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EVALUATION OF GLADIOLUS VARIETIES FOR FLOWERING AND CUT FLOWER TRAITS UNDER INDO-GANGETIC PLAINS

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ABSTRACT
An experiment was conducted at Horticultural Research Farm of the Department of Horticulture, Banaras Hindu University, Varanasi, Uttar Pradesh, India during 2018-19. In this experiment 29 varieties of gladiolus were taken as treatments in a Randomized Block Design with three replications. The variety Chemistry showed early spike emergence (70.88 days), early opening of 1st, 3rd and 5th florets (88.35 days, 88.92 days and 90.40 days, respectively) while, variety Anjali showed late withering of 1st, 3rd, 5th and last florets (109.30, 110.89, 111.75 and 117.70 days, respectively). The variety American Beauty reported maximum length of 1st, 3rd and 5th florets (10.90 cm, 10.75 cm and 10.57 cm) and maximum diameter of 1st, 3rd, 5th and last florets (10.55 cm, 10.25 cm, 9.71 cm and 9.18 cm, respectively). The variety Pink Friendship reported maximum flowering duration (14.17 days), maximum number of florets open (15.00) and maximum florets per spike (16.00). Longest spike and inter-node (1st to 4th floret) was observed in the variety IIHR (74.06 cm and 15.13 cm, respectively) while, longest rachis was in American Beauty (46.35 cm). The varieties Pink Friendship and American Beauty were found superior to others in this study.

INTRODUCTION

Cut flowers are mainly used for floral decorations and bouquets. Gladiolus is one of the leading cut flower in domestic as well as international flower market (Singh and Sisodia, 2017). Gladiolus (*Gladiolus* sp) is bulbous flower crop belonging to family Iridaceae with a chromosome number of 2n = 30-120 and originating from South Africa. The word gladiolus is derived from the Latin word Gladius which means sword, as the leaves of the plant are sword shaped it is also known as Sword lily (Singh, 2014; Mushtaq *et al*., 2018). Gladiolus is mainly used as cut flower, flower beds, pots, *etc*. Gladiolus inflorescence is known as spike which is commercially and ornamentally valued part. The spike consists of number of florets arranged alternately on the axis which open acropetally. Gladiolus has gained importance as cut flower since its beautiful spikes contain elegant coloured florets, long flowering duration and good shelf life, the character which are required for a better cut flower (Singh, 2006). Gladiolus has quite a large number of varieties with varying colour (mono or multi), size and texture (plain, frilled or ruffled) (Rashmi and Chandrashekar, 2016). In India, it is mainly cultivated in states like West Bengal, Uttar Pradesh, Karnataka, Himachal Pradesh, Sikkim, Tamil Nadu, Punjab and Delhi (Bhaskar *et al*., 2019). Indo-Gangetic plain has sub-tropical climate with sandy loam soil which is suitable for the cultivation of gladiolus, it is even a major market for cut flowers like gladiolus. Gladiolus consists of more than 30,000 established varieties and every year new varieties are being added to the list which makes it necessary for evaluation (Rashmi and Chandrashekar, 2016). Most of the varieties are purpose specific and agro-climate specific, hence varietal evaluation helps find region specific varieties. Several experiments on varietal evaluation were previously carried out in Indo-Gangetic plains by Singh *et al*. (2013), Singh *et al*. (2017) and Sisodia *et al*. (2018) which reported significant differences between the varieties. Therefore, for further evaluation an experiment was carried out to find the suitable gladiolus varieties under Indo-Gangetic plains of Uttar Pradesh for flowering traits and cut flower production.

MATERIALS AND METHODS

A field trial was carried out to see the performance of various Indian and exotic varieties of gladiolus for different flowering traits. The experiment was conducted at Horticultural Research Farm of the Department of Horticulture, Banaras Hindu University, Varanasi, Uttar Pradesh, India during the year 2018-19. In this experiment 29 varieties of gladiolus *viz*. Priscilla, American Beauty, Sunayna, Aldebaran, Anjali, Nova Lux, Snow Princess, Pink Friendship, Jester Gold, IIHR, Chandini, Subhangini, Tiger Flame, Punjab Dawn, Punjab Morning, Dhanvantari, Flevo Laguna, Green Star, Arti, Chemistry, Jyotsna, Pusa Shubham, Pusa Srijan, Surya Kiran, Yellow Star, Princess Margaret Rose, White Prosperity, Darshan and Sabnam were used as treatments. The healthy corms of these varieties were planted at a spacing of 30 cm between the rows and 20 cm between the plants in a Randomized Block Design with three replications on 17th of November, 2018. All cultural practices were followed uniformly. Flowering parameters were observed from randomly selected plants. The required measurements were done using standard

meter scale and mean value of the selected plants in each treatment was taken to represent a particular variety with respect to a character and noted observations were later subjected to statistical analysis as suggested by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Flowering parameters

Significant differences were observed in flowering parameters due to the varieties (Table 1). Early spike emergence was observed in variety the Chemistry (70.88 days) which was at par with IIHR (72.12 days) and Chandini (72.83 days), whereas, late spike emergence was noticed in Anjali (94.38 days). The early colour show was exhibited in variety Jyotsna (83.25 days) which was at par with the varieties Chandini (84.78 days) and Chemistry (85.02 days), whereas, it was last in Anjali (103.83 days). Early opening of 1st floret was noticed in the variety Chemistry (88.35 days) which was statistically at par with Jyotsna (88.89 days) and Chandini (89.11 days). Early opening of 3rd floret was recorded in the variety Chemistry (88.92 days) which was at par with Jyotsna (90.00 days) and Princess Margaret Rose (91.44 days). Early opening of 5th floret was observed in the variety Chemistry (90.40 days) which was at par with Jyotsna (91.92 days), Princess Margaret Rose (92.55 days) and Chandini (93.67 days). Early opening of last floret was in the variety Jyotsna (95.48 days) which was at par with Chandini (96.55 days), Chemistry (97.00 days) and Princess Margaret Rose (98.25 days). The variety Anjali (106.93 days, 108.56 days, 109.56 days and 114.75 days) showed late opening of 1st, 3rd, 5th and last florets, respectively. The spike emergence and floret opening depends on the maturity period of the variety and environmental factors, which can be further used for planned cultivation. Differences in days to floret opening were earlier reported by Singh *et al*. (2013), Kadam *et al*. (2014), Singh *et al*. (2017) and Kaur and Bajpay (2019). Late withering of 1st floret was in the variety Anjali (109.30 days) which was statistically at par with the varieties Tiger Flame (108.26 days), White Prosperity (106.53 days) and Yellow Star (106.00 days). Late withering of 3rd floret was recorded in the variety Anjali (110.89 days) which was at par with the varieties Tiger Flame (108.97 days), White Prosperity (107.58 days) and Flevo Laguna (107.43 days). Late withering of 5th floret was observed in the variety Anjali (111.75 days) which was statistically at par with the varieties Tiger Flame (110.06 days), White Prosperity (109.55 days), Flevo Laguna (108.88 days) and Yellow Star (108.00 days). Late withering of last floret was in the variety Anjali (117.70 days) which was at par with the varieties Flevo Laguna (108.88 days) and Tiger Flame (116.07 days). Whereas, early withering of 1st, 3rd, 5th and last florets was observed in the variety Chemistry (91.03 days, 91.67 days and 92.97 days) and Jyotsna (98.19 days), respectively. The variation in flowering parameters of various cultivars may be due to the genetic makeup of the cultivars which was similar to the findings of Chaudhary and Dhatt (2017), Mushtaq *et al*. (2018), Singh *et al*. (2018) and Kumar *et al*. (2019).

The diameter of 1st, 3rd, 5th and last floret was maximum in the variety American Beauty (10.55 cm, 10.25 cm, 9.71 cm and 9.18 cm, respectively) which was at par with the variety Priscilla (9.56 cm and 9.40 cm) for 3rd and 5th florets respectively and with Priscilla (8.93 cm), IIHR (8.90 cm) and Nova Lux (8.68

Table 1:Performance of gladiolus varieties for flowering parameters

	Days to spike emergence	Days to colour show	Days to 1st floret opening	Days to 3rd floret opening	Days to 5th floret opening	Days to last floret opening	Days to 1st floret withering	Days to 3rd floret withering	Days to 5th floret withering	Days to last floret withering
Priscilla	74.39	87.31	92.15	93.27	94.6	100.52	95.21	96.4	97.61	103.16
American Beauty	76.62	89.84	94.24	95.76	96.96	104.71	97.09	98.7	99.9	107.14
Sunayna	74.05	87	91.78	92.78	94.39	100.22	94.61	95.89	97.39	103.28
Aldebaran	83.97	94.08	97.58	98.77	100.2	102.38	100.29	101.63	103	105.05
Anjali	94.38	103.83	106.93	108.56	109.56	114.75	109.3	110.89	111.75	117
NovaLux	84	96.17	100.67	101.17	101.33	106.5	103.17	104.33	104.17	108.5
Snow Princess	78.73	91.25	95.18	96.03	97.18	103.17	97.61	98.62	99.83	106.08
Pink Friendship	82.83	94.83	97.56	99	100.25	109.58	100.36	102	103.33	112.33
Jester Gold	84	96	98.83	99.67	100.83	105.33	101.67	102.83	103.83	108.17
IIHR	72.12	87.65	92.35	93.92	95.38	100.31	95.57	96.58	97.83	102.98
Chandini	72.83	84.78	89.11	92.5	93.67	96.55	94	94.72	95.76	98.89
Subhangini	82.33	95	98.44	99.29	100.39	106.06	100.6	101.48	102.25	108.2
Tiger Flame	89.51	101.31	105.13	105.94	106.84	113.4	108.26	108.97	110.06	116.07
Punjab Dawn	81.16	91.9	95.75	96.7	98.06	101.87	98.39	99.18	100.53	104.95
Punjab Morning	82.95	94.33	98.05	99.19	100.59	103.39	100.33	101.48	102.79	106.23
Danavantri	86.67	96.89	100.15	101.36	102.53	108.11	102.68	103.79	105.07	110.63
Flevo Leguna	90.55	100.58	103.25	104.7	106.03	114.08	105.62	107.43	108.88	116.72
Green Star	83.83	95.17	97.83	98.83	99.83	105.33	101	102	102.33	107.67
Arti	86.11	97.86	101.95	103.25	104.99	110.51	104.26	105.66	107.53	112.96
Chemistry	70.88	85.02	88.35	88.92	90.4	97	91.03	91.67	92.97	99.36
Jyotsna	73.03	83.25	88.89	90	91.92	95.48	92.35	93.13	94.5	98.19
Pusa Shubham	83.44	93.33	96.83	97.83	97.83	104	99.17	100.89	100.89	107
Pusa Srijan	82.13	93.42	95.71	96.67	97.31	101.27	97.92	99.05	99.76	104.13
Surya Kiran	82.4	91.47	94.92	95.7	96.97	102.9	96.92	97.83	99.38	105.62
Yellow Star	91.67	99	102.67	103.33	105	106.67	106	107	108	109.67
Princess Margaret Rose	74.5	86.94	90.61	91.44	92.55	98.25	93.47	94.5	95.36	100.72
White Prosperity	89.28	100.19	103.61	104.89	106.75	110.11	106.53	107.58	109.55	112.78
Darshan	84.25	96.33	100.08	101.25	103.17	109.83	102.33	104.08	105.33	112.25
Sabnam	84.33	94.5	99.17	100.33	102.67	108.33	101.83	103.17	105.5	110.67
S.E.	1.46	1.25	1.3	1.3	1.35	1.25	1.27	1.31	1.36	1.23
C.D. 5%	4.12	3.53	3.69	3.69	3.83	3.55	3.61	3.7	3.84	3.48

Table 2:Performance of gladiolus varieties for flowering parameters

	Diameter of 1st floret (cm)	Diameter of 3rd floret (cm)	Diameter of 5th floret (cm)	Diameter of last floret (cm)	Length of 1st floret (cm)	Length of 3rd floret (cm)	Length of 5th floret (cm)	Length of last floret (cm)
Priscilla	9.64	9.56	9.4	8.93	10.34	10.15	10.03	9.81
American Beauty	10.55	10.25	9.71	9.18	10.9	10.75	10.57	9.84
Sunayna	8.62	8.2	7.91	6.59	9.91	9.74	9.4	8.87
Aldebaran	8.98	8.21	8.29	8.13	9.43	8.99	8.98	8.85
Anjali	5.01	4.93	5.21	4.47	8.3	8.09	8.52	7.79
Nova Lux	8.46	7.66	7.81	8.68	10.08	9.95	9.97	10.08
Snow Princess	6.8	7	6.7	6	9.99	9.95	9.95	8.79
Pink Friendship	8.79	8.97	8.79	8.07	9.63	9.95	9.73	9.07
Jester Gold	7.85	8.48	7.73	7.43	9.83	10.07	9.97	9.82
IIHR	9.44	9.36	8.74	8.9	9.9	10.37	9.83	9.44
Chandini	7.37	7.13	7.12	6.11	9.03	9.01	8.83	8.75
Subhangini	5.38	5.47	5.54	5.05	9.38	9.54	9.38	8.83
Tiger Flame	8.35	8.2	8.18	6.87	9.75	9.71	8.86	8.39
Punjab Dawn	7.42	6.97	7.1	6.77	8.76	8.66	8.67	8.4
Punjab Morning	7.13	6.94	6.73	6.36	8.8	8.75	8.54	8.46
Dhanvantari	7.86	7.79	7.67	7.64	10.67	10.58	10.47	9.85
Flevo Laguna	5.02	5.29	5.15	4.98	6.92	7.44	6.8	6.65
Green Star	7.83	8.22	7.56	6.34	8.73	8.87	8.37	7
Arti	6.67	6.6	6.53	6.72	9.6	9.6	9.41	9.03
Chemistry	8.29	7.92	7.68	7.09	9.69	9.75	9.72	8.86
Jyotsna	8.3	8.21	7.63	6.39	9.99	10.18	9.65	9.24
Pusa Shubham	8.21	8.24	7.73	7.47	10.1	9.85	9.82	9.58
Pusa Srijan	8	7.83	7.76	7.58	8.75	8.82	8.7	8.91
Surya Kiran	8.23	8.01	7.59	7.03	10.1	9.57	9.65	9.15
Yellow Star	8.42	8.18	7.57	8.5	10.33	10.17	10.17	10.17
Princess Margaret Rose	7.43	6.88	6.52	6.54	9.67	9.66	9.36	8.52
White Prosperity	7.78	7.43	7.99	6.76	10.01	9.79	9.8	9.11
Darshan	6.77	6.68	6.44	6.6	8.99	8.87	8.79	8.68
Sabnam	7.54	7.65	7.47	6.64	9.37	10.05	9.82	9.23
S.E.	0.31	0.3	0.3	0.35	0.22	0.23	0.27	0.27
C.D. 5%	0.88	0.86	0.86	0.98	0.63	0.65	0.77	0.78

cm) for last floret (Table 2). Whereas, it was minimum for 1st, 3rd and last florets in variety Anjali (5.01 cm, 4.93 cm and 4.47 cm, respectively) and for 5th floret in the variety Flevo Laguna (5.15 cm).The length of 1st floret was highest in the variety American Beauty (10.90 cm) which was at par with the variety Dhanvantari (10.67 cm) and Yellow Star (10.33 cm). The length of 3rd floret was highest in the variety American Beauty (10.75 cm) which was at par with the variety Dhanvantari (10.58 cm), IIHR (10.37 cm), Jyotsna (10.18 cm), Yellow Star (10.33 cm) and Priscilla (10.15 cm). The length of 5th floret was highest in the variety American Beauty (10.57 cm) which was at par with the variety Dhanvantari (10.47 cm), Priscilla (10.03 cm), Nova Lux (9.97 cm), Jester Gold (9.97 cm), Snow Princess (9.95 cm), IIHR (9.83 cm), Pusa Shubham (9.23 cm), Sabnam (9.82 cm) and White Prosperity (9.80 cm). However, the length of last floret was highest in the variety Yellow Star (10.17 cm) which was at par with the variety Nova Lux (10.08 cm), Dhanvantari (9.85 cm), American Beauty (9.84 cm), Jester Gold (9.82 cm), Priscilla (9.81 cm) and Pusa Shubham (9.58 cm). Whereas, it was least in the variety Flevo Laguna (6.92 cm, 7.44 cm, 6.80 cm and 6.65 cm) for 1st, 3rd, 5th and last florets respectively. Variations in size of the florets were also reported by Chourasia *et al*. (2015), Chaudhary and Dhatt (2017), Singh *et al*. (2018), Sisodia *et al*. (2018) and Nalage *et al*. (2019). The difference in size of the floret in different gladiolus cultivars may be due to their corm vigour which is inherent genetic variability (Nalage *et al*., 2019).

The maximum number of florets per spike was found in the variety Pink Friendship (16.00) which was at par with varieties Flevo Laguna (14.70), American Beauty (14.29), Snow Princess (14.11) and Priscilla (14.03) whereas, minimum was in the variety Yellow Star (8.33). Number of florets depends on the rachis and inter-nodal length, higher number of florets per spike is preferred for commercial purpose. The maximum number of florets opened at a time was in recorded the variety Princess Margaret Rose (5.95) which was statistically at par with the varieties Yellow Star (5.67), Green Star (5.50), Priscilla (5.34), Pink Friendship (5.7), Jester Gold (5.17), Chemistry (5.17), Snow Princess (5.06), Tiger Flame (4.94), American Beauty (4.90), Sunayna (4.89), Chandini (4.89), Nova Lux (4.83) and White Prosperity (4.83), whereas, the minimum was in the variety Anjali (3.32). The maximum number of florets open per spike was in the variety Pink Friendship (15.00) which was statistically at par with the varieties Flevo Laguna (13.47), American Beauty (12.40) and Darshan (12.17), whereas, minimum was in the variety Yellow Star (7.00). The maximum flowering duration was in the variety Pink Friendship (14.17 days) which was at par with the varieties Flevo Laguna (13.47 days), American Beauty (12.40 days) and Darshan (12.17 days), whereas, the minimum was in Yellow Star (7.00 days). The longest spike was found in the variety IIHR (74.06 cm) which was at par with the variety American Beauty (65.97 cm), whereas, the shortest was in the variety Anjali (36.19 cm). The maximum rachis length was observed in the variety

Table 3:Performance of gladiolus varieties for flowering parameters

	Spike length (cm)	Rachis length(cm)	Inter-nodal length (cm) (upto 4th floret)	No. of florets / spike	No.of florets open at a time	No. of florets open / spike	Flowering duration
Priscilla	63.73	44.12	12.13	14.03	5.34	13.03	11.01
American Beauty	65.97	46.35	13.22	14.29	4.9	12.63	12.4
Sunayna	62.85	39.52	12.67	12.94	4.89	12	11.5
Aldebaran	48.73	27.41	11.12	8.44	4.44	7.32	7.4
Anjali	36.19	24.02	9.56	10.25	3.32	9.12	9.83
Nova Lux	47.67	26.92	10.83	10.17	4.83	8.83	7.83
Snow Princess	57.25	43.88	12.49	14.11	5.06	13.01	10.9
Pink Friendship	59.8	44.6	12.04	16	5.17	15	14.17
Jester Gold	61.12	34.82	11.43	11.17	5.17	9.83	9.33
IIHR	74.06	43.73	15.13	12.31	4.42	11.36	10.63
Chandini	58.58	25.96	11.07	9.28	4.89	8.28	9.22
Subhangini	59.01	41.53	12.46	13.37	4.46	12.01	9.84
Tiger Flame	55.71	34.89	11.73	11.9	4.94	10.95	10.94
Punjab Dawn	48.56	28.39	10.73	12.12	4.76	10.99	9.2
Punjab Morning	44.52	22.46	9.86	10	4.1	8.95	8.24
Dhanvantari	57.39	36.81	11.3	12.57	4.31	11.57	10.49
Flevo Laguna	50.6	32.5	9.08	14.7	3.45	13.8	13.47
Green Star	60.67	37.48	13.5	13	5.5	11.83	9.83
Arti	48.85	30.34	9.66	10.66	3.58	9.57	11.01
Chemistry	59.69	39.88	13.06	13.28	5.17	12.28	10.64
Jyotsna	61.8	31.57	11.11	10.92	4.18	9.7	9.52
Pusa Shubham	43.39	27.36	11.72	9.67	4.11	8.67	10.17
Pusa Srijan	60.26	30.78	11.69	10.2	4.42	9.27	8.42
Surya Kiran	50.33	30.38	9.88	12.68	4.15	11.47	10.7
Yellow Star	45.5	23.83	10.33	8.33	5.67	7.33	7
Princess Margaret Rose	53.38	34.97	11.55	12.28	5.95	11.39	10.11
White Prosperity	54.97	32.44	12.76	10.61	4.83	9.39	9.17
Darshan	42.8	27.99	9.49	12.42	3.92	11.42	12.17
Sabnam	57.52	32.83	12.53	11.17	3.67	10.17	11.5
S.E.	3.46	2.72	0.51	0.89	0.3	0.92	0.77
C.D. 5%	9.81	7.71	1.45	2.53	0.86	2.61	2.17

American Beauty (46.35 cm) which was statistically at par with the varieties Pink Friendship (44.60 cm), Priscilla (44.12 cm), Snow Princess (43.88 cm), IIHR (43.73 cm), Chemistry (39.88 cm) and Sunayna (39.52 cm), whereas, the minimum was found in Punjab Morning (22.46 cm). The maximum inter-nodal length (1st to 4th floret) was observed in the variety IIHR (15.13 cm), whereas, the minimum inter-nodal length was observed in the variety Flevo Laguna (9.08 cm). Variations in the parameters were due to the genetic makeup of the varieties and size of the plants (Sisodia *et al*., 2018), better vegetative growth increases photosynthetic area thereby leading to better food accumulation and better flowering (Bhaskar *et al*., 2019). Similar findings for flowering parameters were also found by Singh *et al*. (2013), Reshma *et al*. (2016), Singh *et al*. (2017) and Swaroop *et al*. (2019) in gladiolus, Maurya *et al*. (2015) and Pal *et al*. (2018) in balsam, Singh *et al*. (2013) in snapdragon and Kumar *et al*. (2014) in tuberose.

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