weeks after treatment. These differences were significant and indicate that a combination of volatilization and translocation of ethyl ester is the cause of reduced shoot growth. Three-year-old field-grown avocado trees topworked to 'Bacon' with some graft-bud growth graft were treated with 1% ethyl ester NAA 10 cm below the graft without causing wilting or reducing total growth in a previous experiment (1).

A precise cost comparison of the chemical and hand methods of sprout control has not been made. Our experience indicates that NAA treatment should reduce total control costs by at least a third.

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Vase Life of Cut Flowers Treated with Rhizobitoxine Analogs, Sodium Benzoate, and Isopentenyl Adenosine[1]

C. Y. Wang and J. E. Baker

Horticultural Crops Marketing and Postharvest Plant Physiology Laboratories, FR, SEA, U.S. Department of Agriculture, Beltsville, MD 20705

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Abstract. **Addition of rhizbitoxin analogs to holding solutions extended vase life of bulbous iris flowers (*Iris xiphium* L), daffodils (*Narcissus pseudo-narcissus* L.) and chrysanthemums (*Chrysanthemum morifolium* Ramat). Sodium benzoate also increased vase life of daffodils but not of irises and chrysanthemums. Isopentenyl adenosine delayed senesence of irises but not of chrysanthemums. None of the chemicals tested extended the vase life of roses (*Rosa hybrida* L). Ethylene production in rose petal tissue was reduced by rhizobitoxine analogs indicating that roses do not have a rhizobitoxine-resistant ethylene producing system. Results suggested that either roses are sensitive to low levels of ethylene or their senescence is triggered by factors other than ethylene.**

The ethoxy analog of rhizobitoxine, L-2-amino-4-(2-aminoethoxy)-*trans*-3-butenoic acid (RO), and sodium benzoate (SB) inhibited ethylene production and increased the vase life of carnations (3). RO and the methoxy analog of rhizobitoxine, L-2-amino-4-methoxy-*trans*-3-butenoic acid (MRO), also reduced ethylene production and delayed the senescence of snapdragons (8). The beneficial effects of these compounds were over and above the effects of sucrose, 8-hydroxyquinoline citrate, and acid pH of the preservative solution. Because RO, MRO and SB did not enhance the capability of flowers to absorb the holding solution, it was suggested that they increased the longevity of carnations and snapdragons by inhibiting ethylene production. We, therefore, evaluated the effect of these compounds and another senescence inhibitor, isopentenyl adenosine (IPA), on the vase life of some cut flowers other than carnations and snapdragons.

Sources and conditions of flowers. Daffodils ('King Alfred' and 'The First') were grown at the Beltsville Agricultural Research Center. Hydrid tea roses ('Forever Yours' and 'Samantha') and chrysanthemums ('Iceberg' and 'Bright Golden Anne') were obtained from a local greenhouse. Irises ('Wedgwood', 'Blue Ribbon', 'Yellow Fantasy' and 'Hildegard') were bought from wholesale flower markets in the vicinity of Washington, D.C. The daffodils, roses and chrysanthemums were picked in the morning the experiment started. The irises were picked on the day before the experiment started. Daffodils were harvested at the goose-neck stage. Both, irises and roses were in the loose bud stage at the beginning of the experiment. All flowers opened within 24 hr at 20°C in the holding solutions under continuous fluorescent light. Chrysanthemums were picked at full open stage. All cultivars were treated as replicates and the data were subjected to Duncan's multiple range test (4).

Preservative solutions. All preservative solutions, including the control, contained 2% sucrose, 0.02% 8-hydroxyquinoline citrate, and 0.02 M potassim citrate buffer with a pH of 4.6. In addition to the above preservatives, one of the following test chemicals was added to each treatment: 0.1 mM RO, 0.1 mM MRO, 1 mM SB or 0.1 mM IPA. The solutions were made up with deionized water. Each flower jar contained 500 ml preservative solution.

Handling of flowers. Each flower stem was re-cut to 30 cm length, and immediately placed in the preservative solution. Leaves on the lower portion of stem were removed. For chrysanthemums, each stem was trimmed to the 3 dominant flowers and 3 stems were placed in each glass jar. Vase life was determined separately for each of 3 flowers on each stem. For the other flowers, 5 or 6 single-stem flowers were placed in each jar. Three jars of flowers were used for each treatment. Vase life was determined independently for each single flower. The jars containing preservative solutions and flowers were placed randomly in a room maintained at 20°C, 50 to 60% relatively humidity and with ca. 1100 1x continuous fluorescent light.

Determination of vase life. Vase life was considered terminated when flowers lost their decorative value. For daffodils and irises, excessive curl of the tips of petals or shrivelling of the bloom was considered to be the end of vase life. In roses, the discoloration of petals or the drooping of the neck terminated the vase life. The chrysanthemum flowers were discarded when half of the petals wilted or when the neck bent.

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Determination of ethylene production by rose petal tissues. Rose petal tissues at bud stage were cut with a 10 mm cork borer. Disks from different petals of the same cultivar were mixed thoroughly and 0.7 g of petal disks was placed in 25 ml Erlenmeyer flasks containing 3 ml of a solution of 0.4 M sucrose, 0.047 M sodium phosphate, 0.027 M citrate buffer at pH 4.6 with or without 0.1 mM RO. Absorption of the solution into petal tissues was facilitated with vacuum infiltration. The flasks were then covered with serum caps and incubated in a water bath at 30°C. Ethylene was measured after 2 and 4 hr with a gas chromatograph equipped with an alumina column and a flame ionization dector (7).

Daffodils. Of all the flowers tested, daffodilis had the shortest vase life (Table 1). The flower buds opened uniformly on day 2 and were in excellent condition on day 3. Some flowers in the control solution began to deteriorate on day 4. While the corona of the control flower stayed fresh, the tip of the perianth wilted, curled and lost its decorative value. The addition of either RO, MRO or SB in the preservative solution delayed the deterioration of daffodils for about 1 day. Because of the short vase life of daffodils, a 1-day extension was a significant 25% increase in vase life.

Irises. One of the major problems in handling cut irises is the failure of buds to open after a prolonged storage at low temp. Failure of the buds to open is caused by water stress in the flowers because stem blockage develops during storage and shipment (6). To avoid this problem, we picked irises 1 day before the experiment started. The flower buds opened within 1 day at 20°C when placed in the preservative solutions under continuous fluorescent light. RO and IPA significantly increased the vase life of irises. SB extended the vase life of irises not significantly.

Chrysanthemums. RO or MRO markedly increased the vase life of chrysanthemums but SB and IPA did not.

Roses. Asen and Lieberman (1) reported that the longevity of cut roses was enhanced by an inhibitor of ethylene production. They found that ethylene oxide increased the keeping quality of cut roses by initially delaying the rate of maturation or bud opening. However, the ethylene synthesis inhibitors we used failed to extend the longevity of cut roses. Vase life of roses was not affected by treatment with RO, MRO, or SB.

Ethylene production was inhibited more than 50% in rose petal tissues that were treated with RO (Table 2). This indicates that rose petals do not have rhizobitoxine-resistant ethylene producing system as do some other plant tissues (2). However, ethylene production was not completely inhibited by RO. Whether or not the small quantities of ethylene produced is sufficient to trigger the deterioration of roses, or other factors cause the senescence of roses is under investigation.

Conclusion. Of all compounds tested, RO was the most effective inhibitor of senescence of flowers. It consistently extended the vase life of daffodils, irises, and chrysanthemums. RO also reduced ethylene production and increased vase life of carnations and snapdragons (3, 8). Suppression of ethylene production by SB or IPA also was reported in carnations or in ripening fruits (2, 3, 5). However, the beneficial effect on keeping quality obtained in our study using SB or IPA varied with types of flowers and was not as striking or as consistent as that obtained from rhizobitoxine analogs.

Table 1. Effect of various preservatives on vase life of daffodils, irises, roses and chrysanthemums.

	Vase life[z]							
	Daffodils		Irises		Chrysanthemums		Roses	
Treatment[y]	Day	%	Day	%	Day	%	Day	%
Control	3.8b	100	4.2b	100	5.8c	100	8.4a	100
RO	4.8a	126	5.3a	126	10.9a	188	8.8a	105
MRO	4.7a	124	--	--	8.5b	146	8.3a	99
SB	4.6a	121	5.0ab	119	6.9c	119	7.5a	89
IPA	--	--	5.2a	124	6.0c	103	--	--

[z]Mean separation in columns within flower type by Duncan's multiple range test, 5% level.
[y]All treatments contained 2% sucrose, 0.02% 8-hydroxyquinoline citrate.
0.02 M potassium citrate buffer, pH 4.6.
RO = Ethoxy analog of rhizobitoxine; MRO = Methoxy analog of rhizobitoxine; SB = Sodium benzoate; IPA = isopentenyl adenosine.

Table 2. Effect of ethoxy analog of rhizobitoxine (RO) on ethylene production of rose petal tissues at 30°C.

	After 2 hr		After 4 hr	
Treatment[z]	nl/g. hr	%	nl/g.hr	%
Control	2.65 ± 0.23	100	2.43 ± 0.22	100
RO	1.19 ± 0.09	44	0.92 ± 0.08	37

[z]Both treatments contained 0.4 M sucrose – 0.047 M sodium phosphate – 0.027 M citrate buffer at pH 4.6.

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