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Reviewed Research Paper

Grape Cultivar Performance on the Tennessee Cumberland Plateau

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Abstract

Twelve American and eleven French hybrid type grape *(Vitis)* cultivars were evaluated for productivity and fruit quality at the University of Tennessee Plateau Experiment Station near Crossville, TN. Concord was more productive than all American type cultivars except Alwood and Moored. Rougeon and Rosette were the most productive French hybrid type cultivars. Winter injury severely damaged and finally destroyed the vineyard.

Introduction

A grape cultivar trial was initiated at the Plateau Experiment Station in 1973. Objectives of the trial were to evaluate productivity, fresh fruit quality and production problems associated with selected cultivars. Two previous trials at this location had failed due to winter injury to the vines. Only cultivars with known or expected winter hardiness were included in the 1973 planting. The Tennessee climate has considerable winter temperature fluctuations which have caused more vine damage than extreme low winter temperatures. The Cumberland Plateau climate (15) is the most rigorous in Tennessee and cultivars hardy at this location should be hardy at most other locations within the state.

Grape cultivars and species are limited in geographic distribution due to climatic conditions (4, 12, 13, 19, 20, 29). Muscadine grapes are usually grown in the southeastern United States where low temperatures seldom reach 10° F. (20). This includes only southern and western Tennessee and then only on selected sites. American and French hybrid grapes can survive at winter temperatures at -5° to -26° F. (6, 10, 11, 16, 17), but injury often occurs at temperatures below -10 to -15 F. (1, 5, 7, 10, 11, 27). Climatic factors such as rapidity of temperature fluctuations, actual minimum temperatures, drought, sunlight, length of frost free growing period and heat units affect winter hardiness of grape vines and other tender fruit crops (7, 12, 14, 25, 28). A frost free growing period of 150 days seems a minimum for survival of even the most hardy grape cultivars (25). The climate of the Cumberland Plateau region and particularly around Crossville, TN is limited to 179 frost free days (18). In most years the frost free growing period is much shorter than this average. It has been over 30 days shorter in either spring or fall in given years (18). A total of 1800 to 2500 heat units with a 50°F. base seem essential for survival of the most hardy grape cultivars (29).

Most of the grape production in the eastern United States is located near the Great Lakes and is of the Concord cultivar (8, 26). Other cultivars seem to be gaining in importance in this region but climatic adaptation is a primary concern with all cultivars. Winter freezes seem to occur on an irregular frequency and severely damage vines of most grape cultivars in most other eastern areas (2, 5, 6, 7, 9, 10, 11, 14). Severe cold at the onset of the 1962-63 winter caused severe grape and other fruit crop damage in several locations in Tennessee, Kentucky and southern Ohio. Injury also

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occurred in other locations in other years.

Several reports have been made on the progress of the cultivar trial (21, 22, 23, 24). This is a concluding report on the trial.

Procedure

Vines of 12 American type and 11 French hybrid type cultivars were set in March of 1973 on a site with Lily (formerly Hartsells) sandy loam soil. Plantings of each type were in a randomized complete block experimental design with 4 replications. Each experimental plot contained 3 vines. Vines were spaced 2.4 m apart in 3.0 m rows. The training system was a modification of the 4-cane Kniffin system using 2 main trunks for most cultivars. After 6 years, one main trunk was eliminated. Pruning levels with this system were 40 to 50 fruiting buds per vine depending on vine vigor. French hybrid cultivars, Seyval, Vidal 256 and Villard Blanc were pruned to shorter canes.

Phosphate and potash were applied to maintain medium soil test levels according to Tennessee soil test laboratory analysis. Nitrogen was broadcast annually in April at a rate of 67 kg/ha. Sulfate of magnesium was banded at 59 kg/ha in 1974 and 1979. Recommended insecticides and fungicides were applied at 10 to 14 day intervals during the growing season each year. Soil management included cultivation with small grain winter cover in 1973 and 1974. Natural vegetation between rows was mowed while paraquat and simazine were used for weed control in the row during the fruiting season. Sprinkler irrigation was used in late May or early April three times in 1976 and once in 1978 to protect the young shoots from freeze damage.

Yields, harvest dates, and other pertinent observations were recorded annually.

Results and Discussion

Concord, Alwood, and Moored were the most productive American type cultivars tested, averaging 9.6 to 8.3 t/ha annually over 9 fruiting years (Table 1). Catawba, Niagara, Bath Fredonia, and Van Buren averaged from 7.2 to 4.4 t/ha. Low yields of Monticello, Yates, and Price were primarily due to winter injury.

Table 1. Yield of American type grape cultivars, Plateau Experiment Station, 1975-1984.

Cultivar	Year										
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	Mean
	tonnes/hectare										
Concord	14.8	7.6	10.1	11.0	13.2	12.6	4.7	0.9	11.7	5.2	9.2
Alwood	11.9	5.8	11.0	10.1	13.7	7.4	3.4	0.2	15.5	1.6	8.6
Moored	13.5	4.7	9.7	12.1	13.5	8.1	2.2	0	10.8	2.8	7.7
Catawba	10.1	4.5	4.9	10.6	8.3	9.4	0	0	17.3	1.6	7.7
Niagara	13.0	2.7	6.3	8.3	11.7	8.1	4.0	0.4	6.3	1.7	6.2
Bath	8.5	6.7	5.6	6.1	9.7	7.2	8.5	0	2.0	0.4	5.5
Fredonia	6.1	2.2	4.0	8.8	8.5	8.8	0	3.1	8.1	6.6	5.6
Van Buren	13.0	2.5	7.2	8.1	4.3	4.3	2.2	3.1	4.5	4.4	5.4
Moore's Early	7.4	2.2	7.0	4.5	9.7	4.9	1.3	0	3.4	0.8	4.1
Monticello	8.3	3.4	2.0	5.4	4.9	2.7	1.6	0	3.8	0.4	3.2
Yates	1.8	2.0	1.3	5.4	3.6	2.5	0	0	0	0	1.7
Price	2.2	1.1	3.7	1.8	0.9	3.8	0.9	0.7	1.1	0	1.6
Mean	9.2	3.8	6.1	7.7	8.5	6.7	2.4	0.7	7.0	2.1	5.4
L.S.D. @ .05	0.4	2.7	3.6	2.7	4.0	3.1	1.3	0.4	4.0	2.1	2.2

Rougeon and Rosette were the most productive French hybrid cultivars tested with an annual average yield of 9.6 and 8.4 t/ha, respectively (Table 2). All other cultivars averaged from 4.1 to 2.3 t/ha annually. Winter injury was primarily responsible for the low yields of most of the cultivars and is also reflected in yield fluctuations among years.

Weather had a catastrophic effect on vineyard performance. The lowest temperatures recorded during the test period were -9° C in January 1977, -18° C in December 1983, and -32° C in January 1985. The low temperature in 1977 was responsible for winter injury to some vines, especially those of Vidal 256 and Villard Blanc cultivars which had very low yields that year. The low in December 1983 followed some very warm temperatures. Vines of Bath, Moore's Early, Monticello, Yates and Price were the most heavily damaged. Vines of Concord, Fredonia and Van Buren survived these conditions. The French hybrid type cultivars with the exception of Rougeon were severely damaged during the freeze of December 1983. The low of -32° C in January 1985 followed a very warm December 1984. Canes of all vines were completely killed to the ground. Due to winter damage, low productivity of the vines over the years and difficulties in establishing renewal trunks from the root system, it was decided to remove the planting completely.

The trunk renewal problem was not diagnosed completely. New shoots grew well from the root system and developed well. However, they seldom survived the following winter. Either damage had occurred in the root system or the young canes failed to harden sufficiently to withstand the winter temperatures.

Immature canes of all cultivars were damaged by the rapid temperature fluctuations which varied by as much as 15° C. within a one to two day period in mid December of 1976, 1977, and 1978. A fluctuation of 11° C. occurred within two days in mid December, 1980. These rapid fluctuations at the onset of the winter season have most likely reduced vigor and productivity of the vines over the years.

Table 2. Yield of French hybrid grape cultivars, Plateau Experiment Station, 1975-1984.

Cultivar	Year										
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	Mean
	tonnes/hectare										
Rougeon	6.7	4.7	4.9	17.3	5.4	13.5	5.4	5.8	18.0	14.4	9.6
Rosette	5.4	5.8	8.1	8.5	8.3	9.7	9.0	7.0	19.1	2.9	8.4
Seyval	7.0	3.4	3.1	10.8	4.0	5.8	2.2	0	4.5	1.6	4.2
Vidal 256	2.2	7.0	0.7	4.0	6.7	6.3	4.0	0	5.6	1.6	3.8
Baco Noir	5.6	9.9	3.8	8.3	4.0	2.2	2.7	0.2	0	0	3.7
Marec'hal Foch	7.6	9.7	2.0	8.1	3.8	1.3	1.1	0.4	0.2	0	3.4
Cascade	3.1	8.1	3.1	9.2	6.1	1.8	0.4	0.9	0.2	0	3.3
Horizon	4.5	3.4	3.6	4.0	4.3	1.8	4.7	0	3.1	1.1	3.0
DeChaunac	6.1	7.2	8.3	2.9	1.1	1.1	1.8	0.2	0	0	2.9
Aurore	4.5	3.6	5.8	5.4	5.6	1.1	1.3	0.4	0.9	0	2.9
Villard Blanc	3.4	6.5	0.4	4.9	0.7	3.4	1.8	0	0	0	2.1
Mean	5.1	6.3	4.0	7.6	4.5	4.4	3.1	1.4	4.7	2.0	4.3
L.S.D. @ .05	2.2	4.0	3.4	3.8	4.5	3.1	2.7	1.6	3.6	1.1	2.0

Spring freezes during flower development were of concern but injury occurred during this period only in 1982 when early shoot growth started due to warm early spring temperatures. A low of minus 7° C. was recorded on April 7 after shoot growth had started and the yields in 1982 were quite low. Fredonia and Van Buren had highest yields of the American type cultivars. Rougeon and Rosette, of the French hybrid cultivars, had good yields in spite of the late freeze. Late freeze damage was highly probable in 1976 and 1978 but sprinkler irrigation protected against probable freeze damage.

Dry weather with only 20 cm of rain during June, July, August, and September resulted in some reduction in cane growth and somewhat lower than average yields in 1981.

Some general quality factors of the American type cultivars were summarized in the fall of 1983 and are shown in Table 3. Concord, Alwood, and Moored had highest yields and good fresh flavor. The blue fruited Alwood and red fruited Moored cultivars matured 11 and 12 days earlier, respectively, than Concord. All had good vine condition and little winter injury in October 1983. Catawba was rated as having 45% winter damage following a very heavy yield in 1983. Niagara produced high quality white fruit but winter damage was rated at 56% in October 1983. Niagara fruit was quite susceptible to black rot unless adequately controlled by frequent fungicide applications. Bath fruit had excellent fresh quality but winter injury weakened the vine condition by 92%. Harvest date averaged August 18 for the Fredonia cultivar. Fredonia vines were vigorous with good condition. However, yields of Fredonia were consistently lower than those of Concord. Van Buren fruit was good quality but clusters were so tight that berries cracked or shattered during harvest. Shoot growth started very late each spring with Van Buren vines. This late shoot growth is one reason why Van Buren was so productive in 1982 when spring freezes greatly reduced yields of other cultivars. Moore's Early fruit ripened early but quality was only fair. Winter damage was rated at 46% for Moore's Early. Monticello, Yates, and Price had poor

Table 3. Effect of American type grape cultivar on fruit color, harvest date and vine condition.[z]

Cultivar	Fruit color	Av. Harvest date	% Winter Injury
Concord	blue	Aug. 28	0
Alwood	blue	Aug. 17	20
Moored	red	Aug. 16	2
Catawba	red	Sept. 12	45
Niagara	white	Aug. 26	56
Bath	red	Aug. 28	92
Fredonia	blue	Aug. 18	1
Van Buren	blue	Aug. 21	15
Moore's Early	blue	Aug. 10	46
Monticello	blue	Aug. 19	70
Yates	red	Sept. 7	98
Price	red	Aug. 10	79
L.S.D. @ .05	—	—	26

[z]Summarized in the fall of 1983.

vine conditions and low yields due to winter injury. Monticello and Price had excellent fruit quality. However, these cultivars were not adapted to climate conditions of this area. Price fruit matured early with a harvest date of August 10, the same as for Moore's Early.

Quality and winter injury were summarized in the fall of 1983 and varied considerably with the French hybrid type cultivars as shown in Table 4. Rougeon had the least winter damage (2%) of all cultivars followed by Rosette with 28% and Vidal with 46%. All other cultivars had very poor vine condition which was attributed to winter injury.

The lack of injury to Rougeon and Rosette vines was reflected in the higher yields of these cultivars. The Marec'hal Foch, Cascade, and Horizon cultivars had severe winter damage in October 1983. DeChaunac produced well early in the trials but the vines rapidly deteriorated as the trials progressed. Aurore matured early (August 25) but black rot control was almost impossible even with frequent fungicide applications. Vine condition was very poor in October 1983. Villard Blanc produced moderate yields in 1975 and 1976 but vine vigor and yields deteriorated after the extreme winter weather conditions in early 1977.

Seyval, Vidal 256 and Horizon fruit had very good quality (22, 23, 24) for the French hybrid type. Soluble solids were consistently near 20%, while acidity was low. Rougeon and Rosette had a low sugar to acid ratio. Fruit of Baco Noir and Villard Blanc had high acidity levels.

The length of the frost free growing season during the test period was 152 days. The average last spring frost date was May 6 and varied from April 18 to May 26. The average date of the first fall frost was Oct. 6 and varied from Sept. 24 to Oct. 15. A freeze was usually associated with each frost date. The first fall frost date usually killed green grape leaves and tender young canes. It appears most probable that the growing season at this location is too short and not well suited to successful grape production.

Conclusions

Grape cultivars established at the Plateau Experiment Station in 1973 generally had unacceptable growth and production due to damage from winter injury. However, winter hardi-

Table 4. Effect of French hybrid type grape cultivar on fruit color, harvest date and vine condition.[z]

Cultivar	Fruit color	Av. Harvest date	% Winter Injury
Rougeon	blue	Sept. 21	2
Rosette	blue	Sept. 14	28
Seyval	white	Sept. 4	50
Vidal 256	white	Sept. 14	46
Baco Noir	blue	Sept. 7	95
Marec'hal Foch	blue	Sept. 1	90
Cascade	blue	Sept. 7	90
Horizon	white	Sept. 4	75
DeChaunac	blue	Sept. 1	95
Aurore	white	Aug. 25	85
Villard Blanc	white	Sept. 21	95
L.S.D. @ .05	—	—	23

[z]Summarized in the fall of 1983.

ness data indicated that Concord, Alwood, and Moored were the most hardy and productive American type cultivars. Rougeon and Rosette were the most hardy and productive French hybrid type cultivars. Weather conditions were very unfavorable for grapes and added to the decline and finally to demise of the vineyard.

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