Effects of Photoperiod and CO_2 Enrichment on Carnation

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Extended photoperiods have been shown to hasten bud initiation (2) and flowering of carnations (3). Two hours of low-intensity light during the middle of the night accomplished the same effects on bud initiation

as those from a 16-hour photoperiod (4), although a night break as short as 2 hours has been questioned by Chan (1). Most of the research on the response of carnation to photoperiod has been confined to single shoots or first crops (2, 3, 5), and has supplied minimum information on the effects of photoperiodic treatment on subsequent growth of the plants. In order to evaluate photoperiod control as a possible tool for the commercial grower, effects of lighting with and without added CO_2 on young and second-year plants were investigated.

Methods and Materials

The experiment was conducted in three separate fiberglass covered houses 15 feet wide and 18 feet long. Each house contained two benches 4 feet wide and 13 feet long. One bench contained equal lots of cvs. Chantilly and CSU Red. These were planted on June 23, 1965, and were approximately a year and a half old during the experiment. The second bench contained young plants, cv. Pink Mamie, planted July 19, 1966.

The CO_2 was added by means of a natural gas burner at a constant input from 8:00 a.m. to 5:00 p.m. and was regulated at 900 ppm on a bright cloudy day when ventilating fans were not running. The level of CO_2 in houses one and two was measured at eleven random sampling times during the experiment with a Beckman Model LB 15 A infrared gas analyzer. CO_2 was added from September 2, 1966, to February 17, 1967.

Plants in houses 1 and 3 were lighted from September 13, 1966, to February 1, 1967. Incandescent floodlights providing a minimum of 7 foot-candles were on from 10:00 p.m. to 2:00 a.m.

Standard cultural procedures were followed including the use of a peripheral watering system using a standard nutrient solution. The temperatures for the three houses were: night - 53-55° in the houses with CO_2 added, 50-52° with no CO_2 added; day - all three houses heated to 60-62° F and cooled at 65°.

Flowers were cut four times a week and graded according to the Colorado 4-grade system. The treatments were:

1. Lighted with CO_2 added,
2. Normal photoperiod with CO_2, and
3. Lighted with no CO_2 added.

Results

Yield and grade from young plants: The light and CO_2 treatment hastened bud initiation and flowering of carnations by two weeks over plants receiving a normal photoperiod with CO_2 or plants lighted without CO_2. First-crop yield of plants given light and CO_2 was 5% higher than for the other two treatments (Fig. 1). The second crop flowered in April-May from plants receiving the normal photoperiod and CO_2, whereas the two treatments receiving additional light did not return a second crop until July. At this time the normal photoperiod treatment was beginning its third crop. Lateral branches were almost absent on flower stems from the first crop of lighted plants.

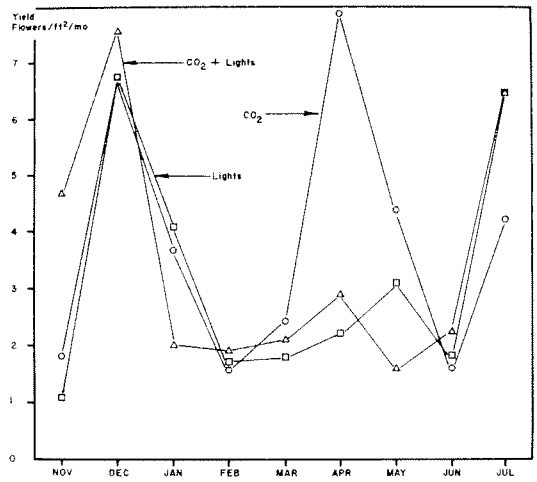

Fig. 1. The effect of fall and winter lighting of young carnation plants on distribution of yield.

Table 1. Effects of lighting[a] and supplementary CO_2 on yield and grade of 1- and 2-year carnations.

Treatment	Grade					Total yield
	Design	Short	Standard	Fancy	Mean	
Lights + CO_2						
1-year	121	61	576	882	4.35	1640
2-year	222	463	844	423	3.75	1952
CO_2						
1-year	53	122	628	977	4.42	1780
2-year	132	388	952	237	3.76	1709
Lights						
1-year	107	60	520	833	4.37	1520
2-year	326	512	817	355	3.60	2010

[a] Lighting from September 13 to February 1.

Average grade of flowers was reduced by lighting young plants (Table 1). When compared to unlighted plants receiving supplementary CO_2, lighting more than doubled the yield of design grade flowers and decreased those produced in all other grades.

Yield and grade from 2-year plants: Lighting started in mid-September increased yields on older plants from November to February when compared to unlighted plants (Fig. 2). Yield of unlighted plants equaled those from lighted plants in March and exceeded them in April. Yields of all three treatments were relatively low in May and June. Yield increase from lighting older plants began seven weeks after lighting was started and continued for 16 weeks.

The effects of lighting on 2-year carnations are clearest when yield and grade of flowers from the mid-November to February period is studied (Table 2). This was the period (Fig. 2) when lighting stimulated yield. Lighting with CO_2 gave only a 5% better yield

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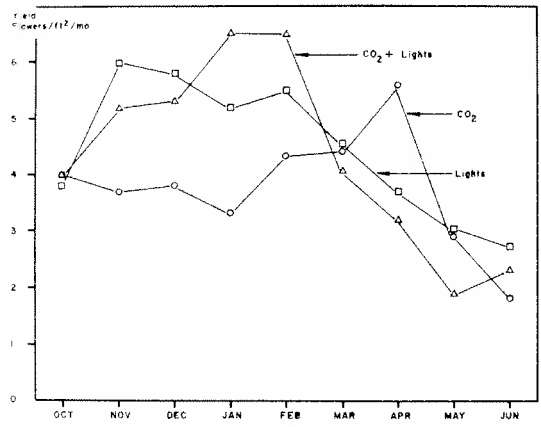

Fig. 2. Effects of lighting and CO_2 on the time 2-year carnations flowered.

Table 2. Effects of lighting[a] and supplementary CO_2 on yield and grade from 2-year carnations during the period from November 17 to March 1.

Treatment	Grade				Total yield
	Design	Short	Standard	Fancy	
Lights + CO_2	111	384	520	336	1349
CO_2	44	306	386	188	924
Lights	151	350	463	317	1281

[a]Lighting from September 13 to February 1.

than lighting without CO_2. Comparing only the CO_2 treatments, lighted plants produced 79% more fancy, 35% more standard, 25% more short and 150% more design grade flowers in this period. Lighting increased the total yield in this period by 46%.

Effects of CO_2: Young carnation plants in their first year produced more flowers of a higher mean grade when receiving supplementary CO_2 without lights (Table 1). Plants lighted with CO_2 yielded slightly more (8%) than lighted plants without CO_2, with nearly equal average grade of flowers.

Total yield was significantly higher from lighted 2-year-old plants than from unlighted plants with CO_2 (Table 1). The addition of CO_2 to lighted plants maintained the average grade with that of the control. Lighted plants not receiving supplementary CO_2 produced more design and short grade flowers and fewer in the standard and fancy grades.

Discussion and Conclusions

Pokorny and Kamp (6) found essentially the same photoperiodic effect, namely that short photoperiods increased the production of side shoots. The first crop on young plants should not be lighted if a second crop in spring is desired. While the first crop was hastened by 2 to 3 weeks, the branches that produce the second crop were inhibited by lighting.

Lighting may have its most practical use on older carnations in their terminal year, or in hastening the second crop for areas where this crop flowers in

June and July. A distinct increase in yield began 7 weeks after lighting was started on older plants and continued for 4 months. This suggests starting lights 22 weeks before plants are to be taken out and continuing the lights for 12 to 16 weeks.

Supplementary CO_2 increased yield of lighted young plants and average grade of flowers on lighted plants in their second year.

Ed. note: Experiments are presently under way to find out how supplementary winter lighting at different times can be used to influence timing of spring crops. We hope also to determine the feasibility of moving July production up to May and June by lighting at the right time. The reaction to this accelerated spring production should be very low July yields on carry-over plants.

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