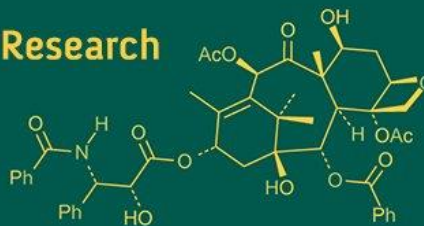


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Effect of eco-friendly wrapping materials on the post-harvest life of cut Gerbera var. Stanza.

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Abstract

The experimental design was laid out in a Factorial Completely Randomized Design (FCRD) with two factors consisting of seven wrapping treatments namely, T₀ (Control viz. Unwrapped), T₁ (Banana leaves), T₂ (Packing leaves viz. *Phrynium pubinerve*), T₃ (Brown paper), T₄ (Butter paper), T₅ (Newspaper) and T₆ (Paper towel) and three storage durations i.e. D₁ (6hrs), D₂ (12hrs) and D₃ (18hrs) respectively and replicated thrice. The experiment were conducted in department of Horticulture, School of agricultural Sciences, Nagaland University. The cut gerberas were pulsed in 6% Sucrose + 200ppm Al₂(SO₄)₃ for 6hrs, then wrapped in different wrapping materials, and subjected to different wrapping durations. After the respective wrapping durations, the cut gerberas were unwrapped and kept in a conical flask filled with 300 ml distilled water for further vase life studies. D₁ gave the highest water uptake on the 6th and 9th day (8.53 g, and 7.16 g), maximum water balance ratio (0.85, 0.78 and 0.72), minimum percentage change in fresh weight (28.42%), and vase life (12.26 days) while in wrapping materials, T₁ gave highest water uptake (8.11g, 10.65g and 8.71 g), maximum water balance ratio (0.97, 0.88 and 0.82), minimum changes in fresh weight (23.95%), and vase life (13.52 days). Interaction between T₁D₁ showed highest water uptake on the 6th and 9th day (11.62 g and 9.46 g), best water balance ratio (0.98, 0.97 and 0.90), minimum changes in fresh weight (22.48%), as well as maximum vase life (14.15 days).

Keywords: Cut gerberas, water loss, water uptake, wrapping material

Introduction

Gerbera (*Gerbera jamesonii*) is one of the popular cut flower used for the flower arrangements and bouquets in India as well as in export markets. A cultivated area of 5,280 ha and production area of 26,660 Mt in India was estimated in advanced for the year 2023-24. (Anon., 2024) ^[1]. As per the analysis of the National Horticultural Board, Madhya Pradesh, Gujarat, Rajasthan, Assam, West Bengal, Orissa, Maharashtra, Haryana, Uttar Pradesh, and Uttarakhand are the top ten gerbera-producing states of India during the year 2021-2022.

Post-harvest losses are the losses that take place after the harvesting of crops. They can be qualitative as well as quantitative. Qualitative losses involve consumers' choice of the produce and are difficult to quantify. Quantitative losses are caused during post-harvest handling and they exist throughout the market chain (Bhattacharjee 2006) ^[2]. That's why, utilization of proper wrapping material for cut gerberas while transportation ensures the maximum freshness retention and price in market. At present, gerbera flowers are transported by using polyethylene flower sleeves. It was stated by Khazir & Shetty. (2014) ^[5] that various plant-based packaging materials will be environmentally friendly and can also act as the best alternative to plastics.

However, little is known about the ability of eco-friendly wrapping materials to extend the vase life of the gerberas. Hence, an attempt for standardization of eco-friendly wrapping materials to retain freshness and extend the vase life of cut gerberas was made along with an aim to promote environmental sustainability.

Materials and Methods

The experiment was conducted in the laboratory, Department of Horticulture, SAS: NU, Medziphema, situated in the foothills of Nagaland at an altitude of 320 m above mean sea

level. The experiment on post-harvest studies was carried out during the months of January-March 2024 under controlled room temperature of $21 \pm 4^\circ\text{C}$.

The experimental design was laid out in a Factorial Completely Randomized Design (FCRD) with three replications and 21 treatment combinations consisting of seven wrapping treatments namely, T_0 (Control viz. Unwrapped), T_1 (Banana leaves), T_2 (Packing leaves viz. *Phrynium pubinerve*), T_3 (Brown paper), T_4 (Butter paper), T_5 (Newspaper) and T_6 (Paper towel) and three storage durations i.e. D_1 (6 hrs), D_2 (12 hrs) and D_3 (18 hrs) respectively. Cut Gerberas were procured from Central Institute of Horticulture, Medziphema. The length of all the stalks was kept uniform at 35cm and were pulsed using a standardized pulsing solution comprising of 6% Sucrose + 200 ppm $\text{Al}_2(\text{SO}_4)_3$ for 6 hours. Initial weight of the flowers was recorded before wrapping in eco-friendly wrapping materials and kept at room temperature to simulate transit for different periods of 6 hrs, 12 hrs, and 18 hrs.

After the required hours of treatment, the cut gerberas were unwrapped and transferred to a 500 ml conical flask filled with 300 ml distilled water.

Parameters like percentage changes in fresh weight (%), rate of elongation (cm), percentage change in flower diameter (cm), stalk girth (mm), water uptake (g), water loss (g), water balance ratio, vase life (days) and stem break percentage were recorded.

Results

Effect of Wrapping Material on Cut Gerbera

The wrapping materials significantly influenced all the floral parameters studied except stalk girth (Tables 1 and 2). Water uptake varied significantly among the treatments throughout the vase period. On the 3rd day, the highest water uptake was recorded in T_1 (8.11 g), followed by the other wrapping treatments, whereas the lowest uptake was observed in the control (T_0) with 4.23 g. A similar trend was observed on the 6th day, where T_1 recorded the maximum water uptake (10.65 g), while T_0 registered the minimum value (5.69 g). On the 9th day, water uptake declined in all treatments; however, T_1 continued to record the highest uptake (8.71 g), whereas T_0 maintained the lowest value (4.47 g).

Water loss also differed significantly among the wrapping materials. On the 3rd day, T_1 recorded the highest water loss (8.64 g), while the lowest water loss was observed in T_0 (5.95 g). The highest water loss was recorded on the 6th day in T_1 (12.07 g), whereas T_0 recorded the lowest value (9.61 g). Water loss decreased thereafter in all treatments by the 9th day.

The water balance ratio was significantly influenced by the wrapping materials. T_1 recorded the highest water balance ratio throughout the observation period, with values of 0.97, 0.88, and 0.82 on the 3rd, 6th, and 9th day, respectively. In contrast, T_0 recorded the lowest water balance ratio of 0.73, 0.64, and 0.51 on the respective days. Irrespective of the treatments, the water balance ratio declined progressively as the vase period advanced. Significant differences were observed in the percentage change in fresh weight among the treatments. The lowest reduction in fresh weight was recorded in T_1 (23.95%), indicating better maintenance of flower freshness, whereas the highest reduction was observed in T_3 (35.95%).

The percentage reduction in flower diameter also differed significantly among the treatments. The minimum reduction in flower diameter was recorded in T_2 (15.49%), while the maximum reduction was observed in T_3 (23.04%).

Stem elongation was observed in all treatments during the vase period. The maximum stem length at senescence was recorded in T_1 (36.09 cm), showing an increase from the initial harvest length of 35.00 cm. The minimum increase in stem length was recorded in the control (T_0), which attained a final length of 35.56 cm.

The vase life of cut gerbera was significantly affected by the wrapping materials. Among the treatments, T_1 recorded the longest vase life (13.52 days), whereas the control exhibited the shortest vase life.

Effect of Wrapping Duration on Cut Gerbera

Wrapping duration significantly influenced the postharvest performance of cut gerbera flowers. Water uptake decreased with increasing storage duration. The highest water uptake was recorded on the 6th day under D_1 (8.53 g), whereas the lowest uptake was observed on the 9th day under D_3 (4.79 g). In general, flowers stored for shorter durations exhibited greater water uptake than those stored for longer durations.

Water loss showed a similar trend across the storage durations. The highest water loss was recorded on the 6th day under D_1 , D_2 , and D_3 , with values of 11.01, 10.31, and 9.89 g, respectively. Comparatively lower water loss was observed on the 3rd day, with values of 5.53, 6.87, and 8.06 g under D_1 , D_2 , and D_3 , respectively.

The water balance ratio declined progressively with increasing storage duration and vase period. Under D_1 , the ratio decreased from 0.85 on the 3rd day to 0.72 on the 9th day. Similarly, it declined from 0.84 to 0.65 under D_2 and from 0.81 to 0.55 under D_3 . Among the storage durations, D_1 consistently maintained the highest water balance ratio throughout the vase period, while D_3 recorded the lowest values on the final day of observation.

Interactive effect of wrapping duration on cut gerbera.

Table. 1, shows the significant interaction between wrapping materials and durations on the 3rd and 6th day of water uptake. Highest water uptake observed in T_1D_1 on 6th day (11.62 g) while lowest in T_0D_1 on 3rd day (3.11 g). Overall, it was observed that all treatments show a decrease in water uptake with increasing wrapping duration and storage days. More water loss due to transpiration was observed in T_1D_2 on 6th day (12.33 g) while less in T_7D_1 on 3rd day (4.24 g). Depending on water uptake and water loss, T_1D_1 and T_2D_1 were found to be leading in water balance ratio with a similar value of 0.98 on 3rd day. The lowest water balance ratio was shown by T_0D_3 on its 9th day (0.41). These may establishment of a modified atmosphere by wrapping materials leading to slowing of metabolic processes such as respiration and moisture loss. Table. 2, show more change in fresh weight in T_4D_2 (41.41%), and less in T_2D_1 (22.48%). T_5D_3 with high change in flower diameter (28.74%) and T_2D_2 (14.71%) with low on their senescence day. Stalk girth had a very uncertain trend of changes, and failed to give any clear idea about the effect of wrapping material and duration on it. T_1D_1 showed an elongation of 36.27 cm from 35 cm in cut gerbera, which was the highest among all while the lowest was found in the case of T_0D_2 (from 35 cm to 35.52 cm). T_1D_1 showed the

longest vase life of 14.15 days and the ones with T₀D₃ treatment showed the shortest of 9.21 days.

Discussion

All the floral parameters except stalk girth were significantly affected by wrapping materials as observed in Tables 1 and 2. Maximum water uptake was recorded in T₁ (8.11g, 10.65g and 8.71g) while minimum water uptake was found in T₀ (4.23g, 5.69g and 4.47 g). This may be due to the ability of banana leaves to cause minimum cell damage during storage and to retain normal cell conditions after storage, which ultimately resulted in normal water uptake. Varu *et al* (2008) [13] also found more water uptake by cut tuberose wrapped in packaging materials than in control one.

Highest water loss was in T₁ with values 8.64 g and 12.07 g on 3rd day and 6th day respectively while, control showed lowest (5.95 g to 9.61 g). LüPeiTao *et al* (2011) studied that water loss rates by the cut individual rose had a parallel pattern to water uptake rates.

T₁ had highest water balance ratio (0.97, 0.88 and 0.82), and T₀ showed the lowest values (0.73, 0.64, 0.51) on the 3rd, 6th and 9th day. Kumar and Gupta (2012) [7] stated, biodegradable packaging material provide an atmosphere that prevent alterations in temperature, light, moisture, humidity, compression, impact, vibration, and biological contamination. Percentage change in fresh weight was minimal in T₁ (23.95%) and maximal in T₃ (35.95%). Bhuvaneswari (2017) [3] observed better freshness index in the sheath cups of banana.

T₂ showed minimum percentage changes in flower diameter (15.49%) and T₃ (23.04%) maximum. Stems of T₁ elongated to 36.09 cm from 35cm on senescence day, while that of T₀ to 35.56 cm. Perik *et al* (2012) [11] stated that stem contains large central cavity at the time of harvest which extends upwards and laterally during entire vase life. More vase life in T₁ (13.52 days) was observed. Patil and Dhaduk (2010) [10], reported reduction in moisture loss by using wrapping materials, increased vase life of tuberose cut spikes cv. Local Double increased. Mishra (2022) [9] found similar results in China aster flowers.

Table 1. shows that maximum water uptake on 6th day at D₁ (8.53 g) and minimum on 9th day at D₃ (4.79). These results conform with the findings of Shil *et al* (2014) who reported that total water absorption decreased with increase in storage duration of cut spikes in tuberose.

High water loss on 6th day of all durations (11.01 g, 10.31 g and 9.89 g) while low on 3rd day (5.53 g, 6.87 g and 8.06 g). Woltering and Paillart (2018) [15], observed in cut roses de-regulated or excess water loss with long-term storage (28 days at 0.5 °C).

D₁ showed decrease in water balance ratio from 0.85 on the 3rd to 0.72 on 9th day. At D₂ and D₃, it decreased from 0.84 to 0.65 and 0.81 to 0.55 on 3rd and 9th day respectively. The present result collaborates with the findings of Khenizy *et al* (2014) [6], in cut gypsophila where they found that cut flowers stored for 0 days showed higher water balance than cut flowers stored for 7 days at 4 °C D₁ (28.48%) show

minimum changes in fresh weight while D₂ and D₃ showed changes of 34.00% and 33.99% respectively. Ghildiyal *et al* (2012) [4], concluded that cut chrysanthemums had lower weight loss percentage at 6 hrs storage of simulated transit than at 16 hrs.

Flower diameter showed an increase in changes with an increase in wrapping duration (16.26%, 20.35% and 21.66%). This result inclined with the findings of Waithaka *et al* (2001) [14] which state that shorter storage duration of tuberose spikes showed more diameter of florets. No significant effect on stalk girth and stalk elongation were observed; whereas vase life had decreasing trend (12.26 days, 11.26 days and 10.35 days). Verma and Jhanji (2021) [16], found that marigold flowers stored for 1 day recorded maximum shelf life (4.05 days) as compared to 2 days (3.05 days) or 3 days (2.11 days).

Table 1: Impact of wrapping material and storage time on water related parameters of cut gerbera.

Treatments	Water Uptake (g)			Water Loss (g)			Water balance ratio (%)		
Wrapping material (T)									
	Day 3	Day 6	Day 9	Day 3	Day 6	Day 9	Day 3	Day 6	Day 9
T ₀	4.23	5.69	4.47	5.78	9.61	8.53	0.73	0.64	0.51
T ₁	8.11	10.65	8.71	8.39	12.07	10.68	0.97	0.88	0.82
T ₂	7.59	9.65	7.78	8.24	11.41	10.08	0.92	0.84	0.77
T ₃	4.96	6.29	4.94	6.43	9.78	9.28	0.77	0.64	0.53
T ₄	5.50	7.94	6.64	6.64	10.66	9.56	0.83	0.75	0.69
T ₅	5.14	6.87	5.64	6.36	10.07	9.28	0.82	0.68	0.61
T ₆	4.62	6.20	4.40	5.94	9.21	7.81	0.78	0.67	0.57
SEm (±)	0.11	0.10	0.18	0.14	0.18	0.21	0.02	0.01	0.01
CD at 5 %	0.32	0.28	0.50	0.40	0.51	0.59	0.04	0.04	0.04
Wrapping Duration (D)									
D ₁	4.84	8.53	7.16	5.53	11.01	9.87	0.85	0.78	0.72
D ₂	5.82	7.72	6.29	6.87	10.31	9.53	0.84	0.75	0.65
D ₃	6.55	6.59	4.79	8.06	9.89	8.56	0.81	0.66	0.55
SEm (±)	0.07	0.06	0.11	0.09	0.12	0.14	0.01	0.01	0.01
CD at 5 %	0.21	0.18	0.33	0.26	0.34	0.39	0.03	0.03	0.03
Interaction (T X D)									
T ₁ D ₁	3.11	6.54	5.83	4.26	9.10	9.55	0.73	0.72	0.61
T ₁ D ₂	4.40	5.99	5.02	6.03	9.26	9.83	0.73	0.65	0.51
T ₁ D ₃	5.17	4.54	2.55	7.04	8.46	6.22	0.73	0.54	0.41
T ₂ D ₁	7.26	11.62	9.46	7.44	12.00	10.50	0.98	0.97	0.90
T ₂ D ₂	8.22	10.70	9.18	8.45	12.22	11.22	0.97	0.88	0.82
T ₂ D ₃	8.85	9.63	7.49	9.27	12.00	10.33	0.96	0.80	0.73
T ₃ D ₁	7.69	10.78	9.22	7.84	12.18	11.04	0.98	0.89	0.83
T ₃ D ₂	6.96	9.73	7.77	7.64	11.49	10.20	0.91	0.85	0.76
T ₃ D ₃	8.13	8.44	6.34	9.24	10.56	9.00	0.88	0.80	0.70
T ₄ D ₁	3.44	7.38	6.13	4.41	10.43	9.89	0.78	0.71	0.62
T ₄ D ₂	5.47	6.44	4.93	6.93	9.33	9.10	0.79	0.69	0.54
T ₄ D ₃	5.97	5.06	3.75	7.95	9.58	8.83	0.75	0.53	0.43
T ₅ D ₁	4.78	8.79	7.53	5.67	11.81	10.44	0.84	0.75	0.72
T ₅ D ₂	5.61	7.97	6.81	6.67	10.38	9.70	0.84	0.77	0.70
T ₅ D ₃	6.11	7.05	5.56	7.58	9.80	8.53	0.81	0.72	0.65
T ₆ D ₁	4.30	7.92	6.70	4.88	11.17	10.26	0.88	0.71	0.65
T ₆ D ₂	5.23	6.89	5.62	6.29	9.67	8.97	0.83	0.71	0.63
T ₆ D ₃	5.89	5.80	4.59	7.90	9.38	8.62	0.75	0.62	0.54
T ₇ D ₁	3.31	6.66	5.22	4.24	9.37	7.39	0.79	0.71	0.71
T ₇ D ₂	4.83	6.33	4.72	6.11	9.14	7.67	0.79	0.69	0.62
T ₇ D ₃	5.71	5.63	3.26	7.47	9.13	8.38	0.76	0.62	0.39
Sem±	0.20	0.17	0.30	0.24	0.33	0.36	0.03	0.02	0.03
CD at 5%	0.56	0.48	NS	0.69	0.94	1.03	NS	NS	0.07

Table 2: Impact of wrapping materials and storage time on the floral parameters of cut gerbera.

Treatments	%Change in flower Weight	%Change in flower diameter	%Change in Stalk Girth	Stem elongation (cm)	Vase life (days)
Wrapping material (T)					
	9 th day	S'day	S'day	S'day	S'day
T ₀	35.7	21.47	7.11	35.56	10.43
T ₁	23.95	16.35	7.24	36.09	13.52
T ₂	27.95	15.49	5.41	35.96	12.16
T ₃	35.94	23.04	7.96	35.83	10.47
T ₄	33.59	18.36	11.62	35.76	11.02
T ₅	32.63	20.88	9.2	35.80	10.75
T ₆	35.18	20.34	14.09	35.79	10.70
SEm (±)	1.25	1.47	2.22	0.09	0.24
CD at 5 %	3.57	4.2	NS	0.25	0.7
Wrapping Duration (D)					
D ₁	28.42	16.26	9.05	35.77	12.26
D ₂	34.00	20.35	7.53	35.85	11.26
D ₃	33.99	21.66	10.25	35.86	10.35
SEm (±)	0.82	0.96	1.45	0.06	0.16
CD at 5 %	2.34	2.75	NS	NS	0.46
Interaction (D X T)					
T ₁ D ₁	37.66	20.49	10.16	35.59	11.62
T ₁ D ₂	36.41	22.39	5.96	35.52	10.45
T ₁ D ₃	33.02	21.53	5.2	35.57	9.21
T ₂ D ₁	22.48	15.71	1.66	35.73	14.15
T ₂ D ₂	23.64	14.82	8.12	36.27	13.57
T ₂ D ₃	25.74	18.52	11.94	36.26	12.83
T ₃ D ₁	24.11	12.88	9.7	35.92	13.44
T ₃ D ₂	28.73	14.71	4.36	36.13	11.93
T ₃ D ₃	31.01	18.89	2.18	35.83	11.11
T ₄ D ₁	29.06	17.85	9.53	35.98	11.26
T ₄ D ₂	41.41	28.37	6.52	35.80	10.58
T ₄ D ₃	37.36	22.9	7.83	35.70	9.56
T ₅ D ₁	25.52	17.54	11.06	35.70	11.88
T ₅ D ₂	39.43	17.52	8.97	35.79	11.10
T ₅ D ₃	35.81	20.02	14.82	35.80	10.08
T ₆ D ₁	26.1	12.06	11.27	35.74	11.82
T ₆ D ₂	34.93	21.85	5.36	35.77	10.66
T ₆ D ₃	36.85	28.74	10.96	35.88	9.77
T ₇ D ₁	34.02	17.26	10	35.71	11.64
T ₇ D ₂	33.42	22.76	13.42	35.65	10.55
T ₇ D ₃	38.11	21.01	18.84	36.00	9.89
Sem ±	2.17	2.55	3.84	0.15	0.42
CD at 5%	6.19	NS	NS	NS	NS

S' day= Senescence day.

Conclusion

From the present investigation, it can be concluded that T₁ showed superiority in terms of water uptake, water balance ratio, retention of fresh weight and vase life. D₁ performed better with respect to water uptake, water balance ratio, retention of fresh weight and flower diameter, and highest vase life. No significant impact of wrapping duration on stalk girth and stalk elongation was observed.

T₁D₁ treatment gave better results with respect to floral parameters like water uptake, water balance ratio, fresh weight retention and vase life.

Authors' Contribution

Conceptualization and designing of experiment; Implementing experiment; Data collection and analysis; Manuscript preparation.

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