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PERFORMANCE OF VARIOUS SNAPDRAGON (*ANTIRRHINUM MAJUS* L.) CULTIVARS AS CUT FLOWER IN PUNJAB, PAKISTAN

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Abstract

Sixteen Snapdragon cultivars were imported from United States of America (PanAmerica Seeds, Chicago. IL) and were grown at University College of Agriculture, University of Sargodha, Sargodha for their outdoor field performance as cut flower production. Data were collected on various vegetative parameters (number of leaves per plant, plant height, number of secondary branches per plant, number of nodes per plant, stem fresh weight and stem dry weight) and flower spike (days for bud formation, days to bud opening, flower spike length, number of buds per spike). The experiment was laid out according to randomized complete block design (RCBD). The data regarding various growth parameters were analyzed by using standard statistical techniques. The studies revealed that Maryland White Yellow, Potomac Orange Dark, Maryland Golden Bronze, Maryland Pink True and Apollo Cinnamon cultivars of Snapdragon performed well for vegetative growth under existing environmental conditions and produced better quality flower spikes compared to other cultivars tested.

Introduction

The world trade of cut flowers runs in billions of dollars and Netherlands serves as the center of cut flower trade. Millions of flowers are sold through the auctions in Netherlands. At present cut flower production is a dynamic, global, fast growing industry which has achieved significant growth rate during the past few decades. In the 1950s, the global cut flower trade was less than 3 billion US dollars and by 1992, it had grown to 100 billion US dollars. In recent years, the flower industry is growing six percent annually and global volume of cut flower trade in 2003 was US$101.84 billion (Anon., 2010).

The cut flowers importing countries are Australia, Denmark, Dubai, France, Italy, Saudi Arabia, South Korea, Syria, Turkey, U.S.A. and United Kingdom and major suppliers of fresh cut flowers are Kenya, Columbia, Zimbabwe, Ecuador, Israel and India. Export of fresh cut flowers from Pakistan has been nominal except some sample exports. Pakistan started cut flowers export in 1996-97 for the first time and exported 87734 kg of cut flowers worth of 3.5l million rupees. It has been reported that cut flower export was increased up to 126354kg in 2001-02 which is worth rupees 8.0 million (Anon., 2003). Recently, it has been reported that Pakistan is earning 35 million rupees from cut flower export (Bashir, 2010). By observing this rapid growth in cut flower export, this business can become Pakistan's second largest export sector after textile if government of Pakistan encourages the cut flower growers by facilitating them to provide better technology in year-round production, refrigerated transportation and exploring more foreign markets.

Antirrhinum is a genus of plants commonly known as Snapdragons. Originally, Snapdragon is a summer flowering perennial in Mediterranean region. However, with the passage of time different hybrids were introduced which flower even in winter. Initially, Snapdragons were used only in landscape of parks and other open public places as in flowering beds or borders. Now-a-days, Snapdragon cultivars are classified into four different response groups because of their growth and flowering response in relation to temperature and day length (Ball, 1991; Rogers, 1992). These response groups can be manipulated as they can be grown in controlled conditions throughout the year in greenhouses as cut flower or in the open fields in the northern or southern areas as different cultivars require different times to produce crop in different seasons and in different growing areas (Sanderson & Link, 1967; Sanderson & Martin, 1984; Rogers, 1961).

Although Snapdragon is among one of the major flowers grown for its wide range of uses in the world but unfortunately trend of Snapdragon growing has not yet been established in Pakistan. Pakistan is only producing roses, gladiolus and tuberose as cut flower. To add more variety in cut flowers and availability of different Snapdragon cultivars at different times of the year, the seeds of different Snapdragon cultivars were imported from USA to check their field performance as cut flower under our local environmental conditions.

Materials and Methods

The research work was conducted at Horticultural Research Area, University College of Agriculture, University of Sargodha, Sargodha, Pakistan during 2009-2010. Seeds of 16 different exotic cultivars of Snapdragon, Apollo Cinnamon (AC), Apollo Purple (AP), Apollo Yellow (AY), Maryland Golden Bronze (MGB), Maryland Lavender (ML), Maryland Pink True (MPT), Maryland Plum Blossom (MPB), Maryland White Yellow (MWY), Monaco Rose (MR), Monaco Violet (MV), Monaco White (MW), Potomac Cherry Rose (PCR), Potomac Early Pink (PEP), Potomac Early Rose (PER), Potomac Orange Dark (POD) and Potomac Royal (P-ROY) were imported from Pan American Seed Company, Chicago, USA. Randomized Complete block design was used in this study with minimum of 200 plants of each cultivar per block. Seeds were sown on September 10, 2009 in trays for germination. Seedlings were transferred in plastic cups (250 ml) as soon as they attained the height of 5-6 cm. Peat moss (Pindstrup Faerdigblanding substrate) was used for seed germination and then in the cups. Nitrophos fertilizer (23:23% nitrogen and phosphorous) @ 50 g per liter of water was applied to the seedlings after the first week of transferring in the plastic cups and then combination of NPK (17:17:17% nitrogen, phosphorous and potassium) @ 150 g per liter of water was applied with an interval of three days. Plants were shifted from plastic cups to the field after 4 weeks. Before transplanting, Di-ammonium phosphate (DAP) @ 190 kg/ha., was added and thoroughly mixed by ploughing the field. Plot size for each block was 20 X 45 ft. There were 16 cultivars and 3 blocks. Cultivars were randomized in each block. Plant to plant and row to row distance of 10 cm was maintained in each cultivar and 2 ft in-between cultivars. For data collection, 10 plants were selected from the middle of each block to record different growth parameters. The dependent (response) variables i.e., vegetative parameters like number of leaves, number of secondary branches and number of nodes per plant were taken by counting, plant height was measured in cm with the help of measuring tape, stem diameter was measured in mm by digital vernier caliper, fresh plant weight and dry plant weight were taken by digital balance. Parameters of flowering spike as days for bud formation, days to bud opening were taken through counting the number of days after transplanting, spike length was measured by measuring tape in cm,

and number of buds per spike was taken by counting. All the experimental plants were maintained under similar agro-climatic condition. Regarding plant protection measures during the study, foliar spray of Ridomil (Matalaxyl+Mancozeb) @ 2.5 g per liter of water was done to control the damping off at seedling stage. After transplanting in the field, Bifenthrin and Amamactin @ 1 ml per liter of water were sprayed as and when needed to control the attack of some insects such as aphid, armyworm and some other caterpillars. The canal water was used for irrigation in the field with 10-14 days intervals.

The data were coded into the computer for further analysis. Statistical software R.2.11.2 by John and Sanford (2010) was used for analysis.

Results and Discussion

Vegetative parameters

Number of leaves: Leaves are well known for photosynthesis. During photosynthesis carbohydrates are produced in the leaves and then translocated to different growing/storage parts of the plant. Hence, leaves are a source of food manufacturing and growing parts of plant are working as sink. The presence of more number of leaves on a plant ensures better health and vigor of the plant. In this experiment significant differences were observed for number of leaves per plant among various cultivars (Table 1). The range for number of leaves per plant for different cultivars was 113.17 to 220.00. The maximum number of leaves was found in POD, MWY, P-ROY, MPB, MR, PER, MGB and ML cultivars with 220.00, 193.67, 190.67, 189.33, 84.92, 170.66, 170.25 and 170.17 leaves per plant respectively and were statistically at par with each other. The minimum number of leaves (113.17) was found in MPT cultivar. It is imperative to note that maximum numbers of leaves were found in those cultivars having more number of secondary branches such as POD, MWY and MPB. Similarly, least number of leaves was found in cultivars without secondary branches such as MPT and AP.

Number of nodes per plant: As it is evident in Table 1, the number of nodes per plant among various cultivars was found significant. The maximum number of nodes (42.92) was found in POD cultivar and minimum number of nodes (24.25, 24.50 & 25.00) was found in cultivar AC, MW and MPT respectively. The cultivars AC, MW and MPT were statistically at par with each other. The other cultivars were either overlapping with maximum number of nodes or minimum number of nodes per plant statistically.

Number of secondary branches: The results regarding the number of secondary branches on each cultivar are presented in Table 1. Highest numbers of secondary branches (44.00) were produced by POD cultivar however; it was statistically at par with P-ROY, MWY, MPB, AC and MW by producing 39.42, 33.47, 33.33, 30.67 and 26.5 numbers of secondary branches respectively. On the other extreme, no secondary branches were produced by the AP, PEP, MR, PCR, MPT, PER and MGB cultivars. It is evident from the data that Snapdragons can be divided into two groups i.e., cultivars with secondary branches (MV, AC, AY, MWY, ML, MW, POD, MPB and P-ROY) and cultivars without secondary branches (AP, PEP, MR, PCR, MPT, PER and MGB). It is further observed that cultivars having secondary branches showed less spike length compared to those without secondary branches with some exceptions like MWY, AC, POD and MPB cultivars which showed better performance on producing number of secondary branches and spike length.

Table 1. Number of leaves, number of nodes, number of secondary branches, plant height, fresh and dry weight of different snapdragon cultivars grown in Sargodha in 2009-10.

Name of cultivar*	No. of leaves per plant	No. of nodes per plant	No. of secondary branches per plant	Plant height (cm)	Fresh weight per plant (g)	Dry weight per plant (g)
MV	164.75c	30.42ab	10.00cd	51.92c	31.01b	6.52c
AP	135.00d	31.42ab	0.00d	49.50c	27.66b	7.24bc
AC	149.67cd	24.25b	30.67abc	59.75b	38.19ab	9.86abc
AY	130.00d	27.67ab	10.67cd	58.33b	28.72b	7.96bc
PEP	152.33cd	34.42ab	0.00d	68.58ab	39.83ab	9.83abc
MWY	193.67a	31.83ab	33.47abc	74.00a	68.96a	14.33a
MR	184.92ab	35.08ab	0.00d	55.50b	34.43ab	8.32bc
PCR	161.33c	30.00ab	0.00d	52.58bc	38.04ab	10.05abc
MPT	113.17e	25.00b	0.00d	65.67ab	32.89ab	7.97bc
PER	170.66ab	35.40ab	0.00d	65.92ab	37.60ab	8.78bc
ML	170.17ab	33.42ab	12.33bcd	70.67a	42.95ab	10.42abc
MW	129.52d	24. 50b	26.5abcd	50.00c	34.93ab	7.30bc
POD	220.00a	42.92a	44.00 a	68.75ab	58.06ab	12.07ab
MGB	170.25ab	30.25ab	0.00 d	70.08a	26.58b	7.64bc
MPB	189.33a	31.58ab	33.33abc	53.58bc	39.26ab	9.60abc
P-ROY	190.67a	38.50ab	39.42 ab	56.92b	43.37ab	9.49 abc

Value in columns followed by the same letter are not significantly different at $p \leq 0.05$. Values are least square means of at least 3 replications.

*Abbreviation for name of snapdragon cultivars : Apollo Cinnamon (AC), Apollo purple (AP), Apollo Yellow (AY), Maryland Golden Bronze (MGB), Maryland Lavender (ML), Maryland Pink True (MPT), Maryland Plum Blossom (MPB), Maryland White Yellow (MWY), Monaco Rose (MR), Monaco Violet (MV), Monaco White (MW), Potomac Cherry Rose (PCR), Potomac Early Pink (PEP), Potomac Early Rose (PER), Potomac Orange Dark (POD) and Potomac Royal (P-ROY)

Plant height: Plant height is an important factor from commercial cut flower production point of view. The results for plant height for different Snapdragon cultivars are presented in Table 1. Cultivars MWY, ML and MGB attained maximum height of 74.00, 70.67 and 70.08 cm respectively but were statistically at par with each other. Cultivar AP attained the minimum height of 49.50 cm which was statistically at par with MW and MV by attaining the height of 50.00 and 51.92 cm respectively. The other cultivars were mediocre in attaining plant height. Considering plant height in relation to flower spike length, it was observed that the cultivars with maximum plant height (MWY, ML and MGB) have also produced longer flower spike as compared to cultivars with smaller heights. Although, cultivars AP and P-ROY were short in stature but were very stout and were resistant to lodging in field production. Furthermore, flower spikes were straight in these cultivars compared to larger spikes which were slightly bending from the top.

Fresh weight per plant: Fresh weight is an important measure to assess the vegetative growth performance of a crop. This quantitative parameter had shown statistically significant results for various cultivars as presented in Table 1. The maximum fresh weight per plant of 68.96 g was obtained for cultivar MWY. On the other hand, cultivar MGB gained the minimum fresh weight of 26.58 g followed by cultivar AP, AY and MV by gaining 27.66, 28.72 and 31.01 g fresh weight respectively but was statistically at par with each other. Other cultivars were mediocre in gaining fresh weight to these extremes. It is apparent that cultivars with more number of secondary branches (MWY, POD and P-ROY) gained more fresh weight compared to without secondary braches (MGB, AP and MPT). This behavior was evident because the secondary branches having extra leaves manufactured more food which ultimately contributes towards fresh weight.

Dry weight per plant: Dry weight of the plant depicts that how efficiently the plant has absorbed the water and minerals and used them to produce the biomass with assimilation. The results regarding dry weight per plant were statistically significant among various cultivars (Table 1). Cultivar MWY produced maximum dry weight per plant (14.33 g) and cultivar MV produced the minimum dry weight per plant (6.52 g). The dry weight per plant for other cultivars was in between these two values.

Flowering spike characteristics

Days for flower bud formation: The number of days required to initiate flower bud are very important to decide cultivar's flower production overtime under the existing environmental conditions. The results regarding this parameter are presented in Table 2. The numbers of days required for flower bud formation in different cultivars of Snapdragon range between 125.67 to 132.67 days and were statistically non-significant. It is evident from the table that least number of days (125.67) was required for flower bud formation by PCR cultivar and more numbers of days (132.67) were required for flower bud formation by MGB cultivar. Our results are in consonance with that of Munir *et al*., (2010) as they recently reported that *Antirrhinum* cultivars are not sensitive to photoperiod during their entire course of growth and development and require 4-8 days of photoperiod at critical phase for flowering.

Table 2. Days for flower bud formation, flower bud opening, flower spike length and number of buds per spike of different snapdragon cultivars grown in Sargodha in 2009-10.

Name of cultivar*	Days for bud formation	Days to bud opening	Flower spike length (cm)	Number of buds per spike
MV	127.33	135.00	15.67ab	38.58b
AP	127.67	134.00	14.42ab	30.92c
AC	130.00	135.33	24.67a	42.00ab
AY	126.33	136.67	17.08ab	32.92c
PEP	128.67	134.00	20.08ab	38.50b
MWY	126.67	135.00	22.17b	43.42ab
MR	131.33	137.67	16.92ab	36.50bc
PCR	125.67	134.33	15.47ab	35.75bc
MPT	131.00	140.33	27.17 a	46.33a
PER	128.67	137.67	16.58ab	33.67c
ML	126.33	136.33	16.75ab	31.00c
MW	129.00	136.67	16.42ab	33.42c
POD	127.33	135.67	17.00ab	39.33b
MGB	132.67	143.00	24.00a	42.08ab
MPB	127.67	135.00	16.33ab	31.83c
P-ROY	130.33	139.33	12.75 c	24.58d

Value in columns followed by the same letter are not significantly different at $P \leq 0.05$. Values are least square means of at least 3 replications.

*Abbreviation for name of snapdragon cultivars : Apollo Cinnamon (AC), Apollo purple (AP), Apollo Yellow (AY), Maryland Golden Bronze (MGB), Maryland Lavender (ML), Maryland Pink True (MPT), Maryland Plum Blossom (MPB), Maryland White Yellow (MWY), Monaco Rose (MR), Monaco Violet (MV), Monaco White (MW), Potomac Cherry Rose (PCR), Potomac Early Pink (PEP), Potomac Early Rose (PER), Potomac Orange Dark (POD) and Potomac Royal (P-ROY)

Days to bud opening: Results of this character depicted non-significant results for various cultivars. The days required for bud opening for various cultivars were ranging from 134.00 to 143.00 days (Table 2). Although the results were non-significant but even then early bud opening was observed in the cultivars AP and PEP while late bud opening was noted in case of cultivar MGB.

Flower spike length: Flower spike length is an important factor in commercial cut flower production. Maximum flower spike length of 27.17 cm was found in cultivar MPT followed by 24.67 and 24.00 cm in cultivars AC and MGB respectively. However, their means for flower spike length were statistically non-significant with each other (Table 2). The minimum flower spike length of 12.75 cm was observed in cultivar P-ROY. It is apparent from the data that different Snapdragon cultivars produced variable flower spike length under our local environmental conditions. Similar results have been reported by Raulston (1970) who also studied the field performance of various Snapdragon cultivars under Florida field conditions. The difference in flower spike length is not only influenced by their genetic makeup but local environmental conditions during production time and soil nutrition also play a vital role on the growth and development of Snapdragon cultivars (Creel & Kessler, 2007).

Number of flower buds per spike: The data regarding number of flower bud per spike for different cultivars is presented in Table 2. The maximum number of 46.33 flower buds per spike was observed in cultivar MPT and least number of 24.58 flower buds per spike in cultivar P-ROY and was significantly different from one another. The other cultivars produced number of flower buds per spike in between of above mentioned means and overlapping either to the highest number or lowest number for flower buds per spike. It has been observed that there is a positive correlation between the flower spike length and number of flower buds per spike i.e., cultivars with longer flower spike (MPT, AC, MGB, MWY) produced more flower buds per spike as compared to cultivars with shorter flower spike length (P-ROY and AP).

Conclusion

Our studies revealed that MWY, POD, MGB, MPT and AC cultivars of Snapdragon performed well for vegetative growth and produced good quality flower spike and proved their superiority over the other cultivars. These are reliable cultivars for flower industry/business of Pakistan as they performed better than other cultivars for plant height, number of leaves, number of secondary branches, spike length and number of flower buds per spike. So these cultivars may be used for cultivation in Punjab, Pakistan under sub-tropical environmental conditions. It is of particular interest that cultivar AC performed well for spike length and number of flower buds per spike despite having less number of leaves and plant height due to this AC may have resistance against lodging in the field. We hope this study will provide baseline for research in genetic evaluation of Snapdragon in Pakistan. As reported by Rogers (1992), Snapdragon cultivars are classified into 4 different groups based on their flowering response to temperature and day-length, there is a dire need to conduct a systematic study to find out the best time of sowing and their flowering behavior overtime under different environmental conditions for regular supply of cut Snapdragons in the country.

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