EFFECT OF GROWTH REGULATORS ON POTTED CHRYSANTHEMUM (dendranthema grandiflora TZVELVE)-A REVIEW ARTICLE

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Abstract: Growth regulators have been defined as organic compounds, other than nutrients, which used in small amounts promote, inhibit or otherwise modify physiological processes in plants. Plant growth regulators or hormones influence the growth of chrysanthemum at all stages from rooting to senescence. Chemicals which scale down many species of plants are called growth retardants. Growth retardants include draught resistance and salt tolerance, decrease in water loss, decrease in sensitivity to air pollution, enhancement of the number and rate of development of roots in cuttings and longevity of flowering plants. As far as use of growth regulators on chrysanthemum is concerned, commonly used chemicals on this crop are phosphon-D, phosphon-S, B-9, ancymidol, cycocel, Amo-1618, maleic hydrazide, paclobutrazol and ethephon etc. These all growth retardants use to yield variable results with the cultivar and the growing condition.

IndexTerms - Chrysanthemum, Growth regulators, phosphon-D, phosphon-S, B-9, ancymido, cycocel, Amo-1618, maleic hydrazide, paclobutrazol.

I. INTRODUCTION

Chrysanthemum (*Dendranthema grandiflora* Tzvelev) is an important flower crop of family Asteraceae (Anderson, 1987) and is native to northern hemisphere, chiefly Europe and Asia. It is the national flower of Japan and is popularly known as 'Guldaudi' in our country and 'Glory of the east' or 'mum' in USA. There is hardly any other garden flower which has such diverse and beautiful range of colours and flower shapes as chrysanthemum. It is one amongst the top most cut flowers as well as pot plants of the world. The major use of small flowered chrysanthemum in our country is for making garlands, venis, and in religious offerings.

The crop comprises of thousands of cultivars majority of which are available for cultivation. It owes this much popularity to the wide range of form and colour of its flowers and excellent keeping quality. Increasing urbanization and population is putting pressure continuously on the pot plant industry as space in the cities is shrinking and people are forced to satisfy their gardening desire by growing plants in pots on the terraces of multistoried buildings. Amongst various flowering pot plants, chrysanthemum holds a great promise. The versatile nature of this flower crop, its early blooming habit along with economy of space, labour and material, and simple propagation method has made pot culture of chrysanthemum increasingly popular. The cultivars suitable for the pot culture fulfilling these requirements are meager. Therefore the growers are forced to use other techniques of keeping the plants in desired shape. To a certain extent, the problem of growers was valued by using different growth retardants to keep the plants dwarf. But the responses of these treatments also vary with cultivar which again is required to be standardized.

Among various flowering pot plants available, chrysanthemum has great potential due to its wide range of flower colour, shape, size, form and long lasting keeping quality of the flower. Beside these, it is easily propagate, economy of space and ease with which the small potted plants are handled, has made pot mum very popular among farmers, amateurs and commercial growers.

As far as use of growth regulators on chrysanthemum is concerned, commonly used chemicals on this crop are phosphon-D, phosphon-S, B-9, ancymidol, cycocel, Amo-1618, maleic hydrazide, paclobutrazol and ethephon etc. These all growth retardants use to yield variable results with the cultivar and the growing condition. Growth retardants are commonly used for obtaining plants of compact habit, mainly in ornamental plant production. Growth retardants are commonly used for obtaining plants of compact habit, mainly in ornamental plant production. These growth regulators are classified as growth promoters and growth retardants. The plant growth regulators are being increasingly used to manipulate the growth and flowering of ornamental plants.

II. EFFECT OF GROWTH REGULATORS

Growth regulators have been defined as organic compounds, other than nutrients, which used in small amounts promote, inhibit or otherwise modify physiological processes in plants. Plant growth regulators or hormones influence the growth of chrysanthemum at all stages from rooting to senescence. The classification, chemical composition and action of both natural and synthetic growth regulators have been described by Cathey (1975) and Menhenett (1977).

Chemicals which scale down many species of plants are called growth retardants. Treated plants have a more compact habit and darkers green foliage compared to untreated plants. Many other processes which are affected by growth retardants include draught resistance and salt tolerance, decrease in water loss, decrease in sensitivity to air pollution, enhancement of the number and rate of development of roots in cuttings and longevity of flowering plants. As far as use of growth regulators on chrysanthemum is concerned, commonly used chemicals on this crop are phosphon-D, phosphon-S, B-9, ancymidol, cycocel, Amo-1618, maleic hydrazide, paclobutrazol and ethephon etc. These all growth retardants use to yield variable results with the cultivar and the growing condition.

The phenomenon of "growing out" which is frequently observed in daminozide-treated plants, and suggest that daminozide exerts its primary effect at a site located in the stem (Dicks and Edwards, 1973).

Hebb *et al*. (1974) recorded that Ancymidol reduced height to acceptable limits at all concentration and the plants needed no support. SADH reduced height only in the 2 week photoperiod treatment, and all SADH and control plants required staking. Ancymidol delayed flowering and tended to reduce flower head diameter slightly.

A new quaternary ammonium growth retardant, i-allyl-i-(3,7-dimethyl-octyl)-piperidinium bromide (ADOPB), was compared with daminozide, ancymidol and chlorphonium chloride for its effectiveness in reducing lateral stem length in the pot chrysanthemum. Foliar spray of ADOPB generally delayed flowering by 2-3 days more than did sprays of daminozide, but this was comparable with that associated with the use of compost drenches of chlophonium chloride. High concentrations of all the retardants reduced the diameter of open flowers (Menhenett, 1977).

Menhenett (1984) demonstrated that a new growth retardant, paclobutrazol (PP 333), applied as a single compost drench or as a foliar spray, is very effective in controlling stem extension in the pot chrysanthemum (*Chrysanthemum morifolium*) 'Bright Golden Anne', a tall cultivar. Moreover, the concentration required, 30-50 mg a.i. l^{-1}, was much lower than with a drench of chlorphonium chloride (Phosfon/Phosfleur), or with a foliar spray of daminozide (Alar/B-Nine) or piproctanyl bromide (Alden/Stemtrol).

Hicklenton (1990) Flowering was delayed in each cultivar by post-plant treatments of uniconazole drench and spray and by daminozide spray (0.08,0.014 and 14 mg a.i. pot^{-1} respectively) and by daminozide and uniconazole pre-plant dips (5.0 mg/l and 4000 mg/l respectively). Drenches of uniconazole at 0, 0.025, 0.05, or 0.10 mg a.i./pot were compared with ancymidol drenches at 0.45 mg a.i./pot for controlling height of 'Bright Golden Anne' (Starman, 1990). Although ancymidol was more effective, a 0.10 mg a.i./pot uniconazole drench adequately reduced height.

Holcomb *et al.* (1991) reported that an application of GA_3 at 3 weeks after uniconazole was applied caused the peduncle to elongate and created a marketable flowering potted chrysanthemum of desirable proportion rather than a clubby one. Two sprays of uniconazol (10 ppm) generally produced plant with height equivalent to daminozide (2500 ppm). Unicanazol was shown to be viable alternative of daminozide for chrysanthemum height control and was effective at much lower concentrations than that of daminozide (Wilfret, 1991).

Plants were shorter the earlier growth regulators were applied. Plants were more responsive to uniconazole, requiring paclobutrazol at up to four times the uniconazole concentration to achieve the same height control. Time to flowering was also lengthened the earlier applications were made, up to 3 days compared to non treated plants. Flower diameter was only minimally affected by the treatments (Gilbertz, 1992).

Sita Ram and Sehgal (1993a) reported that MH (2000 ppm) proved to be most effective in reducing plant height as well as final plant spread and increasing the number of side shoots. They also observed more number of side shoots per plant under controlled photoperiod. Eight concentrations of ancydimdol and paclobutrazol ranging from 0 to 100 mg/l were supplied constantly in sub irrigation water to potted plants to identify critical levels at which plant growth is affected. The results provide useful information for managing plant growth by using growth retardants i.e. ancydimdol and paclobutrazol in sub irrigation water (Million *et al*., 1999).

Petty *et al.* (2003) demonstrate the feasibility of producing a dwarf (pot) chrysanthemum without the need for growth retardant chemicals through heterologous expression of the mutant Arabidopsis gai gene driven from its own promoter. Velmurugan and Vadivel (2003) conducted pot experiment under greenhouse conditions to study the effect of photoperiod and paclobutrazol on flowering and yield characters of chrysanthemum. Artificial short days by providing 14 hours shade result in earliest flowering and longest flowering duration while artificial long days by providing 3 hours extended light delay the flowering period. Paclobutrazol 100 ppm produced earliest flowering while paclobutrazol 50 ppm produced the longest flowering duration.

Karlovic *et al*. (2004) stated that the use of the lower daminozide concentration in height regulation of 'Revert' chrysanthemum is recommended for environmental reasons and daminozide concentrations were more efficient in regulating the upward growth than chlormequat concentrations.

Sheibany *et al.* (2007) reported that ALAR:

- Treated plants, compared to untreated, were significantly shorter in stem length, internodes length associating with increased in stem diameter.
- The short foliage stature was proportional with the concentration of ALAR.
- ALAR application had no effect on apical dominance, flower initiation and time of sprouting of auxiliary buds.
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Dalal *et al*. (2009) revealed that, foliar application of gibberellic acid at 200 ppm concentration resulted in maximum plant height, hastened the flowering, increased the diameter of flower, length of flower stalk and flower yield. However, number of branches per plant and vase life of flower were maximum in MH at 750 ppm.

Kazaz *et al.* (2010) reported 14.11 flowers were obtained from the plants treated with daminozide, while 11.17 flowers per stem were obtained from the plants untreated with daminozide. In the study, compact and higher quality flowers with a desired stem length were obtained both under short day conditions and with daminozide application.

Plant sprayed with MH at 1250 mg/l recorded the maximum reduction in plant height with maximum number of branches, plant spread, shelf life and vase life of flowers, whereas it was also found beneficial for delaying and increasing the duration of flowering. However, in case of flower yield per plant and per hectare, the lower concentration of MH at 750 mg/l was found significantly superior as compared to other treatment (Navale *et al*., 2010).

Sharifuzzaman *et al*. (2011) stated that GA_3 treated plants showed significant increase in plant spread, leave number and leave length. Irrespective of concentration, GA_3 also produced the higher number of sucker and flowers and CCC produced less. GA_3 also caused faster initiation of flowering and CCC and MH delayed it. Length of flower stalk significantly increased with GA_3. Use of CCC showed an increasing vase life of flowers. In this study, foliar application of 150 ppm GA_3 was the best for obtaining better growth of plants, maximum number of cut blooms with longer stalk as well as bigger flower size.

Dorajeerao *et al*. (2012) the economic analysis revealed that maximum benefit cost ratio was recorded by the foliar application of SA (salicylic acid) at 100 ppm, 150 ppm followed by GA at 100 ppm. This is because of higher cost of GA chemical compared to others. However, higher gross returns are obtained by the application of GA 100 ppm followed by SA at 100 ppm and GA 150 ppm in the order during both *kharif* and *rabi* seasons.

Foliar spray of cycocel at 3000 ppm recorded maximum number of flowers per plant, when compared to other concentrations. But their average weight being relatively lesser, they were making a gross weight of flowers per ha only next to gibberellic acid at 100 ppm. SA spray at 100 ppm resulted in significant increase in flower and seed yield when compared to other concentrations. Paclobutrazol at 40 ppm recorded a higher number of flowers per plant compared to other higher concentrations of 60 and 80 ppm. Flower quality in terms of average flower weight, flower diameter and seed quality in terms of test weight were also at maximum by the application of GA at 100 ppm (Dorajeerao and Mokashi, 2012).

Papafotiou and Vagena (2012) reported that substitution of 50% peat with cotton gin trash compost in the commonly used medium for potted chrysanthemum commercial cultivation resulted in a reduction of at least 33% of the dose of daminozide necessary to meet the needs of the market for compact plants with multiple economic and environmental benefits.

Roepke *et al.* (2013) determined that daminozide application was associated with a 22–50 % increase in the flavones apigenin 7-O-rutinoside, acacetin 7-O-rutinoside, diosmetin 7-O-rutinoside, and eupatorin, and a 68 %increase in the flavonol quercetin 3-O-glucoside, in ray florets of 'Pelee' relative to control plants. There was no relative change in 'Baton Rouge' flavone and flavonol levels. The accumulation of bronze *C. morifolium* flavones and flavonols following foliar daminozide application suggests that red color loss is associated with inhibition of anthocyanidin synthase of 'Pelee' ray florets.

Ganesh *et al*. (2014) observed that single application of daminozide at 2500 ppm at seven days after darkening reduced the plant height at critical stages and improved total leaf area at bud appearance and peak flowering stage. It also showed earliness in flowering and days to harvest, increased pedicel length , cut stem girth , stem fresh weight and chlorophyll and soluble protein content at critical stages. Increased cut stem yield and improved vase life were also recorded.

There are several plant growth retardants like Paclobutrazol, Ancymidol, Sumagic, A-Rest, Daminozide, Cycocel. Plant growth retardants in ornamental plants are commonly applied to limiting stem elongation and produce more compact, sturdy potted plants without changing developmental patterns or evoke phytotoxic effects. Growth retardants also enhance stress tolerance, green colour of the foliar and postharvest longevity. These growth retardants may be applied as foliar spray, drench at different concentrations according to the variety (Ghosh and Rao, 2015).

Economics of chrysanthemum indicated that the plant sprayed at 30 days after transplanting and treated with MH @ 700 mg l^{-1} found most remunerative as they gave highest net returns (Rs. 208980) with maximum Benefit Cost Ratio (1:4.50). It can be concluded that the foliar application of MH @ 700 mg l^{-1} at 30 days after transplanting proved superior in terms of growth, flowering, flower yield and more economical as compared to all other growth retardants treatments (Vaghasia and Polara, 2015).

III. CONCLUSION

It can be concluded that for the best quality pot mum production of chrysanthemum cultivars should be sprayed with paclobutrazol, daminozide, CCC, MH etc. after one week of pinching.

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