig	Sig	N.S.
S.E. (M) ±	0.49	0.25	0.51
CD at 5%	1.58	0.74	—

EFFECT OF NITROGEN :-

N_3, N_2 and N_1 level of nitrogen recorded significantly more average vase life period than N_0 level, being at par with each other.

EFFECT OF GIBBERELLIC ACID :-

G_3, G_2 and G_1 concentration recorded significantly superior results over G_0 concentrations. All the concentrations recorded significantly more average vase life period than control. However, all the concentrations of GA were at par with each other.

EFFECT OF INTERACTION :-

Interaction effects were found non significant.

CHAPTER V

DISCUSSION

The findings in respect of growth and yield of tuberose, presented in the previous chapter are discussed in this chapter by reviewing the available literature.

PRE-HARVEST OBSERVATIONS

5.1. NUMBER OF LEAVES :-

Increasing levels of nitrogen exhibited increasing trend in respect of production of leaves. At all the stages of growth more number of leaves were recorded under increasing levels of nitrogen. Similar results were reported by Jana et.al. (1974) in tuberose, Rahman and Mitra (1976) in dahlia, Allurwar (1980) in tuberose, Bhattacharjee et.al. (1982) in hippeastrum, Shah et.al. (1984) in gladiolus, Uttarwar (1984) and Bankar and Mukhopadhyay (1985) in tuberose.

It is well established fact that GA act in cell elongation or enlargement, resulting in increasing number of leaves. Increasing concentration of GA exhibited increasing trend in production of more number of leaves at all the stages of growth. Soaking of tuberose bulbs in GA at 40 ppm concentration recorded maximum number of leaves and minimum in control at all the stages. Similar results were reported by Singh et.al. (1983) in onion, Bhattacharjee (1984) in gladiolus. But Laiche and Box (1973) in lily, Mukhopadhyay and Sadhu (1985) in tuberose recorded reduction in number of leaves.

However, increasing dose of nitrogen with increasing concentration of GA i.e. N_3G_3 (70 kg N/ha + 40 ppm GA_3) recorded maximum number of leaves (26.25) and minimum (19.35) under N_0G_0 (0 kg N/ha + water soaking). The results were not significant at 75 days after planting.

5.2. DAYS REQUIRED FOR EMERGENCE AND HARVESTING OF FLOWER STALK FROM PLANTING :-

The data (Table 7 and 8) revealed that N_3 level (75 kg N/ha) recorded maximum days (100.66) for emergence of flower stalk followed by N_2 and N_1 level (60 kg N, 50 kg N/ha respectively). N_0 (0 kg N/ha) recorded minimum days for emergence of flower stalk. Thus it can be said that increasing dose of nitrogen helped in increasing vegetative growth and delays emergence and harvesting of flower stalk. Similar findings were recorded by Wilsie (1961), Bhattacharjee (1981) in gladiolus, Bhattacharjee (1982) in hippeastrum, Jagtap (1983) in tuberose, Shah et.al. (1984) in gladiolus.

Similarly, soaking of bulbs in higher concentration of GA (40 ppm) recorded maximum days for emergence and harvesting (99.40 and 86.22 days respectively) of flower stalk from emergence, followed by 20 ppm (94.77 days and 84.52 days) and 10 ppm (90.81 days and 80.97 days). These findings are in agreement with the findings of Biswas et.al. (1983) in tuberose. However, Bhattacharjee (1984) in gladiolus, reported that gibberellic acid stimulated flower stalk. Thus GA_3 helped in developing more vegetative growth and hence delayed emergence and harvesting of flower stalk.

However, combined effect of nitrogen level and GA concentration was found non significant.

POST-HARVEST OBSERVATIONS :-

5.3. NUMBER OF LEAVES AT HARVEST :-

The data recorded (Table 10) revealed that N_3 level of nitrogen (70 kg N/ha) recorded (76.17 leaves) followed by 60 kg N/ha and 50 kg N/ha (74.95 leaves and 72.12 leaves respectively).

Similarly GA at 40 ppm concentration recorded (85.60 leaves) followed by 20 ppm and 10 ppm (78.42 leaves and 69.57 leaves respectively).

As regards combined effect N_3G_3 (70 kg N/ha + 40 ppm GA concentration) recorded maximum number of leaves (93.15 leaves) followed by N_1G_3 (87.10 leaves) and N_2G_3 (83.60 leaves). These results are in agreement with the findings of Bhattacharjee et.al. (1982) in hippeastrum and Uttarwar (1984) in tuberose.

5.4. NUMBER OF RACHIS PER HILL AND PER HECTARE :-

The data (Table 12) revealed that maximum rachis (1.86/hill and 132444.45/ha) were recorded under N_3 level (70 kg N/ha).

Similarly GA at 40 ppm concentration recorded maximum rachis (1.41/hill and 96555.55/ha) similar findings were recorded by Bhattacharjee et.al. (1982) in hippeastrum, Biswas et.al. (1983) in tuberose, Borelli (1984) and, Potti and Arora (1984) in gladiolus.

However, combined effect of nitrogen level and GA concentration recorded maximum number of rachis (163555.56/ha) under N_3G_3 (75 kg N/ha + 40 ppm concentration).

These results might be due to the fact that enhanced physiological activities of plant due to application of higher nitrogen level and GA_3 concentration, helped in development of more number of leaves, resulted in enhanced production and uptake of nutrients for productin of more number of rachis.

5.5. LENGTH OF RACHIS AND FLOWER STALK :-

The data (Table 13 and 14) indicated that nitrogen level (70 kg N/ha) and GA concentration (40 ppm) recorded maximum length of rachis (30.68 cm and 30.93 cm respectively).

Similarly the nitrogen level, 70 kg N/ha and GA concentration (40 ppm) recorded maximum length of flower stalk (88.78 cm and 91.06 cm respectively). This is due to enhanced growth rate of vegetative plant part due to the enhanced physiological activity influenced by higher dose of nitrogen and growth regulator. These findings are in agreement with Kosugi (1960) in gladiolus, Bhattacharjee et.al. (1982) in hippeastrum, Shah et.al. (1984) in gladiolus, Bankar and Mukhopadhyay (1985) in tuberose, Lemeni and Lemeni (1985) in gladiolus, Gowda et.al (1988) Sidhu and Arora (1989) in gladiolus.

As regards combined effect of nitrogen level and GA concentration was found non significant.

5.6. **NUMBER OF FLOWERS PER STALK** :-

The data (Table 15) revealed that maximum (40.65) flowers were recorded under higher nitrogen level (70 kg N/ha) and GA (40 ppm) recorded (46.20). This might be due to more number of internodes on increased length of rachis. These findings as regards effect of nitrogen levels, are in agreement with the findings of Garibaldi (1964) in gladiolus, Mitra et.al. (1976) in tuberose, Potti and Arora (1980) in gladiolus, Nanjan et.al. (1980) in tuberose, Jana and Bose (1980) and Bhattacharjee et.al. (1982) in hippeastrum, Jagtap (1983) in tuberose, Shah et.al (1984) and Gowda et.al (1988) in gladiolus.

As regards effect of GA, similar results were recorded by Bose et.al. (1980) in hippeastrum, Biswas et.al. (1983) in tuberose, Bhattacharjee (1984) in gladiolus, Corr and Widmer (1991) in Zantedeschia.

However, combined effect of nitrogen level and GA concentration, recorded maximum flower (52.60) under N_3G_3 (70 kg N/ha + 40 ppm GA concentration).

5.7. **YIELD OF FLOWERS PER HECTARE** :-

The data (Table 18) revealed that maximum yield of flowers (63.10 q/ha) were recorded under higher level of nitrogen (70 kg N/ha) followed by 60 kg N and 50 kg N/ha (59.55 and 53.66 q/ha respectively).

Similarly 40 ppm GA concentration recorded maximum flower yield (75.21 q/ha) followed by 20 ppm and 10 ppm concentration. (56.88 and 50.55 q/ha respectively). Similar results were reported by Garibaldi (1964) and Lemeni and Lemeni (1965) in gladiolus, Jana et.al. (1974) in tuberose, Mitra et.al. (1979) in tuberose, Bose et.al (1980) in hippeastrum, Nanjan et.al (1980) and Biswas et.al (1983) in tuberose, Deswal et.al (1983), Bhattacharjee (1984), Shah et.al. (1984) and Potti and Arora (1987) in gladiolus, Mugge et.al. (1987) in tulip, Gowda et.al. (1988) in gladiolus, Corr and Widmer (1991) in Zantedeschia.

The combined effect in respect of yield of flowers per hectare was maximum (81.77 q/ha) under N_3G_3 (70 kg N/ha + 40 ppm GA_3) followed by N_2G_3 (60 kg N/ha + 40 ppm GA_3) (80.44 q/ha).

More number of leaves, their enhanced activity due to higher dose of nitrogen and soaking of bulb in growth regulator (GA) enhanced physiological activity and uptake of nutrients, which might have increased chlorophyll content. Chlorophyll pigment consists of chloroplasts. Chloroplasts are dynamic entities of green cells in which photosynthesis continues. The plant synthesize food from CO_2 and H_2O in presence of chlorophyll and radiation. Thus increased quantity of chlorophyll might have resulted in increased yield of flowers.

5.8. **NUMBER OF ROOTED AND UNROOTED BULBLETS** :-

The data (Table 19 and 20) revealed that higher level of nitrogen (70 kg N/ha) and more concentration of GA_3 (40 ppm) recorded more number of rooted bulblets (8.11 and 8.47 respectively) and unrooted bulblets (21.23 and 21.39 respectively). These findings are in agreement with the findings of Joiner et.al. (1964) in amaryllis, Winkler (1969) in gladiolus, Cirrito (1975) and Allurwar (1980) in tuberose, Bhattacharjee (1984), Potti and Arora (1986) in gladiolus. However kosugi (1960) and Sakalska (1968) in gladiolus reported that the number of cormels was greater at low nitrogen and decreased markedly at the highest nitrogen level.

This might be due to more production of food material in the leaves, due to enhance physiological activities resulted in development of more number of rooted and unrooted bulblets.

5.9. **VASE LIFE PERIOD OF CUT FLOWERS (RACHIS)** :-

The data (Table 21) revealed that higher nitrogen level (70 kg N/ha) and higher GA concentration (40 ppm) recorded maximum vase life period 12.74 days and

12.94 days respectively. Similar findings were also observed by Deswal and Patil (1983) and Bhattacharjee (1984) in gladiolus.

The enhanced activity of plant due to high nitrogen and high GA concentration accumulated such substances in the rachis (flowers) which might have helped in prolonging vase life of cut flowers (rachis).

The interaction effect with regard to a length of rachis, length of flower stalk, number of rooted and unrooted bulblets and days for vase life were found to be non significant.

CHAPTER VI

SUMMARY AND INFERENCES

A field experiment "Effect of Nitrogen levels and Gibberellic acid on growth and flowering of tuberose (Polianthes tuberosa, L.) was conducted from July 91 to January 92 at Agriculture college Garden, Maharajbag, Nagpur.

The experiment was laid out in Split Plot Design with four levels of Nitrogen (0, 50, 60 and 70 kg N/ha) and four concentrations of Gibberellic acid (0, 10, 20 and 40 ppm) with a common level of Phosphorus and Potash (20 and 30 kg/ha respectively), replicated four times.

The results in respect of growth and yield are summerised below :-

Higher dose of Nitrogen (70 kg N/ha) and higher concentration of GA (40 ppm) exhibited significantly superior growth in respect of number of leaves, throughout the period of experimentation. Similarly above levels of Nitrogen and GA concentration also exhibited significantly superior results in respect of days required for harvesting, number of rachis/hill, length of rachis, yield of flowers/ha, number of bulblets (rooted and unrooted) and prolonging vase life of rachis.

Amongst various treatment combinations N_3G_3 (70 kg N/ha + soaking of bulbs in 40 ppm GA concentrations) exhibited significantly superior results in respect of number of leaves per hill, days required for harvesting of flower stalk, number of rachis/hill, length of rachis, number of flowers/stalk, yield of flowers/ha, number of rooted and unrooted bulblets and prolonging vase life of rachis.

The present investigation thus, revealed that response of Nitrogen and Gibberellic acid combination (70 kg N/ha + 40 ppm GA_3) exhibited significantly superior results in respect of vegetative growth and yield of tuberose flowers. Being the first attempt of the present investigation the results are suggestive and not conclusive. The findings need confirmation.

LITERATURE CITED

Allurwar, S.V. (1980) : Effect of different levels of nitrogen on growth and flowering in tuberose (*Polianthes tuberosa*, linn) Unpublished M.Sc. thesis submitted to Punjabrao Krishi Vidyapeeth, Akola.

* Auge, R. (1982) : The inflence of gibberellic acid on the flowering of Gladislus Cr. Hunting song. Hort. Abst. 53(3) : 1875.

* Auge, R. (1982) : Research on the forcing of tubblips Cv. Apeldron (heat treatment of bulbs and action of gibberellin) Hort. Abst. 53(4) : 2745

Bankar, G.J. and A. Mukhopadhyay (1985) : Response of *Polianthes tuberosa* L. Cv. 'Single' to high dose of NPK. Soth Indian Hort. 33(3) : 214-216

Bankar, G.J. and A. Mukhopadhyay (1990) : Effect of NPK on growth and flowering in tuberose Cv.Double. Indian J. Horti. 47(1) : 120-126

* Bhattacharjee, S.K. (1981) : Influence of nitrogen, phosphorus and potash fertilization on flowering and corm production in gladioli. Singapore J. of Primary industries. 9(1):23-27

Bhattacharjee, S.K. and L.P. Yadav (1982) : Effect of nitrogen, phosphorus and potash fertilization on Hippeastrum.
Indian Agriculturist. 26(3) : 193-197.
(Hort. Abst. 53(10) : 7239)

Bhattacharjee, S.K. (1984) : Effect of growth regualting chemicals on growth, flowering and tuberous-root formation of Dahlia.
The Punjab Hort. J XXIV (1) : 138-143

* Bhattacharjee, S.K. (1984) : The effect of growth regulating chemicals on gladiolus
Gartembauwissenschast 49 (3) : 103-106
(ornamental Hort. 10(11) : 162)

Biswas, J, T.K. Bose and R.G. Maiti (1983) : Effect of growth substances on growth and flowering of tuberose (*Polianthes tuberosa* L.)
South Indian Hort. 31 : 129-132

* Bragt, J.V. and H.V. Gelder (1979) : Effect of GA, 6-benzylaminopurine, α-napthaleneacetic acid and ethephon on growth and floweing of tulip bulbs <u>Acta Hort.</u> 91 : 161-165
(Hort. Abst. 51(3) : 2022)

* Borrelli, A. (1984) : Planning density and nitrogen fertilizing in the cultivation of gladoli summer and autmun.
<u>Revista della Ortoflorofratticolture italiana.</u>
68(3) : 201-210.

Bose, T.K ; B.K. Jana and T.P. Mukhopadhyay (1980) : Effects of growth regulators on growth and flowering in <u>Hippeastrum hybridum.</u>
<u>Scientia Horticulture.</u> 12(2) : 195-200
(Ornamental Hort. 6(9) : 113)

* Cirrito, M.(1972): Preliminary studies on fertilizing to increase the size of tuberose bulbs.
<u>Hort. Abst.</u> 45 : 9872.

* Cirrito, M. (1975) : The effect of manuring and bulbil circumference on the enlargement of bulbs of tuberose.
<u>Annali dell'Istituto spermentale per la Floricultura.</u> 6(1) : 27-43
(Hort. Abst. 42(12) : 1647).

Corr, B.E. and R.E. Widmer (1987) : Gibberellic acid increases flower numbers in Zantedeschia elliottiana and Z. rehmannii.
Hort. Science. 22 (4) : 605-607.

Deswal, K.S ; V.K. Patil and K.W. Anserwadekar (1983) : Nutritional and plant population studies in gladiolus.
Indian J. of Hort. 40(3 & 4) : 254-259

* Deswal, K.S and V.K. Patil (1983) :Vase life of spiklets of Gladiolus grandiflora as influenced by soil fertility and induction media.
J. of Maharashtra Agricultural Universities. 8 (1) : 34-36
(Hort. Abst. 53 (1) : 8009)

* Dua, I.S ; O.P. Sehgal and K.S. Chark (1984):Gibberellic acid induced parliness and increased production in gladiolus.
Gartenbauwlssenschart. 49 (2) : 91-94
(Ornamental Hort 10(9) : 124)

* Eldabh, R.S ; A.E. Awad and A. Nabih (1978) : Effect of growth regulators on tulip Cv. Apeldron.
Research bulletin Faculty of Agriculture. 958 (12)
(Hort. Abst. 51(1).

* El-Meligy, M.M. (1982) : Effect of gibberellin and radiation on corm formation and anthocyanin content in gladiolus.
Agril. Research review: 60(3) : 265-280
(Growth Regulator Abst. 13 : 179.)

* Garibaldi, A.E. (1964) : Preliminary results of a fertilizer trial on Gladioli.
Riv. ortoflorofrnttic.ital. 48 : 535-540.
(Hort. Abst. 35(2) : 408)

Gordon, R.H. and A.R. Ress (1977) : Growth regulator treatments to improve the yield of twin-scaled narsissus.
Scientia Horticultura 6 : 237-240.

* Gowda, J.V.N ; R. Jayanti and B. Raju (1988): Studies on the effect of nitrogen and phosphorus on flowering in Gladiolus Cv. Debonair.
Current Research. 17(6) : 80-81.
(Hort. Abst. 59(3) : 2285)

Haider, M.M ; M.V. Rao and A.S. Murty (1981) : Effect of nitrogen on growth and development of Gladiolus.
Indian J. of Hort. 38 (1 & 2) : 241-245.

Hetman, J. (1977) : The residual effect of organic mineral fertlization on the suitability of tulip bulb for forcing and reproduction.
Hort. Abst. 47 : 9639.

Jagtap, M.P. (1983) : Effect of different fertilizer doses on vegetative growth and flower yield of tuberose (Polianthes tuberosa, linn.)
Unpublished M.Sc. thesis submitted to Punjabrao Krishi Vidyapeeth, Akola.

Jana, B.K ; S. Roy and T.K. Bose (1974) : Studies on nutrition of ornamental plants. Effect of nutrition on growth and flowering of Dahlia and Tuberose.
Indian J. of Hort. 31 (2) 181-185.

Jana, B.K. and T.K. Bose (1980) : Effects of fertilizers on growth and flowering of Hippeastrum.
Indian Agriculturist. 24(1) : 23-30.

Jana, B.K. and S. Biswas (1982) : Effect of growth regulators on growth and flowering of tuberose.
Hort. Abst. 53(4) : 2751.

* Joiner, J.N. and T.J. Sheeham (1964) : Macro-element nutrition of certain Horticulture crops.
A.R. Fla. agric. exp. stats : 152-153.

* Kosugi, K. (1960) : Studies on blindness. VI effect of fertilizer treatment on flowering in gladiolus.
J. Hort. Ass. Japan 29 77-82
(Hort. Abst. 31(1) : 117)

* Laiche, A.J. and C.O. Box. (1973): Response of lilies of Gibberellic acid.
MAFES Research Highlights 36(6) : 8
(Hort. Abst. 44(6) : 370)

* Lemeni, C. and V. lemeni (1965): Effect of fertilizer on gladiolus.
Hort. Abst. 36 : 1401

* Lin, W.C. and H.F. Wilkins (1975): The influence of bulb harvest dats, temperature treatment and frowth substances an ontogeny of Lilum longforum.
Acta Horticulture 47 : 225-233.

* Lopez, P.D. and O.A. Lopez (1985) : Influence of gibberellic acid on the development of Liatris spictata.
Comumicadones de la III reunion de ornamental Jornadas ternicas 12 : 205.

* Mantrova, E.Z. (1957) : Gladiolus nutrition.
Bjul. Gl. bot. sada AN sssR. 24 : 64-70.
(Hort. Abst. XL(2))

* Mathur, S.N. and R.A. Sharma (1969) : Influence of gibberellic acid on flowering and critical day length of Dahlia.
Abstr. 11th int. bat, congr, seattle. : 142.
(Hort. Abst. XL (2))

Misra, A.K. and S.E. Negi (1977) : Effect of nitrogen and pinching of main short on tuberisation in gladiolus.
South Indian Hort. 25(2) : 88-89.

Mitra, S.N, S.P. Munshi and S. Roy (1979) : Effect of different levels of nitrogen and bulb size on growth and flowering of tuberose.
Indian Agriculturist. 23 (3) : 185-188.

Motilal, V.S., K.K. Basaria, R.P. Singh and R.S. Singh(1979): Response of gladiolus to NPK fertlization. Plant science. 11 : 69-73.

* Mugge, A. and Richter P. (1975) : The use of growth regulators in tulip propgation. Archiv fur Garentbau. 22(2) : 55-56. (Ornamental Hort. 14(2) - 9)

* Mugge, A; H. Benkenstein, P. Richter and H. Alex (1987): Effect of increasing N. applications to tulips on cut flower yield and bulb reproduction during forcing. Archiv fur Gartenbau. 35(6) : 249-253. (Ornamental Hort. 14(I) - 7)

Mukhopadhaya, A. and Sadhu M.K. (1985) : Studies on the effects of preplanting treatments of bulbs of Polianthes tuberosa with Gibberellic acid Progressive Hort. 17(2) : 125-128.

* Nanajan, K ; K.M.P. Nambisan ; D. Veeraragavathatham and B.M. Krishnan (1980) : The effect of NPK on the yield of tuberose (Polianthes tuberosa L.) National seminar on Production technology for commercial flower crops. : 76-78. (Hort. Abst. 51(9) : 715)

* Paleg, L.G. (1961) : Phsyiological effect of GA-I on carbohydrate metabolism and analyse activity of barley endosperm.
Pl.Phy. 35(3) : 293-299.

Potti, S.K. and J.S. Arora (1986) : Nutritional studies on Gladiolus Cv. Sylvia. Effect of NPK on growth, flowering, corm, and cormel production.
The Punjab Hort. J. 24(1-4) : 125.

* Rahman, M.M. and S.N. Mitra (1974) : Effects of nitrogen on growth and flowering of Dahlia variabillis
Bangladesh Hort. 2(2) : 15-18.
(Ornamental Hort. Oct. 1976)

* Rikhter, M.A. (1976) : The effect of nitrogen on the reproductive capacity of narcissus.
Khimya V. Selskom Khozyaistve. 14(8) : 18-19
(Ornamental Hort. 47(8) : 7664)

* Roychowdhry, N. (1989) : Effect of plant spacing and growth regulators on growth and flower yield of gladiolus grown under polythene tunnel.
Acta Horticulture. 246 : 259-263.
(Ornamental Hort. 16(2) : 51)

Rudnicki, R.M ; J. Nowak and M. Saniewski (1976) : The effect of gibberellic acid on sprouting and floweing of some tulip cultivars.
Scientia Horticulturae. 4(4) : 387-397.

* Sakalska, E. (1968) : Some facts on the nutrition of Gladioli.
Acta Pruhon. 17 : 29.47.
(Hort. Abst. XL (1))

* Saniewski, M. (1978) : The effect of GA on the flowering and growth of Muscan Comosum Mill.
Ornamental Hort. 4(10) : 9198.

Sandhu, M.K. and T.K. Bose (1973) : Tuberose for most artistic garlands.
Indian Hort. 18(3) : 17-20.

* Sasso, G. (1962) : An experiment of mineral nitrogen fertilizing of dahlias growth for cut flowers.
Hort. Abst. 32 : 1215.

* Sabanek, J, F. Kopecky and K. Slaby (1976) : Effect of Gibberellic and ethrel on the growth and development of tulips and hyacinths.
Acta Universitatis Agriculturae. 24(3):387-396
(Ornamental Hort. 5(3) - 3037)

Shah, A, S.D. Lal and J.N. Seth (1984) : Effect of different levels of nitrogen and phosphorus on growth, flowering and corm yield of gladiolus Cv. Vink's Glory.
Prog. Hort. 16(3-4) : 305-307.

* Shoushan, A.M; A.M. AbouDahab; R.S. Eldabh and M.Auda (1978) : Mineral nutrition of Amaryllis II effect of fertilizer on bulb growth, bulblet production and nitrogen an sugar content of leaf & bulb Research bulletin, faculty of Agriculture. 966 : 11.
(Hort. Abst. 51(1) : 495)

Sidhu, G.S. and J.S. Arora (1989) : Response of Gladiolus varieties to nitrogen application.
Indian J. Hort. 46(2) : 250-254.
(Hort. Abst. 60(8) : 6366)

Singh, A.R, S.L. Pankaj and G.N. Singh (1983) : Effect of growth regulators on growth, yield and quality on onion.
The Punjab Hort. J. 1(23) : 100

* Stuart, N.W. (1949) : Fertilizers for gladiolus.
Flor. Exch. 113(11) : 19
(Hort. Abst. 20(4) : 3081)

* Stuart, N.W. and Mcclellan (1950): Effect of nutrient on gladiolus growth.
Flor. Exch. 114(23) : 14,47
(Hort. Abst. 21(3) : 2232)

Singh, R.S, V.S. Motilal and L.B. Singh (1976) : Effect of N,P and K fertlization on tuberose.
Indian J. Hort. 32(3 and 4) : 289-294.

* Syrtanova, G. and I. Rachimbaev (1973) : Endogenous gibberellic during dormacy and growth of tulip bulbs.
Fiziologiya Rastenii 20(4) : 721-724.

* Talia, M.C. and P. Stellacci (1980) : The effect of gibbereelic on spring flowing bulbs.
Revista della Ortoforfruitticoltura Italiana. 64(4) : 303-313.
(Hort. Abst. 51(5) : 3753)

Thomas, P.A, G.D. Goorts, and J.E. Preece (1983) : Phthalimides, GA and flowering of cyclamen.
Hortiscience 18(5) : 752-753.
(Ornamental Hort. 10(6) : 66)

* Tjia, B. (1986): Growth and flowering of container-grown calla lillies as affected by growth regulating chemicals.
Proceedings of the Interamerican society for Tropical Horticulture. 30 : 159-163.
(Hort. Abst. 59(5) - 4080).

* Tuskamoto, Y. (1974) : Breaking dormancy of Gladiolus corms and inhibitors inducing dormancy.
Acta Horticulture. 43(II) : 393 - 404.
(Ornamental Hort. Oct - 1975)

Tymoszvk, J; M. Saniewski and R.M. Rudnicki (1979) : The effect of GA and silver nitrate on Dormancy Release and growth Scientia Horticulture. 11 : 95-99.

* Wanjo, L.W. and K. Waithaka (1983) : The effect of GA_3 application on growth and flowering of liatris.
Hort. Abst. 53(7) : 5302.

* Waltz, S.S.C. (1954) : Gladiolus fertility studies.
A.R. Fia. agric. stn. : 259-260.
(Hort. Abst. 26(2) : 2002)

* Wilsie, P. (1961) : Crop and distribution.
IOWA state Univ. 191-94.

Winkler G. (1969) : Investigations on the effect of growth substances on the corn yield of Gladioli.
Arch. Gortenb. 17 : 325-340.

(* Originals not seen)

THESIS ABSTRACT

1.	Title of Thesis	: "EFFECT OF NITROGEN LEVELS AND GIBBERELLIC ACID ON GROWTH AND FLOWERING OF TUBEROSE (<u>Polianthes tuberosa</u> L.)"
2.	Full name	: Sudhir Rajaram Dalal
3.	Name and address of Major advisor	: Shri. P.V. Belorkar, Asst. Prof. of Horticulture College of Agriculture, Nagpur.
4.	Degree to be awarded	: M.Sc. (Agri.)
5.	Year of award of Degree	: 1992
6.	Major subject	: Horticulture
7.	Total number of pages in the thesis	: 84
8.	Number of words in abstract	: 290
9.	Signature of the student	: [signature]
10.	Signature, name and address of forwarding authority.	:

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ABSTRACT

The present investigation was undertaken to decide the optimum dose of Nitrogen and optimum concentration of Gibberellic acid for maximising the flower yield of tuberose. The title of the research work was "Effect of Nitrogen levels and Gibberellic acid on growth and flowering of tuberose (Polianthes tuberosa, L.)". The experiment was carried out at College Garden, Department of Horticulture, College of Agriculture, Nagpur from July 1991 to January 1992. The variety used was single flowered.

The experiment was carried out in Split Plot Design with four levels of Nitrogen and four concentration of Gibberellic acid. Treatments were replicated four times.

Levels of Nitrogen and concentration of Gibberellic acid were as follows :-

a) Main treatments :- Nitrogen levels.

1> N_0 ____ 0 kg N/ha (control)

2> N_1 ____ 50 kg N/ha

3> N_2 ____ 60 kg N/ha

4> N_3 ____ 70 kg N/ha

b) Sub treatments :- Gibberellic acid.

1> G_0 ____ Water soaking (control)

2> G_1 ____ 10 ppm

3> G_2 ____ 20 ppm

4> G_3 ____ 40 ppm

Nitrogen was applied in two split doses, first dose was applied at the time of planting and second 30 days after planting. Preharvest and postharvest observations were recorded.

The findings revealed that increasing Nitrogen levels attributed the superior growth and yield of flowers. 70 kg N/ha recorded maximum number of rachis (132444.45/ha), maximum flowers/stalk (40.65) maximum yield of flowers (63.10 q/ha) followed by 60 kg N/ha and 50 kg N/ha.

Similarly increasing concentration of GA attributed in superior results in respect of growth and yield of flowers. GA 40 ppm concentration recorded maximum number of rachis (96555.55/ha), maximum number of flowers per stalk (46.20), maximum yield of flowers (75.21 q/ha).

The combined effect of Nitrogen level and concentration of GA_3 also exhibited the same trend. Higher level of Nitrogen with higher concentration of GA (70 kg

N/ha + 40 ppm GA) recorded maximum number of rachis (163333.56/ha), maximum flowers per stalk (52.60), maximum yield of flowers (81.77 q/ha).

However, the results are suggestive and needs confirmation.

APPENDIX - I

Weekly metrological data from 2^{nd} July 1991 to 4^{th} February 1992 recorded at observatory of College of Agriculture, Nagpur.

Met.Weeks Nos.	Date and Month	Temperature (°C)		Rainfall in (mm)	Humidity in (%)
		Max.	Min.		
27	2 July to 8 July 91	34.4	25.1	7.0	75
28	9 July to 15 July 91	33.8	23.8	200.4	88
29	16 July to 22 July 91	29.6	23.8	69.4	87
30	23 July to 29 July 91	29.5	23.8	20.4	85
31	30 July to 05 Aug. 91	30.1	21.2	126.4	87
32	06 Aug. to 12 Aug. 91	29.2	23.3	56.6	87
33	13 Aug. to 19 Aug. 91	26.6	21.9	128.8	88
34	20 Aug. to 26 Aug. 91	30.2	25.4	18.0	85
35	27 Aug. to 02 Sept.91	29.9	23.0	3.0	81
36	03 Sept to 09 Sept 91	32.0	23.3	9.0	79
37	10 Sept to 16 Sept 91	35.4	22.0	-	73
38	17 Sept to 23 Sept 91	34.2	22.6	1.0	71
39	24 Sept to 30 Sept 91	35.4	21.9	-	68
40	01 Oct. to 07 Oct 91	34.6	21.8	13.0	67
41	08 Oct. to 14 Oct. 91	34.4	20.0	-	67
42	15 Oct. to 21 Oct. 91	34.8	18.2	-	64
43	22 Oct. to 28 Oct. 91	31.1	15.0	-	63
44	29 Oct. to 04 Nov. 91	32.3	14.6	-	55
45	05 Nov. to 11 Nov. 91	31.8	11.3	5.0	62
46	12 Nov. to 18 Nov. 91	22.5	17.6	-	73
47	19 Nov. to 25 Nov. 91	28.6	14.0	8.0	71
48	26 Nov. to 02 Dec. 91	30.1	12.2	-	69
49	03 Dec. to 09 Dec. 91	29.2	09.5	-	60
50	10 Dec. to 16 Dec. 91	29.0	09.1	-	72
51	17 Dec. to 23 Dec. 91	28.8	10.7	-	85
52	24 Dec. to 31 Dec. 91	27.1	08.1	-	67
01	01 Jan. to 07 Jan. 92	25.8	8.0	-	64
02	08 Jan. to 14 Jan. 92	28.8	9.0	-	62
03	15 Jan. to 21 Jan. 92	30.7	11.0	-	67
04	22 Jan. to 28 Jan. 92	31.3	13.5	2.0	62
05	29 Jan. to 04 Feb. 92	32.3	13.0	-	69

VITA

Sudhir Rajaram Dalal was born on 27th March 1968 at Bramhapuri, District Chandrapur of Maharashtra State (India). He passed S.S.C. Examination from Newjabi Hitakarini Highschool, Bramhapuri, in the year 1983 and H.S.C. Examination from Newjabai Hitkarini College, Bramhapuri in the year 1985. Then he joined College of Agriculture, Nagpur and was awarded B.Sc. (Agril.) degree of Punjabrao Krishi Vidyapeeth, Akola in the year 1989 in First class. He secured admission to Post Graduate course for M.Sc.(Agri.) in discipline of Horticulture in the college of Agriculture, Nagpur in the year 1990. He represented University in Cricket held at Amravati in the year 1991.

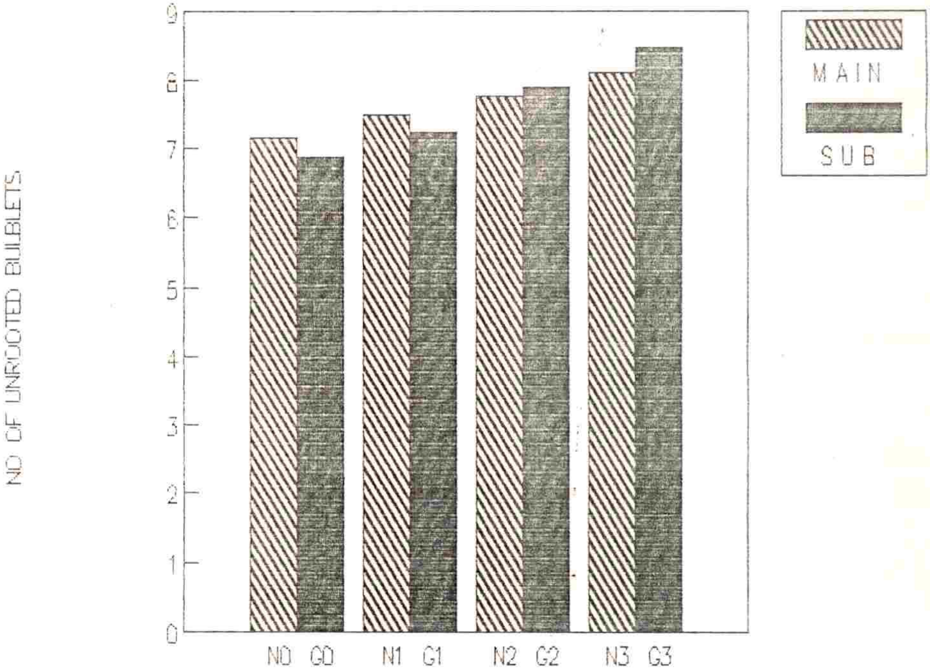

FIG 13. AVERAGE NUMBER OF ROOTED BULBLETS PER HILL.