The Pharma Innovation Journal 2024; 13(5): 16-20

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
TPI 2024; 13(5): 16-20

www.thepharmajournal.com
Received: 02-03-2024
Accepted: 03-04-2024

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Studies on the effect of plant growth retardants on growth and post-harvest parameters in Nerium (*Nerium oleander* L.) cv. Pink Single

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Abstract
An investigation was undertaken to study the effect of growth retardants on growth and post-harvest parameters of nerium cv. Pink Single at College of Horticulture, Mysuru during 2020-2021. The growth retardants used were PCB (150, 250 and 350 ppm), MH (1500, 2000 and 2500 ppm) and SADH (1500, 2000 and 2500 ppm) in randomized block design with three replication. Among different treatments, MH at 2500 ppm gave maximum reduction in plant height (127.53 cm), internodal length (4.45 cm) and individual leaf area (36.07 cm^2). However maximum plant spread in (111.00 cm) North – South and (116.60 cm) East – West direction, number of secondary branches (53.80) and chlorophyll content (1.91 mg/g) with minimum physiological loss of weight (8.40 %) and extended shelf life up to 10.16 hours was also noticed with the same treatment.

Keywords: Nerium, PCB, MH, SADH

1. Introduction
Nerium botanically known as *Nerium oleander* belongs to the family Apocyanaceae and it is indigenous to Mediterranean region. The flowers of nerium are extensively used for garland making, worshiping in home and temple, hair adornment and floral decoration. The ornamental value of this flower is attributed with avenue planting, border planting and potted plant. Along with its ornamental use and loose flower production, this shrub is known for its medicinal purpose (Adome *et al.*, 2003) [1].

Total area under the floriculture crops in India is 305 thousand ha with the production of 3063 thousand MT in that Karnataka covers an area of 24.79 thousand ha with the loose flower production of 178.03 thousand MT (Anon., 2018) [3]. Now a days there is a huge demand for loose flowers in domestic market. With the advanced agricultural techniques, there are multiple ways to increase the yield and profits from the crops. Apart from the genetic and management tools, present day scientists make use of growth regulators for fixing the desired ratio of vegetative and reproductive portions.

Plant growth retardants are the substances that reduces the shoot length of plants in a required manner without being toxic to the plants. Their primary action is through decreasing the cell elongation and also by lowering the rate of cell division. In recent years, notable plant growth retardants like paclobutrazol (PCB), maleic hydrazide (MH), succinic acid – 2.2 – dimethylhydrazide **(**SADH), cycocel (CCC) and ethrel have been found to control stem elongation which leads to the creation of compact plants coupled with the higher yield (Sudhagar and Kamalakannan, 2017) [46]. Their effect varies with the plant species, variety, concentration used, frequency of application and various other factors which influence the uptake and translocation of chemicals. Hence the present investigation was undertaken to ascertain the most appropriate concentration of growth retardants for improving the growth and post-harvest quality of *Nerium oleander* cv. Pink single.

2. Materials and Methods
The experiment was conducted at the Department of Floriculture and Landscape Architecture, College of Horticulture, Mysuru, Karnataka. The experiment field was located at the latitude and longitude of 12º 184´ North and 74º 658´ East respectively, and at an altitude of 770 m above the mean sea level. During the study period the maximum mean temperature was ranged from 33.6 ºC to 27.0 ºC.

While, the minimum mean temperature was ranged from 21.2 ºC to 16.4 ºC. The soil of the experimental field was red sandy loam with an almost uniform fertility having a pH of 7.8.

Two years old nerium plants which were already established in the field were pruned by cutting back the shoots at 45 cm height from the ground level. Dead, diseased and excess branches were removed. To maintain optimum moisture level the plants were irrigated thoroughly. The first spray was given on newly emerged shoots at 60 days after pruning as per treatment schedule and second spray was employed at 90 days after the first spray (150 days after pruning) and third spray was applied at 90 days after the second spray (240 days after pruning). Control plants were sprayed with water. Foliar application of growth retardants was applied as per treatment. Both the surface of leaves and apical meristem were fully moistened.

Treatments details

T_1- PCB @ 150 ppm
T_2- PCB @ 250 ppm
T_3- PCB @ 350 ppm
T_4- MH @ 1500 ppm
T_5- MH @ 2000 ppm
T_6- MH @ 2500 ppm
T_7- SADH @ 1500 ppm
T_8- SADH @ 2000 ppm
T_9- SADH @ 2500 ppm
T_{10}- Control

3. Results and Discussions

The results obtained from the present investigation are summarized in Table 1 and 2.

Effect of growth retardants on growth attributes of *Nerium oleander* cv. Pink single

It is revealed from the Table 1 that the vegetative growth of nerium varied significantly with the different growth retardant treatments. There was marked reduction of plant height observed due to all growth retarding chemicals depending upon the concentrations. The maximum retardation was obtained with T6- MH 2500 ppm (127.53 cm) followed by SADH at 2500 ppm (T_9) (134.13 cm) whereas, highest plant height was observed in control (152.40 cm). Plant height was found to decrease with increase in the concentration of growth retardants due to its action as an anti-auxin, with the stimulation of dwarfing properties and nullification of apical dominance (Renu and Srivastava, 2013) [37]. The diminish in height of the plant was due to spraying of maleic hydrazide inhibited the gibberlin biosynthesis and suppression of apical dominance completely by inhibiting the cell division on the apical meristem, thereby resulting in shorter plant (Kumar *et al*., 2020) [21]. This trend retarded plant height due to MH was in consonance with the reports of Srivastava and Bajpai (1964) [45] in calendula, Saha (1966) [38] in zinnia, Sen and Sen (1968) [39] in chryasanthemum and petunia, Dubey (1972) [13] in carnation, Sen and Maharana (1972) [40], Nagarjuna *et al*. (1988) [29], Moond *et al.* (2006) [28], Navale *et al*. (2010) [32] in chrysanthemum, Reddy and Sulladmath (1983) [36] in china aster, Kumar (1987) [19], Wasiq *et al*. (2020) [48] in marigold, Baladha *et al*. (2016) [5] Rashmi and Deen (2017) [35] in gladiolus, Jain *et al*. (2016) [15] in bougainvillea cv. shubra, Malik *et al.* (2017) [25] in dahlia, Dhanasekaran *et al.* (2018) [12] in gaillardia, Ahmad *et al*. (2019) [2] in dahlia, Kumar *et al.* (2020) [21] in Nerium and Singh *et al*. (2021a) [44] in tuberose.

Plant spread towards North – South direction varied significantly among the different levels of growth retardants. The data on spread of plants showed that maximum spread was observed in MH at 2500 ppm (T_6) with 116.60 cm on east west and 111.00 cm on north south directions. Spraying of growth retardants seemed to restrict the height of the plant by suppressing apical dominance leads to bushy expansion of plants and thereby promoted the plant spread (Kumar *et al*., 2020) [21]. Similar results were also obtained by Porwal *et al.* (2002) [33] in rose, Singh (2004) [43] in dahlia, Navale *et al*. (2010) [32], Vaghasia and Polara (2016) [47] in chrysanthemum, Kumar and Haripriya (2010) [20], Dhanasekaran *et al.* (2018) [12] in gaillardia, Kumar *et al*. (2020) [21] in nerium, Chandrasekhar *et al.* (2020) [8] in jasmine and Wasiq *et al*. (2020) [48], Karki *et al.* (2021) [17] in marigold.

No significant difference was observed in case of number of primary branches. Maximum number of secondary branches (53.80) was recorded in MH at 2500 ppm (T_6) in growing period whereas, minimum number of branches (38.00) were recorded in control (T_{10}).

It is mainly due to inhibitory effect of plant growth retardant (MH) on the cell division in the apical bud which subsequently might have stopped the growth of the main axis. This in turn would have more secondary meristamatic activity through movement of nutrients from the primary meristem to secondary meristem which subsequently increased the production of more number of branches (Cathey, 1964) [7].

These outcomes are in agreement with that of Powel and Anderson (1956) [34], Beach and Leopold (1963) [6], Moond *et al.* (2006) [28], Dalal *et al*. (2009) [10], Navale *et al*. (2010) [32], Vaghasia and Polara (2016) [47] in chrysanthemum, Narayana reddy (1978) [28], Reddy and Sulladmath (1983) [36], Aswath *et al*. (1994) [4] in china aster, Kumar (1987) [19], Narayanagowda and Jayanthi (1991) [29], Khandelwal *et al*. (2003) [18], Singh (2004) [43] in marigold, El-Shennwy (2004) in Acacia saligna, Malik *et al.* (2017) [25] in dahlia, Dhanasekaran *et al.* (2018) [12] in gaillardia, Chandrasekhar *et al.* (2020) [8] in jasmine, Kumar and Haripriya (2010) [20], Kumar *et al*. (2020) [21] in nerium, Karki *et al.* (2021) [17] in marigold.

Treatment with foliar spray of different growth retardants significantly influenced internodal length at grand growth stage. Maximum reduction in internodal length (4.45 cm) was attained in T_6 (MH at 2500 ppm) followed by T_5 (MH at 2000 ppm) while, least reduction (7.55 cm) was seen in control (T_{10}).

The reduction in inter nodal length as affected by MH spray was attiributed to the suppression of apical meristem and thereby resulting in shorter internodes (Cathey, 1964) [7]. Similar findings were also given by Sen and Sen (1968) [39] in chrysanthemum and petunia, Narayan Reddy (1978) [28], Aswath *et al*. (1994) [4] in china aster, Khandelwal *et al.* (2003) [18] in marigold, Joshi and Reddy (2006) [16] in china aster, Jain *et al*. (2016) [15] in bougainvillea cv. shubra.

Maximum reduction in leaf area (36.07 cm^2) was recorded in MH at 2500 ppm (T_6) while the maximum leaf area (42.13 cm^2) was found in control (T_{10}).

The reduction in leaf area as a result of application of growth retardants could perhaps be due to reduction in cell size and construction of cell (Kumar and Haripriya, 2010) [20].

The findings of this study are in coherence with the earlier reports of Joshi and Reddy (2006) [16] in china aster, Kumar

and Haripriya (2010) [20], Kumar *et al.*, (2020) [21] in nerium.

Highest chlorophyll content (1.91 mg/g) was recorded with MH at 2500 ppm (T_6). The least chlorophyll content (1.18 mg/g) was recorded in control (T_{10}).

Both treated and untreated leaves contain same number of cells, but the cells in the treated leaves are smaller, and the chlorophyll is more concentrated in the reduced cell volume and also increased phytol, an essential part of the chlorophyll molecule is produced through the same terpenoid pathway as gibberlins. Maliec hydrazide treatment blocks production of gibberllins, resulting in a shunting of the intermediate compounds from gibberellins synthesis to the production of even more phytol (Chaney, 2005) [9].

These findings are also in line with Liu *et al.* (1996) [22], Mahalle *et al.* (2001) [23] in chrysanthemum, Seob *et al.* (1997) [39] in *Campamulla takesimana*, Deotale *et al.* (2015) [11] in mung bean.

Effect of growth retardants on post-harvest parameters of *Nerium oleander* cv. Pink Single

It is revealed from the Table 2 that the post harvest parameters of Nerium varied significantly with the different growth retardant treatments. Anthocyanin content, Shelf life and physiological loss of weight is an important parameter which attracts the consumers. Weight loss of flowers after 4, 8 and 12 hours of harvesting differed significantly with the treatments.

The treatments were non – significant for the character of anthocyanin content.

Among the different treatments, weight loss was minimum (8.40, 16.80 and 31.20 %) with the application of MH at 2500 ppm (T_6) followed by SADH at 2500 ppm (T_9) while, the loss was rapid (18.00, 31.20 and 48.00 %) in control (T_{10}) during 4 hrs, 8 hrs and 12 hrs of harvesting respectively.

Among the treatments, MH at 2500 ppm (T_6) recorded maximum shelf life (10.16 hrs) followed by T_9 (9.51 hrs) while, control (T_{10}) registered minimum shelf life (7.06 hrs).

The flower buds harvested from the nerium plants treated with different growth retardants were better in quality and remained fresh for a longer time. This could be due to the fact that, by the application of growth retardants delayed activity of hydrolytic and proteolytic enzymes, maintainance of more water potential and cell integration and increased the number of lateral branches and ultimately leaves per primary shoot leading to more utilization of photosynthetic products in turn producing better quality of flowers with increased turgidity which helped them to last longer after harvesting.

These discoveries are in line with Navale *et al.* (2010) [32], Vaghasia and Polara (2016) [47] in chrysanthemum, Sheetal and Chawla (2015) [40] in heliconia, Maheshwari and Sivasanjeevi (2019) [24] in tuberose.

Table 1: Effect of growth retardants on growth attributes of *Nerium oleander* cv. Pink Single

Treatment details	Plant height (cm)	Plant spread (cm)		Number of primary branches	Number of secondary branches	Internodal length (cm)	Leaf area (cm^2)	Chlorophyll content (mg/g)
		(E-W)	(N-S)					
T_1-PCB @ 150 ppm	147.00^{ab}	95.53^{ef}	91.53^{e}	7.13	40.40^{fg}	7.19^{a}	39.70^{b}	1.30^{e}
T_2-PCB @ 250 ppm	144.13^{bc}	98.80^{de}	94.00^{e}	7.40	42.33^{ef}	6.42^{b}	39.27^{bc}	1.35^{de}
T_3-PCB @ 350 ppm	143.27^{bc}	99.93^{cde}	95.20^{e}	6.47	44.87^{de}	6.16^{b}	38.83^{bcd}	1.44^{cd}
T_4-MH @ 1500 ppm	138.33^{cde}	104.80^{bcd}	100.73^{cd}	6.20	47.07^{bcd}	5.18^{d}	36.90^{fg}	1.84^{a}
T_5-MH @ 2000 ppm	135.00^{de}	108.33^{b}	104.60^{bc}	7.20	49.40^{bc}	4.80^{de}	37.47^{defg}	1.71^{b}
T_6-MH @ 2500 ppm	127.53^{f}	116.60^{a}	111.00^{a}	6.53	53.80^{a}	4.45^{e}	36.07^{g}	1.91^{a}
T_7-SADH @ 1500 ppm	141.07^{bcd}	106.13^{bc}	100.27^{d}	5.67	45.67^{cde}	5.94^{bc}	38.53^{bcde}	1.48^{c}
T_8-SADH @ 2000 ppm	138.20^{cde}	103.27^{bcd}	101.47^{cd}	7.40	47.73^{bcd}	5.36^{cd}	38.07^{cdef}	1.60^{b}
T_9-SADH @ 2500 ppm	134.13^{e}	109.13^{b}	106.53^{b}	7.33	50.00^{b}	4.95^{de}	37.17^{efg}	1.65^{b}
T_{10}- Control	152.40^{a}	90.00^{f}	87.00^{f}	6.60	38.00^{g}	7.55^{a}	42.13^{a}	1.18^{f}
S. Em±	2.17	2.23	1.44	0.72	1.26	0.20	0.52	0.03
CD at 5 %	6.45	6.62	4.30	NS	3.74	0.60	1.55	0.11

Mean values with same alphabetical superscript within a column are not significantly different

Table 2: Effect of foliar application of growth retardants on post harvest parameters in *Nerium oleander* cv. Pink single

Treatment details	Anthocyanin content (mg/100g)	Shelf life (hrs)	PLW (%)		
			4 hrs	8hrs	12hrs
T_1-PCB @ 150 ppm	13.72	7.25^{g}	16.00^{b}	29.46^{b}	45.20^{b}
T_2-PCB @ 250 ppm	13.58	7.43^{f}	15.20^{b}	27.20^{c}	43.60^{c}
T_3-PCB @ 350 ppm	13.63	8.06^{e}	14.00^{c}	25.60^{d}	42.80^{c}
T_4-MH @ 1500 ppm	14.18	8.48^{d}	12.80^{d}	23.60^{e}	41.20^{d}
T_5-MH @ 2000 ppm	14.66	9.43^{bc}	10.40^{ef}	19.20^{g}	34.80^{g}
T_6-MH @ 2500 ppm	13.11	10.16^{a}	8.40^{g}	16.80^{h}	31.20^{i}
T_7-SADH @ 1500 ppm	14.33	8.53^{d}	12.00^{d}	22.66^{e}	38.80^{e}
T_8-SADH @ 2000 ppm	14.15	9.35^{c}	10.80^{e}	20.40^{f}	36.40^{f}
T_9-SADH @ 2500 ppm	13.62	9.51^{b}	9.60^{f}	18.40^{g}	33.60^{h}
T_{10}- Control	14.37	7.06^{h}	18.00^{a}	31.20^{a}	48.00^{a}
S. Em±	0.33	0.39	0.02	0.31	0.36
CD at 5 %	NS	1.18	0.08	0.92	1.08

PLW: Physiological loss of weight; Mean values with same alphabetical superscript with in a column are not significantly different.

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