Discussion

Tuberose has a special position among the bulbous flowering plants. Pre-planting dipping treatments of bulbs with growth regulators as well as suitable growing media have great potential in promoting growth, flowering, bulb production and vase life. Keeping these views in mind present experiment entitled. “Study the response of NAA and GA₃ on growth, flowering, bulb production and vase life of tuberose (Polianthese tuberosa L.) C.v. Single.” was conducted at the Horticultural Research Farm of Udai Pratap Autonomous College, Varanasi (India) during 2004-05 and 2005-06. The findings detailed in preceding chapter are being discussed here in the light of relevant available literature.

Gibberellic acid is one of the most important growth regulators. One of the main plants responses to gibberellins is shoot elongation. It works as stimulator of growth by cell division. Growth is stimulated in the younger internodes and tissues and frequently the length of the individual internodes remain unchanged. The application of GA₃ to stem produces a pronounced effect on cell division in the subtropical meristem (Kuraishi et al., 1964a). 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 flowers and fruits. It after increases the size of flowers as well as size of peduncle, pedicel and petal (Lang, 1965, 1971).

Naphthalene acetic acid (NAA) belongs to auxin group. It plays many important roles in plant physiology. The most important role of NAA is the elongation of cell by synthesizing DNA, which lead to protein synthesis and finally increase in the cell volume, thicker cell wall. Other roles of NAA are apical dominance, fruit setting, fruit thinning, formation of female flowers, morphogenesis (Brian, 1966; Baker et al 1965).

The vegetative growth of tuberose attributes in terms of germination studies is sprout emergence percentage and plant studies that includes number of leaves per clump, height of plant, leaf area and fresh weight of top leaves per clump.
The sprout percentage of tuberose bulb at 14 days and 28 days was noted maximum (51.92 and 50.92) and (97.00 and 98.00) respectively when bulbs were treated with GA\textsubscript{3} 100ppm for 12 hours dipping (T\textsubscript{4}) followed by GA 150 ppm for 6 hours dipping (T\textsubscript{5}) and GA 150 ppm for 12 house dipping (T\textsubscript{6}) during the year 2005 and 2006, respectively. With 12 hours dipping in 100 ppm GA the absorption was maximum against 6 hours which has broken the dormancy of bulbs and ultimately hasten sprout emergence earlier. These results are in conformity with the findings of Roh (1978); Tonecki (1979); Roh (1982) and Auge (1982). Sindhu and Verma (1997) in a trial revealed that 250 ppm GA\textsubscript{3} treatment to the cormels before planting reduced the number of days for sprouting. Similarly, Nagaraja et.al, (1999) in a trial on tuberose with different treatment of GA\textsubscript{3} for 24 house soaking of bulbs revealed that GA\textsubscript{3} 500 and 1500 ppm resulted earlier plant emergence and a higher percentage of sprouting.

The number of leaves per clump at flower initiation, peak flowering and at end of flowering were recorded maximum at higher concentration of GA i.e. 200 ppm bulb dipping for 12 hours during both year of study. At lower concentration GA increased leaf number but as concentration increases its effect increased leaf number. This might be due to absorption of growth regulator which stimulated earlier and more cell division and caused increase in leaf number per clump. Present findings are in line with the reports of Kumar et.al., (1978); Sano (1975); Jana and Biswas (1982); Choudhary (1987); Bhattacharjee 1984a); Deotale et.al., (1995); Bhuj et.al., (1998); Singh (1999); Kirad et.al., (2001), Wankhode et.al., (2002) Manish et.al., (2002), Pros pod et.al., (2002), El-Naggar and sharaf (2002). Tiwari and Singh (2002) and Sanap et.al., (2004) in a experiment on tuberose bulb pre planting soaking in GA found that number of leaves per clump was highest with 200 ppm GA.

Among the growth parameters plant height is one of the important factor influenced by gibberellic acid. Maximum plant height at initiation of flowering, peak stage of flowering and end of flowering was recorded in $T_8$ (GA\textsubscript{3} 200 ppm + 12 hours dipping). At peak stage GA\textsubscript{3} stage plant height increased 64.79% and 69.58% more than
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control. GA$_3$ very much involved in cell division, cell elongation particularly in the intact plant part which might be the main reason of increase in plant height. The results reported by Kumar et al. (1978); Lin et al. (1975); Murray et al. (1975); Jana and Biswas (1979); Mukhopadhyay and Banker (1986); Hore and Sen (1986); Pal and Das (1990); Das et al. (1992); Tiwari (1992); Mahesh and Mishra (1993); Mohanty et al. (1994); Deotale et al. (1995); Kumar (1995); Sindhu and Verma (1997); Bhuj et al. (1998); Devendra and Nagda (1999); Devendra Tak et al. (1999); Wankhade et al. (2002); Manisha et al. (2002) and Tiwari and Singh (2002) and are in line to present investigation. Prasad et al. (2002) in a trial on gladiolus reported that GA$_3$ 250 ppm increased plant height. Similarly, Sagar et al. (2005) also found that tuberose bulb dipped GA$_3$ 200 ppm for 24 hours increased plant height.

Among the growth parameters leaf area is also influenced by growth regulator treatment. At higher concentration of GA and maximum dipping duration i.e. treatment T8 (GA 200 ppm + 12 hours dipping) was found superior in all the three stage of study i.e. at flower initiation peak flowering and end of flowering during the year 2005 and 2006, respectively. At peak stage the increase was 23.69% and 22.15% more than control. Increase in leaf area might be due to increase in leaf length and width which is promoted by cell enlargement and cell elongation. The above findings are in conformity with the findings of Sano (1975); Bhattacharjee (1984a); Mahesh and Mishra (1993); Deotale et al. (1995); Prasad et al. (2002) and Snap et al. (2004). Spray of GA$_3$ 100 ppm as foliar increased leaf length and width (Bhuj et al., 1998). Tiwari and Singh (2002) also found that bulb soaking in GA$_3$ 150 ppm increased leaf width of tuberose.

As Gibberellic acid application increases vegetative growth viz. leaf number length and width, there is proportionate increase in leaf fresh weight of tuberose in both years. Maximum fresh weight of leaf at initiation of flowering, peak stage of flowering and end of flowering was noted in treatment T8, (GA 200 ppm + 12 hours dipping) while minimum weight was noted in control (without PGR). Increase in leaf fresh weight due to GA treatment was also reported by Bhattacharjee (1984); Pal and Das (1990); Bhuj (1992); Kumar (1999); Singh (1999); Data Ram et al. (2001) and Tiwari and Singh
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(2002). Possible reason for increase in fresh weight of leaf might be due to increased length and width of leaf with the application of GA$_3$, which initiated cell elongation at earlier stage when bulbs were dipped for 12 hours before planting in the field.

The genetic constitution of the plants, growing environment, nutrition etc are the important factors influencing flowering in tuberose. Besides, growth regulators applied as dipping of bulbs at different concentration influenced the flowering parameters viz. spikes per clump, height of the flowering scape, length of inflorescence, diameter of rachis, number of florets per spike, fresh weight of spikes, length and width of first basipetal floret, duration required for emergence of scape, duration required for opening of first basipetal floret from the date of scape emergence and duration of flowering of spike.

Number of spikes as affected by bulb dipping in GA shows that at higher concentration GA 200 ppm plus 12 hours dipping promoted maximum number of spikes per clump in both year of experiment. This might be due to profuse cell division and finally faster growth in bulb laid more axillary buds production which produced spikes and ultimately contributed in spike number per clump. Increase number of spike due to GA treatment was also observed and confirmed by, Nagraja et al., (1999); Maurya and Nagda (2002); Manisha et al., (2002); Tiwari and Singh (2002); and Panwar et al., (2006). Maurya and Nagda (2002) and Panwar et al., (2006) in a trial on gladiolus and tuberose found that GA at 100 ppm resulted more number of spikes per plant.

Scape emergence was significantly influenced by bulb dipping in growth regulator solution in both the year. It was observed that at lower concentration GA was effective than control but at higher concentration of 200 ppm + 12 hours dipping treatment produced early spike (83.83 and 85.17 days) in tuberose during both year of experiment. This might be due fact that GA breaks dormancy, hastened growth, earlier flower bud differentiation which caused early spike emergence. The above findings are in complete agreement with the reports of Mittal (1967); Shanmugam et al., (1973); Murari et al., (1975); Bhattacharjee and Mukherjee (1979); Sanewski et al., (1997); Dua et al.
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Tuberose is commonly cultivated for sale of spikes, therefore length of spike length of inflorescence and floret number are important factor influence value of spike. In the present investigation bulb dipping treatment of GA$_3$ at 200 ppm for 12 hours (T8) proved to be most effective in improving the height of the flowering scape, length of inflorescence and floret per spike. T8 increased length of spike 29.29% and 26.38% more than control during both the year. However, floret number increased 52.94% and 58.78% more than control (T17). The length of spike increases due to increase in growth by cell division elongation which increases internodal length of stem. Where as number of florets might be due to that GA$_3$ hastens flowering and helps to increase in flower number. These findings are in conformity with the reports of Mastalerz (1959-60); Shanmugam et al., (1973); Bhattacharjee and Mukherjee (1979); Mukhopadhyay and Bankar (1986); Raychaudhary (1989); Dua et al. (1984); Awad and Hammed (1985); Patel et al., (1986); Ravidas et al., (1992); Das et al., (1992); Tiwari (1992); Mahesh and Mishra (1993); Hatibarua et al., (1997); Reddy et al.,(1997) Sindhu and Verma (1997); Pal and Chaudhary (1998); Parkas and Jha (1998); Singh (1999); Devendra and Nagda (1999); Data et al., (2001); Maurya and Nagda (2002); Manisha et al., (2002) and Tiwari and Singh (2002) observed that GA$_3$ 200 ppm increased inflorescence length and flowers per spike. Similarly, Singh et al., (2003) and Panwar et al., (2006) also found that GA$_3$ 100 ppm increased spike length and number of floret per spike. However, Paswan (1985) reported that GA reduced spike length.

Diameter of rachis and weight of spike was improved with the bulb dipping treatment with GA$_3$. At lower concentration is was not so effective although it was more than control. GA$_3$ 200 ppm plus 6 hours dipping treatment were significant in increasing diameter (0.74 and 0.68) and weight of spike (90.33 and 87.80 gram) during the both
year of experiment. The increase in diameter of rachis was 42.30% and 36.0% more than control during both the years. The increase in length due to cell division and elongation caused mere diameter of spike and ultimately increased spike weight. Similar, trend of results were also observed by there workers. Karaguzel et al., (1999), Moshrefi et al., (1999) and Panwar et al., (2006). Foliar spray of GA$_3$ at 200 ppm significantly increased diameter of spike(Wankhede et al.,2002)

Length and width basipetal florets were also significantly affected by growth regulator treatments. GA$_3$ was found to increase size of floret and thus increased length and width of floret. Maximum length (5.0 and 4.89 cm.) of flower and width (3.51 and 3.42 cm.) was measured in T$_8$ (GA 200 ppm + 12 hours dipping) on both year of experiment. Increase in length and width of floret is due to in crease in cell division and enlargement of cells in comparison to control. The findings are in line with the Hasan et al. (1985); Deotale et al. (1995); Sindhu and Verma (1997); Devendra and Nagda (1999); Dataram et al. (2001); Maurya and Nagda (2002); Wankhede et al., (2002). Singh and Panwar (2003). GA$_3$ 100 ppm treatment increase size of second floret, flower length (Maurya and Nagda, 2002 and Singh et al., 2003).

Time taken to open first basipetal florets from the date of scape emergence was calculated in days as influenced by growth regulator treatment. Opening of first basipetal floret was much earlier (21.08 and 22.08 days) than control (27-25 and 28.17 days). It is 6 days earlier in treatment T4 (GA 100 ppm+ 12 hours dipping) than control during both the experimental year. Earliness in floret opening was also reported by De and Dhiman (2001) Sanap et al., (2004) and Sagar et al., (2004).

Flowering duration is counted in term of opening of 1$^{st}$ floret to opening of last floret in spike as in field condition. This character was found most superior in GA 200 ppm plus 12 hour dipping i.e. (16.50 and 17.10 days). There is as a spatial separation of the site of stimulus and the site of response. The buds do not receive the stimulator for flowering. This is in complete agreement with the reports of Mahesh and Mishra (1993). Pal and Chaudhary (1998) and Singh and Panwar (2003) in a trial on gladiolus found that
corm soaking for 12 hours in GA 40 ppm increased field life of spike. However, delay in flowering time due to GA$_3$ was reported by Suh and Suh (1997).

Maximum number of bulbs, weight of bulbs per clump, fresh weight of each bulb, diameter of bulb, number of bulblets per clump and weight of bulblets per clump in tuberose were found in treatment T$_8$ (GA 200 ppm+2 hrs. bulb dipping). At lower level of GA there was also increase in all the above characters. Among two plant regulators tested GA treatments were found better than the effect of NAA and control. As the GA level and dipping hour increased its effect also contributed more to increase in all the above characters. The probable reason for increased bulb size and production might be due to increased height, number of leaves which ultimately synthesized maximum carbohydrate which was translocated to the bulbs for storage. The above findings are in agreement with Bose et al. (1980); Bhattacharjee (1983); Bhattacharya (1983b); Ray Chaudhary (1989); Arora et al. (1992); Leena et al. (1992); Mahesh and Mishra (1993); Singh (1995); Pal and Chaudhary (1998), Nagaraja et al. (1999), De and Dhiman (2001) Maurya and Nagda (2002). El-Naggar and Sharaf (2002) and Tiwari and Singh (2002) observed that soaking tuberose bulb in GA$_3$ 200 ppm increased number of bulbs and bulblets per clump, fresh and dry weight of bulb and bulblets per clump.

Singh et al., (2003) and Panwar et al., (2006) in a trial on tuberose concluded that bulb dipping in 100 ppm GA significantly increased the number of bulblet, weight, diameter and yield of tuberose bulb. Similarly, Sagar et al., (2005) also observed that GA$_3$ helps in formation of more food material and thereby resulted in more number of bulbs.

The vase life of tuberose is also one of the most important parameter, which influenced the quality of spike in the present investigation. GA$_3$ 200 ppm for 12 hrs. dipping (T8) was significantly superior than control. Maximum vase life (9.00 and 8.75 days) was found in T8 which was non significant with T 7 and T6 in both the years. Vase life of tuberose spike was increased by 2.25 and 2.33 days more than control during 2005 and 2006, respectively. Increase in vase life might be due to accumulation of more
food materials in the spike due to mobilization and translocation of photosynthates from increased number of leaves and leaf area in treated bulbs. Thus also increased the fresh weight of flowers which finally contributed to the increased vase life as reported by Deotale et al., (1995); Nagaraja and Gowda (1998); Dalal et al. (1999); Reddy et al. (1997); Arora and Singh (2000); Rekha et al. (2001) and De and Dhiman (2001). Bhaskar and Rao (1998) studied the effect of BA, GA, NAA and MH at concentration of 50 or 100 ppm on vase life of cut tuberose spike cv. Double and found that GA at 100 ppm increased vase life in comparison to control. Similarly, Kumar and Singh (2004) investigated the post harvest life of tuberose spike and noticed that GA$_3$ 50 and 100 ppm influenced vase life of tuberose spike.