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Response of passive storage duration and polymeric packaging films on postharvest life of Suvasini tuberose cut spikes

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ABSTRACT

A study was conducted at Department of Horticulture, MPUAT Udaipur on response of storage duration and packaging materials under passive modified atmosphere storage of tuberose cut spikes *cv.* Suvasini to find out the suitable packaging material and storage duration in tuberose to avoided seasonal glut in market. The experiment was conducted in completely randomized design with factorial concept and with three replications. The cut spikes were harvested when 1-2 florets showed colour, after pre cooling, pulsing with 20% sucrose solution cut spikes were packed in five wrapping materials (LDPE-25µ, 50µ, PP-25µ, 50µ and news paper wrapping served as control) and stored on five level of storage duration (0, 3, 6, 9 and 12 days). The cut spike packed sleeves were stored vertically under refrigerated condition at 3-4°C, 85-90 % relative humidity. The stored spikes were removed after storage duration and kept in corrugated fibre board boxes for 6hrs simulated transit and various postharvest parameters were recorded. Polypropylene sleeves exerted varying effect on keeping quality of spikes. Vase life was maximum in polypropylene-25µ (11.64 days) and minimum in low density polyethylene 50µ sleeves. The keeping quality of unpackaged stored tuberose cut spikes was highly deteriorated, which decreases with increase in refrigerated storage duration. An ideal level of CO_2 (1.98%), lower level O_2 (13.84 %) and C_2H_4 (0.78 ppm) respectively were recorded at 3 days storage duration packed in polypropylene- 25µ. The spikes stored in polypropylene- 25µ with 3 days storage level also showed highest basal florets diameter (3.55 cm), vase life (11.64 days), gain in fresh weight (7.72%) and water uptake (34.39 ml), which continued to decrease with increase in storage duration irrespective to packaging material. Optimum level of CO_2 (2.48%), lower level O_2 (12.36 %) and C_2H_4 (0.80 ppm) after 6 hrs simulated transit were recorded at 3 days storage in polypropylene- 25µ. On the basis of three year study, it is recommended that polypropylene -25µ along with 3 days storage duration were found most suitable for post harvest life under passive modified atmosphere storage of tuberose.

Key words: *Polianthes tuberosa*, low density polyethylene, polypropylene vase life.

INTRODUCTION

Tuberose is native from Mexico, which is known as 'Gulcheri' in Hindi, 'Rajanigandha' in Bengali and belongs to family Amaryllidaceae, with deploid chromosome number 2n =50, 60 in double and single type respectively as reported by Schiva and Lanteri (10). The more than three row of corolla exist in double type of tuberose and which are ideally suited for preparation of flower bouquet, bunch and vase on dining table due to pleasant aromatic fragrance. Total area under floriculture in India during 2015-16 is 278000 ha with an annual flower production 21,84, 000 MT by Sexena (11). The leading cut flower producing states are West Bengal (27%), Karnataka (13%), Odisha (11%), U.P. (10%) and Maharashtra (8%), 6 percent each contributed by Telangana, Andhra Pradesh and Assam respectively as par Indian Horticulture Data Base 2014. However, the present area under floriculture crops during 2013-14 increasing at 9.6 % and while loose flower production at 1.48 % growth rate over the NHB data base 2012-13. 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 along with effective packing polymeric film for tuberose cut spike during period of decline demand and also to facilitate long term sea-shipment for export. Immature harvest stage, improper packaging practice and defective storage facility lead to deterioration in post harvest quality of cut spike during transportation to distant market supply, which 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.* (15). Gaseous permeability properties of the polymeric film sleeves are also known to vary and the suitable package sleeves have to be worked out for cut spike storage by Grover (3) in gladiolus. With a view to find out

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effective packaging films and storage duration on post harvest life of tuberose 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.

MATERIALS AND METHODS

The present experiment was conducted at AICRP on Floriculture Lab, Horticulture Farm, RCA Campus, Maharana Pratap University of Agriculture & Technology, Udaipur, which is situated at an elevation of 561.9 meters above mean sea level at latitude of 24°34' North and longitude of 73°42' East during 15^{th} June- 15^{th} July from 2011 to 2014. The experiment was conducted in completely randomized block design with factorial concept and with three replications. The good quality spikes of tuberose cv. 'Suvasini' were harvested from the field grown crop, at uniform stages of floret development *viz*. when 1-2 floret show colour in morning hours at 8.00 AM and pre-cooled in water to avoid field heat entry in xylem vessel for 30 minutes . 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 10 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 -25 µ, low density polyethylene -50 µ, polypropylene-25 µ, polypropylene-50 µ thickness and news paper packing (control), 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, 3, 6, 9 and 12 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 vase life , basal floret diameter, total water uptake by stem, percent gain / loss in fresh weight of spike, CO_2,O_2 by head space gas analyzer , C_2H_4 by ethylene analyzer (Model: Bioconservacion) after storage and simulated transit for 16 hours in corrugated fibre board boxes. Vase life of cut spike 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 ten 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 three year pooled data presented in Table 1, showed highly significant reduction influence on vase life of tuberose cut spike among various modified interaction treatments than without storage. A highest vase life of cut spike was recorded in treatment polypropylene-25 µ × 3 days storage duration (11.64 days), as compared to control × 3, 6, 9 and 12 days storage, while minimum was in polypropylene-50 µ × 12 days storage duration (4.04 days). The transpiration loss of water and respiration loss of carbohydrate is lower down 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*.(6) in tuberose, Mahawar *et al*. (7), Jhanji and Dhatt (5), Singh *et al.* (13) in gladiolus.

Further data on basal flower diameter indicates that combined influence between packaging films × storage duration showed highly significant improve trends on floret diameter up to 12 days storage duration among various polymeric packaging. The highest floret diameter was recorded at interaction polypropylene-25 µ × 3 days storage duration (3.58 cm), followed by LDPE-25 µ × 3 days storage duration (3.55 cm) under refrigerated storage duration at ± 4 °C, while minimum was observed in news paper packing (c) × 12 days storage duration (2.32 cm). However, floret diameter showed decline trends with increasing storage duration after 3 days either packaging in low density polyethylene-25 µ, 50 µ, polypropylene-25 µ, 50 µ and news paper (Control). Moreover, floret diameter on the spikes stored in polypropylene-25 µ and polypropylene-50 µ film sleeves were higher than those stored in other film sleeves. These finding are in agreement with those obtained in gladiolus by Varu and Barad *et al*. (14), Sahare *et al.* (9) and Ghildhyal *et al.* (1) in Tuberose and Mahawar *et al.* (7). Jhanji and Dhatt (5), Grover and Singh (2), Grover *et al*. (4) and Singh *et al.* (13) in gladiolus.

Whereas, highly significant influence on highest total water uptake was observed at interaction treatment low density polyethylene-25 µ packaging × 0 days storage means freshly harvested spike after 16 hrs simulated transit (36.42 ml), followed by low density polyethylene-25 µ × 3 days storage (35.83 ml), however lowest trend was noticed at news paper packing × 12 days storage duration interaction level (24.98 ml). The higher water uptake in freshly harvested tuberose cut spike due to higher transpiration loss of water and better water uptake by xylem tissue system for various physiological processes. However, total water up take by tuberose cut spike decreases in various packaging × storage duration interaction level increases at 4-6 °C

Table 1. Combined influence of packaging material and storage duration on tuberose cv. Suvasini (Three year pooled).

Treatment	Vase life (days)	Basal floret diameter (cm)	Total water absorbed (cm)	Percent gain/ loss in fresh wt.	CO_2 after storage (%)	CO_2 after simulated transit (%)	Total CO_2 (%)
LDPE-25 µ X 0day	11.95	2.88	36.42	5.17	0.04	0.06	0.10
LDPE-25 µ X 3day	10.08	3.55	35.83	6.34	1.95	2.29	4.24
LDPE-25 µ X 6day	8.22	3.47	32.73	6.89	1.98	2.48	4.46
LDPE-25 µ X 9day	6.42	2.65	29.83	7.72	1.18	1.55	2.73
LDPE-25 µ X12day	4.58	2.53	26.73	4.62	1.38	1.80	3.18
LDPE-50 µ X 0day	12.63	3.02	34.73	4.73	0.07	0.07	0.14
LDPE- 50 µ X 3day	9.69	3.45	34.68	6.67	0.78	1.00	1.78
LDPE- 50 µ X 6day	7.27	3.19	33.10	2.77	0.90	1.15	2.05
LDPE-50 µ X 9day	5.60	2.94	33.61	7.25	1.38	1.79	3.17
LDPE- 50 µ X12day	4.37	2.78	31.46	0.87	1.39	1.83	3.22
PP- 25 µ X 0day	13.15	3.38	35.37	5.18	0.09	0.09	0.18
PP -25 µ X 3day	11.64	3.58	34.39	9.38	1.98	2.48	4.46
PP - 25 µ X 6day	8.87	3.43	33.05	0.49	3.49	4.33	7.82
PP -25 µ X 9day	7.66	2.99	29.95	-1.96	2.92	3.60	6.52
PP -25 µ X12day	5.66	2.57	27.13	-1.35	4.13	5.08	9.21
PP-50 µ X 0day	10.17	3.28	34.68	3.82	0.14	0.14	0.28
PP -50 µ X 3day	6.97	3.53	32.42	1.29	3.58	4.47	8.05
PP -50 µ X 6day	5.58	3.37	30.37	-2.98	2.98	3.65	6.63
PP -50 µ X 9day	4.48	2.93	28.71	-2.77	2.70	2.84	5.54
PP -50 µ X12day	4.04	2.88	25.68	-3.16	3.05	3.43	6.48
Control X 0day	11.74	3.66	35.69	3.37	0.05	0.05	0.10
Control X 3day	8.00	3.53	34.96	-7.95	0.38	0.60	0.98
Control X 6day	6.38	3.39	28.68	-16.44	0.39	0.56	0.95
Control X 9day	6.14	3.14	25.05	-19.89	0.20	0.39	0.59
Control X12day	5.88	2.32	24.98	-26.47	0.23	0.37	0.60
SEM±	0.198	0.039	0.575	0.486	0.058	0.060	0.092
CD(P=0.01)	0.735	0.145	2.136	1.804	0.217	0.224	0.340

refrigerated condition might be due to lower up take of water by xylem tissue and lower transpiration rate from floret surface. 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 (8) in tuberose cv. Local Double. These results corroborate with those reported by Varu and Barad (14), Sahare *et al.* (9), Ghildhyal *et al.* (1) in Tuberose, Mahawar *et al.* (6), Jhanji and Dhatt (5), Grover *et al.* (4) and Singh *et al.* (13) in gladiolus.

The per cent gain / loss in fresh weight of spike were show highly significant influence by various interaction treatment *viz*. packaging level × storage durations. The maximum percent gain in fresh weight of spike was recorded in treatment polypropylene -25 µ packaging × 3 days storage duration (9.38 %) followed by low density polypropylene 25 µ packaging × 9 days storage duration (7.72 %), whereas minimum at polypropylene 25 µ packaging × 6 days storage duration (0.49 %) while maximum percent loss in fresh weight was observed in news paper packaging × 12 days storage durations (-26.47%). 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, than the outside atmosphere which reduced respiration, transpiration rate during the storage of cut spike in gladiolus Grover *et al.* (4) and shipment of rose and golden rod by Zeltzer *et al.* (15). Furthermore, the increased storage duration recorded higher loss in fresh weight of tuberose cut spikes due to increased loss of carbohydrate and water reported by Patil and Dhaduk (8) in tuberose *cv.* 'Local Double'.

However, as perusal of data indicated combined interaction between packaging materials × storage duration showed highly significant effect on CO_2 level after storage. According to data analysis higher percent CO_2 after storage duration was recorded in interaction level polypropylene 25 µ packaging × 12 days storage duration (4.13 %) followed by polypropylene 50 µ packaging × 3 days of storage duration (3.58%), while minimum was recorded in low density polyethylene 25 µ packaging × 0 days storage duration (0.04 %). The higher concentration of CO_2 after 12 days storage duration was not desirable in tuberose with polypropylene 25 µ packaging × 12 days storage which reduces floret opening and vase life of cut spike in tuberose, therefore the ideal level of CO_2 after storage was recorded in polypropylene 25 µ packaging × 3 days storage duration (1.98 %). 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.* (13), 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 (12).

The highest significant influence on CO_2 after simulated transit for 16hrs was recorded in polypropylene 25 µ packaging × 12 days storage duration (5.08 %) followed by polypropylene 50 µ packaging × 3 days of storage duration (4.47%), while minimum was recorded in news paper packaging × 0 days storage duration (0.05 %). The higher concentration of CO_2 after 12 days storage duration was not desirable in tuberose with polypropylene 25 µ packaging × 12 days storage which reduces floret opening of cut spike in tuberose, therefore the ideal level of CO_2 after simulated transit of cut spike was recorded in polypropylene 25 µ packaging × 3 days storage duration (2.48 %) which improve floret opening on cut spike in tuberose. 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 tuberose. Similar findings were observed by Grover (3) and Singh *et al.* (13) reported that spike held in other package films showed more florets opening during storage.

Further, highly significant influence on total CO_2 produced inside packages after storage and simulated transit for 16 hrs was recorded in interaction treatment in polypropylene 25 µ × 12 days storage duration (9.21 %) followed by polypropylene 50 µ packaging × 3 days of storage duration (8.05%), while minimum CO_2 (0.10 %) produced in treatment low density polyethylene 25 µ × 0 days storage duration and news paper × 0 days storage duration. The ideal total CO_2 (4.46 %) produced in packages after storage and transit hours was recorded in polypropylene 25 µ × 3 days storage duration which improve vase life, water uptake, gain in fresh weight and improve basal floret diameter in tuberose cut spike. Similar results on total CO_2 produced after storage and simulated transit have been also reported by Varu and Barad, *et al*. (14), Sahare *et al.* (9) and Ghildhyal *et al.* (1) in Tuberose.

The three year pooled data revealed in Table 2 for ethylene production show highly significant influence by various interaction between storage duration × packaging material after storage, Whereas, ideal level of ethylene after storage, simulated transit and total quantum production for floret opening and vase life was recorded in treatment polyethylene 25 µ × 3 days storage duration (0.78, 0.80 and 1.58 ppm, respectively) in tuberose. Whereas highest ethylene level was recorded in polypropylene 50 µ packaging × 12 days of storage duration (2.79, 2.91 and 5.70 ppm respectively), which lower down the vase life by improving senescence after 6 to 12 days storage in tuberose cut spike. Lowest level of ethylene was recorded after storage, simulated transit and total quantum production in news paper × 0 days storage duration (0.20, 0.22 and 0.42 ppm respectively) as a control in tuberose 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 tuberose, which were reported by Varu and Barad (14), Sahare *et al.* (9), Ghildhyal *et al.* (1) in Tuberose, Jhanji and Dhatt (5), Mahawear *et al.* (7) in gladiolus.

While, mean data in Table 2 indicated highly significant influence on percent O_2 level after simulated transit except percent O_2 after storage and total O_2 production. The lower O_2 percent after storage, simulated transit and total O_2 produced were recorded in polypropylene 25 µ × 12 days storage duration (5.60, 5.02 and 10.62 %, respectively), whereas higher level of O_2 (21.00, 20.90 and 41.90 %) were

Table 2. Combined influence of packaging and storage duration tuberose cv. Suvasini (Three year pooled).

Treatment	C_2H_4 after storage (ppm)	C_2H_4 after transit (ppm)	Total C_2H_4 (ppm)	O_2 after storage (%)	O_2 after simulated transit (%)	Total O_2 (%)
LDPE-25 µ X 0day	0.65	0.66	1.31	21.00	20.90	41.90
LDPE-25 µ X 3day	0.68	0.77	1.45	14.20	11.98	26.18
LDPE-25 µ X 6day	0.79	0.88	1.67	14.00	11.70	25.70
LDPE-25 µ X 9day	1.05	1.18	2.23	16.40	13.78	30.18
LDPE-25 µ X12day	1.89	2.00	3.89	15.00	12.78	27.78
LDPE-50 µ X 0day	0.49	0.51	1.00	20.90	20.90	41.80
LDPE- 50 µ X 3day	0.89	0.95	1.84	17.25	13.88	31.13
LDPE- 50 µ X 6day	0.95	1.08	2.03	16.77	13.63	30.40
LDPE-50 µ X 9day	1.25	1.28	2.53	14.85	11.98	26.83
LDPE- 50 µ X12day	1.65	1.69	3.34	14.76	11.87	26.63
PP- 25 µ X 0day	1.24	1.28	2.52	20.90	20.90	41.80
PP -25 µ X 3day	0.78	0.80	1.58	13.84	12.36	26.20
PP - 25 µ X 6day	0.89	0.95	1.84	11.76	10.65	22.41
PP -25 µ X 9day	2.35	2.41	4.76	8.15	7.36	15.51
PP -25 µ X12day	3.49	3.69	7.18	5.60	5.02	10.62
PP-50 µ X 0day	1.24	1.28	2.52	20.90	20.90	41.80
PP -50 µ X 3day	0.90	0.91	1.81	6.75	6.57	13.32
PP -50 µ X 6day	1.05	1.13	2.18	7.79	7.49	15.28
PP -50 µ X 9day	2.49	2.64	5.13	8.54	8.28	16.82
PP -50 µ X12day	2.79	2.91	5.70	8.05	7.69	15.74
Control X 0day	0.20	0.22	0.42	20.90	20.90	41.80
Control X 3day	0.65	0.64	1.29	17.67	14.18	31.85
Control X 6day	0.68	0.74	1.42	17.78	15.00	32.78
Control X 9day	0.89	0.96	1.85	17.95	16.13	34.08
Control X12day	0.78	0.82	1.60	18.35	17.25	35.60
SEM±	0.044	0.046	0.096	0.099	0.094	0.189
CD(P=0.01)	0.164	0.172	0.358	0.367	0.351	0.702

noticed in LDPE-25, 50, PP-25, 50 µ and news paper packaging with 0 days storage. The ideal level of O_2 after storage, simulated transit and total O_2 produced were noticed in polypropylene 25 µ × 3 days storage duration (13.84, 12.36 and 26.20% 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 Varu and Barad (14), Sahare *et al.* (9) and Ghildhyal *et al.* (1) in Tuberose and Jhanji and Dhatt (5), Mahawer *et al.* (7) in gladiolus.

From the three years pooled results it can be recommended that 3 days storage duration with polypropylene -25 µ packaging were found most suitable for post harvest life of tuberose cut spike under passive modified atmosphere storage to avoid glut in the market.

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