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Effect of planting dates and photoperiod on growth and flowering of chrysanthemum (C*hrysanthemum morifolium* Ramat) cv. yellow Reagan

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Abstract
Rooted cuttings of chrysanthemum (*Chrysanthemum morifolium* Ramat.) cv. Yellow Reagan were planted in different planting dates and treated with two different photoperiod. The experiment was carried out with nine treatments in Completely Randomized Design with three replications. The vegetative growth, flowering, flower yield and flower quality parameters were recorded. The results of present investigation treatment T_5-1st June (16 hours dark and 8 hours daylight) recorded higher plant height (63.63 cm) and maximum number of flowers per spray (5.33). Early flowering (41.33 days) was obtained in T_9-1st December (Natural photoperiod). Maximum number of side shoots per plant (11.00) and number of flowers per plant (42.33) were recorded in treatment T_6-1st June (14 hours dark and 10 hours daylight). Maximum number of flowers per spray (5.33), duration of flowering (26.00 days), size of the flower (5.93 cm) and weight of flower (2.77 gm) were noticed in treatments T_7-1st August (Natural photoperiod).

Keywords: Chrysanthemum, growth and flowering, photoperiod, planting dates, yellow Reagan

Introduction
Chrysanthemum, popularly known as "Queen of East" is a herbaceous perennial plant, belongs to family Asteraceae. It is a popular flower crop of commercial importance grown in India. It has diverse and beautiful range of color shades, shapes and size, making it suitable for every purpose conceivable for a flower crop. It is grown as cut flower, loose flower, potted flowering plants, bedding plant and for exhibitions. In many countries, including the United States and Japan, it is considered as the number one dollar earning flower crop; while in other countries, it ranks next to rose (Sheela, 2008) [11]**.** Chrysanthemum is sensitive to photoperiod *i.e.*, short-day induces flower bud initiation. The manipulation of photoperiod to maintain the plants in vegetative phase or to induce flowering, as per demand, revolutionized the cultivation of chrysanthemum (Blanchard and Runkle, 2009) [2]. Chrysanthemum being a qualitative short day plant, its blooming can be programmed depending on market demand, thus, making it possible for yearlong availability of flowers for trade. The present investigation was taken up with an objective to expand the blooming period of spray type chrysanthemum cv. Yellow Reagan by manipulating day length. The information generated will help the growers for successful round the year cultivation of chrysanthemum through manipulation of photoperiod.

Materials and Methods
The experiment was carried out during 2013-2015 at College of Horticulture, Orissa University of Agriculture and Technology, Chiplima campus. The experiment was laid out in a Completely Randomized Design with three replications and nine treatments comprising of combination of different planting dates (1st February, 1st April, 1st June, 1st August, 1st October and 1st December) and photoperiod (16 hours dark and 8 hours daylight, 14 hours dark and 10 hours daylight and Natural photoperiod). The treatment combinations are T_1-1st February (16 hours dark and 8 hours daylight), T_2-1st February (14 hours dark and 10 hours daylight), T_3-1st April (16 hours dark and 8 hours daylight), T_4-1st April (14 hours dark and 10 hours daylight), T_5-1st June (16 hours dark and 8 hours daylight), T_6-1st June (14 hours dark and 10 hours daylight), T_7 - 1st August (Natural photoperiod), T_8-1st October (Natural photoperiod) and T_9-1st December (Natural photoperiod).
The 25 days old, uniform, sand rooted terminal cuttings of chrysanthemum (*Chrysanthemum morifolium* Ramat.) cv. Yellow Reagan with vigorous growth were used as

the planting material for the study under pot culture condition. The planting media consists of garden soil, organic manure and sand at the ratio of 2:1:1. One plant was planted in each earthen pot and each plant was supported by a wooden stake to get an upright growth. Pots were spaced 20 cm apart. Immediately after planting, the pots were provided with long day condition, for 45 days, to encourage vegetative growth. The plants were fertilized with a compound fertilizer containing 15% N, 15% P_2O_5, 15% K_2O at planting at 5 weeks after planting. The plants were irrigated as and when necessary using rose can. Potted plants were subjected to two photoperiodic treatments (16 hours dark and 8 hours daylight, 14 hours dark and 10 hours daylight and Natural photoperiod) from 45 days after planting. The photoperiod treatment 16 hours dark and 8 hours daylight condition at three different planting dates (1st February, 1st April and 1st June) for T_1, T_3 and T_5 were achieved by covering the pots with black tarpaulin suspended on an iron frame from 5 PM until 7 AM. The photoperiod treatment 14 hours dark and 10 hours daylight condition at three different planting dates (1st February, 1st April and 1st June) for T_2, T_4 and T_6 were achieved by covering the plants with black tarpaulin suspended on wooden frame from 3 PM until 7 AM. Three plants were selected from each treatment for analysis.

The data on vegetative parameters *viz*., plant height (cm) and number of side shoot per plant; flowering parameters like days taken to first bud initiation (days) and duration of flowering (days), number of flowers per plant and number of flowers per spray, size of the flower (cm) and weight of flower (gm) were recorded at respective stages of growth. The data obtained were analysed; mean data and analysis of variance have been furnished with the levels of significance.

Results and Discussion

The results of present investigation from (Table 1) on vegetative growth parameters revealed that higher plant height (63.63 cm) was recorded in T_5 *i.e.* 1st June planting with 16 hours dark and 8 hours daylight and maximum number of side shoots per plant (11.00) were recorded in treatment T_6-1st June planting with 14 hours dark and 10 hours daylight. Early flowering (41.33 days) was recorded in T_9-1st December (Natural photoperiod) and maximum duration of flowering (26.00 days) was recorded in treatment T_7-1st August (Natural photoperiod). Earliness in planting enhanced extension growth caused by increased photosynthesis and respiration with enhanced carbon dioxide fixation. Delayed flowering because of photoperiod exposure might have resulted from interference with carbohydrate and florigene movement to the receptive site, production of transmissible inhibitor and production of a substance which acts antagonistically to the flowering hormone at the apex under long day condition (Vince-Prue, 1975) [14].

Flower yield parameters like maximum number of flowers per plant (42.33) was recorded in treatment T_6-1st June (14 hours dark and 10 hours daylight) and maximum number of flowers yield per spray (5.33) were recorded in two treatments T_5-1st June (16 hours dark and 8 hours daylight) and T_7-1st August (Natural photoperiod). Enhanced flower yield per plant might be attributed to increased vegetative growth and branching during early stages which then had sufficient time to accumulate reserved carbohydrate for proper bud differentiation. Similar record of enhanced flower yield resulting from photoperiod were also reported by (Andersson, 1990) [1] and Flower quality parameters like maximum size of the flower (5.93 cm) was recorded in treatment T_7-1st August (Natural photoperiod) and maximum weight of flower (2.77 gm) was recorded in treatment T_7-1st August (Natural photoperiod). Flower size and weight might have enhanced due to increase in the length of petals and pedicles and their numbers which is attributable to the drawing of photosynthesis to the flower as a consequence of intensification of the sink (Jyothi *et al.*, 1998) [6]. The results of the research on the effect of the photoperiod on growth and flowering of chrysanthemum reported was similar to those obtained by Farina *et al.* (1985) [5], Kenneth (1992) [8], Jyothi *et al*., (1998) [6], Velmurugan and Vadivel (2003) [13] and Kahar (2008) [7] in chrysanthemum, Ryan (2010) [10] in petunia, Christopher and Erwin (2011) [3] in kalanchoe and Mata and Botto (2011) [9] in salvia.

Table 1: Effect of planting date and photoperiod on growth and flowering of spray type chrysanthemum cv. Yellow Reagan

Treatments		Vegetative growth parameters		Flowering parameters		Flower yield parameters		Flower quality parameters		
Planting date and photoperiod		Plant Height (cm)	No of side shoot/plant	Days taken for flower bud initiation	Duration of flowering (days)	No of flowers/plant	No of flowers/ spray	Size of the flower (cm)	Weight of flower (g)	Flower colour as per RHS colour chat
T_1	1st February (16 hours dark and 8 hours daylight)	44.20	6.67	130.67	9.67	28.33	3.67	4.73	2.53	Yellow 2A
T_2	1st February (14 hours dark and 10 hours daylight)	49.83	7.33	126.33	10.67	32.33	3.67	4.93	2.52	Yellow 2A
T_3	1st April (16 hours dark and 8 hours daylight)	54.90	6.33	120.33	12.00	27.33	4.00	4.67	2.63	Yellow 2B
T_4	1st April (14 hours dark and 10hours daylight)	55.43	6.67	118.33	13.67	31.67	4.33	4.97	2.67	Yellow 2B
T_5	1st June (16 hours dark and 8 hours daylight)	63.63	10.33	115.33	19.33	38.67	5.33	5.23	2.73	Yellow 2B
T_6	1st June (14 hours dark and 10 hours daylight)	56.03	11.00	111.33	18.33	42.33	5.00	5.43	2.74	Yellow 5B
T_7	1st August (Natural photoperiod)	60.67	8.33	58.67	26.00	38.33	5.33	5.93	2.77	Yellow 5B
T_8	1st October (Natural photoperiod)	39.80	7.33	48.33	19.33	22.67	3.33	5.80	2.64	Yellow 5B
T_9	1st December (Natural photoperiod)	35.20	6.33	41.33	15.33	20.33	2.67	5.47	2.65	Yellow 3B
	S.Em.±	1.64	0.51	0.59	0.70	0.98	0.51	0.11	0.022	
	C.D. at 5%	3.49	1.07	1.26	1.49	2.09	1.07	0.24	0.047	

Conclusions

From foregoing discussion, it can be concluded that the response of photoperiod on flowering which planted on different dates was less in 14 hour short day treatment than 16 hour short day treatment provided by covering chrysanthemums cv. Yellow Reagan using black tarpaulin during the 45 days after planting.

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