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Original Research Article

Evaluation of Inbreds and Their F_1s For Flowering and Post-Harvest Attributes in Snapdragon (*Antirrhinum majus* L.)

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ABSTRACT

The present investigation was carried out in half diallel crossing pattern using ten parental lines (AG-1, AG-2, AG-3, AG-4, AG-5, AG-6, Vilmorin, SA-1, Sant-11 and Sant-22) to evaluate the diversity created. The evaluation of F_1s was done in two years 2016-2017 and 2017-2018 for flowering and post-harvest characters. The experimental material (10 parents and 45 F_1s) was planted in Randomized Block Design. Twelve stems of each genotype were cut to 8 cm from the ground and placed in distilled water. Stems were discarded when last floret was about to wilt. Significant differences were noted among the genotypes for all the characters in both years. Among different genotypes of snapdragon, diameter of spike ranged from 4.29 to 12.61 mm. Maximum spike weight was observed in SA-1 × AG-4. This also gave highest number of open florets/spike and maximum weight of spike at senescence. Spike length was found to be maximum with SA-1, which was at par with SA-1 × AG-4. The maximum diameter of florets was recorded with AG-1 × Vilmorin, whereas maximum number of spikes per plant for cut-flower was recorded with AG-3 × AG-5. The cross AG-1 × Sant-11 was resulted in maximum number of florets per spike during both the years. However no definite pattern followed in per cent opening of florets. Vase life ranged from 11.00 days to 14.45 days during first year. Whereas in second year, it varied from 10.22 days to 21.50 days. This variation in range may be due to insect infestation occurred more during first year.

***Key words*:** Snapdragon, *Antirrhinum majus*, Evaluation, Flowering, Post-harvest

INTRODUCTION

Snapdragon (*Antirrhinum majus*), also known as dog flower, is one of the most demanding winter annual flowering plant. The genus belongs to family Scrophulariaceae. It is widely grown as bedding plant in small and big gardens and is now becoming popular as a cut flower worldwide due to attractive colour and long vase life. Flowers have good keeping quality and they remain fresh from 6 to 25 days (Martin and Stimart, 2003). Novelty is always in demand in floricultural crops and to improve the genotypes for cut flowers is the present day need to fulfill the demand of national and international market. There is enough variability present in snapdragon in terms of flowering and post-harvest parameters. The use of chemicals in floriculture industry perhaps may improve the quality and vase life of lowers, but their use ultimately shows several direct or indirect impacts on health and environment. Most of these chemicals are carcinogenic in nature and toxic in low concentration. They also remain for longer time in the environment (Nell, 1992 and Ohkawa *et al*., 1999). Thus, it becomes necessary to sort out some alternative method to enhance vase life. Harnessing the hybrid vigour through hybridization and selection is one of the safest and ecofriendly method to explore the quality flowers and higher vase life (Stieve and Stimart, 1994 and Stimart and Shroeder, 1999). However, it is the easiest way to improve cut flower quality, limited efforts has only recently been shifted towards this approach. Variability for vase life has been earlier noticed in *Antirrhinum majus* (Stieve and Stimart, 1994 and Martin and Stimart, 2003), Begonia × Cheimantha Everett (Hvoslef-Eide *et al*., 1995), *Callistephus chinensis* (Patil and Rane, 1999), Eustoma sp. Raf. (Ohkawa and Sasaki, 1999), *Leptosermum* sp. (Bicknell, 1995), *Limonium* sp. (Burge *et al*., 1998), *Lupinus havardii* Wats (Mackay and Davis, 1998), Paeonia sp. (Heuser and Evensen, 1986) and genera of Proteaceae family (Joyce and Bael, 1999). Therefore, the present study was undertaken to find out variability for selecting improved genotypes among various inbreds and their F_1 hybrids for super quality cut flowers of *Antirrhinum majus*.

MATERIALS AND METHODS

The present study was undertaken with ten inbreds and their 45 crosses of *Antirrhinum majus* L. to evaluate the present variability for further selection. The experiment was conducted at Horticulture Research Block of School of Agricultural Sciences, Shri Guru Ram Rai University, Dehradun, Uttarakhand during 2016-17 and 2017-18. Post-harvest study of cut flowers was carried out in the post-harvest lab of Department of Horticulture. During 2016-17, four varieties were collected from different parts of India, whereas six inbreds were selected at Dehradun developed from continuous selfing since last 5 year. These ten parental lines of snapdragon were crossed in diallel mating design, reciprocals were excluded (Griffing, 1956). Thus, seeds of these fifty five inbreds and hybrids were sown on 14th October, 2016 and 2017 in the pots containing soil mixture of 1:1:1 ratio of soil, sand and farmyard manure, respectively. Developed seedlings were transplanted into main field after 40 days of sowing at 50 × 50 cm distance. Farmyard manure, phosphorus and potassium were applied one day before transplanting at 5 kg/m^2, 20 g/m^2 and 15 g/m^2, respectively. Nitrogen at 15g/m^2 was given after one month of transplanting and second dose of N at 15 g/m^2 was top dressed at bud initiation stage. Irrigation was provided at 15-20 days interval. A regular care and maintenance of plants was done during the experiment and all practices were adopted uniformly to plants of all the genotypes. The experiment was laid out in a randomized block design with three replications. To study the post-harvest life of flowers, spikes of snapdragon were harvested when one third of the florets opened. Harvesting of spikes was done at 8 cm above the ground. Harvested spikes were immediately placed in distilled water and transported to the post-harvest laboratory. Spikes wee again re-cut and six leaves from the top were left and remaining lower portion leaves were removed. Then spikes were placed in bottle containing measured distilled water for post-harvest study. Observations on diameter of spike, weight of spike, spike length, diameter of floret, number of spikes/plant of cut flower value, number of florets/spike, number of open florets/spike, per cent opening of florets, weight of spike at senescence, water uptake, per cent weight loss of spike and vase life were recorded. The analysis of variance for each character was carried out as suggested by Panse and Sukhatme (1969).

RESULTS AND DISCUSSION

Overall the F_1s performed better in comparison to inbreds for various flowering and post-harvest parameters except length of spike. All these parameters varied significantly in different genotypes. The inbreds performed better in terms of various flowering and post-harvest characteristics also resulted in better F1s when crossed with inbreds showed average performance. For several characters, all genotypes showed similar results in both years, while some of them did not follow the same trend in both years. Therefore, the average performance of all the characters is necessary to see the overall variation present among genotypes. Diameter of spike varied from 4.29 mm (AG-2 × AG-3) to 12.61 mm (AG-3 × Sant-22) in first year and in second year, same trend was followed. Both parents in AG-3 × Sant-22 showed the poor or average performance of diameter of spike.

Table 1: Diameter of spike, weight of spike, spike length as influenced by parents and F_1s of snapdragon

Parent and F_1	Diameter of spike (mm)		Weight of spike (g)		Spike length (cm)	
	I year	II year	I year	II year	I year	II year
AG-1	7.05	7.15	21.17	25.73	45.70	34.10
AG-1 × AG-2	7.21	7.28	18.21	18.87	48.86	24.80
AG-1 × AG-3	6.27	6.38	22.67	16.89	45.95	31.50
AG-1 × Vilmorin	10.24	10.30	32.14	39.84	58.91	57.22
AG-1 × SA-1	8.55	8.65	24.61	36.07	54.73	44.57
AG-1 × AG-4	7.19	7.27	32.83	20.72	54.62	32.51
AG-1 × Sant-11	8.32	8.42	26.56	29.46	55.63	48.39
AG-1 × AG-5	8.03	8.10	29.94	22.11	28.39	46.91
AG-1 × Sant-22	8.54	8.62	29.63	28.43	44.33	40.90
AG-1 × AG-6	9.25	9.29	25.29	16.11	43.26	41.25
AG-2	7.39	7.44	18.55	13.30	28.80	27.03
AG-2 × AG-3	4.29	4.36	18.55	13.00	33.33	32.97
AG-2 × Vilmorin	9.20	9.30	22.67	21.52	43.20	43.03
AG-2 × SA-1	8.97	9.03	11.06	13.46	24.56	30.12
AG-2 × AG-4	7.30	7.40	18.35	19.17	34.33	33.17
AG-2 × Sant-11	7.00	7.10	18.07	13.90	34.30	40.90
AG-2 × AG-5	5.40	5.46	16.61	11.46	27.13	27.75
AG-2 × Sant -22	6.07	6.11	20.48	17.02	34.30	31.86
AG-2 × AG-6	4.67	4.75	15.67	13.28	32.80	33.06
AG-3	4.37	4.47	15.67	13.28	34.53	20.50
AG-3 × Vilmorin	6.36	6.46	29.72	20.30	45.16	50.61
AG-3 × SA-1	6.39	6.47	22.67	20.58	41.26	40.25
AG-3 × AG-4	6.96	7.05	23.70	20.77	35.70	33.38
AG-3 × Sant-11	6.51	6.61	10.44	19.40	36.13	33.00
AG-3 × AG-5	6.93	7.03	13.29	20.13	26.20	34.81
AG-3 × Sant-22	12.61	12.71	19.33	17.87	35.13	40.01
AG-3 × AG-6	6.33	6.43	17.17	12.06	39.20	41.08
Vilmorin	9.20	9.29	29.65	36.97	61.66	63.41
Vilmorin × SA-1	8.80	8.90	26.17	38.51	48.60	62.87
Vilmorin × AG-4	8.18	8.25	24.67	22.72	54.26	66.00
Vilmorin × Sant-11	10.08	10.18	17.03	26.84	58.26	44.25
Vilmorin × AG-5	6.99	7.05	28.09	20.69	52.70	52.55
Vilmorin × Sant-22	7.03	7.12	28.60	24.54	62.16	65.60
Vilmorin × AG-6	9.65	9.73	29.13	21.38	52.20	66.25
SA-1	10.07	10.16	18.67	41.88	76.00	73.41
SA-1 × AG-4	6.71	6.78	36.82	48.60	66.03	71.16
SA-1 × Sant-11	7.23	7.32	17.31	19.39	44.13	43.43
SA-1 × AG-5	7.17	7.24	20.36	22.47	54.50	57.40
SA-1 × Sant-22	5.37	5.45	27.00	21.58	23.06	29.50
SA-1 × AG-6	7.22	7.32	17.01	21.58	51.56	52.96
AG-4	7.12	7.17	33.73	17.26	58.53	59.91
AG-4 × Sant-11	8.39	8.47	20.36	24.55	51.59	55.00
AG-4 × AG-5	8.68	8.76	25.67	19.63	50.56	52.46
AG-4 × Sant-22	7.57	7.65	33.58	30.09	59.66	63.67
AG-4 × AG-6	6.15	6.26	28.67	13.71	32.60	32.93
Sant-11	10.39	10.43	21.19	12.98	46.70	44.01
Sant-11 × AG-5	10.32	10.39	20.00	30.02	35.43	55.66
Sant-11× Sant-22	11.14	11.23	16.22	35.14	45.96	55.12
Sant-11 × AG-6	6.27	6.36	20.29	22.25	45.33	61.12
AG-5	9.05	9.12	24.69	10.61	38.90	31.36
AG-5 × Sant-22	8.23	8.32	29.46	12.01	26.10	22.41
AG-5 × AG-6	8.58	8.65	23.22	23.95	38.60	69.98
Sant-22	8.07	8.15	32.78	30.13	70.76	52.62
Sant-22 × AG-6	6.44	6.50	21.28	21.91	32.20	29.57
AG-6	6.21	6.28	22.67	18.58	26.63	22.81
C.D. at 5%	0.57	0.57	15.58	3.37	2.72	4.11

Table 2: Performance of parents and F_1s of snapdragon on diameter of floret, spikes/plant of cut flower value and florets/spike

Parent and F_1	Diameter of floret (cm)		Spikes/plant of cut flower value		Florets/spike	
	I year	II year	I year	II year	I year	II year
AG-1	4.02	3.87	7.27	7.97	32.55	43.40
AG-1 × AG-2	3.57	3.50	14.03	15.00	34.33	45.03
AG-1 × AG-3	3.56	3.27	7.93	8.67	43.78	39.03
AG-1 × Vilmorin	4.40	4.60	9.63	10.57	39.55	57.00
AG-1 × SA-1	3.56	3.57	10.75	11.42	51.44	59.33
AG-1 × AG-4	3.74	3.73	10.65	11.37	54.33	43.00
AG-1 × Sant-11	3.92	3.87	10.43	11.00	55.66	60.33
AG-1 × AG-5	3.83	3.47	12.50	14.00	30.33	34.40
AG-1 × Sant-22	3.78	3.63	11.43	11.50	34.66	44.42
AG-1 × AG-6	3.27	3.10	11.40	12.00	31.44	26.03
AG-2	3.38	3.13	12.43	12.33	20.55	23.75
AG-2 × AG-3	3.48	3.43	8.10	8.67	21.99	22.67
AG-2 × Vilmorin	4.00	3.90	9.03	9.67	24.89	55.43
AG-2 × SA-1	4.23	3.90	8.73	9.00	21.22	22.23
AG-2 × AG-4	3.78	3.63	9.77	10.33	21.11	22.73
AG-2 × Sant-11	3.45	3.24	12.45	13.00	22.22	23.13
AG-2 × AG-5	3.94	4.03	9.50	10.00	20.55	21.83
AG-2 × Sant -22	3.50	3.30	8.40	9.00	23.77	24.40
AG-2 × AG-6	3.62	3.47	9.37	10.00	20.00	35.40
AG-3	3.58	3.43	9.40	10.00	36.11	26.58
AG-3 × Vilmorin	3.69	3.67	7.42	8.00	37.89	38.57
AG-3 × SA-1	3.49	3.37	9.15	9.67	35.33	36.41
AG-3 × AG-4	3.53	3.40	8.60	9.00	39.88	40.50
AG-3 × Sant-11	3.49	3.37	10.63	11.33	35.89	55.25
AG-3 × AG-5	3.67	3.50	18.34	19.04	32.33	36.43
AG-3 × Sant-22	3.50	3.40	14.83	15.53	34.55	34.50
AG-3 × AG-6	3.56	3.37	13.63	14.33	36.00	36.43
Vilmorin	3.59	3.37	7.80	8.50	43.33	55.00
Vilmorin × SA-1	3.99	4.07	6.30	7.00	45.55	40.40
Vilmorin × AG-4	3.68	3.35	7.97	8.67	45.11	34.73
Vilmorin × Sant-11	3.87	4.00	14.13	14.83	43.44	57.92
Vilmorin × AG-5	3.71	3.34	6.80	7.50	34.11	42.53
Vilmorin × Sant-22	3.71	3.63	13.30	14.00	39.22	39.03
Vilmorin × AG-6	3.73	3.60	10.63	11.33	25.55	49.40
SA-1	3.04	2.63	7.47	8.17	54.77	41.00
SA-1 × AG-4	3.58	3.33	10.30	11.00	40.55	48.15
SA-1 × Sant-11	3.60	3.50	7.97	8.67	43.66	46.07
SA-1 × AG-5	4.03	4.10	9.30	10.00	41.55	42.00
SA-1 × Sant-22	3.56	3.37	10.30	11.00	27.33	29.03
SA-1 × AG-6	2.79	2.36	8.97	9.67	26.22	35.00
AG-4	3.33	3.10	9.30	10.00	40.89	46.57
AG-4 × Sant-11	3.61	3.34	7.50	8.20	13.77	44.67
AG-4 × AG-5	3.03	2.60	6.30	7.00	38.89	41.17
AG-4 × Sant-22	3.38	3.13	6.97	7.67	35.33	38.50
AG-4 × AG-6	3.16	2.77	7.63	8.33	30.33	33.78
Sant-11	3.47	3.30	9.63	10.33	25.66	27.97
Sant-11 × AG-5	3.54	3.43	15.13	15.83	32.67	45.60
Sant-11× Sant-22	3.73	3.60	11.30	12.00	31.33	48.63
Sant-11 × AG-6	2.60	2.44	8.30	9.00	31.66	45.50
AG-5	3.50	3.30	6.30	7.00	22.33	41.10
AG-5 × Sant-22	3.12	3.07	8.63	9.33	24.22	29.17
AG-5 × AG-6	3.37	3.10	9.80	10.50	25.00	35.70
Sant-22	3.77	3.70	8.30	9.00	31.00	38.10
Sant-22 × AG-6	3.52	3.27	7.63	8.33	23.55	35.73
AG-6	2.91	2.73	5.97	6.67	17.00	24.70
C.D. at 5%	0.40	0.39	2.79	2.76	3.13	4.28

Maximum weight of spike, weight of spike at senescence and water uptake during both years and maximum number of open florets in vase and vase life during first year were recorded with SA-1 × AG-4. The cross SA-1 × AG-4 was at par with Vilmorin × Sant-11 and Sant-11 × AG-6 during I year for number of open florets/spike, while for second year, it was at par with AG-5 × AG-6, Sant-11 × AG-5 and SA-1 × AG-4. Whereas the cross SA-1 × AG-4 was significantly different from the other genotypes during both the years for weight of spike at senescence and for water uptake. The widest florets were observed with AG-1 × Vilmorin in both years, which was statistically at par with AG-2 × SA-1and SA-1× AG-5 in the first year and with SA-1 × AG-5 in second year. For commercial and economic point of view it is necessary that genotype must have more number of spikes of cut flower value. Such type of genotype in the present study was selected as AG-3 × AG-5, which resulted into maximum number of spikes of cut flower value in both years. This was followed by Sant-11 × AG-5, AG-3 × Sant-22 and Vilmorin × Sant-11. Higher floret density always attracts and improves the beauty of spike.

Table 3: Evaluation of parents and F_1s of snapdragon on the basis of open florets/spike, per cent opening of florets and weight of spike at senescence

Parent and F_1	Open florets/spike		Per cent opening of florets		Weight of spike at senescence (g)	
	I year	II year	I year	II year	I year	II year
AG-1	16.00	20.16	70.95	77.00	19.67	13.43
AG-1 × AG-2	14.17	16.89	64.08	60.98	18.67	11.44
AG-1 × AG-3	13.50	16.00	56.35	76.40	16.67	5.90
AG-1 × Vilmorin	17.50	16.82	57.43	49.16	30.50	26.66
AG-1 × SA-1	19.83	19.22	67.70	69.17	30.33	16.06
AG-1 × AG-4	20.83	11.67	72.29	60.15	21.83	14.81
AG-1 × Sant-11	19.00	22.81	80.78	88.53	17.50	17.45
AG-1 × AG-5	17.17	21.27	70.88	73.06	19.50	14.80
AG-1 × Sant-22	18.17	17.50	63.39	81.23	25.50	15.91
AG-1 × AG-6	18.67	12.75	68.73	75.07	13.67	7.20
AG-2	16.07	18.53	80.34	79.82	10.67	10.25
AG-2 × AG-3	18.33	19.91	84.01	88.92	8.83	11.90
AG-2 × Vilmorin	14.67	14.48	64.09	67.02	17.83	15.05
AG-2 × SA-1	14.06	16.42	73.24	67.99	6.50	10.41
AG-2 × AG-4	18.67	19.61	81.31	90.86	13.83	17.50
AG-2 × Sant-11	18.50	17.07	79.07	78.39	13.17	14.66
AG-2 × AG-5	15.90	20.56	68.61	81.74	10.33	13.65
AG-2 × Sant -22	14.50	17.53	62.74	82.95	12.83	12.05
AG-2 × AG-6	11.17	13.22	61.49	70.71	13.50	11.07
AG-3	12.17	15.30	57.09	79.79	11.00	6.92
AG-3 × Vilmorin	14.67	17.48	46.33	48.62	16.83	11.37
AG-3 × SA-1	22.17	19.00	81.21	70.45	12.17	11.70
AG-3 × AG-4	15.17	18.23	55.99	76.79	16.67	12.15
AG-3 × Sant-11	14.17	15.68	69.09	74.35	9.67	12.29
AG-3 × AG-5	13.33	22.09	52.31	73.99	12.50	15.56
AG-3 × Sant-22	15.33	19.78	57.92	71.13	15.00	15.56
AG-3 × AG-6	16.83	22.16	68.66	97.12	7.00	7.01
Vilmorin	17.33	21.51	63.59	74.52	31.67	31.02
Vilmorin × SA-1	18.83	20.72	70.67	64.60	17.17	23.30
Vilmorin × AG-4	18.23	27.33	69.39	80.98	25.17	16.35
Vilmorin × Sant-11	24.47	17.16	77.78	73.63	14.83	17.67
Vilmorin × AG-5	20.50	18.73	70.69	73.71	26.00	12.02
Vilmorin × Sant-22	18.22	17.50	64.71	82.18	21.00	9.67
Vilmorin × AG-6	17.00	14.23	71.15	72.28	23.83	15.08
SA-1	14.67	19.83	59.64	71.27	14.33	32.75
SA-1 × AG-4	25.33	25.16	80.01	82.80	42.67	41.06
SA-1 × Sant-11	14.67	17.53	47.59	53.99	14.33	15.50
SA-1 × AG-5	16.39	17.52	57.86	52.48	18.00	15.25
SA-1 × Sant-22	10.95	11.37	61.62	73.11	24.00	19.81
SA-1 × AG-6	18.50	17.33	77.70	95.22	20.33	13.35
AG-4	19.28	20.66	70.53	75.24	18.17	15.00
AG-4 × Sant-11	12.33	12.61	77.89	76.18	18.83	11.50
AG-4 × AG-5	17.17	18.61	63.16	73.14	17.17	14.37
AG-4 × Sant-22	20.00	22.43	65.46	76.14	34.33	31.22
AG-4 × AG-6	16.06	22.06	78.03	86.11	15.50	13.57
Sant-11	16.67	18.36	81.90	69.28	14.33	12.56
Sant-11 × AG-5	17.80	26.00	69.25	71.54	12.83	13.74
Sant-11× Sant-22	15.27	19.23	58.35	70.62	14.00	12.70
Sant-11 × AG-6	24.17	23.16	75.20	68.09	11.67	12.50
AG-5	16.00	20.91	71.28	63.24	9.17	8.87
AG-5 × Sant-22	10.83	13.37	64.44	65.73	11.33	8.32
AG-5 × AG-6	11.89	26.68	60.32	77.27	9.67	19.50
Sant-22	16.40	18.29	71.39	70.94	27.33	13.95
Sant-22 × AG-6	14.67	18.79	75.05	94.28	18.67	13.62
AG-6	10.00	14.56	64.05	79.96	13.17	15.13
C.D. at 5%	1.53	2.78	8.39	4.89	3.44	3.05

Table 4: Water uptake, weight loss and vase life influenced by parents and F_1s of snapdragon

Parent and F_1	Water uptake (ml)		Weight loss (%)		Vase life (days)	
	I year	II year	I year	II year	I year	II year
AG-1	44.33	56.00	20.67	51.85	12.00	13.50
AG-1 × AG-2	42.33	26.00	21.18	47.86	13.00	13.00
AG-1 × AG-3	38.33	34.00	32.96	53.61	13.17	17.00
AG-1 × Vilmorin	54.50	53.50	26.44	31.90	13.00	15.00
AG-1 × SA-1	50.33	52.00	12.91	42.19	14.22	17.00
AG-1 × AG-4	39.67	73.50	31.27	33.71	12.28	16.00
AG-1 × Sant-11	40.50	44.00	33.24	22.80	12.00	17.50
AG-1 × AG-5	41.00	28.50	39.61	42.31	13.11	13.00
AG-1 × Sant-22	43.33	46.50	26.80	50.73	12.44	18.16
AG-1 × AG-6	50.33	22.00	36.55	54.64	12.45	16.00
AG-2	41.57	42.37	30.84	22.21	11.78	16.12
AG-2 × AG-3	46.83	42.97	38.76	23.40	12.68	17.22
AG-2 × Vilmorin	51.67	52.81	24.91	40.69	13.56	13.66
AG-2 × SA-1	41.22	36.51	25.17	17.64	13.22	17.42
AG-2 × AG-4	43.02	35.22	23.53	17.64	12.89	15.00
AG-2 × Sant-11	51.00	52.26	28.63	16.63	12.89	13.66
AG-2 × AG-5	50.40	43.56	29.05	19.47	13.22	15.76
AG-2 × Sant -22	35.10	34.26	33.04	10.58	12.44	16.82
AG-2 × AG-6	37.81	32.28	18.87	13.96	13.55	10.22
AG-3	44.33	42.00	28.59	56.56	13.56	18.50
AG-3 × Vilmorin	53.08	52.24	38.08	38.23	13.22	13.61
AG-3 × SA-1	44.05	31.50	34.86	42.46	12.22	14.50
AG-3 × AG-4	55.67	38.50	27.77	46.42	14.00	13.00
AG-3 × Sant-11	35.67	36.50	15.57	45.28	12.33	15.50
AG-3 × AG-5	37.50	33.00	25.14	48.42	14.22	14.00
AG-3 × Sant-22	51.12	22.50	21.68	21.81	12.44	17.50
AG-3 × AG-6	43.83	39.35	34.23	41.53	11.44	15.91
Vilmorin	50.11	37.55	18.52	22.83	12.22	18.06
Vilmorin × SA-1	36.56	80.50	30.61	37.36	13.68	12.62
Vilmorin × AG-4	45.67	53.50	20.73	29.43	13.78	15.00
Vilmorin × Sant-11	51.72	43.50	19.67	33.16	13.11	21.50
Vilmorin × AG-5	35.19	37.50	20.65	47.76	12.56	15.50
Vilmorin × Sant-22	45.82	48.00	39.64	63.44	12.33	14.00
Vilmorin × AG-6	50.14	31.50	25.94	36.97	13.89	16.50
SA-1	40.83	68.50	32.59	39.65	11.00	12.50
SA-1 × AG-4	115.99	90.96	21.25	10.41	14.45	17.34
SA-1 × Sant-11	83.50	82.06	22.14	27.34	13.89	19.66
SA-1 × AG-5	46.21	46.92	22.11	21.38	12.42	18.66
SA-1 × Sant-22	46.33	43.38	26.00	7.39	11.56	20.16
SA-1 × AG-6	47.51	31.00	9.74	49.28	12.44	16.50
AG-4	48.67	33.00	41.44	27.93	12.56	18.00
AG-4 × Sant-11	55.65	55.66	20.99	61.44	13.78	15.50
AG-4 × AG-5	47.56	47.99	29.72	27.23	12.33	15.17
AG-4 × Sant-22	43.88	41.31	22.11	7.84	14.22	13.24
AG-4 × AG-6	55.55	46.46	35.31	34.48	12.89	11.12
Sant-11	47.36	42.47	25.22	40.65	12.00	16.16
Sant-11 × AG-5	50.05	44.50	31.89	62.27	12.50	11.50
Sant-11× Sant-22	54.87	63.50	19.58	67.34	13.56	12.50
Sant-11 × AG-6	45.61	23.00	30.41	44.34	12.89	20.00
AG-5	30.85	28.52	36.92	28.61	11.55	21.12
AG-5 × Sant-22	34.88	61.50	39.15	43.53	12.11	21.50
AG-5 × AG-6	46.93	85.00	39.12	33.44	12.33	17.50
Sant-22	55.77	46.56	27.59	60.72	11.78	19.16
Sant-22 × AG-6	58.86	44.71	21.72	26.33	13.22	15.16
AG-6	34.29	23.91	34.74	20.88	11.22	11.26
C.D. at 5%	4.97	5.04	14.20	3.26	0.72	4.09

This is directly related to more number of flowers/spike (Robinowitch *et al.*, 1977). The maximum number of florets/spikes was observed in AG-1 × Sant-11 during both the years. This was followed by SA-1 and AG-1 × SA-1 during first year and by AG-1 × SA-1 and Vilmorin × Sant-11 during second year. The lesser loss in spike weight was indirectly related to the post-harvest life of flowers. The minimum per cent weight loss of spike was observed with SA-1 × AG-6 which was significantly different from the other genotypes during first year whereas in second year, this was found minimum with

SA-1 × Sant-22, which was at par with AG-4 × Sant-22, SA-1 × AG-4 and AG-2 × Sant-22.

The average vase life was higher in Vilmorin × Sant-11, while in first year, vase life was found maximum with SA-1 × AG-4. Cross SA-1 × AG-4 was found at par with AG-3 × AG-5, AG-1 × SA-1, AG-4 × Sant-22, AG-3 × AG-4, Vilmorin × AG-6 and Vilmorin × AG-4 during first year while the vase life was found maximum with Vilmorin × Sant-11 and this was at par with cross AG-5 × Sant-22, AG-5, crosses SA-1 × Sant-22, Sant-11 × AG-6 and SA-1 × Sant-11. These results confirm the findings of Rabinowitch *et al.* (1977), Stieve and Stimart (1994), Martin and Stimart (2003) and Singh (2005).

CONCLUSION

The demonstration of large differences among the genotypes in the expression of their genetic potential is of interest, both to the grower and the plant breeder. On the basis of evaluation of 10 inbreds and 45 F_1s, crosses SA-1 × AG-4, Vilmorin × Sant-11 and AG-3 × AG-5 were selected for cut flower production.

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