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Effect of Low Temperature Storage Techniques on Post Storage Quality of Rose cvs. Bordeaux, Poison and Avalanche

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ABSTRACT: An investigation was conducted to study the effect of different cold storage (at 2°C) techniques *viz*., dry storage with packaging of HDPE, LDPE, PP (polypropylene) and without packaging and wet storage methods of holding cut stems in water, $Al_2(SO_4)_3$ 200mg/l and citric acid 200mg/l solutions on flower quality and vase life of rose cvs., Bordeaux, Poison and Avalanche for the period of 10 days. Wet storage techniques failed to restrict marketable bud stage and showed increased bud opening by the end of the storage period (10 days). Among three packaging films cut flowers packed with PP packaging maintained higher CO_2 (9.72%) and decreased O_2 (11.24%) per cent within the packaging film as compared to HDPE and LDPE packaging in cold stored rose cut flowers as recorded just after storage. The HDPE, LDPE and PP stored at 2°C rose buds showed significantly, negligible physiological loss in weight, absence of bent neck after storage, higher TDS, dry weight, improved bud size, petal length and width and minimum bent neck during vase life as compared to without packaged stored and wet stored rose buds. Rose cut spikes held in vase solution during low temperature storage showed advance opening of flowers with decrease in vase life upon removal from low temperature storage. Thus PP packed cold stored rose flowers retained best flower quality as well as showed higher vase life as compared to the rose flowers stored with other treatments.

Keywords : Rose, Polypropylene, low temperature storage, vase life, dry storage and wet storage.

INTRODUCTION

"Rose" is one of the nature's beautiful creations and is universally acclaimed as "Queen of flowers". It belongs to the family 'Rosaceae' and genus Rosa. Rose flowers are beautiful in shape, size, fragrance and colour and have good demand in domestic as well as export market. Dutch roses are gaining popularity in global market because of its magnificent medium size bloom, remarkable yield and its keeping quality. However, the international market demands a very high quality produce. Nearly, 30-50 percent loss of cut flowers occurs due to improper postharvest handling during entire market chain (Singh *et al*., 2007). Generally two methods, *viz*. dry storage and wet storage are used. Flower quality and vase life tend to decrease after dry storage of cut flowers (Van Doorn, 2004). Wet storage ensures flower quality but only for short duration as long duration storage results into increase in the advanced stage of bud opening which again declines its market value whereas PP packaged rose flowers maintained marketable bud stage (Makwana *et al*., 2015). According to Poonsri (2017), higher CO_2 and lower O_2 during storage period decrease the production of ethylene and extended the life of fresh produce. MAP during cold storage in orchid flowers showed promising results in maintaining flower quality after completion of storage duration (Paansri 2021). Considering the immense importance of rose in domestic as well as overseas market, it seemed the right way to plan the experiment to evaluate proper low temperature storage technique along novel packing material for rose cut flower.

MATERIAL AND METHODS

Fresh rose cut flower of cultivars Bordeaux, Poison and Avalanche were obtained from greenhouse complex, Navsari Agricultural University, Navsari and were brought to the Floriculture Laboratory, College of Horticulture and Forestry, NAU Navsari at an ambient temperature (18-21°C). The experiment was conducted in completely randomized block with factorial design. There were eight treatments and each treatment was repeated three times. Cut roses at uniform bud size, fresh weight (10±2 g) and stem length (50±5 cm) were selected and divided into seven groups each having ninety flowers (30 in each repetition) and subjected to different treatments. According to treatments these bunches were seal packaged with High Density Poly Ethylene (HDPE), Low Density Poly Ethylene (LDPE), Polypropylene (PP) and without any packaging for dry storage where as others were dipped in aluminium sulphate 200 mg/l [$Al_2(SO_4)_3$], citric acid 200 mg/l and water. All bunches were stored at 2°C temperature in cold storage for 10 days. After 10 days of cold storage, the flowers were taken out from cold storage, and re cut 2 cm from the base and kept in distilled water at room temperature for taking observations and recording data. Fresh flowers of cultivars Bordeaux, Poison and Avalanche as control (T_0) bought from the same greenhouse complex were also held in distilled water in order to compare with treated and stored flowers. Different postharvest parameters regarding quality of flowers were recorded at different intervals during vase life. Observations on post harvest parameters like physiological loss in weight (%), O_2 and CO_2 content within the packaging and bent neck (°degree) were recorded just after storage. Total water up take at 6[th] DAS, Total dissolve solids at 4[th] DAS, bud length, bud diameter, petal length, petal diameter and bud opening were recorded on 2[nd] day during vase life, while dry weight was observed after completion of vase life. The statistical analysis was done following the method of Panse and Sukhatme (1978).

RESULT AND DISCUSSION

Data depicted in Table 1 revealed that rose cut spikes wrapped with different types of plastic material recorded minimum physiological loss in weight while west stored cut spikes showed increase in the fresh weight compared to fresh flowers (Control) after 10 days of cold stored at 2°C temperature while cut flowers kept cold stored without any packaging suffered severe physiological loss of weight during same course of storage time. In terms of varieties cv. Bordeaux showed promising results in all storage techniques over all three varieties in the study. Interaction of rose cv. Bordeaux cut spikes packed with polypropylene and cold stored at 2°C temperature recorded minimum physiological loss of weight (1.83%) after 10 days of cold storage which was at par with T_3V_2.

In case of storage techniques, cut spikes stored with polypropylene recorded significantly higher total water uptake (ml) at 6[th] DAS (137.26 ml) and total dissolve solids (°brix) at 4[th] DAS (7.11°brix) which was at par with HDPE and LDPE packaging while in case of varieties cv. Bordeaux recorded significantly higher water uptake (100.60 ml) and TDS (6.87°brix). The interaction of cv. Bordeaux cut spikes wrapped with polypropylene and cold stored measured significantly higher water uptake (142.27 ml) and TDS (7.84 °brix) which was at par with V_1T_1, V_1T_2total water uptake andV_1T_2 for TDS respectively.

Seal packed fresh produce in poly films is known to create modified internal gaseous components passively (Farber *et al*., 2003), that helps in minimizing metabolic activities during storage and retains fresh produce in normal condition (Zeltzer *et al*., 2001). Thus, PP, HDPE and LDPE packaging contributed in maintaining higher water uptake as well as reduced physiological loss of weight and higher total dissolves solids in stored cut flowers during vase life. Packaging with poly films have been earlier known to enhance water uptake after cold storage as well as retain fresh weight in rose cut flowers (Makwana *et al*., 2015; Singh *et al*., 2012).

Data presented in table 2 showed significant influence of storage techniques and varieties on flower parameters like bud length, bud diameter, petal length and width at 4[th] DAS. Fresh flowers recorded significantly higher bud length (4.37 cm), bud diameter (5.22 cm), petal length (3.76 cm) and (4.29cm) which was at par with cut spikes packed with polypropylene in all the parameters while also at par with T_2 in bud length and T_1 and T_2 in bud diameter. In case of varieties, cv. Avalanche recorded significantly higher bud diameter (5.11 cm), petal length (3.53 cm) and petal width (4.03 cm) while it was at par with cv. Bordeaux in petal length and cv. Poison. In case of interaction effect bud diameter recorded significantly higher in T_0V_3 which was at par with T_1V_3, T_2V_3, and T_3V_3 while petal length recorded significantly higher in T_0V_3which was at par with T_0V_2, T_0V_1, T_2V_3, T_3V_3 and T_3V_1 whereas petal width recorded significantly higher in T_0V_3 which was at par with T_3V_3. Increase in bud and petal size can be attributed to the retention of higher fresh weight and petal tissue integrity. The enhanced water uptake by fresh rose flowers and in cut rose packed with polypropylene and HDPE and LDPE packaged might have increased the cell-turgidity and cell enlargement leading to petal expansion as also observed earlier in gerbera (Patel and Singh 2009).

Data presented in Table 3 showed significant influence of storage techniques in O_2 and CO_2 content within packaging and % bud opening. All the packing *viz*., HDPE, LDPE and polypropylene recorded higher CO_2 and lower O_2 content compared to control (open) conditions. Among different packaging films polypropylene recorded significantly higher CO_2(9.44%)and lower O_2 (11.24%) content. While in case of fresh flowers recorded significantly higher % bud opening which was at par with PP packed rose cut spikes and HDPE packed rose cut spike while varieties and interaction effect was found non-significant. Farber *et al*. (2003) stated that sealed packaging of fresh commodity with a PP packaging film of selective permeability which also referred as passive modified atmosphere storage (MAP) is known for the evolution of beneficial equilibrium of modified atmosphere (EMA) with high CO_2, and low O_2 and high relative humidity on account of products, flowers metabolic activities *viz*., respiration and transpiration. Similar finding relation with CO_2 and O_2 content within packaging films have been found in orchid resulting in enhanced quality flowers in orchid (Poonsri 2021).Increase in bud diameter and water uptake in PP, HDPE, LDPE packaged and fresh flowers (4[th] DAS) can be attributed to increase in bud opening. Significant correlation of water uptake with bud opening flower diameter in cut flowers have been earlier established (Mayak and Halevy 1974).

Data in Table 4 showed fresh flowers recorded significantly lower bent neck (2.02°) and higher dry weight (8.42 g) and vase life (4.86 days) which was at par with PP packed cut flowers and stored for 10 days (2.10°, 8.38 g and 4.77 days) respectively. While in case of varieties cv. Bordeaux recorded significantly lower bent neck (6.71°) and higher dry weight (7.65 g) and vase life (3.63 days). In case of interaction effect fresh flowers recorded significantly lower bent neck (1.82°) and higher dry weight (8.84 g) and vase life (5.30 days) which was at par with PP packed rose cut flowers cv. Bordeaux and stored for 10 days (1.98°, 8.82 g and 5.17 days) respectively. Bent neck is a result of water stress (Burdett, 1970). Lower bent neck and higher dry weight in cut roses (fresh and PP packaged cold stored flowers) can be attributed to better balance in stem and petals with maintained high water uptake, lower physiological loss of weight and high petal TDS, as explained earlier. Among all three different packaging HDPE and LDPE packaging also showed similar flower quality (visual basis) as PP packaging, but in case of vase life and other quality parameters PP packaging showed better results. There was minimal cell damage in PP packaged rose cut flowers during storage as indicated by lower physiological loss in weight (PLW%). Further, there was continued and increased water uptake in the cut flowers during vase life after storage, followed by higher dry weight and high dissolved solids (TDS) content in petals. Cut flowers packed with poly films have been earlier known to maintain flower quality during storage periods in rose cut flowers (Makwana *et al*., 2015; Singh *et al*., 2012), gladiolus cut spikes (Singh *et al*., 2008; Grover *et al*., 2005), gerbera (Patel and Singh 2009), Orchid (Poonsri, 2017; Poonsri 2021) and solidago (Zeltzer *et al*., 2001).

Table 1 : Effect of different storage techniques on physiological loss in weight (%) just after storage, Total water uptake (ml) 6th DAS and Total dissolve solids (°brix) at 4th DAS in rose (cv. Bordeaux, Poison and Avalanche).

Treatment	Physiological loss in weight (%)				Total water uptake (ml) at 6th DAS				Total dissolve solids (°brix) at 4th DAS			
	V_1	V_2	V_3	MEAN	V_1	V_2	V_3	MEAN	V_1	V_2	V_3	MEAN
T_0 (Control)	-	-	-	-	135.55	131.51	124.54	130.53	7.89	7.13	6.47	7.16
T_1 (HDPE)	2.50	2.78	3.15	2.81	141.09	137.95	131.13	136.72	7.73	6.90	6.15	6.92
T_2 (LDPE)	2.30	2.68	2.89	2.63	141.31	137.82	130.65	136.59	7.57	6.85	6.09	6.84
T_3 (Polypropylene)	1.83	1.94	2.16	1.98	142.27	138.22	131.30	137.26	7.84	7.09	6.41	7.11
T_4 (Water)	6.44*	6.62*	7.12*	6.72*	67.55	64.05	55.70	62.43	6.29	5.30	4.58	5.39
T_5 (200 mg/l $Al_2(SO_4)_3$)	4.59*	4.99*	5.33*	4.97*	79.92	73.14	71.39	74.82	6.36	5.37	4.74	5.49
T_6 (200 mg/l Citric acid)	5.01*	5.37*	5.51*	5.29*	72.96	69.94	65.27	69.39	6.31	5.35	4.61	5.43
T_7 (Without any packaging)	23.09	23.91	24.51	23.84	24.12	21.78	21.25	22.38	5.00	4.30	3.89	4.40
MEAN	5.72	6.03	6.33		100.60	96.80	91.40		6.87	6.04	5.37	
	T	V	T x V		T	V	T x V		T	V	T x V	
CD (p=0.05)	0.23	0.14	0.28		1.03	0.63	1.26		0.08	0.05	0.10	

* Increase in fresh weight

Table 2 : Effect of different storage techniques on Bud length (cm), Bud diameter, Petal length (cm) and Petal width (cm) at 4thDAS in rose (cv. Bordeaux, Poison and Avalanche) at just after storage.

Treatment	Bud length (cm) at 4th DAS				Bud diameter at 4th DAS				Petal length (cm) at 4th DAS				Petal width (cm) at 4th DAS			
	V_1	V_2	V_3	MEAN	V_1	V_2	V_3	MEAN	V_1	V_2	V_3	MEAN				
T_0 (Control)	4.38	4.33	4.39	4.37	4.86	5.26	5.55	5.22	3.75	3.73	3.80	3.76	4.14	4.31	4.43	4.29
T_1 (HDPE)	4.25	4.25	4.29	4.27	4.83	5.23	5.53	5.19	3.65	3.65	3.70	3.67	3.93	4.15	4.24	4.10
T_2 (LDPE)	4.31	4.25	4.32	4.30	4.82	5.22	5.52	5.18	3.71	3.64	3.73	3.69	3.93	4.20	4.21	4.11
T_3 (Polypropylene)	4.36	4.33	4.38	4.36	4.85	5.24	5.53	5.21	3.76	3.72	3.79	3.75	4.08	4.29	4.40	4.26
T_4 (Water)	4.03	4.06	4.07	4.05	4.37	4.60	4.73	4.56	3.43	3.46	3.47	3.45	3.89	3.94	3.94	3.92
T_5 (200 mg/l $Al_2(SO_4)_3$)	4.13	4.10	4.21	4.14	4.44	4.66	4.77	4.62	3.53	3.49	3.66	3.56	3.98	3.98	4.01	3.99
T_6 (200 mg/l Citric acid)	4.10	4.09	4.12	4.10	4.42	4.63	4.74	4.59	3.49	3.49	3.52	3.50	3.99	3.97	4.00	3.99
T_7 (Without any packaging)	3.27	3.22	3.20	3.23	3.69	4.21	4.51	4.14	2.65	2.61	2.55	2.61	2.79	3.00	3.03	2.94
MEAN	4.10	4.08	4.12		4.53	4.88	5.11		3.50	3.47	3.53		3.84	3.98	4.03	
	T	V	T x V		T	V	T x V		T	V	T x V		T	V	T x V	
CD (p=0.05)	0.07	NS	NS		0.06	0.04	0.07		0.06	0.03	0.07		0.08	0.05	0.10	

Table 3: Effect of different storage techniques on O_2 (%) and CO_2 (%) content within packaging and bud opening at 4th DAS in rose (cv. Bordeaux, Poison and Avalanche).

Treatment	O_2 (%)content				CO_2 (%)content				Bud opening (%)			
	V_1	V_2	V_3	MEAN	V_1	V_2	V_3	MEAN	V_1	V_2	V_3	MEAN
T_0 (Control)	20.96	20.96	20.96	20.96	0.04	0.04	0.04	0.04	92.11	92.46	92.59	92.39
T_1 (HDPE)	14.20	14.78	14.53	14.50	6.91	6.76	6.79	6.82	91.48	92.11	92.26	91.95
T_2 (LDPE)	14.67	14.98	15.07	14.90	6.71	6.67	6.53	6.64	91.29	91.94	92.09	91.77
T_3 (Polypropylene)	11.18	11.19	11.36	11.24	9.30	9.46	9.56	9.44	91.92	92.41	92.37	92.23
T_4 (Water)	-	-	-	-	-	-	-	-	82.77	81.05	78.88	80.90
T_5 (200 mg/l $Al_2(SO_4)_3$)	-	-	-	-	-	-	-	-	84.09	82.08	79.52	81.90
T_6 (200 mg/l Citric acid)	-	-	-	-	-	-	-	-	83.72	81.55	79.11	81.46
T_7 (Without any packaging)	-	-	-	-	-	-	-	-	70.02	74.27	75.31	73.20
MEAN	15.25	15.48	15.48		5.74	5.73	5.73		85.92	85.98	85.27	
	T	V	T x V		T	V	T x V		T	V	T x V	
CD (p=0.05)	0.34	NS	NS		0.17	NS	NS		0.58	NS	NS	

Table 4: Effect of different storage techniques on bent neck (°degree), dry weight (%) and vase life in rose (cv. Bordeaux, Poison and Avalanche).

Treatment	bent neck (°degree)				Dry weight (%)				Vase life			
	V_1	V_2	V_3	MEAN	V_1	V_2	V_3	MEAN	V_1	V_2	V_3	MEAN
T_0 (Control)	1.82	2.07	2.18	2.02	8.84	8.25	8.18	8.42	5.30	4.97	4.30	4.86
T_1 (HDPE)	2.39	2.52	3.17	2.69	8.31	7.90	7.43	7.88	5.07	4.57	4.00	4.55
T_2 (LDPE)	2.57	2.80	2.93	2.77	8.19	7.53	7.43	7.72	4.97	4.37	3.90	4.42
T_3 (Polypropylene)	1.98	2.07	2.24	2.10	8.82	8.19	8.12	8.38	5.17	4.87	4.27	4.77
T_4 (Water)	8.41	8.68	8.97	8.69	7.07	6.71	6.43	6.74	2.10	1.97	2.00	2.03
T_5 (200 mg/l $Al_2(SO_4)_3$)	6.22	6.59	6.42	6.41	7.69	7.39	7.61	7.56	2.57	2.40	2.27	2.42
T_6 (200 mg/l Citric acid)	6.88	7.13	6.90	6.97	7.55	7.18	7.30	7.34	2.37	2.17	2.31	2.38
T_7 (Without any packaging)	23.42	23.69	23.95	23.69	4.75	4.19	3.83	4.26	1.50	1.30	1.40	1.40
MEAN	6.71	6.94	7.09		7.65	7.17	7.04		3.63	3.33	3.09	
	T	V	T x V		T	V	T x V		T	V	T x V	
CD (p=0.05)	0.16	0.10	0.19		0.19	0.12	0.24		0.11	0.07	0.13	

CONCLUSION

Among different storage techniques (wet and dry storage) rose cut spikes (cv. Bordeaux, Poison and Avlanche) packed with PP (polypropylene) and cold stored at 2°C temperature can help in maintaining flower qualities as similar to fresh flowers up to 10 days of storage. Moreover,cut rose spikes stored with conventional wet storage techniques *viz*., water, aluminum sulphate or citric acid solution may lead to advancement of flower stage which again decrease the marketable value of rose cut spikes.

FUTURE SCOPE

It's evident that packaging with PP during cold storage helps to maintain flower quality as well as vase life after storage. A part from packaging lot of factors effect post-harvest life of flowers like pulsing, vase solution, storage duration and CA storage on which more experiments should be conducted to find out best post-harvest package of practices for rose flowers.

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Conflict of Interest. The research has been conducted by Dr. R. J. Makwana during the doctorate programme for research and study purpose under the guidance of Dr. B. K. Dhadul, at ASPEE College of Hort., NAU, Navsari,

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