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Greenhouse Production of Bachelor Button

Results of supplementary lighting treatments to shorten the production time of single stem plants grown for cut flowers at high plant densities

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Corn flower or bachelor button, *Centaurea cyanus*, is a long-day annual flower often used as a cut flower because of its distinctive blue color, small flower size and long vaselife. Traditional techniques involve the production of a large plant in a greenhouse or outdoors and continued harvest of cut flowers from that plant over 4-6 months. Armitage (1993) recommended plants should be grown in a cool greenhouse and receive 8-12 weeks of short days followed by an equal period of long days from incandescent lighting for flower initiation and continued flower harvest. Yahel, *et.al.* (1972) suggested that seedlings should not be treated with long days after germination because the plants elongate rapidly, produce few flowers and die.

This project evaluated the use of supplementary lighting to shorten the production time of individual or single stem plants grown at high plant densities in small pots in a greenhouse. Single stem cut flower production seeks to optimize plant growth and greenhouse space utilization.

Research on corn flower is part of an on-going effort at the University of Kentucky that strives to adapt cut flowers to high density, high turnover production systems in state-of-the-art greenhouses with mobile trays, ebb-flood irrigation, robotic materials handling equipment and other labor multiplication devices (Anderson, 1989).

Seed Germination

Corn flower `Blue Boy' seed germination required only 24-30 hours in a germination chamber. Seed was sown into MetroMix Plug growing medium in plug trays at a density of 1200 plants m^{-2}. Germination occurred in a germination chamber with a constant temperature of 24°C and approximately 100% humidity. This demonstrated that germination in controlled conditions could be much faster than seed catalog and Nau's (1989) recommendations of 7-10 days.

Supplemental Lighting Treatments

Plug treatment - Newly germinated corn flower seedlings were transferred to greenhouse benches with 24 hr supplemental high intensity discharge (HID) lighting from high pressure sodium lamps

(HPS)(80 micromoles $sec^{-1}m^{-2}$) for treatments of 3, 12, 17, or 22 days to determine whether short-term long day supplemental lighting treatments would be sufficient to initiate flowering. Seedlings were grown at greenhouse temperatures of 62°F (17°C) night and 72°F (22°C) day.

Production treatment - Plants were transplanted into MetroMix 510 bark-based growing medium with two plants in a 4 inch (10 cm) square pot at a density of 18 plants ft^{-2} (approx. 180 plants m^{-2}) and grown at greenhouse temperatures of 57°F (14°C) night and 64°F (18°C) day. Following seedling treatments, young corn flower plants were transferred to separate greenhouse sections where they received:

AMB - ambient light in the greenhouse (late January to May light conditions),
INC - ambient plus 6 hours day extension supplementary lighting (1800-2400 HR) with incandescent lamps (10 micromoles $sec^{-1}m^{-2}$) or
HID - ambient plus 6 hours day extension supplementary lighting (1800-2400 HR) with HPS lamps (60 micromoles $sec^{-1}m^{-2}$).

Three replicates, 30 plants each, were grown in each lighting treatment in a complete block design. The number of days to visible flower buds and flower opening were noted during plant production as well as the number of nodes and stem height at flowering.

Cut Stem Lengths

High quality cut corn flower stems were produced with both supplementary lighting production treatments (INC & HID). Stem lengths ranged from 45 to 70 cm, depending on the treatment (Table 1). Stems were significantly shorter when grown under HID lamps compared to incandescent lamps. At harvest, these stems were observed to be thicker and stronger than those grown under incandescent lighting.

No commercial quality cut stems were produced in the ambient light production treatment (AMB). Corn flower stems with 12, 17 or 22 days of supplemental HID lighting after germination were too short for cut flower use. These plants had a much different form than those grown with supplemental lighting during production. The lateral branches did not elongate and only the terminal flower was mature at harvest. Plants that received only three days of supplemental HID lighting after germination were tall enough for cut flower use, but the lateral branches did not elongate normally.

Table 1. The mean height of corn flower plants at flowering grown with ambient (AMB), incandescent (INC) or high pressure sodium (HID) supplemental lighting after initial supplemental HID treatments for 3,12,17, or 22 days after germination.

	Plant height at flowering in inches (cm)			
Production supplemental lighting treatment	Number of days of supplemental HID after germination			
	3	12	17	22
AMB	24.8 (62) c[x]	15.0 (38) a	10.2 (26) a	10.5 (26) a
INC	19.8 (50) b	24.3 (61) c	22.2 (55) c	27.0 (68) c
HID	17.3 (43) a	20.0 (50) b	18.1 (46) b	21.8 (55) b

x - Means in the same column with different letters are significantly different at the P=.05 level.

Days to Cut Flower Harvest

High quality cut corn flower stems were harvested from the supplementary lighting treatments in 50-60 days from seed sowing. Flowering time was similar for plants produced with incandescent or high intensity discharge lamps regardless of the number of days of post-germination supplemental lighting (Table 2). The similarity between the production lighting treatments began 26 days after germination and continued to 38 and 47 days after germination as demonstrated by the percent of stems with visible flower buds at these time intervals (Table 3).

Corn flower plants grown with ambient production lighting required significantly longer to flower than those that received supplementary lighting during production (Table 2). Plants that received 3, 12, 17 and 22 days of supplemental HID lighting after germination required 35, 23, 10 and 13 more days to flower, respectively. This demonstrates the facultative short day response of corn flower demonstrated by Kadman-Zahavi and Yavel (1985). The standard commercial recommendations outlined by Armitage (1993) require 8-12 weeks of short day treatment followed by 8 or more weeks of long days for flowering requires twice as long to produce cut corn flower stems than was demonstrated in this study.

Table 2. The mean number of days to flowering of corn flower plants grown with ambient (AMB), incandescent (INC) or high pressure sodium (HID) supplemental lighting after initial supplemental HID treatments for 3,12,17, or 22 days after germination.

	Mean number of days to flowering			
Production supplemental lighting treatment	Number of days of supplemental HID after germination			
	3	12	17	22
AMB	92.8 b[x]	73.4 b	69.6 b	75.2 b
INC	57.7 a	49.5 a	59.2 a	62.2 a
HID	53.7 a	49.2 a	59.5 a	63.1 a

x - Means in the same column with different letters are significantly different at the P=.05 level.

Table 3. Percent of corn flower plants with visible flower buds 26, 38 and 47 days after the seed was sown. Data were not collected in the treatment that received 3 days of supplemental lighting after germination.

Production treatment	Days after seed sowing		
	26	38	47
12 days of supplemental HID after germination			
HID	5 %	78 %	90 %
INC	2	69	90
AMB	1	8	33
17 days of supplemental HID after germination			
HID	1	23	88
INC	0	20	86
AMB	0	10	64
22 days of supplemental HID after germination			
HID	5	37	87
INC	8	48	84
AMB	2	24	51

Mean Node Number at Flowering

The number of nodes on each stem at flowering indicates significant differences in the supplementary lighting treatments. The mean node number was similar in all supplementary lighting production treatments and the ambient production treatments that received HID lighting for 12, 17 and 22 days after germination (Table 4). The treatment that received only 3 days of HID lighting after germination followed by ambient light during production was very different with more than double the number of nodes on the stems at flowering. This demonstrates that flower initiation has not occurred by the third day of long day HID supplementary lighting but has occurred by the twelfth day. Kadman-Zahavi and Yavel (1985) reported that approximately three weeks of long day treatment with incandescent lamps was required for floral initiation.

Table 4. The mean number of nodes on each stem at flowering of corn flower plants grown with ambient (AMB), incandescent (INC) or high pressure sodium (HID) supplemental lighting after initial supplemental HID treatments for 3,12,17, or 22 days after germination.

	Mean node number at harvest			
Production supplemental lighting treatment	Number of days of supplemental HID after germination			
	3	12	17	22
AMB	50.7 b[x]	23.9 a	19.2 a	17.8 a
INC	21.3 a	20.8 a	20.1 a	18.7 a
HID	22.1 a	21.2 a	20.5 a	17.0 a

x - Means in the same column with different letters are significantly different at the P=.05 level.

Flower Number at Flowering

The single stem corn flower plants produced 3.92 ±0.14 flowers per stem in these trials. Each stem had a terminal flower and generally 3 lateral flowers. The lateral flower branches were always 25-35% of the total stem length. The lateral flowers opened nearly synchronously 6-7 days after the terminal flower opened. In a separate experiment, the terminal flower was removed 7-10 days before opening and the stems produced a good "spray" form cut stem when the lateral flowers opened.

SUMMARY

Corn flower has been an excellent secondary cut flower for flower arrangements because of the striking blue flower color and the moderate flower size. Although Yavel etal suggest that corn flower plants should not be treated with long days as seedlings, the excellent cut stem quality and fast production time demonstrated in this study suggest that greenhouse operators should consider this production technique. Calculations of potential yields and returns indicate that this crop could be successful for greenhouse operators.

ASSUMPTIONS FOR WINTER GREENHOUSE CROP OF CORN FLOWER CUT STEMS:
1. Thirteen crops, sow seed every 2 weeks from October 1 to April 1. Use greenhouse from October 1 to June 1.
2. Each crop requires 8 weeks and plants are grown at 18 stems per square foot (2 plants per pot) in 4 inch pot under supplemental incandescent lighting (mum lighting). Seedlings (plugs) are grown for two weeks under 24hr supplemental HID lighting.
3. Utilize 500 ft^2 of bench space for each crop, total 2000 ft^2 with a single layer of cutflower support netting.
3. Receive $2.50 per 10 stem bunch.
GROSS RETURNS CALCULATIONS:
500 ft^2 bench space x 18 stems per sq.ft. = 9000 stems per crop.
9000 stems/crop x 13 crops =117,000 stems x 5% shrink =111,150 stems
111,150 stems/ 10 stems per bunch =11,115 bunches
11,115 bunches x $2.50 = $27787.50
$27,787.50 / 2000 ft^2 bench space = $13.90 per sq.ft. gross returns for fall, winter and spring crops.

REFERENCES

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