Journal of Applied Horticulture, 16(3): 225-230, 2014

Effect of pulsing, 1-methyl cyclo propene (1-MCP) and packaging treatments on postharvest physiology of cut rose *cv*. First Red

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Abstract

An experiment was conducted to study the influence of different pulsing, pre packaging (1-Methyl Cyclo Propene) and packaging treatments on postharvest physiology, quality and vase life of cut rose flowers cv. First Red. Among the treatments, W_1 (Pulsing with 200 ppm 8-HQC and 10 % sucrose + pre packaging treatment with 0.18 % of 1 - MCP/m^3 for 6 hours + polythene wrapping) was found superior and it was associated with the highest values for appearance (score 5 - excellent), stem strength (90^0 angle), relative water content (92.95 per cent), water uptake (11.53 g stalk^{-1}), freshness of flowers (100 per cent) and vase life (6.3 days). The same treatment W_1 (Pulsing with 200 ppm 8-HQC and 10 % sucrose + pre packaging treatment with 0.18 % of 1 - MCP/m^3 for 6 hours + polythene wrapping) exhibited the lowest values for physiological loss in weight (3.58 per cent), transpirational loss of water (2.01 g stalk^{-1}), loss of membrane integrity (7.48 per cent) and peroxidase activity (0.016 units g^{-1} of fresh weight of flowers).

Key words: Pulsing, 1-MCP (1-methyl cyclo propene), packaging, physiology, vase life

Introduction

Rose ranks first among the cut flowers trade in domestic and international markets. However, the diminishing keeping quality of cut roses badly affects both the growers and as well the traders. Lower status of water, carbohydrates, proteins and fats in the floral tissue, poor handling and marketing methods adopted badly impair the physiology and biochemistry of flower petals leading to shortened vase life of cut flowers (Hassan and Ali, 2014). The extension of cut flower vase life and improved postharvest development practices has now become commercial and economically important practice based on scientific principles. Once cut flower is severed from the parent plant, the continuity of water movement to the flower is disrupted. Accomplishing extension of vase life mainly depends on postharvest cut flower handling and a preservative solution ensuring continuous ample supply of water and metabolites in addition to reserved food materials in the stems to petals and leaves of flowers.

Though roses occupy the top place in all international cut flower markets, competitions are very intensive where quality plays a priority role. The optimum quality for export of cut roses can be achieved by adopting proper postharvest handling techniques. Packaging is an important aspect in the cut flower trade and much depends on the proper method of packaging to ensure quality flowers to the consumer. The main principle of packaging is to prevent mechanical injury and retain their freshness, attractiveness, consumer appeal and quality in order to lower the rate of transpiration and respiration during transportation (Asghari *et al*., 2014). Packaging must ensure protection of flowers against damage, water loss and external conditions, which are detrimental to flowers in transit. Wrapping the cut carnation cv. Malaga flowers with 100 gauge polyethylene sleeve resulted in the lowest transpirational loss of water, loss of cell membrane integrity, physiological loss in weight and the highest freshness of flowers, water uptake and vase life compared to that of untreated control and other treatments (Punitha, 2007).

Rose as cut flower is highly perishable in nature and need to be pulsed, pre packaged and packaged properly to improve their postharvest quality and vase life. Hence, the present study was undertaken to determine the effect of pulsing, prepackaging (1-MCP) and packaging treatments on postharvest quality and vase life of cut rose cv. First Red.

Materials and methods

Location: The postharvest studies were carried out at the Department of Floriculture and Landscaping, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore which is geographically situated at 11° 02'' N latitude, 76° 57'' E longitude and at an altitude of 426.76 m above mean sea level.

Treatment details

W_0: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + without wrapping (control)

W_1: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + polythene (100 gauge) wrapping

W_2: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + brown paper wrapping

W_3: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + news paper wrapping

W_4: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + butter paper wrapping

Experiment was planed in Completely Ranodmized Design with 4 replicaiton. Treatment methods are described hereunder:.

Pulsing: The flower stalks were placed in the pre-conditioning pulsing solutions for 2 hours at ambient temperature.

1-Methyl Cyclo Propene (1-MCP): The flowers were exposed to 0.18 % of 1-MCP / m^3 for 6 hours after pulsing treatment. Pre packaging treatment of flowers with 1-MCP was carried out in airtight chamber. The flowers were kept in bucket containing distilled water. The 0.18 % 1-MCP in the form of tablets (celfresh) was dissolved in small beaker and required concentration was achieved (0.18 %) and then the chamber was sealed air tight immediately. Duration of the treatment was 6 hours.

Wrapping: After exposing the flowers to pulsing solution and 1-MCP, a bunch of 5 flowers were taken and wrapped with different lining materials. Then the flowers were kept in the ambient condition and different postharvest parameters were analysed.

Wrapping materials

Polythene sleeves: The polythene sleeves of 100 gauge thickness and size of 45 cm x 11 cm were used for wrapping the flower stalks.

Butter paper: The butter papers that are used in the bakery and confectionery were used here as covering material in the packaging experiment.

Brown paper: The brown sheets that are used for wrapping notebooks available in stationary shops were utilized for the packaging experiment.

News paper: The locally available newspaper dailies were used as the lining material in the packaging experiment.

Observations

Appearance: Flower appearance was stated as excellent, very good, good, poor and very poor to 5, 4, 3, 2 and 1 sensory score for the flowers showing 0-5 %, 6-10%, 11-25 %, 26-50 % and > 51 % wilting or abscission or discoloration or bent neck, respectively.

Stem strength: Angle of bent neck of rose flowers were measured in degree with protractor by holding the base of the flower stem and bloom facing up.

Physiological loss in weight: The initial weight of the flower was taken and subsequent weights were taken in the following days. The physiological loss in weight was arrived by using the following formula and expressed in percentage.

$$\text{Physiological loss in weight} = \frac{\text{Initial weight - Final weight}}{\text{Initial weight}} \times 100$$

Relative water content: The relative water content of rose petals was estimated as per the method suggested by Venkatarayappa *et al.* (1980). Petals were punched uniformly and the fresh weight of punches (30 numbers) was taken. Then the punches were made to float in water for two hours, after which turgid weight of those bunches was recorded after removing excess water by blotting them thoroughly. The dry weight was found out after drying in an oven at 70^o C. The relative water content of the petal was calculated using the following formula and expressed in percentage.

$$\text{Relative water content} = \frac{\text{Fresh weight – Dry weight}}{\text{Turgid weight – Dry weight}} \times 100$$

Water uptake: The difference between consecutive measurements of the container and the vase solution (without flower) were recorded at every alternate day interval to measure the water uptake within that particular duration of vase period and presented as gram per flower (Venkatarayappa *et al.*, 1980).

Transpirational loss of water: The difference between consecutive measurements of the container and the vase solutions (with flower) were recorded at every alternate day interval to measure the transpirational loss of water within that particular duration of vase period and presented as gram per flower (Venkatarayappa *et al.*, 1980).

Freshness of flowers: The number of flowers found fresh without senescence symptoms was recorded throughout the course of study and expressed in per cent.

Loss of membrane integrity: The loss in membrane integrity was assessed with the aid of UV visual spectrometer as per the method suggested by Leopold (1981). In this method, 25 equal sized petals were immersed in 25 mL of distilled water for two hours to allow leakage of solutes and the initial optical density (O.D) value was observed at 273 nm, thereafter it was boiled for 10 minutes in a water bath to complete total destruction of the membrane. The final O.D value was observed at 273 nm. The loss in membrane integrity was expressed as percentage of leaked solutes.

$$\text{Leachates (\%)} = \frac{\text{Final O.D at 273 nm - Initial O.D at 273 nm}}{\text{Final O.D at 273 nm}} \times 100$$

Vase life: The vase life of cut flower was recorded as per the method suggested by Halevy and Mayak (1981). The vase life of cut flower was evaluated daily by counting the number of days taken for the symptom of shriveling and wilting.

Peroxidase activity: Peroxidase activity was determined by adopting the procedure of Malik and Singh (1980). One gram sample was extracted with 10 mL of phosphate buffer (pH 7.0). A known volume of extract was added to the experimental cuvette containing 3 mL of pyrogallol and 0.5 mL hydrogen peroxide solution as a substrate and increase in absorbance at 420 nm was recorded. The change in every one minutes was used to calculate the enzyme activity. The enzyme activity was expressed as units per gram of fresh weight (1 unit = 1m mole/ minute).

Statistical analysis: The statistical analysis was done by adopting the standard procedures of Panse and Sukhatme (1985) and the results were interpreted.

Results

Appearance: On day 1, the rose flowers in all the treatments were excellent in appearance (score 5) and were on par with each other (Table 1). On day 3, the treatment W_1 showed excellent in appearance with score 5 and was significantly differed from W_0 (control). On day 5 also, the treatment W_1 exhibited excellent in appearance followed by W_4. During the entire vase life period W_1 showed superior scores for appearance over all other treatments, whereas the control (W_0) recorded minimum values for the same.

Stem strength: On day 1, treatment W_1 recorded maximum stem strength of 90^0 angle but there was no significant difference among the treatments (Table 2). The same trend was followed on day 3 also. On day 5, the treatment W_1 recorded the maximum stem strength of 86.46^0 angle and was closely followed by W_4 while the treatment W_0 showed lower value for the same (81.05^0 angle). There was declining trend in stem strength from day 1 to day 7 in all the treatments. However, during the entire vase life period the treatment W_1 exerted superior performance for stem strength.

Physiological loss in weight: There was an increasing trend in physiological loss in weight from day 1 to day 7 in all the treatments (Table 3). The treatment W_0 recorded highest physiological loss in weight during the entire experimental period whereas W_1 showed lowest values for the same.

Relative water content: The relative water content was increased from day 1 to day 3 and the highest relative water content of 92.95 per cent was recorded in W_1 on day 3 (Table 4). From day 5 onwards the relative water content started to decline towards the end of vase life period. During the entire experimental period the maximum relative water content was recorded in W_1, while W_0 recorded minimum values for the same.

Water uptake: Packaging the cut rose flower with different wrapping material exhibited significant influence on water uptake throughout the period of vase life. In all treatments including control (W_0) the water uptake was increased from day 1 to day 3 and thereafter started declining from day 5 onwards (Table 5). During the entire period the treatment W_1 exerted superior performance for water uptake at successive intervals of observation.

Transpirational loss of water: On day 1, the treatment W_1 recorded lower transpirational loss of water (2.01 g stalk^{-1}) while treatment W_0 recorded higher transpirational loss of water (3.21 g stalk^{-1}). During the entire vase life period the treatment W_1 exhibited the lowest transpirational loss of water while the

Table 1. Influence of pulsing, 1-Methyl Cyclo Propene and packaging treatments on appearance of cut rose flowers

Treatments	Day 1	Day 3	Day 5	Day 7	Mean
W_0: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + without wrapping	5*	4	3	2	3.5
W_1: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + polythene (100 gauge) wrapping	5	5	5	4	4.8
W_2: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + brown paper wrapping	5	4	3	3	3.8
W_3: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + news paper wrapping	5	4	3	3	3.8
W_4: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + butter paper wrapping	5	4	4	3	4.0
Mean	5.0	4.2	3.6	3.0	
LSD (*P*=0.05)	0.389	0.32	0.28	0.23	

*Score: 5 – Excellent; 4 – Very good; 3 – Good; 2 – Poor; 1 – Very poor

Table 2. Influence of pulsing, 1-Methyl Cyclo Propene and packaging treatments on stem strength (^{0} angle) of cut rose flowers

Treatments	Day 1	Day 3	Day 5	Day 7	Mean
W_0: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + without wrapping	89.94	85.93	81.05	77.56	83.62
W_1: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + polythene (100 gauge) wrapping	90.00	90.00	86.46	82.53	87.25
W_2: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + brown paper wrapping	89.98	86.93	83.01	77.93	84.46
W_3: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + news paper wrapping	89.96	86.38	82.97	77.81	84.28
W_4: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + butter paper wrapping	89.99	87.43	85.92	79.56	85.73
Mean	89.98	87.33	83.88	79.08	
LSD (*P*=0.05)	7.002	6.798	6.530	6.156	

Table 3. Influence of pulsing, 1-Methyl Cyclo Propene and packaging treatments on physiological loss in weight (%) of cut rose flowers

Treatments	Day 1	Day 3	Day 5	Day 7	Mean
W_0: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + without wrapping	5.65	7.56	11.42	16.53	10.29
W_1: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + polythene (100 gauge) wrapping	3.58	4.92	5.76	7.53	5.45
W_2: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + brown paper wrapping	5.09	6.18	9.45	14.58	8.83
W_3: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + news paper wrapping	5.13	6.30	9.53	14.72	8.92
W_4: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + butter paper wrapping	4.12	5.36	8.36	13.43	7.82
Mean	4.71	6.06	8.90	13.36	
LSD (*P*=0.05)	0.371	0.477	0.707	1.066	

Table 4. Influence of pulsing, 1-Methyl Cyclo Propene and packaging treatments on relative water content (%) of cut rose flowers

Treatments	Day 1	Day 3	Day 5	Day 7	Mean
W_0: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + without wrapping	77.89	82.48	76.35	72.81	77.38
W_1: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + polythene (100 gauge) wrapping	88.46	92.95	87.46	82.65	87.88
W_2: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + brown paper wrapping	79.53	84.97	79.53	73.41	79.36
W_3: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + news paper wrapping	78.29	84.82	79.12	73.03	78.82
W_4: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + butter paper wrapping	80.52	85.35	80.32	75.49	80.42
Mean	80.94	86.11	80.57	75.48	
LSD (P=0.05)	6.306	6.708	6.276	5.881	

Table 5. Influence of pulsing, 1-Methyl Cyclo Propene and packaging treatments on water uptake (g $stalk^{-1}$) of cut rose flowers

Treatments	Day 1	Day 3	Day 5	Day 7	Mean
W_0: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + without wrapping	6.11	7.98	5.95	4.32	6.09
W_1: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + polythene (100 gauge) wrapping	10.76	11.53	9.71	8.58	10.15
W_2: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + brown paper wrapping	8.43	9.56	7.32	6.41	7.93
W_3: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + news paper wrapping	8.38	9.48	7.25	6.31	7.86
W_4: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + butter paper wrapping	9.45	10.32	8.48	7.53	8.95
Mean	8.63	9.77	7.74	6.63	
LSD (P=0.05)	0.681	0.766	0.610	0.527	

Table 6. Influence of pulsing, 1-Methyl Cyclo Propene and packaging treatments on transpirational loss of water (g $stalk^{-1}$) of cut rose flowers

Treatments	Day 1	Day 3	Day 5	Day 7	Mean
W_0: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + without wrapping	3.21	4.11	7.10	6.00	5.11
W_1: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + polythene (100 gauge) wrapping	2.01	3.06	3.48	2.85	2.85
W_2: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + brown paper wrapping	2.81	3.90	4.86	5.32	4.22
W_3: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + news paper wrapping	2.85	3.99	5.04	5.38	4.32
W_4: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + butter paper wrapping	2.56	3.41	4.17	3.48	3.41
Mean	2.69	3.69	4.93	4.60	
LSD (P=0.05)	0.211	0.289	0.395	0.370	

treatment W_0 recorded the highest transpirational loss of water (Table 6).

Freshness: The freshness of the flowers decreased from day 1 to day 7 in all the treatments (Table 7). The treatment W_1 exhibited exemplary performance for freshness during the entire vase life period. On day 7, W_1 exhibited higher freshness percentage of 86.32 whereas W_0 recorded the lower value (73.43) for the same.

Loss of membrane integrity: On day 1, lower leachates (7.48 per cent) were registered in W_1 and higher leachates (16.43 per cent) were noticed in W_0 (Table 8). Similar trend was recorded at each successive interval from day 1 to 7. The leachates percentage was lowest on day 1 and increased towards the end of vase life period. On day 7, the leachates were lower in W_1 with the value of 22.51 per cent.

Vase life: Significant influence on vase life of the cut rose flowers was observed among the different treatments. The superior performance was displayed by W_1 with the vase life of 6.3 days followed by W_4 with the vase life of 5.6 days (Table 9). The least record on vase life was executed by W_0 with only 4.4 days.

Peroxidase activity: The peroxidase activity was the lowest (0.016 units g^{-1} of fresh weight of flowers) in W_1 and was significantly differed from all other treatments while W_0 recorded highest peroxidase activity of 0.027 units g^{-1} of fresh weight of flowers.

Discussion

During the entire vase life period, the treatment W_1 showed superior values for appearance and stem strength over all the treatments. This may be due to increased water uptake, reduced transpirational loss of water, ethylene synthesis and lower physiological loss in weight by polythene packaging in

Table 7. Influence of pulsing, 1-Methyl Cyclo Propene and packaging treatments on freshness (%) of cut rose flowers

Treatments	Day 1	Day 3	Day 5	Day 7	Mean
W_0: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + without wrapping	99.95	91.97	81.46	73.43	86.70
W_1: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + polythene (100 gauge) wrapping	100	100	96.63	86.32	95.74
W_2: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + brown paper wrapping	99.23	92.93	87.41	77.41	89.25
W_3: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + news paper wrapping	99.11	92.67	86.98	77.39	89.04
W_4: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + butter paper wrapping	99.56	94.13	90.53	78.15	90.59
Mean	99.57	94.34	88.60	78.54	
LSD (P=0.05)	7.749	7.346	6.906	6.121	

Table 8. Influence of pulsing, 1-Methyl Cyclo Propene and packaging treatments on loss of membrane integrity (% solute leakage) of cut rose flowers

Treatments	Day 1	Day 3	Day 5	Day 7	Mean
W_0: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + without wrapping	16.43	20.22	29.59	38.36	26.15
W_1: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + polythene (100 gauge) wrapping	7.48	10.41	15.93	22.51	14.08
W_2: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + brown paper wrapping	14.93	17.56	26.42	32.96	22.97
W_3: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + news paper wrapping	15.01	17.96	26.81	33.04	23.21
W_4: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + butter paper wrapping	10.43	12.56	19.59	25.75	17.08
Mean	12.856	15.742	23.668	30.524	
LSD (P=0.05)	1.034	1.257	1.884	2.416	

Table 9. Influence of pulsing, 1-Methyl Cyclo Propene and packaging treatments on vase life (days) and peroxidase activity (units g^{-1} of fresh weight of flowers) of cut rose flowers

Treatments	Vase life (days)	Peroxidase activity (units g^{-1} of fresh weight of flowers)
W_0: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + without wrapping	4.4	0.027
W_1: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + polythene (100 gauge) wrapping	6.3	0.016
W_2: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + brown paper wrapping	4.8	0.024
W_3: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + news paper wrapping	4.9	0.026
W_4: Pulsing (200 ppm 8-HQC + 10 % sucrose) + pre packaging treatment (0.18 % of 1- MCP / m^3 for 6 hours) + butter paper wrapping	5.6	0.018
Mean	5.2	0.022
LSD (P=0.05)	0.4	0.002

combination with pulsing and 1-MCP treatment. The sucrose added in the pulsing solution improves the water uptake and 1-MCP treatment inhibit the synthesis of ethylene by binding in the ethylene binding sites (Hassan and Ali, 2014). Additionally the polythene packaging modifies environmental conditions and also provides sufficient mechanical strength as a result the appearance and stem strength of cut rose of cv. First Red was improved.

During the entire vase life period the treatment W_1 showed minimum physiological loss in weight of flowers while W_0 exhibited maximum values for the same parameter. The reduced physiological loss in weight of flowers might be due to creation of modified atmosphere conditions with high humidity, which reduced the concentration of oxygen thereby reducing respiration (Bayleyegn *et al*., 2012). In turn the concentration of carbon dioxide might increase. The limited substrate for respiration resulted low physiological loss in weight as postulated by Suhrita *et al.* (2005). Similarly the carbohydrate supply through pulsing treatment replaces the depleted carbohydrate, while the 1-MCP treatment prevented ethylene damage and abscission. So the treatment W_1 exhibited the minimum values for the physiological loss in weight of cut rose flowers.

In the present investigation, different wrapping materials (polythene sleeves, brown paper, news paper and butter paper) were used for packaging the flowers. The highest water uptake and relative water content were recorded in W_1. This may be due to the combination of pulsing with sugar and quinoline salts, 1-MCP treatment in combination with polythene packaging. This combined packaging treatment of cut rose flowers reduced damage in the conducting vessels ensuring continuous water uptake through arresting microbial growth and providing continuous supply of carbohydrates and providing conducive modified environment through packaging. These results are in line with the findings reported by Jeeva and Balakrishnamoorthy (1999) in rose. The decreased water uptake in W_0 was mainly due to plugging of xylem vessels caused by bacteria (Doorn, 1986).

During the entire vase life period the treatment W_1 exhibited the lowest transpirational loss of water while the treatment W_0 recorded the highest values for the same. This may be due to mechanical strength and modified environment created by polythene wrapping. This results are in agreement with the reports of Bindu Panicker (2001) and Punitha (2007). Higher freshness W_1 was due to the presence of higher turgor and lower moisture loss during storage. Increased water uptake might also be the other reason for maintenance of freshness. Divya (2003) also reported higher freshness in rose due to high water content.

The lowest loss of membrane integrity W_1 may be due to increased mechanical strength and conducive modified environment. Benificial effects of modified environment have been noticed by Bindu Panicker (2001) in chrysanthemum and Punitha (2007) in carnation.

Peroxidase activity was found to be the lowest in W_1. Wrapping of cut rose flowers in polyethylene sleeves modifies atmosphere which slows down respiration, enzyme activity and transpiration of cut rose flowers. Such observation has also been reported by Prem *et al.* (2004) and Dastagiri *et al*. (2014) in cut Rose cv. Super Star.

The study revealed that polythene packaging in combination with pulsing and 1-MCP treatment maintained freshness, increased water uptake, reduced transpirational loss of water and lowered physiological loss of cut rose flowers cv. First Red. Sucrose added in the pulsing solution improved the water uptake and the polythene packaging created the modified environment conditions and also provided sufficient mechanical strength resulting better appearance and stem strength of cut rose.

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Received: February, 2014; Revised: March, 2014; Accepted: April, 2014