CHAPTER I

INTRODUCTION

Flowers are one of the god's most beautiful boons to mankind, which bring joy and happiness to one and all. Flowers symbolize beauty, purity, love, passion and tranquillity. No ceremony or function can be considered complete without the use of flowers, in more than one way. Though flower cultivation has been practiced in India since time immemorial, floriculture has blossomed into viable business only in recent years. Commercial cultivation of cut flowers -roses, gladiolus, carnations, anthurium, gerbera and lilies has become popular. It is estimated that about 98,000 hectares of land is covered under flower crops in India. In Maharashtra total area under floriculture is 6,931 hectares with 29,766 tonnes of flower production during 2000-2001 (Singh, 2002).

China aster which is commonly known as aster (*Callistephus chinensis* (L.) Nees) is one of the most popular showy and free blooming annual or seasonal crop belongs to the family Asteraceae. Among the annual flowers it ranks next to chrysanthemum and marigold and is mainly grown by marginal and small farmers.

The genus *Callistephus* derived its name from two Greek words, *Kalistos* means most beautiful and *Stephos,* a crown referring to the large and coluring flower heads. Cassini described the china aster as *Callistephus hortensis*. Linnaeus first named it as *Aster chinensis* and Nees subsequently changed this name to *Callistephus chinensis.* The genus includes the only one species *chinensis.*

The evolution of china aster is a history of remarkable variation. The present day aster has been developed form of wild species, *Callistephus chinensis*, a plant native to China. The plant was introduced in Europe in 1731, by Jesuit Missionary,R.P.d' Incarville (Bailey, 1963).

The original plant had a single flower with two to four rows of blue, violet or white ray florets, French florist s contributed much in the development of double

forms. German growers also raised many double cultivars. These asters were then known as German aster because the first great advance in the evolution of the plant was made in Germany and the seeds then used came largely from that country. The comet type introduced in 1886 or 1887 subsequently replaced the quilled types. With the introduction of new branching type of James Vick in 1983, the U.S.A. becomes main centre of development of this plant as well as for the production of seeds. Since its introduction into Europe, it is one of the most popular of all garden annuals grown throughout world.

In India, aster is commercially important crop of South India and it is widely grown in Karnataka, Tamilnadu, West Bengal and Maharashtra. In Pune district (Maharashtra) alone, it is cultivated on an area of 400 ha (during 2000). In Karnataka, it's area, production and productivity were reported to be 1000 ha, 11250 tonnes and 11.25 tonnes per hectare respectively during 1997-98. In Bangalore rural and urban district, it occupied about 500 ha area (Singh and Raghva, 2001). In Konkan region, china aster is grown on small scale in Thane district with an area of 56 ha and having productivity of 6 tonnes per hectares. In Raigad district the area under china aster is around only 6 hectares having very low productivity of 1.85 t/ha (Anon., 2002).

Most of the present day asters are diploids (2n=18). Aster is a half hardy annual. Plants are erect having hispid hairy branches, bearing alternate, broadly ovate or triangular ovate, deeply and irregularly toothed leaves. Flowers are solitary. The plant height ranges from 15 cm to about 1 meter with pompon flowers, head having single, double anemone florets, incurved shaggy or quilled types. The plant is self-pollinated crop with approximately 10 per cent natural crossing. Flower head consists of both pistillate ray florets and perfect disc florets. The production of ray florets to disc florets is a measure of doubleness of the flower. As a rule, the stamens and pistils do not mature simultaneously in the individual flower. The stigma of the individual flowers unfolds after the pollens are discharged from the flower. The china aster was, therefore mentioned as geitonogamous.

Aster can be easily grown in the open field and cloth house for the production of cut flowers. Flowers are used commercially for interior decoration as well as for worship. Aster is used for bedding plant in landscaping and some dwarf cultivars

are suitable for edging, herbaceous border and window boxes. Cut aster flowers lasts long and used in vase and floral decoration.

Aster is cool season shallow rooted crop, however frost is dangerous for its cultivation during this season. It needs open sunny situation. It can be grown best in rich, porous and well drained soils. The summer crop is commonly produced in the cloth house. Seeds are sown during August to October and the plants bloom in about 3 and 1/2 to 4 months from the date of sowing.

It is estimated that aster occupies an area of about 300 hectares in Maharashtra, which is approximately $1/10^{th}$of the total area under flower crops. This area is mainly concentrated in Pune district. Konkan region of Maharashtra is warm and humid. The winter season is mild and the situations are mostly frost-free. It provides great scope for cultivation of floriculture crop like aster. Demands for cut flowers are increasing in the region day by day. Due to better communication facilities, the region is now well connected to big cities like Mumbai, Thane, Pune, Goa etc.

Presently the aster cultivation in the Konkan region is scanty. The area used for aster cultivation is very limited. Low productivity and inferior quality of flowers might be the constraints for aster cultivation in the region. Hence, maximization of flower yield and extending vase life of flowers are of prime importance in the cultivation of aster. It can be achieved through proper management practices like optimum manurial dose, plant protection, proper spacing, growing improved varieties coupled with advance techniques like use of growth regulating substance.

Uses of growth regulators can help to maximize the yield and improve the quality of flowers. It is therefore necessary to undertake studies to find out suitable plant growth regulators for increasing yield and improve quality of aster. It is also necessary to find out optimum concentration of growth regulators for improving yield in aster.

Critical review showed that no much work has been done on these aspects for commercial production. Hence, the present investigation was undertaken with following objectives.

1. To study the effect of growth regulators on vegetative parameters of aster.

2. To study the effect of growth regulators on flower parameters of aster.

3. To find out optimum concentration of growth regulators for improving yield in aster.

4. To study influence of growth regulators on keeping quality (vase life) of aster.

CHAPTER II

REVIEW OF LITERATURE

The commercial importance of aster is increasing in the floriculture industry. This is because of its attractive flowers, long lasting quality in vase and ability to withstand the vigour of transportation adequately etc. is the popular and versatile annual flower crop grown in the many parts of the country. In commercial cultivation of aster, growing of suitable variety for cut flower production and optimum management have profound influence on the yield, quality and ultimately the income from the crop. In the present study the efforts were made to study the effect of growth regulators on yield and quality of aster.

The reports on the foliar application of growth regulators on aster are very merge. Hence, literature available on taxonomically related crops like chrysanthemum, gerbera, marigold, dahlia, gaillardia, calendula, gladiolus, anthurium and zinnia etc. have been included in this chapter.

The relevant literature is presented under following heads.

2.1. Effect of NAA on vegetative parameters.

2.2. Effect of NAA on flowering parameters.

2.3. Effect of NAA on vase life of flowers.

2.4. Effect of TRIA on vegetative parameters.

2.5. Effect of TRIA flowering parameters.

2.6. Effect of TRIA on vase life of flowers.

2.7. Effect of preservative solutions on vase life of flowers

2.1. Effect of NAA on vegetative parameters:

2.1.1 Plant height:

Reddy and Sulladhmath (1983a) conducted a field trial with aster cv. 'Vicks Branching', and observed that application of NAA at 60 ppm significantly decreased the plant height.

Sharma *et al*. (1995) studied the effects of two growth regulators on the growth of chrysanthemum cv. 'Move-In-Carvin' and found that plant height is directly proportional to the NAA concentrations (25-100 ppm). Similar results were reported in chrysanthemum at 50, 75 and 100 ppm NAA by Dutta *et al.*; (1998).

Sawant (2000) reported that in aster all the levels of NAA (50 and 100 ppm) significantly influenced plant height with respect to control.

2.1.2. Plant spread:

Sakhare (1991) reported that in gaillardia cv.'Yellow Doll'; NAA treatments (30, 45 and 60 ppm) resulted in maximum plant spread as compared to control and GA_3 treated plants.

Parab (1993) reported that in gerbera, there is no significant difference in plant spread due to application of NAA at 30 and 60 ppm in cv. 'Single Orange'.

Sawant (2000) recorded significantly maximum plant spread when aster plants treated with 50 ppm NAA.

2.1.3 Number of branches per plant:

Ravindra (1980) reported that NAA application increased number of branches in chrysanthemum.

Reddy and Sulladhmath (1983a) reported that NAA at 30 and 45 ppm significantly decreased the number of branches over the control in cv.'Vicks Branching'.

Sakhre (1991) reported that in gaillardia cv. 'Yellow Doll', number of branches was significantly increased with all the levels of NAA (30 45 and 60 ppm).

2.1.4. Number of leaves:

Tsukamoto and Harda (1957) reported that chrysanthemum plants, when treated with 50 or 100 ppm NAA before flower bud differentiation recorded 4 to 5 leaves more then untreated plants.

` Pal and Das (1990) observed that all concentrations of NAA (100 and 200 ppm) increased number of leaves over control and significant rise in leaf number resulted with NAA at 200 ppm in *Lilium longifolium*.

Parab (1993) reported that there was significant increase in the production of leaves in gerbera cv.'Single Orange', by application of 60 ppm NAA that was superior over the control and NAA 30 ppm.

Dutta *et al.* (1998) reported that in chrysanthemum significant increase in number of leaves per plant as compared to control by all levels of NAA sprays (50, 75 and 100 ppm).

2.1.5 Leaf area:

Reddy and Sulladhmath (1983a) reported that, NAA at 30 ppm and 45 ppm showed mixed trends in terms of leaf area and leaf area index in aster cv.'Vicks Branching'.

Sawant (2000) reported that all the levels of NAA (50 and 100 ppm) superior over all other treatments with respect to leaf area in aster.

2.1.6.Leaf area index:

Significantly, maximum leaf area index was observed in gladiolus by foliar spray of 200 ppm NAA (Ravidas *et al.* 1992).

Dharkar (1997) recorded significantly higher leaf area index under foliar spray of 100 ppm NAA, which was superior over all the other treatments.

2.1.7. Dry matter production:

Sakhare, (1991) reported that significant increase in total dry matter with NAA 45 ppm over the control which was at par with 200 ppm GA_3 in gaillardia.

Sawant (2000) recorded significantly maximum dry matter production by foliar spray of 100 ppm NAA over the control in aster.

2.2. Effect Of NAA on flowering parameters:

2.2.1.Flowering:

2.2.1.1.**Days for commencement of flowering:**

Tsukamoto and Harda (1957) demonstrated that in chrysanthemum flowering was delayed by 12 days with 100 ppm NAA. Similarly, Saini and Arora (1974) recorded significant delay in flowering of chrysanthemum by 10 and 6 days at 100 and 500 ppm concentrations of NAA.

Reddy (1978) noticed that in china aster cv. 'Vicks Branching' NAA sprays had little effect on flowering.

Reddy and Sulladhmath (1983b) reported in China aster that NAA sprays had no applicable effect on flowering, compared to the control.

Bhattacharjee (1984) found that in dahlia cv. 'Kelvin Rose' NAA at 10 ppm induced early flowering by 4 to 5 days as compared to the control plants.

2.2.1.2. **Duration of flowering:**

Dutta *et al.* (1983) reported in case of chrysanthemum var. 'CO-1' NAA treatments (50,75 and 100 ppm) significantly increased the duration of flowering as compared with the control.

Sawant (2000) opined that foliar application of 100 ppm NAA significantly increased duration of flowering as compared to 50 ppm NAA and control in aster.

2.2.1.3 **Number of days from bud stage to harvest stage:**

Sawant (2000) reported that significantly more number of days was required by NAA at 100 ppm, which was at par with NAA at 50 ppm and the control.

2.2.2. **Yield:**

2.2.2.1. **Flower yield per plant:**

Reddy (1978) while working on china aster cv.'Vicks Branching' observed that NAA at 60 ppm produced the maximum number of saleable flowers (15.6) per plant in summer season.

Pal *et al.* (1986) reported that in calendula significantly increased number of flowers per plant with application of NAA at 50, 100 and 200 ppm concentrations.

2.2.2.2. **Flower yield per plot:**

Dutta *et al.* (1993) reported that in chrysanthemum var.'CO-1', NAA treatments (50,75 and 100 ppm) increased the flower yield per plot as compared to the control.

Parab (1993) recorded significantly more number of flowers per plot under foliar spray of 60 ppm NAA as compared to control plants in gerbera.

Dutta *et al.* (1998) observed that in chrysanthemum NAA sprays (50,75 and 100 ppm) increased the flower yield per plot over the untreated plants.

2.2.2.3. **Flower yield per hectare:**

Pal *et al.* (1986) noticed that in calendula significantly more flowers per hectare with application of NAA at 50, 100 and 200 ppm concentrations.

Sakhare (1991) recorded significantly more flower yield tonnes per hectare under foliar spray of 30 ppm NAA (9.70 t/ha) than 45 ppm NAA (8.30 t/ha), 60 ppm NAA (8.21t/ha) and control (8.01 t/ha).

2.2.2.4. **Harvesting index:**

Parab (1993) observed that foliar spray of 60 ppm NAA could significantly increased harvesting index in gerbera.

Sawant (2000) reported that significantly more harvesting index was observed when aster plants were sprayed with 100 ppm NAA than control.

2.2.3. Flower quality:

2.2.3.1. **Stalk length of flower:**

Saini and Arora (1974) opined that in chrysanthemum cv.'Yellow Doll' and 'White', stalk length of flower was not influenced by application of NAA (50 to 400 ppm), while Dutta *et al.* (1993) observed increased flower stalk length over control in chrysanthemum cv.'CO-1'by foliar spray of (50,75 and 100 ppm) NAA respectively.

Sawant (2000) reported that application of NAA at 50 ppm concentration significantly influenced stalk length of the flower over the control plants in aster.

2**.2.3.2.Flower diameter:**

Muthuswami and Sayed (1983) recorded in china aster cv. 'Vicks Branching Purple' that flower diameter was slightly increased by NAA (30 ppm) during winter season. Reddy and Sulladhmath (1983b) recorded in china aster that flower diameter was increased with NAA treatments (30,45 and 60 ppm) but not significantly.

Dutta *et al.* (1998) observed in chrysanthemum that NAA sprays (50,75 and 100 ppm) significantly increased the flower diameter over the control plants.

2.2.3.3. **Fresh weight of flowers**:

Reddy (1978) noticed in china aster cv.'Vicks Branching' that application of NAA (30, 45 and 60 ppm) in winter increased the fresh weight of flowers as compared to the control.

Sakhare (1991) reported in gaillardia cv.'Yellow Doll' that significantly maximum fresh weight of flowers was recorded with NAA at 30 ppm.

Sawant (2000) observed significantly maximum fresh weight of flowers when aster plants sprayed with NAA at 50 and 100 ppm over the control.

2.2.3.4. **Dry weight of flowers**:

Parab (1993) noticed in gerbera cv.'Single Orange' that application of 60 ppm NAA significantly increased dry weight of flowers as compared with the control.

Sawant (2000) recorded that dry weight of flowers significantly influenced by aster plants when sprayed with NAA at 50 and 100 ppm NAA over the control.

2.2.3.5. **Longevity of flowers in the field:**

Sakhare (1991) reported that in gillardia cv.'Yellow Doll', there was no significant difference with regard to longevity of flowers in the field by application of NAA (30, 45 and 60 ppm).

Parab (1993) did not find any significant effect of NAA on longevity of flowers in the field in gerbera. Similar results were recorded by Joshi (1999) in gladiolus variety 'Tradehorn'.

2.3. Effect of NAA on vase life of flowers:

2.3.1. Vase life of cut flowers:

Reddy (1978) reported that in china aster cv. 'Vicks branching', NAA treatments (30 45 60 ppm) had no influence on vase life of flowers.

Reddy and Sulladhmath (1983b) reported that NAA had not influenced the vase life of the china aster flowers.

Parab (1993) did not find any significant effect of NAA on longevity of gerbera flowers on field as well as in vase.

2.4. Effect of Triacontanol on vegetative parameters:

Triacontanol (TRIA) is a ubiquitous natural compound occurring in all plants. It is a 30 carbon straight chain saturated primary alcohol which is bound to and / or located in plant waxes and occurred in small amounts in parenchyma tissues.

Exogenous application of TRIA regulate directly or indirectly several physiological and biochemical processes. Pramotory effect of TRIA has been reported in crops such as beans, cucumbers, lettuce, sweet corn, tomato, maize, cotton, sugerbeet, and rice, and yield have been increased by 10 to 30 per cent (Ries *et al.,* 1977, Ries 1985). Also studies on effect of TRIA have revealed that TRIA enhances the growth of vegetables and cereal crops when applied as a foliar spray or added to the root medium (Ries *et al.,* 1978, and Sagral *et al.* 1978). The growth response seems to be quite rapid, as early as 3-6 hr after treatment an increase in fresh weight was observed (Ries and Wert, 1977; Bitterbender *et al.* 1978). Ries and Houtz (1983) suggested that carbohydrate metabolism may be involved in he response of plants to TRIA.

2.4.1. Plant height:

Miniraj and Shanmugavelu (1987) reported that application of 2 ppm TRIA enhanced all growth and cropping characteristics including plant height in chilli.

Vaishmpayan (1997) reported that stimulation of plant height in capsicum cv.'California Wonder'with 5 ppm TRIA.

Dharkar (1997) observed that there was no any significant effect of TRIA at 2.5 and 5 ppm concentration on plant height in anthurium.

Joshi (1999) reported in gladiolus var. 'Tradehorn' that foliar application of 5 ppm TRIA promoted the plant height at all the stages of growth whereas 2.5 ppm TRIA had a significantly pramotary effect only at 60 and 75 days after planting.

2.4.2. Plant spread:

Vasundhara *et al.* (1992) reported in marjoram that the TRIA at higher concentration had a negative effect on plant spread.

Gadgil (1997) observed that foliar application of 5 ppm TRIA on wild brinjal increased plant spread.

Geete (2001) recorded that application of TRIA at 5 ppm resulted in significant increase in plant spread at 150 days after transplanting in gaillardia cv. 'Yellow Doll'.

2.4.3. Number of branches per plant:

Miniraj and shanmugavelu (1987) reported that TRIA at 2 ppm produced more number of branches than 1ppm and control in chilli.

Madav (1999) obtained more number of branches in krishna tulsi when plants were sprayed with 5 ppm concentration of TRIA.

Samant (2000) observed that, the plant treated with 4 ppm TRIA along with 150 ppm paclobutrazol had significantly more number of branches (15.17) which was superior over all other treatments in marigold var. 'Pusa Navrangi'.

2.4.4. Number of leaves:

Dharkar (1997) reported that in anthurium foliar application of TRIA at 2.5 ppm significantly produced more number of leaves (4.93) than TRIA at 5 ppm (4.5) and control (4.10).

Gadgil (1997) in wild brinjal reported that triancontanol had promontory effect on the number of leaves per plant.

Parab (1998) recorded significantly more number of leaves in tuberose than control at 5 ppm TRIA.

2.4.5. Leaf area:

Dhawade (1996) noticed in chilli increase in leaf area that when plants were sprayed with 5 ppm TRIA.

Joshi (1999) observed that foliar spray of TRIA at 5 ppm increased leaf area significantly over control plants in gladiolus var. 'Tradehorn'.

2.4.6. Leaf area index:

Gadgil (1997) recorded maximum leaf area index in wild brinjal, when plants were sprayed with 5 ppm TRIA.

Geete (2001) reported that among the different TRIA spray (5, 10 and 15 ppm), significantly more leaf area index was recorded by foliar spray of 5 ppm TRIA.

2.4.7. Dry matter production:

Skogen *et al.* (1982) observed that application of TRIA (0.1 ppm) to chrysanthemum cv. 'Golden Horim' and 'Golden Miguel' increased 11-12 per cent dry matter production over control.

Miniraj and Shanmugavelu (1987) reported more dry matter production in chilli when treated with 1ppm TRIA.

2.5. Effect of Triacontanol on Flowering Parameters:

2.5.1 Flowering:

2.5.1.1. **Days for commencement of flowering:**

Miniraj and Shanmugavelu (1987) in chilli reported earlier flowering in the plants treated with 2 ppm TRIA.

Dharkar (1997) observed that TRIA 2.5 ppm reduced the interval of emergence of flower spikes in anthurium.

Significantly less number of days (62.58 days) were required for the commencement of flowering, when the gaillardia plants cv. 'Yellow Doll', were sprayed with TRIA at 5 ppm as compared to control (69.47 days) (Geete, 2001).

2.5.1.2. **Duration of flowering:**

Parab (1998) reported that application of TRIA 2.5 ppm reduced the flowering duration in tuberose.

Joshi (1999) observed that there was no any significant effect of TRIA at 2.5 and 5 ppm on duration of flowering in gladiolus var. Tradehorn.

Padmapriya *et al.* (2002) reported that though there was no any significant effect of TRIA (1, 2 and 3 ppm) on duration of flowering in chrysanthemum, but increase in concentration of TRIA increases duration of flowering.

2.5.1.3.Number of days from bud stage to full bloom:

Geete (2001) noticed significantly less number of days from bud stage to full bloom in gaillardia cv. 'Yellow Doll', when plants were sprayed with 5 ppm TRIA as compared to control.

Padmapriya *et al.* (2002), in chrysanthemum observed that 3 ppm TRIA significantly reduced number of days from bud stage to full bloom, and 1 ppm TRIA required significantly more number of days from bud stage to full bloom as compared to control.

2.5.2.Yield:

2.5.2.1. **Flowers yield per plant:**

Parab (1998) opined that foliar application of TRIA 2.5 ppm increase flower yield per plant than the control.

Padmapriya *et al.* (2002) recorded maximum flower yield per plant by foliar application of 3 ppm TRIA in chrysanthemum plants.

2.5.2.2. **Flower yield per plot:**

Parab (1998) reported that number of flowers per plot was greater than the control when tuberose plot sprayed with 2.5 ppm TRIA.

Samant (2000) noticed significantly more numbers of flowers per plot when marigold plants cv. 'Pusa Navrangi', treated with 40 ppm TRIA along with 50 ppm paclobutrazol.

Geete (2001) recorded significantly more flower yield per plot when gaillardia plants cv. 'Yellow Doll' sprayed with 5 ppm TRIA.

2.5.2.2. **Flower yield per hectare:**

Significantly maximum spike yield per hectare were found in gladiolus plants var. tradehorn, when sprayed with 5 ppm TRIA (Joshi, 1999).

Geete (2001) reported that, TRIA at 5 ppm significantly produced maximum flower per hectare (32.31 t/ha) over the control (20.87 t/ha) in gaillardia cv.'Yellow Doll'.

2.5.2.4. Harvesting index:

Parab (1998) recorded significantly more harvesting index when tuberose plants were sprayed with 2.5 ppm TRIA.

Joshi (1999) observed significantly more harvesting index when gladiolus var.'Tradehorn' was treated with 3 ppm TRIA.

2.**5.3. Flower quality:**

2.5.3.1. **Stalk length of the flower:**

Dharkar (1997) reported that TRIA 2.5 ppm registered higher elongation of flower stalk in anthurium.

Significantly maximum length of flower stalk was produced when gaillardia cv. 'Yellow Doll' plants were sprayed with 5 ppm TRIA (Geete, 2001).

2.5.3.2. **Flower diameter:**

Samant (2000) reported that in marigold cv. 'Pusa Navrangi', when plants sprayed with TRIA 4 ppm along with paclobutrazol 50 ppm maximum flower diameter (6.16 cm.) over the control (5.12 cm).

Padmapriya *et al.* (2002) recorded significantly more flower diameter when chrysanthemum plants sprayed with 3 ppm TRIA.

2.5.3.3. **Fresh weight of flowers:**

Samant (2000) reported that there was no any significant effect of triaconatanol on marigold plants to increase fresh weight of flowers.

Geete (2001) reported that among the different TRIA spray, 5 ppm TRIA registered significantly more fresh weight of flowers (48.76 g) than control (41.33 g) in gaillardia cv.'Yellow Doll'.

2.5.3.4. **Dry weight of flowers:**

Parab (1998) observed significantly more dry weight of flowers when tuberose plants were sprayed with 2.5 ppm TRIA than control.

Padmapriya *et al.* (2002) recorded significantly more dry weight of flowers when chrysanthemum plants were sprayed with 3 ppm TRIA.

2.5.3.5. **Longevity of flowers in the field:**

Joshi (1999) reported that, maximum longevity of spikes in field (13.44 days) observed with 5 ppm TRIA than 2.5ppm TRIA (12.66 days) in gladiolus.

Geete (2001) observed that TRIA spray has non-significant effect on longevity of flowers in the field. The maximum longevity (10 days) of flowers was found in the treatment of 5 ppm TRIA in gaillardia cv.'Yellow Doll'. Though, the effect was non-significant.

2.6. Effect of Triacontanol on vase life of flowers:

2.**6.1. Effect of TRIA on vase life of cut flowers:**

Dharkar (1997) sprayed the anthurium plants with 2.5 and 5 ppm TRIA and did not find any significant effect on vase life of flowers. Similar results where obtained by Parab, (1998) and Joshi, (1999) in tuberose and gladiolus respectively.

Geete (2001) registered significantly more vase life (7.75 days) when gaillardia cv.'Yellow Doll' was sprayed with 5 ppm TRIA over the control (6.34 days).

2.7.Effect of preservative solutions on vase life of flowers:

Steinitz (1982) observed that when the stems of immature gerbera flowers cv. 'Climentine' were cut at the ripening stage of the first circle's stamens and placed in $AgNO_3$ (30 mg/litre) + 6 per cent sucrose solution, increased the rigidity and mechanical stability of flowers, the flowers remained erect for 10 days even after the petals wilted.

Gowda (1986) recorded maximum vase life in mansoon (13.17 days) and in winter (14.63 days) with holding solution of sucrose (2%) in china aster cv. 'Ostrich Plume'.

Mantur and Nalawadi (1989) reported maximum vase life of china aster flowers during *kharif* and *rabi* seasons (8.0 days and 8.3 days, respectively) with holding solution of sucrose 0.2%.

Harode *et al.* (1993) found that 1 per cent sucrose solution increased the vase life of flowers in gaillardia, and flowers had a better colour and freshness.

Parab (1993) reported that gerbera flowers kept in preservative solution containing 4 per cent sucrose + 30 ppm $AgNO_3$ solution recorded the maximum vase life of flowers (13.4 days) which was significant over control and the other treatments.

Thoke (1993) observed that the vase life was prolonged upto 14.33 days, when china aster flowers were held in solution containing 2 per cent sucrose.

Sawant (2000) reported maximum vase life (16.45 days) with 8-HQ (0.2%) + sucrose (5 %) in cv. 'Phule Ganesh Voilet'.

Gette (2001) found that among different preservatives maximum vase life (12.67 days) was exhibited in the preservative solution of 10 ppm $AgNO_3$ in gaillardia.

Sangare (2001) found that the treatment with 5 per cent sucrose recorded maximum vase life (15.75 days) and $AgNO_3$ was found to be next best treatment for improving vase life of gladiolus (14.75 days).

Singh *et al.* (2001) found maximum vase life with $AgNO_3$ (300 ppm) + sucrose (4%) in rose, carnation and gerbera.

CHAPTER III

MATERIALS AND METHODOLOGY

Aster (*Callistephus chinensis* (L.) Nees) is a valuable most beautiful showy garden cut flower and the used for vase and floral decorations. Present studies were undertaken to know the response of aster to growth regulators; under Konkan agro-climatic conditions. The details regarding the materials used and the methodology followed during the course of investigation have been described in this chapter.

3.1.Experimental Site:

The experiment was conducted at nursery farm, Department of Horticulture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratanagiri (M.S.), India 415712 during the *rabi* season of the year 2004-2005. The experimental plot was uniform and leveled. The soil was lateratic with uniform depth and good drainage having a pH around 6.1.

3.2.Geographical Location, Climate and Weather Conditions:

Dapoli is situated on the West Coast of Maharashtra at an altitude of 280 m above MSL. It is located in the subtropical region at 17^0 45' North latitude and $73^0$12' East longitude. The mean annual rainfall at Dapoli is 3500 mm normally distributed from June-October. The data recorded at meteorological observatory Dapoli regarding weather conditions prevailing during the course of investigation are presented in Appendix I.

3.3.Cropping History of Experimental Field:

The cropping sequence followed on the experimental plot for the previous three years of the experiment is presented in table-1.

Table-1: Cropping history of experimental field:

Year	**Season**	**Crop**
2002-2004	Annual	Banana
2004	*Kharif*	Guar
2004-2005	*Rabi*	Aster (Experimental plot)

3.4.Experimental Details:

The present field experiment was laid out with seven treatments of growth regulators replicated in three times in Randomized Block Design. The experimental details are given below.

1.Crop: Aster (*Callistephus chinensis* N.)

2.Variety: Ostrich plum mix.

3.Number of treatments: 7

4.Number of replication: 3

5.Number of plots: 21

6.Design: Randomized Block Design (RBD)

7.Total area of plot: 17 x 7.8

8.Plot size: a. Gross plot size: 1.5 x 1.6m

b. Net plot size: 0.9 x 0.8m

9.Spacing: 30 x 40 cm

10.Layout: Flat beds

11.Number of plants:

a. Gross plot: 20

b. Net plot: 6

12.planting season: *Rabi* (2004-2005)

13.Treatments: The details of the treatment and symbol used are given below.

Sr. No.	Treatments	Concentrations	Treatment Number
1.	α –Naphthalene Acetic Acid (NAA)	a.50 ppm b.100 ppm c.200 ppm	T_1 T_2 T_3
2.	TRIA (TRIA)	a.2.5 ppm b.5 ppm c. 7.5 ppm	T_4 T_5 T_6
3.	Control (water spray)	a. Water spray	T_7

The growth regulators were applied through the foliar spray.

14.Sowing date: 14th October 2004.

15.Date of transplanting: 6th December 2005.

3.5.Source of seed:

The seeds of aster variety Ostrich Plum Mixed were obtained from Floriculture unit, Department of Horticulture, College of Agriculture Dapoli, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratanagiri (M.S.).

3.6.Source of growth regulators:

Sr.No	**Growth regulator**	**Symbol**	**Source**
1	α-Naphthalene Acetic Acid	NAA	Thomas Baker (chemicals) Ltd.4/86 Bharat Mahal, Marine Drive, Mumbai 400062.
2	TRIA	TRIA	Herba Agro India Ltd. Mumbai.

The chemicals of AR grade were used for the experiment.

3.7.Nursery operations:

3.7.1.Preparation of Raised Bed:

For raising aster seedlings, 12.0 x 1.0 x 0.15meter size raised, bed was prepared. Well rotten FYM was mixed thoroughly with soil on the beds and dusted with lindane powder as protectant against ants and termites. The beds were prepared under polysheds in order to protect the seedlings from heavy rains and direct sunlight.

3.7.2.Sowing:

Before sowing seeds were treated with Bavistin @ 3 g/Kg of seed as a prophylactic measure against fungal diseases. Seeds were sown in line on raised bed at 3-5 cm apart and 1-2 cm deep. After sowing, the seeds were covered with soil and bed was covered with paddy straw and watered immediately. A regular watering twice in a day was followed. After seed germination, paddy straw was removed. The beds were drenched with 0.1 per cent Bavistin to avoid the damping off disease. Then spraying of 0.03 per cent Endosulphan was also done to protect the seedlings from insect attack.

3.7.3.Preparation of Experimental Plot:

The land was brought to fine tilth by ciss-cross ploughing, clod crushing and harrowing. The land was leveled properlly.well decomposed FYM @ 20 t/ ha was added in the soil at the time of field preparation. FYM was mixed with lindane powder against termites and white grub as a preventive measure. The experimental plot was marked and each plot of 2 x 2.1 m size was laid out. A distance of 1.0 m was kept between two replications and 0.5 m between two treatment plots. The plan of layout of experimental plot is presented in Fig.1.

3.7.4.Transplanting:

The transplanting of healthy aster seedlings was done six weeks after sowing when 6-8 leaves were developed. Transplanting of the seedlings was done on 6th December 2005 as per treatments allotted. Experimental plot was watered three days before transplanting. Two weeks before transplanting, the shade provided on nursery

beds was removed for hardening of seedlings. Before actual transplanting, roots of seedling were dipped in 0.1 per cent Bavistin solution for five minutes. The transplanting was carried out in the evening hours.

3.7.5.Application of manures and fertilizers:

Well decomposed F.Y.M. @ 20 t/ha was applied in the soil at the time of field preparation. F.Y.M. was mixed with lindane powder against termites and white grub as a preventative measure. Fertilizers were applied @ 300 Kg Nitrogen, 100 Kg Phosphorus and 100 Kg Potash per hectare. The complete dose of Phosphorus in the form of Single Super Phosphate and Potash in the form of Murate of Potash was given at the time of transplanting. The nitrogen in the form of urea was applied in thee split doses. First dose was applied 8 days after transplanting. Second and third doses were given at 20 and 40 days after first dose respectively.

3.7.6.Cultural operations:

Light shade was provided by using glyricidia twigs during initial 3-4 days after transplanting for better establishment of seedlings in field. Hand weeding was carried out as an when required in order to keep the plot weed free. The irrigation was given through flood irrigation system every after three days upto harvesting of the crop.

3.7.7.Plant protection:

The prophylactic sprays of Endosulphan 0.05 per cent, Monocrotophos (Nuvacron) 0.05 per cent and Rogar 0.05 per cent were given alternately at 15 days interval to control the attack of leaf eating caterpillars and sucking pests. Copper oxycholoride (0.02%) was added in the insecticidal spray.

3.8.Preparation and application of plant growth regulator solutions:

Requisite quantity of NAA as per requirement was weighed accurately on an electric balance and the powder was dissolved separately in little quantity of 95 per cent alcohol (ethanol) and final volume was made with double distilled water. The stock

solution of NAA was first prepared and then solutions of desired concentrations were prepared from the stock solution by dilution and were applied immediately

For TRIA, the measured quantities (ml) of TRIA (Vipul) was taken and directly dissolved in distilled water as per the required concentrations.

The above mentioned plant growth regulators were sprayed uniformly on aster plants with help of Marut Hand Sprayer. Fresh solutions of plant growth regulators were prepared at the time of each foliar spray. Two sprays of above mentioned growth regulators (NAA and TRIA) were given to each plot as per the treatments allotted. First spray was given 25 days after transplanting and second spray was given 15 days after first spray.

3.9.Harvesting:

Harvesting of flowers was undertaken at five days interval. Flowers were harvested alongwith stalks of 10-12 cm length when their outer two to three whorls of disc florets dehiscenced their pollens. Harvesting was done with help of secateur during early morning hours.

3.10.Sampling and recording observations:

3.10.1.Sampling procedure:

For recording growth parameters and other observations, five plants in each plot were randomly marked and labeled. The biometric observations such as plant height, spread, number of branches, number of leaves were recorded at 15 days interval. Similarly, other three plants in each plot were selected randomly at final harvest stage (150 days after sowing) and used for recording observations such as leaf area and dry matter production. The data recorded from all the three plots, i.e. one plot from each replication under each treatment were averaged and used for further analysis

3.10.2.Observations recorded:

The following observations were recorded.

3.10.2.1.Growth parameters:

a.) Plant height:

The plant height was measured from ground level to the tip of the plant and recorded in cm at 15 days interval.

b.) Plant spread:

Plant spread was recorded in centimeter by a meter scale along the direction of maximum spread of branches, at 15 days interval.

c.) Number of branches per plant:

The number of branches i.e. primary branches arising from the main stem was counted and recorded art 15 days interval.

d.) Number of leaves per plant:

The numbers of fully developed leaves of five selected plants from each treatment were counted at 15 days interval.

e.) Leaf area:

The leaf area, which was estimated at final harvest stage by leaf area meter. The randomly selected three plants per plot were uprooted and their entire foliage was removed and total leaf area of plant was measured from which average leaf area per plant was calculated.

f.) Leaf area index (LAI):

Leaf area index was calculated at final harvest stage by using formula suggested by Watson (1947).

$$LAI = \frac{\text{Leaf area of plant}}{\text{Land covered by a plant (spacing)}}$$

3.10.2.2.Dry matter production:

Dry matter production was recorded for whole plant i.e. the portion above the ground and roots. After removal of the foliage from the plant for leaf area estimation, the leaf over the stem portion, flowers and the roots were dried separately at 55^0-60^0 C until constant weight was observed. The foliage that was used for the leaf area estimation was also oven dried simultaneously. The total dry matter produced by the plant was calculated by addition of dry matter of all plant parts, such as leaves, stem, flowers and roots.

3.10.2.3.Flowering parameters:

a.) Days for commencement of flowering:

The number of days required for commencement of flowering in each treatment under different replication were recorded by counting the days from the date of transplanting to the date of first flowering.

b.) Duration of flowering:

The duration of flowering in days from first flowering to last flowering in each treatment under different replications was recorded.

c.) Number of days from bud stage to harvest stage:

The numbers of days from bud stage to harvest stage i.e. full bloom stage, in each treatment, under all replications were recorded and the average numbers of days from bud stage to harvest stage were calculated.

3.10.2.4. Yield:

a.) Flower yield per plant:

The earlier five randomly selected plants per treatment in each replication were used for this observation. Harvesting was done at 5 days interval. The numbers of flowers harvested and cumulative weight of flowers during all harvest were recorded as flower yield per plant in gm. The average values for these observations were worked out.

b.) Flower yield per plot:

The yield of the net plot was considered for this purpose. Harvesting was done at 5 days interval and weight of flowers obtained at each harvest was summed up to know total weight of flowers from each plot. The weight of flowers from five observation plants were also added to it and recorded as a flower yield per plot in gm.

c.) Flower yield per hectare:

The yield of the plot was considered for fhis purpose. Harvesting was done at 5 days interval and weight of flowers obtained at each harvest were recorded for each treatment under each replication. The weight of flowers produced from the first harvest to the last harvest was recorded. Based on the yield of each plot the average yield per hectare was calculated in tonnes.

d.) Harvesting index:

The proportion of economic yield with biological yield, which denote in percentage as harvesting index.

$$\text{Harvesting index} = \frac{\text{Economical yield per plant (g)}}{\text{Biological yield per plant (g)}} \times 100$$

Biological yield is the dry plant weight including root system.

3.10.2.5. Flower quality attributes:

To record the observations on flower quality ten flowers per treatment per replication were randomly selected. The average was worked out and used for further analysis. The following observations were recorded

a.) Stalk length of flower:

The cut flowers were randomly selected from each treatment plot at full bloom stage and the stalk length of the flower was measured in cm by a foot scale.

b.) Flower diameter:

The maximum spread of the flower petals on any direction was recorded as diameter of flower in centimeter.

c.) Fresh weight of ten flowers:

The flowers at full bloom stage under each treatment in different replications were selected randomly and their total fresh weight was recorded immediately, by keeping the stalk length 10.5cm. The average weights of ten flowers were calculated in gm.

d.) Dry weight of ten flowers:

Previously selected ten flowers for fresh weight were oven dried at 55^0-60^0C until constant weight was obtained. In this way, average dry weight of ten flowers was calculated in grams.

e.) Longevity of flowers in the field:

The longevity of flowers was observed for five randomly selected flowers on the plant, when their outer two whorls of disc floret showed pollens. The selected flowers were labeled and number of day's upto which these flowers remained in fresh condition, was recorded as longevity of the flowers in the field.

3.10.2.6. Vase life studies:

a.) Vase life of cut flowers:

Five flowers were randomly selected from each treatment at full bloom stage. The selected five flowers were cut along with flower stalk of 10.5cm and lower leaves on flower stalk were removed to reduce transpiration losses and kept the cut flowers immediately in glass bottles, dipping the cut stalk end in distilled water. The stalk end cut every alternate day to prevent clogging of vascular bundles. The number of day's upto, which each flower remained in fresh condition, was recorded and finally mean was worked out.

b.) Effect of preservative solutions on vase life of aster flowers:

The experiment was conducted in laboratory. The experimental details are as under.

Design: Completely Randomized Block Design.

Number of treatments: 8

Number of replications: 3

Treatment details:

Sr.No.	Vase treatment	Treatment number
1	$AgNO_3$ 10ppm	T_1
2	$AgNO_3$ 20ppm	T_2
3	$AgNO_3$ 30ppm	T_3
4	Sucrose 1%	T_4
5	Sucrose 2%	T_5
6	Sucrose 3%	T_6
7	Control (Distilled water)	T_7
8	Absolute control (No water)	T_8

Methodology:

Five flowers of uniform diameter and stage were selected when outer whorls of disc florets showed their pollens. Selected flowers were cut along with flower stalk of 10.5cm and kept in glass bottles by dipping the cut ends in preservative solution. The stalk ends were cut about 1-2mm every alternate day to prevent clogging of vascular bundles.

Observations:

The number of days upto, which flowers under each treatment, remained in fresh condition were recorded and mean value was worked out.

3.11. Statistical analysis:

Statistical analysis of the data collected during the course of studies was carried out by standard method of analysis of variance as given by Panse and Sukhatme (1985). The standard error of mean (S.Em.) was worked out and the critical difference at 5 per cent level of significance was calculated, wherever the results were found significant. Graphs and plates have been used to project the important results.

3.12. Economics of production:

The per hectare cost of cultivation was worked out by using the existing rates of various inputs used and the other cost items. The gross income was worked out by considering the existing selling rates of flowers. The net profit and benefit : cost ratio have been calculated for different items.

Literature Cited:

Anonymous, (1990).A report on Horticulture Development in Maharashtra state Directorate of Horticulture, Pune-5(M.S.).pp-25.

Bailey, L.H. (1963). 'China Aster' In 'Commercial Flowers'Ed.by Bose,T.K.and L.P.Yadav.Naya Prakash,Calcutta. pp: 681-696.

Dharkar, A.P. (1997). Varietal variation and effect of growth regulators on growth and flowering in anthurium (*A.andereanum*). M.Sc. (Agri.) thesis submitted to Dr.B.S.K.K.V.Dapoli.

Dutta, J.P.Seemanthini Ramdas M.A.Khadkar and S.Ramdas (1993). Regulation of flowering by growth regulators in chrysanthemum (*chrysanthemum indicum* Linn.) Cv.'Co-1'. South Indian Hort.41 (5): 70-75.

Gadgil, P.W. (1997). Physiological analysis of effect of growth regulators and nitrogen on growth, yield and productivity of wild brinjal (*Solanum khasianum* Clarke.).M.Sc. (Agri.) thesis submitted to Dr.B.S.K.K.V.Dapoli.

Joshi, M.D. (1999). Effect of different growth regulators on growth, flowering, yield and quality of gladiolus (*Gladiolus grandiflorus* L.) var. 'Tradehorn' under Konkan conditions. M.Sc. (Agri.) thesis submitted to Dr.B.S.K.K.V.Dapoli.

Miniraj,N.and Shanmugavelu,K,G. (1987).Studies on effect of TRIA on growth flowering, yield, quality and nutrient uptake in chillies (*Capsicum annum* L.).South Indian Hort.35 (4): 362-366.

Muthswami, S.and Sayad (1983). Influence of growth regulators on flower characteristics of china aster. (*Callistepus chinensis* N.). South Indian Hort. 31(3): 252 255.

Parab R.L. (1993). Studies on effect of growth regulator on growth, flowering, yield and quality of gerbera (*Gerbera jamsonii*) var.'Single orange'. M.Sc. (Agri.) thesis submitted to Dr.B.S.K.K.V.Dapoli.

Parab, S.S. (1998). Effect of different growth regulator on growth, flowering yield and quality of tuberose (*Polianthes tuberosa* L.) M.Sc. (Agri.) thesis submitted to Dr.B.S.K.K.V.Dapoli.

Reddy, Y. T.N. (1978). Effect of growth substances on growth and flowering of china aster (*Callistephus chinensis* N.).Mysore J.Agric.Sci.,12(3) :526.

Reddy Y.T.N.and U.V. Sulladhmath (1983a) effect of growth regulator on flowering of china aster (*Callistephus chinensis* N.). South Indian Hort.31 (2/3):95-98.

Saini, A.A. and V. S. Arora (1974).Effect of NAA on flowering of chrysanthemum. Punjab Hort.J.14 (2):160.

Sakhare, U.M. (1991). Effect of growth regulator on growth, flowering yield and quality of blanket flower (*Gaillardia pulchella*).var.'Yellow Doll'. M.Sc. (Agri.) thesis submitted to Dr.B.S.K.K.V.Dapoli.

Samant, M.J. (2000). Effect of growth regulators and pinching on growth, flowering yield and quality of marigold (*Tagetes sp*.L.) cv.'Pusa Kranti' under Konkan agroclimatic conditions. M.Sc. (Agri.) thesis submitted to Dr.B.S.K.K.V.Dapoli.

Singh, H.P. (2002).Floriculture industry in India: Its perspectives Indian hort.46 (4) pp: 54.

Subramanyam, K.M.and M.Sudhha (1992).Economics of aster flower cultivation in Karnataka Indian J. Hort.49 (1):92-95.

Vaishampayan,D.C.(1997).Effect of growth regulators, micronutrient complex and potassium growth and yield of sweet pepper (*Capsicum annum)* var.grossum (L) Sendt.) Cv.'California Wonder'. M.Sc. (Agri.) thesis submitted to Dr.B.S.K.K.V.Dapoli.

Vasundhara, M. Farooqui A.A.Davaiah K.A. and Shridharayya, M.(1992).Influnce of some growth regulators on growth, herbage ands oil yield on marjioram (*Marjorana hortensis* M.). Indian perfumer 36 (3).pp:171- 172.