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Effects of Ethephon on Maturation and Postharvest Quality of 'Concord' Grapes[1]

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Abstract. **Single and split applications of (2-chloroethyl)phosphonic acid (ethephon) at different concentrations to 'Concord' grapes(*Vitis labrusca* L.)did not influence maturation. When ethephon was applied 8 days prior to harvest, abscission was enhanced and postharvest alcohol accumulation was reduced when fruit was shaken from the vine and held at 30°C for up to 24 hours.**

Ethylene is a well-known fruit ripening hormone (8, 11). However, the influence of endogenous ethylene on grape maturation may be questionable since its production rapidly declines after anthesis (6) and remains at low levels throughout grape maturation (4, 6). Ethephon has been used successfully with many *Vitis vinifera* cultivars to improve color (1,4,10,13,14) and to increase the rate of soluble solids accumulation in some cultivars (1, 2, 7, 10, 12). However, ethephon applied prior to harvest has not improved quality of the *labrusca* cultivars 'Delaware' (5) and 'Concord' (3), even though fruit abscission can be induced easily. The use of ethephon as a harvesting aid has been considered in mechanical harvesting of grapes because the resulting dry stem scar may protect the berry from postharvest quality loss. Since 'Concord' grapes in Arkansas are harvested at high temperatures, postharvest quality loss can be very rapid (9).

The purposes of this study were to determine the effects of ethephon on fruit maturation and postharvest quality changes of 'Concord' grapes.

Materials and Methods

Study 1. Ethephon was applied to 12-year-old own rooted 'Concord' grapevines at 0, 100, 200, 300, 400, and 500 ppm with a 10-liter hand sprayer 8 days prior to harvest. Vines were selected on the basis of uniform size and fruit load. Experimental design was a randomized block with 3 replications of 1-vine plots.

Fruit were harvested by hand-shaking onto a canvas, and the percentage of berries with leaking stem scars was determined. The ambient air temperature at harvest, during early morning, was 23°C, and berry temperature ranged from 20° to 24° at the time of harvest. Immediately after harvest, 1-kg samples of grapes from each plot were placed in non-vented polyethylene bags and either frozen immediately or held for 12 or 24 hr at 18, 24, and 30°, after which bags of grapes were frozen for later quality analysis.

Study 2. Ethephon was applied to 21-year-old own rooted 'Concord' grapevines in concentrations of 0, 200, 400, and 800 ppm in single applications and 0, 100, 200, and 400 ppm in split applications. All single applications and the first part of the split application of ethephon were made 20 days prior to harvest when approximately 50% of the berries were developing some color. The second part of the split application was made 10 days prior to harvest.

At harvest, fruit removal force was determined on 10 random berries from each vine using a Hunter L-500 mechanical force gauge (Hunter Spring Division, Hatfield, PA 19440), and fruit samples consisting of 3 whole basal clusters were frozen for later quality analysis.

Quality analyses. Samples were thawed and blended for 15 seconds and warmed to 20°C. Soluble solids concentrations were determined using a Bausch and Lomb Abbe refractometer. After being heated for 1 hr at 85°, pulp was separated from juice with cheesecloth. A 5-ml aliquot of juice was diluted to 125 ml with distilled water, pH was recorded, and the sample was titrated to pH 8.4 with 0.1 N NaOH. Tristimulus color of the juice was determined using a Gardner Color and Color Difference meter standardized to the dark red plaque with values of "L"=23.1, "a"=22.0, and "b"=7.1. In the first study, 300 ml of juice was taken from each sample, and alcohol concentration was determined with a pycnometer.

Results and Discussion

Study 1. Ethephon applied 8 days before harvest apparently enhanced abscission, which reduced the percentage of grapes with damaged or wet stem scars when they were hand shaken from the vine, but affected no other quality parameters determined at harvest (Table 1).

During postharvest holding, fruit soluble solids declined and titratable acidity and pH slightly increased (Table 2). Juice color became lighter (higher "L") and less blue (higher "b") and alcohol content increased with holding time. The holding temperature had no influence on soluble solids and no consistent effect on titratable acidity or the "a" or "b" color values. However, juice color became darker at the higher holding temperatures and alcohol content increased. A slight reduction in pH occurred at 30°C.

Ethephon had no influence on alcohol production when grapes were held at 18 or 24°C for 12 or 24 hr (Table 3). However, at the 30° holding temperature, which is common during 'Concord' harvest in Arkansas (9), all ethephon concentrations significantly reduced alcohol levels compared to the control after both the 12 and 24 hr holding times. Alcohol content can be an indicator of quality loss, and levels above 0.25% are often associated with off-flavors in processed juice products (9). On this basis, ethephon allowed these grapes to be held without quality loss at 18, 24, or 30°for 12 hr, but not for 24 hr.

Study 2. Since ethephon, when applied in a single application 8 days prior to harvest, did not appear to affect fruit maturation, the following season a study was designed to evaluate the effect of

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Table 1. Main effects of ethephon applied 8 days before harvest on raw product quality of 'Concord' grapes at harvest.

Ethephon concn. (ppm)	Damaged[z] scars (%)	Soluble solids (%)	Tartaric acid (%)	pH	CDM color L	a	b
0	90.0	16.2	.72	3.53	12.1	11.4	4.6
100	48.3	16.5	.73	3.67	11.0	11.4	4.1
200	33.7	15.3	.72	3.53	12.5	12.3	4.6
300	30.0	16.2	.73	3.64	11.8	11.7	4.0
400	—[y]	14.8	.72	3.66	13.9	11.2	5.4
500	—[y]	15.2	.72	3.67	13.2	11.3	5.0
LSD 5%	11.3	NS	NS	NS	NS	NS	NS

[z]Stem scars torn sufficient to leak juice.
[y]Values not determined, but essentially no damaged stem scars at 400 and 500 ppm ethephon.

Table 2. Main effects of postharvest holding time and temperature on raw product quality of 'Concord' grapes. Ethephon was applied 8 days before harvest.

Main effect	Soluble solids (%)	Tartaric acid (%)	pH	CDM color L	a	b	Alchol (%)
Holding Time (hr)							
0	15.7	.72	3.62	12.4	11.5	4.6	—[z]
12	15.3	.73	3.63	12.7	11.7	4.9	.18
24	14.7	.75	3.68	13.1	11.5	5.3	.45
LSD 5%	0.4	.01	0.04	0.2	NS	0.3	.03
Holding Temp. (°C)							
18	15.2	.71	3.67	13.2	11.1	5.1	.13
24	15.3	.76	3.67	12.8	12.0	4.7	.20
30	15.1	.73	3.61	12.7	11.5	5.2	.37
LSD 5%	NS	.01	0.03	0.2	0.5	0.3	0.3

[z]Not determined at harvest.

ethephon at different concentrations and with split applications. Ethephon applied 20 days prior to harvest, or at both 20 and 10 days before harvest, had no effect on any of the quality parameters evaluated at harvest (Table 4). The fruit removal force was reduced by ethephon at 800 ppm applied 20 days before harvest and at 400 ppm applied both 20 days and 10 days before harvest; the single application at 800 ppm was especially effective. The reduction was such that a high wind could have removed a major portion of the fruit. Although fruit removal force was not determined in Study 1, fruit treated with 400 or 500 ppm 8 days prior to harvest have been observed to be vulnerable to loss by wind or rain.

These results show that color and maturity of 'Concord' grapes were not influenced by ethephon applications under the conditions of this study, as has been reported for many *V. vinifera* cultivars. Alcohol production at a holding temperture of 30°C was reduced up to 50% when ethephon was used. However, this reduction in alcohol during postharvest holding, which probably occurred as a result of less torn and damaged berries, may occur commerically only when a non-slapper mechanical harvester is used. Use of ethephon as a harvesting aid for 'Concord' grapes would not be practical in areas where high winds commonly occur at harvest. The addition of SO_2 to the grapes at the time of mechanical harvest may be a more practical method of delaying postharvest deterioration (9).

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Table 3. Interactive effects of ethephon concentration, holding time, and holding temperature on alcohol content of 'Concord' grapes. Ethephon was applied 8 days before harvest.

Holding time and ethephon concn (ppm)	Alcohol content (%) after holding at 18°C	24°	30°
12 hr			
0	.11	.14	.40
100	.15	.17	.20
200	.11	.15	.19
300	.13	.18	.23
400	.13	.16	.21
500	.15	.15	.20
24 hr			
0	.22	.39	1.17
100	.26	.41	.71
200	.18	.38	.55
300	.21	.50	.82
400	.20	.35	.47
500	.18	.32	.66
LSD 5% = 0.17			

Table 4. Effects of single and split ethephon applications on raw product quality and fruit removal force of 'Concord' grapes.[z]

Ethephon concn (ppm)	No. of applications	Soluble solids (%)	Tartaric acid (%)	pH	CDM color L	CDM color a	CDM color b	Fruit Removal force (g)
0	0	15.7	.85	3.73	17.4	9.9	3.6	305
200	1	16.1	.86	3.73	15.7	11.6	2.4	311
400	1	16.9	.92	3.75	14.9	11.7	1.8	293
800	1	16.1	.93	3.74	16.1	11.3	2.7	144
100	2	16.7	.86	3.74	13.9	11.4	1.4	335
200	2	15.4	.86	3.74	19.5	10.2	4.2	291
400	2	15.0	.85	3.74	18.1	10.8	3.5	249
LSD 5%		NS	NS	NS	NS	NS	NS	51

[z]Single application and first split application applied 20 days prior to harvest (approx. 50% of berries showing some color development). The second split application was applied 10 days prior to harvest.

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Effect of Poultry Manure on Strawberry Fruiting Response, Soil Nutrient Changes, and Leaching[1]

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Abstract. **Strawberries (*Fragaria* X *ananassa* Duch.) were grown for 3 seasons on a well-drained fine sand which received 0, 4.5, 9, 18, and 36 metric tons (MT)/ha of poultry manure annually. Fruit yields increased each season with increased rates of manure up to 18 MT/ha. The 36 MT/ha rate caused a foliage burn during the first 3 seasons which may have reduced yields. Considerable leaching of the soluble nutrients from manure to and below the 60-cm soil depth occurred from season to season. Analyses of saturated soil extracts indicated that concentrations of soluble salts, K, and NO_3–N increased with increasing rates of manure at all 4 depths to 60 cm. The Ca, K, and Mg concentrations at all 4 soil depths increased with increased manure rates and generally decreased with depth. Organic matter content of the surface 15 cm of the soil increased with increased manure rate. Soil pH was only slightly affected by the manure treatments.**

Concentration of dairy and poultry farms near large population centers have created manure disposal problems. In west central Florida, a large poultry industry produces some 300,000 MT of manure per year. Although sufficient land is generally available for disposal, and poultry manure is used to some extent in animal feed, transportation to disposal sites is often expensive and inconvenient. In areas where the poultry industry is concentrated, large volumes of manure are often applied annually to fields which are farmed continuously to horticultural crops. The soils in west central Florida are fine sands and many are quite porous and well-drained (4). The 130 cm of annual rainfall and the application of moisture by sprinkler irrigation for strawberry production presents a serious leaching problem for the plant nutrients in the manure (1, 3, 5, 14). If applied properly, poultry manure is beneficial to strawberry production when using the matted row cultural system (6, 9).

The objectives of this study were to evaluate the effect of poultry manure rates on marketable fruit yields of strawberries grown with the annual hill cultural system and on changes in the concentration and the leaching of soil nutrients.

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