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Performance of gerbera (*Gerbera jamesonii*) cultivars under fan and pad cooled greenhouse environment

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Abstract

Performance of nine exotic cultivars of gerbera (*Gerbera jamesonii*) *viz*., Diablo, Lyonella, Ornella, Sunset, Tara, Thalassa, Tiramisu. Twiggy and Whitsun was studied under fan and pad cooled greenhouse environment, at Indian Institute of Horticulture Research, Bangalore, during July 1998 to June 1999. The maximum plant height (48.83 cm), number of suckers (5.16) and leaves (46.27) per plant were obtained with cultivars Tiramisu, Lyonella and Ornella, respectively, while the minimum growth of above parameters was obtained in cultivars Whitsun (47.88 cm), Sunset (3.82) and Tiramisu (26.74), respectively. Earliest flowering (47.88 and 57.47 days) was obtained in Whitsun and latest (83.10 and 88.30) in Tiramisu. The maximum diameter of flower (10.70 cm.) and length of flower stalk (58.27cm) were recorded in cultivars Tiramisu and Lyonella respectively. The thickest (0.70 cm dia) and heaviest (22.20 g) flower stalks were produced in Twiggy and the thinnest (0.60 cm dia.) and lightest (13.94) in Whitsun. The highest total number of flowers produced per plot in a year and mean number of flowers per plant and per month in a year were obtained in Ornella (1058.00, 47.26 and 5.02, respectively) followed by Thalassa (988.00, 44.52 and 4.61) and the minimum in Tara (591.33, 29.48 and 2.82) followed by Sunset (600.00, 31.15 and 3.11). Higher percentage of 1st grade flowers were obtained in Lyonella (73.85). Sunset (70.41 and Tiramisu) (70.54) and lower in Tara (47.16) and Thalassa (47.87). Higher percentage of discard flowers was recorded in Thalassa (37.30) followed by Whitsun (20.47). Considering the overall performance, cultivars Lyonella, Ornella. Tiramisu and Twiggy are recommended for commercial cultivation. The temperature inside the greenhouse could be controlled from 24.7 to 30.5^{o} C when the ambient temperature varied from 27.4 to 35.5^{0} C. The maximum drop of 8.0^{o} C and 6.7^{o} C was recorded during April and March, respectively. The RH in the green house varied from 44 to 77% while the outside RH was 20 to 67% when the rate of ventilation was 1018 cubic meter per minute.

Key words: Gerbera, cultivar, fan and pad cooling , green house,growth, yield, environmental parameters, temperature, relative humidity.

Introduction

Gerbera (*Gerbera jamesonii* Bolus ex Hook. f.), commonly known as Transvaal Daisy, Barberton Daisy or 'African Daisy' is an important flower crop grown throughout the world in wide range of climatic condition. It is a dwarf perennial herbaceous plant, growing in clumps with solitary flower heads on long slender stems which grow well above the foliage. The flowers come in wide range of colour including yellow, white, red, orange, pink, maroon, crimson and various other intermediate shades. The flowers are also available in different forms like single, semi-double, double and a low related types. The flowers have long vase life (8 to 12 day) and can withstand in long distance transportation. Beside upcoming demand in domestic flower markets, it has great potential for export also. In Aalsmeer flower auctions, Holland, it occupies sixth place among top ten cut flowers (Reddy, 1996). Gerberas are good for use in beds, borders, rock gardens and cut flowers. It can be grown successfully both in plains and hills.

There is a very good demand of gerbera from European markets particularly during winter and almost throughout the year in India. The country like India, which is bestowed with various types of agro-climates and also the availability of good land, water and labour, there are wide opportunities to cultivate gerbera on a commercial scale. However, it is difficult to get exportable or even for domestic market good quality cut blooms of gerbera under open field condition (Khan, 1999). Hence to meet the qualitative standards, the high yielding and long lasting exotic cultivars have to be grown under some sort of protected environment. In recent years, due to liberalization of import policies, several enthusiastic entrepreneurs and nurserymen are getting latest and imported gerbera cultivars from abroad for cultivation on commercial scale. Locally, several companies have also started supplying imported plant materials multiplied through tissue culture technique. Performance of gerbera cultivars varies with the region, season and growing environments. Birdar and Khan (1996) have evaluated 3 growing environments *viz.,* under low cost polyhouse, under 50% shade net and under open field conditions for 5 exotic cultivars of gerbera under Bangalore condition and recommended cultivation of exotic gerbera under low cost polyhouse condition. In our earlier research (Mandhar *et al.*, 2001) nine exotic cultivars of gerbera have been evaluated with good success under naturally ventilated low cost polyhouse environment under Bangalore condition. The present experiment was therefore planned to evaluate same nine exotic cultivars of gerbera for their greater productivity, quality and adaptability under partially environmental control medium cost fan and pad cooling system greenhouse environment.

Materials and methods

Greenhouse structure: A medium cost (east-west oriented) greenhouse, having fan and pad cooling system and quonset type structure was fabricated at Indian Institute of Horticultural Research, Hessaraghatta, Bangalore, during 1997. The dimension of the structure was 30 m length, 12m width, 3m sidewalls height and 5m peak roof height in 12 m width, 2 spans of 6 m width were provided, having a 32 m long 24 gauge G.I. gutter sheets. The distance between two trusses was 2 m which were made of 1.5 inch diameter B class galvanised iron (G.I. pipes). The greenhouse structure was cladded with single layer of 200 micron (800 gauge) thick ultra violet stabilised low density polythene film (200 micron LDPE). Fifty percent agro shade of green colour net was fitted at 3m height inside the roof of polyhouse. The shade net used to spread and rolled according to requirement, to provide shade as well as cooling effects inside the polyhouse as and when required. Drip irrigation system was installed on the entire cropped area of polyhouse. Four axial flow fans of 1.2 meter diameter operated by 1.4 hp electric motor were fitted to greenhouse. The fans had 460 revolutions per minute and the volumetric capacity was recorded as 509 m^3 per minute with average air velocity of 7.5 m/sec. Two fans were operated during daytime to cool the greenhouse and other 2 fans were operated during night to ventilate the greenhouse and to avoid the condensation in the greenhouse. A cooling pad of 11m length, 2 m width and 7.5 cm thickness made of cross corrugated cellulose pad was fitted in the widthwise of polyhouse. The average air velocity in the pads was 0.386 meter per second. An one horse power monoblock pump for water circulation and two nos. polyvinylchloride (PVC) tanks for storage of 2000 liter water in each tank were provided with all accessories. Polyvinlychloride (PVC) water pipe lines of 50 mm diameter were fitted to circulate water from tank to pad and again re-circulate it. Dry and wet bulbs temperatures were recorded at 1.00 pm daily in the centre of polyhouse and ambient conditions from July 1998 to June 1999. The mean of dry and wet bulbs temperature and relative humidity at fortnightly intervals are presented in Table 1. The other meteorological data of experimental station are also given in Table 2.

Table 1. Temperature and relative humidity recorded inside fan and pad cooling system greenhouse and ambient conditions

Month	Temperature (°C)			Relative humidity (%)		
	Inside polyhouse	Ambient	Difference	Inside polyhouse	Ambient	Difference
July (A) 1998	29.2	31.2	-2.0	61	51	10
July (B)	27.0	28.0	-1.0	70	64	06
August (A)	27.7	28.1	-0.4	77	67	10
August (B)	27.8	28.0	-0.2	68	45	23
September (A)	28.7	29.0	-0.3	65	60	05
September (B)	30.5	30.8	-0.3	65	57	09
October (A)	28.0	29.0	-1.0	74	60	14
October (B)	28.3	28.3	-0.0	59	56	03
November (A)	28.1	27.4	-0.4	74	66	11
November (B)	27.9	28.6	-0.7	65	53	12
December (A)	28.3	27.7	-0.6	65	51	14
December (B)	30.0	28.2	-1.2	48	36	12
January (A) 1999	29.2	28.2	-1.0	48	43	05
January (B)	28.5	28.8	-0.3	40	24	16
February (A)	28.0	33.0	-3.0	60	28	32
February (B)	24.7	30.5	-5.0	61	27	34
March (A)	28.2	34.5	-6.7	48	20	28
March (B)	31.4	35.6	-4.2	60	38	22
April (A)	28.5	36.5	-8.0	62	22	40
April (B)	28.3	34.4	-6.1	70	36	34
May (A)	29.6	32.9	-3.3	72	52	20
May (B)	28.4	31.2	-2.8	72	54	18
June (A)	28.1	30.0	-1.9	74	53	21
June (B)	26.9	30.1	-3.2	68	26	42
Average	28.38	30.41	-2.03	63.58	45.37	+18.21

A = First fortnight B= Second fortnight

Table 2. Mean of maximum and minimum temperature relative humidity and other material data of experimental station.

Month	Temperature (°C)		Relative Humidity (%)		U.S.W.B. Class A Pan evaporation month mean (mm)	Mean wind speed (km/h)	Monthly rainfall (mm)
	Max.	Min.	7.30h	14.00h			
Juy 98	28.4	20.5	78.3	68.3	3.7	8.4	189.8
August	28.0	20.1	82.7	68.5	3.7	6.0	393.6
September	27.8	20.1	79.4	68.0	3.3	6.2	115.6
October	28.1	18.6	79.8	66.7	2.7	4.6	173.4
November	27.1	17.0	72.5	60.0	2.8	3.7	23.3
December	27.1	14.7	71.5	51.8	3.1	4.6	15.5
Jan. 1999	28.4	14.1	58.8	35.4	3.9	4.4	-
February	30.3	14.5	46.1	31.2	5.6	6.1	10.5
March	33.4	16.2	51.8	25.0	6.5	4.4	-
April	33.9	19.9	61.7	32.5	6.7	5.7	66.6
May	30.1	20.8	75.7	56.7	4.8	6.0	218.4
June	29.1	19.5	70.5	53.5	4.0	9.1	42.5

Planting material and package of cultural practices: Beds of 14 m length, 1 m width and having 30 cm height were prepared by mixing of well rotten farmyard manure and fine sand @ 7.5 kg m^{-2}. and 3 kg/sq.m, respectively. The prepared beds were fumigated with 4% concentrated solution of Formaldehyde (Formalin) HCHO=30.03 @ 1.81 m^{-2} area basis and covered with polythene film for seven days. Ten days before planting, neem cake @ 500 g m^{-2} and nitrogen, phosphorus and potassium @ 10:10:20 g m^{-2} were supplied to sterilized beds. Nine exotic cultivars of gerbera (treatments) were selected for this experiment (details are given in Table 3). Two months old tissue cultured plants having uniform vegetative growth were procured and transplanted on 01.07.1998 at a spacing of 30 cm (row) x 30 cm (plant), accommodating 3 rows per bed. For each treatment (cultivar) 8 rows per plot (2.40 m length) were planted, having 24 plants per treatment (cultivar). The treatment were replicated thrice in

randomised block design. The polyhouse had 62.2% total cropped area. Up to 2 months of transplanting, watering was done through water can by hand, thereafter drip irrigation was provided. Application of 10:15:20 g NPK m^{-2} $month^{-1}$ during first 3 month and 15:10:30 g NPK m^{-2} $month^{-1}$ from 4^{th} month onwards was supplied through urea, single super phosphate and sulphate of potash, respectively. Multiplex (a micronutrients mixture) @ 2 ml/l was also supplied through foliar spray at bimonthly intervals. Uniform package of cultural practices were adoped as suggested by Khan (1999) for green house cultivation of gerbera.

Table 3. Details of gerbera cultivars planted in greenhouse

Sl. No.	Cultivar	Colour Flower	Type
1.	Diablo	Red (45.A)	Semi double + Black Centre 2.
Lyonella		Yellow (7.A)	Single
3.	Ornella	Orange – Red (33.A)	Semi double 4.
Sunset		Orange – Red (33.B)	Semi double+ Black centre
5.	Tara	Orange (28.A)	Semi double
6.	Thalassa	Yellow (9.A)	Double
7.	Tiramisu	Yellow – Orange (19.B)	Semi double + Black centre 8.
Twiggy		Red-purple (67.A)	Double
9.	Whitsun	Pure White	Single

Kumar Gen-Tech and Tissue Cultures Private Ltd., 2413 East Stree, Maharastra Herald Camp. Pune 411 002.

Observations on vegetative growth parameters such as mean height and spread of plant and number of suckers and leaves per plant and survival percentage of plant were recorded just a year after transplanting. The qualitative parameters of flowers such as mean fresh weight of flower stalk and diameter, length and thickness of cut flowers were recorded 5 months after transplanting when all plants were fully grown up and started profuse flowering. Number of days taken for flowering and yield of flowers were recorded from flowering stage up to June 1999. Cut flowers were graded according to Polish gerbera classification (Birdar and Khan, 1996). Stalk length and flower diameter above 50 cm and 10 cm, respectively are classified as I^{st} (A) grade, between 30-50 cm and 8-10 cm were grouped in II^{nd} (B) grade and stalk length below 30 cm attacked by pests and malformed were classified under IIIrd (C) grade and therefore treated as unmarketable or discard. Colours of flower heads were compared with the Horticultural Colour Chart issued by British Colour Council in collaboration with the Royal Horticultural Society in natural light (Anon., 1938) and presented in Table 3.

Results and discussion

Vegetative growth: Table 4 reveals that height of plant and number of suckers and leaves produced per plant significantly varied with different cultivars. Cultivar Tiramisu recorded maximum height of plant (48.83 cm) while cultivar Whitsun recorded minimum plant height (32.38 cm). The maximum number of suckers per plant (5.16) was obtained in cultivar Lyonella followed by Ornella (4.82). Diablo (4.55) and Tiramisu (4.49). The minimum number of suckers per plant (3.82) were recorded in cultivar Sunset closely followed by Tara (3.83). The maximum number of leaves per plant (46.27) were recorded in cultivar Ornella followed by Twiggy (40.16) and minimum in cultivar Tiramisu (26.74) followed by cultivar Thalassa (31.99).

Table 4. Vegetative growth parameters in exotic gerbera cultivars recorded under fan and pad cooled greenhouse condition (one year after transplanting)

Name of cultivar	Height of plant (cm)	Number of suckers per plant	Number of leaves per plant	Survival of plant (%)
Diablo	33.61	4.55	35.94	75.00
Lyonella	38.66	5.16	39.88	77.16
Ornella	39.38	4.82	46.27	88.88
Sunset	35.49	3.82	35.33	73.61
Tara	37.83	3.83	35.22	79.16
Thalassa	39.94	4.22	31.99	94.44
Tiramisu	48.83	4.49	26.74	75.00
Twiggy	36.50	4.41	40.16	71.52
Whitsun	32.38	4.29	37.49	77.05
SEm±	2.10	0.23	3.15	6.68
CD(*p*=0.05)	6.31	0.69	9.46	NS

Table 4 also indicates that survival of plants upto one year of planting did not differ significantly in different cultivars. Although the highest survival (94.44%) was obtained in Thalassa followed by Ornella (88.88%). The lowest survival (71.52%) was reported in Twiggy followed by Sunset (73.61%). The non significant difference in plant establishment of different cultivars might be due to the fact that all plants were multiplied under same aseptic tissue culture laboratory and thereafter uniform environments were provided for their hardening and crop production. After transplanting under fan and pad cooling system greenhouse environment also, uniform plant protection schedules and other package of cultural practices were followed during the entire experimentation.

Floral characters: Table 5 shows that different cultivars under study took 47.88 to 83.10 days for 50% flowering and 57.47 to 88.30 days for 100% flowering from the date of transplanting under fan and pad cooled greenhouse environment. The earliest flowering was recorded in Whitsun (47.88 and 57.47 days). On the other hand the latest flowering was observed in Tiramisu (83.10 and 88.30 days) followed by Ornella (73.44 and 82.63 days). Accordingly cultivars may be used for having a prolonged blooming period merely by way of selection. Significant variation in early and late flowering among the cultivars used was found to be genetically controlled.

Flower quality parameters such as mean length, thickness and fresh weight of flower stalk and size (diameter) of flower were significantly different with each other (Table 5). Better performance of above parameters are quite vital so far as commercial value of cut gerbera flowers is concerned. The maximum flower diameter (cm) was noticed in Lyonella (58. 26) followed by Sunset (57.99) and Tiramisu (58.26) and the minimum in Diablo. (49.67), which is closely followed by Thalassa (49.83). The thickest (cm) and heaviest (g) flower stalks were recorded in Twiggy (0.70 and 22.20) followed by Tiramisu (0.69 and 20.95). The thinnest and lightest flower stalks were produced by Whitsun (0.60 and 13.94) followed by Diablo (0.65 and 16.25). The marked variation in above cut flower quality parameters might be due to inherent characters of the individual

Table 5. Performance of exotic gerbera cultivars under fan and pad cooling system greenhouse environment

Name of Cultivars	No. of days taken for flowring (50%)	(100%)	Flower diameter (cm)	Stalk length (cm)	Flower stalk thickness (cm)	Fresh weight of flower stalk (g)	Yield of flowers (Nos.) plot^{-1} year^{-1}	plant^{-1} year^{-1}	plant^{-1} month^{-1}	Grading of flowers (%) of (Yield plot^{-1} year^{-1}) First (A)	Second (B)	Discard (C)
Diablo	60.58	69.42	9.04	49.67	0.65	16.25	740.66	39.27	3.95	60.60	24.20	14.20
Lyonella	73.38	77.67	9.48	58.26	0.66	18.13	735.33	34.87	3.60	73.85	11.71	14.60
Ornella	73.44	82.63	9.82	53.50	0.67	20.43	1058.00	47.26	5.02	62.33	23.68	13.97
Sunset	67.29	73.12	10.66	57.99	0.67	20.20	600.00	31.15	3.11	70.41	14.60	14.97
Tara	67.87	77.40	9.95	51.16	0.66	18.70	591.33	29.48	2.82	47.16	33.27	19.54
Thalassa	64.32	71.94	9.96	49.83	0.68	18.46	988.00	42.52	4.61	47.87	14.81	37.30
Tiramisu	83.10	88.30	10.70	56.69	0.69	20.95	684.33	34.79	3.12	70.54	12.22	18.22
Twiggy	68.80	79.76	10.07	53.43	0.70	22.20	707.00	37.80	4.16	61.50	18.99	19.48
Whitsun	47.88	57.47	8.64	56.30	0.60	13.94	621.00	35.24	3.30	61.70	11.83	20.47
SEm+	1.98	2.45	0.30	2.07	0.01	1.37	81.18	2.25	0.34	3.42	3.80	3.01
CD(p=0.05)	5.94	7.36	0.90	6.23	0.04	4.12	243.37	6.75	1.02	10.27	11.41	9.04

cultivar. Our findings are also in accordance with the results of Gutz (1983) and Birdar and Khan (1996) who reported significant differences in flower quality parameters of gerbera cultivars.

Total yield (number) of flower per plot per year and mean number of flower per plant and per month in a year and grading (%) of flower (I, II, III) produced per plot in a year, were significantly influenced due to cultivars (Table 5). The maximum yield of flowers per plot (1058.00 no.) and mean number of flowers per plant (47.26) and per month (5.02) were produced by cultivars Ornella followed by Thalassa (988.00, 42.52 and 4.61, respectively). The minimum yield of above parameters was recorded in Tara (591.33, 29.48 and 2.82) followed by Sunset (600.00, 31.15 and 3.11). The higher Ist and IInd grades and moderate IIIrd grade flowers were recorded in Lyonella (73.85, 11.71 and 14.60, respectively) followed by Tiramisu (70.54, 12.22 and 16.22, respectively) and Sunset (70.41, 14.60 and 14.97 respectively). The lower Ist grade and higher IIIrd grade flowers were obtained in Thalassa (47.87, 14.81 and 37.30, respectively). Cultivar Tara gave lowest grade flowers but produced highest II grade flowers and moderate discard flowers. Cultivar Thalassa produced highest discard (37.30%) and second lowest (47.87%) Ist grade flowers, but second highest flower yield and hence can not be recommended for cultivation. Above differences are due to inherited characters of individual cultivars. Birdar and Khan (1996) and Bhautkar (1994) also reported variations in total yield of flowers and their corresponding grades in gerbera and carnation, respectively under greenhouse environment.

Environmental parameters: The temperature and relative humidity (RH) inside the greenhouse and ambient are shown in Table 1. It has been noticed that the drop of the temperature inside the greenhouse was not significant from August to January when the ambient RH was 36 to 67%. The temperature drop in greenhouse was 6.7 to 8.0 ^{o}C during March and April when the ambient RH was 20 to 22%. The temperature inside greenhouse varied from 24.7 to 30.5 ^{0}C while the ambient temperature was 27.4 to 36.5 ^{0}C. The ambient RH varied from 20 to 67% while the RH in greenhouse varied from 40 to 77%. The build of temperatures from 0.4 to 1.2 ^{0}C were recorded in the greenhouse due to occasional damage to glazing due to wind or rains.

From the present study it can be inferred that exotic cultivars of gerbera namely, Lyonella, Ornella, Tiramisu and Twiggy may be recommended for commercial cultivation under fan and pad cooling system greenhouse environment in and around Bangalore and places having similar mild climates.

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