# APPLICATION FOR

# LANCASTER VALLEY VITICULTURAL AREA

# LANCASTER COUNTY, PENNSYLVANIA


SUBMITTED BY

R. MARTIN KEEN

CONESTOGA VINEYARDS, INC.

415 S. QUEEN ST.

LANCASTER, PA. 17603


FEBRUARY 6, 1981

The Lancaster Valley is located within Lancaster County, Pennsylvania. The valley is located in the middle third of the county and is approximately 31 miles long by 12 miles wide, running in an east-west direction. About 225,000 acres are involved in this viticutural area.

The majority of Lancaster County is in the Piedmont Province physiographic division, which is further subdivided within the county into the Piedmont Upland, Northern Piedmont Lowland, and the Lancaster-Frederick Lowland (2). The Lancaster Valley is located in the Lancaster-Frederick Lowland.

Consisting of a vast rolling plain of low relief, the Lancaster Valley averages an altitude of 400 feet. The valley decreases gently in altitude in an east to west direction, with the eastern edge at 500 feet and the western boundary along the Susquehanna River at 300 feet.

The Lancaster Valley is generally bounded by areas of higher elevation ranging from 100 to 600 feet above the valley floor. These include the Welsh Mountain (1000 feet), and the Baron Hills (800 feet) on the eastern boundary. The Gap Hill (800 feet), Mine Ridge (800 feet), Bunker Hill (540 feet), the Piedmont Upland (500 feet), and Turkey Hill (600 feet) are higher elevations along the southern boundary. Along the western boundary are the Manor Hills (600 feet), Chestnut Ridge (600 feet), Chestnut Hill (660 feet), and Chickies Ridge (620 feet). Higher elevations on the northern boundary include the Northern Piedmont Lowland (500 feet), Sporting Hill (500 feet), Kissel Hill (500 feet), Ephrata Mountain (800 feet), and Turkey Hill (840 feet).

Geologically, the Lancaster Valley is a limestone plain deposited between 425 million and 600 million years ago during the Ordovician and Cambrian periods. The limestones found in the valley include Conestoga, Beekmantown, Conococheague and Elbrook limestones, with Ledger and Vintage dolomites (4,5,6). Limestone is composed of calcium carbonate, while dolomite is a limestone containing over 21% magnesium carbonate (5). The land surrounding the Lancaster Valley is composed of rocks other than limestone, these include quartzite, phyllite, shale, schist, gneiss, and gabbro (4,5,6).

The soils found in the Lancaster Valley are typical of those derived from limestone. They are deep, well drained, highly productive soils with a high moisture holding capacity (1). Only two major soil associations, of the twelve found in Lancaster County, are in the Lancaster Valley: the Duffield-Hagerstown association and the Conestoga-Hollinger association, both limestone derived soils (1). The soils on land contiguous to the Lancaster Valley are generally of other soil associations and are not as productive, nor as deep and well drained (1).

The climate is not a factor in differentiating the Lancaster Valley from the surrounding area. Because of the lack of high mountains to block weather patterns, the climate throughout Lancaster County is relatively uniform.

The county lies in an area of prevailing westerly winds, which originate in the interior of North America. The Atlantic Ocean to the east (130 miles), represents a modifying factor and source of moisture. These conditions give a "Humid

Continental" type of climate (8). The average annual temperature is 52.1°F with the coldest month being January (30.4°F) and the warmest month July (74.0°F) (1). Based on the California system of climatic regions, the Lancaster Valley would correspond to Region III with 3100 growing degree days (3). Precipitation occurs fairly evenly throughout the year with an average of 41 inches (1).

The name Lancaster Valley is utilized by the Pennsylvania and United States Geologic Surveys to describe the region proposed in this viticultural area application (4,5,6,7). The United States Geologic Survey bulletin, Geology of the McCalls Ferry-Quarryville District, includes four of the 7.5 minute quadrangles in the Lancaster Valley: Safe Harbor, Conestoga, Quarryville, and Gap quadrangles (6). Manheim, Lititz, Columbia East, and Lancaster 7.5 minute quadrangles are covered by the Pennsylvania Geologic Survey in the Topographic and Geologic Atlas of Pennsylvania, Lancaster Quadrangle (5). The Topographic and Geologic Atlas of Pennsylvania, New Holland Quadrangle, covers the Ephrata, Terre Hill, Leola, and New Holland 7.5 minute quadrangles (4).

The main criteria that can be used to differentiate the Lancaster Valley from surrounding areas are topography, soils, and geology. The topography of the Lancaster Valley is nearly level. It is a gently rolling plain with little change in elevation. At its eastern edge the valley rises to an average of 500 feet and over a distance of 30 miles the valley descends 200 feet to an altitude of 300 feet at its western edge. The valley has areas of higher elevation and increasing slope at its boundaries that range from 100 to 600 feet above the valley floor.

Only two soil associations are found in the approximately 372 square miles of the Lancaster Valley. Both soil associations are limestone derived and have similar characteristics: deep, well drained, highly productive, with high moisture holding capacity. There are other areas in Lancaster County that contain these two soil associations, but they represent other limestone valleys. The soils bordering the Lancaster Valley are generally of other associations that are not as productive, deep, or well drained.

The topography and soils of the Lancaster Valley both result from the geology of the area. The valley is a limestone bed that has been weathered to a gently rolling plain. The hills and upland areas surrounding the Lancaster Valley are composed of harder rocks (quartzite, schist, gneiss, etc.) that are more resistant to erosion and weathering than the softer and more soluble limestones of the valley. The deep, fertile soils of the valley were formed from the insoluble and weathered products left from the decay of the parent limestones. The formation of the Lancaster Valley resulted from the presence of a large unbroken expanse of limestone.

LITERATURE CITED


1) Carey, John B. Soil Survey, Lancaster County, Pennsylvania. U.S. Dept. of Agriculture, Soil Conservation Service, Washington, D.C. (1959).

2) Fenneman, Nevin M. Physiography of Eastern United States. McGraw-Hill Book Company, Inc., New York. (1938).

3) Haeseler, Carl W. Climatic Factors and the Potential for Wine-Grape Production in Several Areas of Pennsylvania. Pa. State Univ. Agricultural Experiment Station Progress Report 303, University Park, Pa. (1970).

4) Jonas, Anna I., and George W. Stose. Topographic and GeologicaAtlas of Pennsylvania, New Holland Quadrangle, No. 178. Pa. Dept. of Internal Affairs, Harrisburg, Pa. (1926).

5) Jonas, Anna I., and George W. Stose. Topographic and Geologic Atlas of Pennsylvania, Lancaster Quadrangle, No. 168. Pa. Dept. of Internal Affairs, Harrisburg, Pa. (1930).

6) Knopf, E. B., and Anna I. Jonas. Geology of the McCalls Ferry-Quarryville District, Pennsylvania. U.S. Geologic Survey Bulletin 799, Washington, D.C. (1929).

7) Miller, B. L. Limestones of Pennsylvania, Pa. Geologic Survey Bulletin M20, Fourth Series. Pa. Dept. of Internal Affairs, Harrisburg, Pa. (1934).

8) Tukey, L. D., H. M. Kauffman, and E. V. Welser, Jr. Regional Weather Summary of Pennsylvania, Climatic Series 1, Southeastern Area. Pa. State Univ. Agricultural Experiment Station Progress Report 254, University Park, Pa. (1965).

MAPS

The appropriate maps for determining the boundaries of the Lancaster Valley Viticultural Area are seventeen U.S.G.S. maps. They are titled:

1) "Morgantown Quadrangle, Pennsylvania," 7.5 minute series

2) "Honey Brook Quadrangle, Pennsylvania," 7.5 minute series

3) "New Holland Quadrangle, Pennsylvania-Lancaster County," 7.5 minute series

4) "Gap Quadrangle, Pennsylvania-Lancaster County," 7.5 minute series

5) "Quarryville Quadrangle, Pennsylvania-Lancaster County," 7.5 minute series

6) "Conestoga Quadrangle, Pennsylvania-Lancaster County," 7.5 minute series

7) "Safe Harbor Quadrangle, Pennsylvania," 7.5 minute series

8) "Lancaster Quadrangle, Pennsylvania-Lancaster County," 7.5 minute series

9) "Columbia East Quadrangle, Pennsylvania-Lancaster County," 7.5 minute series

10) "Columbia West Quadrangle, Pennsylvania," 7.5 minute series

11) "York Haven Quadrangle, Pennsylvania," 7.5 minute series

12) "Elizabethtown Quadrangle, Pennsylvania," 7.5 minute series

13) "Manheim Quadrangle, Pennsylvania," 7.5 minute series

14) "Lititz Quadrangle, Pennsylvania," 7.5 minute series

15) "Ephrata Quadrangle, Pennsylvania-Lancaster County," 7.5 minute series

16) "Leola Quadrangle, Pennsylvania-Lancaster County," 7.5 minute series

17) "Terre Hill Quadrangle, Pennsylvania," 7.5 minute series

BOUNDARIES

The Lancaster Valley Viticultural Area is located in Lancaster County, Pennsylvania.

From the beginning point in the Morgantown Quadrangle where PA. Route 23 crosses the Lancaster and Berks County line,

1) The boundary proceeds in a southeasterly direction along the Lancaster County boundary for approximately 0.9 mile to the 500 foot contour line immediately south of the Conestoga River.

2) The boundary follows the 500 foot contour line in a southwesterly direction into the Honey Brook Quadrangle to the Caernarvon-East Earl Township boundary.

3) South for approximately 0.1 mile along the Caernarvon-East Earl Township boundary to U.S. Route 322;

4) West along U.S. Route 322 for 1.7 miles, into the New Holland Quadrangle, to the electric transmission line between Fetterville and Cedar Grove School;

5) From the electric transmission line crossing on U.S. Route 322, southwest for 2 miles in a straight line to the Rancks Church;

6) From the Rancks Church, southwest for 3.3 miles in a straight line to the Zeltenriech Church;

7) East, from the Zeltenriech Church, for 1.45 miles in a straight line to the Summitville School;

8) From the Summitville School southeast for approximately 2.2 miles in a straight line to the intersection of East Earl, Earl, Leacock, and Salisbury Townships on Peters Road;

9) From Peters Road due east for approximately 4.9 miles, into the Honey Brook Quadrangle, to the 500 foot contour line just east of the Pequea Creek;

10) Follow the 500 foot contour line south to the Lancaster County boundary.

11) The boundary extends 1.4 miles southwesterly along the Lancaster County line to the 500 foot contour line east of Cole Hill.

12) The boundary follows the 500 foot contour line in a southwesterly direction into the New Holland Quadrangle, thence into the Gap Quadrangle, passing through the town of Gap and along the base of Mine Ridge to the 76°07'30" west longitude line forming the division between the Gap and Quarryville Quadrangles;

13) From the intersection of the 500 foot contour line and 76°07'30" west longitude in the Quarryville Quadrangle, the boundary extends west for 1.2 miles in a straight line to the intersection of Calamus Run and the Paradise-Strasburg Townships boundary.

14) The boundary extends for approximately 4 miles west in a straight line from Calamus Run to the Walnut Run School;

15) West from the Walnut Run School in a straight line for 2.5 miles to the Boehm Church in the Conestoga Quadrangle;

16) Northwest from the Boehm Church in a straight line for 1.2 miles to the Township School in West Willow;

17) West from the Township School in West Willow in a straight line for 4.2 miles to the dam on the Conestoga River at Rockhill;

18) Northwest from the dam at Rockhill in a straight line for 0.5 mile to the confluence of Indian Run and Little Conestoga Creek;

19) Follow Indian Run upstream (west), into the Safe Harbor Quadrangle, for approximately 3.6 miles, following the more northern branch to its source;

20) From the source of the more northern branch of Indian Run, northwest in a straight line for approximately 0.25 mile to the source of Wisslers Run;

21) Follow Wisslers Run downstream (west) for approximately 0.7 mile to the 300 foot contour line;

22) Follow the 300 foot contour line northward to the southern boundary of Washington Boro;

23) Continue northward along the eastern boundary of Washington Boro, into the Columbia East Quadrangle, to the northeast corner of Washington Boro;

24) From the northeast corner of Washington Boro, due east for 2.5 miles to the Camp Meeting Grounds northwest of Central Manor;

25) From the Camp Meeting Grounds northwest for 1.2 miles to the Manor Church;

26) From the Manor Church, due north for approximately 0.75 mile to the Manor-West Hempfield Townships boundary;

27) From the Manor Township boundary due east for approximately 1.1 miles to the West Branch of the Little Conestoga Creek.

28) The boundary follows the West Branch of the Little Conestoga Creek north to PA. Route 462;

29) From the West Branch of the Little Conestoga Creek, west along PA. Route 462 for approximately 1.5 miles to Strickler Run.

30) The boundary follows Strickler Run southwest (downstream) to the Columbia Boro boundary;

31) Follow the eastern boundary of Columbia Boro north to Shawnee Run;

32) From the intersection of the Columbia Boro boundary and Shawnee Run, northeast for approximately 5.8 miles to the intersection of Marietta Pike, PA. Route 23 and Running Pump Road;

33) From Running Pump Road east along the Marietta Pike, PA. Route 23, into the Lancaster Quadrangle, for approximately 0.5 mile to the 400 foot contour line;

34) Follow the 400 foot contour line north around Chestnut Ridge, back into the Columbia East Quadrangle, crossing Millers Run and Centerville Road. Continue on the contour line west and then south until it crosses an unnamed stream;

35) From the contour line crossing the unnamed stream, due south for approximately 0.2 mile to the East Hempfield-West Hempfield Townships boundary;

36) Follow the East Hempfield-West Hempfield Townships boundary southeast for approximately 0.8 mile to the Marietta Pike, PA. Route 23, at Oyster Point;

37) Follow the Marietta Pike, PA. Route 23, west into the Columbia West Quadrangle to PA. Route 441;

38) Follow PA. Route 441 west into the York Haven Quadrangle to the elevation check point of 309 feet in the town of Bainbridge;

39) From the elevation check point in Bainbridge, northwest in a straight line for approximately 5.6 miles, through the Columbia West Quadrangle and into the Elizabethtown Quadrangle, to the quarry 0.2 mile north of Rheems;

40) From the quarry north of Rheems, east in a straight line for approximately 3.1 miles to the Mt. Pleasant Church;

41) From the Mt. Pleasant Church southeast in a straight line for approximately 1.0 mile, into the Manheim Quadrangle, to the confluence of the Little Chickies Creek and Back Run;

42) From the confluence of Back Run and Little Chickies Creek, due east for approximately 2.4 miles to an electric transmission line;

43) Continue east along the electric transmission line to PA. Route 72 and a 400 foot contour line;

44) Follow the 400 foot contour line east into the Lititz Quadrangle, crossing the Fruitville Pike to PA. Route 501;

45) From PA. Route 501 east in a straight line for approximately 2.9 miles to the Union Meetinghouse;

46) From the Union Meetinghouse southeast in a straight line for 1.2 miles, through the Ephrata Quadrangle and into the Leola Quadrangle, to where the Cocalico Creek is crossed by the Oregon Pike, PA. Route 272;

47) Follow the Cocalico Creek southeast (downstream) to its confluence with the Conestoga River;

48) Follow the Conestoga River northeast (upstream) to PA. Route 772;

49) From the Conestoga River, northwest on PA. Route 772, into the Ephrata Quadrangle, to the Cocalico Creek;

50) From the Cocalico Creek and PA. Route 772, northeast in a straight line for approximately 1.0 mile to the southwestern corner of the Akron Boro boundary;

51) Follow the southern boundary of Akron Boro in a northeasterly direction to the Ephrata-West Earl Townships line;

52) Follow the Ephrata-West Earl Township boundary east to U.S. Route 322;

53) From U.S. Route 322, east in a straight line for approximately 3.5 miles to the Lincoln Independence School in the Terre Hill Quadrangle;

54) From the Lincoln Independence School south in a straight line for approximately 1.0 mile to the crossroad at Martindale;

55) From Martindale east in a straight line for approximately 1.7 miles to the southwest corner of the Terre Hill Boro boundary;

56) Follow the southern boundary of Terre Hill Boro east to PA. Route 897;

57) From PA. Route 897 east in a straight line for approximately 4.0 miles to the Smoketown School in the Morgantown Quadrangle;

58) From the Smoketown School east in a straight line to the starting point.

CONESTOGA VINEYARDS INC.
C.V.

[redacted]

415 S. QUEEN STREET
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*FINE TABLE WINES*

Mr. Charles N. Bacon
Research and Regulations Branch
Bureau of Alcohol, Tobacco and Firearms
Washington, D.C. 20226

April 14, 1981

Dear Mr. Bacon

Enclosed is a copy of Climatic Factors and the Potential for Wine-Grape Production in Several Areas of Pennsylvania. I hope this publication will help to answer some of the questions you might have.

At the present time the Lancaster Valley contains 41.5 acres of wine grapes. There are two wineries located within the proposed Lancaster Valley Viticultural Area. Nissley Vineyards (R.D. #1, Bainbridge, Pa. 17502) produces approximately 30,000 gallons per year with Conestoga Vineyards (415 South Queen Street, Lancaster, Pa. 17603) producing 10,000 gallons per year. Both wineries grow wine grapes within the Lancaster Valley and purchase grapes from growers within and outside the proposed viticultural area. Within Lancaster County, excluding the Lancaster Valley, there are 68.5 acres of wine grapes grown.

If you have any more questions regarding the proposed Lancaster Valley Viticultural Area please feel free to contact me.

Sincerely,

R. Martin Keen

R. Martin Keen

*PENNSYLVANIA'S OLDEST WINERY*

Progress Report 303, January, 1970

# Climatic Factors and the Potential for Wine-Grape Production in Several Areas of Pennsylvania

The Pennsylvania State University, College of Agriculture, Agricultural Experiment Station, University Park, Pennsylvania

# Climatic Factors and the Potential for Wine-Grape Production in Several Areas of Pennsylvania

Carl W. Haeseler

The phrase "Wine-Grape Industry in Pennsylvania" has acquired considerable significance since the passage of House Bill 1274 in 1968. This bill permits the sale of table wine at the winery provided annual wine production by a given winery does not exceed 50,000 gallons per year. Now that the wine industry will be on its way – with wineries planned for Erie County, in addition to Conestoga Winery in Chester County – it seems appropriate to look into other areas of the Commonwealth to determine if areas other than Erie and Chester Counties are suitable for the production of wine grapes. Since there are well-established commercial fruit areas in south central and southeastern Pennsylvania, this discussion will be limited to locations within those areas. However, this does not and is not meant to preclude other areas of Pennsylvania that may show promise.

## Development of Pennsylvania's Grape Industry

Is wine-grape production new to Pennsylvania? Several (2, 3, 6) have written about the journey of the grape in eastern United States. According to these accounts, in the mid 1600's Queen Christina of Sweden instructed John Printz, Governor of New Sweden, "to encourage culture of the vine and give it his personal attention." The area of New Sweden currently would include Delaware County in Pennsylvania and the Wilmington area of Delaware. Shortly after acquiring his colony in the area of Philadelphia, William Penn imported grape cuttings from France and Spain and established several experimental vineyards in the Philadelphia area. These experiments were not successful. In fact it wasn't until the 1790's that any success was achieved with the European grape in Pennsylvania. This was accomplished by Peter Legaux, a Frenchman, who founded a company for the cultivation of the grape in 1793. His four-acre vineyard was located in Spring Mill, Pa., thirteen miles northwest of Philadelphia on the Schuylkill River. In spite of his ability as a vineyardist, he was successful with only one variety which he called the Cape Grape or Cape Madiera. Actually, this variety was determined to be a cross between a European and American grape and was named Alexander (6). However, Legaux was the chief disseminator of the first distinctive commercial American grape variety, and he was responsible for the early success of the wine grape in Pennsylvania. About that time other vineyards were planted around Middletown, Pa., and in the early 1800's the Harmonists, immigrants from Germany, attempted to grow grapes around Pittsburgh, but they failed.

York, Pa., has been credited with being one of the first, if not the first, extensive center of native grape production in America (6). In 1818 Thomas Eichelberger set out four acres of grapes, primarily the Alexander, and by 1826 there were about 150 acres of grapes in and around York. Adams, Chester, Lancaster, and Westmoreland Counties also had acreages planted in grapes. The Alexander grape eventually was replaced by the Catawba and Isabella varieties. It is reported that the grape industry in this area finally succumbed to diseases, yet York and Lancaster Counties are considered among the starting places of American viticulture.

The main causes of failure of the Old World grape were *Phylloxera vastatrix* (a soil-borne root louse), mildews, black rot, and – quite likely – low winter temperatures. Hedrick (6) stated, "Our northern climate is not well-suited to production of the Old World grape. As a species *Vitis vinifera* thrive best in climates equable in both temperature and humidity. The climate of eastern America is not equable."

Grape growing ventured from the York area into the Finger Lakes section of New York in 1830 when the Rev. William Bostwick planted the first vines at Hammondsport. Commercial grape production actually started in that area around 1853 when Andrew Reisinger, a German vintner, set out Catawba and Isabella vines in Harmonyville, a few miles north of Hammondsport.

Prior to this time, in 1818, the Rev. Elijah Fay from Southborough, Mass., set out his "Fox" grape in Brocton, New York, along the southern shore of Lake Erie. This variety was unproductive. Commercial grape growing really did not start in the lake area until around 1824.

The first grape vines in North East, Pennsylvania, were set out in 1850 by Messrs. Hammond and Griffith. The South Shore Winery was established in 1869 and lasted until 1914 or 1915, at which time its stock was sold to Grimshaw's Winery on Orchard Beach Road in North East. The latter winery was forced to close as a result of the 1917 prohibition legislation. Until recently, no wineries have been established in this area since prohibition.

What is the potential for wine grapes in Pennsylvania? Recently, D. P. Moorhead expressed his enthusiasm for wine-grape production in Pennsylvania (11). In addition, he described the more promising wine-grape varieties in considerable detail.

## Climate's Role in Wine-Grape Production

In the establishment of any fruit planting, selection of a suitable site will (in the long run) prevent the occurrence of many problems. Site selection is closely associated with climate, and production problems increase as climate becomes less favorable. This paper is primarily concerned with climatic factors in grape production.

Climatic factors considered for the various areas of Pennsylvania were heat units, mean monthly temperatures, dates of last spring and first fall frosts, temperatures during bloom, solar radiation, hours of sunshine, lowest minimum temperature, expected winter minimum temperatures, frequency of exposure to temperatures of −5 F or lower, wind velocity, rainfall, snowfall, and relative humidity as reflected in U. S. Weather Bureau summaries. Data relative to those factors reflect a general climatic condition rather than a localized or site situation. Therefore, they cannot be considered to be specific for any given area or site, except in the immediate vicinity where they were recorded. Nevertheless, they do provide a base for determining the general climate.

Heat units usually are expressed as the number of growing-degree days, with 50 F as base. To calculate the number of degree days for any given day, find the daily mean temperature by adding the maximum and minimum temperatures for that day and dividing by two. Then, subtract the base temperature (50 F) from this value to obtain the number of growing-degree days for any given day. For example, assume a maximum temperature of 80 F and a minimum temperature of 60 F. The daily mean temperature would be $(80 + 60)/2$ or 70 F. Therefore, the number of growing-degree days with a base of 50 F would be 70 minus 50 or 20. These values are then totaled for the duration desired.

Winkler (21) emphasized the importance of heat units (growing-degree days) from April 1 to October 1. For western conditions this criterion is extremely valuable. However, history has shown that in the east factors in addition to heat units must be considered (6). The New York Agricultural Experiment Station has conducted trials with *Vitis vinifera*

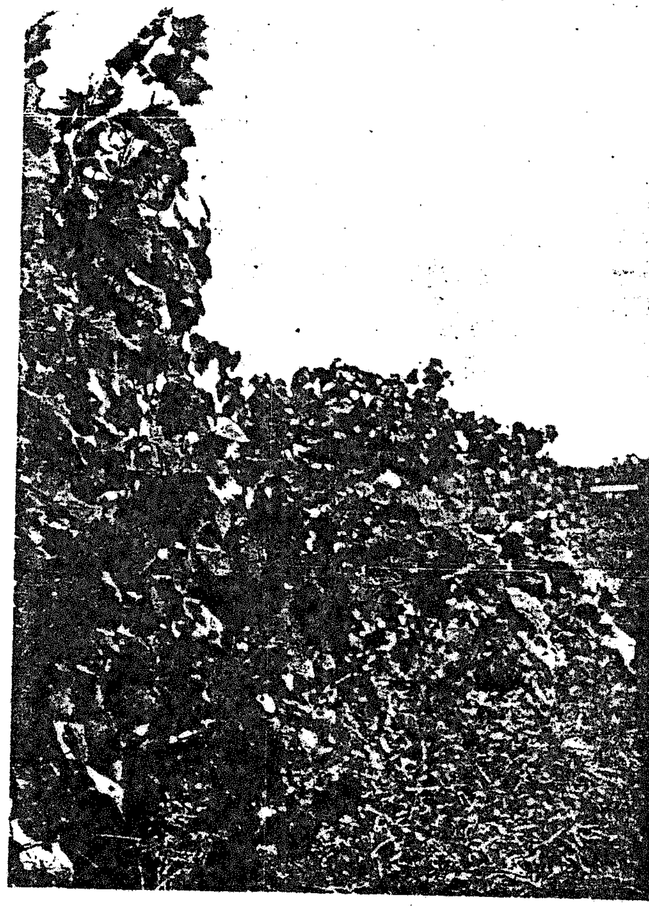

Table 1. Growing degree days, frost dates, winter minimum temperatures, and maximum temperatures during bloom for Erie and several prospective wine-grape areas of Pennsylvania.

| Area of Commonwealth | Growing-Degree Days for Grapes (Base 50 F) from 5 Apr-25 Oct | Blm to Hvst Min | Blm to Hvst Max | Temperatures (F) Record Min Temp | Range of Expected Minimum | Record High at Bloom | Range of Expected Maximum at Bloom | Mean Frost Dates Range Last in Spring (32 F) | First in Fall (24 F) |
|---|---|---|---|---|---|---|---|---|---|
| 1. South Central | | | | (F) | (F) | (F) | (F) | | |
| a. Gettysburg | 3438 | 2531 | 2670 | −14 | 11 to 34 | 99 | 83 to 94 | 11 Apr-1 May | 6 Nov-30 Nov |
| b. York | 3406 | 2450 | 2606 | −15 | 8 to 34 | 99 | 84 to 95 | 19 Apr-11 May | 28 Oct-19 Nov |
| 2. Southeast | | | | | | | | | |
| a. Bethlehem | 3361 | 2400 | 2764 | −13 | 14 to 30 | 100 | 83 to 92 | 3 Apr-26 Apr | 15 Nov-6 Dec |
| b. George School | 3236 | 2415 | 2692 | −16 | 13 to 30 | 98 | 84 to 91 | 13 Apr-5 May | 1 Nov-23 Nov |
| c. Lancaster | 3137 | 2296 | 2418 | −18 | 10 to 28 | 99 | 85 to 92 | 22 Apr-14 May | 26 Oct-17 Nov |
| d. Philadelphia | 3570 | 2738 | 2805 | −12 | 15 to 31 | 99 | 85 to 92 | 7 Apr-28 Apr | 9 Nov-4 Dec |
| 3. Northwest | | | | | | | | | |
| a. Erie | 2644 | 1618 | 2078 | −15 | 7 to 29 | 93 | 84 to 92 | 16 Apr-24 May | 28 Oct-1 Dec |

(Adapted from references 16, 17, 20.)

and has had poor success in this area up to the present time (1, 7). The primary obstacles, initially, were diseases and grape phylloxera. In later years, after phylloxera-resistant rootstocks became available and technology for controlling diseases was developed, the greatest difficulty resulted from occurrence of winter injury (1, 7). Only in the last fifteen years or so has any success been attained in growing *V. vinifera* commercially (4). The largest acreages of *V. vinifera* are located in the Gold Seal Vineyards and in the vineyards of Vinifera Wine Cellars near Hammondsport, New York. In the last few years, perhaps fifteen or twenty acres of this species have been planted in Erie County, Pennsylvania. The greater portion of wine varieties planted to date, however, are native varieties and French hybrids, some of which are more resistant than *V. vinifera* to low winter temperatures.

Data for growing-degree days, except for Erie, cover a period of twenty-nine years (Table 1). The Erie data are for the past sixteen years. For the areas indicated, all locations have a sufficient number of growing-degree days during the growing season for the production of wine grapes. In fact, the south central and southeastern areas appear to be better in this respect than the Erie area. When compared with data presented by Winkler, only Algeria, Italy, and California have areas that exceed the selected areas of Pennsylvania in heat units (21).

**Mean temperature** during two periods of the growing season is another criterion used to assess potential vineyard areas (7). Hedrick stated that ideal temperature conditions for the grape for the period of May, June, and July are when the average is between 55 and 65 F. For the period of August, September, and October, he stated the average temperature should fall between 65 and 75 F. Average temperatures for the first-named period for Erie, Pa., and Trier, Germany, fall within the 55 to 65 F range whereas that for York, Pa., is slightly higher than the ideal stipulated by Hedrick (Fig. 1). On the other hand, York has an average temperature for the period of August, September, and October that is within the 65 to 75F range whereas Erie's average temperature for that same period is slightly under the ideal. The average temperature for Trier, Germany, is well below the 65 to 75 F range for the maturing months of August, September, and October.

The warmer temperatures experienced in York may be advantageous for fruit maturation. On the other

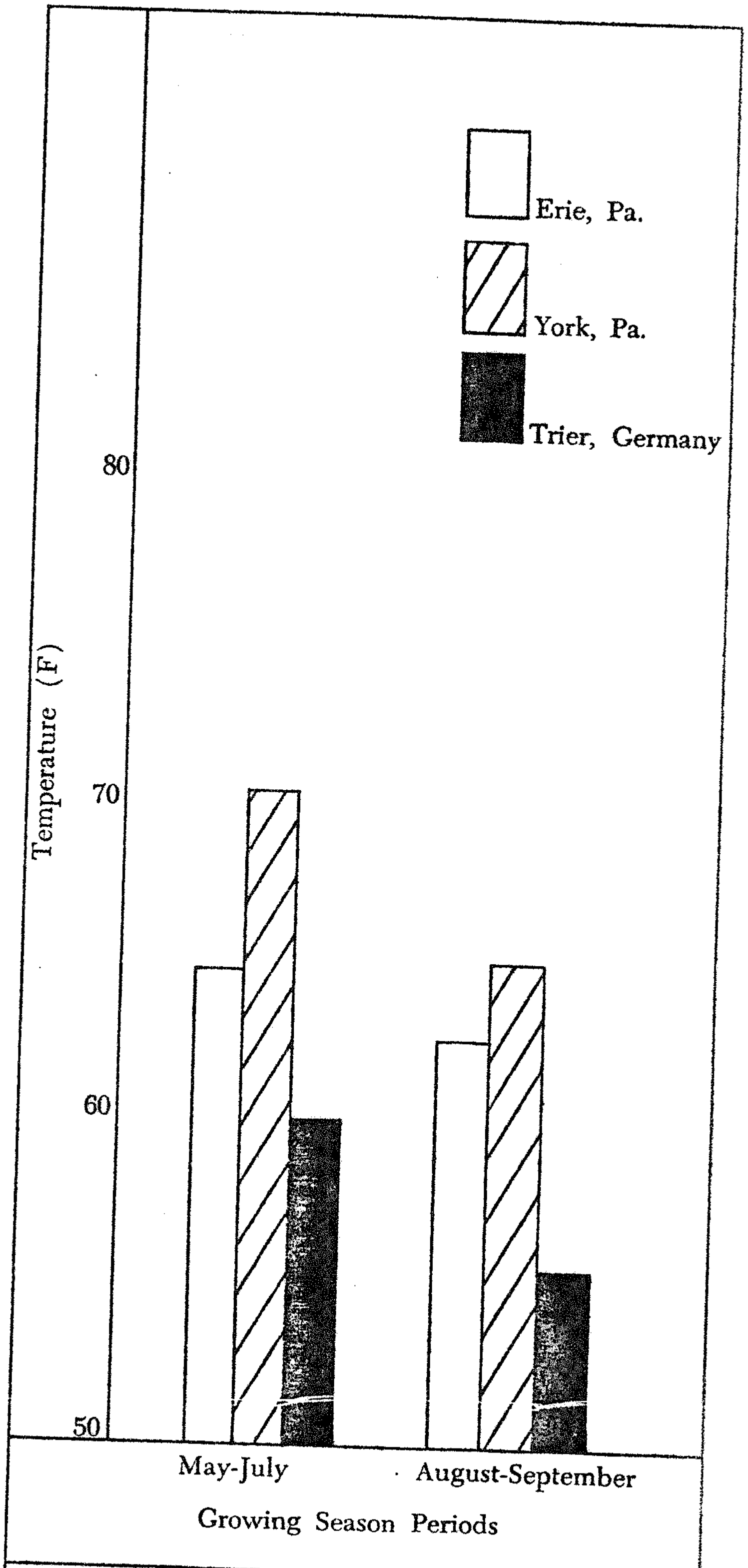


**Figure 1.** Average temperatures for two periods during the growing season (May-Jul and Aug-Oct) for Erie and York, Pennsylvania, and Trier, Germany. Source of data for Trier: Winkler (21).

hand, warm temperatures during April and early May might force bud-break too early. If this should happen, the risk of crop loss due to spring frost could be greater than in the Erie area. Warm temperatures, also, may be important from the standpoint of increased insect activity and disease occurrence.

When compared to data of one of the principal wine-producing areas of Germany, both Erie and York have higher growing-season temperatures than Trier (12).

Spring and fall frost expectancies, as for any fruit crop, are of utmost importance when selecting a site for wine-grape production (Table 1). Expected ranges for the date of the last spring frost in southern Pennsylvania seem favorable, providing bud-break and subsequent shoot growth do not occur to any great degree during April and the first part of May. The data indicate, also, that the Erie area can expect frost until the latter part of May. However, the data for Erie are the actual extremes experienced. A total crop loss due to low temperature has not been experienced in the lake area since 1945.

The average date for the last spring frost at Penn Yan, N.Y., is May 13th (19) while that for the Erie area is April 20th (20). For the other Pennsylvania areas, the latest average for the last spring frost is May 4th in Lancaster (17). Loss due to spring frost, although an important factor, probably will not be as significant as some other factors discussed later in this publication.

Grapes, when mature, usually will endure temperatures of 25 F, provided exposure is not too long (about 5 hours). Therefore, the mean date when fall temperatures first reach 24 F should give some indication of whether or not wine grapes will mature fully in a given location (Table 1). Evaluation of first occurrence of early fall temperatures of 24 F is difficult as proper evaluation is dependent on other factors – such as bloom date and rate of maturation during the growing season. When bloom period occurs prior to or about the same time as in Erie, this factor probably will seldom be significant. For example, the average first occurrence of 24 F in the fall for Penn Yan, N.Y., is November 3rd (19) whereas the earliest average first occurrence of 24 F in the areas considered in Pennsylvania is November 6th for Lancaster (17) and not until November 30th for Erie (20).

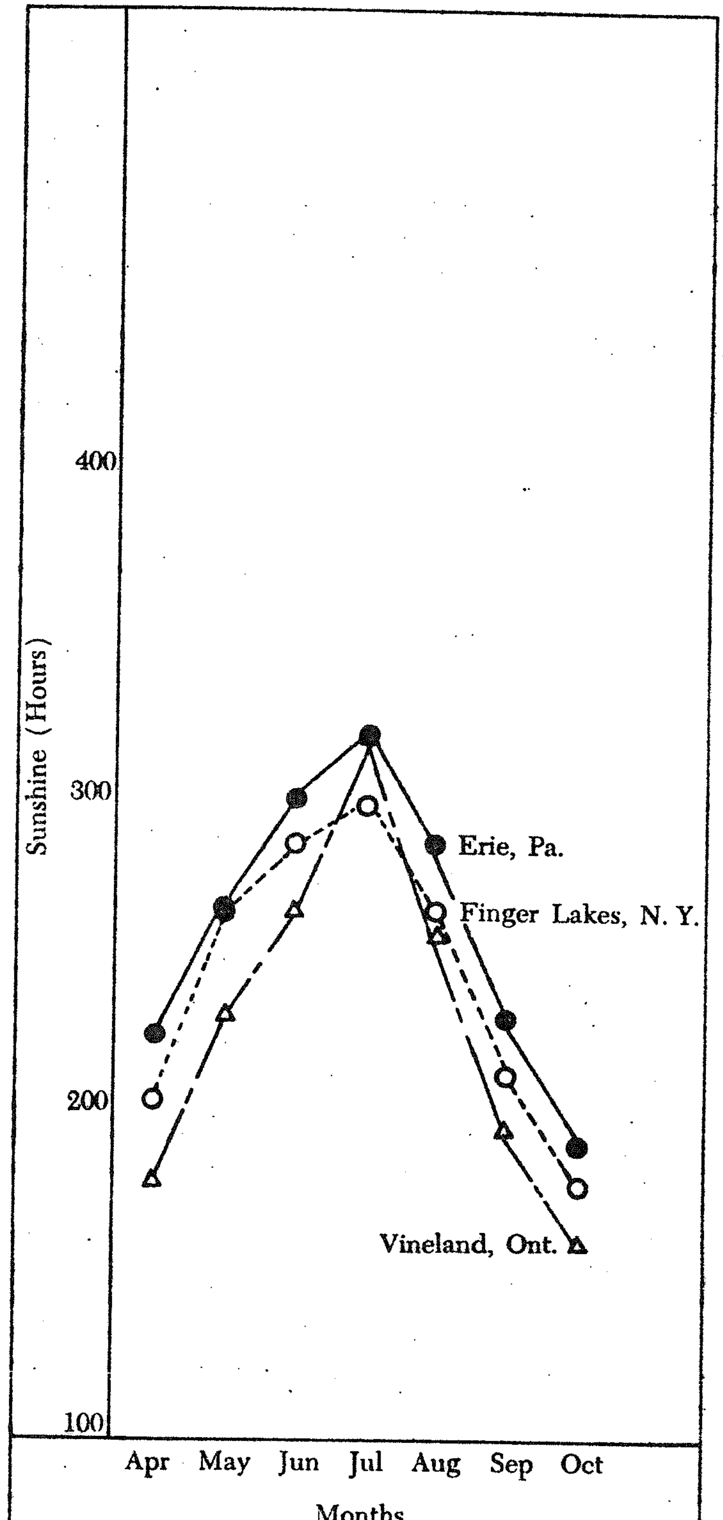


Figure 2. Mean monthly hours of sunshine from April through October for Erie, Pennsylvania, Finger Lakes area of New York, and Vineland, Ontario. Source of data for Vineland: Mercier (10).

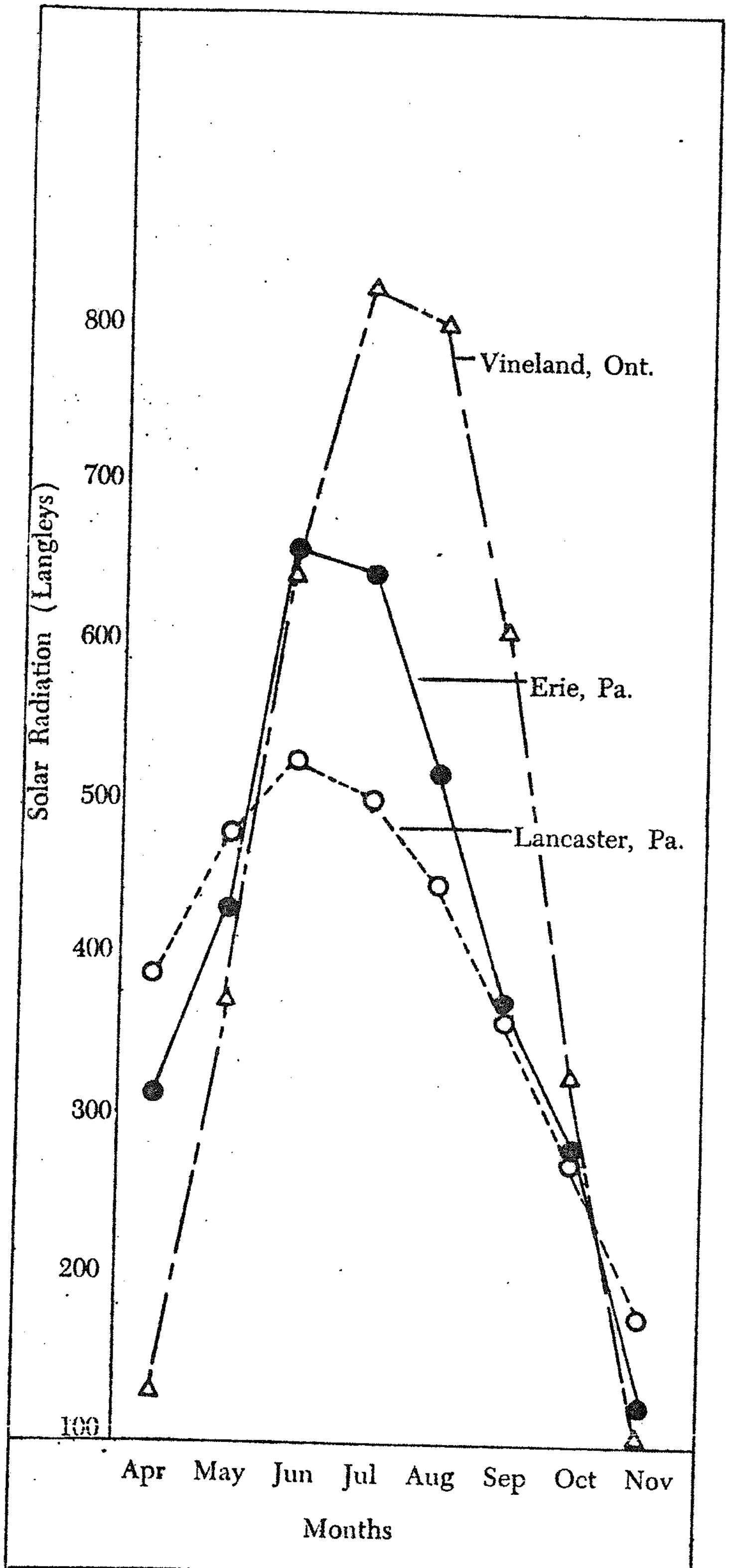


**Figure 3.** Mean solar radiation from April through October for Erie and Lancaster, Pennsylvania, and Vineland, Ontario. Source of data for Vineland: Mercier (10).

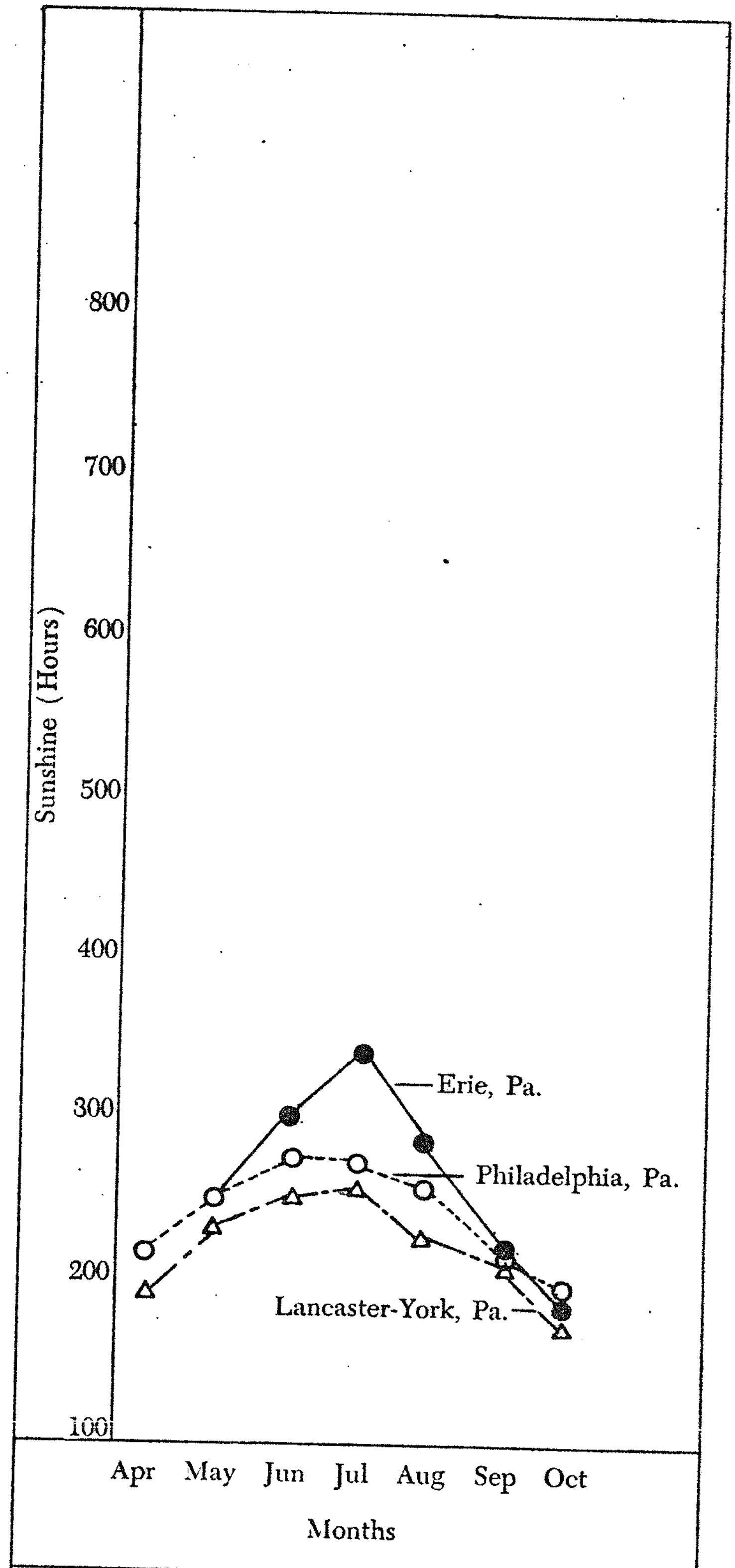


**Figure 4.** Mean monthly hours of sunshine from April through October for Erie, Philadelphia, Lancaster and York, Pennsylvania.

**Temperature extremes during bloom** have caused crop failure in grapes as well as other fruit crops. Usually, loss was attributed to low temperatures prior to or during bloom. In 1908 Hedrick (6) stated that high temperatures during bloom (90 F or above) could be responsible for crop loss. Subsequent research (5, 9, 15) has substantiated Hedrick's observations. Also, uneven ripening of Concord grapes has been related to high temperatures during bloom (5). The expected high-temperature ranges during bloom and the highest temperature experienced during the bloom period are in the range of 90 F or higher (Table 1). This could be a factor with respect to yield and maturity. However, the differences in expected ranges among the areas in Pennsylvania are not particularly large. Also, wine varieties may not be adversely affected by high temperatures during the bloom period as Concord vines have been in the warmer areas of the United States (1). Erie's highest temperature during bloom is lower than the other areas under consideration, and in the lake area, cool temperatures during bloom have been more harmful than high temperatures. Temperature extremes during the bloom period are important.

**Solar radiation and hours of sunshine** during the growing season are related to growing-degree days and mean monthly temperatures. Hedrick (6) stated that sunshine is especially important during the fruit maturation period. More recently, training the vines so as to take advantage of solar radiation has been emphasized, not only during the fruit maturation period, but also during the early season (8, 13). Data for solar radiation and hours of sunshine are presented in Figures 2, 3, and 4. The number of hours of sunshine received in the major eastern grape-growing areas of the United States and Vineland, Ontario are nearly identical during the growing season (Fig. 2). As far as solar radiation is concerned, Vineland accumulates a greater amount of solar radiation than Erie during July, August, and September (Fig. 3). Yet, the Lake Erie area receives more sunshine (Fig. 4) and solar radiation (Fig. 3) during June, July and August than the Lancaster, York, and Philadelphia areas (Fig. 4).

The importance of these factors has been questioned by Winkler (21). He stated that under California conditions, heat units are more closely related than solar radiation to wine quality. The significance of these factors under Pennsylvania conditions could

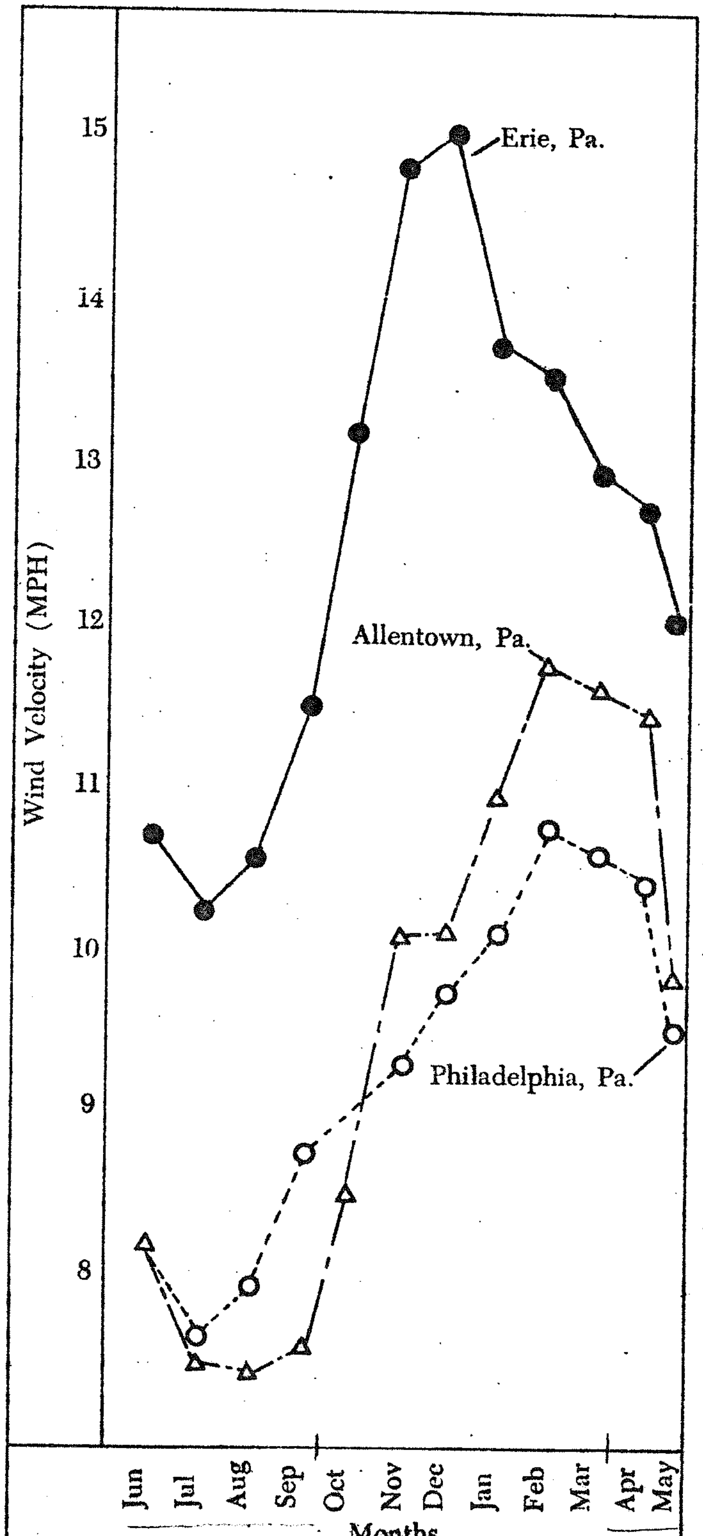


**Figure 5.** Mean monthly wind velocities for Erie, Allentown, and Philadelphia, Pennsylvania.

be ascertained by research. At this time solar radiation and hours of sunshine during the growing season are not expected to be factors that limit the expansion of wine-grape production in Pennsylvania.

**Lowest temperature** on record and frequency of exposure to –5 F or lower are criteria of considerable importance as many wine-grape varieties are seriously damaged when exposed to temperatures of –10 F (14). All of the areas of Pennsylvania considered in this publication have experienced winter temperatures below –10 F (Table 1). Shaulis and Einset (14) used frequency of exposure to –5 F or lower as a criterion for evaluating prospective wine-grape sites in New York State. It is in this category where definite differences occur within Pennsylvania (Table 2). From these data it is evident that in the last sixteen years, the Erie area has been exposed to temperatures of –5 F or lower considerably less frequently than Lancaster, York, and George School. On the other hand, the Philadelphia, Bethlehem, and Gettysburg areas compare favorably with the lake shore in this respect. Shaulis et al. (14) have reported lowest temperatures and frequency of exposure to –5 F or lower for Penn Yan, Westfield, and Fredonia, N.Y., for the past sixteen years. The lowest temperatures reported for these areas were as follows: Westfield, – 15 F; Fredonia, –18 F; and Penn Yan, –21 F. Lowest winter minimums for the principal German wine areas, Trier and Geisenheim, were +9 F and –9 F, respectively, from 1899 to 1949 (12). Frequency of exposure to –5 F or lower for these New York areas for that same period were Westfield 10, Fredonia 23, and Penn Yan 23. Several areas of Pennsylvania (Erie, Bethlehem, Philadelphia, and Gettysburg) compare favorably with Westfield, N.Y. in terms of frequency of exposure to temperatures of –5 F or lower (Table 2). None has as favorable winter temperatures as those in the principal vineyard areas

Table 2. Frequency of exposure to temperatures of –5 F or lower in selected areas of Pennsylvania (1952 to 1968).

| Location | No. Times at or Below –5 F |
|---|---|
| Philadelphia | 1 |
| Bethlehem | 6 |
| Erie | 6 |
| Gettysburg | 9 |
| Lancaster | 19 |
| George School | 21 |
| York | 28 |

Example: A 20 F temperature at a wind velocity of 15 mph is equivalent in chilling effect to a still-air temperature of –5 F.

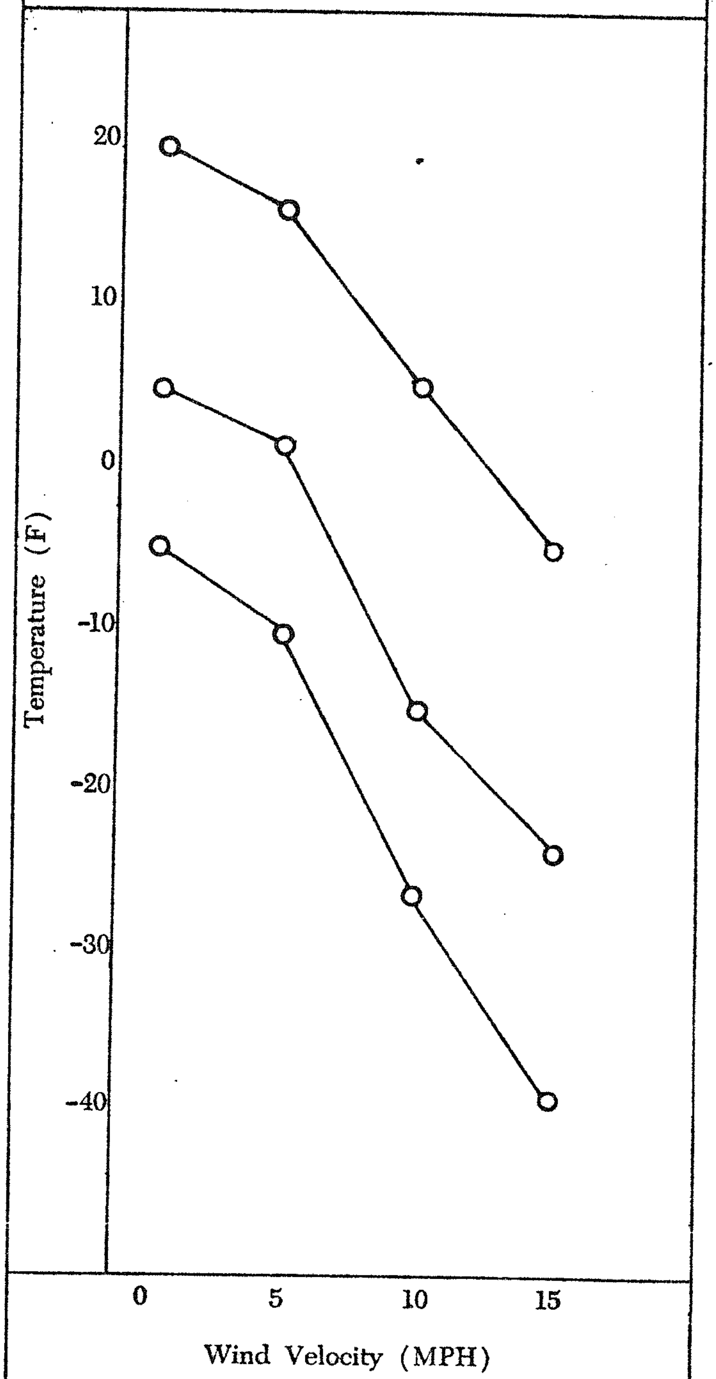


**Figure 6.** Wind-chill indexes for selected temperatures for human beings. Source of data: Eastern Regional newsletter, U. S. Weather Bureau *Cooperative Observer* for 1966. 4(4):7.

of Germany. Other areas of Pennsylvania are similar to the Fredonia and Penn Yan areas of New York. Therefore, it appears that winter minimum temperatures pose the greatest threat, culturally, to the expansion of wine-grape production, especially of V. *vinifera,* in Pennsylvania.

Cold injury, alone, can be devastating, but it also may lead to Crown Gall infections. This bacterial disease is caused by the organism *Agrobacterium tumefaciens* (Smith & Town) Conn. and gains entrance through injured tissue. As a result, considerable difficulty in maintaining vine vigor and production may be experienced, especially in locations where soils become cold and wet.

**Air movement** is a factor in disease incidence during the growing season. In the Lake Erie area, air movement has been credited as being a major factor in the relative ease with which grape diseases have been controlled (7). Average wind velocity is approximately 5 mph greater in the lake area than in southeastern and south central Pennsylvania (Fig. 5).

Conversely, wind velocity in the winter months may be responsible for greater occurrence of winter damage to grapes than would be experienced at equal temperatures with relatively little wind. If the wind-chill indexes that have been determined for man are applicable to grapes, wind may play a significant role in winter survival of grapevines (Fig. 6). Observations in the Finger Lakes area of New York State (1967-68) substantiate the wind-chill index to some degree. Considerable observation will be necessary to determine the impact of the wind-chill factor on winter survival of wine grapevines.

**Rainfall** during the growing season in southern Pennsylvania is higher than for the Erie area (Fig. 7). Even in the grape belt of Pennsylvania, the amount of rainfall is higher than in Trier, Germany (12). The Vineland, Ontario, grape district receives about the

Table 3. Average snowfall from 1957 to 1968 for Philadelphia, Lancaster, Gettysburg, and Erie, Pennsylvania.

| Location | Inches of Snowfall | | |
|---|---|---|---|
| | December | January | February |
| Philadelphia | 3.7 | 5.5 | 5.9 |
| Lancaster | 4.6 | 7.0 | 7.3 |
| Gettysburg | 4.6 | 6.9 | 6.2 |
| Erie | 21.6 | 20.1 | 14.2 |

(References 15, 17, 20).

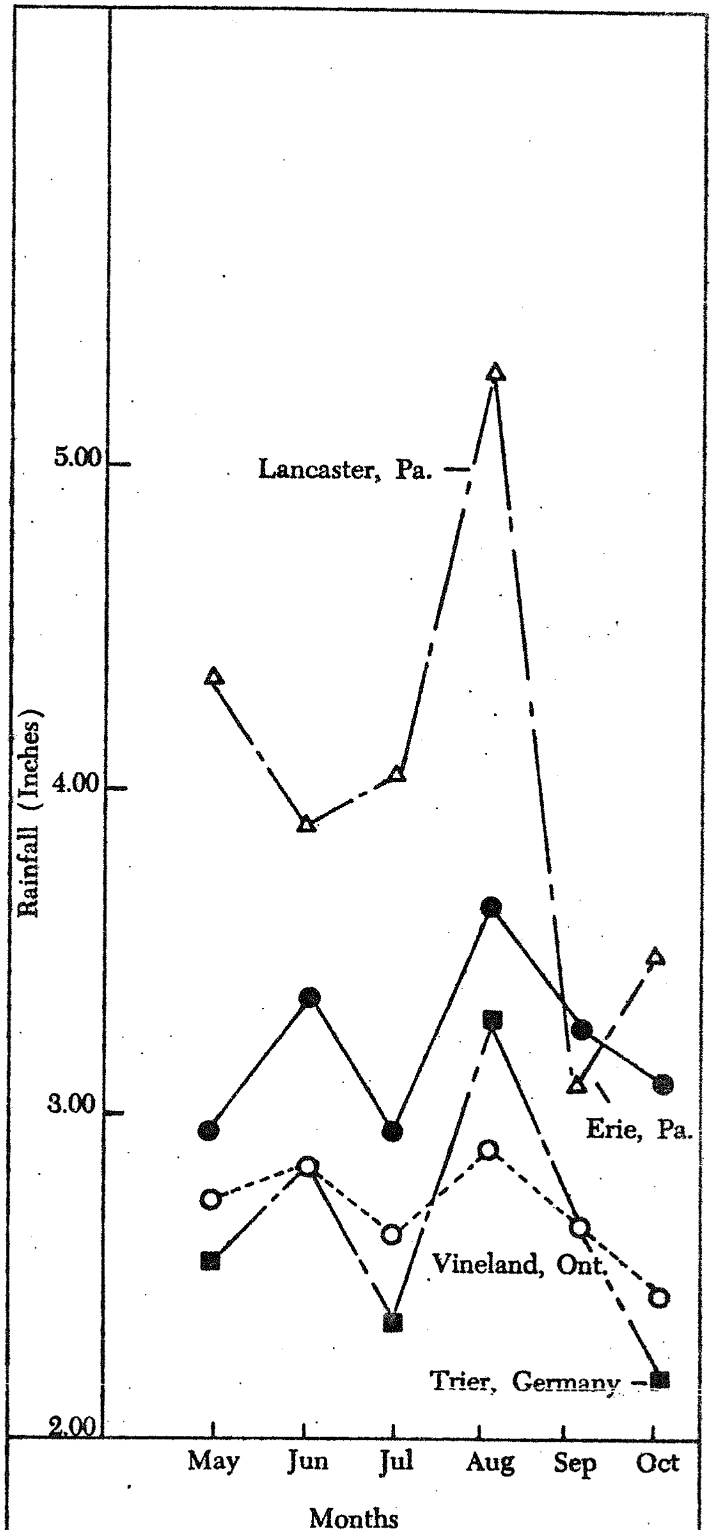


Figure 7. Mean monthly rainfall from May through October for Lancaster and Erie, Pennsylvania, Vineland, Ontario, and Trier, Germany. Source of data for Vineland (10) and Trier (12).

same amount of rainfall as the Geisenheim and Trier areas (10). Southern Pennsylvania receives nearly double the rainfall of these two German wine-grape areas (16, 17). Therefore, it appears that the incidence of disease in southern Pennsylvania could be higher than in the presently established grape areas. In addition, rainfall in southern Pennsylvania during July and August could have some adverse effects on juice quality and wood maturation.

**Snow cover** could have a favorable influence on winter survival of wine-grape varieties. Erie, in the past sixteen years, received from two to five times the amount of snow during December, January, and February than did southeastern and south central Pennsylvania (Table 3). From these data, it would seem the Erie area should receive some protection as a result of snow cover. However, the wind factor may alter snow cover significantly. The probability of winter protection by snow cover is considerably less for the other areas of Pennsylvania. Yet, snow protection appears as good as or better in Pennsylvania than in the Trier and Geisenheim areas of Germany (12).

Dependable protection of grapevines from winter minimum temperatures by snow cover is speculative for all fruit areas of Pennsylvania.

**Relative humidity** values are obtainable from most first-order weather bureau stations. The data reflect only small differences in relative humidity values among the various areas of Pennsylvania, at least during the growing season (Table 4). Differences are apparent during the winter months, with Erie having higher relative humidity values than other parts of the state. It could be hypothesized that Erie will have

Table 4. Mean relative humidity values reported for Trier and Geisenheim, Germany, and several potential wine-grape areas in Pennsylvania.

| Location | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Trier, Germany | 84 | 81 | 75 | 69 | 69 | 69 | 71 | 74 | 79 | 83 | 84 | 85 |
| Geisenheim, Germany | 84 | 81 | 74 | 68 | 68 | 69 | 71 | 74 | 79 | 84 | 84 | 86 |
| Erie, Pa. | 74 | 76 | 73 | 69 | 66 | 68 | 69 | 73 | 73 | 68 | 71 | 74 |
| Allentown, Pa. | 69 | 68 | 66 | 63 | 66 | 66 | 68 | 73 | 75 | 73 | 71 | 73 |
| Philadelphia, Pa. | 67 | 64 | 63 | 61 | 64 | 67 | 70 | 70 | 72 | 70 | 67 | 68 |
| Harrisburg, Pa. | 64 | 63 | 61 | 59 | 63 | 64 | 66 | 69 | 72 | 69 | 68 | 67 |

Adapted from References 12, 16, 17

less winter injury because of this fact. However, data to reject or to substantiate this hypothesis is lacking. As indicated earlier, Erie has considerably more wind to contend with than southern Pennsylvania and this factor may offset any beneficial effect of relative humidity.

Relative humidity values for Pennsylvania during the growing season compare favorably with those reported for Geisenheim and Trier, Germany (12). During the winter months relative humidity values for these two areas are considerably higher than for any area of Pennsylvania reported herein.

## Conclusions

Based on the climatic data for Erie and for several localities in south central and southeastern Pennsylvania, most of the pertinent climatic variables seem quite favorable. The Erie County grape belt appears to have a more favorable climate for the production of wine grapes (present acreages are predominantly used for juice-grape production). However, it is evident from these data that there are areas in south central and southeastern Pennsylvania which should be investigated more thoroughly in terms of suitability for growing wine grapes.

In general, the greatest factors to be overcome seem to be winter injury and disease. Southern Pennsylvania may have more difficulty in these areas than does the lake area, especially since it receives more rainfall, has higher mean monthly temperatures, and can expect temperatures of –5 F or lower more frequently.

Ecologically, a site for wine-grape production should have protection from cold prevailing winter winds, good air drainage, well-drained soils, and infrequent exposure to temperatures of –5 F or lower.

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