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INFLUENCE OF CERTAIN CHEMICALS ON VASE LIFE OF CUT TULIP

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SUMMARY

An experiment was undertaken in two consecutive seasons of 2003-04 and 2004-05 to understand the physiological and biochemical events leading to senescence and the role of chemicals in advancing the longevity of cut tulip. Standard grade of tulip bulbs cv. 'Apeldoorn' were grown in the open field conditions following the recommended package and practices. Tulip scapes were harvested at bud colour break stage and placed in conical flasks (250 ml) containing vase solution comprised of sucrose (Suc) 2.0 per cent and 4.0 per cent plus aluminum sulphate (AS) 200 and 300 ppm, and citric acid (CA) 1000 and 2000 ppm. Distilled water without any chemical was served as control. The flasks were kept in the laboratory at a room temperature of 20 ± 2 ^{0}C with a relative humidity of 70 ± 5 % under cool light of 2000 lux (12 h). Floral preservatives significantly influenced the different physiological attributes and improved the quality and vase life of cut tulip by about 4 days. Holding solutions comprised of Suc 4% + AS 200 ppm resulted in maximum fresh weight gain of scapes (30.22%), leaf chlorophyll content (0.41 mg g^{-1} f.w.), leaf and petal relative water content (RWC) (64.5 % and 58.7%), petal membrane stability index (MSI) (53.7%) and leaf and petal sugar (29.35 mg g^{-1} d. w. and 38.3 mg g^{-1} d. w.) and protein (18.55 mg g^{-1} d. w. and 28.9 mg g^{-1} d. w.). Similar treatment also recorded the highest scape length (29.80 cm), tepal diameter (8.96 cm) and vase life (11.66 day).

Key words: **Biocide, MSI, RWC, sucrose, tulip, vase life**

INTRODUCTION

The post harvest life and quality of cut tulip is an outcome of physiological processes occurring within the harvested organ. Many of the post harvest phenomena of cut flowers are dependent on the water supply and balance which is controlled by uptake, conductance and maintenance. Unlike fruits and vegetables, cut flowers are composed of many morphological units including sepals, petals, androecium, gynoecium, stem and often leaves. The relationship among these units determines the water balance and ultimately the quality of cut flowers. Cut flowers are also distinguished into two different phases, i.e. (i) bud growth and development to full flower opening and (ii) the maturation, senescence and wilting. Flower ageing is accompanied by changes in carbohydrate, protein and nucleic acid contents of the petal. Exogenous supply of sucrose balanced the depletion of carbohydrate and improved the vase life and quality of many cut flowers (van Doorn 2004). Various chemicals like citric acid, aluminum sulphate, chlorine, silver thiosulphate, etc. have also been used in the vase solution to check the microbial growth and ethylene production. Senescing petals showed increased leakage of anthocyanins and electrolytes which indicate loss of selective permeability of both the tonoplast and the plasma membrane (Matile 1997). This results in contact between the membrane-bound lytic enzymes and

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disintegration of the remaining membranes including the plasma membrane. However, informations are lacking with this regards in tulip. Therefore, the present experiment was undertaken to understand the physiological and biochemical events leading to senescence and the role of chemicals in advancing the longevity of cut tulip.

MATERIALS AND METHODS

The standard grade of tulip bulbs cultivar 'Apeldoorn' were planted during 2003-04 and 2004-05 in the experimental field of the Division of Floriculture, Medicinal and Aromatic Plants (SKUAST-K), Shalimar and recommended package and practices were adopted. Tulip scapes, at bud colour break stage, were harvested in the morning during the first week of March and brought to the laboratory in a bucket containing water. Before placing in the vase solution, scapes were cut in a slanting manner to a uniform size (20 cm) and leaving only one leaf on each scape. After taking the initial weight, scapes were placed in conical flasks (250 ml) containing vase solution of different floral preservatives. Different treatments were comprised of sucrose (Suc) 2.0 per cent and 4.0 per cent plus aluminum sulphate (AS) 200 and 300 ppm, and citric acid (CA) 1000 and 2000 ppm. Distilled water without any chemical was taken as control. Each treatment was replicated thrice and ten flasks constituted one unit. The flasks were covered with aluminum foil to prevent evaporation loss and kept in the laboratory at a room temperature of 20 ± 2 ^{0}C with a relative humidity of 70 ± 5 % under cool light of 2000 lux (12 h). The difference between consecutive measurements of the weight of flask + solution + scape and weight of flask + solution represented the fresh weight of flower on that day and was expressed as percentage of initial fresh weight. Leaf chlorophyll content was measured following the non-maceration method (Hiscox and Israelstam, 1979). Relative turgidity (RWC), total sugar and soluble protein in leaf and petals were estimated by the methods of Weatherley (1970), Yemm and Willis (1954) and Lowry *et al.* (1951), respectively. The loss of membrane integrity in petals was measured by the efflux of electrolytes (Bailley *et al.* 1996) and membrane stability index (MSI) was calculated as per cent. The termination of vase life was considered when petals expressed first sign of wilting. The experiment was protracted up to twelve days when more than 90 per cent of the scapes were terminated their usable life. Data were analyzed statistically by analysis of variance and means were compared by least significant difference (LSD) test (Gomez and Gomez 1984).

RESULTS AND DISCISSION

The per cent fresh weight change of the scapes kept in different holding solutions was found to increase up to day 9 and then decreased slightly (Fig. 1). An obvious difference in per cent fresh weight gain was recorded

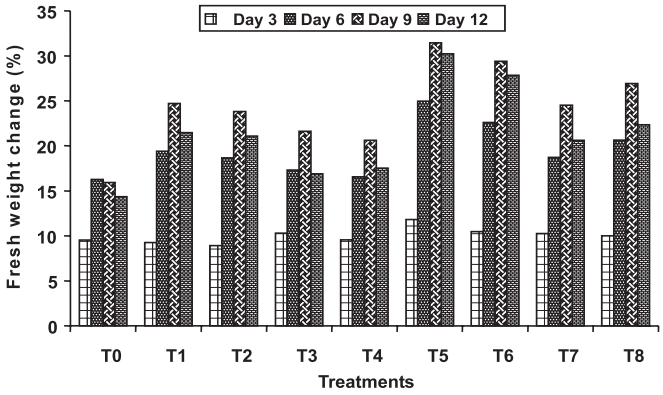

Fig. 1. Effect of chemicals on fresh weight changes in tulip scapes. SEm± amongst the treatments at day 3 (0.61), day 6 (0.74), day 9 (0.56) and day 12 (0.63)

at day 6 and onward and the maximum fresh weight gain at the last day of experiment was recorded with Suc 4% + AS 200 ppm (30.22%) followed by Suc 4% + AS 300 (27.85%). Maintenance of higher fresh weight of cut flowers with sucrose and biocides have been reported by many workers (Qadri *et al*. 2001, Patel and Mankad 2002, Pal *et al.* 2003). The increase in fresh weight gain of sucrose treated flowers may be attributed to the translocation and accumulation of sugars in petal tissues which increased the osmotic potential and thus ability to absorb more water. Besides, role of both AS and CA in facilitating the water transport by inhibiting the microbial growth is well known. Decrease in chlorophyll content is a well known fact in senescing organs. We have also found that the leaf chlorophyll content of cut tulip was decreased with progression of time in vase but floral preservatives significantly slowed down the rate of chlorophyll depletion (Table 1). AS treatments maintained their superiority over CA combinations

throughout the holding period and at day last the highest chlorophyll content (0.43 mg g^{-1}) was recorded with Suc 2 % + AS 300 ppm which was at par with other treatment combinations of Suc and AS. Different treatment combinations of Suc and CA differed significantly with Suc and AS combinations.

Table 1. Effect of certain chemicals on leaf chlorophyll content (mg g^{-1} fw) of cut tulip

Treatment	Days after keeping scapes in holding solution				
	0	3	6	9	12
Control (Distilled water)	0.65	0.50	0.41	0.31	0.25
Sucrose 2 % + AS 200 ppm	0.63	0.60	0.55	0.44	0.39
Sucrose 2 % + AS 300 ppm	0.65	0.63	0.58	0.48	0.43
Sucrose 2 % + CA 1000 ppm	0.66	0.57	0.47	0.38	0.30
Sucrose 2 % + CA 2000 ppm	0.64	0.55	0.45	0.36	0.28
Sucrose 4 % + AS 200 ppm	0.63	0.57	0.55	0.46	0.41
Sucrose 4 % + AS 300 ppm	0.64	0.58	0.54	0.45	0.38
Sucrose 4 % + CA 1000 ppm	0.64	0.54	0.50	0.41	0.31
Sucrose 4 % + CA 2000 ppm	0.65	0.52	0.49	0.40	0.33
CD at 5 %	NS	0.05	0.07	0.07	0.09

AS: Aluminium sulphate; CA: Citric acid

Leaf turgidity (Table 2) of different treatment was at par up to day 3; however, a significant difference due to treatments was recorded on day 6 which become more pronounced with passing of time. Similar results by acidifying vase solution have also been reported by earlier workers (Gowda and Gowda 1990, Pal *et al*. 2003). Among all the treatments AS combinations proved better in maintaining leaf turgidity as compared to CA combinations. At day 12 Suc 4% + AS 200 ppm and Suc 4% + CA 1000 ppm witnessed the highest relative turgidity of 58.7% and 50.9% among AS and CA group of treatments, respectively. Turgidity of flower petals also followed the same pattern with slightly lesser values. As the cut flowers are deprived of its natural source of food, water, minerals and hormones and carries out their life processes at the expense of the reserved food, chiefly sugars, external supply of sucrose maintains the respiratory substrate pool and improve the water balance of cut flowers by contributing the osmotic adjustment leading to increase in flower longevity. Role of sucrose in maintaining the water status may also partly be due to its effect on stomatal closure. Addition of AS as well as CA into the vase solution along with sugars further improved water uptake. A better water balance under AS treatments may also be attributed to its role in closing of stomata and reducing transpirational loss (Halevy and Mayak 1979, Singh *et al*. 2001).

Table 2. Effect of certain chemicals on leaf and petal RWC (%) of cut tulip

Treatment	Days after keeping scapes in holding solution									
	0		3		6		9		12	
	Leaf	Petal	Leaf	Petal	Leaf	Petal	Leaf	Petal	Leaf	Petal
Control (Distilled water)	83.3	77.8	68.0	75.0	59.1	63.6	52.5	54.3	46.7	42.5
Sucrose 2 % + AS 200 ppm	84.5	78.5	74.2	77.3	66.0	69.3	63.0	62.5	61.0	56.4
Sucrose 2 % + AS 300 ppm	83.6	77.6	75.3	77.0	68.3	67.5	63.3	69.8	58.3	55.2
Sucrose 2 % + CA 1000 ppm	84.0	78.0	73.8	77.7	64.2	68.0	58.3	57.6	55.4	49.5
Sucrose 2 % + CA 2000 ppm	83.3	77.9	70.2	76.6	62.0	64.7	58.0	57.6	53.0	46.0
Sucrose 4 % + AS 200 ppm	82.5	77.9	76.6	77.5	70.5	72.8	65.7	65.3	64.5	58.7
Sucrose 4 % + AS 300 ppm	84.1	78.3	73.1	77.8	64.2	66.1	60.9	61.4	58.0	53.4
Sucrose 4 % + CA 1000 ppm	82.3	77.1	74.4	76.2	65.4	67.3	61.1	59.4	57.8	50.9
Sucrose 4 % + CA 2000 ppm	81.8	78.2	73.5	77.5	63.5	67.4	59.2	59.6	54.5	48.8
CD at 5 %	NS	NS	NS	NS	3.05	4.16	5.21	3.25	5.70	5.13

AS: Aluminium sulphate; CA: Citric acid

Membrane stability index (MSI) was highest at the start of the experiment which was significantly decreased in all the treatments at each successive interval of observation (Fig. 2). Similar results have also been reported by Elenchezhian and Srivastava (2001), Singh and Jegadheesan (2003) and Singh (2005). A decrease in MSI indicates the loss of selective permeability or integrity of membranes which leads to electrolyte leakage. However, decrease in MSI was gradual in treated flowers as compared to a sharp decrease in control. Combinations of AS with Suc again proved its superiority as it maintained better MSI as compared to CA combinations. Membrane integrity is known to be closely related to physical and chemical changes in the lipids. It has been demonstrated that phospholipids and fatty acid breakdown is slowed down in the presence of sugars (Paulin 1986). The instrumental role of AS in maintaining the membrane integrity has also been reported by Bhaskar *et al*. (2003).

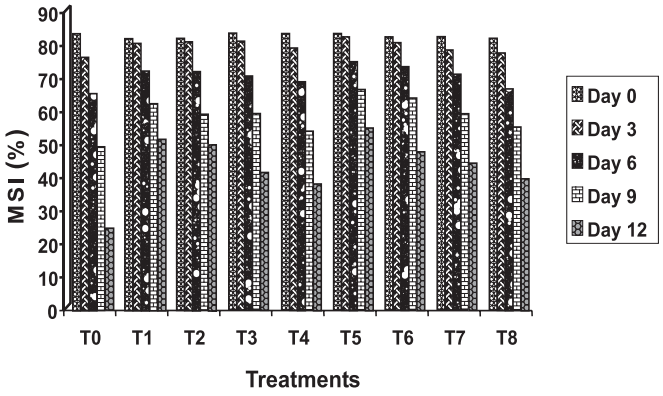

Fig. 2. Effect of chemicals on petal membrane stability index (MSI) in cut tulip. SEm± amongst the treatments at day 0 (0.64), day 3 (0.80), day 6 (1.07), day 9 (1.08) and day 12 (1.58)

Leaf sugar content (Table 3) decreased in all the treatments with passing of time and a significant difference due to treatments was evidenced from day 6 to day 12. Different combinations of AS as well as CA with Suc 4% maintained the higher level of leaf sugar throughout the holding period and at day 12 the maximum sugar content was recorded with Suc 4% + AS 200 ppm (29.35 mg g^{-1} dw) followed by Suc 4% + AS 300 ppm (25.18 mg g^{-1} dw), Suc 4% + CA 2000 ppm (23.58 mg g^{-1} dw) and Suc 4% + CA 1000 ppm (22.05 mg g^{-1} dw) A faster diminishing rate of sugar was witnessed in control with minimum sugar content (18.86 mg g^{-1} dw) at day 12. However, in contrast to leaf, petal sugar content was found to increase initially at day 3 then again decreased in consequent days of observations. The rate of respiration in many flowers rises to a maximum as flower start to open (Halevy and Mayak 1979, Amariutei *et al*. 1986). Tulip scape might have also required considerable quantity of food reserves to ensure efficient opening of flower buds. Supplying the cut tulips with exogenous sugars might have maintained the pool of dry matter and respirable substrates in leaves as well as petals.

A progressive decrease in leaf protein content was recorded in all the treatments including control but a significant difference due to different chemicals in holding solution over control was recorded only from the day 9 to day 12 (Table 4). However, petal protein content of treated flowers was found to increase up to day 6 of observation then decrease at day 9 and reached to minimum at day 12 against a steady decrease in petal protein content of untreated flowers. The petal protein content was recorded greater with higher dose of sugars (Suc 4%) as compared to lower dose of sugars (Suc 2%). At the termination of experiment Suc 4% + AS 200 ppm resulted in highest protein content (28.90 mg g^{-1} f.w.) followed by Suc 4% + AS 300 ppm, Suc 4% + CA 1000 ppm and Suc 4% + CA 2000 ppm against a minimum protein content (17.50 mg g^{-1} f.w.) in control. Our results with regard to petal protein content corroborated with the findings of Paulin (1986) and Singh and Jegadheesan (2003). The initial increase in soluble protein content in flower petals may be because of the supplied sugars, as sugars are known to favour various vital synthesis including proteins by giving a sufficient energetic level (Paulin 1977). Use of labeled sugar (^{14}C-sucrose) clearly revealed that sucrose is incorporated into soluble protein content of the petals (Halevy and Mayak 1979, Paulin 1986). However, once the reserve carbohydrate has depleted due to higher metabolic requirement during early phase of flower development, protein might have been used as respiratory metabolite to supply substrate for respiration and as a result its level started declined in the later stage of flower development i.e. senescence.

Data presented in Table 5 revealed that different floral preservatives significantly influenced the scape length, tepal diameter and vase life of cut tulip. The

Table 3. Effect of certain chemicals on leaf and petal sugar content (mg g^{-1} dw) of cut tulip

Treatment	Days after keeping scapes in holding solution									
	0		3		6		9		12	
	Leaf	Petal	Leaf	Petal	Leaf	Petal	Leaf	Petal	Leaf	Petal
Control (Distilled water)	46.55	51.2	40.17	54.2	33.60	46.5	25.52	35.0	18.86	19.4
Sucrose 2 % + AS 200 ppm	46.75	50.4	42.18	56.7	36.59	48.4	28.50	39.5	22.65	33.6
Sucrose 2 % + AS 300 ppm	46.45	51.5	42.35	55.4	35.65	50.9	26.15	38.8	21.85	31.8
Sucrose 2 % + CA 1000 ppm	46.10	49.5	42.62	56.4	36.36	47.3	27.30	46.4	20.75	32.7
Sucrose 2 % + CA 2000 ppm	46.42	51.6	41.70	57.2	38.65	48.4	25.52	38.6	19.10	30.9
Sucrose 4 % + AS 200 ppm	46.32	51.7	44.22	58.4	40.35	53.7	35.45	45.3	29.35	38.3
Sucrose 4 % + AS 300 ppm	46.83	51.4	43.62	57.1	38.81	52.2	32.73	45.6	25.18	36.6
Sucrose 4 % + CA 1000 ppm	46.35	51.0	42.32	58.0	37.28	52.0	30.10	40.6	22.05	35.4
Sucrose 4 % + CA 2000 ppm	45.40	50.2	43.53	59.8	38.19	51.2	31.65	41.5	23.58	34.5
CD at 5 %	NS	NS	NS	2.03	5.37	3.19	4.36	3.73	3.20	3.66

AS: Aluminium sulphate; CA: Citric acid

Table 4. Effect of certain chemicals on leaf and petal soluble protein content (mg g^{-1} dw) of cut tulip

Treatment	Days after keeping scapes in holding solution									
	0		3		6		9		12	
	Leaf	Petal	Leaf	Petal	Leaf	Petal	Leaf	Petal	Leaf	Petal
Control (Distilled water)	24.36	32.8	20.51	30.8	17.30	30.2	14.65	24.5	11.48	17.5
Sucrose 2 % + AS 200 ppm	25.50	34.0	22.63	42.1	18.57	47.7	16.42	37.9	15.09	24.0
Sucrose 2 % + AS 300 ppm	24.75	32.8	21.50	43.9	17.32	46.0	15.18	34.5	14.85	23.1
Sucrose 2 % + CA 1000 ppm	23.55	32.5	19.62	44.6	18.51	45.3	17.85	34.0	15.05	23.2
Sucrose 2 % + CA 2000 ppm	23.38	33.9	18.75	41.6	18.14	43.8	17.38	36.4	14.65	21.7
Sucrose 4 % + AS 200 ppm	24.80	30.9	22.50	48.8	21.15	57.0	19.43	40.7	18.55	28.9
Sucrose 4 % + AS 300 ppm	25.18	31.2	22.25	45.8	19.86	51.8	18.50	38.8	16.35	27.0
Sucrose 4 % + CA 1000 ppm	24.31	32.0	21.85	47.0	19.48	54.7	17.75	37.7	16.12	25.8
Sucrose 4 % + CA 2000 ppm	23.75	33.0	20.92	48.1	19.08	53.5	17.63	39.8	15.87	25.1
CD at 5 %	NS	NS	NS	3.80	NS	4.66	3.2	3.45	3.45	2.75

AS: Aluminium sulphate; CA: Citric acid

maximum scape length (29.80 cm), tepal diameter (8.96 cm) and vase life (11.66 day) was recorded with Suc 4% + AS 200 ppm against the minimum scape length (23.96 cm), tepal diameter (8.88 cm) and vase life in control. The increase in flower diameter and vase life by the addition of sucrose and biocides in holding solution have also been reported in several studies. The increased scape length and tepal diameter with extended vase life may be attributed to an improved tissue water status and availability of respiratory substrate as these are the prerequisite for normal metabolism and growth.

Table 5. Effect of certain chemicals on water relations, flower quality and vase life of cut tulip

Treatment	Scape length (cm)	Tepal diameter (cm)	Vase life (day)
Control (Distilled water)	23.96	7.25	07.88
Sucrose 2 % + AS 200 ppm	28.16	8.55	11.33
Sucrose 2 % + AS 300 ppm	27.86	8.23	11.00
Sucrose 2 % + CA 1000 ppm	26.16	7.66	10.33
Sucrose 2 % + CA 2000 ppm	26.06	7.83	10.00
Sucrose 4 % + AS 200 ppm	29.80	8.96	11.66
Sucrose 4 % + AS 300 ppm	24.96	7.98	11.00
Sucrose 4 % + CA 1000 ppm	26.06	8.16	10.66
Sucrose 4 % + CA 2000 ppm	25.13	7.65	10.33
CD at 5 %	2.17	0.29	0.850

AS: Aluminium sulphate; CA: Citric acid

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