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Variation in growth, flowering and seed yield of satin flower (*Godetia grandiflora*) planted on different dates

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Satin flower (*Godetia grandiflora* Lindl.) belongs to family Onagraceae is usually grown as bedding plant for landscaping purposes and also as a cut flower. Earlier it was known as *Clarkia amoena* ssp. *whitneyi.* Satin flower is grown as a greenhouse cutflower in Japan and has received renewed interest as a field grown cutflower in California (Anderson 1994). Satin flower plants are relatively large and have a free branching habit. The plants are vigorous and quite easy to grow. Both flower initiation and development were enhanced under long day conditions and plants grown under long day conditions (natural winter short day plus supplementary photoperiodic light) produced flowering stems of superior quality (Halevy and Weiss 1990). Seed production of annual flowers seems one of the viable options to explore with the great export potential. North Indian climatic conditions are favourable for winter annuals cultivation. Farmers have already entered into flower seed production and have reported 2.5 to 3 times more profit than traditionally grown wheat crops in Punjab (Singh *et al*. 2009). Planting dates depend upon the environmental conditions and the geographical location of the area. Environmental conditions vary from one location to other. Therefore, there is need to work out the planting schedules for the particular zone to get the best growth, flowering and seed yield of different annuals. Hence, the objective of the study was to examine the influence of planting time on growth, flowering and seed yield of satin flower to find out the optimum time of planting for flower and seed production.

The experiment was conducted at the experimental farm of the Department of Floriculture and Landscaping of Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during 2010-2011 and 2011-12 (altitude of 1270 m amsl and latitude of $32^{0}51'0"$ North and longitude of $77^{0}11'30"$ East). Open pollinated seeds of satin flower used for raising plants were procured from the Department of Floriculture and Landscaping. Nursery raising was done one month before transplanting. Seedlings having four leaves were planted after basal application of farmyard manure 5 kg/m^2 and fertilizers 30 g/m^2 each of nitrogen, phosphorus and potassium. Half dose of nitrogen was applied at the time of planting and remaining half dose was applied after 30 days of transplanting. The transplanting of uniform sized seedlings was done at a spacing of 30 cm × 30 cm from plant to plant and row to row accommodating nine plants per square meter area. Transplanting was at an interval of 15 days during 2010 and 2011. Planting dates were six, viz. 17 September, 2 October, 17 October, 1 November, 16 November and 1 December. The observations recorded on various growth and flowering parameters were subjected to analysis of variance (ANOVA) using randomized block design (Gomez and Gomez 1984) keeping planting dates as treatments with four replications. Monthly weather parameters for growing season were taken from the meteorological observatory, Department of Environment Science, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan (HP).

Planting dates significantly influenced the vegetative growth of satin flower. Maximum plant height (68.35 cm), plant spread (50.66 cm), number of side stems per plant (10.64) and stem length (58.38 cm) were obtained with 17 September planting (Table 1; Fig 1). Maximum plant height and spread in case of 17 September planted crop could be attributed to the fact that plants were exposed to relatively more short day period as compared to other planting dates. Anderson (1994) also reported more plant height (75 nodes) when godetia was given short day treatment as compared to long day treatment resulted in plants having less plant height (37 nodes). Utami *et al.* (1990) also observed better growth in godetia with earlier planting (10 April) as compared to late planting. With delay in planting date there was decrease in temperature which could be the reason for decrease in vegetative growth parameters. As temperature

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Table 1 Effect of planting dates on growth, flowering and seed yield of satin flower

Planting date	Plant height (cm)			Plant spread (cm)			Stem length (cm)			Days taken for visible bud formation			Days taken for flowering			Duration of flowering (days)		
	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled
17 September	69.35	67.35	68.35	51.63	49.70	50.66	59.54	57.23	58.38	154.00	161.89	157.95	183.20	189.73	186.47	37.30	38.52	37.91
2 October	66.80	65.45	66.13	46.92	47.37	47.14	56.71	53.05	54.88	145.10	144.06	144.58	176.45	175.60	176.03	36.25	36.76	36.51
17 October	64.35	63.37	63.86	44.25	46.10	45.18	53.12	52.53	52.82	135.80	142.34	139.07	167.25	173.35	170.30	33.75	32.40	33.07
1 November	62.45	61.75	62.10	43.43	44.68	44.05	51.95	51.55	51.75	130.50	139.00	134.75	162.00	168.93	165.46	31.50	31.79	31.64
16 November	60.55	59.35	59.95	39.05	41.48	40.26	50.52	49.73	50.12	127.00	132.19	129.59	155.75	163.07	159.41	31.25	30.72	30.98
1 December	58.50	56.78	57.64	37.64	38.19	37.92	48.13	46.05	47.09	120.95	121.76	121.36	152.50	150.55	151.53	30.85	30.71	30.78
Mean	63.67	62.34		43.82	44.58		53.33	51.69		135.56	140.21		166.19	170.20		33.48	33.48	
CD(P=0.05) for	3.17	2.40	1.84	3.86	4.86	2.97	4.17	6.06	3.42	2.66	7.67	3.92	3.30	8.52	4.43	1.44	1.86	1.27
Year (Y)			1.06			NS			NS			2.27			2.56			NS
Year × planting date (Y×D)			NS			NS			NS			7.67						NS
	Number of flowers/ stem (central)			*Number of flowers/ stem (side)*			*Days taken for capsule formation*			*Number of capsules/plant*			*Number of seeds/ capsule*			*Seed yield/plant (g)*		
17 September	111.40	108.77	110.08	17.43	14.06	15.74	249.30	241.34	245.32	337.13	317.87	327.50	90.35	91.03	90.69	9.87	8.49	9.18
2 October	108.65	107.29	107.97	14.28	13.07	13.67	242.00	230.42	236.21	278.35	275.03	276.69	86.80	88.53	87.66	8.02	7.15	7.58
17 October	108.35	102.10	105.22	12.76	10.95	11.85	236.25	224.94	230.59	270.90	253.94	262.42	84.44	85.93	85.18	6.48	6.03	6.25
1 November	98.35	93.89	96.12	10.89	10.37	10.63	227.50	220.59	224.04	264.39	235.35	249.87	83.24	84.75	83.99	5.61	5.73	5.67
16 November	74.45	77.94	76.20	9.90	10.00	9.95	215.75	209.80	212.78	214.36	211.90	213.13	82.58	83.34	82.96	4.90	5.37	5.13
1 December	67.95	64.10	66.03	10.13	9.85	9.99	209.25	201.59	205.42	198.13	188.47	193.30	81.59	83.01	82.30	4.56	4.48	4.52
Mean	94.86	92.35		12.56	11.38		230.01	221.45		260.54	247.09		84.83	86.10		6.57	6.21	
CD(P=0.05) for	10.81	5.83	6.06	2.29	1.95	1.40	2.31	5.72	2.89	34.72	24.37	21.53	5.67	5.47	3.71	1.56	0.75	0.66
Year (Y)			NS			0.81			1.67			NS			NS			NS
Year× planting date (Y×D)			NS			NS			NS						NS			NS

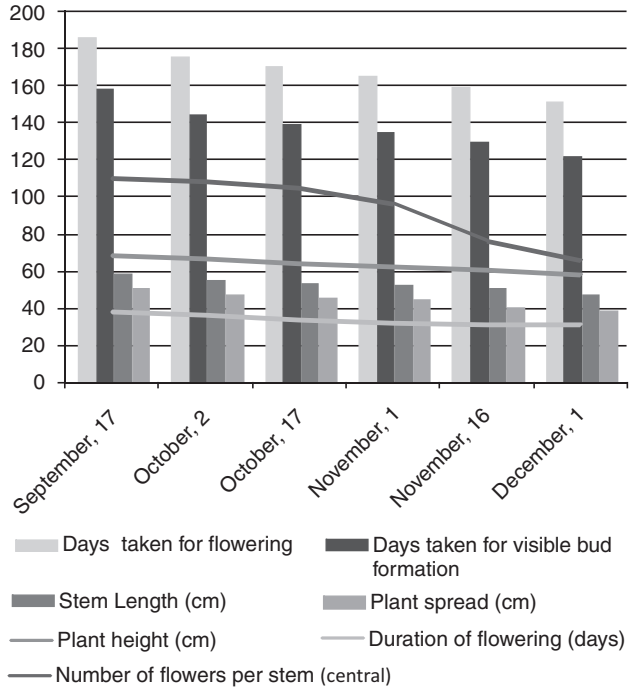

Fig 1 Effect of planting dates growth and flowering parameters of satin flower

decreased, node number at flowering in African marigold, angelonia, blue salvia, browallia, cosmos, dahlia, dianthus, moss rose, petunia, snapdragon, verbena and zinnia decreased linearly (Blanchard and Runkle 2011).

Earliest bud formation (121.36 days) and flowering (151.53 days) was obtained in 1 December planting (Table 1; Fig 1), However, 17 September planting resulted in maximum duration of flowering (37.91 days), number of flowers per stem (central) (110.08) and number of flowers/ stem (side) (15.74). Earlier flower bud formation and flowering in godetia might be due to the fact that godetia is a long day plant and it requires certain minimum exposure to long days for flower initiation (Halevy and Weiss 1990). Thus, earlier planted crop took more time for visible flower bud formation and flowering. Pascale (1998) also recorded earlier flowering in godetia with late planting. Anderson (1994) reported that godetia plants took 21 weeks for flowering when grown under short day treatment and 13 weeks under long day treatment. Flowers per stem recorded maximum in 17 September planted crop may be attributed to luxuriant vegetative growth in terms of plant height, plant spread and number of side shoots per plant. Moreover the longer duration of vegetative growth period this might have resulted in relatively more accumulation of photosynthates in plants resulting in more flowers/plant.

Earlier capsule formation (205.42 days) was obtained with 1 December planting (Table 1; Fig 1), however more number of capsules/plant (327.50), seeds/capsule (90.69) and seed yield/plant (9.18 g) was observed in 17 September planting. Earlier capsule formation in 1 December planting might be due to the fact that flowering was also earlier in 1 December planting and the temperature prevailing after anthesis was comparatively high which might have favoured early maturation of seeds however, the seeds produced were low in quality as compared to 17 September planted crop. These results are in confirmation with the findings of Dubey *et al.* (2002) in cosmos and Poonam *et al.* (2002) in zinnia. Number of capsules obtained maximum in 17 September planted crop might be due the fact that number of flowers per stem (central and side) were also maximum in this crop, as a result producing more number of capsules/plant. More seed yield produced in 17 September planting could be attributed to more number of capsules per plant. Results are in confirmation with the findings of Kumar and Kaur (2000) in phlox, Dhatt and Kumar (2010) in larkspur and Sharma (2012) in pansy.

In conclusion, our results and those of previous workers clearly indicate that early planting, i.e. 17 September, resulted in more luxuriant vegetative growth which ultimately resulted in better-quality flowering and seed production than late plantings. Thus, to get maximum quality flower and seed yields in satin flower, mid September is an optimum planting time.

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SUMMARY

The effect of climatic conditions and planting dates on growth, flowering and seed production of satin flower (*Godetia grandiflora* Lindl.) under mid hill conditions of Himachal Pradesh during 2010-11 and 2011-12 were investigated. Plantings were done at an interval of 15 days starting from 17 September in both the years with planting dates as; 17 September, 2 October, 17 October, 1 November, 16 November and 1 December under randomized block design. The maximum plant height (68.35 cm), plant spread (50.66 cm), stem length (58.38 cm), duration of flowering (33.91 days), number of flowers/stem (central and side; 110.08 and 15.74), number of capsules/plant (327.50), number of seeds/capsule (90.69) and seed yield/plant (9.18 g) were recorded when planting was done on 17 September. However, earliest visible flower bud formation (121.36 days), days to flowering (151.53) and capsule formation (205.42 days) were observed in 1 December planting.

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