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Vase life of spray chrysanthemum cultivars (*Dendranthema grandiflora* Tzvelev.) cultivated in polyhouse conditions

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Abstract
A study was conducted to examine the efficacy of vase solutions on postharvest life of spray chrysanthemum cultivars Terry, White Dolly, Yellow Spoon, Red Stone, Star Pink, Bronze Spoon, Paper White, Kelvin Victory and Indiana. Vase life and flower quality were significantly influenced by vase solutions. The maximum vase life (7.50 days) was observed in S_2 and its interaction S_2 C_4 recorded maximum vase life (9.50 days). C_9 recorded maximum fresh weight of flower (104.0 g) and as far as interaction is concerned, S_1 C_9 recorded maximum fresh weight of flower (106.7 g). The minimum water loss (4.19 g) was recorded on day 4-5 in S_1, as far as interaction is concerned S_1 C_8 recorded minimum water loss (3.20 g). The maximum water uptake (8.30 days) was recorded on day 0-1 in S_1 and interaction S_1 C_4 recorded maximum water uptake (11.81 g).

Keywords: Spray chrysanthemum cultivars, vase life, distilled water and 8HQC.

Introduction
World trade of fresh cut flower is increasing, day by day. Cut flowers make up about one-third of the value of the global ornamental horticulture market. Fresh flowers lose their freshness and quality both during travel and also during and after arrangements due to flower specific short vase life. Such deficiencies can be ameliorated through application of nutrient additives to vase water. Use of preservative solutions has been known for many years to increase the vase life of cut flowers. Different methods like use of holding, pulsing and bud opening solution, growth regulators, gamma irradiation, precooling, cold storage, packaging etc. are already in practice in the flower trade to ensure the garden fresh quality of flowers to consumers (Singh *et al.*, 2001) [7]. Influence of different holding solutions on chrysanthemum *(Dendranthema grandiflora* Tzvelev.) have been reported earlier (Koframek and Halevy, 1972; Marousky, 1969, 1971; Talukdar *et al.*, 2004) [3, 5, 6, 8]. Informations on this subject are scattered. There is need to develop appropriate crop specific postharvest technology, suitable to specific agro-climatic zone, to avoid loses at the growers, florists and consumers levels. Keeping this in view, attempts were made to find out the best holding solutions for commercial exploitation to increase the vase life.

Materials and methods
The experiment was conducted in post-harvest technology laboratory at Horticultural college and research institute, located at Anantharajupeta, Kadapa district, Andhra Pradesh during the period October 2015 – March 2016. The experimental material consisted of nine spray cultivars of chrysanthemum such as Terry – anemone, White Dolly – anemone, Yellow Spoon – spoon, Red Stone – decorative, Star Pink – decorative, Bronze Spoon – spoon, Paper White – decorative, Kelvin Victory – Pompon and Indiana – pompon, was collected from the crop raised under naturally ventilated polyhouse with uniform standard cultural practices. The crop was raised under naturally ventilated polyhouse with uniform standard cultural practices. The stems were harvested with help of sharp secateurs at 8:00 am in the morning when 50 per cent of flowers were about ¾ th open. The stems lengths of all flowers were uniformly maintained i.e. 35 cm. The cut stems were kept in two different solutions S_1 – distilled water and S_2 – sucrose (2%) + 8HQC (500 ppm). The experiment was laid out in 2 – factorial CRD with three replications. Observations like vase life, fresh weight of flower, water uptake and transpiration loss of water.

Results and Discussion

Post-harvest characteristics of cut chrysanthemum cultivars were significantly affected by two vase life solutions as well as cultivars and their interaction.

Vase life

The maximum mean vase life was observed in (7.50 days) S_2 and (8.50 days) C_4: Red Stone. it's The interaction effects showed that interaction S_2 C_4 recorded maximum vase life (9.50 days) followed by in S_2 C_6 (8.75 days) while minimum vase life (4.00 days) in S_1 C_3. (Table 1). The variations in vase life may be due to the difference in accumulation of carbohydrates due to varied leaf production and sensitivity of cultivars to ethylene and in turn variations in these aspects might be due to genetical makeup of genotypes as reported by Vetrivel and Jawaharlal (2014) [9].

Table 1: Vase life of spray chrysanthemum cultivars

Name of the cultivar	Distilled water (days) (S_1)	Sucrose (2%) + 8HQC (500ppm) (days) (S_2)	Mean
C_1: Terry	5.00	7.00	6.00
C_2: White Dolly	6.25	8.25	7.25
C_3: Yellow Spoon	4.00	7.00	5.50
C_4: Red Stone	7.50	9.50	8.50
C_5: Star Pink	5.25	5.50	5.37
C_6: Bronze Spoon	5.50	8.75	7.12
C_7: Paper White	5.00	7.75	6.37
C_8: Kelvin Victory	4.50	6.75	5.62
C_9: Indiana	5.50	7.00	6.25
Mean	5.38	7.50	
	SE m±	CD	
S	0.11	0.31	
C	0.23	0.67	
S x C	0.33	0.95	

Fresh weight of cut stems (g)

The cultivar, C_9 (Indiana) recorded maximum fresh weight of flower (104.0 g) followed by C_5 (Star Pink) (80.08 g) and as far as interaction is concerned, S_1 C_9 recorded maximum fresh weight of flower (106.7 g) followed by S_2C_9 (101.2 g) which is statistically on par with S_1C_9 whereas minimum weight (45.47 g) was recorded in S_1 C_2 on second day. (Table 2).

The increase in fresh weight can happen only when the rate of water absorption is greater than transpiration rate (Rogers, 1973). Similar findings were reported by Baskaran *et al.* (2009) [1] in chrysanthemum and Kumar *et al.* (2013) [4] in gerbera.

Table 2: Fresh weight (g) changes during the period of vase life studies in spray chrysanthemum cultivars

Name of the Cultivars	1 day			2 day			3 day			4 day			5 day		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
C_1: Terry	65.87	72.77	69.32	66.45	75.05	70.51	64.39	72.55	68.57	54.47	70.19	62.33	52.25	67.50	59.87
C_2: White dolly	43.92	65.34	54.63	45.47	67.24	56.36	43.75	64.51	54.13	41.45	63.73	52.59	39.75	61.10	50.42
C_3:Yellow Spoon	65.12	58.26	61.69	67.30	59.87	63.58	65.62	58.79	62.21	63.37	57.09	60.23	60.75	54.87	57.81
C_4: Red Stone	72.27	75.46	73.87	73.75	77.47	75.61	71.47	75.02	73.25	69.80	73.08	71.44	67.00	71.30	69.15
C_5: Star Pink	76.85	79.66	78.25	78.85	81.31	80.08	77.30	78.55	77.92	75.12	76.94	76.03	73.00	74.27	73.63
C_6:Bronze Spoon	75.77	77.86	76.81	76.90	78.98	77.94	74.97	76.32	75.64	73.00	74.05	73.52	71.00	71.85	71.42
C_9: Paper white	105.8	99.40	102.6	106.7	101.2	104.0	102.3	97.90	100.1	99.67	96.80	98.23	96.50	95.02	95.76
C_8:Kelvin Victory	78.80	61.94	70.37	80.17	63.46	71.81	77.92	58.37	68.15	76.42	55.85	66.13	73.00	52.63	62.78
C $_9$: Indiana	55.25	52.07	53.66	56.17	53.57	54.87	54.37	51.30	52.83	52.10	49.47	50.78	46.50	48.25	47.37
Mean	71.08	71.42		72.42	73.13		70.24	70.39		67.26	68.58		64.41	66.30	
	S.E m± CD			S.E m± CD			S.E m± CD			S.E m± CD			S.E m± CD		
S	0.27 0.77			0.26 0.74			0.24 0.70			0.22 0.63			0.23 0.66		
C	0.57 1.63			0.55 1.57			0.52 1.48			0.47 1.35			0.49 1.41		
S x C	0.81 2.31			0.78 2.23			0.74 1.85			0.67 1.91			0.70 1.99		

Transpiration loss of water (g)

The minimum water loss (4.19 g) was recorded on throughout the vase life period upto day 4-5 in S_1, as far as interaction is concerned S_1 C_8 recorded minimum water loss (3.20 g) while maximum average water loss (8.27 g) was recorded in S_2 on day 0-1 and its interaction S_2 C_1 showed maximum water loss (9.49 g). (Table 3). The water loss due to decline in uptake of water coupled with transpiration leads to water deficit, which ultimately reduces turgidity in cut flowers as stated by Halevy and Mayak (1981) [2] and Baskaran *et al.* (2009) [1].

Table 3: Transpiration loss of water (g) (TLW) during the period of vase life studies in spray chrysanthemum cultivars

Name of the Cultivars	Day 0-1			Day 1-2					Day 2-3			Day 3-4		Day 4-5		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
C_1: Terry	11.89	9.49	10.69	8.29	7.85	8.07	4.57	6.80	5.68	5.53	5.37	5.45	5.18	5.22	5.20
C_2: White dolly	8.67	8.45	8.56	10.50	7.84	9.17	4.58	6.06	5.32	6.52	5.77	6.15	5.77	5.63	5.70
C_3: Yellow Spoon	54.63	9.93	7.59	6.17	9.08	7.62	6.63	8.39	7.51	5.09	7.15	6.12	4.32	6.07	5.20
C_4: Red Stone	5.24	6.58	7.07	5.14	5.65	5.40	4.66	4.87	4.76	6.54	4.57	5.55	5.28	3.52	4.40
C_5: Star Pink	7.56	8.08	5.66	1.67	7.90	4.78	5.38	7.90	6.64	5.22	5.27	5.25	3.65	5.17	4.41
C_6: Bronze Spoon	3.24	9.75	8.38	10.01	8.21	9.11	9.62	7.81	8.72	3.88	6.54	5.21	3.32	6.49	4.90

C_9: Paper white	7.01	8.55	7.38	6.28	7.04	6.66	2.63	6.18	4.41	4.20	6.08	5.14	3.56	5.34	4.45
C_8: Kelvin Victory	6.21	7.26	5.11	5.71	6.15	5.93	3.76	4.25	4.21	4.85	3.90	4.37	3.20	3.55	3.37
C $_9$: Indiana	2.96	6.30	5.30	4.05	5.24	4.64	4.13	4.87	4.50	3.61	4.59	4.10	3.45	3.55	3.50
Mean	6.34	8.27		6.42	7.22		5.11	6.35		5.05	5.47		4.19	4.95	
	S.E m± CD			S.E m± CD			S.E m± CD			S.E m± CD			S.E m± CD		
S	0.05 0.16			0.05 0.15			0.04 0.11			0.04 0.11			0.03 0.10		
C	0.12 0.24			0.11 0.33			0.08 0.24			0.08 0.24			0.08 0.22		
S x C	0.17 0.48			0.16 0.47			0.12 0.34			0.12 0.34			0.11 0.32		

Water uptake (g)

The maximum water uptake (8.30 days) was recorded on day 0-1 in S_1 and interaction S_1 C_4 recorded maximum water uptake (11.81 g) followed by interaction S_1 C_5 (11.60 g) while minimum water uptake (3.11 g) was recorded in S_1 on day 4-5 as far as interaction is concerned, S_1 C_7 showed minimum water uptake (0.80 g). (Table 4). The increased water uptake maintains turgidity, freshness of flowers and thus enhances vase life owing to improved water balance and post-harvest physiology as observed by Kumar *et al.* (2013) [4] in gerbera.

Table 4: Water uptake (g) changes during the period of vase life studies in spray chrysanthemum cultivars

Name of the Cultivars	Day 0-1			Day 1-2				Day 2-3		Day 3-4			Day 4-5		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
C_1: Terry	10.50	11.08	10.79	8.71	4.91	6.81	6.50	6.90	6.70	5.26	4.94	5.10	5.14	3.73	4.44
C_2: White dolly	5.26	3.67	4.47	5.68	7.82	6.75	5.19	8.81	7.00	4.73	8.22	6.47	3.84	7.55	5.70
C_3: Yellow Spoon	4.59	5.16	4.88	3.66	6.43	5.04	3.07	5.37	4.22	2.17	4.93	3.55	1.36	4.78	3.07
C_4: Red Stone	11.81	8.49	10.15	6.70	7.40	7.05	5.61	9.22	7.41	4.20	8.58	6.39	3.48	7.48	5.48
C_5: Star Pink	11.60	9.73	10.66	8.28	8.08	8.18	6.27	5.37	5.82	5.56	3.19	4.37	4.61	2.43	3.52
C_6: Bronze Spoon	10.32	5.77	8.05	8.23	6.08	7.15	4.18	6.56	5.37	4.25	6.09	5.17	3.43	5.60	4.52
C_9: Paper white	7.54	8.50	8.02	5.34	10.48	7.91	3.79	7.46	5.62	1.99	6.78	4.38	0.80	5.53	3.16
C_8: Kelvin Victory	8.28	10.27	9.27	6.42	12.82	9.62	3.35	7.90	5.62	3.24	7.09	5.16	2.53	6.23	4.38
C $_9$: Indiana	4.79	7.47	6.13	3.67	11.27	7.47	3.11	4.75	3.93	2.51	3.10	2.80	2.82	2.61	2.71
Mean	8.30	7.79		6.30	8.37		4.56	6.93		3.77	5.88		3.11	5.10	
	S.E m± CD			S.E m± CD			S.E m± CD			S.E m± CD			S.E m± CD		
S	0.02 0.07			0.02 0.07			0.01 0.04			0.01 0.04			0.04 0.12		
C	0.05 0.16			0.05 0.15			0.03 0.09			0.03 0.10			0.09 0.25		
S x C	0.08 0.22			0.07 0.22			0.04 0.13			0.05 0.14			0.12 0.36		

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