In summary it should be emphasized that cherries are a rather fragile crop to grow both climatically and because of especially numerous virus and insect vectored disease problems. Thus, many research problems remain. This is probably because of their relatively insignificant dollar value compared to citrus, bananas, pome fruits and grapes and because many fewer human cultures have learned to desire them in their diets.

Cherries have good genetic variability in their centers of genetic diversity (primarily Adriatic and Turkish Eurasia). They hold great promise for genetic improvement of both sweet and tart types as well as hybrids between them. Relatively little interspecific hybridization has been utilized and much is possible. The pioneering mutation genetics efforts in England and Canada to provide self-fertile genes appears invaluable in sweets.

Pseudomonas research and size controlling genetic improvements from both compact scions (Italy, Canada and California) and rootstocks (England, Germany and U.S.A.) also appear to be advancing well. The most significant challenges for future breeding are in disease tolerance and size controlling procedures to allow efficient orchard production. More pigmented tart types with new flavors may offer development of new cherry products.

It is unfortunate that closer collaboration with Soviet scientists has not been achieved. Germplasm and pomological information exchange between most other major research groups shows promise of significant genetic advance for cherry culture.

Performance of Selected Grape Cultivars Under Marginal Climatic Conditions in Tennessee. I. French Hybrid Type.

C. A. Mullins, D. L. Coffey, D. W. Lockwood, and J. L. Collins[1]

Commercial grape production in Tennessee is limited to less than 40 ha, mostly of American type cultivars (15). Considerable interest has been expressed in producing wine grapes in the state. Cultivars of *Vitis vinifera L.*, the major wine grape of the world have not been very successful in the eastern United States due to lack of winter hardiness (10, 11). Some cultivars of French hybrid type grapes, crosses of *V. vinifera L.* and American grape species perform well and are winter hardy. Cultivars reported winter hardy are Rosette in Tennessee (9); Aurore, Chancellor, Vidal 256, DeChaunac, and Villard Blanc in Ohio (3); and Vidal 256, DeChaunac, and Chelois in Pennsylvania (6, 7, 8) trials. Trials were established by University of Tennessee researchers to evaluate performance of selected French hybrid type cultivars.

PROCEDURE

One-year-old plants of the most hardy French hybrid type cultivars available were set in the spring of 1973 at the Plateau Experiment Station at

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Crossville. This site is somewhat characteristic of much of the state, except that temperatures are slightly lower throughout the year. The site is at an elevation of 579 m. Rainfall averages 127 cm annually with rather favorable distribution. Soil type is Hartsells sandy loam. The soil is slightly less than one m deep over solid sandstone. Although native fertility is quite low, the soil responds well to fertilization. Soil internal drainage is fair. Surface water drainage at the site is excellent. Two previous grape trials at the Plateau Experiment Station failed due to problems associated with low winter temperatures, spring freezes, and unusual summer droughts.

Plot design was a randomized complete block with 4 replications of 3 vines each spaced 2.4 m apart in 3.0 m rows. Training was to the 4 cane Kniffin system using 2 main trunks per vine. Balanced pruning was to be followed (1, 2); however, due to excessive cane dieback in the fall and winter, adequate growth was not available for conforming to this system. Cluster thinning was not practiced due to the generally light fruit set. Sprinkler irrigation was not needed for drought protection during the study but was used for freeze protection in the springs of 1976 and 1978.

Soil pH was 6.0 at the start of the test and no lime was applied. N was broadcast at 67 kg/ha annually. P and K were applied to maintain medium soil test levels. Mg was applied on a 3-year schedule. Cultivation was used for weed control the first 2 years with row middles moved thereafter and herbicides used in the row. Other cultural practices followed were standard for grapes in Tennessee (14).

RESULTS

Maximum and minimum temperatures, with interval between in days, for the October through May period from 1974 through 1978 are shown in Table 1. The low of −23° C in January 1976 was associated with slight winter kill. The low of −27° C in January 1977 severely damaged several cultivars. The rapid fluctuations of over 30° C that occurred within 1 or 2 days in December 1976 and 1977 are similar to those reported to cause considerable stress and yield reduction of fruiting crops (5, 13, 17).

Spring freezes occurred on April 17 and 28, and May 4, 1976, and April 21 and 22, 1978, but plants were protected by irrigation. Considerable cane die-back due to early October freezes was observed almost every year. Spring and fall freezes limit grape production in several locations (3, 14, 16). The number of freeze free days was usually less than 180 which may have reduced proper maturity of the fruiting wood (16).

Table 1. October to May monthly maximum and minimum temperatures and days between, Plateau Experiment Station, 1975 - 1978.

Month	1974-75			1975-76			1976-77			1977-78		
	max.	min.	days between	max.	min.	days between	max.	min.	days between	max.	min.	days between
	(° C)											
October	25	− 4	6	25	0	6	25	− 6	14	26	− 3	16
November	24	− 9	12	24	− 7	6	21	−16	3	21	−10	27
December	14	−12	12	19	−16	13	18	−16	2	18	−18	1
January	20	−16	15	13	−23	5	7	−27	12	13	−16	1
February	18	−12	14	21	−16	27	23	−16	26	10	−18	18
March	23	−11	18	25	− 6	12	26	− 7	29	22	−14	19
April	27	− 5	27	25	− 1	8	27	− 3	8	25	− 1	12
May	29	0	18	27	− 2	19	29	0	21	29	2	26

Table 2. Monthly 50° F. (10° C.) base heat units accumulated during each grape growing season, Plateau Experiment Station, 1975 - 1978.

Month	Monthly heat units (° C) 1975	1976	1977	1978	Mean
May	469	250	461	342	380
June	572	534	582	588	569
July	668	620	756	710	688
August	708	610	726	692	684
September	380	378	544	560	466
October	136	100	110	142	122
Total	2933	2492	3179	3034	2909

[1]Official National Oceanic and Atmospheric Administration data taken approximately 700 m. away from the test site.

Table 3. Yields of 11 French hybrid grape cultivars, Plateau Experiment Station, 1975 - 1978.

Cultivar	Yields (MT/ha) 1975	1976	1977	1978	Mean
Rougeon	6.7 ab[1]	4.7 bcd	4.9 abc	17.3 a	8.5 a
Rosette	5.4 abc	5.8 bcd	8.1 a	8.5 bcd	7.0 ab
Marechal Foch	7.6 a	9.6 a	2.0 cd	8.1 bcd	6.7 ab
Baco noir	5.6 abc	9.9 a	3.8 bc	8.3 bcd	7.0 ab
DeChaunac	6.1 ab	7.2 abc	8.3 a	2.9 e	6.1 b
Seyval	7.0 ab	3.4 d	3.1 bcd	10.8 b	6.1 b
Cascade	3.1 c	8.1 ab	3.1 bcd	9.2 bc	5.8 b
Aurore	4.5 bc	3.6 cd	5.8 ab	5.4 cde	4.9 bc
GW 7	4.5 bc	3.4 d	3.6 bc	4.0 e	3.8 c
Villard Blanc	3.4 c	6.5 abcd	0.4 d	4.9 de	3.8 c
Vidal 256	2.2 c	7.0 abcd	0.7 d	4.0 e	3.6 c
Mean	4.7	6.1	3.6	7.1	

[1]Mean separation within columns by Duncan's multiple range test, 5% level.

Table 4. Fruit composition of 11 French hybrid grape cultivars, Plateau Experiment Station, 1975 - 1978.

Cultivar	Soluble solids %[2]	pH[3]	Fruit composition acidity (%)[4]	Black rot rating[5]	Fruit color
Rougeon	15.9 e[1]	3.1 a	1.03 b	4.2 cd	blue
Rosette	16.4 de	3.1 a	0.76 cde	4.9 a	blue
Marechal Foch	19.5 a	3.7 a	0.69 de	4.6 b	blue
Baco noir	18.2 b	3.3 a	1.23 a	5.0 a	blue
DeChaunac	16.8 de	3.1 a	0.80 cde	4.1 de	blue
Seyval	20.3 a	3.5 a	0.86 bcd	3.6 f	white
Cascade	16.8 de	3.5 a	0.65 e	4.2 cd	blue
Aurore	17.9 bc	3.3 a	0.69 de	2.3 h	white
GW 7	17.4 bcd	3.5 a	0.62 e	3.2 g	white
Villard Blanc	17.0 cd	3.4 a	0.86 bc	4.4 bc	white
Vidal 256	20.2 a	3.2 a	1.03 b	4.0 e	white
Mean	17.9	3.3	0.84	4.1	

[1]Mean separation within columns by Duncan's multiple range test, 5% level.
[2]Soluble solids at harvest with hand refractometer, 1975 - 1978.
[3]Fruit pH by pH meter, 1977-1978.
[4]As tartaric acid, 1977-1978.
[5]Black rot rating at harvest: 1 (severe) through 5 (none).

The average accumulation of heat units in the short growing season (Table 2) was in the range found necessary for higher production, higher sugar content and optimum fruit quality in Washington (16). Weather with 2,500 to 3,000 heat units (F units) during the growing season was described as moderately cool (16).

Cumulative yields from 1975 - 1978 varied from 3.6 to 8.5 MT/ha (Table 3). Rougeon, Rosette, Marechal Foch, and Baco noir had the highest yield. White-fruited cultivars, Seyval, Aurore, GW 7, Villard Blanc, and Vidal 256, yielded less than most blue-fruited cultivars. Although all cultivars fruited, most showed winter damage and yields were lower than those reported in Ohio (3) or Pennsylvania (6, 8).

Fruit composition (Table 4) was similar to that observed in other eastern trials (3, 4, 6, 8, 12). Seyval, Vidal 256, and Marechal Foch had mean soluble solids levels greater than 19.5% and all cultivars averaged 17.9%. Aurore was the most and Rosette and Baco noir the least susceptible to black rot.

We conclude that the Tennessee Cumberland Plateau test location is not well suited to French hybrid grape production. Spring freezes would have caused considerable plant injury had not protection been used. Fruiting wood failed to "harden" sufficiently to withstand the fall and winter freezes without dieback. Low temperatures severely damaged fruiting wood of some cultivars and likely reduced fruiting wood vigor.

Rougeon, Rosette, Marechal Foch, and Baco noir were the most hardy cultivars; and thus, are most suitable for trials in Tennessee.

Literature Cited

1. Armstrong, W. D. and C. E. Chaplin. 1974. *Growing Grapes in Kentucky.* Dept. of Horticulture Publication HO-21. Univ. of Kentucky, Lexington.
2. Banta, E. S., G. A. Cahoon, and R. G. Hill, Jr. 1969. *Grape Growing.* The Ohio State Univ. Cooperative Extension Service Bull. 509.
3. Cahoon, G. A. and D. A. Chandler. 1972. Performance of grape cultivars and selections at the Southern Branch of the Ohio Agricultural Research and Development Center. *Proceedings of the 1972 Ohio Grape-Wine Short Course.* Hort. Dept. Series 383:1-21.
4. Cahoon, G. A., J. F. Gallander, and C. F. Rife. 1972. Ohio's re-emerging grape-wine industry. *HortScience* 7: 229-232.
5. Cain, D. W. and R. L. Anderson. 1979. Temperature and moisture effects on wood injury of cold-stressed Siberian C and Redhaven peaches. *HortScience* 14:518-519.
6. Haeseler, C. W. 1977. Characteristics of the wine grape cultivar Vidal 256 as grown in Erie County, Pennsylvania. *Fruit Var. J.* 31:36-39.
7. Haeseler, C. W. 1978. Characteristics of the wine grape cultivar Chelois as grown in Erie County, Pennsylvania. *Fruit Var. J.* 32:17-20.
8. Haeseler, C. W. and R. B. Beelman. 1976. Characteristics of the wine grape cultivar DeChaunac as grown in Erie County, Pennsylvania. *Fruit Var. J.* 30:65-67.
9. Jones, T. H. 1954. Variety test results on grapes in Tennessee. *Tennessee Farm & Home Science* 11:8.
10. Magoon, G. A. and E. Snyder. 1943. *Grapes for different regions.* U.S.D.A. Farmers Bull. 1936.
11. Phillips, E. L., C. R. Odell, and C. L. McCombs. 1977. *Grape Growing in Virginia.* Extension Publication 5, VPI and SU, Blacksburg, Virginia.
12. Pool, R. M., J. Einset, K. H. Kimball, *Farm & Home Science* 11:8. J. P. Watson, W. B. Robinson, and J. J. Bertino. 1976. *1958-1973 Vineyard and Cellar Notes.* Special report 22, New York State Agricultural Experiment Station, Geneva.
13. Proebsting, E. L. and A. Sakai. 1979. Determining T-50 of peach flower buds with exotherm analysis. *HortScience* 14:597-598.
14. Rutledge, A. D. 1977. *Growing grapes in Tennessee.* Tennessee Agricultural Extension Service Pub. 718.

15. Rutledge, A. D. 1979. *Tennessee Vegetable and Small Fruit Situation.* Memograph of the Tennessee Agricultural Extension Service, Department of Plant and Soil Science, Knoxville, TN.
16. Tukey, R. B. and W. J. Clore. 1973. *Grapes—Their Characteristics and Suitability for Production in Washington.* EB 635, Washington State University Cooperative Extension Service, Pullman, Washington.
17. Wildung, D. K., C. J. Weiser, and H. M. Pellett. 1973. Temperature and moisture effects on hardening of apple roots. *HortScience* 8:53-55.

Performance of Selected Grape Cultivars Under Marginal Climatic Conditions in Tennessee. II. American Type.

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Twelve American type *(Vitis labrusca, L.)* cultivars were evaluated concurrently with the French hybrid cultivars. Climatic and cultural data were the same as given in part I.

In previous studies in Tennessee, American type cultivars excluding seedless ones were more productive and had higher yields than did French hybrid cultivars (3). Those recommended for production in Tennessee are Concord, Fredonia, Niagara, and Delaware; all American type (5).

Concord is reported to account for 80 to 90% of all production of American type cultivars (6). Although several other American type cultivars have desirable fruit characteristics, Concord is reported as most popular as it is widely adapted, vigorous, hardy, and easily trained (1). Only American type cultivars are recommended for areas having 140 to 150 frost free days in Washington (6). However, 150 to 170 frost free days are optimum for American type cultivars (6).

Oberle (4) released four American type cultivars, Alwood, Moored, Monticello, and Price, which he found to be hardy in the mountainous areas of Virginia. These cultivars had not been tested extensively when this study was initiated and were so included.

PROCEDURE

One year old plants were set at the University of Tennessee Plateau Experiment Station at Crossville in the spring of 1973. Plot design was a randomized complete block with four replications of three vine plots. Cultivars tested were Concord, Moored, Alwood, Van Buren, Niagara, Catawba, Bath, Fredonia, Moore's Early, Monticello, Yates, and Price. Plants were set 2.4 m apart in 3.0 m rows.

The training system used was a modification of the four cane Kniffin system. The modification consisted of two main trunks for each plant to help offset potential winter damage. Pruning was generally to 10 buds per cane with 12 buds per cane on more vigorous hardy plants. The less hardy vines had more severe pruning as some of the fruiting canes had considerable cane die-back. Balanced pruning was not attempted but, perhaps, the more hardy cultivars would have benefited if pruned to this concept.

At harvest, fruit color, flavor, the degree of insect damage, and firmness and other physical conditions of the

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