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Influence of auxins on rooting efficacy in carnation (*Dianthus caryophyllus* L.) cuttings

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ABSTRACT

Effect of various auxins (IBA, IAA and NAA) on different types of cuttings was investigated to determine efficacy of auxins in promoting rooting in carnation (*Dianthus caryophyllus* L.). Auxin and type of cutting significantly affected rooting traits. NAA was found to be more effective in promoting early rooting and inducing profuse rooting, root number, fresh and dry weight of roots and longer roots. Among the auxins used, earliest rooting (18.69 days), highest rooting percentage (58.70 %), number of roots (13.18), root length (12.26 cm), and, highest fresh and dry weight of roots (4.93g and 45.08 mg), respectively, were obtained with NAA @ 500 ppm. Tip cuttings responded better in rooting-characteristic of carnation - than basal cuttings, and recorded highest rooting percentage (73.02 %) and number of roots (12.25), longest roots (10.04cm) and maximum fresh and dry weight of roots (4.27 g and 43.19 mg), respectively. Interaction effect of auxin and cutting type was found to the significant, and highest rooting percentage, (85.26%), number of roots (18.36), longest roots (14.81cm), and highest fresh and dry weight of roots (6.85g and 68.02mg), respectively, observed with NAA @ 500 ppm in tip cuttings.

Key words: Carnation, rooting efficacy, IBA, IAA and NAA

INTRODUCTION

Carnation (*Dianthus caryophyllus* L.) is one of the important commercial flowers owing to its excellent keeping quality, wide range of forms and colour, ability to withstand long-distance transport and high rehydration capacity. It ranks next only to rose and chrysanthemum in global floriculture trade (Sanyat *et al*, 2006). It is a herbaceous perennial belonging to the family Caryophyllaceae and is widely used for beds, pots, rock gardens, window boxes, bouquets and flower arrangements. Besides its aesthetic value, carnation is also used as cardiotonic, diaphoretic, alexiteric, vermifuge and for perfume extraction. In India, carnation is grown commercially in Delhi, Chandigarh, Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu, Kerala, Himachal Pradesh and Punjab. Carnation is multiplied through cuttings, seed and tissue culture for commercial purposes. Seed propagation is mainly used in Marguerite or Chabaud type carnation, while the perpetual-flowering carnation is multiplied vegetatively. Carnation can be grown round–the-year in polyhouse at temperatures of 18-23°C and 50-60% relative humidity (Sehgal, 2001).

Plant growth regulators play an important role in manipulating growth, flowering and rooting behaviour in flower crops. Exogenous auxin application improves rooting efficiency and quality of stem cuttings, while IBA and NAA stimulate adventitious rooting in cuttings (Copes and Mandel, 2000). The promoting effect of IBA on rooting is mainly due to its conversion to IAA in plant tissue (Epstein and Lavee, 1984). Auxins like indole-3-butyric acid (IBA), indole-3-acetic acid (IAA) and naphthalene acetic acid (NAA) were found to promote rooting in Virginia creeper (Taleb *et al*, 2012). Climatic conditions of North Western Himalayan region are highly suitable for commercial cultivation of carnation. In a temperate climate, flowering starts from May and lasts up to October if under polyhouse condition. Carnation can withstand extreme low temperatures during winter and survive even frost and snowfall under open condition. Despite high yield and quality, long flowering duration and vase life, rehydration capacity, good market demand and winter hardiness, carnation is not taken up for commercial cultivation in North Western Himalayan region particularly, in Kashmir valley owing to lack of availability of quality planting material on a large-scale. Therefore the present study was designed to optimize concentrations of auxins (IBA, IAA and NAA) and to select a suitable plant part for standardization of *ex-vitro* propagation technique in carnation for large-scale multiplication.

MATERIAL AND METHODS

The experiment was carried out at Central Institute of Temperate Horticulture, Srinagar during 2010-2011 using carnation variety Bizet. Cuttings 12-15cm long with 4-5 pairs of leaves were obtained from terminal (tip) and lower (basal) portions of healthy plants. Three auxins, namely, IBA, IAA and NAA, each at 100, 200 and 500mg/l, along with Control (distilled water), were used. The experiment was laid out in Factorial Completely Randomized Design, with three replications. The basal portion of both type of cuttings was dipped in the respective auxins for 10 minutes while the Control was dipped in distilled water. Treated cuttings were planted in polythene bags (20x10cm^2) filled with sand, under a mist chamber. Twenty cuttings were planted separately for recording days to formation of the root initial. Temperature was maintained at 18-25°C, and relative humidity at 80-85 % within the mist chamber. The rooting substrate was treated with 0.3% Carbendazim to control fungal infection. Observations were recorded on different root characteristics of the cuttings at 60 days from planting. The cuttings were picked randomly, and days from planting to formation of root initials were treated as days to rooting. Per cent rooting was determined by counting the number of rooted cuttings per replication and dividing this by the total number of cuttings per replication. For number of roots per cutting, all the roots originating from the cuttings were counted, and, the total number of roots was divided by the total number of rooted cuttings. All roots produced per replication were collected and their length was measured; the sum of the length was divided by the total number of cuttings to calculate average root length. The weight of freshly harvested roots was determined and weight per rooted cutting was taken as fresh weight of root. Freshly harvested roots of rooted cuttings were dried in an oven at 60°C for 48 hours to a constant weight, and weight of dried roots per rooted cutting was taken as the dry weight of root. All the data were analyzed statistically as per Gomez and Gomez (1984) and Chandel (2004).

RESULTS AND DISCUSSION

Application of auxins improved the rooting efficacy of carnation cuttings over the Control, and tip cuttings were found to be better than basal cuttings for root attributes (Table 1). Auxin treatment significantly reduced time-to-rooting, and early rooting was recorded with NAA 500mg/l (18.69 days), followed by IBA 500mg/l (22.43 days) over the Control (33.54 days). With regard to type of cutting, tip cuttings resulted in earliest rooting (23.22 days) compared to the basal cuttings (28.04 days). Interaction between auxin and cutting type was found to be significant, and the earliest rooting was observed in NAA 500mg/l (17.14 days) in tip cuttings, followed by NAA 200mg/l (20.25 days) in basal cuttings. Early rooting in tip cuttings compared to that in basal cutting was also reported by Kumar *et al* (2006) in carnation. A high concentration of root promoting substances in leaves and meristematic cells in terminal cuttings most probably resulted in early rooting compared to that in basal cutting **(**Bharathy *et al*, 2004). Delay in rooting in basal cuttings may be due to lack of nutrition, insufficient concentration of auxins or presence of inhibitory substances (Nanda *et al*, 1967).

Auxin treatments significantly improved rooting percentage, and tip cuttings responded better than basal cuttings. High rate of rooting (58.70%) was recorded in NAA 500mg/l followed by IAA 500mg/l (56.39%) over the Control (23.22%), whereas tip cuttings resulted in higher percentage of rooting (73.02%) over basal cuttings (25.18%). Interaction between auxin and cutting type was significant, and highest rate of rooting was observed in NAA 500mg/l (85.26%), followed by IAA 500mg/l (83.54%) in tip cuttings. Kumar *et al* (2006) reported higher rooting in tip cuttings than in basal cuttings in carnation. Chmiel (1985) also reported better rooting in carnation stem cuttings with IBA, IAA and NAA application.

Table 1. Effect of auxins on days to root and rooting percentage in carnation cuttings

Treatment	Days to root			Rooting (%)		
	Tip	Basal	Mean	Tip	Basal	Mean
IBA 100mg/l	25.14	32.22	28.68^{e}	65.01	20.24	42.62^{b}
IBA 200mg/l	22.25	27.45	24.85^{cd}	73.25	25.25	49.25^{c}
IBA 500mg/l	20.30	24.57	22.43^{b}	77.06	27.69	52.37^{de}
IAA 100mg/l	26.61	34.20	30.40^{f}	73.78	23.38	48.58^{c}
IAA 200mg/l	23.22	28.31	25.76^{d}	80.65	26.14	53.39^{e}
IAA 500mg/l	22.14	26.24	24.19^{c}	83.54	29.25	56.39^{f}
NAA 100mg/l	23.33	26.17	24.75^{c}	75.25	27.20	51.23^{d}
NAA 200mg/l	21.87	24.20	23.03^{b}	81.14	29.30	55.22^{f}
NAA 500mg/l	17.14	20.25	18.69^{a}	85.26	32.14	58.70^{g}
CONTROL	30.25	36.83	33.54^{g}	35.24	11.21	23.22^{a}
Mean	23.22^{a}	28.04^{b}		73.02^{b}	25.18^{a}	
	SE(d)	SE m+	CD at 5%	SE(d)	SE m+	CD at 5%
Auxin	0.46	0.32	0.93	0.62	0.43	1.25
Cutting type	0.20	0.14	0.41	0.27	0.19	0.56
Auxin X Cutting type	0.65	0.46	1.31	0.87	0.62	1.77

Note: For each experimental factor, any two means within the column or row, followed by the same letter, are not significantly different at 0.05 level of significance

Table 2. Effect of auxins on root number and root length in carnation cuttings

Treatment	Root number cutting^{-1}			Root length (cm)		
	Tip	Basal	Mean	Tip	Basal	Mean
IBA 100mg/l	6.15	3.14	4.64^{b}	6.72	3.65	5.18^{b}
IBA 200mg/l	8.22	4.26	6.24^{c}	7.15	4.57	5.86^{c}
IBA 500mg/l	11.36	5.43	8.39^{d}	8.23	6.17	7.20^{d}
IAA 100mg/l	13.18	6.25	9.71^{e}	9.20	7.43	8.31^{e}
IAA 200mg/l	14.73	6.81	10.77^{f}	10.25	8.58	9.41^{f}
IAA 500mg/l	16.12	7.96	12.04^{g}	13.61	10.90	12.25^{h}
NAA 100mg/l	13.00	6.45	9.72^{e}	11.42	7.45	9.43^{f}
NAA 200mg/l	15.55	7.90	11.72^{g}	13.57	8.65	11.11^{g}
NAA 500mg/l	18.36	8.00	13.18^{h}	14.81	9.72	12.26^{h}
CONTROL	5.91	2.12	4.01^{a}	5.44	4.03	4.73^{a}
Mean	12.25^{b}	5.83^{a}		10.04^{b}	7.11^{a}	
	SE(d)	SE m+	CD at 5%	SE(d)	SE m+	CD at 5%
Auxin	0.25	0.17	0.51	0.16	0.11	0.32
Cutting type	0.11	0.07	0.22	0.07	0.05	0.14
Auxin X Cutting type	0.35	0.25	0.72	0.22	0.16	0.46

Note: For each experimental factor, any two means within the column or row, followed by the same letter, are not significantly different at 0.05 level of significance

Table 3. Effect of auxins on root fresh and dry weight in carnation cuttings

Treatment	Root fresh weight (g)			Root dry weight (mg)		
	Tip	Basal	Mean	Tip	Basal	Mean
IBA 100mg/l	2.74	1.01	1.87^{b}	36.49	13.40	24.94^{c}
IBA 200mg/l	3.15	1.41	2.28^{c}	36.75	14.62	25.68^{c}
IBA 500mg/l	4.05	1.65	2.85^{d}	40.60	15.70	28.15^{d}
IAA 100mg/l	3.60	1.77	2.68^{d}	34.10	12.46	23.28^{b}
IAA 200mg/l	4.57	2.02	3.29^{e}	43.83	15.89	29.86^{e}
IAA 500mg/l	5.36	2.85	4.10^{f}	48.40	17.20	32.80^{g}
NAA 100mg/l	4.91	2.20	3.55^{e}	46.11	15.40	30.75^{f}
NAA 200mg/l	5.70	2.84	4.27^{f}	54.52	18.92	36.72^{h}
NAA 500mg/l	6.85	3.01	4.93^{g}	68.02	22.15	45.08^{i}
CONTROL	1.80	0.64	1.22^{a}	23.14	9.64	16.39^{a}
Mean	4.27^{b}	1.94^{a}		43.19^{b}	15.53^{a}	
	SE(d)	SE m+	CD at 5%	SE(d)	SE m+	CD at 5%
Auxin	0.46	0.32	0.93	0.62	0.43	1.25
Auxin	0.17	0.12	0.35	0.40	0.28	0.81
Cutting type	0.07	0.05	0.15	0.18	0.12	0.36
Auxin X Cutting type	0.24	0.17	0.50	0.57	0.40	1.15

Note: For each experimental factor, any two means within the column or row, followed by the same letter, are not significantly different at 0.05 level of significance

Data presented in Table 2 divulges that number of roots per cutting was significantly affected by auxin and type of cutting. A high number of roots per cutting (13.18) was recorded in NAA 500mg/l, followed by IAA 500mg/l (12.04) over the Control (4.01). Similar results were obtained by Suh (1997) in carnation. As for the type of cutting, tip cuttings resulted in the highest number of roots per cutting (12.25) compared to that in basal cuttings (5.83). Higher amount of rooting hormones in leaves and better mobilization of food reserves in terminal portions, along with early rooting may be the cause for a higher number of roots in carnation tip cuttings (Bharathy *et al*, 2004). Interaction between auxin and cutting-type was significant, and maximum number of roots per cutting was recorded in NAA 500mg/l (18.36), followed by IAA 500mg/l (16.12) in tip cuttings. All the auxins improved root length significantly over the Control, but NAA and IAA were found to be more efficient. Root length was greater in tip cuttings than in basal cuttings. Average root length was highest in NAA 500mg/l (12.26cm) which was at par with IAA 500mg/l (12.25cm); lowest root length (4.73cm) was recorded in the Control, while tip cuttings resulted in the longest root (10.04cm) compared to basal cuttings (7.11cm). In the interaction effect, longest roots (14.81cm) were found in NAA 500mg/l, followed by IAA 500mg/l (13.61cm) in tip cuttings. Early rooting in tip cuttings may have resulted in longer roots as against that in basal cuttings. Kumar *et al* (2006) also obtained better results in most of the root parameters in carnation like earliness to root formation, rooting percentage, number of roots and root length with NAA application.

Data presented in Table 3 reveals that fresh and dry weight of roots was significantly affected by auxin treatment and type of cutting. Highest fresh and dry weight of roots per cutting was recorded in NAA 500mg/l (4.93g and 45.08mg), followed by NAA 200mg/l (4.27g and 36.72mg) and lowest recorded in Control (1.22g and 16.39mg), respectively, while tip cuttings recorded highest fresh and dry weight of roots (4.27g and 43.19mg) over basal cuttings (1.94g and 15.53mg), respectively. Interaction between auxin and type of cutting was significant, and, highest fresh and dry weight was recorded in NAA 500mg/l (6.85g and 68.02mg), followed by NAA 200mg/l (5.70g and 54.52mg), respectively, in tip cuttings. Fresh and dry weight of roots per cutting was lowest in Control (0.64g and 9.64mg, respectively) in basal cuttings. Higher number of roots, in addition to longer roots, in tip cuttings may have resulted in higher fresh and dry weight, as against that in basal cuttings. Similar results were obtained by Panahi and Morteza (2000) who recorded improved root length, and fresh and dry weight per rooted cutting, in carnation with NAA application.

Auxin and type of cutting significantly affected rooting traits in carnation cuttings. NAA was more effective in rooting carnation cuttings; tip cuttings responded better than

basal cuttings. Application of NAA 500mg/l resulted in highest rooting percentage (85.26%), number of roots (18.36), longest roots (14.81cm) and highest fresh and dry weight of root (6.85g and 68.02mg, respectively) in tip cuttings.

REFERENCES

Bharathy, P.V., Sonawane, P.C. and Sasnu, A. 2004. Effect of plant growth regulators, type of cutting and season on rooting of carnation (*Dianthus caryophyllus* L.) cuttings. *Ind. J. Hort.*, **61**:338-341

Chandel, S.R.S. 2004. A Handbook of Agricultural Statistics. Achal Prakashan Mandir, Kanpur, India, pp B1-129

Chmiel, H. 1985. The effect of NAA, IBA and IAA auxins and their mixture on rooting of carnation cuttings cv. Scania. *Acta Hort*., **167**:162-167

Copes, D.L. and Mandel, N.L. 2000. Effect of IBA and NAA on rooting Douglas fir stem cuttings. *New Forest*, **20**:249-257

Epstein, E. and Lavee, S. 1984. Conversion of indole-3-butyric acid to indole-3-acetic acid by cuttings of grapevine (*Vitis vinifera*) and olive (*Olea europea*). *Pl. Cell Physiol*., **25**:697-703

Gomez, K.A. and Gomez, A.A. 1984. Statistical Procedures for Agricultural Research. 2nd Edn., John Wiley and Sons, Inc., New York

Kumar, S., Verma, M.S., Lodhi, S.K. and Tripathi, S.K. 2006. Effect of growth chemicals, type of cutting and season on root formation of carnation (*Dianthus caryophyllus* L.) cutting. *Int'l. J. Agril. Sci.*, **2**:596-598

Nanda, K.K., Purohit, A.N., Tondon, R. and Bala, A. 1967. Plant growth substances. In: *Proc. Int'l. Symp. Plant Growth Substances*, Sircar, S.M. (Ed.), pp 221-229, Calcutta, India

Panahi, R. and Morteza, K. 2000. Effects of auxins on rooting and flowering of two cultivars of carnation (*Dianthus caryophyllus* L.). *Iranian J. Hortl. Sci. Tech*., **1**:91-108

Sanyat, P.S. and Mishra, R.L. 2006. Carnation. In: Advances in Ornamental Horticulture. S.K. Bhattacharjee (Ed), Vol. **2**, Pointer Publishers, Jaipur, India, pp 66-80

Sehgal, O.P. 2001. Carnation. In: Handbook of Horticulture. Chadha, K.L. (Ed). Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, KAB, Pusa, New Delhi, pp. 548-54

Suh, J. 1997. Effect of photoperiod to stock plant, temperature, media and plant growth regulators pre-treatment on root development and quality of cuttings in carnation plug cuttings. *J. Korean Soc. Hortl. Sci.*, **38**:303-308

Taleb, R.A., Hasan, M.K. and Hasan, H.S. 2012. Effect of different auxins concentrations on Virginia creeper (*Parthenocissus quinquefolia*) rooting. *World Applied Sci. J.*, **16**:7-10

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