SANDING: OUR CURRENT UNDERSTANDING

Teryl R. Roper
Dept. of Horticulture
University of Wisconsin-Madison

The practice of sanding is thought to have begun with Henry Hall of Barnstable, Massachusetts in 1816. When sand blew from a knoll onto a section of wild cranberries, he noticed the condition of the vines improved. The idea of improving cranberry marshes via sanding began early and has been followed more or less diligently since then. Substantial misunderstanding and misinformation exists about sanding. Dr. F.B Chandler writes "When Director Sievers hired me, he asked me to get rid of sanding and said that it was an expensive method not used for any other crop." Dr. Chandler then goes on the extol the virtues of sanding. Some of these are listed below.

Benefits of sanding

The benefits associated with sanding are many. Unfortunately, for most of these no good research data is available to provide quantitative measures of the benefits of sanding. I have gone back through the available literature and have tried to summarize the documented work.

Insect management

Much has been written about sanding as an insect management practice. Sanding has been advocated for controlling both tipworm and girdler. The latest research suggests that sanding will temporarily suppress tipworm populations by burying over-wintering tipworm pupae. However, the benefit will last at most one year. Tipworm populations in beds increases quickly after sanding either from adjoining unsanded beds or from bed edges that are more likely to be unsanded.

Sanding does produce higher mortality of cranberry girdler larvae. Research in British Columbia show higher survival in the duff layer than in sand.

Prunes vines and encourages rooting

This is probably the best documented aspect of sanding. Horticulturally sanding is similar to pruning. It "removes" dead wood. Other perennial fruit plants are selectively pruned to remove unproductive wood. Low bush blueberries are burned periodically to remove unwanted wood. Sanding provides a similar function in cranberries. Woody runners under the canopy do not send down roots into the soil. However, runners that are covered with sand produce roots in the new layer of sand. This keeps the distance between roots and buds as short as possible. Some few uprights may also be bent down as the sand settles, thus improving light relations within the cranberry canopy.

Actual vine pruning where runners are cut and uprights and runners are removed from the bed will accomplish much of the same results over time.

Drainage and aeration

Since coarse sand is used when sanding movement of air and water through the new layer is improved. Since coarse sand has relatively large particle size the pieces fit together poorly leaving air pockets between the particles. Oxygen can diffuse through the sand layer easier than through thick duff or finer soils. Since cranberry roots are alive, they require oxygen to grow and function. Oxygen can reach the roots only through the soil.

Water is held on the surface of soil particles. Since sand has a relatively small surface to volume ratio, it cannot hold much water Excess water drains into lower soil layers. Improving soil drainage would be sufficient reason to sand even if no other benefits resulted.

Soil radiation

An exposed sand layer will capture and release more radiant heat than a duff layer. This can be important on a frosty night. Measurements in Massachusetts suggest that a newly sanded bed may be 2°F higher on a frosty night than an unsanded bed.

Some people have suggested that a newly sanded bed will reflect light back into the canopy thus increasing the rate of photosynthesis. I know of no data to support these statements. This would only be true if light were the limiting factor for photosynthesis on a given day. Our research has shown that cranberry photosynthesis saturates for light at about 60 to 70% of full sunlight. On a sunny day or a lightly cloudy day photosynthesis is probably not limited by light. Adding more light under these circumstances will not increase photosynthesis anyway.

Weed management

There are mixed results and interpretations of the effects of sanding on weed development. Traditional wisdom is that sanding covers weed seeds and small annual weeds and smothers them. On the other hand it hold moisture and may provide ideal conditions for germination. After sanding weed seeds that blow onto a sanded bed also find ideal conditions and a more open canopy thus improving their chances for survival. Sanding affects perennial weeds much the same as cranberries and may actually invigorate their growth.

Sanding is thought to enhance the effectiveness of many of our herbicides. Herbicides may be “tied up” by the organic matter in soils. Sanding covers the duff layer and allows herbicides to retain activity in the low organic matter sandy layer. As a result growers can use a reduced herbicide rate and still get acceptable results.

Sanding practices

There is a certain amount of variability between growers for all cultural practices. Sanding is no exception. Sanding practices are likely more easily justified on an economic basis than a biological basis. How deep to sand, how often to sand and what time to sand are determined more by costs and benefits than absolute biology. A discussion of sanding practices follows.

Sanding depth

Very little is known about the proper depth of sanding from the scientific literature. Our practices are based on experience and practicality. Generally in Wisconsin 3/4 to 1 inch of sand is spread on the surface of the ice in winter. Research in Oregon (where there is no winter flood) demonstrated that yields are reduced in the year of sanding when 1 inch of sand is spread but not when l/2 inch is spread. However, the benefits of sanding are lost the year following l/2 inch sanding, but yields are improved the year following 1 inch sanding (Strik, unpublished data). One of the strong determinants of sanding depth is the amount of sand that must be applied per acre. While the requirement for sand is linear, costs also increase while the benefits of sanding will be lost or be marginal at some higher sanding depth. Again, sanding depth is likely more an economic question than a biological question.

Frequency of sanding.

I could find no citations in the literature showing experiments on the correct frequency of sanding. There was general agreement that in most cases with good marsh management sanding every 3 to 5 years was adequate. Again, frequency of sanding is an economic question not a biological question. Newly planted beds are frequently sanded each year for the first 2 or 3 years to encourage rooting and runner development and to anchor the vines before harvesting.

Time of sanding

This is one area where there has been a lot written. Some old literature suggests that sanding should be delayed as long as possible so as not to block light that may reach the vines. This light would allow plants to photosynthesize and release oxygen that could be used for respiration. Growers fear that if they sand early that leaf drop will follow in the spring. Unfortunately, in my opinion, this recommendations are based on a poor understanding of cranberry biology. In Wisconsin, sand can be applied anytime there is thick ice on a bed. The limitation is the ability of the ice to support the weight of a dump truck and sander. Following is a discussion of the reasons why I think time of sanding is irrelevant in cranberry culture.

Rationale discussion

There is a voluminous literature explaining the need for dormant cranberry vines to have sufficient oxygen. Dormant cranberry vines do need oxygen as all living organisms do. Oxygen is required for respiration which is the process of converting the chemical energy in food to energy usable for cellular functions.

Air contains roughly 21% oxygen and most of the balance is nitrogen gas. Oxygen moves primarily by diffusion. Water also contains oxygen. The ability of water to hold oxygen is related to its temperature. Cold water can hold more oxygen than warm water. The saturation values for water's ability to hold oxygen at different temperatures are 10 ml/l at 32°F, 8.7 ml/l at 40°F and about 7.8 ml/l at 50°F. As water temperature increases its ability to hold oxygen decreases.

The rate of respiration in plants respond to two primary factors. The first is temperature. As the temperature rises the rate of respiration increases. In the normal range of temperatures, respiration doubles when the temperature increases by 10C. At temperatures at or below freezing the rate of respiration is very low, so the need for oxygen is also very low. Plant respiration also responds to oxygen availability. As oxygen concentrations surrounding plants decrease, the rate of respiration also decreases. This is the basis of controlled atmosphere storage for apples. Apple growers keep storage temperatures near 32 and oxygen concentrations between 2 and 5% by volume. By doing so apple respiration slows markedly.

In plants, the inverse process of respiration is photosynthesis. Photosynthesis has two parts, the "light reactions" where light energy is harvested and oxygen is released. These functions are almost temperature independent, meaning they will proceed at most any temperature if light is present. The second part of photosynthesis are the "dark reactions". In these reactions, the harvested light energy is used to "fix" CO(2) into carbon containing sugars. These reactions are very temperature dependent. Virtually no CO(2) is fixed in vines under ice in the winter. Both temperatures and CO(2) concentrations are limiting. The problem occurs when the "light reactions" are still proceeding, but the dark reactions are stopped for whatever reason. When this happens there are high energy bonds and molecules in plants with nothing to do. Over time, these reactive molecules can actually disrupt the plant cells and cause injury or death.

We think that one reason plants like cranberry turn red in fall and winter is to protect the photosynthetic apparatus of the leaves from injury. The red pigments reflect some light to protect the cells. It follows that they are less efficient at capturing light and transferring it to chlorophyll. If this is true, low light would be more beneficial to over-wintering vines than high light.

Using very crude instrumentation, light levels under ice were measured in Massachusetts between 1938 and 1942. In general they found that ice alone (ranging from 4 to 8 inches thick) blocked between 20 and 60 percent of the light incident on the top of the ice at solar noon. By afternoon when the sun was lower on the horizon the levels were always lower. Other factors that influence light penetration through ice are the amounts of solids and debris in the ice, the amount of snow on or between ice layers, and the crystal size of the ice. In Massachusetts, only about 5% of incident light penetrated 4 inches of snow.

Back to sanding practices. You are probably wondering what all this has to do with sanding on ice. It is my opinion that time of sanding doesn't make any difference. First, oxygen requirements for respiration are very low when the vines are dormant. Second, plants don't need or want much light during the winter. Light can actually be damaging to dormant vines. Third, oxygen evolution via photosynthesis would be very low if only from the light limitation from ice and snow. Very little light is needed to produce some oxygen through photosynthesis that could subsequently be used for respiration.

The typical explanation given to me for late sanding or plowing snow from ice in winter is leaf drop. During dark, cloudy winters or snowy winters growers remember having more leaf drop than during more "normal" years. Leaf drop may also be greater around bed edges where snow tends to accumulate. I can't dispute your observations. However, a correlation does not establish a cause and effect relationship. Let me offer some alternative interpretations.

Dr. Frank Caruso of the University of Massachusetts associates significant leaf drop with beds that have cropped heavily the year before. What may be happening here is that carbohydrate reserves are too low following a heavy crop and leaves drop from lack of resources. Virtually no CO(2) will be fixed under ice in winter, so all energy needs for respiration must come from storage compounds.

Because of the risk of dropping a loaded dump truck through the ice on the edges of beds, growers tend to sand bed middles preferentially to bed edges. Over time the bed edges may be significantly lower than the middles. This would lead to poor internal soil drainage on the bed edges. Poorly drained soils are more likely to be anaerobic, leading to leaf drop.

The other observation I would offer is that larger growers who must begin sanding early in order to get their sanding done don't suffer ill effects from early sanding. This inconsistency alone should be enough to question the issue of early *vs.* late sanding.

Conclusion

Sanding is a beneficial cultural practice that has been shown to invigorate plantings and increase yields over time. Many of the issues regarding sanding are best examined from their economics in terms of what does it cost to sand, yield loss in the year of sanding and increases in yield that may be realized in subsequent years. Economics will also guide frequency of sanding.

The proper time to sand is more a function of convenience than of blocking light to vines. Given the choice between sanding early and not sanding because of rotten ice, I would sand early.

Further Reading

Chandler, F.B. 19__. Is sanding necessary? Cranberries Magazine 28 (2): 13.

DeMoranville, I.E. 1987. Resanding cranberry bogs. pp.43-46 in Modern Cranberry Cultivation. University of Massachusetts Cooperative Extension.

Eck, P. 1990. The American Cranberry. Rutgers University Press, New Brunswick.

Franklin, H. J. 1948. Cranberry Growing in Massachusetts. Massachusetts Agr. Exp. Stn. Bulletin 447.

Franklin, H.J., H.F. Bergman and N.E. Stevens. 1943. Weather in cranberry culture. Massachusetts Agr. Exp. Stn. Bulletin 402.

Raven, P.H., R.F. Ever-t and H. Curtis. 1981. Biology of plants. 3rd edition. Worth Publishers, Inc. New York. 686 pages.

Whitson, A.R. and O.G. Malde. 1907. Cranberry investigations. Agricultural Experiment Station of the University of Wisconsin Annual Report 24:302-308.