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Effect of pre harvest spray of BA on shelf life of chrysanthemum (*Dendranthema grandiflora* Tzvelev)

Sagar Jagadale, Puja Sharma and SR Dhiman

Abstract
The present investigations entitled, "Studies on postharvest handling of loose flowers of chrysanthemum (*Dendranthema grandiflora* Tzvelve) cultivars 'Solan Shringar' and 'Surf' were carried out at Department of Floriculture and Landscape Architecture, Dr Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P) during 2016-2017. Studies included effect of pre harvest spray of BA on shelf life. Studies revealed that pre-harvest sprays of BA 50 ppm at bud stage resulted in maximum shelf life of 3.13 days in 'Solan Shringar' and 3.43 days in 'Surf' highest freshness index maximum per cent moisture content, minimum weight gain and per cent spoilage were also obtained in this treatment over control i.e. distilled water in both the cultivars. Among storage durations, maximum shelf life was observed under one day storage and minimum shelf life when the flowers were stored for five days in both the cultivars. In storage conditions, better shelf life was observed under refrigerated conditions as compared to room temperature in both the cultivars.

Keywords: BA (Benzyl Adenine) solutions, ambient storage, refrigerated storage, storage durations, storage conditions

Introduction
Flowers, by nature attract every human being. Despite of huge production and domestic consumption of flowers, the post-harvest losses are estimated to be more than 30-35%. Considering the potential of this sector in generating income and employment opportunities to farmers, studies needs to be carried out to reduce post-harvest losses and make it more profitable.The present study was carried out on post-harvest handling of chrysanthemum (*Dendranthema grandiflora* Tzvelve), an important loose flower crop. Chrysanthemum is one of the most important loose flower crops which is being cultivated and traded throughout country. Improper post-harvest handling sometimes causes serious damage to the final produce and causes loss to the farmers. In case of loose flowers, it becomes difficult to treat loose flowers with chemical preservative solutions after harvesting, as an increase in moisture content may lead to spoilage of flowers.

Materials and Method
The present studies were carried out in the Post-Harvest Laboratory of Department of Floriculture and Landscape Architecture of Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan during 2016-2017. The crop was grown in the experimental farm of the department. The crop was grown following recommended cultural practices. Flower buds when attained a size of 13-15mm in diameter were sprayed with solution of Benzyl Adenine (25 and 50 ppm) till droplet formation. In control, the buds were sprayed with distilled water. Loose flowers were harvested at standard stage i.e. fully opened flowers. In this experiment harvested flowers were kept in cardboard boxes (37.5x16.4x12.5cm) lined with polyethylene and sealed from the top. These boxes were then stored at 4°C in cold storage for various durations (1, 2, 3, 4 and 5 days). After removal from storage the boxes were opened and kept at prevailing room for temperature conditions in well ventilated room and various shelf life parameters were recorded.
Freshly harvested flowers were sealed in cardboard boxes lined with polyethylene (200 gauge) and were maintained under 2 storage conditions i.e. cold storage (4˚C) and ambient room temperature for five storage durations i.e. 1, 2, 3, 4 and 5days. Shelf life studies were

carried out at room temperature. Observations recorded are per cent weight gain, shelf life (days) appearance (colour, freshness index & percent wilting) of loose flower, per cent spoilage, per cent moisture conte

Results and Discussion

Per cent weight gain

Table 1a: Effect of pre-harvest bud spray and storage of loose flowers on weight gain (%) after storage of chrysanthemum cultivar 'Solan Shringar' and 'Surf'

Per cent weight gain cv. 'Solan Shringar'								
Bud spray treatments (T)	**Storage durations (D)**					**Mean**	**Storage conditions(C)**	
	1 day	**2 days**	**3 days**	**4 days**	**5 days**		**Cold Storage (4°C)**	**Room temperature**
BA (25 ppm)	2.50	4.17	5.13	6.13	7.17	5.00	4.42	5.58
BA (50 ppm)	1.98	3.10	4.30	5.00	6.37	4.13	3.57	4.79
Control (distilled water)	3.80	5.05	6.05	7.03	7.93	5.95	5.37	6.54
Mean	2.79	4.11	5.16	6.09	7.16	-	4.45	5.67
Storage conditions (C)						CD $_{0.05}$ for T: 0.06 D × T: 0.13 D: 0.08 C × D: 0.11 C: 0.19 C × T: 0.08		
Cold Storage (4°C)	2.17	3.50	4.68	5.50	6.52			
Room temperature	3.42	4.61	5.74	6.68	7.69			
Per cent weight gain cv. 'Surf'								
Bud spray treatments (T)	Storage durations (D)					Mean	Storage conditions(C)	
	1 day	2 days	3 days	4 days	5 days		Cold Storage (4°C)	Room temperature
BA (25 ppm)	3.08	4.13	5.23	6.13	7.23	5.10	4.78	5.63
BA (50 ppm)	2.12	3.13	4.17	5.22	6.72	4.27	3.69	4.75
Control (distilled water)	4.12	5.10	5.26	6.11	7.95	6.14	5.75	6.53
Mean	3.14	4.12	5.26	6.11	7.17	-	4.77	5.60
Storage conditions (C)						CD $_{0.05}$ for T: 0.07 D × T: 0.16 D: 0.09 C × D: 0.13 C: 0.06 C × T: 0.10		
Cold Storage (4°C)	2.64	3.63	5.08	5.52	6.69			
Room temperature	3.63	4.61	5.53	6.11	7.17			

Data presented in Table 1a shows the significant effect of pre-harvest bud sprays, and storage durations on per cent weight gain of loose flowers of cv. 'Solan Shringar'. It was found that out of pre-harvest sprays, minimum gain in flower weight was obtained with BA 50 ppm application (4.13%), however maximum weight gain (5.95%) was observed in control. Among storage durations, minimum change in weight was noted when the flowers were taken out after one day storage (2.79%) and maximum weight change was observed when the flowers were taken out after five days storage (7.16%). In case of storage conditions, less weight gain was observed in cold stored flowers (4.45%) as compared to the flower kept at room temperature (5.67%).

Interaction between storage durations and bud spray treatments revealed that least weight gain (1.98%) was observed when flowers were treated with BA 50 ppm and stored for one day. In contrast, maximum weight gain (7.93%) was observed when flowers sprayed with distilled water (control) were kept for five days storage. It was, however, found to be at par with weight gain observed in flowers sprayed with BA 25 ppm and stored for 5 days (7.17%).

Interaction between storage durations and storage conditions indicates that minimum weight change (2.17%) was noted when the flowers were stored for one day in cold store. Maximum weight gain (7.69%) was observed when the flowers were stored for five days at room temperature.

Interaction between storage conditions and bud spray treatments (Table 1a) shows that minimum weight change was observed when the flowers were sprayed with BA 50 ppm and stored under refrigerated conditions (3.57%) and maximum weight change was noted when flowers were kept under room temperature conditions (6.54%) after spraying with the distilled water.

Table 1a shows the significant effect of pre-harvest sprays, and storage durations on weight gain of chrysanthemum loose flowers. It was found that out of pre-harvest sprays, minimum per cent weight change was obtained with BA 50 ppm application (4.27%). On the other hand, maximum weight loss (6.14%) was noted when buds were sprayed with water i.e. in control. Among storage durations, least change in weight was observed when the flowers were taken out after one day storage (3.14%) and maximum weight change was observed when the flowers were taken out after five days storage (7.17%). In case of storage conditions, flowers stored in cool chamber at 4°C showed less loss in weight (4.77%) as compared to flowers stored at room temperature (5.60%).

Interaction between storage duration and bud spray treatments revealed that minimum weight gain (2.12%) was observed when flowers were treated with BA 50 ppm and stored for one day. In contrast, maximum weight change (7.95%) was observed when flowers sprayed with distilled water (control) were kept for five days storage

Data an interaction between storage duration and storage conditions indicates that minimum weight gain (2.64%) was observed when the flowers were stored for one day in cold store. A gradual increase in weight of flowers was noted with increasing storage duration. Maximum weight gain (7.17%) was, however observed when the flowers were stored for five days at room temperature.

Table 1b: Interaction effect of bud spray treatments, storage conditions and storage durations on weight gain (%) of loose flowers of chrysanthemum cv. 'Solan Shringar' and 'Surf'

Per cent weight gain cv. 'Solan Shringar'										
Bud spray treatments (T)	**Storage conditions (C)**									
	Cold Storage (4ºC)					**Room temperature**				
	Storage durations (D)									
	1 day	**2 days**	**3 days**	**4 days**	**5 days**	**1 days**	**2 days**	**3 days**	**4 days**	**5 days**
BA (25 ppm)	1.67	3.60	4.77	5.63	6.73	3.43	4.63	5.50	6.53	7.50
BA (50 ppm)	1.40	2.67	3.87	4.30	5.63	2.47	3.63	4.93	5.70	6.90
Control (distilled water)	3.23	4.43	5.30	6.57	7.30	4.47	5.67	6.70	7.50	8.57
$CD_{0.05}$ T × D × C: 0.18										
Per cent weight gain cv. 'Surf'										
Bud spray treatments (T)	**Storage conditions (C)**									
	Cold Storage (4ºC)					**Room temperature**				
	Storage durations (D)									
	1 day	**2 days**	**3 days**	**4 days**	**5 days**	**1 days**	**2 days**	**3 days**	**4 days**	**5 days**
BA (25 ppm)	2.37	3.77	4.87	5.70	6.80	3.70	4.50	5.50	6.10	7.67
BA (50 ppm)	1.83	2.67	3.83	4.33	5.70	2.50	3.60	4.40	7.50	7.03
Control (distilled water)	3.63	4.67	6.43	6.53	7.37	4.50	5.63	6.40	7.67	8.53
$CD_{0.05}$ T × D × C: 0.22										

Effect of interaction between bud spray treatments, storage conditions and storage durations in Table 1b indicates that minimum weight gain occurred when the flowers were sprayed with BA 50 ppm and stored for one day (1.40 %) under refrigerated conditions. In contrast, maximum weight change (8.57%) was observed when flowers were sprayed with distilled water and stored for five days at room temperature conditions.

Similar trend was observed for both the cultivars i.e. 'Surf' and 'Solan Shringar' for percent weight gain of loose flowers. Weight gain of loose flowers was significantly less in flowers treated with Benzyl Adenine at both the concentrations with minimum of it obtained at 50 ppm.

In the present studies, an increasing trend in flower weight was observed with increasing the duration of storage irrespective of conditions. It is attributed to more expansion of disc florets and ray florets with the passage of time after harvest. Similar results of increase in weight of cut flowers of chrysanthemum were also reported by Kavita (2016) [4].

It has also been found that minimum weight gain was noted in BA 50 ppm than BA 25 ppm and control treatments. It could be due to effect of BA to reduce the membrane permeability and hence reducing the process of increase weight of flowers. Our results are in conformity with findings of Zhi Hong and Weiming (1998) [9] in cut chrysanthemum flowers, where BA at high dose was found more effective than lower dose.

Further flowers kept at room temperature showed more weight gain as compared to cold stored flowers. Cold storage reduced the metabolic activities of plant tissues including flowers and reduced the rate of respiration also. Therefore the expansion of disc and ray florets is lesser when kept under refrigerated conditions in our studies.

Interaction between storage conditions and bud spray treatments show that minimum weight change was observed when the flowers were sprayed with BA 50 ppm and stored under refrigerated conditions (3.69%). In contrast, maximum weight gain was noted when flower buds were sprayed with distilled water and room temperature conditions (6.53%).

Effect of interaction between bud spray treatments, storage conditions and storage durations in Table 1b indicates that minimum weight gain occurred when the flowers sprayed with BA 50 ppm were stored for one day (1.83 %) under refrigerated conditions. In contrast, maximum weight gain (8.53%) was observed when flowers were sprayed with distilled water and stored for five days under room temperature.

Shelf life (days)

Table 2 shows the significant effect of pre-harvest sprays, and storage durations on shelf life of loose flowers of cultivar 'Solan Shringar'. It has been observed that spray of BA to flower buds at both the concentrations showed significant effect of increased shelf life over control. Maximum shelf life was, however obtained with the BA 50 ppm application (3.92 days) (Plate 4). However, minimum shelf life was obtained with the application of distilled water (2.24 days). Among storage durations, maximum shelf life (4.50 days) was noted when flowers were store for one day, and minimum (2.10 days) when the flowers were stored for five days. Data also shows that storage of flowers under refrigerated conditions resulted in more shelf life (3.60 days) as compared to room temperature (2.70 days).

Table 2: Effect of pre-harvest bud spray and storage of loose flowers on shelf life (days) of chrysanthemum cultivars 'Solan Shringar' and 'Surf'

Shelf life of cv. 'Solan Shringar'								
Bud spray treatments (T)	**Storage durations (D)**					**Mean**	**Storage conditions(C)**	
	1 day	**2 days**	**3 days**	**4 days**	**5 days**		**Cold Storage (4°C)**	**Room temperature**
BA (25 ppm)	4.60	3.80	3.20	2.90	2.00	3.30	3.72	2.88
BA (50 ppm)	5.40	4.5	3.70	3.20	2.80	3.92	4.44	3.40
Control (distilled water)	3.50	2.50	1.90	1.80	1.50	2.24	2.64	1.84
Mean	4.50	3.60	2.93	2.63	2.10	-	3.60	2.70
Storage conditions (C)						$CD_{0.05}$ for T: 0.23 D × T: NS		
Cold Storage (4°C)	5.00	3.93	3.33	3.07	2.67			

Room temperature	4.00	3.27	2.53	2.20	1.53	D: 0.29 C × D: NS C: 0.19 C × T: NS

Shelf life of cv. 'Surf'								
Bud spray treatments (T)	**Storage durations (D)**					**Mean**	**Storage conditions(C)**	
	1 day	**2 days**	**3 days**	**4 days**	**5 days**		**Cold Storage (4°C)**	**Room temperature**
BA (25 ppm)	4.70	4.10	3.80	3.20	2.80	3.70	4.28	3.16
BA (50 ppm)	5.50	4.80	4.20	3.50	3.10	4.22	5.00	3.44
Control (distilled water)	3.50	2.80	2.60	2.20	1.60	2.54	2.84	2.24
Mean	4.57	3.90	3.53	2.97	2.50	-	4.04	2.95
Storage conditions (C)						CD $_{0.05}$ for T: 0.21 D × T: NS D: 0.27 C × D: 0.39 C: 0.18 C × T: 0.29		
Cold Storage (4°C)	5.47	4.47	3.93	3.33	3.00			
Room temperature	3.67	3.33	3.13	2.60	2.00			

Data on interaction between storage durations and bud spray treatments was found to be non significant. However, maximum shelf life (5.40 days) was observed when the flowers were sprayed with the BA 50 ppm and stored for one day. In contrast, minimum shelf life (1.50 days) was noted when flowers sprayed with distilled water (control) were kept for five days storage.

Interaction between storage conditions and storage durations was found to be non significant. However, maximum shelf life (5.0 days) was observed when flowers were stored for one day under refrigerated conditions and minimum (1.53 days) in flowers stored at room temperature for five days.

Our results suggest that BA 50 ppm was the best for increasing shelf life of both the cultivars i.e. 'Surf' & 'Solan Shringar'. These results are in agreement with the findings of Asil and Karimi (2010) [1] who reported that the use of 25 and 50 mg/l BA resulted in a greater extension in vase life of eustoma cut flowers.

The role of BA increasing shelf life of cut chrysanthemum flowers has been established in earlier studies also; Bhat *et al.* (1999), Zhihong and Weiming (1998) and Kavita (2016) [2, 9, 4].

In a study on bud spray treatment in tulip Kim and Miller (2007) [6] reported that the application of GA_{417} and BA in the form of bud spray has pronounced effect on increasing flower longevity and improving post production life. In another study Asil and Karimi (2010) [1] sprayed the flowers of Eustoma with a fine mist of BA at different levels. They also reported increased vase life of flowers at all the levels of BA over control, with best results obtained with BA 50 ppm. Foliar spray application of BA as pre harvest factor had proved most effective for improving all traits (Ramtin *et al.* 2015) [8] in cartion.

Freshness index (colour retention, per cent wilting)

Table 3 indicates the effect of pre-harvest sprays and storage on loose flowers of chrysanthemum cv.'Solan Shringar'. It was found that out of pre-harvest sprays, flowers sprayed with BA 50 ppm scored highest (3.93 out of 5) for freshness index. In contrast, lowest score was obtained by flowers sprayed with the distilled water (control) with a score of 3.57 out of 5. Among storage durations, one day storage obtained the best appearance score of 4.41. In contrast, lowest score was obtained by five days storage with a score of 3.08. In storage conditions, flowers kept under refrigerated storage obtained better score (3.77) as compared to score obtained by flowers kept at room temperature (3.73 out of 5).

Table 3: Effect of pre-harvest bud spray and storage of loose flowers on freshness index (score out of 5) of chrysanthemum cultivar 'Solan Shringar' and 'Surf'

Freshness index (clouor retention, per cent wilting) of cv. 'Solan Shringar'								
Bud spray treatments (T)	**Storage durations (D)**					**Mean**	**Storage conditions(C)**	
	1 day	**2 days**	**3 days**	**4 days**	**5 days**		**Cold Storage (4°C)**	**Room temperature**
BA (25 ppm)	4.40	4.07	3.70	3.40	3.13	3.70	3.77	3.73
BA (50 ppm)	4.53	4.13	3.90	3.77	3.33	3.93	3.90	3.97
Control (distilled water)	4.30	3.80	3.50	3.17	2.77	3.57	3.53	3.50
Mean	4.41	3.93	3.73	3.44	3.08	-	3.77	3.73
Storage conditions (C)						CD $_{0.05}$ for T: 0.06 D × T: 0.10 D: 0.06 C × D: NS C: 0.04 C × T: NS		
Cold Storage (4°C)	4.48	4.01	3.76	3.48	3.11			
Room temperature	4.44	3.96	3.71	3.41	3.04			

Freshness index (colour retention, per cent wilting) of cv. 'Surf'								
Bud spray treatments (T)	**Storage durations (D)**					**Mean**	**Storage conditions(C)**	
	1 day	**2 days**	**3 days**	**4 days**	**5 days**		**Cold Storage (4°C)**	**Room temperature**
BA (25 ppm)	4.40	3.97	3.63	3.37	3.37	3.63	3.77	3.60
BA (50 ppm)	4.50	4.10	3.90	3.70	3.30	3.90	3.93	3.87
Control (distilled water)	4.30	3.77	3.57	3.10	2.73	3.53	3.57	3.40
Mean	4.40	3.94	3.70	3.39	3.01	-	3.76	3.62
Storage conditions (C)						CD $_{0.05}$ for T: 0.05 D × T: 0.10 D: 0.06 C × D: NS C: 0.04 C × T: NS		
Cold Storage (4°C)	4.43	3.98	3.73	3.42	3.11			
Room temperature	4.37	3.91	3.67	3.01	3.62			

Interaction of storage durations and bud spray treatments revealed that flowers sprayed with BA 50 ppm and stored for one day got the best score for appearance i.e. 4.53 out of 5. Minimum score was, however obtained in control (2.77) followed by 5 day storage.

Interaction of storage durations and storage conditions was found to be non-significant. However, flowers stored under refrigerated condition for one day got the best score for appearance (4.48 out of 5). On the other hand, least score was noted when flowers were stored at room temperature for five days (3.04).

Interaction of storage conditions and bud spray treatments was found to be non-significant. However, flowers treated with BA 50 ppm and stored under refrigerated storage scored maximum (3.97) while least score was noted in flowers treated with distilled water (control) and stored at room temperature (3.50).

Data presented in Table 3 was found to be non significant. However, flowers sprayed with BA 50 ppm and stored for one day under refrigerated conditions scored highest for freshness index (4.60 out of 5). While, least score was obtained when flowers were sprayed with distilled water and stored for five days at room temperature (2.73).

In our studies, similar trend was observed for both the cultivars i.e. 'Surf' & 'Solan Shringar' for Freshness index (colour retention, per cent wilting)

Table 3 indicates the effect of pre-harvest bud sprays and storage of flowers of chrysanthemum cv.'Surf'. Out of pre-harvest sprays, flowers sprayed with BA 50 ppm scored highest (3.90 out of 5) whereas lowest score for freshness was obtained by flowers sprayed with the distilled water (control) with a score of 3.53 out of 5. It has been observed that freshness index reduced with increasing storage duration. One day storage gave the best appearance with the score of 4.40 out of 5. In contrast, lowest score was obtained under of five days storage with a score of (3.01 out of 5). In storage conditions, flowers kept under refrigerated storage obtained better score (3.76 out of 5) as compared to score obtained by flowers kept at room temperature (3.62 out of 5).

Interaction of storage durations and bud spray treatments revealed that flowers sprayed with BA 50 ppm and stored for one day got the best score for appearance ie. 4.50 out of 5 which were found statistically at par with flowers sprayed with BA 25 ppm (4.40 out of 5) In contrast, flowers sprayed with distilled water which scored minimum when stored for five days (2.73).

Interaction of storage durations and storage conditions was found to be non-significant. However, flowers stored under refrigerated storage for one day obtained the best score for appearance (4.43 out of 5), least score on the other hand, was noted when the flowers were stored at room temperature for five days (3.01).

Interaction of storage conditions and bud spray treatments was also found to be non-significant. However, flowers treated with BA 50 ppm and stored under refrigerated conditions obtained maximum score (3.93 out of 5) for freshness index. In contrast, least score was noted in flowers treated with distilled water (control) and stored under room temperature with the score of 3.40

A perusal of data presented in Table 3 shows the interaction effect of storage conditions, storage durations and bud spray treatments and was found to be non-significant. However,

These results are in congruence with the results of Karimi *et al.* (2013) [5] who reported that treatments with 20 or 30 mg/l BA reduced ethylene production in flowers and improves the visual quality of potted carnation plants.

In another study, Asil and Karimi (2010) [1] reported that BA at 25, 50 or 75 mg /l reduced petal colour fading and maintained the quality of eustoma cut flowers.

Per cent spoilage

Data presented in Table 4 reveals the effect of pre-harvest sprays, storage conditions and storage durations on per cent spoilage of flowers of chrysanthemum cv. 'Solan Shringar'. It was found that out of pre-harvest sprays, minimum spoilage (10.50%) was observed with BA 50 ppm application, however maximum spoilage (19.00%) was noted in control. Among storage durations, no spoilage was observed up to 2 days of storage. Maximum flower spoilage (35.00%) on the other hand, was observed when the flowers were stored for five days. In storage conditions flowers stored under refrigerated conditions showed less spoilage (13.67%) as compared to flowers stored at room temperature (15.56%).

Table 4: Effect of pre-harvest bud spray and storage on per cent spoilage of flowers of chrysanthemum cultivar 'Solan Shringar' and 'Surf'

Per cent spoilage of cv. 'Solan Shringar'								
Bud spray treatments (T)	**Storage durations (D)**					**Mean**	**Storage conditions(C)**	
	1 day	**2 days**	**3 days**	**4 days**	**5 days**		**Cold Storage (4°C)**	**Room temperature**
BA (25 ppm)	0.00 (0.00)*	0.00 (0.00)	11.67 (19.72)	28.33 (32.00)	31.67 (34.21)	14.33 (17.25)	13.33 (16.52)	15.33 (17.98)
BA (50 ppm)	0.00 (0.00)	0.00 (0.00)	9.17 (17.59)	15.00 (22.41)	28.33 (32.00)	10.50 (14.48)	9.67 (13.72)	11.33 (15.04)
Control (distilled water)	0.00 (0.00)	0.00 (0.00)	15.00 (22.41)	35.00 (36.27)	45.00 (42.09)	19.00 (20.19)	18.00 (19.46)	20.00 (20.83)
Mean	0.00 (0.00)	0.00 (0.00)	11.94 (19.97)	26.11 (30.23)	35.00 (36.10)	-	13.67 (16.56)	15.56 (17.92)
Storage conditions (C)						CD $_{0.05}$ for T: 1.30 D × T: 3.02 D: 1.76 C × D: NS C: 1.11 C × T: NS		
Cold Storage (4°C)	0.00 (0.00)	0.00 (0.00)	10.56 (18.78)	24.44 (29.18)	33.33 (35.16)			
Room temperature	0.00 (0.00)	0.00 (0.00)	13.33 (21.16)	27.78 (31.48)	36.67 (37.14)			
Per cent spoilage cv. 'Surf'								
Bud spray treatments (T)	**Storage durations (D)**					**Mean**	**Storage conditions(C)**	
	1 day	**2 days**	**3 days**	**4 days**	**5 days**		**Cold Storage (4°C)**	**Room temperature**
BA (25 ppm)	0.00 (0.00)*	0.00 (0.00)	21.67 (27.62)	38.33 (38.23)	41.67 (40.17)	20.33 (21.20)	19.33 (20.56)	21.33 (21.84)
BA (50 ppm)	0.00 (0.00)	0.00 (0.00)	18.33 (25.20)	25.00 (29.86)	38.33 (38.23)	16.33 (18.68)	15.33 (17.95)	17.33 (19.31)
Control (distilled water)	0.00 (0.00)	0.00 (0.00)	25.00 (29.86)	45.00 (42.09)	55.00 (47.85)	25.00 (23.98)	24.00 (23.32)	26.00 (24.54)
Mean	0.00 (0.00)	0.00 (0.00)	21.67 (27.59)	36.11 (36.79)	45.00 (42.05)	-	19.56 (20.61)	21.56 (21.96)
Storage conditions (C)						CD $_{0.05}$ for		

Cold Storage (4°C)	0.00 (0.00)	0.00 (0.00)	20.00 (26.30)	34.44 (35.75)	43.33 (41.10)	T: 1.28 D × T: 2.71 D: 1.61 C × D: NS C: 1.09 C × T: NS
Room temperature	0.00 (0.00)	0.00 (0.00)	23.33 (28.79)	37.78 (37.73)	46.67 (43.00)	

***** Figures in parenthesis are angular transformed values.

Interaction between storage durations and bud spray treatments revealed that flowers sprayed with BA 50 ppm can be stored for two days without spoilage. On the other hand, maximum spoilage (45.00%) was observed when the flowers were sprayed with the distilled water and stored for five days.

Interaction between storage duration and storage conditions was also found to be non-significant. However, no spoilage was noted under refrigerated conditions upto two days. In contrast, maximum flower spoilage (36.67%) was observed when the flowers were stored for five days at room temperature.

Interaction between bud spray treatments and storage conditions was also found to be non-significant. However, minimum flower spoilage (9.67%) was noted when flowers were sprayed with the BA 50 ppm and stored under refrigerated conditions. Maximum flower spoilage (20.0%) on other hand was observed when flowers were sprayed with distilled water and stored under room temperature.

Data presented in Table 4 reveals the effect of pre-harvest sprays, storage conditions and storage durations on spoilage of chrysanthemum loose flowers of cv. 'Surf'. It was found that out of pre-harvest sprays, minimum spoilage (16.33%) was observed with BA 50 ppm applied at bud stage. Maximum spoilage (25.00%) was, however, observed in control. Data also indicates that flowers remained fresh i.e. no spoilage recorded upto 2 days of storage. On other hand, maximum flower spoilage (45.00%) was noted when the flowers were stored for five days. In storage conditions, flowers stored under refrigerated conditions showed less spoilage (19.56 %) as compared to flowers stored at room temperature (21.56%).

Interaction between storage durations and bud spray treatments revealed that flowers sprayed with BA 50 ppm and stored for one day and two days resulted in no spoilage (0.00%). On the other hand, maximum spoilage (55.00%) was observed when the flowers were sprayed with the distilled water and stored for five days.

Per cent moisture content

Data presented in Table 4 indicates the significant effect of pre-harvest sprays, storage conditions and storage durations on per cent moisture content of loose flowers chrysanthemum cv. 'Solan Shringar'. It was found that flowers sprayed at bud stage with BA 50 ppm were observed with the maximum moisture content (78.75%). Minimum moisture content, on other hand was obtained in flowers sprayed with the distilled water (73.25%). Among storage durations, flowers stored for one day showed the maximum moisture content (83.14%). A gradual decrease in moisture content of stored flowers was observed with increasing storage duration. Minimum moisture content (67.49%) was noted in flowers stored for five days. Further, Flowers stored under refrigerated conditions recorded greater moisture content (76.69%) than the flowers stored at room temperature (75.26%).

Interaction data between storage durations and bud spray treatments revealed that maximum moisture content (87.20%) was noted when the flowers were sprayed with BA 50 ppm and stored for one day. Minimum moisture content (65.27%), on the other hand was observed when the flowers were sprayed with the distilled water and stored for the five days.

Table 4: Effect of pre-harvest bud spray and storage of loose flowers on per cent moisture content of chrysanthemum cultivar 'Solan Shringar' and 'Surf'

Per cent moisture content cv. 'Solan Shringar'								
Bud spray treatments (T)	**Storage durations (D)**					**Mean**	**Storage conditions(C)**	
	1 day	**2 days**	**3 days**	**4 days**	**5 days**		**Cold Storage (4°C)**	**Room temperature**
BA (25 ppm)	83.22	80.37	77.23	71.45	66.92	75.84	76.39	75.39
BA (50 ppm)	87.20	82.78	79.20	74.48	70.18	78.75	79.45	78.05
Control (distilled water)	78.80	75.97	76.55	69.67	65.27	73.25	73.94	72.46
Mean	83.14	79.67	77.63	71.87	67.49	-	76.69	75.26
Storage conditions (C)						CD $_{0.05}$ for T: 0.77 D × T: 1.75 D: 0.90 C × D: NS C: 0.66 C × T: NS		
Cold Storage (4°C)	83.37	80.26	78.53	72.33	68.58			
Room temperature	82.81	79.09	76.72	71.30	66.30			
Per cent moisture content cv. 'Surf'								
Bud spray treatments (T)	**Storage durations (D)**					**Mean**	**Storage conditions(C)**	
	1 day	**2 days**	**3 days**	**4 days**	**5 days**		**Cold Storage (4°C)**	**Room temperature**
BA (25 ppm)	85.75	82.62	79.85	74.18	70.02	78.56	79.10	77.93
BA (50 ppm)	90.30	85.57	82.03	77.08	72.85	81.57	82.25	80.99
Control (distilled water)	82.07	79.10	77.03	72.42	67.83	75.73	76.47	74.99
Mean	86.01	82.49	79.64	74.59	70.23	-	79.24	77.97
Storage conditions (C)						CD $_{0.05}$ for T: 0.65 D × T: 1.42 D: 0.82 C × D: NS C: 0.56 C × T: NS		
Cold Storage (4°C)	86.56	83.21	80.27	75.11	71.14			
Room temperature	85.56	81.68	79.01	73.98	69.42			

Interaction between storage durations and storage conditions was found to be non-significant. However, maximum moisture content (83.37%) was obtained when the flowers were stored for one day under refrigerated conditions, while moisture content was minimum (66.30%) when the flowers were stored for five days at room temperature.

Interaction between storage conditions and bud sprays was also found to be non-significant. However, maximum moisture content (79.45%) was observed when flowers were treated with BA 50 ppm and stored under refrigerated condition, while minimum moisture content (72.46%) was observed when flowers were sprayed with distilled water and stored at room temperature.

Table 4 indicates the significant effect of pre-harvest sprays, storage conditions and storage durations on per cent moisture content of chrysanthemum loose flowers. It was found that flowers sprayed with BA 50 ppm were observed with the maximum moisture content (81.57%). Minimum moisture content, on the other hand was obtained in flowers sprayed with the distilled water (75.73%). Among storage durations, maximum moisture content (86.01%) was recorded in flowers stored for one day. Minimum moisture content (70.23%), on the other hand was observed in flowers which were stored for five days. Data also suggests that in storage conditions flowers stored under refrigerated conditions showed greater moisture content (79.24%) than flowers which stored at room temperature (77.97%).

Interaction between storage durations and bud spray treatments revealed that maximum moisture content (90.30%) was noted when the flowers were sprayed with BA 50 ppm and stored for one day. On the other hand, moisture content (67.83%) was observed minimum when the flowers were sprayed with the distilled water and stored for the five days.

Our results suggests that BA 50 ppm was the best spray treatment for increasing moisture content of loose flowers of both the cultivar 'Solan Shringar' & 'Surf'.

Simultaneously, flowers stored in the cold storage were observed with more moisture content and less spoilage. This might be due to the decreased respiration rate at low temperature which results in reduction in the loss of moisture. Similar results were obtained by Nagaraja *et al.* (1999) [7] who noticed the same trend on the tuberose flowers treated with BA upto day five.

Table 5: Comparison of cultivars 'Solan Shringar' and 'Surf' of chrysanthemum for effect of packaging material on shelf life of loose flowers after storage by using Fisher's t-test

Characters studied	'Solan Shringar'	'Surf'	t Stat (calculated)
Per cent weight gain	5.01	5.18	0.48
Shelf life (days)	3.13	3.43	2.21
Freshness index (colour retention, percent wilting)	3.74	3.69	-0.59
Per cent spoilage	16.78	21.22	1.79*
Per cent moisture content	75.99	78.53	2.84*

Results obtained shows that minimum weight loss, maximum moisture content and minimum spoilage was obtained in three days storage. Similar results were obtained by Nagaraja *et al.* (1999) [7] in tuberose flowers packaged in 200 gauge polyethylene. They also reported the increase in wilting percentage with the storage duration. This might be reason for the increase in spoilage as the storage duration increases.

The performance of cultivar 'Solan Shringar' is at par with 'Surf' (Table 5) for shelf life characters under study. Cultivar 'Surf' was significantly superior over 'Solan Shringar' for higher moisture content in flowers till end. However the cultivars did not differ significantly for weight gain, freshness index. More flower spoilage, on the other hand was noted in loose flowers of 'Surf' than 'Solan Shringar'.

The variations could be attributed to the genotypic differences between the cultivars. Similar results in vase life studies of cut chrysanthemum flowers were reported by Kavita (2016) [4].

Conclusions

Based on the present findings, it can be concluded that spraying the buds of chrysanthemum (15mm diameter) with BA showed a considerably increased shelf life of loose flowers in cultivars 'Solan Shringar' and 'Surf'. Flowers stored under refrigerated conditions (4 °C) was found to have better shelf life over flowers stored under room temperature in both cultivars. While comparing cvs, i.e. 'Solan Shringar' and 'Surf' were found at par for shelf life and freshness index of loose flowers.

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