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Full Length Article

Planting Time Affects Vegetative and Reproductive Growth of Exotic Cultivars of Snapdragon (*Antirrhinum majus*)

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Abstract

The field performance of 24 exotic cultivars of snapdragon (*Antirrhinum majus* L.) at three planting dates (November 10, 2009; March 10 and October 10, 2010) was assessed. Data of vegetative traits i.e., number of leaves, nodes, secondary shoots, plant height, fresh weight per plant and reproductive traits, including days to bud opening, spike length, and number of buds/spike, were recorded. Six cultivars ('Potomac Early Rose', 'Maryland Lavender', 'Potomac Royal', 'Potomac White', 'Potomac Early Orange' and 'Monaco Violet') showed superior vegetative growth while five cultivars ('Potomac Early Pink', 'Maryland Golden Brnz', 'Monaco Yellow', 'Potomac Orange Dark' and 'Monaco Baltimore Rose') performed poorly. 'Potomac Early Rose' and 'Maryland Lavender' performed best reproductively, and produced better quality flower spikes than all other cultivars. When considering the reproductive performance of these 24 snapdragon cultivars, sowing on November 10, 2009 was most suitable compared to the two other sowing dates. © 2017 Friends Science Publishers

Keywords: Cut flower; Field performance; Floriculture; Sowing dates; Spike flower quality

Introduction

Floriculture involves aesthetic aspects of ornamental field and potted plants, including annuals, biennials and perennials. According to an estimate, the global flower trade was estimated at about 5 billion US$, with China, India, Kenya, Columbia and Israel being the leading producers / exporters to fulfill rapidly developing markets that require new producers (Jameel, 2011). Pakistan is a relatively unexplored market with 17,000 acres reserved for cut flower crops, exporting 24 t of fresh flowers and 115 t of dried flowers (Nasir, 2000), although more recent statistics are not publicly available. Global values place total consumption of cut flowers in 1985 at about 12.5 billion US$, in 1990 about 25 billion US$, in 1995 about 31 billion US$ and in 2011, it was about 35 billion US$ (Hack, 2010).

Snapdragon (*Antirrhinum majus* L.), a perennial in warm regions but mostly grown as a winter annual, is used in flowering beds, mainly as short cultivars, or as a green background of flower beds, mainly as tall varieties (Ball, 1991). Snapdragon cultivars are sensitive to photoperiod (Munir *et al.*, 2010), thus trials of field performance in different seasons are important. To better exploit Pakistan's climate for the production of seasonal cut flowers, and to expand snapdragon production, expanding from a base that includes roses, gladiolus and tuberose (Ahmad *et al.*, 2010), this study aimed to assess the field performance of 24 exotic snapdragon cultivars when seeded at three different times of the year in a bid to standardize their optimal sowing time. Since very few studies exist on the field performance of snapdragon, these results will be useful for growers.

Materials and Methods

The research was conducted at the Horticultural Research Area, University College of Agriculture, University of Sargodha, Sargodha (Punjab), Pakistan during 2009–2010. Seeds of 24 snapdragon cultivars (Table 1) were imported from Pan-American Seed Co. (Chicago, USA). Their adaptability to Punjab's soil and environmental conditions at three different sowing times was tested. A split randomized complete block design was used with a minimum of 200 plants for each cultivar/replication. Sowing dates in the main plot were 10 November 2009 (1st sowing), 10 March 2010 (2nd sowing) and 10 October 2010 (3rd sowing). The cultivars were grown in sub-plots.

Seeds were sown in sowing trays, one seed/hole, and then transplanted into cups (250 mL), after 4 weeks, at a height of 5–6 cm. Peat moss (Pindstrup Faerdigblanding substrate, MI, USA) was used for seed germination and then in cups as the growing medium. There were 24 cultivars divided among three blocks. Cultivars were randomized in

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each block. Plants were shifted from plastic cups to the field (sandy loam soil, pH 7.64, EC 2589 µS cm^{-1}, soil organic matter of 8.79 g kg^{-1}) 8 weeks after sowing. A plant-to-plant and row-to-row distance of 10 cm was maintained for each cultivar and 60 cm in between cultivars. For data collection, 10 plants from each cultivar were selected to study vegetative and reproductive parameters. The vegetative parameters assessed were: number of leaves/plant, number of nodes/plant and number of secondary shoots/plant by manual counting; plant height was measured in cm; stem diameter was measured in mm with a digital vernier caliper (Incrome, part no. 2313); fresh weight (g) measured with a digital balance. The reproductive parameters assessed were: days to bud opening; spike length measured in cm; number of buds/spike. R.2.11.2 software (John and Sanford, 2011) was used for data analysis. The data collected were analyzed statistically by analysis of variance (ANOVA) and means were compared by Tukey's multiple range test ($P< 0.05$).

All experimental plants were maintained under similar agro-climatic conditions. A foliar spray of fungicide (Ridomil; Matalaxyl+Mancozeb; Syngenta, Sargodha, Pakistan) was applied at 2.5 g L^{-1} to control damping off at the seedling stage at 3 and 5 weeks after sowing. To control the attack of insects such as aphids, armyworm and caterpillars, Bifenthrin and Amamactin were applied at 1 mL L^{-1} of water and sprayed when needed. Canal water was used for field irrigation every 10–12 days.

Results

Vegetative Traits

Most leaves and nodes per plant formed in POD on the first sowing date, in PCR on the second sowing date, and in P-ROY on the third sowing date (Table 2). Based on the presence or absence of secondary shoots, the 24 cultivars were divided into two groups: AC, MWY, POD, MPB, PR, MY, MW, and MBR formed secondary shoots while the remaining 16 cultivars did not. More secondary shoots were produced by POD in the first, in MPB in the second, and in P-ROY in the third sowing dates (Table 3). Plant height is an important parameter from a commercial production point of view in cut flower industry. Maximum plant height was recorded in MWY in the first, in MV in the second, and in P-ROY in the third sowing dates (Table 3). Higher fresh weight per plant was observed in MWY, PY P-ROY (61.02 g) for the first, second and third sowing dates, respectively (Table 4 and 5).

Reproductive Traits

The numbers of days required for flower bud opening are very important to forecast the harvesting time and to decide the sowing time for timely harvest and availability of flowers at the time of high market demand. For the first sowing date, maximum days were required for bud opening (146 d) by MW, in the second sowing date by MBR (107 d), and in the third sowing date by PW and PEO (180 days). Number of flower buds per spike plays an important role in defining the quality of flower spikes as more buds makes it compact, beautiful and attractive for consumers. More buds maintains the spike in bloom for longer and extends the vase life as the basal buds present on the spike open first and then opening proceeds sequentially to apical buds. More flower buds per spike (46.33) were formed in MPT for the first, in PR for the second (11.83), and in MBR for the third sowing dates (44) (Table 6). From a commercial point of view, larger flower spikes in the first sowing period would be most beneficial. Flower spike length is an important factor in commercial cut flower production, and flowering plants with larger flower spikes are desirable due to more flowering buds per spike, seem more attractive and fetch better prices in the market. Longer spikes were found on MPT in the first, on MW for the second, and on PER in the third sowing date (Table 6 and 7).

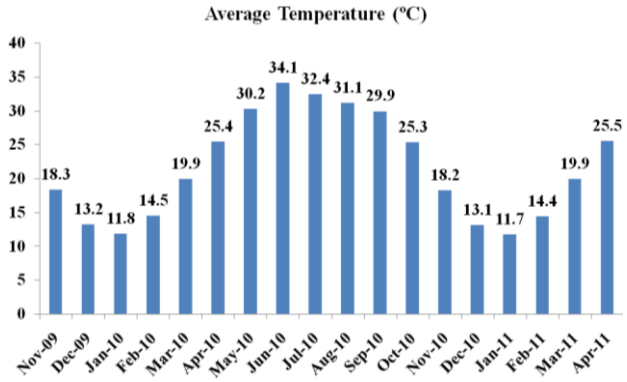

Fig. 1: Average monthly temperature during the experimental period (November 2009 to April 2011)

Discussion

There are very limited studies on the performance of snapdragon plants in the field. Some studies showed that planting density, choice of pinching node position and the choice of container size affected seedling growth, plant height, number of axillary buds, and cut flower quality (Inaba and Ohshiro, 2005; Inaba, 2006; Inaba *et al.*, 2010a, b). The difference in flower spike length is influenced by genetic makeup and also by local environmental conditions during the production period while nutrition also plays a vital role in the growth and development of snapdragon cultivars (Creel and Kessler, 2007). Our results show that plant height, spike length and number of flower buds per spike were comparatively more on the third and first sowing dates (October 10, 2010 and November 10, 2009) while these traits of commercial importance were substantially reduced during the second sowing date (March 10, 2010). If we correlate the climatic data (Fig. 1) with sowing dates, it can be observed that after second sowing (March 10, 2010), the average monthly temperature gradually increased from 19.9 to 34.1ºC in ensuing months,

Table 1: Names (and abbreviations) of snapdragon cultivars used in the study

'Monaco Violet' (MV)	'Monaco Rose' (MR)	'Maryland Golden Brnz' (MGB)	'Potomac Early Orange' (PEO)
'Apollo Purple' (AP)	'Potomac Cherry Rose' (PCR)	'Maryland Plum Blossom' (MPB)	'Maryland Apple Blossom' (MAB)
'Apollo Cinnamon' (AC)	'Maryland Pink True' (MPT)	'Potomac Royal' (P-ROY)	'Potomac Yellow' (PY)
'Apollo Yellow' (AY)	'Potomac Early Rose' (PER)	'Monaco Yellow' (MY)	'Potomac Apple Blossom' (PAB)
'Potomac Early Pink' (PEP)	'Maryland Lavender' (ML)	'Monaco White' (MW)	'Potomac Red' (PR)
'Maryland White Yellow' (MWY)	'Potomac Orange Dark' (POD)	'Potomac White' (PW)	'Monaco Baltimore Rose' (MBR)

Table 2: Number of leaves and nodes/plant for 24 snapdragon cultivars on three sowing dates

Cultivars	November 10, 2009	March 10, 2010	October 10, 2010	November 10, 2009	March 10, 2010	October 10, 2010
	Number of leaves/plant			Number of nodes/plant		
Monaco Violet	164.75 abcdB	139.72 abcB	219 abcA	30.41 bcdeB	20.17 bcdeC	37.16 bcA
Apollo Purple	135.00 bcdA	87.83 bcdeB	84 eB	31.41 bcdeA	14.92 cdefB	13.83 efB
Apollo Cinnamon	149.66 abcdA	122.00 abcdAB	83 eB	24.25 eA	20.5 abcdeA	13.33 efB
Apollo Yellow	130 .00 bcdA	103.00 bcdeAB	79 eB	27.66 cdeA	17.33 bcdeB	13 efB
Potomac Early Pink	152.33 abcdA	120.58 abcdeAB	82 eB	34.41 abcA	19.67 bcdeB	13.66 efC
Maryland White Yellow	193.66 abA	137.33 abcB	75 eC	31.83 bcdeA	22.83 abcdB	12.16 fC
Monaco Rose	184.91 abA	64.89 deB	74 eB	35.08 abcA	11.77 efB	13 efB
Potomac Cherry Rose	161.33 abcdA	186.67 aA	88 eB	30 bcdeA	29.5 aA	15 efB
Maryland Pink True	113.16 cdAB	119.92 abcdeA	74 eB	25d eA	19.2 bcdeB	13.33 efC
Potomac Early Rose	170.66 abcB	88.25 bcdeC	251 abA	35.41 abcB	17.42 bcdeC	41.83 abA
Maryland Lavender	170.16 abcAB	134.08 abcdB	188 bcdA	33.42 bcdA	23.58 abcB	30.33 cdA
Potomac Orange Dark	220.00 aA	112.00 bcdeB	70 eB	42.91 aA	19.33 bcdeB	11.67 fC
Maryland Golden Brnz	170.25 abcA	140.67 abcA	78 eB	30.25 bcdeA	22.19 abcdB	14 efC
Maryland Plum Blossom	189.33 abA	132.00 abcdB	74 eC	31.58 bcdeA	23.5 abcB	12 fC
Potomac Royal	190.66 abB	146.33 abB	262 aA	38.5 abB	23.83 abcC	48.33 aA
Monaco Yellow	103.50 cdAB	147.67 abA	83 eB	13.67 fB	24.67 abA	13.83 efB
Monaco White	101.16 cdAB	133.17 abcdA	86 eB	12.75 fB	22 abcdA	14 efB
Potomac White	102.16 cdA	97.00 bcdeA	80 eA	12.17 fA	15.67 bcdef A	13.33 efA
Potomac Early Orange	102.50 cdA	113.17 bcdeA	83 eA	11.42 fB	18.83 bcdeA	13.17 efAB
Maryland Apple Blossom	102.33 cdB	98.75 bcdeB	230 abcA	9.67 fC	16.75 bcdef B	38.33 bcA
Potomac Yellow	101.50 cdB	70.75 cdeB	199 abcdA	11.83 fB	11.58 efB	33.83 bcA
Potomac Apple Blossom	100.66 cdB	86.00 bcdeB	161 cdA	11.17 fB	14.33 defB	33.5 bcA
Potomac Red	99.91 cdB	83.33 bcdeB	188 bcdA	10.67 fB	13.91 defB	31.33 cA
Monaco Baltimore Rose	94.58 dAB	49.67 eB	132 deA	11.58 fB	8.16 fB	22 deA
Means*	141.84 A	113.11 A	125.95 A	24.46 A	18.82 B	21.5 AB

Table 3: Number of secondary shoots/plant and plant height of 24 snapdragon cultivars on three sowing dates

Cultivars	November 10, 2009	March 10, 2010	October 10, 2010	November 10, 2009	March 10, 2010	October 10, 2010
	Number of secondary shoots/plant			Plant height (cm)		
Monaco Violet	0 eA	0 cA	0 dA	51.92 efB	39.25 aC	83.33 aA
Apollo Purple	0 eA	0 cA	0 dA	49.5 fA	33.25 abcdB	38.83 eB
Apollo Cinnamon	30.67 cA	18.17 aB	14.83 cB	59.75 bcdefA	38 abB	34.33 eB
Apollo Yellow	0 eA	0 cA	0 dA	58.33 bcdefA	23.08 cdefC	41.17 eB
Potomac Early Pink	0 eA	0 cA	0 dA	68.58 abcA	24.17 bcdefC	38 eB
Maryland White Yellow	33.42 bcA	18.37 aB	13.5 cB	74 aA	19.33 defC	36.33 eB
Monaco Rose	0 eA	0 cA	0 dA	55.5 cdefA	19.55 cdefC	39.67 eB
Potomac Cherry Rose	0 eA	0 cA	0 dA	52.58 defA	24 cdefC	43.17 deB
Maryland Pink True	0 eA	0 cA	0 dA	65.67 abcde A	28.64 abcdeC	41.83 deB
Potomac Early Rose	0 eA	0 cA	0 dA	65.97 abcdA	19.77 cdefC	79.33 aB
Maryland Lavender	0 eA	0 cA	0 dA	70.67 abA	28.42 abcdeC	47.17 cdeB
Potomac Orange Dark	44 aA	20.25 aB	12.33 cC	68.75 abcA	18.25 efC	38.67 eB
Maryland Golden Brnz	0 eA	0 cA	0 dA	70.08 abA	27.25 abcdeC	42.25 deB
Maryland Plum Blossom	33.33 bcA	23.67 aB	14 cC	53.58 defA	33.33 abcB	41.33 eB
Potomac Royal	39.42 abA	20.33 aB	36.67 aA	56.97 bcdefA	29.08 abcdeC	88.5 aB
Monaco Yellow	16.92 dAB	19.97 aA	14.83 cB	29.17 gB	29.83 abcdeB	40.83 eA
Monaco White	16.58 dA	18 aA	15.33 cA	29.42 gA	32.5 abcdA	37.33 eA
Potomac White	0 eA	0 cA	0 dA	28.58 gB	23.83 cdefB	40.57 eA
Potomac Early Orange	0 eA	0 cA	0 dA	22.33 gB	21.97 cdefB	39.17 eA
Maryland Apple Blossom	0 eA	0 cA	0 dA	27.75 gB	22.75 cdefB	60.72 bcA
Potomac Yellow	0 eA	0 cA	0 dA	26.33 gB	21.92 cdefB	55.67 bcdA
Potomac Apple Blossom	0 eA	0 cA	0 dA	25.42 gB	23.33 cdefB	63.58 bA
Potomac Red	0 eA	0 cA	0 dA	25.98 gB	23.42 cdefB	44.72 deA
Monaco Baltimore Rose	17.58 dB	9.33 bC	23.17 bA	23.32 gB	11 fC	62.67 bA
Means*	9.66 A	6.17 B	6.03 B	48.34 A	25.66 B	49.13 A

Lower case letters represent comparisons among treatments; capital letters represent the response of the same cultivar at different sowing dates. The average of 10 plants from each cultivar was used for statistical analysis. Means were compared by Tukey's multiple range test ($P< 0.05$). * Means across cultivars, for each date.

Table 4: Fresh weight of 24 snapdragon cultivars on three sowing dates

Cultivars	November 10, 2009	March 10, 2010	October 10, 2010
Monaco Violet	10.35 aC	25.94 abcB	60.02 bA
Apollo Purple	9.21 aB	23.25 abcA	19.91 fAB
Apollo Cinnamon	12.73 aA	21.83 abcA	20.28 fA
Apollo Yellow	9.58 aA	20.38 abcA	20.21 fA
Potomac Early Pink	13.27 aA	8.35 cA	20.00 fA
Maryland White Yellow	22.99 aA	23.41 abcA	18.5 fA
Monaco Rose	11.47 aB	26.84 abcA	15.61 fAB
Potomac Cherry Rose	12.68 aA	14.24 abcA	21.22 fA
Maryland Pink True	10.86 aA	20.67 abcA	14.56 fA
Potomac Early Rose	12.57 aB	14.27 abcB	45.98 bcdeA
Maryland Lavender	14.30 aB	15.39 abcB	32.05 cdefA
Potomac Orange Dark	19.35 aA	31.92 abA	19.4 fA
Maryland Golden Brnz	8.86 aA	13.48 abcA	17.10 fA
Maryland Plum Blossom	13.08 aB	27.12 abcA	15.07 fAB
Potomac Royal	14.47 aB	26.14 abcB	61.02 aA
Monaco Yellow	15.38 aA	18.6 abcA	21.14 fA
Monaco White	14.45 aA	21.99 abcA	20.03 fA
Potomac White	15.24 aA	14.58 abcA	18.18 fA
Potomac Early Orange	15.07 aB	15.51 abcB	25.04 efA
Maryland Apple Blossom	14.68 aB	15.2 abcA	30.27 defAB
Potomac Yellow	15.94 aB	33.46 aA	21.44 fAB
Potomac Apple Blossom	15.88 aB	18.03 abcB	58.42 bA
Potomac Red	13.63 aB	10.63 cB	50.46 bcdA
Monaco Baltimore Rose	11.63 aB	11.66 bcB	52.03 bcA
Means*	13.65 B	19.70 AB	30.04 A

Lower case letters represent comparisons among treatments; capital letters represent the response of the same cultivar at different sowing dates. The average of 10 plants from each cultivar was used for statistical analysis. Means were compared by Tukey's multiple range test ($P< 0.05$). * Means across cultivars, for each date

Table 5: Pooled means for number of leaves, buds and secondary shoots/plant, plant height and fresh weight of 24 snapdragon cultivars

Cultivars	Number of leaves/plant	Number of buds/plant	Number of secondary shoots/plant	Plant height (cm)	Fresh weight (g)
Monaco Violet	174.49 ab	29.25 bc	0 e	58.17 a	32.10 ab
Apollo Purple	102.27 ghi	20.05 def	0 e	40.53 defgh	17.46 d
Apollo Cinnamon	118.22 efghi	19.36 efg	21.22 bc	44.03 cdef	18.28 d
Apollo Yellow	104.00 fghi	19.33 efg	0 e	40.86 cdefgh	16.72 d
Potomac Early Pink	118.30 efghi	22.58 de	0 e	43.58 cdef	13.87 d
Maryland White Yellow	135.33 bcdefg	22.28 de	21.76 b	43.22 cdef	21.64 bcd
Monaco Rose	107.93 efghi	19.95 def	0 e	38.24 efghij	17.97 d
Potomac Cherry Rose	145.33 bcde	24.83 cd	0 e	39.97 defghi	16.05 d
Maryland Pink True	102.36 ghi	19.17 efg	0 e	45.39 cde	15.36 d
Potomac Early Rose	169.97 abc	31.55 b	0 e	55.01 ab	24.27 bcd
Maryland Lavender	164.08 abcd	29.11 bc	0 e	48.75 bc	20.58 bcd
Potomac Orange Dark	134.00 bcdefgh	24.63 cd	25.53 b	41.89 cdefg	23.56 bcd
Maryland Golden Brnz	129.69 cdefghi	22.15 de	0 e	46.53 cd	13.15 d
Maryland Plum Blossom	131.78 cdefghi	22.36 de	23.67 b	42.75 cdef	18.43 d
Potomac Royal	199.6667 a	36.89 a	32.14 a	58.17 a	41.55 a
Monaco Yellow	111.39 efghi	17.39 efghi	17.22 cd	33.28 hijk	18.38 d
Monaco White	106.78 efghi	16.25 fghi	16.64 d	33.08 hijk	18.83 cd
Potomac White	93.06 hi	13.72 i	0 e	30.99 jk	16.00 d
Potomac Early Orange	99.56 ghi	14.47 ghi	0 e	27.81 k	18.54 d
Maryland Apple Blossom	143.69 bcdef	21.58 de	0 e	37.07 fghij	20.05 bcd
Potomac Yellow	123.75 defghi	19.08 efgh	0 e	34.64 ghijk	23.62 bcd
Potomac Apple Blossom	115.89 efghi	19.67 defg	0 e	37.44 efghij	30.77 abc
Potomac Red	123.75 defghi	18.69 efhi	0 e	31.37 jk	24.91 bcd
Monaco Baltimore Rose	92.08 i	13.91 hi	16.69 d	32.33 ijk	25.11 bcd

Different letters within a column represent comparisons within each parameter across cultivars. The average of 10 plants from each cultivar was used for statistical analysis. Means were compared by Tukey's multiple range test ($P< 0.05$)

while after the first and third sowing dates (November 10, 2009 and October 10, 2010) the average monthly temperature decreased and then gradually increased. Since snapdragon is classified as a winter season cut flower, these cultivars performed well during low temperature months compared to high temperature months. Raulston (1970) noted that 23 snapdragon cultivars classified on their flowering response under glasshouse conditions showed variable responses under field conditions in Florida, USA. The use of arbuscular mycorrhizal fungi improved the

Table 6: Number of flower buds/spike and flower spike length for 24 snapdragon cultivars on three sowing dates

Cultivars	November 10, 2009	March 10, 2010	October 10, 2010	November 10, 2009	March 10, 2010	October 10, 2010
	Number of flower buds/spike			Flower spike length (cm)		
Monaco Violet	38.58 abcdA	7.75 aB	15.17 bB	15.67 cdefgA	8.00 aB	11.50 bcdAB
Apollo Purple	30.92 bcdefgA	7.33 aB	11.67 bB	14.42 defghA	8.83 aB	6.667 dB
Apollo Cinnamon	42.00 abA	8.17 aB	12.83 bB	24.67 aA	9.33 aB	7.50 cdB
Apollo Yellow	32.92 bcdefgA	7.33 aB	15.00 bB	17.08 bcdeA	7.00 aB	9.83 cdB
Potomac Early Pink	38.50 abcdA	7.25 aB	14.00 bB	20.08 abcdA	7.97 aB	8.67 cdB
Maryland White Yellow	43.42 abA	7.20 aB	12.00 bB	22.17 abcA	6.33 aB	7.33 dB
Monaco Rose	36.50 abcdeA	5.77 aB	12.33 bB	16.97 bcdefA	5.87 aB	7.33 dB
Potomac Cherry Rose	35.75 abcdefA	3.67 aC	16.83 bB	15.42 cdefgA	2.75 aB	11.17 bcdA
Maryland Pink True	46.33 aA	8.67 aB	13.00 bB	27.17 aA	8.47 aB	8.00 cdB
Potomac Early Rose	33.67 abcdefgA	8.08 aB	41.17 aA	16.58 cdefB	8.00 aC	35.00 aA
Maryland Lavender	31.00 bcdefgA	5.00 aC	17.83 bB	16.75 bcdefA	4.47 aC	11.33 bcdB
Potomac Orange Dark	39.33 abcA	9.67 aB	14.67 bB	17.00 bcdeA	9.17 aB	9.00 cdB
Maryland Golden Brnz	42.08 abA	10.50 aB	14.00 bB	24.00 abA	9.11 aB	8.00 cdB
Maryland Plum Blossom	31.83 bcdefgA	9.33 aB	13.33 bB	16.33 cdefgAB	7.50 aB	8.33 cdA
Potomac Royal	24.58 efgA	8.75 aB	19.67 bA	12.75 efghA	8.83 aB	14.67 bcAB
Monaco Yellow	27.17 cdefgA	4.67 aC	13.50 bB	10.25 efghiA	5.00 aA	8.50 cdA
Monaco White	27.00 cdefgA	11.00 aB	13.67 bB	10.00 efghiA	10.00 aA	7.67 cdA
Potomac White	26.50 defgA	6.75 aC	15.00 bB	9.83 efghiA	5.83 aA	8.33 cdA
Potomac Early Orange	26.67 cdefgA	5.17 aC	14.00 bB	9.67 fghiA	5.92 aA	10.50 bcdA
Maryland Apple Blossom	27.47 cdefgA	8.08 aC	16.33 bB	10.50 efghiA	7.58 aA	10.53 bcdA
Potomac Yellow	28.67 cdefgA	8.25 aB	18.83 bB	11.42 efghiB	8.75 aB	17.50 bA
Potomac Apple Blossom	26.25 defgB	7.97 aC	41.17 aA	9.17 ghiB	9.33 aB	32.67 aA
Potomac Red	23.50 fgB	11.83 aC	14.67 bA	7.25 hiA	8.75 aA	11.33 bcdA
Monaco Baltimore Rose	21.50 gB	4.67 aC	44.00 aA	5.17 iB	6.40 aB	34 aA
Means*	32.58 A	7.61 C	18.11 B	15.01 A	7.46 B	12.72 A

Lower case letters represent comparisons among treatments; capital letters represent the response of the same cultivar at different sowing dates. The average of 10 plants from each cultivar was used for statistical analysis. Means were compared by Tukey's multiple range test ($P< 0.05$). * Means across cultivars, for each date

Table 7: Pooled means for flower buds/spike and length of flower spikes of 24 snapdragon cultivars

Cultivars	Number of flower buds/spike	Flower spike length (cm)
Monaco Violet	174.49 ab	29.25 bc
Apollo Purple	102.27 ghi	20.05 def
Apollo Cinnamon	118.22 efghi	19.36 efg
Apollo Yellow	104.00 fghi	19.33 efg
Potomac Early Pink	118.30 efghi	22.58 de
Maryland White Yellow	135.33 bcdefg	22.28 de
Monaco Rose	107.93 efghi	19.95 def
Potomac Cherry Rose	145.33 bcde	24.83 cd
Maryland Pink True	102.36 ghi	19.17 efg
Potomac Early Rose	169.97 abc	31.55 b
Maryland Lavender	164.08 abcd	29.11 bc
Potomac Orange Dark	134.00 bcdefgh	24.63 cd
Maryland Golden Brnz	129.69 cdefghi	22.15 de
Maryland Plum Blossom	131.78 cdefghi	22.36 de
Potomac Royal	199.67 a	36.89 a
Monaco Yellow	111.39 efghi	17.39 efghi
Monaco White	106.78 efghi	16.25 fghi
Potomac White	93.06 hi	13.72 i
Potomac Early Orange	99.56 ghi	14.47 ghi
Maryland Apple Blossom	143.69 bcdef	21.58 de
Potomac Yellow	123.75 defghi	19.08 efgh
Potomac Apple Blossom	115.89 efghi	19.67 defg
Potomac Red	123.75 defghi	18.69 efhi
Monaco Baltimore Rose	92.08 i	13.91 hi

Different letters within a column represent comparisons within each parameter across cultivars. The average of 10 plants from each cultivar was used for statistical analysis. Means were compared by Tukey's multiple range test ($P< 0.05$)

performance of cv. 'Butterfly' in the field (Asrar *et al.*, 2012). This study revealed that PER, ML, P-ROY, PW, PEO and MV performed well in terms of vegetative growth, while PEP, MGB, MY, POD and MBR performed poorly. PER and ML showed best reproductive performance by producing best quality flower spikes. Similar results were reported by some scientists who studied the field performance of various snapdragon cultivars in Florida, USA and Pakistan (Raulston, 1970; Shafique *et al.*, 2011). The use of MGB, POD, MPB, PAB, and PR would allow for the

availability of snapdragons to be extended if sown late. The adaptability of these cultivars should be verified in more locations or over more sowing dates to expand and fortify the floriculture industry in Pakistan. Finally, these cultivars may be equally cultivated in other countries or areas with the same subtropical climatic conditions as Punjab, Pakistan.

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