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Visual quality, root production and vase life of syngonium as influenced by growth retardants

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Abstract
Growth and quality management of ornamental foliage plants with the use of growth retardants is not an accustomed method and meagre importance was disposed to enhance growth and improve visual quality of foliage plants by using plant growth retardants. Keeping this point in view, during the year 2021-22, a research trial was conducted at College of Horticulture, VR gudem with an intent of studying the effect of certain plant growth retarding substances on visual quality and root parameters of syngonium plants and leaf longevity and vase life of cut foliage. Thirteen PGR treatments were administered twice i.e., at 30 and 60 DAT as spray applications. Treatments were imposed in Completely Randomized Design with four concentrations each of PBZ (50, 100, 150 and 200 ppm), B-nine (1000, 1500, 2000 and 2500 ppm), CCC (1000, 1500, 2000 and 2500 ppm) and plant sprayed with water were treated as control. The experiment was laid out with two replications. With respect to root growth parameters, highest root length of 74.55 cm/plant, root spread of 15.96 cm/plant, root fresh weight of 37.10 g/plant and root dry weight of 8.95 g/plant were observed with 2000 ppm of cycocel sprays. With regard to quality parameters, paclobutrozol 150 ppm sprays resulted in more attractive syngonium plants with visual plant grade score of 4.84 (T_3). However, the visual colour grade score was recorded highest in cycocel 2500 ppm sprays applied twice (4.84) and was followed by 150 ppm foliar sprays of paclobutrozol (4.65). Cycocel at 2000 ppm concentration was found very effective in enhancing the visual root grade of syngonium plants recording a highest score of 4.75. At 150 DAT, highest leaf longevity of 84 days was observed in syngonium plants treated with paclobutrazol at 200 ppm which was found to be at a par with 150 ppm paclobutrazol (81.5 days). It was observed that the paclobutrazol dose effectively delayed wilting of syngonium cut leaf and potential vase life was extended to a maximum of 32.45 days in PBZ 200 ppm treatment.

Keywords: *Syngonium podophyllum*, paclobutrazol sprays, visual colour grade, plant grade, root growth

Introduction

During the past few years, we have witnessed a significant change in our urban housing system and major scenic beauty of nature has been replaced by densely populated areas that exists for miles from urban centers with higher amounts of pollution and limited spaces for growing plants. The awareness of using attractive foliage plants indoors and in shady garden corners is increasing day by day. Under this scenario, the awareness of using attractive foliage plants indoors and in shady garden corners is increasing day by day. Foliage plants form an interesting group of ornamentals, generally grown for their attractive foliage. For a touch of green and beauty, they can be retained for longer periods in an interior environment. Indoor foliage plants are very ideal and they generate an attractive and serene environment. In addition, ornamental foliage plants can help to reduce stress levels and improve our whole outlook on work. Creating a small indoor garden around the living area with attractive foliage plants will increase the oxygen levels in the air. Besides this, growing of potted plants also benefits the nursery industry as they require less maintenance and there is a great demand for foliage plants for both domestic market as well as export market. Among a number foliage plants available, *Syngonium podophyllum* is typically grown for its attractive ornamental foliage and it is a hardy plant that is adaptable to any climatic conditions. However, when syngonium plants are placed in the home or office, their continued growth with long petioles may cause them to appear unsightly. Moreover, as these plants are often produced in low lit areas, they tend to stretch, become leggy or simply overgrown and makes the plants less marketable and harder to maintain. Hence, they requires regular pruning and trimming to maintain its shape and attractiveness. In this context, plant growth retardants may be applied to foliage plants to reduce unwanted longitudinal shoot growth and to produce more compact plants without lowering ornamental value (Anderson and Andersen, 2000) [3].

Growth retardants *viz*. paclobutrazol, daminozide, and cycocel, are extensively used by the researchers but the detailed study of their doses and intensity of application in improving quality syngonium plants is still meagre. Hence, with a view to promote the landscaping industry for the livelihood of nurserymen and to meet the demand of household customers a research trial was conducted in Floriculture and Landscape Architecture Department, College of Horticulture, Venkata Ramannagudem. The objective of the experiment was to study the influence of plant growth retardants on syngonium plant ornamental value and root growth and longevity and vase life of leaves.

Materials and Methods

One month old syngonium plants were planted in polythene bags of 30 cm^2 size containing a potting mixture of soil, sand and Farm Yard Manure in 2:1:1(v/v) proportion. Later, they were placed under partial shade and watered with rose can. Growth retarding chemicals *viz*., paclobutrazol, B-nine and cycocel with four concentrations each, were used in the experiment. There were totally thirteen treatments and the plants were sprayed with growth retardants as T_1–PBZ (50 ppm), T_2 - (100 ppm), T_3 - PBZ (150 ppm), T_4 - PBZ (200 ppm), T_5 - B-nine (1000 ppm), T_6 - B-nine (1500 ppm), T_7 - B-nine (2000 ppm), T_8 - B-nine (2500 ppm), T_9 - CCC (1000 ppm), T_{10} - CCC (1500 ppm), T_{11} - CCC (1500 ppm), T_{12} - CCC (2000 ppm) and T_{13} - control. Growth retardants were applied as foliar sprays in two schedules, at one month and two months after transplantation and the treatment without application of growth retardant was taken as control. The experiment was conducted in a completely randomized block design with two replications. Data on ornamental quality parameters *viz*., longevity of leaves, visual plant grade, colour grade and root grade and vase life of cut foliage were recorded at 150 DAT. Longevity of leaves was measured in days from the day the leaf is fully unfurled to the day the leaf became unfit (as indicated by drying, wilting, twisting, drooping, yellowing, blackening etc.). Syngonium plants were rated according to its fullness, growth and visual appearance *viz*., texture, shape and pattern and size of the foliage during the growth period. A grading system of 1-5 scale as suggested by Poole and Conover (1992) [16] was followed for determining visual plant grade where, 1 = dead, 2 = poor quality, 3 = Fair quality, 4 = Good quality and 5 = Excellent quality. Based on the leaf colour and pigmentation, plants were graded as 1 (poor colour), 3 (good, light green) and 5 (excellent dark green & silver contrast). At the end of the experiment, as per the root grading system followed by Stamps and Evans (1999) [20], extent of white healthy looking roots covering the outside of the soil mass was visually evaluated as 1 (20% soil ball covered with roots), 2 (20-40% soil ball covered), 3 (40-60% soil ball covered), 4 (60-80% soil ball covered) and 5 ($p \geq$ 80% coverage). Observations for root parameters *viz*., root length, root spread (NS & EW), fresh weight of root and dry weight of root were recorded at 150 DAT.

Results and Discussion

Leaf longevity (days)

Data recorded on longevity of syngonium leaves indicated that there was a significant difference for the parameter (Table 1). Plants treated with paclobutrazol @ 200 ppm (T_4) recorded highest leaf longevity (84 days) at 150 DAT and found at par with paclobutrazol 150 ppm treatment (81.5 days) and paclobutrozol 100 ppm (T_2) (80.5 days). Lowest leaf longevity (67.5 days) was observed in water sprayed control plants (T_{13}) followed by B-nine @ 1000 ppm (T_5) (72 days). Based on the data it is evident that highest leaf longevity was observed in paclobutrazol treated plants. The results are in line with the findings of Jiao *et al.* (1986) [10] who noticed a decrease in leaf senescence and increase in leaf longevity by paclobutrazol in ‘Nellie White’ Easter lily. In syngonium, Chaitanya *et al.* (2017) [4] observed maximum leaf longevity of 78 days with PBZ at 50 ppm and the minimumleaf longevity of 62 days in B-Nine 2000 ppm and control. In *Ficus benjamina*, paclobutrazol at 100 ppm showed the highest leaf longevity of 74.20 days and the lowest was in control (69.93 days). according to Fletcher *et al.* (2000) [8] the delay in leaf senescence may be attributed to the effect of paclobutrazol on cytokinin levels increase and reduced chlorophyll catabolism. Dewy *et al.* (2016) [6] ascribed the delay in leaf senescence of paclobutrazol treated plants to reduced the cell maturation with an increased activity of oxidative enzymes.

Table 1: Effect of plant growth retardants on longevity of leaves and vase life of cut foliage (days) at 150 DAT in syngonium

Treatments	Longevity of leaves (days)	Vase life of cut foliage (days)
T_1 - PBZ @ 50 ppm	73.00	27.45
T_2 - PBZ @ 100 ppm	80.50	30.00
T_3 - PBZ @ 150 ppm	81.50	31.20
T_4 - PBZ @ 200 ppm	84.00	32.45
T_5 - B-nine @ 1000 ppm	72.00	23.00
T_6 - B-nine @ 1500 ppm	74.00	23.13
T_7 - B-nine @ 2000 ppm	73.00	23.16
T_8 - B-nine @ 2500 ppm	76.50	24.68
T_9 - Cycocel @ 1000 ppm	72.50	25.28
T_{10} - Cycocel @ 1500 ppm	73.50	27.18
T_{11} - Cycocel @ 2000 ppm	78.00	29.13
T_{12} - Cycocel @ 2500 ppm	76.50	25.48
T_{13} - Control (Water spray)	67.50	13.63
S Em (+)	1.29	0.76
CD at 5%	3.99	2.36

Vase life of cut foliage (days)

The observations regarding life of cut foliage of syngonium at 150 DAT had shown significant differences among the treatment means (Table 1). Paclobutrazol @ 200 ppm (T_4) registered maximum life of cut foliage (32.45 days) and at par with paclobutrazol 150 ppm (T_3) (31.2 days) and paclobutrazol @ 100 ppm (T_2) (30 days). Minimum vase life of cut foliage (13.62 days) was observed in water spray ((T_{13}) followed by B-nine at 1000 ppm (23 days). The data indicated that increasing paclobutrazol dose effectively delayed wilting of syngonium cut leaf and potential vase life was extended which could be ascribed to reduced number of stomata, leaf area, high density of stomata and water stress tolerance initiation (Sankar *et al.*, 2007) [18]. The other possible reason might be the retention of chlorophyll in leaves and delay in senescence of leaf thereby, enhancing life of cut foliage (Abshahi *et al.*, 2014) [1]. Xia *et al.* (2018) [22] stated that in peony leaves, paclobutrazol induced a darker green colour when compared to control plants. They also observed increased volume of starch granules in the paclobutrazol treated peony plants with darker green leaves and concluded that this change in the quantity of starch granules and morphology of leaveswould have prolonged the time for the photosynthates to degrade and hence contributed for the maximum vase life in darker leaves.

Visual plant grade

At 150 DAT treatments differed significantly in the parameter visual plant grade (Table 2 and Fig.1). Maximum visual plant grade score (4.84) was registered at 150 ppm paclobutrazol treatment and was at a par with cycocel 2500 ppm (4.75) and paclobutrazol @ 200 ppm (T_4) (4.71). Minimum visual plant grade was recorded in plants sprayed with water (T_{13}) (3.64) which was followed by alar 2500 ppm (T_8) (4.13) and B-nine @ 1500 ppm (T_6) (4.15). The data from Table 2 brings to conclusion that paclobutrazol was very effective in suppressing growth and due to which treated plants were smaller and compact with intense greener leaves. The results are in congruity with Starman and Williams (2000) [21] and Sebastian *et al.* (2002) [19] who affirmed that PBZ treatment improve the presentability of plants and plants will become dwarf with compact, growth and darker green in look. These results are in confomity with Chaitanya *et al.* (2017) [4] who recorded highest plant quality rating (9.1) with 100 ppm paclobutrazol in many indoor plants like *Dieffenbachia amoena*, *Dracaena sanderiana*, *Scindapsus aureus* and *Ficus benjamina*. Mansuroglu *et al.* (2009) [13] concluded that formation of growth-active gibberellins is inhibited by most plant growth retardants and hence can be used more efficiently to reduce shoot elongation. The resulting stems are thicker and leaves may be a deeper green as a result of higher concentrations of chlorophyll in smaller cells.

Visual colour grade

The data regarding visual colour grade recorded at 150 DAT had significant differences among the treatment means (Table 2 and Fig.1). The visual colour grade was significantly recorded highest score of 4.84 in cycocel 2500 ppm (T_{12}) and was followed by T_3 treatment (paclobutrazol 150 ppm) (4.65) which was found to be at par with 200 ppm paclobutrozl (T_4) (4.54). Least visual colour grade was recorded in control plants (T_{13}) (3.81). It is evident that visual colour grade, given according to colour and pigmentation (green and silver contrast) was highest and almost equal in both cycocel and paclobutrazol treated plants. For the control of quality characters, growth retardants such as Cycocel and paclobutrazol are prominently used in many plants (Karlovic *et al.*, 2004) [11]. Diana *et al.* (2014) [7] assessed the influence of different concentrations of cycocel on coleus plants and reported that it had induced color enhancement in the leaves with increased amounts of pigments (chlorophylls, carotenes, anthocyanins) and produced more compact plants with multiple buds per shoot.

Visual root grade

The data regarding visual root grade (Table 2) recorded at 150 DAT had showed significant differences among the treatment means. Cycocel @ 2500 ppm (T_{12}) recorded the highest visual root grade (4.75) which was found to be at par with cycocel @ 2000 ppm (T_{11}) (4.60) and cycocel @ 1500 ppm (T_{10}) (4.55). Visual root grade (3.05) was recorded minimum at 200 ppm paclobutrazol which was found to be at par (3.10) at paclobutrazol 150 ppm. Based on the data it is clear that visual grade of the root was highest in cycocel treatments as they reported highest root growth characters such as root length and spread responsible for covering most of the soil mass (as evident from data presented on root parameters). Lowest visual root grade (3.05) was registered in paclobutrazol possibly due to least length and spread of the root resulting in less coverage of the soil mass.

Data recorded on root parameters of syngonium treated with different growth retardants is presented in Table 3.

Table 2: Effect of plant growth retardants on visual colour grade, plant grade and root grade at 150 DAT in syngonium

Treatments	Visual colour grade	Visual plant grade	Visual root grade
T_1 - PBZ @ 50 ppm	3.92	4.25	3.20
T_2 - PBZ @ 100 ppm	4.14	4.32	3.38
T_3 - PBZ @ 150 ppm	4.65	4.84	3.10
T_4 - PBZ @ 200 ppm	4.54	4.71	3.05
T_5 - B-nine @ 1000 ppm	4.31	4.31	4.18
T_6 - B-nine @ 1500 ppm	4.41	4.15	4.25
T_7 - B-nine @ 2000 ppm	4.18	4.18	4.40
T_8 - B-nine @ 2500 ppm	4.13	4.13	4.50
T_9 - Cycocel @ 1000 ppm	4.45	4.24	4.48
T_{10} - Cycocel @ 1500 ppm	4.51	4.41	4.55
T_{11} - Cycocel @ 2000 ppm	4.42	4.63	4.60
T_{12} - Cycocel @ 2500 ppm	4.84	4.75	4.78
T_{13} - Control (Water spray)	3.81	3.64	3.90
S Em (+)	0.06	0.05	0.09
CD at 5%	0.18	0.14	0.29

Visual plant grade: 1 = dead, 2 = poor quality, 3 = Fair quality, 4 = Good quality and 5 = Excellent quality

Visual colour grade: 1= poor colour, 3 = good, light green, 5 = excellent dark green & silver contrast.

Visual root grade: 1= 20% soil ball covered with roots, 2 = 20-40% soil ball covered, 3 = 40-60% soil ball covered, 4 = 60-80% soil ball covered, 5= ≥ 80% coverage.

Table 3: Effect of plant growth retardants on root length (cm), spread (cm), root fresh weight (g) and root dry weight (g) at 150 DAT in syngonium

Treatments	Root length (cm)	Root spread (cm)	Fresh weight of root (g)	Dry weight of root (g)
T_1 - PBZ @ 50 ppm	54.03	9.30	25.25	5.55
T_2 - PBZ @ 100 ppm	48.72	9.88	25.18	4.40
T_3 - PBZ @ 150 ppm	43.94	9.95	23.95	4.18
T_4 - PBZ @ 200 ppm	37.42	10.42	22.38	3.63
T_5 - B-nine @ 1000 ppm	55.10	11.00	32.40	8.30
T_6 - B-nine @ 1500 ppm	62.42	11.44	27.10	7.30
T_7 - B-nine @ 2000 ppm	67.10	11.17	34.05	6.65
T_8 - B-nine @ 2500 ppm	65.45	11.69	31.36	6.90
T_9 - Cycocel @ 1000 ppm	69.55	10.49	33.70	8.60
T_{10} - Cycocel @ 1500 ppm	71.00	12.49	35.15	8.75
T_{11} - Cycocel @ 2000 ppm	73.12	13.13	35.50	8.85
T_{12} - Cycocel @ 2500 ppm	74.55	15.96	37.10	8.95
T_{13} - Control (Water spray)	63.40	7.18	25.03	7.45
S Em (+)	1.26	0.34	1.51	0.21
CD at 5%	3.88	1.06	4.65	0.64

Root length (cm)

Root length of syngonium was found significant by the treatments at 150 DAT. Highest root length was registered in cycocel @ 2500 ppm (T_{12}) (74.55 cm) and was at a par with 2000 ppm cycocel treatment (T_{11}) (73.12 cm) and cycocel 1500 ppm (T_{10}) (71.00 cm). Minimum root length (37.42 cm) was recorded in paclobutrazol 200 ppm sprays followed by paclobutrazol 150 ppm (43.94 cm) and paclobutrazol 100 ppm sprays (T_2) (48.72 cm). it can be inferred that paclobutrazol treatments not only reduced aerial portion but also reduced the root growth to a greater extent. According to Desta and Amare (2021) [5], GA biosynthesis is inhibited with paclobutrazol tretment by blocking the oxidation of *ent*-kaurene and results in reduced cell division and elongation for the root growth. These findings are in line with the findings of Samia (2007) [17] in *Aniscacanthus wrightii* where paclobutrazol gave a reduction of root growth ranging from18.1% -23.3% when compared to untreated plants. Similar trends were attained by Gent (1997) [9] in *Rhodendron catawbiense*, Auda *et al.* (2002) [2] in Barleria and Montasser (2004) [15] in *Jacobinia carnea*.

Root spread (cm)

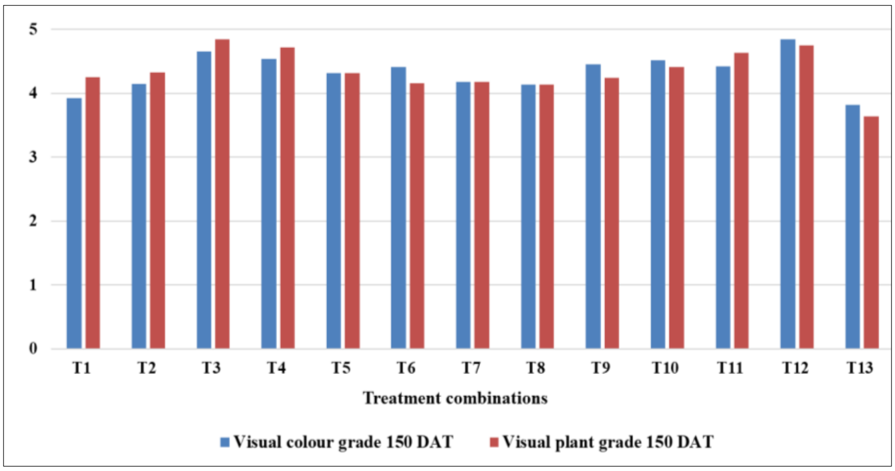
At 150 DAT, significantly highest root spread was registered in cycocel @ 2500 ppm (T_{12}) (15.96 cm) followed by 2000 ppm cycocel treatment (T_{11}) (13.13 cm) and was at a par with cycocel 1500 ppm (T_{10}) (12.49 cm). The least root spread (7.18 cm) was observed in water spray plants (T_{13}) followed by paclobutrazol 50 ppm (T_1) (9.3 cm) and paclobutrazol 100 ppm (T_2) (9.88 cm). Plants treated with paclobutrazol had lowest root spread which are in conformity with the findings of Samia (2007) [17] in *Aniscacanthus wrightii* where paclobutrazol gave a reduction of root growth ranging from 18.1% - 23.3% than the control plants. Similar findings were attained by Gent (1997) [9] when he treated *Rhodendron catawbiense* plants by Triazole at 25, 50, and 75 mg/L, Maadawy *et al.*, (2001) [12] on Begonia and Montasser (2004) [15] on *Jacobinia carnea*. On contrary, highest root spread was observed in cycocel treatments probably due to its longest root length and highest soil mass coverage.

Root fresh weight (g)

The data had showed significant differences among the treatment means. Highest fresh weight of root was registered in cycocel @ 2500 ppm (T_{12}) (37.10 g) which was found to be at par with cycocel @ 2000 ppm (T_{11}) (35.50 g) and cycocel @ 1500 ppm (T_{11}) (35.15 g). The lowest fresh weight of root (22.38 g) was noticed at 200 ppm paclobutrazol (T_4) and was at a par with 150 ppm paclobutrazol (T_3) (23.95 g) and 100 ppm paclobutrazol treatments (T_2) (25.18 g). Highest fresh weight of root recorded in cycocel treated plants might be due to highest root growth characters *i.e.*, root length and spread contributing for its fresh weight. In contrast, paclobutrazol treatments recorded lowest fresh weight of root. The reason could be limited root growth as observed in paclobutrazol treatments. These findings are in conformity with Samia (2007) [17] in *Aniscacanthus wrightii* and with Medina *et al.* (2012) [14] in *Manihot esculenta* Crantz cv. Rocha.

Root dry weight (g)

Significantly maximum root dry weight was registered in cycocel @ 2500 ppm treatment (T_{12}) (8.95 g) which was found to be at par with cycocel @ 2000 ppm (T_{11}) (8.85 g) and cycocel @ 1500 ppm (T_{10}) (8.75 g). Paclobutrazol @ 200 ppm treatment (T_4) recorded the lowest (3.63 g) which was at par with paclobutrazol sprays at 150 ppm (T_3) (4.18 g) and 100 ppm (T_2) (4.40 g). It was evident from the data that highest dry weight of root was registered in cycocel treatments which could possibly be due to highest root growth resulting in more dry matter accumulation. On contrary, lowest of root dry weight was observed in paclobutrazol treatments which might be due to reduced root growth which caused less dry matter accumulation. Paclobutrazol is a triazole compound which inhibits GA biosynthesis (Desta and Amare, 2021) [5] resulting in reduced cell division and elongation for the root growth. Thus, higher concentrations of paclobutrazol might have resulted in reduced root growth. These findings are in line with Samia (2007) [17] in *Aniscacanthus wrightii* where paclobutrazol gave a reduction of root growth traits when compared to untreated plants. Similar trends were attained by Gent (1997) [9] when *Rhodendron catawbiense* plants were treated by Triazole at 25, 50, and 75 mg/L and Montasser (2004) [15] on *Jacobinia carnea*.



T_1 - Paclobutrazol @ 50 ppm
T_2 - Paclobutrazol @ 100 ppm
T_3 - Paclobutrazol @ 150 ppm
T_4 - Paclobutrazol @ 200 ppm
T_5 - B-nine @ 1000 ppm
T_6 - B-nine @ 1500 ppm
T_7 - B-nine @ 2000 ppm
T_8 - B-nine @ 2500 ppm
T_9 - Cycocel @ 1000 ppm
T_{10} - Cycocel @ 1500 ppm
T_{11} - Cycocel @ 2000 ppm
T_{12} - Cycocel @ 2500 ppm
T_{13} – Control (Water spray)

Fig 1: Effect of growth retardants on visual colour grade and visual plant grade at150 DAT in syngonium

Conclusion

Foliar sprays of paclobutrazol @ 150 ppm improved quality parameters in syngonium plants recording highest plant grade and colour grade when compared to other treatments.

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