

# SENESCENCE OF 'SANDRA' CARNATION

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## Abstract

'Sandra' carnation flowers (*Dianthus caryophyllus* L.) lasted twice as long as flowers of 'White Sim'. They showed neither the normal increase in ethylene production, nor a marked respiration climacteric during their eventual senescence. The EFE activity and ACC content of the flowers remained unchanged for 6 days in the vase. Exogenous application of ethylene did, however, induce sleepiness. The extended vase life of 'Sandra' carnations appears to be the result of repressed ethylene biosynthesis.

## 1. Introduction

The senescence of carnation flowers is normally studied using the cultivar 'White Sim' (Bufler *et al.*, 1980; Whitehead *et al.*, 1984). In this cultivar, wilting of the corolla is accompanied by a marked burst of ethylene synthesis and a climacteric rise in respiration (Maxie *et al.*, 1973; Nichols, 1968). Inhibition of the synthesis or action of ethylene can extend the life of 'White Sim' carnations (Fujino *et al.*, 1980; Reid *et al.*, 1980; Spear and Gladon, 1982; Veen, 1979). Reports that flowers of the Sandra carnation cultivar lasted much longer than those of White Sim (Harcharak, pers. comm.), suggested that, in this new cultivar, the production of ethylene or response to it was somehow inhibited. We report here an examination of the role of ethylene in the senescence of 'Sandra' carnation flowers.

## 2. Materials and Methods

### *2.1. Plant materials*

Carnations (cvs 'Sandra' and 'White Sim') were grown in the greenhouse at U.C. Davis using standard procedures, or obtained from a commercial grower and kept cool until needed. Flowers were either harvested at commercial maturity (outer petals horizontal, day 1), or after a further 3 days on the plant (day 4).

### *2.2. Evaluation of longevity*

Freshly harvested flowers were trimmed to a length of 40 cm, then placed in deionized water (DI) containing 200 ppm Physan-20. The life of the flowers was evaluated in standard conditions (20°C, 12 h cool-white fluorescent light {15  $\mu\text{mol m}^{-2} \text{s}^{-1}$ }, 55% R.H.). Vase life

was considered terminated when the corolla was noticeably wilted, dried or necrotic. In some experiments, flowers were pre-treated with silver thiosulfate (STS) by allowing them to take up the desired volume of a 1 mM solution of the complex. Each treatment was replicated at least five-fold, and all experiments were repeated at least once.

### 2.3. Measurement of respiration and ethylene production

Ethylene and CO<sub>2</sub> production were determined by measuring concentrations of these gases (by gas and infrared absorption, respectively) in air passed over individual flowers sealed in small glass chambers. Flowers were treated with different concentrations of ethylene in large glass tanks ventilated with flowing streams of air containing ethylene at the desired concentrations.

### 2.4. Determination of ACC content and EFE activity

The ACC content of the flowers was determined on petals from the outermost whorl. The petals were ground in liquid nitrogen, then the powder was extracted with 3 times its weight of 80% ethanol (v/v) overnight with constant stirring. The homogenate was centrifuged at 25,000 x g for 15 min, the supernatant was carefully decanted, and the pellet was re-suspended in 80% ethanol and re-centrifuged. The combined supernatants were evaporated under vacuum at 50°C and re-dissolved in 2 ml of distilled water. The ACC content of 0.1 ml aliquots of this aqueous solution was determined according to the method adapted by Bufler *et al.* (1980) from that of Lizada and Yang (1979).

EFE activity in petals was determined according to Whitehead *et al.* (1984). Pre-weighed petals (five from the outermost whorl of a flower) were immersed in a solution containing 1 mM ACC and infiltrated twice under vacuum (40 mm Hg for 2 minutes). The petals were blotted dry, then curved gently and slid into a 13.5 ml test tube which was flushed with ethylene-free air, then sealed with a serum cap. The ethylene concentration in the vial was measured by gas chromatography after 1 hour.

## 3. Results

### 3.1. Vase life comparison

The vase life of 'Sandra' flowers harvested on day 1 was about twice that of 'White Sim' flowers (Fig. 1). Older 'Sandra' flowers had a correspondingly reduced vase life, but the life of 'White Sim' flowers appeared unaffected by flower age. 'Sandra' carnations do not normally show the wilting or "sleepiness" characteristic of 'White Sim'. The flowers normally fade, and turn brown as the petals dehydrate from their tips.

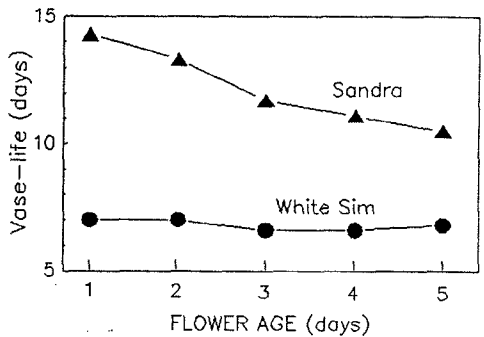


Fig. 1. Effect of age at harvest on vase life of 'White Sim' and 'Sandra' carnations.

### 3.2. Respiration and ethylene production

The climacteric respiration patterns typical of 'White Sim' flowers contrasted with a non-climacteric steady decline in respiration in flowers of the Sandra cultivar (Fig. 2). Ethylene production in 'White Sim' flowers showed a typical climacteric burst; ethylene production by 'Sandra' flowers increased only slightly towards the end of their life (Fig. 3).

### 3.3. Ethylene biosynthetic pathway

The ACC content at harvest of 1 day and 4 day 'Sandra' petals was substantially less than that of corresponding 'White Sim' petals (Table 1). The ACC content of 'Sandra' petals was constant during their vaselife; in 'White Sim', they were 8-10 times higher than in freshly harvested flowers (Table 1). The EFE activity of similar 'Sandra' flowers was one third that of corresponding 'White Sim' flowers (Table 1) at the day of harvest. After 6 days in the vase, the EFE activity in both young and old 'White Sim' increased dramatically, but remained unchanged in 'Sandra' flowers. By day 6, the EFE activity in 'White Sim' petals was more than 100 fold that of 'Sandra' petals.

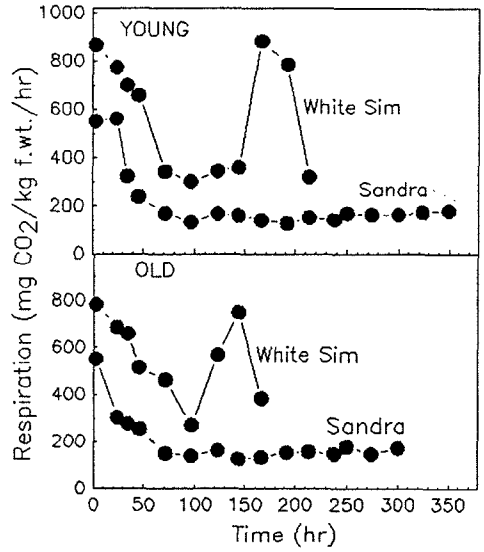


Fig. 2. Respiration of 1- and 4-day old flowers of 'White Sim' and 'Sandra' carnations.

Table 1. ACC content (n mol/g fresh weight), and EFE activity (nl/g fresh weight/h) of young (1D, the day of opening) and old (4D, 3 days after opening) 'Sandra' and 'White Sim' carnation cut flowers. Petals were removed from the outermost whorl and infiltrated with 1 mM ACC.

	Day 1		Day 6	
	ACC	EFE	ACC	EFE
'Sandra'				
1D	0.22	0.26	0.18	0.28
4D	0.29	0.21	0.27	0.24
'White Sim'				
1D	0.67	0.73	1.67	39.50
4D	0.72	0.85	1.95	45.32

### 3.4. Sensitivity to ethylene and the effect of STS

Although 'Sandra' carnation showed neither an ethylene peak nor a respiratory climacteric during their normal senescence, exogenous application of ethylene did shorten their vase life and induce "sleepiness". The vase life of 'Sandra' and 'White Sim' flowers was reduced by exposure to increasing concentrations of ethylene (Fig. 4). STS pretreatment overcame the deleterious effects of ethylene in both cultivars (Table 2).

## 4. Discussion

The data shown here indicate that in the Sandra carnation cultivar, long vase life is due to inhibition, under normal conditions, of the pathway for ethylene biosynthesis. The respiratory climacteric in 'White Sim' is probably initiated by increased ethylene biosynthesis (Bufler *et al.*, 1980). The observations that the vase life of these flowers is independent of age at harvest suggests that harvest itself may trigger the start of ethylene biosynthesis. In the absence of such triggering, 'Sandra' flowers senesce at a time that relates to their age at harvest.

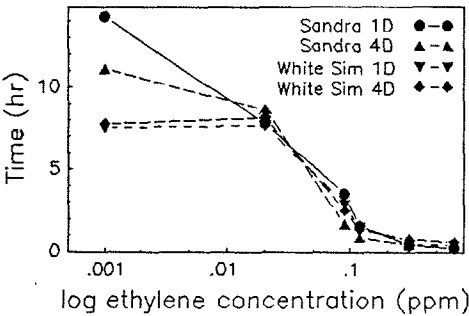


Fig. 4. Effect of increasing ethylene concentrations on rate of senescence of 'White Sim' and 'Sandra' carnations.

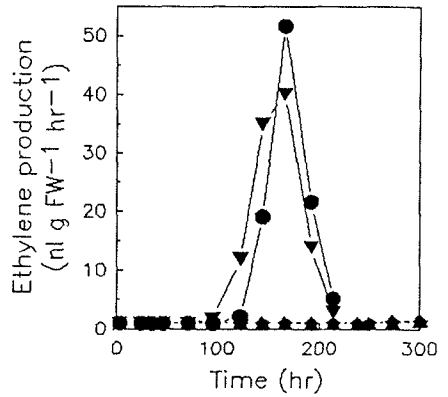


Fig. 3. Ethylene production by 1-day and 4-day flowers of 'White Sim' and 'Sandra' carnations. (●) 1-day WS, (▼) 4-day WS, (◊) 1-day S, (▲) 4-day S.

Our data indicate interesting possible variations in senescence pattern even within a single species. Genetic analysis of the control of ethylene biosynthesis in 'Sandra' may provide improved understanding of the control of flower senescence. In any case, the existence of substantial variance for vase life in carnations should be of great interest to breeders.

**Table 2.** Effect of STS pretreatment on vase life (days) of young (1D, the day of opening) and old (4D, 3 days after opening) 'Sandra' and 'White Sim' carnation cut flowers in different ethylene concentrations.

	Ethylene (ppm)							
	Air		0.08		0.4		0.9	
	+STS	-STS	+STS	-STS	+STS	-STS	+STS	-STS
'Sandra'								
1D	17.6	15.6	17.0	7.0	17.6	0.5	17.2	0.5
4D	16.2	11.4	17.3	6.7	16.6	0.6	17.0	0.5
'White Sim'								
1D	14.6	7.0	14.1	5.6	15.2	0.5	14.0	0.5
4D	13.6	7.0	14.0	5.9	13.3	0.6	14.3	0.5

### References

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