25 Anthropogenic Influences in Cranberry Production

New Anthropogenic Soil Series

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Currently a soil survey update of Plymouth County Massachusetts is in progress. Numerous soil scientists have completed soil survey fieldwork in the Plymouth County area. Through their thorough work they have encountered numerous abandoned sand and gravel pits where material was removed down to the water table. It was agreed that the area in acres of these abandoned sites were plentiful enough to propose a tentative soil series to be added to the National Cooperative Soil Survey. The proposed series name is Tihonet and profile pictures (centimeters) and pertinent information are now available via the web at http://nesoil.com/muds/tihonet.htm

This human altered or anthropogenic soil series was developed for glaciofluvial areas where sand and gravel was mined to the water table. These excavated landscapes where the original solum and much of the substratum has been removed are poorly drained and considered hydric (Figure 1). This series replaces the Psammaquents map unit on former provisional Plymouth County legends. Future plans are to develop a catena for these excavated areas (excessively drained and moderately well drained).

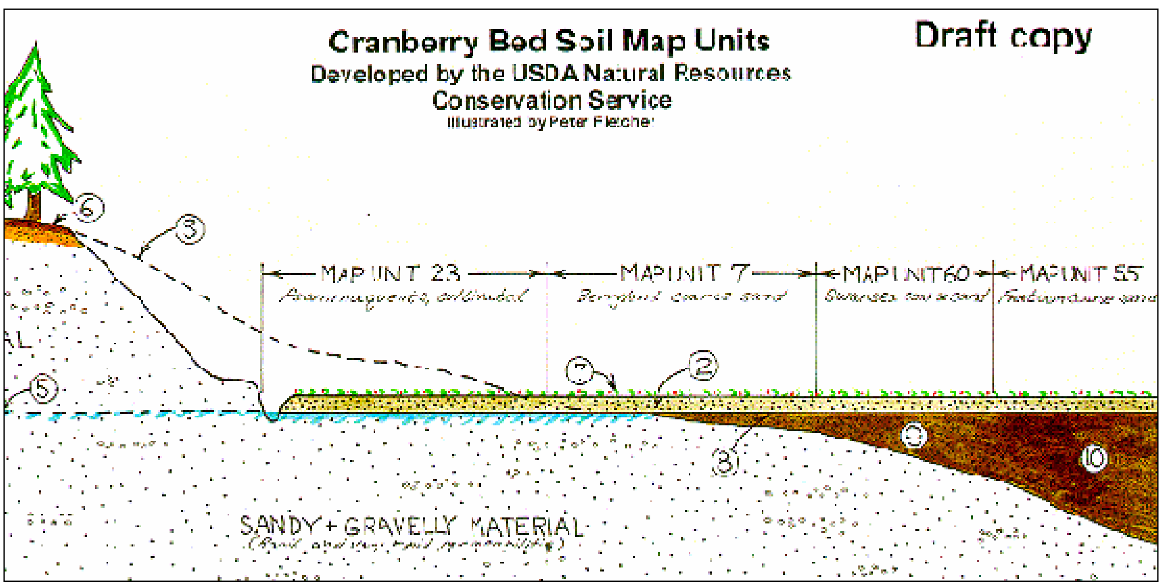

Figure 1. Typical landscape position of Tihonet soil series. Notice original soil surface. Drawing courtesy of P.C. Fletcher.

The Tihonet soil series consists of three primary land uses. The first as previously discussed occurs throughout the Northeast as abandoned pits. The main reason for abandoning these gravel pits is the cost of operation to continue the mining activity into the water table. The second land use primarily occurs in southeastern Massachusetts where sand and gravel (formerly Carver and Hinckley soils) is mined to water tables and cranberry beds are installed after mining operations cease (Figures 2, 3, & 4). These newly installed cranberry beds are exponentially increasing in acreage in the Southeastern Massachusetts area. The sandy wet materials have been found to dramatically increase cranberry vine density and fruit yields. Many areas are also used for wetland restoration and replication projects.

The purpose of this article was to introduce the soil scientists within the Northeast to a new soil series currently being used in soil survey production. Human altered and disturbed soils are exponentially increasing in area throughout the nation. The Tihonet soil series is an attempt to address some of these human altered areas. Feel free to examine this new soil series on the above mentioned web sites. Comments, suggestions, and additional support data are more than welcome. Please contact Jim Turenne (Plymouth County Soil Survey Project Leader) or the author for full profile descriptions and/or pictures. Hopefully soil scientists throughout the Northeast will begin using this anthropogenic soil series in future soil survey and field consulting operations.

Figure 2. (left) Sand and gravel mined down to the water table.

Figure 3. The mounds of sand represent the area where cranberry beds are being installed. These beds also represent an area formerly mapped as Hinckley soils. The bed in the foreground is a traditional cranberry bog containing peat (Swansea soil series).

Figure 4. Tihonet soil series with original land surface in background.

Map Unit Description

Tihonet Soils: The Tihonet series consists of very deep poorly drained soils that formed in thick sandy glaciofluvial deposits. They are on excavated landscapes where the original solum and substratum has been excavated to the depth of the water table.

A profile of the Tihonet soil is shown in Figure 5.

Figure 5. Tihonet Profile

Map Unit (s): 23, 657

Map Phase:

23A: Tihonet coarse sand, 0 to 3 percent slopes.

657: Tihonet sand, 0 to 3 percent slopes (formerly called Aquents).

Taxonomic Classification: Mixed, mesic Typic Psammaquents.

Drainage Class: Poorly drained.

Parent Material: Human altered material underlain by glacial fluvial deposits.

Permeability: Rapid to very rapid throughout.

Available Water Holding Capacity: Low.

Soil Reaction: Extremely acid to strongly acid throughout.

Depth to Bedrock: Greater than 60 inches.

Seasonal High Watertable: Depth: 3.0 feet above to 1.5 feet below the surface. Type: Apparent. Months: November to June.

Hydrologic Group: C.

Hydric Soil: Yes.

Flooding/Ponding Potential: Frequency and Type: Frequently Flooded and/or Ponded.

Duration and Months: Brief to long, November to May. Regulated by human activities

Soil Suitability: Agriculture: Map unit 23 is used for Cranberry production. Map unit 657 is poorly suited for most agricultural uses mainly due to wetness.

Woodland: Poorly suited due to wetness.

Development: Wetness, due to seasonal high water table limits the use of this soil as a site for dwellings and for septic tank absorption fields. The nature of the wet sandy soils causes sloughing and pit collapse during excavation.

The Best Soils for Cranberry Production

Dennis Robinson, Michigan Department of Agriculture
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http://www.mda.state.mi.us/prodag/cranberry/soils.html

Most traditional cranberry sites are two general soil types -- acid organic soils or poorly drained sandy soils with shallow organic surfaces. Examples of these soils would be the Dawson and Kinross. The properties of these soils include a pH of 3.5 to 5.0 in the surface and a water table of 6 to 12 inches during the growing season. These traditional sites are easily converted and have adequate water. The disadvantage of these soils is that they are wetlands with surface water systems, and their development requires permitting. The following characteristics of traditional cranberry sites are fundamental plant requirements:

1. Surface texture -- usually a peat surface or sandy soil with a high percentage of organic matter.
2. Depth -- greater than 40 inches to bedrock
3. Slope -- 0 to 2 percent
4. Water table -- ranges from 1.5 to 3.0 feet during the growing season (generally poorly drained or very poorly drained soils).
5. Reaction -- surface horizon pH of 4.0 to 5.5

Some cranberry operations have recently been developed by modifying non-traditional sites so that the basic requirements above are met. This approach has been taken to avoid wetland and water use regulations, and because these sites are readily available in some areas. Other non-traditional soils have been proposed for cranberries, but they have not been tested. It is important to recognize that although several basic non-traditional sites have been proposed, the basic requirements listed above need to be met in order to successfully produce cranberries. This may require significant additional development costs. We have categorized non-traditional sites into three alternatives:

1. Somewhat poorly drained and moderately well-drained sands with regional watertables. These soils have sandy surfaces with varying amounts of organic matter, pH of 4.0 to 5.5 in the surface, and water tables 1 to 3 feet (somewhat poorly drained) to 2.5 to 6.0 feet (moderately well drained) during the growing season. Examples would be the AuGres and Croswell soils. An advantage of these soils is that they are not typically classified as wetlands. The major disadvantage is their high permeability, which could lead to problems maintaining desired water table levels or with movement of chemicals into groundwater. Several existing cranberry operations in Wisconsin have expanded into these upland sites.
2. Somewhat poorly drained and moderately well drained sands with perched water tables. These soils have sandy surface horizons above slowly permeable "clayey" lower horizons at 20 to 40 inches. The pH is 4.6 to 6.0 in the surface material, and the water table is perched at 1. To 6 feet (depending on drainage class) during the growing season. The Allendale and Manistee soils would be examples. The advantage of these soils is that their slowly permeable substrata can prevent the loss of excessive water from the beds and also minimize the movement of chemicals into groundwater. The primary limitation is that these soils may not be as common in as extensive areas as some other soils. These types of soils are being recommended by the Maine Department of Agriculture.
3. Moderately well drained to poorly drained clays. Properties of these soils include silty clay loam to clay surfaces with a pH of 4.5 to 6.5. Soils often become calcareous within 36 inches and have water tables at depths of 1 to 6 feet (depending on drainage class) during the growing season. Examples would be the Ontonogon and Rudyard soils. Advantages of these soils is that they are slowly permeable, and could be developed into "closed" systems where little water is lost to deep percolation. Some areas of the state have extensive acreage of these soils that are prior converted (ie, idle farmland). Many are classified as disturbed wetlands, and their use would more likely be allowed than undisturbed wetlands. In fact, currently farmed areas should not require a wetlands permit to change the agricultural crop to cranberries. These soils have been proposed by the

Michigan Department of Environmental Quality as potential cranberry sites. The main disadvantage are the costs of development. Clean sand would have to be brought in as a rooting medium for the plants, and adequate water reservoirs would have to be constructed if surface water is not available.

Cranberry Site Requirements

http://www.michigan.gov/mda/1,1607,7-125-1567_1599_1605-13725--,00.html

The three basic considerations in choosing a suitable cranberry site are climate, soils, and water. We will discuss these items separately, although they are related to some degree. The climatic considerations can be discussed on a regional basis. However, the suitability of a specific location is based primarily on the soil and water characteristics. Since these characteristics are very site specific, we will discuss soil and water requirements in a general sense.

Climate: The American cranberry is native to Maine and Nova Scotia, west to Minnesota, and as far south as Virginia and Tennessee. This represents a wide range of climatic conditions. Commercial production areas also vary enormously, from the moderated marine climates of western Oregon and Washington to the harsh continental climate of central and northern Wisconsin. The suitability of Michigan regions for cranberry production can be assessed by comparing the climate to perhaps the harshest production area, Wisconsin. There is little doubt that most of Michigan offers suitable climate. Cranberries have been successfully grown experimentally and commercially in the severe conditions of the Upper Peninsula. In most respects, the climate in southern Michigan is less challenging. Minimum Winter Temperatures Cranberry leaves and buds are subject to cold injury during the winter. Generally, midwinter temperatures below 10F will injure plants and higher temperatures may cause injury if accompanied by wind. Since these temperatures are common in Wisconsin, Massachusetts and New Jersey, bogs in these states are typically covered during the winter with a protective layer of ice. The USDA Hardiness Zones reflect primarily average minimum winter temperatures. Cranberry production regions range from Zone 3 (N. Wisconsin) to Zone 9 (Pacific Northwest). Michigan falls between these extremes (Zone 4 in the Western U.P. to Zone 6 in Southwest Lower Michigan). The fact that Michigan winters are more moderate than those in Wisconsin, presents some questions about winter protection. Wisconsin growers are able to maintain ice on beds throughout the winter. Southern Michigan frequently experiences "winter thaws", when ice cover would likely be lost. Beds would periodically need to be re-flooded to form new ice. Southwest Michigan also receives more snow than production areas of Wisconsin, which could impede ice formation and cause oxygen shortages beneath the ice. Growers in this area may need to develop winter protection strategies more similar to those in Massachusetts or New Jersey than Wisconsin. It is not clear whether the low growing degree day (GDD) totals in the U.P. might affect cranberries. Plantings in northern Wisconsin apparently yield slightly lower on average than plantings in southern areas of the state. Perhaps this is related to differences in growing degree days. We do not expect low GDD totals to be a serious problem, even in cooler parts of the Upper Peninsula. A recently renovated commercial planting on Whitefish Point, which likely received less GDDs than any other area of Michigan, will provide useful information in future years.

Soils: Most traditional cranberry sites are on two general soil types - acid organic soils or poorly drained soils with shallow organic surfaces. Examples of these soils would be the Dawson and Kinross. The properties of these soils include a pH of 3.5 to 5.0 in the surface and a water table at 6 to 12 inches during the growing season. These traditional sites are easily converted and have adequate water. The disadvantage of these soils is that they are wetlands with surface water systems, and their development requires permitting.

The following characteristics of traditional cranberry sites are fundamental plant requirements:

1. Surface Texture - usually a peat surface or sandy soil with a high percentage of organic matter.
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4. Water Table - ranges from 1.5 to 3.0 feet during the growing season (generally poorly drained or very poorly drained soils).
5. Reaction - surface horizon pH of 4.0 to 5.5. Some cranberry operations have recently been developed by modifying non-traditional sites so that the basic requirements above are met.

This approach has been taken to avoid wetland and water use regulations, and because these sites are readily available in some areas.

Other non-traditional soils have been proposed for cranberries, but they have not been tested. It is important to recognize that although several basic non-traditional sites have been proposed, the basic requirements listed above need to be met in order to successfully produce cranberries. This may require significant additional development costs. We have categorized non-traditional sites into two alternatives: Somewhat poorly drained and moderately well drained ands with regional watertables These soils have sandy surfaces with varying amounts of organic matter, pH of 4.0 to 5.5 in the surface, and water tables 1 to 3 feet (somewhat poorly drained) to 2.5 to 6.0 feet (moderately well drained) during the growing season. Examples would be the AuGres and Croswell soils. An advantage of these soils is that they are not typically classified as wetlands. The major disadvantage is their high permeability, which could lead to problems maintaining desired water table levels or with movement of chemicals into groundwater. Several existing cranberry operations in Wisconsin have expanded into these upland sites. - Moderately well drained to poorly drained clays Properties of these soils include silty clay loam to clay surfaces with a pH of 4.5 to 6.5. Soils often become calcareous within 36 inches and have water tables at depths of 1 to 6 feet (depending on drainage class) during the growing season. Examples would be the Ontonagon and Rudyard soils. An advantage of these soils is that they are slowly permeable, and could be developed into "closed" systems where little water is lost to deep percolation. Some areas of the state have extensive acreage of these soils that are prior converted (i.e. idle farmland). Many are classified as disturbed wetlands, and their use would more likely be permitted than undisturbed wetland. These soils have been proposed by the Michigan Department of Natural Resources as potential cranberry sites. The main disadvantages are the costs of development. Clean sand would have to be brought in as a rooting medium for the plants, and adequate water reservoirs would have to be constructed if surface water is not available.

Water: Cranberry production requires large amounts of water. Water is needed to protect plants against frost damage in the spring and fall. Traditionally, plantings were flooded before predicted frosts. Most growers now frost protect by sprinkling water on plants, since this requires much less water than flooding. Irrigation is also needed throughout the growing season to meet the water demands of the plants. Cranberry plants are shallow rooted and desiccate easily. Sprinkler systems may also be used to cool the plants during hot summer weather. Beds that are wet harvested are flooded in October with 1 foot of water to remove the berries, and a second 1 foot flood may be used to remove trash from the bed. Beds are again flooded with 1 foot of water in the winter to protect plants from winter weather. Actual water requirements vary with location and management practices, and are often expressed in acre-feet. One acre-foot is the water needed to cover an acre to a depth of one foot (about 330,000 gallons). Water use estimates range from 5.1 acre-feet in Maine, to 6 acre-feet in Wisconsin, and 7.8 acre-feet in Massachusetts. However, if beds and reservoirs are designed to recycle water, actual water use may be as little as 1.5 feet. This system would require an impervious soil substrata to prevent deep seepage losses of water, and a topographical layout that allows cycling of water from one bed to another and from beds to reservoirs. Acquiring and discharging water are prime concerns in selecting cranberry sites. Cranberry operations typically use surface water from existing sources (lakes, streams, drainage ditches) or from reservoirs. Access to water from lakes or streams may require permits. Construction of reservoirs of sufficient size may also require permits if they are located on existing wetlands. Wells typically do not have the capacity to supply the large volumes of water required at specific times. Well water may also be difficult to use for winter floods because it requires more time to cool and freeze. Wells can be used to replenish smaller reservoirs. In addition, relatively large volumes of water may be discharged to drainage ditches, streams or lakes. Discharge may also require permits, since the temperature and chemistry of receiving waters can be affected.

Spring and Autumn Frost Potential: The average time between the last killing spring frost and the first killing fall frost defines the growing season. In natural environments, cranberries need about 150 frost free days to mature the berry crop. The growing season in cranberry production areas is longest in Oregon and Washington (280 days) and shortest in Wisconsin (110 days in some northern areas and 160 days in the south). The growing season in Michigan ranges from 100 days in the western U.P. to 170 days in southwest lower Michigan. Cranberry growers protect against frosts and extend the effective growing season by sprinkle irrigating or flooding. However, production in short season areas will require more frequent frost protection and thus greater management costs.

Precipitation/Evapotranspiration: Irrigation Requirements: Irrigation requirements are dependent on the amount of precipitation and evapo-transpiration or amount of water lost to the air from leaves and the soil surface. Annual precipitation in major production areas ranges from 30 inches in Wisconsin to 80 inches in parts of Oregon and Washington. Average annual precipitation in Michigan ranges from 28 inches in parts of the U.P. to 36 inches in southern Michigan. Warm-season precipitation (April-September) provides a indication of the need for supplemental irrigation during the growing season. Production areas in Wisconsin receive 20-22 inches between April and September, whereas warm-season totals for Michigan range from 16 to 22 inches. The lowest April to September totals in Michigan (16 inches) occur in the eastern U.P. and the extreme northern portion of the Lower Peninsula. The evapo-transpiration from cranberry bogs in Michigan would likely be similar to that of bogs in Wisconsin. Air temperatures and relative humidity, which largely control evapo-transpiration, are generally similar in Wisconsin and Michigan. Because water losses through evapo-transpiration and precipitation are similar, irrigation requirements are generally expected to be similar between the two states. Sprinklers are also used to cool cranberry plants during very warm days. High temperatures or dry winds early in the season may cause new growth to desiccate and "blast", whereas hot weather later in the season may cause scalding of the berries. Temperatures as low as 80°F can injure plants in the normally cool Pacific Northwest, whereas 85°F may cause injury under New Jersey conditions. Plantings in Michigan may require less water for cooling than plantings at similar latitudes in Wisconsin.

Heat Units and Growing Degree Days: Temperatures during the growing season may have affected the growth of cranberry plants and fruit differently. Optimum temperatures appear to be 60-80°F. Lower temperatures may limit yields by slowing growth and berry development. Higher temperatures can cause sunburning of berries during the summer, and inhibit color development if occurring during the fall. Growing degree days (GDD) are a measure of the heat accumulation during the season. Production areas in Wisconsin usually accumulate 2500 (north-central areas) to 3000 (central) GDD base 45°F. The upper peninsula of Michigan typically accumulates 2300-2500 GDD base 45, and extreme southern Michigan sees up to 3800 GDD. On average, GDDs in the U.P. are slightly lower than those in even the cooler production areas of Wisconsin, and the GDDs in southern Michigan are comparable to those in southern Wisconsin.