

Plant height control of obligate long day herbaceous annuals using plant growth retardants and light

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Abstract

To control plant height of obligate long day plants, two trials were conducted, that is the use of plant growth retardants (A-Rest, Bonzi, and Cycocel), excluding control and exposure of plants to light for specific time (2, 4, 6 and 8 weeks). Results indicated that plant height was significantly reduced by all plant growth retardants. Similarly, plants transferred to a short day (SD) light chamber for 2 weeks produced more or less similar plant height when compared to plant growth retardants. The study suggested that for taller plants production the duration can be prolonged up to 8 weeks. The use of light to control plant height is non-toxic and eco-friendly.

Key word: Obligate long day, herbaceous annuals, plant height control, plant growth regulators, light

Introduction

The height of herbaceous plants is commercially controlled by plant growth retardants like Cycocel, B-Nine, A-Rest, Bonzi, Ethephon etc. They are anti-gibberellins, which reduce cellular elongation. The re-entry glasshouse intervals after chemical application is also varied from 12 to 48 hours, which indicates the hazardous nature of the chemicals (Holt and Jennings, 1999). Therefore, non-chemical cultural methods are getting preference to control plant height. Plant height can be controlled by biological method through selection and plant breeding. Through these methods, tall or dwarf cultivars can be established, which attain a desirable height according to the market demands. However, optimum-height-cultivars are not available for all herbaceous annuals, so horticulturists rely on other plant height control techniques (Schnelle *et al.*, 1992). Physical methods such as use of light intensity, temperature, container size, abiotic stressors, are also used (Munir *et al.*, 2004a,b; Baloch *et al.*, 2012, 2013a,b; Alhajhoj, 2017). Manipulation of light environment is one of the non-chemical plant height control methods (Lykas *et al.*, 2008; Baloch *et al.*, 2012).

Floriculturists' interest in non-hazardous methods is increasing due to firm controls measure are introduced by the governments across the globe. Consumers' preference is also differed depending on the choice of plant such as dwarf poinsettia (Clifford *et al.*, 2004) or having a three times pot diameter plants height of outdoor or indoor bedding and cut flower plants (Incrocci *et al.*, 1994). Ornamental plant's growers need to be aware of the importance of customers' choice including plant height. The present research study was designed to compare chemical and non-chemical methods (duration under non-inductive light environment) and their effect on plant height of selected obligate long day plants (LDPs).

Materials and methods

Seeds of five obligate LDPs were sown in seed trays containing leaf compost and were kept under partially shaded area. After

germination (70%), two experiments were laid out in Completely Randomised design having six replicates in each treatment (Table 1). In experiment No. 1, plants of five obligate LDPs were treated with plant growth retardants *viz.* A-Rest (30ppm), Bonzi (30ppm) and Cycocel (1000ppm). The spray solutions of these chemicals were prepared as stated by Lopes and Stack (2003), Tol-Bert (1960) and Anonymous (2007). After 3-weeks of germination, first spray of each chemical was carried out, while after 6-weeks of germination, second spray of same concentration of each chemical was done.

In experiment No. 2, six replicates of each obligate LDPs were moved into SD non-inductive environment for 2, 4, 6 and 8 weeks. Plants from that chamber were transferred to long day inductive environment chambers. Plants were remained in the ambient environment from 8 am to 4 pm and then they were moved into the light controlled chamber. Environmental variables

Table 1. Obligate LDPs subjected to plant growth retardants and SD-light duration

Annual herbaceous	Plant growth retardants	SD-light duration
	A-Rest, Bonzi, Cycocel	2, 4, 6, 8 weeks
Pot Marigold cv. Resina	do	do
Annual Phlox cv. Astoria Magenta	do	do
Cornflower cv. Florence Blue	do	do
Oriental Poppy cv. Burning Heart	do	do
Flax cv. Scarlet Flax	do	do

Table 2. Environmental detail of the experiment

Months	Temperature (°C)			Light integral 8 am-4 pm	Length of day (h)
	Max	Min	Avg		
March	25.84	13.03	19.44	8.63 MJ.m ⁻² .d ⁻¹	13.30
April	38.77	18.53	28.65	9.87 MJ.m ⁻² .d ⁻¹	14.21
May	41.58	23.26	32.42	9.87 MJ.m ⁻² .d ⁻¹	15.40
June	41.33	27.33	34.33	10.12 MJ.m ⁻² .d ⁻¹	16.16
July	39.29	26.61	32.95	9.76 MJ.m ⁻² .d ⁻¹	16.14

were recorded in the weather station (Table 2). Fertiligation was done manually with a nutrient solution of 8-8-8 (NPK) twice a week. Plants height was measured weekly until flowering and an average was calculated. GenStat-8 (VSN International Ltd. UK) statistical program was used to analyse the data.

Results and discussion

Findings of present study (experiment No. 1) revealed that plant height can be reduced by the application of different plant growth retardants however there was a non-significant difference among three plant growth retardants studied. Plant height was reduced by all plant growth retardants up to 40, 32 and 30% when Pot Marigold cv. Resina (Fig. 1a) was sprayed with Cycocel (22.17 cm), A-Rest (25.17 cm) and Bonzi (25.83 cm), respectively. However, control plants were 37cm tall. Annual Phlox cv. Astoria Magenta (Fig. 1b) when treated with Cycocel (14.83 cm), A-Rest (15 cm) and Bonzi (15.33 cm) reduced plant height by 35, 34 and 33%, respectively as compared to control (22.83 cm). Similarly,

plant height was reduced up to 40, 33 and 32% when Cornflower cv. Florence Blue (Fig. 1c) was treated with Cycocel (21 cm), Bonzi (23.33 cm) and A-Rest (23.50 cm), respectively, whereas plants in control were tallest (34.83 cm) than the other treatments. Plants of Oriental Poppy cv. Burning Heart (Fig. 1d) were reduced in size up to 36, 34 and 31% when they were sprayed with Bonzi (40.33 cm), Cycocel (41.50 cm) and A-Rest (43.67 cm), respectively when compared with control (63 cm). Flax cv. Scarlet Flax (Fig. 1e) plant height was reduced to 35, 24 and 23% when Cycocel (20.67 cm), Bonzi (24.17 cm) and A-Rest (24.67 cm) were sprayed than the control one (31.80 cm).

Results obtained from experiment No. 2 revealed that the effect of SD non-inductive duration was significant ($P \leq 0.05$) regarding plant height attribute. Plants subjected to a shorter SD duration for 2 weeks were smaller than those kept for 8 weeks in the same SD chamber. In Pot Marigold cv. Resina (Fig. 2a), plant height was reduced up to 38, 31 and 14% when grown in 2 weeks (30.33 cm), 4 weeks (33.67 cm) and 6 weeks (41.67 cm), respectively. However, plants placed for 8 weeks in SD environment were 48.67cm tall. Annual Phlox cv. Astoria Magenta (Fig. 2b) grown in SD for 2 weeks (17.67 cm), 4 weeks (21 cm) and 6 weeks (23.33 cm) reduced plant height by 40, 28 and 21% respectively as compared to 8 weeks duration (29.33 cm). Similarly, plant height of Cornflower cv. Florence Blue (Fig. 2c) was reduced up to 21, 14 and 9% exposed to SD for 2 weeks (30.67 cm), 4 weeks (33.67 cm) and 6 weeks (35.67 cm), respectively. However, plants

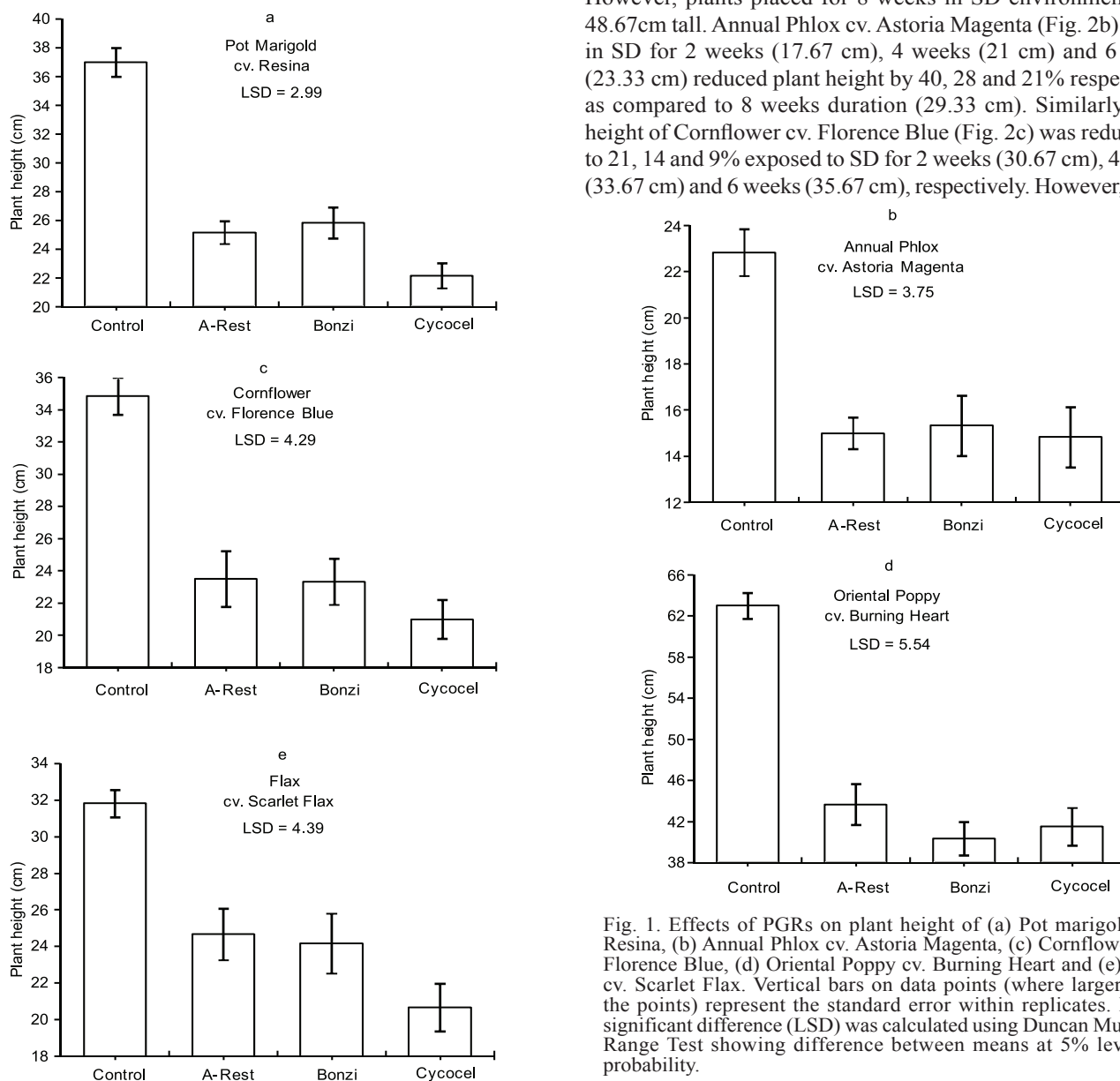


Fig. 1. Effects of PGRs on plant height of (a) Pot marigold cv. Resina, (b) Annual Phlox cv. Astoria Magenta, (c) Cornflower cv. Florence Blue, (d) Oriental Poppy cv. Burning Heart and (e) Flax cv. Scarlet Flax. Vertical bars on data points (where larger than the points) represent the standard error within replicates. Least significant difference (LSD) was calculated using Duncan Multiple Range Test showing difference between means at 5% level of probability.

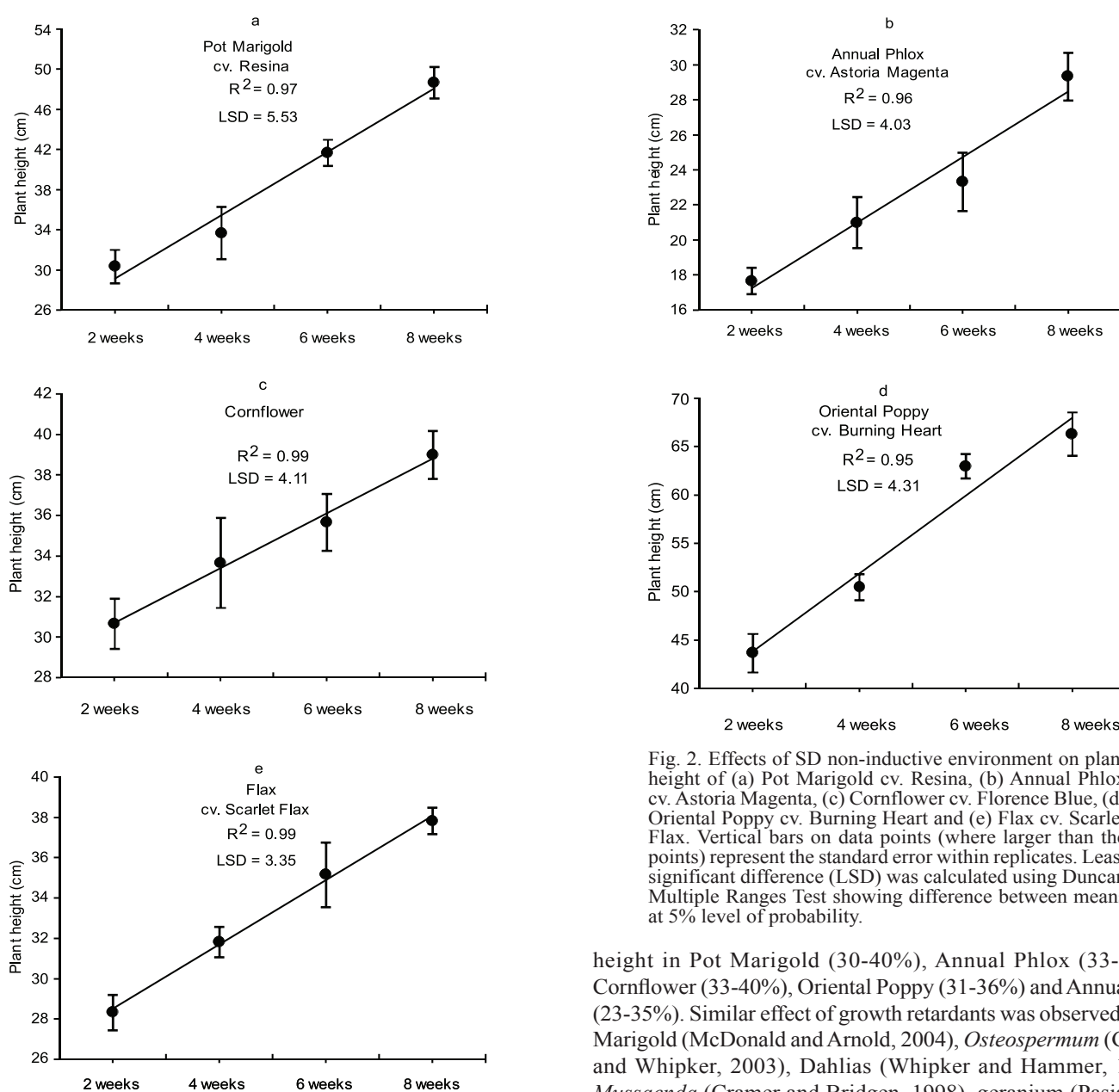


Fig. 2. Effects of SD non-inductive environment on plant height of (a) Pot Marigold cv. Resina, (b) Annual Phlox cv. Astoria Magenta, (c) Cornflower cv. Florence Blue, (d) Oriental Poppy cv. Burning Heart and (e) Flax cv. Scarlet Flax. Vertical bars on data points (where larger than the points) represent the standard error within replicates. Least significant difference (LSD) was calculated using Duncan Multiple Ranges Test showing difference between means at 5% level of probability.

in SD chambers for 8 weeks were tallest (39 cm) than the rest ones. Plants of Oriental Poppy cv. Burning Heart (Fig. 2d) were reduced in size by up to 34, 24 and 5% in SD chamber kept for 2 weeks (43.67 cm), 4 weeks (50.50 cm) and 6 weeks (63 cm) as compared to 8 weeks SD plants (66.33 cm). Similarly, in Flax cv. Scarlet Flax (Fig. 2e) plant height was reduced to 25, 16 and 7% when plants were kept 2 weeks in SD (28.33 cm), 4 weeks (31.83 cm) and 6 weeks (35.17 cm), than 8 weeks duration plants (37.83 cm).

The floral response of herbaceous LD annuals to light regimes have been intensively studied (Baloch *et al.*, 2012; Baloch *et al.*, 2013a,b). Consumers' preference for plant height of bedding or cut flower annuals is widely known characteristic (Townsend-Brascamp and Marr, 1995). Therefore, current research was conducted to examine the effect of chemical and non-chemical methods on plant height of obligate LDPs. Results of present research revealed that A-Rest, Bonzi and Cycocel reduced plant

height in Pot Marigold (30-40%), Annual Phlox (33-35%), Cornflower (33-40%), Oriental Poppy (31-36%) and Annual Flax (23-35%). Similar effect of growth retardants was observed in Pot Marigold (McDonald and Arnold, 2004), *Osteospermum* (Gibson and Whipker, 2003), Dahlias (Whipker and Hammer, 1996), *Mussaenda* (Cramer and Bridgen, 1998), geranium (Pasian and Bennett, 2001) and *Caladium* (Barrett *et al.*, 1995).

Cycocel (1000, 1250 and 1500 mg L⁻¹) significantly reduced plant height in LDPs (Kuehny *et al.*, 2001). Outcome of present research agreed with these results as Cycocel (1000 ppm) reduced plant height up to 40 (Pot Marigold and Cornflower), 35 (Annual Flax) and 34% (Oriental Poppy). Plant height was reduced when LDPs were sprayed with 30ppm Bonzi (Wang, 1999; Magnitskiy *et al.*, 2006) or when same chemical (0.15 to 0.30 mg/pot) was drenched (Runkle *et al.*, 2006). Similar results were recorded in present studies where plant height was reduced to 36 (Oriental Poppy), 33 (Cornflower and Annual Phlox), 30 (Pot Marigold) and 24% (Annual Flax). Application of A-Rest is also considered to control plant height in ornamental annuals (Latimer, 1991). Present results indicated that plant height was reduced up to 34 (Annual Phlox), 33 (Cornflower), 32 (Pot Marigold), 31 (Oriental Poppy) and 23% (Annual Flax).

Floriculture industry, generally use plant growth retardants for

the dwarfing of ornamental plants. However, these chemical are hazardous and damage the eco-system. Therefore, the demand to preserve environment from these toxic materials is rising. It is hence, necessitated to adopt environment-friendly techniques to control plant such as modulating the light environment (light intensity, light duration and light spectral quality). The findings of present study showed that plant height can be controlled by regulating the non-inductive plant environment. Miralles *et al.* (2000) obtained similar results when wheat and barley plants were grown under SD non-inductive environment. Similarly, Talon and Zeevaart (1990) recorded highest level of gibberellins (GA₅₃) in *Silene armeria* (LDP) when placed in SD, which was decreased in plants transferred to LD conditions. It is well known that gibberellins is responsible for shoot elongation and when plants grow under non-inductive environment the endogenous gibberellins level increases which encourage vegetative growth (stem elongation) under non-inductive environment. Present study not only provide information about reducing the plant height of obligate LDPs under non-inductive environment (for 2 weeks), but if consumer prefer taller bedding or cut flower plants then they can be kept for 4 to 8 weeks under the same non-inductive environment.

The use of plant growth retardants (A-Rest, Bonzi and Cycocel) to control plant height of obligate LDPs was revealed in present study. However, plants of Pot Marigold, Annual Phlox, Cornflower, Oriental Poppy and Flax kept in SD chamber for 2 weeks produced more or less same plant height as its was recorded when plant growth retardants were applied. The additional piece of information was if taller bedding or cut flower plants are on demands then the duration of SD environment can be extended until the desired plant height is attained. The merit of using the non-inductive environment technique over the use of plant growth retardants is that it is eco-friendly and non-toxic. This physical method can be combined with photoperiod to acquire early, mid and late flowering along with an ideal plant height in agreement with the consumers' choice.

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