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Effect of stem length and stage of harvest on vase-life of cut flowers in tuberose (*Polianthes tuberosa* L.) cv. Double

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ABSTRACT

A study was carried out to explore the effect of length of stem and stage of harvest on vase life and display quality of tuberose. As regards stem length, 90 cm stem length (L_4) had longest vase life, maximum uptake of water, minimum loss-uptake ratio, maximum fresh weight and percentage of opened florets, and, lowest percentage of abscised floret; whereas, 60 cm stem length (L_2) enhanced longevity of individual florets. In the case of stage of harvest, significantly high vase life, least loss of water, minimum loss-uptake ratio and lowest physiological loss of weight were recorded in two-florets open stage (S_3). Maximum percentage of opened florets and lowest percentage of abscised florets were observed in three-florets open stage (S_4), whereas, maximum uptake of water and fresh weight of spike were seen in one-floret open stage (S_2). Interaction effect of stem length and harvest stage was also found to be significant showing that 75 cm of stem length with one-floret open stage (L_3S_2) was superior for maximum vase life of spike as well as lowest physiological loss of weight.

Key words: Stem length, stage of harvest, tuberose, vase life

INTRODUCTION

Cut flowers like rose, gladiolus, tuberose, chrysanthemum, etc. have greater demanded in both local and international markets. Among these, tuberose is one of the most important cut flowers. The tuberose is grown under a wide range of soil and climatic conditions, but flowers best in warm and humid climates. Among four types of tuberose, the Double type is mainly cultivated for cut flowers. Post-harvest management is one of the most important factors in the cut flower industry.

The components of cut-flower quality are size, stage of florets, fragrance and freshness of flowers. Vase life of cut flowers is dependant on many factors. Standardization of the stage of harvest and stem length for longer vase life is needs to be done for any new cultivar. Hence, the effect of harvest-stage and spike length on vase life was studied in this experiment.

MATERIAL AND METHODS

Healthy spikes of tuberose cv. Double were used in this investigation. The trial was conducted with 16 different treatments comprising four lengths of stem and four stages of harvest, during the year 2003-04 in Factorial C.R.D. with three replications, at P.G. Laboratory, Department of Horticulture, Junagadh Agriculture University, Junagadh (Gujarat). The same was repeated in the second year (2004-05). Spikes were harvested in the evening with lengths of 45 cm (L_1), 60 cm (L_2), 75 cm (L_3) and 90 cm (L_4) at unopened floret (S_1), first-floret open (S_2), second-floret open (S_3) and third-floret open (S_4) stage. Freshly harvested spikes were placed in glass bottles filled with distilled water as per treatment combinations. Observations for vase life and qualitative parameters were recorded and data were analyzed in FCRD.

RESULTS AND DISCUSSION

Vase life of spike

Vase life of tuberose cut-flower was significantly affected by various stem lengths and was maximum in 90 cm stem length (13.72 days) and 75 cm stem length (L_3). Minimum vase life (12.55 days) was recorded in 45 cm stem length (L_1). Better vase life in longer stems could be due to higher water uptake, water conductivity and water balance with higher turgidity and freshness of the spike. Longer stems also contained higher amounts of reserve carbohydrates.

These results are supported by work of De and Barman (1998) and Singh *et al* (2000) in tuberose; Renu *et al* (1994) in rose; Sangama and Singh (1999), Satpute and Patel (2002); Barman and Rajni (2004) in gladiolus, and, Singh and Sangama (2002) in gerbera.

In the case of stage of harvest, significantly maximum vase life of 14.02 days was recorded in two-florets open stage (S_3) followed by one-floret open stage (S_2). Similarly, interaction also significantly influenced vase life. Maximum vase life of 14.52 days was observed in the treatment combination L_3S_2. The vase life of spike started to increase from the unopened stage of harvest and was maximum at two-florets open stage, but reduced at the three-florets open stage. This may be due to higher uptake of water, water status and freshness of the spike, with lower weight-loss. These results are in accordance with observations made by De and Barman (1998) and Singh *et al* (2000) in tuberose; Ahn *et al* (1996) and De and Bhattacharjee (1999) in rose; Barman and Rajni (2004) in gladiolus; Nagaraja and Gopinatha (2001) in gerbera; Brahmankar *et al* (2005) in golden rod and Khalighi and Shafie (2000) in carnation.

Longevity of individual florets

It was obvious that among stem lengths, significantly longer vase life of individual floret (3.24 days) was recorded in 60 cm of stem length (L_2) and L_4. Harvest of spikes in the unopened-florets stage (S_1) significantly increased longevity of individual florets (3.31 days), followed by two-florets open stage (S_3). The interaction effect was also found significant (Tables 1 and 2).

Water uptake

Highest uptake of water (74.63, 82.79 & 94.00 g) at 6th, 8th and 12th day of vase life was recorded in stem length 90 cm (L_4), followed by 75 cm (L_3) (Tables 3 & 4). Similarly, for stage of harvest, maximum water uptake (60.21, 65.04 & 67.88 g) at 6th, 8th and 12th day of vase life, respectively, was recorded in one-floret open stage (S_2). The result was also found to be significant for interaction and maximum-uptake of water was registered in the combination L_4S_2. Increased water-uptake might be due to a greater area of xylem as well as more amounts of carbohydrates responsible for higher absorption and retention of water in a longer stem. Similar reasons were also assigned by De and Barman (1998) and Singh *et al* (2000) in tuberose; Sangama and Singh (1999), Satpute and Patel (2002) and Barman and Rajni (2004) in gladiolus; Renu *et al* (1994) in rose, and Brahmankar *et al* (2005) in golden rod.

Loss of water

Minimum water-loss (43.67, 53.92 & 63.75g respectively) at 6th, 8th and 12th day of vase life of the spike was observed in 45 cm of stem length (L_1), followed by 60 cm (L_2) (Tables 3 & 4). Likewise, for stage of harvest, lowest values for loss of water (50.29, 59.17 & 71.21 g) at 6th, 8th and 12th day were recorded in two-floret open stage (S_3). Interaction effect of stem length and harvest stage on loss of water was significantly higher in the combination L_2S_3. This may be due to lower amount of carbohydrates, less area of xylem and poor water conductivity in the shortest stem, as also lowest rate of transpiration and ethylene production at an advanced stage. The result is in conformity

Table 1. Effect of stem length and stage of harvest on longevity of individual florets and vase life of spike in tuberose (days)

Treatments	Longevity of individual floret (days)			Vase life of spike (days)		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
L_1	2.63	2.68	2.65	12.50	12.59	12.55
L_2	2.88	2.87	2.87	13.13	13.33	13.23
L_3	2.88	3.00	2.94	13.51	13.78	13.64
L_4	3.22	3.51	3.37	13.71	13.73	13.72
S.Em. ±	0.04	0.04	0.06	0.19	0.13	0.11
CD *(P=0.05)*	0.12	0.11	0.29	0.53	0.38	0.32
Stage of harvest						
S_1	3.35	3.38	3.36	11.79	12.03	11.91
S_2	2.71	2.77	2.74	13.48	13.82	13.65
S_3	2.90	3.10	3.00	13.94	14.10	14.02
S_4	2.63	2.82	2.73	13.63	13.48	13.35
S.Em±	0.04	0.04	0.03	0.19	0.13	0.11
CD *(P=0.05)*	1.12	0.11	0.08	0.53	0.38	0.32
Interaction L X S						
S.Em±	0.08	0.08	0.11	0.37	0.266	0.23
CD *(P=0.05)*	0.24	0.22	0.36	1.07	0.76	0.64
CV (%)	5.04	4.42	4.73	4.88	3.45	4.22

Table 2. Interaction effect of stem length and stage of harvest on longevity of individual floret and vase life of spike (days)

Treatments	Longevity of individual floret (days)			Vase life of spike (days)		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
L_1S_1	2.83	2.85	2.84	10.00	10.23	10.12
L_1S_2	2.50	2.50	2.50	12.67	13.13	12.90
L_1S_3	2.77	2.90	2.83	13.50	13.67	13.58
L_1S_4	2.40	2.47	2.43	13.83	13.33	13.58
L_2S_1	3.40	3.33	3.37	12.00	12.23	12.12
L_2S_2	2.83	2.37	2.60	13.00	13.47	13.23
L_2S_3	2.78	2.97	2.88	14.07	14.23	14.15
L_2S_4	2.48	2.80	2.64	13.43	13.40	13.42
L_3S_1	3.68	3.83	3.76	12.17	12.67	12.42
L_3S_2	2.83	2.93	2.88	14.33	14.70	14.52
L_3S_3	2.67	2.80	2.73	13.90	14.20	14.05
L_3S_4	2.33	2.43	2.38	13.63	13.53	13.58
L_4S_1	3.50	3.48	3.49	13.00	12.97	12.98
L_4S_2	2.67	3.27	2.97	13.93	13.97	13.95
L_4S_3	3.40	3.73	3.57	14.30	14.30	14.30
L_4S_4	3.32	3.57	3.44	13.60	13.67	13.63
S.Em. ±	0.08	0.08	0.11	0.372	0.266	0.229
CD *(P=0.05)*	0.24	0.22	0.36	1.07	0.76	0.64
CV (%)	5.04	4.42	4.73	4.88	3.45	4.22

Table 3. Effect of stem length and stage of harvest on uptake of water, loss of water and loss uptake ratio at 6th, 8th and 12th day during vase life in tuberose (pooled)

Treatments	Uptake of water at (g)			Loss of water at (g)			Loss-uptake ratio at		
	6th day	8th day	12th day	6th day	8th day	12th day	6th day	8th day	12th day
Length of spike									
L_1	48.46	51.46	52.75	43.67	53.92	63.75	0.91	1.07	1.23
L_2	43.75	52.38	52.71	49.42	63.08	71.38	1.20	1.23	1.39
L_3	56.63	60.71	64.42	58.00	67.63	74.96	1.04	1.13	1.17
L_4	74.63	82.79	90.04	66.63	81.42	93.04	0.90	0.99	1.04
S Em±	0.54	0.50	0.49	0.369	0.56	0.581	0.056	0.033	0.048
CD (*P=0.05*)	1.53	1.40	1.39	1.04	1.58	1.63	0.25	0.15	0.22
Stage of Harvest									
S_1	58.54	63.67	66.13	55.04	68.92	76.33	0.96	1.12	1.19
S_2	60.21	65.04	67.88	61.79	75.88	80.71	1.12	1.26	1.29
S_3	54.13	60.13	64.08	50.29	59.17	71.21	0.89	0.96	1.11
S_4	50.58	58.50	61.83	50.58	62.08	74.88	1.09	1.08	1.25
S Em±	0.54	0.50	0.49	0.369	0.56	0.58	0.06	0.04	0.03
C D (*P=0.05*)	1.53	1.40	1.39	1.04	1.58	1.63	0.25	0.19	0.12
Interaction L x S									
S Em±	1.09	0.98	0.99	1.38	1.12	1.16	0.13	0.07	0.08
C D (*P=0.05*)	3.06	2.76	2.78	3.89	3.16	3.27	0.40	0.23	0.25
CV (%)	4.76	3.89	3.73	3.32	4.13	3.75	8.41	8.32	6.41

with that of De and Barman (1998) and Singh *et al* (2000) in tuberose.

Loss-uptake ratio

Except for 60 cm spike length, all treatments (45, 75 & 90 cm) showed a lower and similar loss-uptake ratio. This indicates that spike length did not affect the ratio significantly.

Fresh-weight of spike

Significantly higher fresh-weight of spike (116.00, 104.33, 95.07, 86.80, 80.94,76.51 and 72.98 g) at 2nd, 4th, 6th, 8th, 10th, 12th & 14th days was noticed consistently, with spikes of 90 cm stem length (L_4) (Tables 5 & 6). Likewise, minimum fresh-weight was recorded in 45 cm stem length (L_1).

Spikes harvested at the unopened-floret stage (S_1) at 2nd, 4th, 6th day of storage recorded significantly higher fresh-weight (85.38, 76.00 & 69.90 g), whereas, in the one-floret stage, fresh-weight was 62.56, 58.45 & 54.15 g at 8th, 10th & 12th day, respectively; at the two-floret stage, fresh-weight was 50.4 g at 14th day.

Interaction effect was also found to be significant. It is a fact that longer spikes have greener biomass with higher uptake of water, water-retention, food materials, etc. which resulted in higher fresh-weight of the spike, while, lower rate of respiration, transpiration and ethylene production at less advanced stages might be responsible for maximum fresh-weight. These results are in accordance with observations reported by De and Barman (1998) in tuberose; Satpute and Patel (2002) and Barman and Rajni (2004) in gladiolus and Brahmankar *et al* (2005) in golden rod.

Table 4. Interaction effect of stem length and stage of harvest on uptake of water, loss of water and loss uptake ratio at 6th, 8th and 12th day during vase life (pooled)

Treatments	Uptake of water (g)			Loss of water (g)			Loss-uptake ratio		
	6th day	8th day	12th day	6th day	8th day	12th day	6th day	8th day	12th day
L_1S_1	45.67	51.33	53.67	48.33	62.67	70.83	1.08	1.26	1.36
L_1S_2	52.67	56.50	57.33	50.67	63.00	71.83	0.97	1.14	1.28
L_1S_3	53.83	55.33	53.67	38.83	46.50	59.17	0.71	0.84	1.12
L_1S_4	41.67	42.67	46.33	36.83	43.50	53.17	0.89	1.03	1.18
L_2S_1	54.50	57.17	58.50	51.83	66.33	71.00	0.96	1.18	1.24
L_2S_2	41.33	47.67	51.83	63.17	81.50	96.17	1.64	1.79	1.94
L_2S_3	40.83	47.33	48.00	20.50	31.00	40.17	0.45	0.63	0.84
L_2S_4	38.33	57.33	52.50	62.17	73.50	78.17	1.75	1.31	1.54
L_3S_1	63.00	67.33	70.67	61.83	74.83	84.83	0.99	1.12	1.21
L_3S_2	48.00	52.00	57.50	47.83	57.83	58.00	1.01	1.13	1.02
L_3S_3	58.50	63.67	63.67	76.17	78.67	84.83	1.34	1.25	1.36
L_3S_4	57.00	59.83	65.83	46.17	59.17	72.17	0.83	1.00	1.11
L_4S_1	71.00	78.83	81.67	58.17	71.83	78.67	0.82	0.91	0.97
L_4S_2	98.83	104.00	104.83	85.50	101.17	96.83	0.87	0.97	0.93
L_4S_3	63.33	74.50	91.00	65.67	80.50	100.67	1.05	1.09	1.11
L_4S_4	65.33	73.67	82.67	57.17	72.17	96.00	0.88	0.98	1.17
S.Em ±	1.09	0.98	0.99	1.38	1.12	1.16	0.13	0.07	0.08
CD (*P=0.05*)	3.06	2.76	2.78	3.89	3.16	3.27	0.40	0.23	0.25
CV (%)	4.76	3.89	3.73	3.32	4.13	3.75	8.41	8.32	6.41

Table 5. Effect of stem length and stage of harvest on fresh weight and physiological loss of weight of spike during vase life of tuberose (pooled)

Treatments	Fresh weight of spike (g)							PLW (%)
	2nd day	4th day	6th day	8th day	10th day	12th day	14th day	
Length of spike								
L_1	53.67	44.42	41.23	36.88	33.55	30.40	28.20	40.87
L_2	73.00	63.83	54.54	47.09	44.75	40.98	36.78	42.59
L_3	92.42	81.67	74.51	69.77	64.78	61.00	56.11	32.64
L_4	116.00	104.33	95.07	86.80	80.94	76.51	72.98	31.29
S Em±	0.85	0.76	0.53	0.63	0.54	0.46	0.42	0.65
CD(*P=0.05*)	2.38	2.15	1.50	1.77	1.53	1.29	1.19	1.84
Stage of harvest								
S_1	85.83	76.00	69.90	61.64	57.96	54.03	49.66	36.13
S_2	83.92	73.58	68.53	62.26	58.45	54.15	50.11	34.82
S_3	82.75	73.08	65.78	61.25	56.97	53.26	50.40	33.66
S_4	82.58	71.58	61.12	55.40	50.65	47.45	43.90	42.78
S.Em±	0.85	0.76	0.53	0.63	0.54	0.46	0.42	0.65
CD (*P=0.05*)	2.38	2.15	1.50	1.77	1.53	1.29	1.19	1.84
Interaction L X S								
S Em±	1.69	1.53	1.07	1.26	1.08	0.92	1.17	1.31
CD (*P=0.05*)	NS	NS	3.01	3.54	3.05	2.58	3.38	3.68
CV (%)	4.94	5.09	3.95	5.13	4.74	4.30	4.27	8.69

Physiological loss of weight

Data on influence of stem length on loss of weight (%) showed that this was significantly affected, and the minimum value (31.29%) was recorded in 90 cm stem length, at par with L_3 (Tables 5 and 6). Stage of harvest had significant effect and a lower PLW% (33.66) was recorded at two-floret open stage (S_3); however, this was at par with S_2. Interaction effect was also found to be significant in the combination L_3S_2. This may be due to higher uptake of water concomitant with lower loss of water and higher water-retention in the spike.

Table 6. Interaction effect of stem length and stage of harvesting on fresh weight and physiological loss of weight of spike during vase life in tuberose (pooled)

Treatments	Fresh weight of spike (g)					PLW (%)
	6th day	8th day	10th day	12th day	14th day	
L_1S_1	44.45	38.22	33.15	28.75	25.97	46.86
L_1S_2	43.77	38.27	34.68	31.60	28.83	38.57
L_1S_3	42.43	38.83	36.58	33.67	31.67	35.36
L_1S_4	34.25	32.20	29.80	27.58	26.32	42.68
L_2S_1	55.25	45.43	46.60	42.92	38.82	37.30
L_2S_2	56.78	46.18	42.45	39.27	35.28	46.77
L_2S_3	55.93	51.83	48.87	45.60	42.75	33.88
L_2S_4	50.18	44.90	41.08	36.15	30.27	52.42
L_3S_1	80.33	74.76	70.25	66.93	58.88	29.59
L_3S_2	78.61	76.50	73.80	67.23	61.97	25.46
L_3S_3	72.08	67.33	61.63	57.60	53.60	35.92
L_3S_4	67.00	60.48	53.45	52.23	49.98	39.58
L_4S_1	99.58	88.13	81.83	77.52	74.97	30.78
L_4S_2	94.97	88.08	82.87	78.48	74.35	28.48
L_4S_3	92.67	87.00	80.80	76.18	73.57	29.48
L_4S_4	93.05	84.00	78.27	73.85	69.05	36.44
S.Em±	1.069	1.259	1.084	0.92	0.85	1.31
CD (*P=0.05*)	3.01	3.54	3.05	2.58	2.39	3.68
CV (%)	3.95	5.13	4.74	4.30	4.28	8.69

Percentage of opened and abscised florets

Among various stem lengths, the longest spike length (L_4) significantly promoted opening of florets (45.95%), followed by L_2 (Tables 7 and 8). This might have been due to higher water-uptake and water balance with higher turgidity and increased amounts of carbohydrates, which promote respiration. Similarly, the maximum number of opened florets (54.46%) was recorded in the three-florets open stage of harvest (S_4), followed by two-florets open (S_3). The treatment combination L_2S_4 performed better with maximum number of opened florets (59.56%). Highest number of opened florets seen at advanced stage might be due to sufficient accumulation of carbohydrates, enhancing petal movement. Similar results were found by De *et al* (1996) in cut rose; Sangama and Singh (1999), Satpute and Patel (2002) and Barman and Rajni (2004) in gladiolus, and, Brahmankar *et al* (2005) in golden rod. Similar results were also observed for percentage of abscised florets.

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Table 7. Effect of stem length and stage of harvest on percentage of opened and abscised florets during vase life in tuberose

Treatments	Opened florets (%)			Abscised florets (%)		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
Length of stem						
L_1	43.50	33.65	38.57	*5.89 (33.69)	5.72 (31.71)	5.80 (32.70)
L_2	49.17	39.28	44.23	5.42 (28.40)	5.21 (26.14)	5.32 (27.26)
L_3	47.56	40.08	43.82	5.31 (27.16)	5.12 (25.12)	5.21 (26.18)
L_4	49.05	42.85	45.95	5.23 (26.36)	5.01 (24.15)	5.12 (25.24)
S.Em. ±	0.78	0.79	0.56	0.04	0.03	0.02
CD (*P=0.05*)	2.25	2.28	1.57	0.11	0.087	0.07
Stage of harvest						
S_1	37.80	29.61	33.70	6.28 (38.49)	6.10 (36.25)	6.19 (37.36)
S2	40.57	32.03	36.30	5.51 (29.37)	5.34 (27.50)	5.42 (28.43)
S_3	52.08	44.12	48.10	5.45 (28.68)	5.24 (26.44)	5.34 (27.55)
S_4	58.82	50.11	54.46	4.61 (20.22)	4.38 (18.22)	4.50 (19.21)
S.Em. ±	0.78	0.79	0.56	0.04	0.03	0.02
CD (*P=0.05*)	2.25	2.28	1.57	0.11	0.08	0.07
Interaction L X S						
S.Em. ±	1.57	1.59	1.12	0.08	0.05	0.05
CD (*P=0.05*)	4.50	4.55	3.14	0.22	0.16	0.13
CV (%)	5.74	7.05	6.33	2.38	1.79	2.12

Table 8. Interaction effect of stem length and stage of harvest on percentage of opened and abscised florets during vase life in tuberose

Treatments	Opened florets (%)			Abscised florets (%)*		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
L_1S_1	35.46	25.89	30.67	7.08 (49.06)	6.92 (46.92)	7.00 (47.98)
L_1S_2	44.76	35.23	39.99	6.05 (35.66)	5.86 (33.39)	5.96 (34.51)
L_1S_3	45.43	35.15	40.29	5.45 (28.71)	5.27 (26.80)	5.36 (27.75)
L_1S_4	48.33	38.33	43.33	4.98 (23.79)	4.82 (22.22)	4.90 (23.00)
L_2S_1	33.56	23.71	28.63	5.93 (34.15)	5.79 (32.47)	5.86 (33.31)
L_2S_2	43.59	33.65	38.62	5.50 (29.24)	5.35 (27.60)	5.42 (28.41)
L_2S_3	55.01	45.19	50.10	6.11 (36.37)	5.88 (33.60)	6.00 (34.97)
L_2S_4	64.53	54.59	59.56	4.15 (16.21)	3.82 (13.63)	3.99 (14.89)
L_3S_1	36.15	29.86	33.01	6.47 (40.92)	6.30 (38.64)	6.39 (39.77)
L_3S_2	41.60	34.70	38.15	4.30 (17.47)	4.16 (16.27)	4.23 (16.86)
L_3S_3	50.49	43.82	47.16	4.94 (23.39)	4.76 (21.67)	4.85 (22.52)
L_3S_4	61.98	51.93	56.95	5.52 (29.44)	5.27 (26.73)	5.39 (28.06)
L_4S_1	46.02	38.99	42.50	5.66 (31.00)	5.41 (28.26)	5.53 (29.62)
L_4S_2	32.33	24.53	28.43	6.19 (37.35)	5.99 (34.83)	6.09 (36.08)
L_4S_3	57.38	52.33	54.86	5.29 (26.98)	5.04 (24.37)	5.16 (25.66)
L_4S_4	60.45	55.57	58.01	3.78 (13.30)	3.63 (12.15)	3.70 (12.72)
S.Em±	1.57	1.59	1.12	0.08 0.05	0.05	
C D *(P=0.05)*	4.50	4.55	3.14	0.22 0.16	0.13	
CV (%)	5.74	7.05	6.33	2.38 1.79	2.12	

* Figures in parentheses indicate square root transformed values

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