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Influence of Auxins and Types of Cutting on Rooting Efficacy in Carnation (*Dianthus caryophyllus* L.)

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ABSTRACT

Effect of Plant Growth Regulators (IAA, IBA and NAA) on different types of cuttings was investigated to evaluate the efficacy of PGRs (Auxin) in promoting rooting in carnation (Dianthus caryophyllus L.). Auxin and types of cutting significantly affected rooting characters. Among the growth regulators treatments NAA were 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 (12.74 days), number of roots (10.48), root length (08.35 cm) and highest fresh and dry weight of roots (3.05g and 38.01 mg) respectively were obtained with NAA 500mg/l while highest rooting percentage (59.03 %) was found in IAA 500mg/l. Terminal cuttings was found better in rooting traits of carnation as compared to basal cuttings and recorded highest rooting percentage (75.46 %) and number of roots (11.34), longest roots (8.80 cm) and maximum fresh and dry weight of roots (3.35 g and 36.44 mg) respectively. Interaction effect of auxin and cutting type was found to the significant and number of roots (15.03), longest roots (11.47 cm), and highest fresh and dry weight of roots (4.53 g and 62.50 mg), respectively observed with NAA 500mg/l in terminal cuttings but rooting percentage was found maximum (92.50%) under IAA 500mg/l in terminal cuttings.

Key words: *Carnation, IBA, IAA, NAA, Rooting efficacy.*

INTRODUCTION

Carnation (*Dianthus Caryophyllus* L.) is belongs to the family Caryophyllacea. The genus name 'Dianthus' is derived from the Greek words 'dios' meaning 'God' or 'divine' and 'anthos' meaning 'flower' and hence known as 'Divine Flower'. The species name 'caryophyllus' is derived from the Greek word 'caryan' meaning 'nut' and 'phyllon' meaning 'leaf'. The name 'caryophyllus' has been chosen by Linnaeus after the genus name of clove, due to the clove-like fragrance of carnation. The common name 'carnation' probably must have come from the Greek word 'coronation' because these flowers were used in decorating the crown of Greek athletes. Carnations are excellent for cut flowers, bedding, pots, borders, edging, indoors and rock gardens.

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Carnation is preferred to roses and chrysanthemums by several exporting countries, on account of its excellent keeping quality, wide range of forms and colours and ability to withstand long distance transportation. Cut carnations, roses and chrysanthemums contribute close to 50% of the world cut flower trade[6]. Though cut carnations are traded in the world market year round, they are in particular demand for the social and family functions, Valentine's Day, Mother's Day and Christmas. In India, carnation is grown in and around Delhi, Chandigarh, Maharashtra, Punjab, Himachal Pradesh, Karnataka, Tamil Nadu and Andhra Pradesh. Plant growth regulators (PGRs) are organic compounds, other than nutrients, that control the physiological processes of plant. PGRs, called biostimulants or bioinhibitors, act inside plant cells to stimulate or inhibit specific enzymes or enzyme systems and help to regulate the plant metabolism. Plant growth regulators in very minute quantities can induce or inhibit the physiological processes dramatically. The response to PGR's however varies with the cultivar, age of the plant, light, temperature, availability of mineral nutrients, vigour of the plant and its endogenous hormonal content. Exogenous application of auxin enhances the rooting efficacy and quality of the stem cuttings, while IBA and NAA stimulate adventitious rooting in cuttings[3]. Today, specific PGRs are used to control the plant growth rate and growth pattern during the various stages of development from germination through harvest and post-harvest preservation. Growth regulating chemicals that have positive influences on ornamental and flowering crops can be of value. Grewal *et al.*[4] studied the effect of IBA and NAA on rooting of chrysanthemum terminal cuttings and indicated that cuttings with IBA at 400 ppm performed well with respect to percentage of rooting. Ranpise *et al.*[10] studied the effect of different levels of IBA on rooting, growth and flower yield of chrysanthemum cv. Sonali Tara and reported maximum survival percentage with IBA at 2000ppm followed by IBA at 1000ppm. Khewale *et al.*[5] studied the influence of different concentrations of IBA and media on root parameters in propagation of carnation cv. Gaudina and recorded highest percentage of rooting with IBA at 125ppm. Hence, the present study was designed to standardize the type of auxin (IBA, IAA and NAA) and to select a suitable plant part for standardization of ex-vitro propagation technique for rooting in carnation cuttings under protected condition.

MATERIAL AND METHODS

The experiment was carried out at Centre for Quality Planting Material, RDS Seed Farm, CCS HAU, Hisar, Haryana during 2016-17, to study the effect of auxin and types of cutting on roots development in carnation variety Baltico. Cuttings 10-12cm long with 3-4 pairs of leaves were obtained from terminal (tip) and lower (basal) portions of healthy plants. Three auxins, namely IBA, IAA and NAA, each at 500mg/l individually and their combinations, along with control (distilled water), were used as treatment. The experiment was laid out in Factorial Completely Randomized Design, replicated thrice. The basal portion of both types of cuttings was dipped in the respective auxins for 10 minutes while the control was dipped in distilled water. Treated cuttings were planted in protrays filled with artificial growing media {cocopeat + vermiculite + perlite (3:1:1)}, under protected condition in the first week of November. Twenty five 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 %. Observations were recorded on different root characteristics of the cuttings at 50 days from planting. The cuttings were picked randomly, and days from planting to formation of root initials were treated as days to rooting. Percent 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 and data obtained from the study was analyzed statistically.

RESULTS AND DISCUSSION

Days taken for root initiation

Application of auxins improved the rooting efficacy of carnation cuttings over the control, and terminal 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 (12.74 days), at par with IBA+ NAA 500mg/l (13.77 days) and IBA+IAA+NAA 500mg/l (14.96 days) over the control (23.59 days). With regard to type of cutting, terminal cuttings resulted in earliest rooting (14.52 days) compared to the basal cuttings (19.05 days). Interaction between auxin and cutting types was found to be significant, and the earliest rooting was observed in NAA 500mg/l (10.74 days) which was at par with IBA+NAA 500mg/l (11.10 days), IBA 500mg/l (11.42 days) and IBA+IAA+NAA 500mg/l (13.78 days) in terminal cuttings as compared to NAA 500mg/l (14.74 days) in basal cuttings. Kumar *et al.*[7] also reported that rooting in terminal cuttings were early as compared to that in basal cutting in carnation. A high concentration of root promoting substances in leaves and meristematic cells in terminal cuttings most probably resulted in early rooting as compared with basal cutting[1]. Delayed rooting in basal cuttings might be due to lack of nutrition, insufficient concentration of auxins or presence of inhibitory substances[8].

Table 1: Effect of Auxins and types of cutting on time taken for root initiation in carnation cv. Baltico

Treatments (Auxins)	Days to root initiation		
	Types of cutting		Mean
	Terminal	Basal	
IAA 500mg/l	16.72	21.74	19.23
IBA 500mg/l	11.42	23.26	17.34
NAA 500mg/l	10.74	14.74	12.74
IAA+IBA 500mg/l	15.54	17.23	16.39
IAA+NAA 500mg/l	15.02	17.52	16.27
IBA+NAA 500mg/l	11.10	16.44	13.77
IAA+ IBA+NAA 500mg/l	13.78	16.13	14.96
Control	21.84	25.35	23.59
Mean	14.52	19.05	

	C.D. at 5%	SE(d)	SE(m)
Auxins	2.47	1.21	0.85
Types of Cutting	1.23	0.60	0.42
Auxins X Type of cutting	3.50	1.71	1.21

Rooting percentage

Data presented in Table 2 divulges that rooting percentage was significantly improved by Auxin treatments and terminal cuttings responded better than basal cuttings. Maximum rooting (59.03%) was recorded in IAA 500mg/l at par with NAA 500mg/l (57.70%) over the control (13.93%), whereas terminal cuttings were recorded higher percentage of rooting (75.46%) over basal cuttings (20.60%). Interaction between auxin and cutting type was significant, and highest rate of rooting was observed in IAA 500mg/l (92.50%), followed by NAA 500mg/l (87.90%) in terminal cuttings. Kumar *et al.*[7] reported higher rooting percentage in terminal cuttings as compared to basal cuttings in carnation. Chmiel[2] also observed better rooting in stem cuttings of carnation with IBA, IAA and NAA application.

Table 2: Effect of Auxins and types of cutting on rooting percentage in carnation cv. Baltico

Treatments (Auxins)	Rooting %		
	Types of cutting		Mean
	Terminal	Basal	
IAA 500mg/l	92.50	25.57	59.03
IBA 500mg/l	85.60	23.36	54.48
NAA 500mg/l	87.90	27.50	57.70
IAA+IBA 500mg/l	69.70	23.410	46.55
IAA+NAA 500mg/l	76.77	18.22	47.49
IBA+NAA 500mg/l	78.90	14.12	46.51
IAA+ IBA+NAA 500mg/l	81.50	23.60	52.55
Control	30.80	9.05	19.93
Mean	75.46	20.60	

	C.D. at 5%	SE(d)	SE(m)
Auxins	3.54	1.73	1.22
Types of Cutting	1.77	0.86	0.61
Auxins X Type of cutting	5.01	2.45	1.73

Number of roots/cutting

Data presented in Table 3 reveals that number of roots per cutting was significantly affected by auxin and type of cutting. Maximum number of roots per cutting (10.48) was recorded in NAA 500mg/l, followed by IAA+IBA+NAA 500mg/l (8.97) over the control (4.31). The results obtained from the study are close conformity with Suh[11] in carnation. As for the type of cutting, tip cuttings resulted in the highest number of roots per cutting (11.34) compared to that in basal cuttings (4.66). 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[1]. Interaction between auxin and cutting-type was found significant and maximum number of roots per cutting was recorded in NAA 500mg/l (15.03) followed by IAA+IBA+NAA 500mg/l (13.04) in terminal cuttings.

Table 3: Effect of Auxins and types of cutting on number of roots/cutting in carnation cv. Baltico

Treatments (Auxins)	Number of roots/cutting		
	Types of cutting		Mean
	Terminal	Basal	
IAA 500mg/l	12.00	4.96	8.48
IBA 500mg/l	9.50	4.17	6.83
NAA 500mg/l	15.03	5.93	10.48
IAA+IBA 500mg/l	11.90	5.16	8.53
IAA+NAA 500mg/l	12.70	4.33	8.51
IBA+NAA 500mg/l	11.60	4.20	7.90
IAA+ IBA+NAA 500mg/l	13.04	4.90	8.97
Control	4.96	3.67	4.31
Mean	11.34	4.66	

	C.D. at 5%	SE(d)	SE(m)
Auxins	0.27	0.13	0.09
Types of Cutting	0.13	0.06	0.04
Auxins X Type of cutting	0.38	0.18	0.13

Root Length (cm)

All the auxins enhanced root length significantly over the control, but NAA were found to be more proficient (Table 4). Root length was found maximum in terminal cuttings than in basal cuttings. Average root length was highest in NAA 500mg/l (8.35 cm) which was followed by IAA+IBA+NAA 500mg/l (7.03 cm); minimal root length (4.16cm) was observed in the control, while terminal cuttings resulted in the longest root (8.80 cm) compared to basal cuttings (4.23 cm). When interaction was compared, longest roots (11.43 cm) were found in NAA 500mg/l, followed by IAA+IBA+NAA 500mg/l (9.71cm) in terminal cuttings. Early rooting in terminal cuttings may have resulted in longer roots as compared to basal cuttings. Kumar *et al.*[7] 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.

Table 4: Effect of Auxins and types of cutting on root length (cm) in carnation cv. Baltico

Treatments (Auxins)	Root length (cm)		
	Types of cutting		Mean
	Terminal	Basal	
IAA 500mg/l	8.80	4.33	6.56
IBA 500mg/l	8.15	3.95	6.05
NAA 500mg/l	11.47	5.23	8.35
IAA+IBA 500mg/l	9.17	4.80	6.99
IAA+NAA 500mg/l	9.39	3.78	6.58
IBA+NAA 500mg/l	8.87	3.92	6.39
IAA+ IBA+NAA 500mg/l	9.71	4.35	7.03
Control	4.86	3.47	4.16
Mean	8.80	4.23	

	C.D. at 5%	SE(d)	SE(m)
Auxins	0.15	0.07	0.05
Types of Cutting	0.07	0.03	0.02
Auxins X Type of cutting	0.21	0.10	0.07

Fresh weight and Dry weight

Data obtained in Table 5 reveals that fresh and dry weight of roots was significantly affected by auxin treatment and type of cutting. Uppermost fresh and dry weight of roots per cutting was recorded in NAA 500mg/l (3.05g and 38.01mg), followed by IAA+IBA+NAA 500mg/l (2.47g and 25.98mg) and least recorded in control (1.04g and 9.04mg), respectively, while terminal cuttings recorded highest fresh and dry weight of roots (3.35g and 36.45mg) over basal cuttings (1.07g and 8.98mg), respectively. Interaction between both treatment was significant, and, highest fresh and dry weight was recorded in NAA 500mg/l (4.53g and 62.50mg), followed by IAA+IBA+NAA 500mg/l (4.01g and 41.46mg), in terminal cuttings respectively. More number of roots, in addition to elongated roots, in terminal cuttings may have resulted in higher fresh and dry weight, as compared to basal cuttings. Panahi and Morteza[9] reported similar results viz. improved root length, and fresh and dry weight per rooted cutting in carnation with NAA application.

Table 5: Effect of Auxins and types of cutting on fresh and dry weight in carnation cv. Baltico

Treatments (Auxins)	Fresh weight (g)			Dry weight (mg)		
	Types of cutting		Mean	Types of cutting		Mean
	Terminal	Basal		Terminal	Basal	
IAA 500mg/l	3.99	1.35	2.67	36.34	11.63	23.98
IBA 500mg/l	3.65	1.90	2.77	36.82	10.59	23.71
NAA 500mg/l	4.53	1.56	3.05	62.50	13.52	38.01
IAA+IBA 500mg/l	2.73	0.70	1.71	32.71	10.97	21.84
IAA+NAA 500mg/l	3.12	0.76	1.94	33.56	5.37	19.46
IBA+NAA 500mg/l	3.21	0.88	2.04	33.76	5.57	19.66
IAA+ IBA+NAA 500mg/l	4.01	0.93	2.47	41.46	10.50	25.98
Control	1.57	0.52	1.04	14.40	3.68	9.04
Mean	3.35	1.07		36.44	8.98	

	Fresh weight			Dry weight		
	C.D. at 5%	SE(d)	SE(m)	C.D. at 5%	SE(d)	SE(m)
Auxins	0.25	0.12	0.08	0.77	0.37	0.26
Types of Cutting	0.12	0.06	0.04	0.38	0.18	0.13
Auxins X Type of cutting	0.36	0.17	0.12	1.08	0.53	0.37

CONCLUSION

As concluded from the data, auxin and type of cutting significantly affected rooting characteristics in carnation cuttings. NAA was found more efficient in rooting carnation cuttings; terminal cuttings give better results than basal cuttings. Application of NAA 500mg/l resulted in number of roots, longest roots and highest fresh and dry weight of root, while highest rooting percentage was recorded in IAA 500mg/l in terminal cuttings.

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