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Response of storage duration, harvest stages and polymeric packaging films on post harvest life of gladiolus cut spikes cv. White Prosperity

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ABSTRACT

A study was conducted on response of storage duration, harvest stage and polymeric packaging film on modified atmosphere storage of gladiolus cut spikes cv. White Prosperity. The cut spikes were harvested at two distinct stages of floret development, *i.e.*, S_1- when 1-2 florets showed colour, S_2 when- 4-5 florets showed colour, packed in various wrapping material and stored for four storage duration levels. Polymeric sleeves exerted varying effect on keeping quality of spikes. S_1- spikes exhibited lower vase-life than S_2- spikes. Vase-life was maximum in polypropylene-100 and minimum in low density polyethylene -200 gauge sleeves. The keeping quality of unpackaged cold stored cut spikes was highly deteriorated, which decreases with increase in refrigerated storage duration. An ideal level of higher CO_2 (4.30%), lower level O_2 (10.64%) and C_2H_4 (0.50 ppm), respectively were recorded at 7 days storage duration with the spike harvested at 4-5 florets show colour and packed in polypropylene -100 guage interaction ($D_2S_2P_3$). The spikes stored at $D_2S_2P_3$ level also showed higher number of florets opened at a time (3.21), gain in fresh weight (6.01%), longevity of floret (3.46 days), opened florets per spike in vase (8.40), second floret diameter (10.42 cm), vase-life (8.40 days) and water uptake (67.86 ml), which continued to decrease with increase in storage duration. Hence, 7 days storage duration with 4-5 florets show colour on spike (S_2) and packed in polypropylene -100 guage sleeves were found most suitable for post-harvest life under modified atmosphere storage of gladiolus.

Key words: Gladiolus, polyethylene wrap , polypropylene wrap, vase-life.

INTRODUCTION

Gladiolus is one of leading bulbous flower belongs to family Iridaceae, with basic chromosome number $\varkappa$ = 15, commercially grown throughout the world, rank fourth in international cut flower trade after rose, carnation and chrysanthemum. It has gained much importance as it also known as 'Queen of bulbous flowers'. In view of market strategy for cut flowers in our country, there is problem of frequent market gluts and price crash. Hence, there is a need to evolve an appropriate storage technique for cut flowers during period of decline demand and also to facilitate long term sea-shipment for export. Improper harvest stage, packaging practice and defective storage facility lead to deterioration in cut spike quality during transportation to distant market resulted in declined vase-life, freshness and moisture loss.

An appropriate packaging technique along with cold storage can maintain quality of cut spike through modified atmosphere storage by Zeltzer *et al.* (9). Gaseous permeability properties of the polymeric film sleeves are also known to vary and the suitable package sleeves have to be worked out for the storage of cut spike by Grover (1). Therefore, to standardize effective storage duration, harvest stage and packaging films on post harvest life of gladiolus cut spikes, the needs arises to improve post harvest quality parameters with ideal CO_2, O_2 and C_2H_4 level during storage. Thus, the present study was under taken.

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MATERIALS AND METHODS

The present experiment was conducted at AICRP on Floriculture Lab, Horticulture Farm, RCA Campus, MPUA&T, Udaipur during January-February 2010 and 2011. The experiment was conducted in completely randomized block design with factorial concept and with three replications. The good quality spikes of gladiolus cv. White Prosperity were harvested from the field grown crop, at two stages of floret development, *viz*., stage-I (S_1) - when 1-2 floret show colour and stage-II (S_2) - when 4-5 florets show colour in morning hours at 8.00 AM and pre-cooled in water to avoid field heat entry in xylem vessel for 30 min. The spikes were cut uniform length up to 75 cm, pulsing with 20% sucrose solution at 4°C kept for 6 h in refrigerator and made into bundles of three spikes per treatment and loosely tied at base with rubber band. After pulsing spikes were inserted in different polymeric film sleeves, *viz*., low density polyethylene-100 gauge, LDPE-200 gauge,

polypropylene-100 gauge (25 µ), PP-200 gauge (50 µ) thickness and control (without packing), which were then sealed hermetically with electronic polythene sealing machine. The sleeves were stored vertically under refrigerated condition at 3-4°C; 85-90% relative humidity for various storage duration, *viz*., 0 days mean without storage, 7, 14 and 21 days. After storage, 2 cm basal ends of spikes were re-cut under water to expose fresh tissue, to facilitate water absorption. The spike were put in cylindrical vases of glass containing distilled water under laboratory condition at 1000 lux light intensity provided by white fluorescent tubes.

The various observations were recorded for gain/ loss in fresh weight of spike, florets opened during storage, days to basal floret opening, floret opened at a time, floret longevity, florets opened per spike in vase, second floret diameter, vase-life, water uptake, O_2, CO_2 by head space gas analyzer, C_2H_4 by ethylene analyzer (Model: Bioconservacion) after storage and simulated transit. Vase-life of cut spikes was measured from the days when one basal floret was open till there was last floret wilt on spike. Freshly harvested spikes served as control. The data presented are a mean of three replications each of three spikes. Statistically analysis of the recorded data was carried out by analysis of variance technique in a factorial CRD layout. Test of significance was determined by using critical difference (P = 0.01).

RESULTS AND DISCUSSION

From the data presented in Table 1, it is seen that percent gain/ loss in fresh weight of spike were show highly significant influence by various interaction treatment, *viz*., storage durations, harvesting stage and packaging films. The maximum percent gain in fresh weight of spike was recorded in treatment $D_2S_2P_3$, *i.e.*, 7 days storage × 4-5 florets show colour × polypropylene-100 (6.01%) followed by 7 days × stage-II × PP-200 (5.65%), whereas, minimum at 21 days storage duration × 1-2 florets show colour × low density poly ethylene-200 (1.17%), while maximum percent loss in fresh weight was observed at 21 days × 1-2 floret show colour × without film (-50.41%). Similar results of retaining fresh weight of cut spike were also obtained by using packaging films, which create passive modified atmosphere for high CO_2, low O_2 and ethylene level within the package, which reduced respiration, transpiration rate during the storage of cut spike in gladiolus (Grover *et al.*, 3) and shipment of rose and golden rod (Zeltzer *et al.*, 9). Furthermore, the increased storage duration recorded higher loss in weight of tuberose cut spikes due to increased loss of carbohydrate and water reported by Patil and Dhaduk (5) in tuberose cv. Local Double.

However, highly significant influence on minimum floret opened during storage in desirable interaction were recorded in treatment $D_2S_1P_3$ (1.11), $D_2S_2P_3$ (1.33), while more floret opening in $D_4S_2P_5$ (4.22) interaction was undesirable. The polypropylene films have been also reported to retain higher CO_2, low O_2 and ethylene levels within the package, which reduced opening of florets during storage and suitable for modified atmosphere storage in gladiolus. Similar findings were observed by Grover (1) and Singh *et al.* (8) reported that spike held in other package films showed more florets opening during storage.

Further, highly significant influence on the maximum number of florets opened at a time was recorded in interaction treatment 7 days storage durations X 4-5 floret show colour X polypropylene-100 (3.21) and minimum in $D_4S_2P_2$ (0.23). The spikes were stored in PP-100 and PP-200 gauge sleeves also showed higher number of florets opening at one time and per-cent opening of florets, which continued to decrease with the increase level of storage duration. Similar results on florets opened at a time with modified atmosphere packaging have been also reported by Grover *et al.* (3), Singh *et al.* (7), and Singh *et al.* (8) in gladiolus.

Although, minimum days to basal floret opening show highly significant influence, which were recorded in interaction treatment $D_1S_2P_3$ (1.03 days) but the desirable effect was observed in treatment $D_2S_2P_3$, *i.e.*, 7 days storage duration × 4-5 floret show colour × polypropylene-100 (1.50 days), followed by treatment $D_2S_2P_4$ (1.60 days). If the storage duration increases among the stage-I, II and various storage durations the days taken to basal floret opening was not desirable, hence florets did not open in case when cut spike harvested at stage-I (1-2 floret show colour) even after 21 days of storage duration onwards but stage-II (4-5 floret show colour) cut spikes took more days to basal floret opening after 21 days storage duration (Grover and Singh, 2).

Whereas, the data on number of florets opened per spike in vase indicates highly significant influence among various interaction treatment, which were recorded in $D_2S_2P_3$, *i.e.*, 7 days storage duration × 4-5 floret show colour × polypropylene-100 (8.40) as compared to $D_1S_2P_3$, *i.e.*, 0 days × stage-II × PP-100 (9.66), while, minimum was noticed in $D_4S_2P_5$ (1.44). The florets opened per spike in vase were directly related to respiration and reserved carbohydrate content in cut spikes, which were wrapped in polypropylene and stored for minimum duration, maintained higher number of floret opening on cut spike. Similar findings on number of florets opened per spike in vase with modified atmosphere packaging have been reported by Grover *et al*. (3), Singh *et al.* (7), and Singh *et al.* (8) in gladiolus.

Table 1. Response of storage durations, harvesting stages and packaging films on post harvest quality parameters in *Gladiolus hybrida* cv. White Prosperity.

Treatment	Gain / loss in fresh wt. of spike	Florets opened after storage	Floret opened at a time	Basal floret opening (days)	Florets opened per spike	Longevity of floret (days)
$D_1S_1P_1$	2.43	0.44	2.41	2.46	6.72	3.03
$D_1S_1P_2$	1.79	0.55	1.87	2.62	6.64	2.55
$D_1S_1P_3$	3.74	0.32	3.20	2.15	8.41	3.46
$D_1S_1P_4$	3.10	0.40	2.84	2.31	7.59	3.31
$D_1S_1P_5$	-16.67	0.77	1.20	2.77	5.28	2.45
$D_1S_2P_1$	3.66	1.11	2.77	1.29	7.97	3.42
$D_1S_2P_2$	2.75	1.33	2.20	1.41	7.74	3.06
$D_1S_2P_3$	5.50	0.56	3.51	1.03	9.66	3.85
$D_1S_2P_4$	4.81	0.67	3.30	1.11	8.73	3.69
$D_1S_2P_5$	-24.66	1.55	1.50	1.43	6.38	2.95
$D_2S_1P_1$	3.17	1.58	1.89	2.99	5.43	2.69
$D_2S_1P_2$	2.32	1.89	1.53	3.15	4.75	2.22
$D_2S_1P_3$	5.61	1.11	2.89	2.68	7.20	3.12
$D_2S_1P_4$	4.16	1.33	2.43	2.84	6.62	2.91
$D_2S_1P_5$	-26.69	2.22	0.89	3.30	3.94	2.17
$D_2S_2P_1$	4.32	1.77	2.22	1.89	6.53	3.04
$D_2S_2P_2$	3.32	2.11	1.89	1.95	5.79	2.67
$D_2S_2P_3$	6.01	1.33	3.21	1.50	8.40	3.46
$D_2S_2P_4$	5.65	1.56	2.77	1.60	7.99	3.31
$D_2S_2P_5$	-28.74	2.33	1.11	2.54	5.05	2.56
$D_3S_1P_1$	2.51	2.44	0.87	3.92	3.54	2.06
$D_3S_1P_2$	1.84	2.66	0.42	4.08	3.22	1.81
$D_3S_1P_3$	3.33	1.77	1.87	3.47	4.75	2.87
$D_3S_1P_4$	2.75	2.11	1.41	3.77	4.31	2.34
$D_3S_1P_5$	-35.28	2.89	0.24	4.25	2.53	1.50
$D_3S_2P_1$	2.43	2.55	1.23	2.11	4.07	2.45
$D_3S_2P_2$	1.87	2.90	0.77	2.33	3.84	2.18
$D_3S_2P_3$	3.55	2.00	2.22	1.77	5.28	3.01
$D_3S_2P_4$	3.01	2.44	1.77	1.90	4.85	2.76
$D_3S_2P_5$	-38.26	3.22	0.44	3.85	3.07	2.07
$D_4S_1P_1$	1.76	3.23	0.00	0.00	0.00	0.00
$D_4S_1P_2$	1.17	3.33	0.00	0.00	0.00	0.00
$D_4S_1P_3$	2.40	2.91	0.00	0.00	0.00	0.00
$D_4S_1P_4$	1.91	3.00	0.00	0.00	0.00	0.00
$D_4S_1P_5$	-50.41	3.89	0.00	0.00	0.00	0.00
$D_4S_2P_1$	2.39	3.44	0.55	2.39	2.26	1.89
$D_4S_2P_2$	2.01	3.55	0.23	2.48	1.91	1.61
$D_4S_2P_3$	2.66	3.23	1.23	1.91	3.86	2.32
$D_4S_2P_4$	2.05	3.33	0.89	2.02	2.74	2.08
$D_4S_2P_5$	-47.29	4.22	0.00	3.99	1.44	1.43
CD at 1%	2.13	0.29	0.25	0.27	0.50	0.22

However, the highly significant influence among various interaction treatment on opened floret longevity, which was maximum recorded in treatment $D_1S_2P_3$ (3.85 days), *i.e*. without storage × stage-II × PP-100 interactions, followed by $D_2S_2P_3$ (3.46 days), *i.e*. 7 days × stage-II × PP-100, while, minimum opened floret longevity was observed in $D_4S_2P_5$ (1.43 days). While, none of the opened florets were showed longevity from $D_4S_1P_1$ to $D_4S_1P_5$ interaction as opening process not happened. The opened florets longevity, directly related to the normal metabolic activities mainly transpiration and water uptake were maintained in those cut spikes, which were wrapped in polypropylene and stored for minimum storage duration and ultimately, which maintained higher opened florets longevity in cut spike. Prolonged storage duration leads to decreased in longevity due to depletion of stored carbohydrates by respiration, water loss by transpiration and senescence process by ethylene, which increase with increment in storage duration Kumar *et al.* (4) and Patil and Dhaduk (5) in tuberose cv. Local Double.

The data in Table 2 indicates that combined influence between storage duration × harvesting stage × packaging films showed highly significant effect on floret diameter. The maximum floret diameter was recorded in interaction $D_1S_2P_3$, *i.e*. 0 days × stage-II × PP-100 (10.71 cm), followed by $D_2S_2P_3$, *i.e*., 7 days x stage-II × PP-100 (10.42 cm), while, minimum was observed in $D_3S_1P_5$ (6.04 cm). However, floret diameter showed decline trends with increasing storage duration. Moreover, floret diameter on the spikes stored in polypropylene-100 and polypropylene-200 film sleeves were higher than those stored in other film sleeves. These finding are in agreement with those obtained in gladiolus by Grover and Singh (2), Grover *et al*. (3), and Singh *et al.* (7).

Moreover, data showed highly significant influence on vase life of cut spike among various interaction treatments. An optimum vase-life of cut spike was recorded in treatment 7 days storage × stage-II × polypropylene-100 (8.40 days), as compared to 0 days storage × stage-II × polypropylene-100 (10.33 days), while, minimum was observed in $D_4S_2P_5$ (1.38 days). The transpiration loss of water and respiration loss of carbohydrate is slowdown due to low temperature in polypropylene wrapping which maintained the fresh weight as well as cell turgidity of cut spike after cold storage which improve vase life according to Kumar *et al*. (4) in tuberose and Singh *et al.* (8) in gladiolus.

Whereas, highly significant influence on higher water uptake was observed at interaction treatment $D_1S_2P_3$ (71.99 ml), followed by $D_2S_2P_3$, *i.e*., 7 days × stage-II × polypropylene-100 gauge (67.86 ml), however, minimum was noticed at $D_4S_2P_5$ (20.18 ml). The higher water uptake in cut spike harvested at stage-II, wrapping in polypropylene-100 gauge and cold stored might be due to normal condition of the petal cells in floret, which maintained optimum levels of carbohydrate and cell turgidity even after storage. The water uptake decreased in cut spikes which stored for longer duration because the ability of xylem cells to absorb water was decreases as reported by Patil and Dhaduk (5) in tuberose cv. Local Double. These results corroborate with those reported by Grover *et al*. (3) and Singh *et al.* (8) in gladiolus.

However, perusal of data indicated combined interaction between storage duration × harvesting stage × packaging films showed highly significant effect on CO_2 level during storage except simulated transit stage. According to data analysis higher percent CO_2 during storage, 16 h simulated transit and total level were recorded at $D_2S_2P_3$, *i.e*. 7 days × stage-II × PP-100 (4.30, 5.50 and 9.80% respectively) and lower CO_2 level in various interaction at $D_1S_1P_5$, $D_1S_2P_5$, $D_2S_1P_5$ and $D_2S_2P_5$ (-0.4,-0.4, -0.8% respectively). Higher CO_2 level within the package and cold storage duration has been reported to reduce respiration, inhibits ethylene production, along with action regards senescence and maintained quality of cut spike in gladiolus as suggested by Singh *et al.* (7), which subsequently helps in reducing microbial contamination, creating high humidity ultimately resulting in lower moisture loss and better quality retention of the cut spike as agreed by Singh (6).

While, mean data in Table 3 indicated highly significant influence on percent O_2 level after simulated transit except percent O_2 after storage and total O_2 parameters. The lower O_2 percent during storage, after simulated transit and total was recorded in treatment $D_2S_2P_3$, *i.e.*, 7 days × stage-II × polypropylene-100 (10.64, 9.47 and 20.11%, respectively), whereas, high level were noticed in $D_1S_1P_2$ (18.64, 15.46 and 34.10%, respectively). Low O_2 level within the package is maintained as result of its consumption in respiration process by the cut spikes and its low influx to outer atmosphere through the polypropylene packaging film. Modified atmospheric packaging retards the physiological metabolism which leading to senescence process by the decreased O_2 concentrations, slowing down the rate of respiration and ethylene biosynthesis. These present results corroborate with finding as reported by Grover *et al*. (3), Singh *et al.* (7), and Singh *et al.* (8) in gladiolus.

The data revealed for ethylene production show highly significant influence by various interaction between storage duration × harvest stage × packaging material during storage, except simulated transit and

Table 2. Response of storage durations, harvesting stages and packaging films on floret diameter, vase-life, water uptake and CO_2 level in *Gladiolus hybrida* cv. White Prosperity.

Treatment	Floret diameter (cm)	Vase-life (days)	Water uptake (ml)	CO_2 % during storage	CO_2 % after simulated transit	Total CO_2 (%)
$D_1S_1P_1$	8.61	7.04	59.67	0.60	2.81	3.41
$D_1S_1P_2$	8.06	6.58	56.46	0.53	2.53	3.07
$D_1S_1P_3$	9.56	8.72	65.42	1.20	3.48	4.68
$D_1S_1P_4$	8.98	7.80	61.92	0.73	3.13	3.87
$D_1S_1P_5$	7.95	5.88	50.91	-0.40	-0.40	-0.80
$D_1S_2P_1$	9.77	8.47	66.24	0.73	2.96	3.69
$D_1S_2P_2$	9.49	8.00	63.03	0.65	2.77	3.42
$D_1S_2P_3$	10.71	10.33	71.99	1.64	3.68	5.32
$D_1S_2P_4$	10.14	9.23	68.49	1.29	3.38	4.67
$D_1S_2P_5$	9.11	7.31	57.48	-0.40	-0.40	-0.80
$D_2S_1P_1$	7.99	5.88	51.38	1.43	3.13	4.56
$D_2S_1P_2$	7.74	5.53	48.75	1.01	2.85	3.86
$D_2S_1P_3$	8.88	6.94	57.54	2.50	4.03	6.53
$D_2S_1P_4$	8.48	6.09	54.10	1.87	3.80	5.67
$D_2S_1P_5$	7.07	3.84	42.96	-0.40	-0.40	-0.80
$D_2S_2P_1$	9.54	7.63	61.70	2.73	4.43	7.17
$D_2S_2P_2$	9.38	7.49	59.07	2.35	4.05	6.40
$D_2S_2P_3$	10.42	8.40	67.86	4.30	5.50	9.80
$D_2S_2P_4$	10.03	8.09	64.42	3.07	5.03	8.10
$D_2S_2P_5$	8.61	5.25	53.28	-0.40	-0.40	-0.80
$D_3S_1P_1$	6.44	3.97	34.01	1.11	3.18	4.29
$D_3S_1P_2$	6.36	3.53	31.05	0.98	3.07	4.05
$D_3S_1P_3$	7.09	4.84	40.17	1.87	3.76	5.63
$D_3S_1P_4$	6.93	4.39	36.40	1.25	3.50	4.75
$D_3S_1P_5$	6.04	2.63	25.26	-0.40	-0.40	-0.80
$D_3S_2P_1$	9.13	5.32	54.24	1.21	3.33	4.54
$D_3S_2P_2$	8.97	4.98	51.27	1.12	3.19	4.31
$D_3S_2P_3$	9.37	6.82	60.39	2.88	5.49	8.37
$D_3S_2P_4$	9.19	6.00	56.62	2.22	4.79	7.01
$D_3S_2P_5$	7.99	4.10	45.48	-0.40	-0.40	-0.80
$D_4S_1P_1$	0.00	0.00	0.00	1.71	4.09	5.80
$D_4S_1P_2$	0.00	0.00	0.00	1.22	3.52	4.74
$D_4S_1P_3$	0.00	0.00	0.00	2.36	4.66	7.02
$D_4S_1P_4$	0.00	0.00	0.00	1.78	4.37	6.15
$D_4S_1P_5$	0.00	0.00	0.00	-0.40	-0.40	-0.80
$D_4S_2P_1$	7.98	2.42	28.94	1.91	4.48	6.39
$D_4S_2P_2$	7.80	1.99	25.97	1.31	4.10	5.41
$D_4S_2P_3$	8.60	3.67	35.06	2.67	3.96	6.63
$D_4S_2P_4$	8.47	2.88	31.32	1.52	3.70	5.22
$D_4S_2P_5$	6.81	1.38	20.18	-0.40	-0.40	-0.80
CD at 1%	0.32	0.43	1.57	0.25	NS	0.57

Table 3. Response of storage duration, harvesting stage and packaging film on O_2 and C_2H_4 during storage, after simulated transit and total in *Gladiolus hybrida* cv. White Prosperity.

Treatment	O_2 after storage (%)	O_2 after transit (%)	Total O_2 (%)	C_2H_4 during storage (ppm)	C_2H_4 after transit (ppm)	Total C_2H_4 (ppm)
$D_1S_1P_1$	17.17	15.02	32.19	0.52	0.90	1.41
$D_1S_1P_2$	18.64	15.46	34.10	0.57	0.97	1.54
$D_1S_1P_3$	15.52	13.45	28.97	0.41	0.69	1.11
$D_1S_1P_4$	16.25	14.39	30.64	0.47	0.84	1.31
$D_1S_1P_5$	20.90	20.90	41.80	0.00	0.00	0.00
$D_1S_2P_1$	16.50	14.48	30.98	0.63	1.00	1.63
$D_1S_2P_2$	17.70	15.14	32.84	0.67	1.08	1.75
$D_1S_2P_3$	14.25	12.99	27.24	0.50	0.78	1.28
$D_1S_2P_4$	15.17	13.78	28.95	0.57	0.89	1.46
$D_1S_2P_5$	20.90	20.90	41.80	0.00	0.00	0.00
$D_2S_1P_1$	13.52	12.17	25.69	0.49	0.86	1.35
$D_2S_1P_2$	14.19	12.93	27.12	0.55	0.94	1.49
$D_2S_1P_3$	12.82	10.78	23.59	0.38	0.68	1.06
$D_2S_1P_4$	13.69	11.77	25.46	0.41	0.78	1.19
$D_2S_1P_5$	20.90	20.90	41.80	0.00	0.00	0.00
$D_2S_2P_1$	14.02	12.67	26.69	0.60	0.97	1.57
$D_2S_2P_2$	14.59	13.06	27.66	0.70	1.17	1.87
$D_2S_2P_3$	10.64	9.47	20.11	0.45	0.82	1.27
$D_2S_2P_4$	11.24	9.62	20.86	0.50	0.91	1.41
$D_2S_2P_5$	20.90	20.90	41.80	0.00	0.00	0.00
$D_3S_1P_1$	15.88	12.99	28.88	0.53	0.88	1.41
$D_3S_1P_2$	16.95	13.80	30.76	0.64	1.07	1.71
$D_3S_1P_3$	13.82	10.78	24.60	0.42	0.71	1.13
$D_3S_1P_4$	14.55	11.90	26.45	0.49	0.79	1.28
$D_3S_1P_5$	20.90	20.90	41.80	0.00	0.00	0.00
$D_3S_2P_1$	16.15	14.20	30.35	0.63	0.97	1.60
$D_3S_2P_2$	17.94	14.57	32.51	0.75	1.18	1.94
$D_3S_2P_3$	12.60	10.14	22.74	0.50	0.83	1.33
$D_3S_2P_4$	13.71	10.25	23.96	0.58	0.91	1.49
$D_3S_2P_5$	20.90	20.90	41.80	0.00	0.00	0.00
$D_4S_1P_1$	15.34	11.90	27.25	0.56	0.91	1.48
$D_4S_1P_2$	16.26	12.96	29.22	0.66	1.09	1.75
$D_4S_1P_3$	14.37	12.14	26.51	0.47	0.74	1.22
$D_4S_1P_4$	14.99	13.81	28.79	0.51	0.82	1.33
$D_4S_1P_5$	20.90	20.90	41.80	0.00	0.00	0.00
$D_4S_2P_1$	15.59	13.22	28.81	0.67	0.99	1.66
$D_4S_2P_2$	16.55	13.51	30.06	0.76	1.19	1.95
$D_4S_2P_3$	13.28	11.06	24.34	0.55	0.84	1.39
$D_4S_2P_4$	13.83	12.70	26.54	0.61	0.93	1.55
$D_4S_2P_5$	20.90	20.90	41.80	0.00	0.00	0.00
CD at 1%	NS	0.55	NS	0.08	NS	NS

Notation: Storage durations- D1 means without storage i.e 0 days, D2 - 7days , D3 -14 days and D4 - 21 days storage duration at 3-4ºC, Harvesting Stage -S1- 1-2 florets shows colour, S2-when 4-5 florets show colour, Packaging films- P1 (Low Density Poly Ethylene-100), P2 (Low Density Poly Ethylene -200), P3 (Polypropylene-100), P4 (Polypropylene -200) and Control, *i.e.* without packaging- (P5)

total quantum production. Whereas, ideal level of ethylene during storage, simulated transit and total quantum production for floret opening and vase-life was recorded in treatment $D_2S_2P_3$, *i.e.* 7 days storage × stage-II × PP-100 (0.45, 0.82, 1.27 ppm, respectively), followed by $D_2S_2P_4$, whereas, maximum ethylene level in $D_4S_2P_2$ (0.76, 1.19, 1.95 ppm, respectively), which lower down the vase-life in gladiolus cut spike. The polypropylene films have been reported to retain lower level of oxygen for respiration, ethylene within the package, which reduced florets opening, senescence of the cut spike during storage, improved fresh weight, cell turgidity by maintain humidity and suitable for modified atmosphere storage of gladiolus, which were reported by Grower (2), Grower *et al.* (3) and Singh *et al.* (8).

From the above results and discussion it can be concluded that 7 days storage duration with cut-spike harvested at 4-5 floret show colour and packed in polypropylene-100 gauge sleeves was found most suitable for post harvest life of gladiolus cut spike under modified atmosphere storage to avoid glut in the market.

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