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EFFECTS OF STATIC CONTROLLED ATMOSPHERE AND REDUCED PRESSURE STORAGE ON FADING OF *VANDA* MISS JOAQUIM FLOWERS

Ernest K. Akamine and Theodore Goo

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AUTHORS

Ernest K. Akamine is Emeritus Plant Physiologist, Hawaii Institute of Tropical Agriculture and Human Resources, and Emeritus Professor of Plant Physiology, Department of Botany, College of Tropical Agriculture and Human Resources, University of Hawaii.

Theodore Goo is Research Associate, Department of Botany, Hawaii Institute of Tropical Agriculture and Human Resources, University of Hawaii.

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EFFECTS OF STATIC CONTROLLED ATMOSPHERE AND REDUCED PRESSURE STORAGE ON FADING OF *VANDA* MISS JOAQUIM FLOWERS

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ABSTRACT

Premature fading is a major problem in the overseas shipment of *Vanda* Miss Joaquim orchid flowers from Hawaii. The prime cause of the fading of normal flowers in shipping packages is C_2H_4 produced by pollinated, senescing, or injured flowers (pollinia disturbed or removed). Of these, the most likely source of C_2H_4 is injured flowers. The effects of storage under static controlled atmospheres (CA) and reduced pressures on fading were investigated in laboratory experiments. Storage atmospheres were modified with CO_2, N_2, and subatmospheric pressures. Exposures of 2–3 days to 1.5–2.0 percent CO_2, or 1.0–2.6 percent O_2 modified with N_2, or 125 mm Hg reduced pressure delayed fading for several days even after removal from storage. Whenever it is necessary to hold Vanda flowers prior to shipping, short static CA or reduced pressure storage may be feasible for controlling fading.

Key Words: CA, C_2H_4, flower fading control, modified CO_2 storage, modified O_2 storage, reduced pressure storage, Vanda.

INTRODUCTION

Premature fading is a major problem in the shipping of *Vanda* Miss Joaquim flowers from Hawaii to the U.S. mainland and elsewhere. These flowers normally fade in senescence, but they also fade prematurely when pollinated, when the pollinia are disturbed or removed, or when exposed to certain noxious gases such as illuminating gas, automobile and other engine exhaust fumes, or tobacco smoke, all of which probably contain ethylene (C_2H_4). Premature fading also occurs when flowers are exposed to C_2H_4 produced by plant materials, especially ripening fruits (*2*). As the Vanda flower fades in a shipping package, it produces C_2H_4 (*1*) which in turn causes fading of normal flowers in the same package. Brominated activated charcoal (*5*) and potassium permanganate (*4*) were found effective for controlling fading in Vanda flowers. We report here the effects of static controlled atmosphere (CA) and reduced pressure storage on fading of these flowers.

MATERIALS AND METHODS

Mature, normal Vanda flowers (1-2 days after opening) were obtained from the nursery of the Horticulture Department, Hawaii Institute of Tropical Agriculture and Human Resources, and used in laboratory experiments within two hours of harvest. The storage atmospheres were modified with CO_2, N_2, and reduced pressures.

CO_2 modifications. Ten to 108 normal flowers and 1-9 flowers with pollinia removed (hereinafter called C_2H_4 generators) were sealed in glass jars (1791 or 6294 ml) at room temperature (23-25°C). The jars were rapidly evacuated to various reduced pressures and then CO_2 was released into them to return the pressure to normal atmospheric pressure (760 mm Hg). The CO_2 concentrations in the jars were determined by gas chromatography. The flowers were held in the modified atmospheres for 1-3 days, then removed from the jars and held open with the stems in tap water for daily observations on fading. The degree of fading (overall percentage of flower parts) of individual flowers or percentage of flowers faded (25 percent or more of flower parts) was recorded.

O_2 modifications with N_2. The procedure was similar to that of CO_2 modifications with the exception that after the partial evacuation of the jars, N_2 was used to return the pressure to atmospheric pressure, thus maintaining the desired levels of O_2 in the jars.

Atmospheric modifications with reduced pressures. The procedure was similar to the above with one exception; after the partial evacuation of the jars, reduced pressures of 62.5-377 mm Hg were maintained in the jars.

RESULTS

CO_2 modifications. In a series of 20 experiments in which CO_2 concentrations in the storage atmosphere were varied from .03 (air)-54 percent CO_2, concentrations above 10 percent controlled fading but caused the flowers to brown. The severity of browning increased with increased CO_2 concentration. The minimal concentration required to control fading was about 1.5 percent. The optimal storage condition was 1.5-2.0 percent for 2 days as indicated by the results of a representative experiment (Table 1). Whereas all the normal flowers and C_2H_4 generators in air faded while still in the jar, the C_2H_4 generators in the CO_2 atmospheres did not fade until 1 day after removal from the jars, indicating a delaying action of CO_2 on fading. After 8 days in the open, only about 17 percent of the flowers from the CO_2 atmospheres faded but all flowers were wilted.

O_2 modifications with N_2. In preliminary experiments in which various O_2 concentrations (0-21 percent [air]) were used in the storage chambers, concentrations above 5 percent were ineffective for controlling fading. A series of 6 experiments was then conducted using only concentrations of about 5 percent and lower. The results of a typical 3-day storage experiment (Table 2) indicated that the effectiveness for controlling fading increased with decreasing O_2 concentrations, but flowers stored at the three lowest concentrations wilted or browned toward the end of the holding period in the open. In general, in terms of fading and injury control to flowers, 2.6 percent was more effective than the other O_2 concentrations for both normal flowers and C_2H_4 generators.

Table 1. Effect of 2-day storage under 1.5 and 2.0 percent CO_2 on fading of Vanda flowers

Initial CO_2 conc. (%)[a]	Percent C_2H_4 generators (E.G.) and normal flowers (N.F.) faded[b] on day										
	0[c]		1		2	3	4	5	6	7	8[d]
	E.G.	N.F.	E.G.	N.F.	N.F.	N.F.	N.F.	N.F.	N.F.	N.F.	N.F.
.03 (air)	100	100									
1.5	0	0	100	0	0	0	0	2.8	6.5	13.0	17.6
2.0	0	0	100	0	0	0	0	4.6	8.3	13.0	16.7

[a]108 normal flowers and 9 C_2H_4 generators per jar (6294 ml).

[b]Individual flowers 25% or more faded.

[c]Day removed from CO_2 storage.

[d]All remaining flowers wilted.

Atmospheric modifications with reduced pressures. Preliminary exploratory experiments using various pressures (62.5–760 mm Hg) indicated that reduced pressures (125–188.5 mm Hg) were effective for delaying the fading of Vanda flowers. The results of 4 additional experiments using these pressures as shown in the results of a representative experiment (Table 3) indicated that 125 mm was more effective than 188.5 mm for delaying the fading of normal flowers. Both pressures also delayed the fading of C_2H_4 generators. In an additional experiment, only 8 percent of normal flowers initially stored under 125 mm pressure faded after 7 days in the open.

DISCUSSION AND CONCLUSION

The possibility of using CA and reduced pressures for delaying the fading of normal flowers in the presence of C_2H_4-producing flowers was shown in this investigation. Static exposures of 2–3 days to 1.5–2.0 percent CO_2, or 1.0–2.6 percent O_2 modified with N_2, or 125 mm Hg reduced pressure effectively delayed fading for several days in the open. The beneficial effects of CA and subatmospheric pressures were residual in that they delayed the fading even after the flowers were removed from storage. CO_2 inactivated the effects of C_2H_4 produced by other flower species thus extending their vase life (*8, 9, 10, 11*). Low O_2 levels extended the vase life of certain flower species (*3, 7*) and subatmospheric pressures also improved the vase life of other flower species including *Vanda* Miss Joaquim (*6*). Short, static CA and reduced pressure storage may be feasible for controlling fading of Vanda flowers if it is necessary to hold them in storage prior to shipping by air.

Table 2. Effect of 3-day storage under various concentrations of O_2 maintained with N_2 on fading of Vanda flowers

Initial O_2 conc. (%)[a]	Percent degree of fading of C_2H_4 generator (E.G.) and normal flowers (N.F.) with standard error on day											
	0[b]		1		2		3		4	5	6	7
	E.G.	N.F.	E.G.	N.F.	E.G.	N.F.	E.G.	N.F.	N.F.	N.F.	N.F.	N.F.
0	10	0	50	0	90	0	100	12.5± 2.76[c]	12.5± 2.76[c]	12.5± 2.76[c]	12.5± 2.76[c]	
1.0	50	0	70	0	90	0	100	0	12.5± 2.99[c]	12.5± 2.99[c]	37.5± 7.08[c]	
2.6	0	0	10	0	75	0	100	0	0	0	12.5± 2.72[c]	50.00± 10.50[c]
3.2	25	12.5± 2.91	87	52.5± 7.16	90	52.5± 7.16	100	55.0± 5.92	55.0± 5.92	66.0± 4.00	87.5± .72	90.0± 1.29
5.2	95	82.5± 1.71	100	100								
21.0 (air)	100	100										

[a] 10 normal flowers and 1 C_2H_4 generator per jar (1791 ml).

[b] Day removed from O_2 storage.

[c] Flowers wilted or browned.

Table 3. Effect of 3-day storage under various pressures on fading of Vanda flowers

Initial Pressure (mm Hg)[a]	Percent degree of fading of C_2H_4 generator (E.G.) and normal flowers (N.F.) with standard error on day										
	O[b]		1		2		3	4	5	6	7[c]
	E.G.	N.F.	E.G.	N.F.	E.G.	N.F.	N.F.	N.F.	N.F.	N.F.	N.F.
125	0	0	70	0	100	0	0	0	0	0	5.10± 1.05
188.5	25	12.5± 2.61	95	47.5± 9.68	100	47.5± 9.68	55.0± 7.42	55.0± 7.42	67.5± 5.59	77.5± 2.91	90.0± 2.24
760	100	100									

[a]10 normal flowers and 1 C_2H_4 generator per jar (1791 ml).

[b]Day removed from pressure storage.

[c]All remaining flowers wilted.

LITERATURE CITED

1. Akamine, E. K. 1963. Ethylene production in fading Vanda orchid blossoms. Science 140(3572):1217-1218.
2. ———. 1976. Postharvest handling of tropical ornamental cut crops in Hawaii. HortScience 11(2): 125-127.
3. ———, and T. Goo. 1981. Controlled atmosphere storage of anthurium flowers. HortScience 16(2): 206-207.
4. ____, and ____. 1981. Controlling premature fading in *Vanda* Miss Joaquim flowers with potassium permanganate. HITAHR Research Series 007.
5. ———, and H. I. Sakamoto. 1951. Brominated charcoal to prevent fading of *Vanda* orchid flowers. Amer. Orchid Soc. Bul. 20:149-152.
6. Burg, S. P. 1973. Hypobaric storage of cut flowers. HortScience 8(3):202-205.
7. Parsons, C. S., S. Asen, and N. W. Stuart. 1967. Controlled-atmosphere storage of daffodil flowers. Proc. Amer. Soc. Hor. Sci. 90:506-514.
8. Smith, W. H., and J. C. Parker. 1966. Prevention of ethylene injury to carnations by low concentrations of carbon dioxide. Nature 211:100-101.
9. Thorton, N. C. 1930. Carbon dioxide storage of fruits, vegetables, and flowers. Ind. and Eng. Chem. 22: 1186-1189.
10. ———. 1930. The use of carbon dioxide for prolonging the life of cut flowers with special reference to roses. Amer. J. Bot. 17:614-626.
11. Uota, M. 1969. Carbon dioxide suppression of ethylene-induced sleepiness of carnation blooms. J. Amer. Soc. Hort. Sci. 94:598-601.

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Stuart. 1967.
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