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Short Communication

EFFECT OF GROWING ENVIRONMENTS ON CARNATION FLOWERING

Rooted carnation cuttings of cvs Red Corso and Cabaret at 4th leaf stage were procured from 'Durga Floritech', Solan (H.P.) and planted in polyhouse and open field. Polyhouse was constructed on a framework of steel pipes, over which UV stabilized plastic sheet of 200 µm covered. The polyhouse was fitted with an evaporative cooling system consisting of two exhaust fans of 45 cm diameter at one end and a cooling pad of 5 x 1.3 m size at the other end.

The experiment was laid out both in polyhouse and open field with a spacing of 15 x 15 cm and replicated 10 times. Observations were recorded on various parameters. A portable 'Infra Red Gas Analyser (IRGA)', LI 6250 (LICOR-USA) was used for measuring photosynthetic activity at vegetative and flowering stages. Nitrate reductase activity (NRA) was measured in the leaves at flowering stage using the method of Klepper *et al.* (1971).

In both the cultivars, polyhouse gave better performance for all the characters (Table 1) except the number of leaf pairs at flowering and total number of lateral shoots which were not affected. There was an advancement of flowering by 10-15 days due to favourable temperature and moist-air inside the polyhouse, which helped in faster growth and flowering. Flower stems of polyhouse were significantly longer than open field. Although total number of lateral shoots was less in polyhouse environment, number of flowers per plant was higher, indicating a higher percentage of flowering shoots in polyhouse.

Under Delhi conditions, the night temperatures in the open field were incongenial for producing quality crop of carnations but polyhouse due to warmer environment encouraged quick vegetative growth, elongation of internodes and produced long stems which is similar to the findings of Sherry and Goldsberry (1980).

In both the cultivars, polyhouse environment recorded lower photosynthetic activity (Table 1) both at vegetative and flowering stages. This could be due to reduction in light intensity under polyhouse conditions (Park and Lee, 1997). It can be therefore, concluded that higher photosynthetic activity under open field conditions results in more vegetative growth (in terms of number of leaf pairs and lateral shoots) rather than flowering. Similar trend was observed in case of nitrate reductase activity (Table 1) also. In leaves and stems, light increases NR activity when NO_3 (nitrate) is available. Light activates one or both photosystems of photosynthesis which increases the supply of ATP, for the transport of stored NO_3 from the vacuole to the cytosol, where induction of nitrate reduction occurs. Secondly, light activates the phytochrome system, which in turn, activates the gene that codes for the mRNA, coding for the NR enzyme (Rajasekhar *et al.*, 1988). Finally, light acting through photosynthesis, promotes activity of NR by increasing the carbohydrate supply from which NADH necessary for nitrate reduction

Table 1. Effect of growing environment on flowering of carnation

Character	Red Corso			Cabaret		
	Polyhouse	Open	t. Cal.	Polyhouse	Open	t. Cal.
Days to flowering	138.00	151.50	2.98*	162.00	177.00	3.41*
Days to 50% flowering	161.00	178.75	4.41*	181.00	195.50	4.01*
Flower stem length (cm)	54.00	42.00	2.68*	36.00	28.00	3.78*
Leaf pairs at flowering	27.00	31.00	1.41	23.00	27.00	1.25
Lateral shoots/plant	8.00	8.50	0.69	7.50	8.00	0.66
Flower diameter (cm)	6.50	4.00	3.96*	7.20	4.50	6.74*
Flowers/plant	7.75	4.50	3.28*	6.25	3.00	3.81*
Petals/flower	64.50	45.50	3.99*	85.50	49.00	7.36*
Photosynthetic activity (μ mole m^{-2} s^{-1}):						
a. Vegetative stage	17.95	22.28	1.53	16.69	23.50	2.06
b. Flowering stage	5.26	18.80	2.37*	6.27	10.68	1.54
Nitrate reductase activity (NRA) at flowering (in moles nitrite formed g^{-1} fr. st. b^{-1})	11.25	29.25	4.03*	1507	3150	5.97*

* Significant at 5% level.

is produced through respiration (Aslam and Huffaker, 1984).

The results of the present study suggest that polyhouse environment produces better quality flowers and higher yield than open field carnations.

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Short Communication

EFFECT OF CHEMICALS ON THE VASE LIFE OF STANDARD CARNATIONS

Carnation cut flowers start to shrink after a vase period of approximately four to six days. This phenomenon, also called "sleepiness", is caused by high production of ethylene (Nichols, 1968). Piskornik (1989) found that vase solutions containing silver thiosulfate were the most effective in inhibiting the ethylene production and extending the vase life. In the present study, therefore the effect of 8-hydroxyquinoline citrate, silver sulfate, zinc sulfate and copper sulfate in extending the vase life of carnation cut flowers, produced under polyhouse and open field conditions was determined.

The present investigation was carried out in Division of Floriculture and Landscaping, IARI, New Delhi, during 1997-98. Rooted carnation cuttings of standard cultivars Red Corso and Cabaret at third or fourth leaf pair stage were procured from 'Durga Floritech', Solan (H.P.) and planted in polyhouse (fan and pad cooling system) and open field.

Carnation cut flowers with 60 cm long stems were harvested in the morning when the outer petals were reflexed at right angles to the stem. The stems were brought to the laboratory with their basal ends dipping in water. The lowest pair of leaves was removed and the stems were re-cut to a uniform length under distilled water to remove any surface embolism. The stems were immediately transferred to vases containing solutions of 8-HQC 200 ppm $AgSO_4$ 100 ppm, $ZnSO_4$ 100 ppm and $CuSO_4$ 1000 ppm. The stems were maintained under constant temperature of 24 ± 2°C at 60-70% RH.

Number of days from date of keeping in vases to appearance of senescing symptoms, i.e. withering, browning, blueing, wilting of petals in vases was recorded. The data presented are mean of 5 stems, each representing a replication.

The data pertaining to cultivars Red Corso and Cabaret are presented in Table 1. In both the cultivars, flowers kept in copper sulfate solution failed to open completely and wilting was observed within 2-3 days. Vase life of polyhouse carnation cutflowers was longer than those from the open field and it is also better for all the vase solutions excepting copper sulfate (ineffective) as compared to control. In Red Corso and Cabaret, 8-HQC was the significantly best treatment in extending the vase life of cut flowers in both the polyhouse and open field conditions (8.67; 10.00 and 5.67; 6.67, respectively) over the control (6.00; 3.67 days and 6.00; 4.34, respectively) but not significantly better than the rest of the treatments. It was followed by silver sulfate, which is on par with zinc sulfate. It can be, therefore, concluded that zinc sulfate can be used as a cheap substitute for silver sulfate. Lukaszenska (1995) also reported that 200 ppm 8-HQC increased vase life of spray carnations of nine cultivars. Staby *et al.* (1978) also found that 200 ppm 8-HQC in combination with 3% sucrose significantly extended the vase life.

Cabaret has recorded highest vase life in all the treatments than Red Corso, though it remained same in control (6.00 days).

Table 1. Effect of 8-hydroxyquinoline citrate (8-HQC), silver sulfate ($AgSO_4$), zinc sulfate ($ZnSO_4$) and copper sulfate ($CuSO_4$), on the vase life of carnation

Treatment	Concentration	Vase life (days)			
		Polyhouse		Open field	
		Red Corso	Cabarat	Red Corso	Cabarat
8-HQC	200 ppm	8.67	10.00	5.67	6.67
$AgSO_4$	100 ppm	8.34	9.34	4.67	5.67
$ZnSO_4$	100 ppm	7.00	9.00	4.67	5.00
$CuSO_4$	0.1%	Not opened	Not opened	Not opened	Not opened
Distilled water	Control	6.00	6.00	3.67	4.34
C.D. at 5%		2.66	2.34	1.94	1.81

Responses to germicides varied widely, as also reported by Jones and Hill (1993), who found that longevity was improved by DICA and BCDMH in *'Gerbera jamesonii'* 'Mercy' but not in 'Double Delight'. Similarly, 8-HQC improved longevity in *Freesia hybrida* 'Aurora' (Woodson, 1987) but had no effect on *F. hybrida* 'Royal Crown' (Accati-Garibaldi and Deambrogio, 1990).

Carnations grown under polyhouse showed greater vase life than those of open field, and all the treatments except 0.1% copper sulfate, were on par with each other. Lukaszenska (1995) also reported that vase life was longer for flowers raised in greenhouses than those obtained from open field. This may be due to the congenial growing environment in the polyhouse during the flower bud initiation and development as compared to the carnations grown in open field conditions.

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Short Communication

DO CHLOROPHYLLS MANIFEST POLLUTION?

In the modern world, the environmental pollution is ever increasing and the problem has become more acute in and surrounding areas of metropolitan cities. Several of the plant species have been reported to be acting as sink and help to reduce pollution to some extent and simultaneously increase the oxygen content in the atmosphere (Bhattacharjee and Palanikumar, 1999). While doing so, the plants themselves would exhibit some physiological changes (Darrall, 1989). The rate of change and the type of response depend upon several factors, such as genetic, age, type and period of exposure of the plant, type of the pollutant, etc. Among these, plant pigments particularly chlorophylls are considered most important since these are involved in primary photosynthetic process and therefore, has been suggested as a diagonistic tool (Rabe and Kreeb, 1979). Reports are also in favour of reduction to long and/or short term exposure for which the species were exposed (Takemoto *et al.*, 1988). Keeping this in view, chlorophylls from different species from non-polluted (Rajpath and Pusa campus-five species) and polluted (ITO and Connaught Place - four and two species, respectively) areas were extracted and estimated according to Barnes *et al.* (1992). From Table 1, it is evident that chlorophyll a, b and total were lower in the samples collected from polluted areas compared to non-polluted areas. The reduction in chlorophyll content varied among the different species. In general, chlorophyll a appears to be reducing more because of pollution than chlorophyll b. There was 67% reduction in chlorophyll a in *Thevetia* whereas it was as low as 9% in *Nerium* (Kulshreshta *et al.*, 1994). Similar was the case with chlorophyll b wherein the greater reduction was noticed once again in *Thevetia* (82%) and *Jatropha* (61%). Thus, it seems the reduction of chlorophyll varies with species. Thus, the present results supports that chlorophylls indeed could serve as bioindicator as suggested by Rabe and Kreeb (1979). The differential response in

Table 1. Chlorophyll contents (mg/fr. wt.) in some ornamental shrubs grown in Delhi as affected by pollution

Shrubs	Rajpath*			Pusa*			ITO**			Connaught Place**		
	TCC	CA	CB	TCC	CA	CB	TCC	CA	CB	TCC	CA	CB
Jatropha	1.99	1.20	0.69	2.85	1.43	1.26	1.30	0.73	0.50	1.26	0.73	0.47
Tobernaemontana	1.67	1.03	0.56	2.06	0.96	0.98	1.08	0.58	0.44	1.46	0.82	0.56
Lagerstroemia	2.43	1.04	1.24	2.27	1.31	0.86	-	-	-	-	-	-
Thevetia	2.21	1.21	0.88	3.78	1.75	1.82	0.95	0.58	0.32	-	-	-
Nerium	2.71	1.47	1.09	2.85	1.36	1.32	1.99	1.24	0.65	-	-	-

CD at 5% for different locations : 0.40 for TCC (total chlorophyll contents), 0.20 for CA (chlorophyll a), and 0.22 for CB (chlorophyll b).

* Non-polluted areas, and ** polluted areas.

reduction of chlorophyll seems to be dependent upon species is evident. These responses are key factors to the health of plants and may be used for predicting injury levels and general stress to individual species which could be of great relevance to future on the ongoing battle to diminish the environmental pollution.

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INFLUENCE OF CONTINUOUS ILLUMINATION DURING VEGETATIVE GROWTH ON FLOWERING RESPONSE OF CARNATION *(DIANTHUS CARYOPHYLLUS* L.)

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SUMMARY

Standard carnation cultivars Red Corso and Cabaret were exposed to continuous artificial illumination at 4-5th, 6-7th and 8-9th leaf pair stages for 10, 15 and 20 days to determine the growth stage which is more responsive and the duration of illumination required for advancing the flowering. Carnations exposed at 6-7th leaf pair stage, for a duration of 15 days produced higher number of quality flowers per plant and gave an earlier crop.

Key words: **Carnation, flowering, illumination, photoperiod, polyhouse.**

INTRODUCTION

Carnation (*Dianthus caryophyllus* Linn.) is one of the most important commercial flower of the world, valued for its excellent keeping quality, wide array of colours and forms, ability to withstand long distance transportation and remarkable ability to rehydrate after continuous shipping. These unique qualities of carnation fetches it a very high price in both national and international market.

Carnation genetically is a quantitative long day plant (Blake, 1955) and several workers (Heins *et al.*, 1979, Healy and Wilkins, 1983) have demonstrated that flowering is influenced by photoperiod. Harris and Ashford (1966) reported that increase in photoperiod up to 24 hours hastened flower initiation in carnation cv. White Sim. Illumination throughout the night was more effective in promoting flowering particularly when day light intensities are low. The shoots with four to seven pairs of leaves are more sensitive to light intensity and photoperiods than other stages (Mastalerz, 1978). However, continuous light during the full growing period reduces the quality of flower in the first flush and delayed flowering in subsequent flushes (Mastalerz, 1978) and it also increased the cost of production considerably. It is, therefore, very important to know the correct growth stage when artificial illumination is needed and its duration. The present study was, therefore, undertaken to determine the flowering response of carnation in relation to growth stages under different durations of continuous light treatments.

MATERIALS AND METHODS

Rooted carnation cuttings of cultivars Red Corso and Cabaret of third or fourth leaf pair stage were procured from "Durga Floratech", Solan, Himachal Pradesh, and planted in pots (15 cm x 25 cm) on 3rd Nov., 1997. The pots were rinsed with dilute solution of potassium permanganate and filled with sterilized potting media consisting of two parts sand, and one part each of vermiculite and farm yard manure.

All the potted carnation plants in the green house were pinched at fourth leaf pair stage. Ten potted plants for each treatment were transferred to the culture room and exposed to light intensity of 48.2 $\mu E\ m^{-1}\ S^{-1}$. Continuous illumination was provided at 4-5th, 6-7th and 8-9th leaf pair stages and for a duration of 10, 15 and 20 days by hanging incandescent bulbs of 100 W at one metre height

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above beds. Temperature regimes of 18±2°C and 15±2°C during day and night respectively and a RH of 70±5% were maintained in the culture room during the experimental period.

After the treatment, potted plants were transplanted in polyhouse with 15 cm x 15 cm spacing. Disbudding was done down to the sixth node after the flower buds had initiated.

RESULTS AND DISCUSSION

Carnations exposed at 6-7th leaf pair stage for 15 days (T_5) showed earliest flowering (120 and 158 days in Red Corso and Cabaret respectively) (Table I) and 50 per cent flowering at 137 and 166 days in Red Corso and Cabaret respectively than other treatments. However, there was no significant difference for number of leaf pairs at flowering (Table I). Earlier flowering may be due to the fact that a carnation shoot changes from vegetative to reproductive condition when it has about six pairs of leaves (Besemer, 1980). The two carnation cultivars Red Corso and Cabaret were not identical in their flowering response under similar treatment conditions. Sparnaaij *et al.* (1990) have reported that flowering response to long days varies with genotypes. Maximum number of flowers (8.0 and 6.7 in Red Corso and Cabaret, respectively) were obtained in treatment T_5 (Table II). The beneficial effect of longer photoperiods on the number of flowers per plant have been reported by various workers (Hanan, 1987, Lolapori and Arora, 1995).

Maximum number of lateral shoots (8.66 and 7.33 in Red Corso and Cabaret respectively) per plant were recorded in the treatment T_5 (6-7 leaf pair 15 days) but it was not significantly different from remaining treatments (Table II) except T_3 and T_9 in Red Corso and T_9 in Cabaret. Long photoperiods inhibit lateral shoot development and the same was promoted by short days (Heins *et al.* 1979, Healy and Wilkins, 1983). Lolapori and Arora (1995) also reported that with the increase in hours of light, there was a decrease in number of lateral shoots. However, under present investigation, illumination was provided for short duration and this short exposure of 10-20 days probably was not sufficient to change the degree of apical dominance. Powell and Bunt (1983) also did not observe significant effect of day length on the number of shoots in the first generation carnations of cv. White Sim. The percentage of flowering shoots to total number of shoots

TABLE I: Effect of continuous illumination on days to flowering, days for 50% flowering, number of leaf pairs at flowering and flower stem length.

Treat-ment No.	Treatment	Days for flowering		Days for 50% flowering		No. of leaf pairs at flowering		Flower stem length (cm)	
		Red	Cabaret	Red	Cabaret	Red	Cabaret	Red	Cabaret
T_1	4-5th leaf pair 10 days	149	171	158	181	32.33	23.33	48.00	28.33
T_2	4-5th leaf pair 15 days	149	175	159	187	27.00	27.33	50.33	34.66
T_3	4-5th leaf pair 20 days	128	168	143	173	28.00	25.33	48.33	36.33
T_4	6-7th leaf pair 10 days	154	167	162	174	32.00	22.66	54.66	31.00
T_5	6-7th leaf pair 15 days	120	158	137	166	24.66	21.33	58.00	44.33
T_6	6-7th leaf pair 20 days	165	170	173	181	29.66	25.66	51.66	36.66
T_7	8-9th leaf pair 10 days	170	179	174	188	31.33	27.00	53.66	34.00
T_8	8-9th leaf pair 15 days	173	185	181	192	33.00	27.66	49.33	33.00
T_9	8-9th leaf pair 20 days	178	193	190	198	32.33	28.00	52.66	33.66
	C.D. at 5%	13.97	5.86	7.36	10.13	6.89	4.98	6.96	8.77

TABLE II : Effect of continuous illumination on total number of lateral shoots, number of flowers per plant, diameter of flower and number of petals.

Treat-ment No.	Treatment	Total No. of lateral shoots		No. of flowers		Diameter of flower (cm)		No. of petals	
		Red Corso	Cabaret	Red Corso	Cabaret	Red Corso	Cabaret	Red Corso	Cabaret
T_1	4-5th leaf pair 10 days	6.00	5.66	4.7	3.7	5.66	6.06	47	68
T_2	4-5th leaf pair 15 days	6.00	5.33	4.0	3.7	5.66	5.93	47	71
T_3	4-5th leaf pair 20 days	5.00	6.00	3.0	4.0	6.26	5.83	51	68
T_4	6-7th leaf pair 10 days	7.66	6.66	6.3	4.7	6.13	6.60	50	78
T_5	6-7th leaf pair 15 days	8.66	7.33	8.0	6.7	6.83	7.10	62	87
T_6	6-7th leaf pair 20 days	6.33	6.33	5.0	5.0	6.60	6.80	55	82
T_7	8-9th leaf pair 10 days	5.66	5.66	3.3	4.7	5.40	5.80	42	67
T_8	8-9th leaf pair 15 days	6.00	5.33	4.7	4.3	6.20	5.73	49	64
T_9	8-9th leaf pair 20 days	5.00	5.00	4.0	4.0	5.86	5.80	51	66
	C.D. at 5%	3.17	2.16	3.29	2.07	0.51	0.71	11.54	10.07

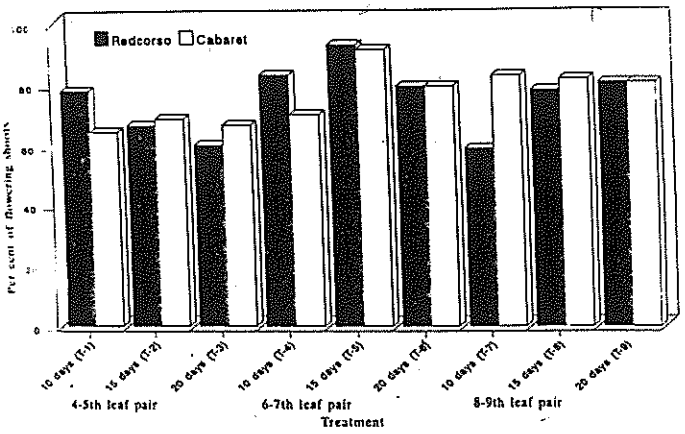

Fig. 1. Effect of continuous illumination on the percentage of flowering shoots in cvs. redcorso and cabaret

were highest (92.3 and 90.8 in Red Corso and Cabaret respectively) when carnations were exposed at 6-7th leaf pair stage for 15 days (Fig. 1).

Flower quality in terms of flower stem length, diameter of flower and number of petals per flower was also best in the carnations exposed at 6-7th leaf pair stage for 15 days. In both the cultivars viz., Red Corso and Cabaret, maximum and minimum flower stem lengths (58.99 cm, 44.00 cm and 48.00 cm, 28.00 cm) (Table I) were recorded in treatments T_5 and T_1, respectively. Diameter of flower and number of petals per flower were highest in treatment T_5 (Table II), but flower diameter was on par with the treatment T_6. Cleland and Zeevart (1970) suggested that increased gibberellin synthesis under long days was responsible for the induction of shoot elongation. Mastalerz (1983) also reported that flower quality was higher when the photoperiods was extended with incandescent dusk to dawn lighting. Improved flower size was due to increased number of petals per flower. As the carnations were grown in polyhouse after the light treatment, it could be the effect of growing environment, which enhanced flower quality. But, Lolapori and Arora (1995) reported that only light treatments were responsible for the improved flower size in carnations.

The results of present study suggest that continuous illumination of the carnations at 6-7th leaf pair stage for 15 days produced higher number of quality flowers and

an earlier crop, instead of illumination throughout the growing period.

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