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Influence of Vineyard Management Practices and Cultivar on Grape Berry Properties

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Abstract
Factors influencing berry properties of grapes are numerous and include environmental factors, management practices, and cultivar differences. Vintners are continually seeking ways to modify these variables to optimize harvest dates and ensure superior fruit quality. The most widely accepted and commonly used measures of berry maturity include pH,soluble solids concentration (SSC), and titratable acidity.

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Influence of Vineyard Management Practices and Cultivar on Grape Berry Properties

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Introduction

Factors influencing berry properties of grapes are numerous and include environmental factors, management practices, and cultivar differences. Vintners are continually seeking ways to modify these variables to optimize harvest dates and ensure superior fruit quality. The most widely accepted and commonly used measures of berry maturity include pH, soluble solids concentration (SSC), and titratable acidity.

Over 90% of the soluble solids within grape juice are from sugars. Tartaric and malic acids are the predominate acids that exist with numerous other secondary metabolites including tannins, anthocyanins, terpenoids, polyphenols, and glyosides. In general, high levels of organic acids are correlated with a lower pH. The relative amounts of these compounds vary according to the environment and cultivar differences. All of these properties are of considerable importance not only in determining maturity and harvest dates, but also in winemaking.

The effects of management practices on berry properties are somewhat ambiguous. Proponents of organic farming claim that berry quality is elevated under organic management practices. Yet, there is no conclusive evidence pertaining to this matter. Research has shown that excess nitrogen applications associated with conventional production systems can decrease the level of antioxidants relative to organic production systems. However, yields tend to be lower in organic vineyards due to numerous factors including the potential of reduced fertility and increased pest damage.

The objective of this project was to evaluate the influence of different production systems on grape berry properties by measuring average berry weight, pH, soluble solids concentration, and titratable acidity. In addition, differences among various cultivars were also evaluated.

Materials and Methods

The vineyard that the berries were harvested from was established in 2002 at the Iowa State Horticulture Research Station. The vines were planted in a randomized complete block design and included the following fifteen cultivars: Marechal Foch, Frontenac, Cynthiana, St. Croix, Chambourcin, Seyval Blanc, La Crosse, Vignole, Traminette, Edelweiss, Marquis, Vanessa, Reliance, Mars, and Jupiter. These fifteen cultivars were blocked within three experimental treatments and replicated a total of five times. The three experimental treatments were: 1) a conventional production system that incorporated the regular use of pesticides, 2) IPM/best management practices that depended on pest monitoring before the application of pesticides, and 3) an organic-approved production system that utilized straw mulch for weed suppression and organic-approved pesticide control strategies.

Vines were planted in an 8 ft × 10 ft spacing with approximately 545 vines/acre. Cultivars with procumbent (trailing) growth habit were trained to the top wire as a single curtain, whereas cultivars with semi-upright growing vines were trained vertically under the vertical shoot positioning (VSP) system.

Harvesting of the grapes was mid August through early October 2006. Approximately 50 berries from each cultivar in each replication receiving one of the three production system treatments were randomly selected. Thirteen of the fifteen cultivars provided sufficient samples to be evaluated for fruit quality.

They included: **Red Wine Cultivars–** Frontenac, Cynthiana, and St. Croix; **White Wine Cultivars–**La Crosse, Vignole, Seyval Blanc, Traminette, and Edelweiss; and **Table Grape Cultivars–**Mars, Marquis, Jupiter, Vanessa, and Reliance.

Data from the cultivars Jupiter, Reliance, Vanessa, Marquis, Edelweiss, and Traminette were analyzed separately due to insufficient yield. Average berry weight, pH, soluble solids concentration, and titratable acidity were then determined for each sample.

Results and Discussion

Average Berry Weight. Of all cultivars assayed, the white wine cultivar Seyval Blanc had the highest average berry weight. Of the red wine cultivars, St. Croix had the highest average berry weight, whereas Cynthiana had the lowest (Tables 1 and 2). When comparing treatments, average berry weight was highest in the IPM production system and lowest in the conventional production system (Table 3). From the composite data, all of the table grape cultivars had a higher average berry weight relative to all the wine cultivars (Table 4).

pH. All grape cultivars in all treatments had similar pH values that ranged from 3.07 to 3.72 (Table 1). When comparing cultivars, St. Croix had the highest average pH value, whereas Cynthiana had the lowest (Tables 1 and 2). Overall, the three treatments averaged similar pH values (Table 3).

Soluble Solids Concentration (SSC). Cynthiana grapes had the highest SSC (Tables 1 and 2). Overall, the organic production system had the highest SSC, whereas the IPM production management system had the lowest (Table 3). All table grape cultivars were harvested at a lower SSC and the wine cultivars were harvested at a higher SSC due to the requirement of a higher sugar concentration for wine production (Table 4).

Titratable Acidity. Cynthiana had the highest titratable acidity, whereas Syval Blanc had the lowest (Tables 1 and 2). On average, the conventional production system had the highest titratable acidity, whereas the IPM production system had the lowest (Table 3). From the composite data, it was determined that all the table grape cultivars had a lower titratable acidity relative to all the wine cultivars (Table 4).

Table 1. Grape berry weight, pH, soluble solids concentration, and titratable acidity for seven cultivars grown under three production management systems.[z]

Cultivar/management treatment	Average berry weight (g)	pH	SSC[y] (%)	Titratable acidity (g/liter)
Mars–Conventional	*	3.25 def	15.53 h	6.82 ghi
Mars–IPM	*	3.25 defg	15.93 h	6.62 hij
Mars–Organic	*	3.19 efghi	16.05 h	6.28 ij
Frontenac–Conventional	1.17 d	3.28 de	22.48 ab	10.28 b
Frontenac–IPM	1.19 d	3.24 efg	21.97 b	10.59 b
Frontenac–Organic	1.17 d	3.26 def	22.83 a	10.58 b
Cynthiana–Conventional	1.10 d	3.08 hi	22.81 a	15.73 a
Cynthiana–IPM	1.19 d	3.09 hi	22.67 a	16.19 a
Cynthiana–Organic	1.22 d	3.07 i	21.96 b	15.82 a
St. Croix–Conventional	1.49 c	3.72 a	17.63 fg	7.40 efg
St. Croix–IPM	1.61 bc	3.72 a	17.16 g	7.21 fgh
St. Croix–Organic	1.58 bc	3.60 ab	17.73 fg	7.46 efg
La Crosse–Conventional	1.67 b	3.22 efgh	17.20 g	8.17 d
La Crosse–IPM	1.60 bc	3.28 de	17.81 ef	7.80 def
La Crosse–Organic	1.62 b	3.29 de	18.40 e	7.98 de
Vignole–Conventional	1.72 b	3.12 fghi	22.40 ab	9.58 c
Vignole–IPM	1.68 b	3.11 ghi	22.51 ab	10.03 c
Vignole–Organic	1.67 b	3.16 efghi	22.39 ab	9.57 c
Seyval Blanc–Conventional	2.16 a	3.51 bc	19.93 c	6.02 j
Seyval Blanc–IPM	2.16 a	3.38 cd	19.03 d	7.16 fgh
Seyval Blanc–Organic	2.16 a	3.38 cd	19.91 c	7.41 efg
LSD P≤0.05	0.25	0.18	0.94	0.766

[z]Data collected at time of harvest and averaged over all cultivars.
[y]Percent soluble solids concentration (brix).
*Data not available.
Values with the same letter are not significantly different from each other.

Table 2. Harvest date, grape berry weight, pH, soluble solids concentration, and titratable acidity of cultivars averaged over all production management treatments.[z]

Cultivar	Harvest date	Average berry weight (g)	pH	SSC[y] (%)	Titratable acidity (g/liter)
Mars	Aug. 28	3.51*	3.23 c	15.73 d	6.58 f
Frontenac	Sept. 19	1.18 d	3.26 c	22.43 a	10.44 b
Cynthiana	Oct. 13	1.17 d	3.08 d	22.45 a	15.89 a
St. Croix	Aug. 30	1.56 c	3.68 a	17.55 c	7.34 e
La Crosse	Sept. 13	1.63 bc	3.26 c	17.83 c	7.93 d
Vignole	Sept. 19	1.69 b	3.13 d	22.43 a	9.73 c
Seyval Blanc	Aug. 30	2.16 a	3.40 b	19.44 b	7.08 e
LSD P≤0.05		0.09	0.076	0.35	0.368

[z]Data collected at time of harvest and averaged over all treatments.
[y]Percent soluble solids concentration (brix).
*Data from sampling just prior to harvest; data from August 28 harvest date not available.
Values with the same letter are not significantly different from each other.

Table 3. Grape berry weight, pH, soluble solids concentration, and titratable acidity from vines grown in different production systems.[z]

Treatment	Average berry weight (g)	pH	SSC[y] (%)	Titratable acidity (g/liter)
Conventional	1.46 b	3.29 a	19.68 b	9.48 a
IPM	1.57 a	3.28 a	19.61 b	9.37 a
Organic	1.53 a	3.27 a	19.96 a	9.47 a
LSD P≤0.05	0.06	0.0492	0.2279	0.237

[z]Data collected at time of harvest and averaged over all cultivars.
[y] Percent soluble solids concentration (brix).
Values with the same letter are not significantly different from each other.

Table 4. Grape berry weight, pH, soluble solids concentration, and titatable acidity from additional cultivars.[z]

Cultivar	Harvest date	Average berry weight (g)	pH	SSC[y] (%)	Titratable acidity (g/liter)
Jupiter	Aug. 16 and 24*	3.01	3.52	18.50	4.64
Reliance	Aug. 24	2.86	3.30	18.00	6.97
Vanessa	Aug. 16 and 24*	2.86	3.46	18.75	4.48
Marquis	Sept. 13	4.50	3.52	17.26	3.76
Edelwiess	Sept. 16	3.15	3.21	14.00	10.13
Traminette	Sept. 13	1.82	3.33	18.20	8.52

[z]Mean from various number of replications (for these cultivars all five replications did not have yield in 2006).
[y] Percent soluble solids concentration (brix).
*Two harvest dates: harvested on August 16 and August 24.