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In the name of Allah

NOTE

EFFECTS OF AMINOETHOXYVINYLGLYCINE ON THE EFFECTIVE POLLINATION PERIOD OF APPLE[1]

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ABSTRACT

Aqueous sprays of aminoethoxyvinylglycine (AVG), an inhibitor of ethylene synthesis, were applied at full bloom to flowers on bagged limbs of 'McIntosh' and 'Delicious' apple (*Malus domestica* Borkh.). The AVG-treated and control flowers were hand pollinated at 1 to 3 day intervals beginning at anthesis. AVG at 200 ppm increased both initial and final fruit set in 'Delicious' but not in 'McIntosh'. In both cultivars, fruit set decreased as the time of pollination was delayed, and the response of AVG-sprayed flowers paralleled that of control flowers. These results suggest that AVG has little or no effect on the effective pollination period.

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اثرات اتکسی واینیل گلیسین روی دوره گرده افشانی موثر سیب

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خلاصه

گلهای سیب قرمزلبنانی ومک اینتاش روی شاخه‌هائیکه قبلا" درکیسه قرارداده شده بودندبوسیله اتکسی واینیل گلیسین که یک ماده بازدارنده سنتزاتیلین میباشددرموقع بازشدن اکثرگلها ، محلول پاشی گردیدند .گلهای محلول پاشی شده وهمچنین شاهدآزمایش یک تا سه روز پس ازشروع آزادشدن دانه‌های گرده ، بوسیله دست گرده افشانی گردیدند .اتکسی واینیل گلیسین بغلظت ۲۰۰قسمت درمیلیون سبب افزایش تشکیل میوه اولیه ونهائی درسیب قرمزلبنانی شدولی اثری روی سیب مک اینتاش نداشت درهردورقم، تشکیل میوه باتاخیردرگرده افشانی کاهش پیداکردوعکس العمل گلهای محلول پاشی شده همانندشاهدبود .نتایج حاصله نشان میدهندکه اتکسی‌واینیل گلیسین بر روی دوره موثرگرده افشانی اثرجزئی داشته ویابی اثربوده است .

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INTRODUCTION

The period during which pollination of the flower results in fertilization is termed the effective pollination period (EPP) (10). It is a function of both ovule longevity and the rate of pollen tube growth. Williams (11) reported that EPP, which varied with cultivar and season, was the principal factor controlling fruit set. The EPP of various apple cultivars ranged from 2 to 10 days after anthesis (10).

Ovule longevity is an important factor affecting fertilization. Hough (5) found that in ovules of 'Delicious', the most frequent abnormality was either a tardy initiation of the megaspore mother cell or a slow rate of development of megaspore embryo sac. Normal embryo-sacs broke down soon after the flowers opened even though pollinated with compatible pollen. Fruit set of 'Richared Delicious' apple flowers pollinated at full bloom and petal fall were greater in trees propagated on seedlings than on M9 rootstocks (7).

Temperature during anthesis influences both pollen tube growth and ovule longevity. Lapins and Arndt (6) considered the optimum temperatures for pollen tube growth in 'Delicious' flowers to be between 7.2 and 12.8°C; pollen grains failed to germinate below 4.4°C. However, low temperatures prolong ovule longevity, increasing the chance of fertilization. Stott (8) found that ovule longevity ranged from 9 to 12 days after pollination in many apple cultivars and at low temperatures (9.4°C), 5 to 6 days were required for compatible pollen tubes to reach the embryo-sac. Lapins and Arndt (6) reported that pollen tubes could reach the base of the style in 3 days at 12.8°C versus 5 days at 7.8°C.

The role of ethylene in regulating EPP and ovule longevity has not been investigated. However, inhibitors of ethylene synthesis such as aminoethoxyvinylglycine (AVG) both increase fruit set and inhibit ethylene evolution in apple (2, 3, 9). The purpose of this study was to determine the

possible role of AVG on EPP in 'Delicious' and 'McIntosh' apple flowers.

MATERIALS AND METHODS

Eight uniform branches per tree were selected on three 'Starking Delicious' and three 'McIntosh' apple trees about 40 years old in a commercial orchard at Leslie, MI, in 1981. These branches were enclosed in cheesecloth bags before full bloom (pink stage) to prevent pollination by insects. At full bloom the "king" flowers and all frost-damaged flowers were removed and about 100 viable flowers were counted on each branch. Four branches on each tree were sprayed with 200 ppm AVG at full bloom (May 6 for 'McIntosh' and May 8 for 'Delicious') and four branches were left untreated.

The following pollination treatments were randomly assigned to four AVG-treated and four control branches on each tree, using a randomized complete block design with trees as blocks: hand pollinated 0, 2, 5, and 6 days (McIntosh) or 0, 3, 4, and 5 days ('Delicious') after AVG application, using pollen previously collected from 'Empire' apple flowers. All branches remained bagged except at the time of pollination, until 10 days after each treatment. The flowers were counted at the time of pollination and initial and final sets were recorded. Ten fruits were harvested at maturity from each treated and non-treated branches and the length, diameter, length to diameter ratio (L/D), and seed number were determined for each fruit.

RESULTS AND DISCUSSION

In 'McIntosh', both initial and final sets declined as pollination was delayed (Table 1), the effect becoming significant after 5 (initial) or 6 days (final set). AVG did not increase fruit set significantly in 'McIntosh' regardless of time of pollination, but reduced fruit size and increased L/D ratio.

Table 1. Effect of AVG on effective pollination period and fruit characteristics of 'McIntosh' at harvest.

AVG (ppm)	Time of hand pollination (days after full bloom) 0	2	5	6	Mean
		Initial set[§] (%), May 27			
0	71	62	40	23	49a
200	78	78	44	28	57a
Mean	75a*	70a	42b	26b	
		Final set[§] (%), June 16			
0	35	20	17	9	20a
200	21	33	22	15	23a
Mean	28a	27a	19ab	12b	
		Seeds per fruit, September 14			
0	4.7	5.2	4.1	4.0	4.5a
200	3.9	4.7	3.8	3.6	4.0a
Mean	4.3a	5.0a	3.9a	3.8a	
		Fruit weight (g), September 14			
0	126.3	116.0	98.0	101.7	110.5a
200	90.3	95.7	98.0	86.3	92.6b
Mean	108.3a	105.8a	98.3a	94.0a	
		L/D ratio, September 14			
0	0.80	0.78	0.79	0.78	0.79a
200	0.80	0.82	0.81	0.80	0.81b
Mean	0.80a	0.80a	0.80a	0.79a	

[§]Fruits per 100 flowers.

*Mean separation within rows and columns by DMRT, 5% level.

In 'Delicious', although fruit set was highest when flowers were pollinated at full bloom, time of pollination did not significantly affect either initial or final set (Table 2). However, AVG increased both initial and final sets significantly. Fruits from AVG-treated flowers were smaller than control fruits except those from flowers pollinated 5 days after full bloom, but the effect was not statistically significant. Neither seed number per fruit nor L/D ratio was altered by AVG.

The results of this experiment varied with cultivar. In 'McIntosh', although final set was higher in AVG-treated flowers in 3 of the 4 comparisons (times of pollination), its overall effects were statistically non-significant. The effect, if indeed real, actually declined with time of pollination. Although the effect of AVG was significant in 'Delicious', the magnitude of the response did not change with the time of pollination.

Interactions between AVG treatment and time of pollination were not significant in either cultivar. If AVG increases ovule longevity, it should prolong the period during which pollination is effective, causing a greater response relative to the control as pollination is delayed. Since fruit set of control flowers declined with time, the basis of comparison for the effect of AVG also declined. If AVG could increase fruit set by prolonging ovlue longevity, a significant interaction would be observed between AVG treatment and time of pollination; specifically, the decline in set would be more rapid in untreated than in treated flowers. Thus the data do not support the hypothesis that AVG prolongs the EPP.

Two results are surprising in view of previous reports. First, 20% of the 'Delicious' flowers were still capable of setting fruit when pollinated 5 days after full bloom, yet Hartman and Howlett (4) reported drastic reductions in the set when pollination was delayed only 48 hours. In

Table 2. Effect of AVG on effective pollination period and fruit characteristics of 'Starking Delicious' at harvest.

AVG (ppm)	Time of hand pollination (days after full bloom)				
	0	3	4	5	Mean
			Initial set[§] (%), May 30		
0	59	37	46	46	47a
200	80	59	70	60	67b
Mean	60a*	48a	58a	53a	
			Final set[§] (%), June 16		
0	33	23	18	20	23a
200	62	41	43	41	47b
Mean	48a	32a	31a	30a	
			Seeds per fruit, October 2		
0	5.1	6.3	5.7	6.0	5.8a
200	5.3	4.9	5.8	5.7	5.4a
Mean	5.2a	5.6a	5.7a	5.9a	
			Fruit weight (g), October 2		
0	115.7	116.3	120.0	107.0	114.8a
200	103.7	98.7	103.3	115.0	105.2a
Mean	109.7a	107.5a	111.7a	110.0a	
			L/D ratio, October 2		
0	0.99	0.99	0.96	0.99	0.98a
200	0.99	0.99	0.97	0.97	0.98a
Mean	0.99a	0.99a	0.96a	0.98a	

[§]Fruit per 100 flowers.

*Mean separation within rows and columns by DMRT, 5% level.

'Delicious', low temperatures (7.8, 3.9, 2.8, and 8.3°C) during the time of pollination might have prolonged ovule longevity, especially in those flowers pollinated 3 and 4 days after full bloom. Considering the high response of 'Delicious' flowers to AVG, the experiment might have been prolonged for several more days. Secondly, percent set in control 'McIntosh' flowers was no better than in 'Delicious', despite previous reports (e.g., 2) of poorer set in the latter. A freeze prior to bloom killed considerably more 'McIntosh' than 'Delicious' flowers; thus, if sub-lethal injury paralleled lethal injury, the viability of the surviving flowers may have been lower in 'McIntosh' than in 'Delicious'.

LITERATURE CITED

1. Dennis, F.G., Jr. 1979. Factors affecting yield in apple with emphasis on 'Delicious'. Hort. Rev. 1: 395-422.
2. Dennis, F.G., Jr., C.E. Creaws, and D.W. Buchanan. 1978. Effect of aminoethoxyvinylglycine in bloom delay and fruit set in tree fruits. HortScience 12: 386 (Abst.).
3. Greene, D.W. 1980. Effects of silver nitrate, aminoethoxyvinylglycine and gibberellins A_{4+7} plus 6-benzylaminopurine on fruit set and development of 'Delicious' apples. J. Amer. Soc. Hort. Sci. 105: 717-720.
4. Hartman, F.O., and F.S. Howlett. 1954. Fruit setting of Delicious apple. Ohio Agric. Expt. Sta. Bull. 745. 64 p.
5. Hough, L.F. 1947. A comparative study of the life history of the Arkansas Delicious and Grimes Golden apple with respect to the variations in fruitfulness shown by these varieties. Ph.D. Thesis, Univ. of Illinois.

6. Lapins, K.O., and H. Arndt. 1974. Main causes of low fruit set in Delicious apple in 1974. British Columbia Orchardist 14: 8-9.
7. Marro, M. 1976. Richerche sulla evoluzione del sacco embrionale del melo Richared nel carsodella fioritura. Rivista Ortoflorofrutticoltura Italiana 60: 184-198.
8. Stott, K.G. 1972. Pollen germination and pollen tube characteristics in a range of apple cultivars. J. Hort. Sci. 47: 191-198.
9. Williams, M.W. 1980. Retention of fruit firmness and increase in vegetative growth and fruit set of apple with aminoethoxyvinylglycine. HortScience 15: 76-77.
10. Williams, R.R. 1965. A summary of research; pomology and plant breeding. Rpt. Long Ashton Res. Sta. for 1964. pp. 17-18.
11. Williams, R.R. 1965. The effect of summer nitrogen applications on the quality of apple blossoms. J. Hort. Sci. 40: 31-41.