2010 Cranberry Management Update: Nutrient Management BMPs

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Nutrient Management

Carolyn DeMoranville
UMass Amherst Cranberry Station
SARE Project surveys at Cranberry Update Meetings

Project (LNE 05-217) funded by Northeast Region Sustainable Agriculture Research and Education Program
## Irrigation/Frost/drainage

<table>
<thead>
<tr>
<th></th>
<th>January-08</th>
<th>January-09</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation automation</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>On-off cycling during frost protection</td>
<td>10</td>
<td>16</td>
</tr>
</tbody>
</table>

### Drainage

- Installed submerged drainage last 2 years 39
  - 60% into existing bogs
- Did other drainage improvements 51
  - Most cleaned or deepened ditches
- Would install drainage tiles in a renovated bog 65
  - Note: depth/spacing very variable, most used shallow depth / wide spacing
## Nutrient management

N-P ratios (by grower reporting)

- All applications 1N to more than 1P (eg. 12-24-12, 5-15-30)
- All applications 1N to no more than 1P (eg. 15-15-15, 18-8-18)

<table>
<thead>
<tr>
<th>January-08</th>
<th>January-09</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Percent</strong></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>15</td>
</tr>
<tr>
<td>34</td>
<td>61</td>
</tr>
</tbody>
</table>

Plan to reduce P use

Reduced P use

<table>
<thead>
<tr>
<th>January-08</th>
<th>January-09</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
<td>51</td>
</tr>
</tbody>
</table>
## Final meeting survey (n=102)

<table>
<thead>
<tr>
<th>Practice</th>
<th>% respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Would prune in lieu of sanding</td>
<td>31</td>
</tr>
<tr>
<td>Schedule irrigation using sensors or floats</td>
<td>21</td>
</tr>
<tr>
<td>Cycle irrigation during frost protection</td>
<td>16</td>
</tr>
<tr>
<td>Improved/installed drainage in the last 3 years</td>
<td>39</td>
</tr>
<tr>
<td>Purposely reduced P use in the past 3 years</td>
<td>51</td>
</tr>
<tr>
<td>Implemented 2 of 5 stated practices</td>
<td>33</td>
</tr>
<tr>
<td>Implemented 3 of 5</td>
<td>14</td>
</tr>
<tr>
<td>Implemented 4 of 5</td>
<td>6</td>
</tr>
<tr>
<td>Implemented all 5</td>
<td>2</td>
</tr>
</tbody>
</table>
Highlights of field research – Supplements
Highlights of field research – New Plantings

Percent vine cover

- Organic 47N, 10P
- Chart (TSP, slow, alt) 62N, 17P
- Polyon Slow 40N, 5P
- Organic chart 50N, 10P
- Chart (less slow) Nutrelease 43N, 15P

Cuttings May 20
Plugs June 30
Nutrient Management BMPs

- Original Guide produced in 1996
- Some practices revised and some added in 2000
- Much research since
- Revision began in 2009
BMP Guide

- Entire Guide to be revised in 2010
- Looking for grower input
- Final product will be posted online
- Will include hot links (Chart Book sections, references)
Nutrient BMP - General

- Soil temperature important to nutrient uptake
  - Wait for 55F

- Drainage!!
  - Nutrient uptake requires water and oxygen
  - Too wet – no oxygen
  - Too dry – elements won’t dissolve and move to roots
Nitrogen – Nitrogen Cycle

- Ammonium
- Soil T
- Low pH
- Removal in crop (~23 lb in 150 bbl)
Nitrogen – Plant Cycle

- Add N when the plant needs it.
- Soil T – best to add when between 55F and 70F.
- Rate based on cultivar, growth stage, appearance, tissue test.
BMP Phosphorus

- Unless you can document a serious deficiency, there is no need to exceed 20 lb/a P.

- Test tissue periodically – 0.1-0.2% is the standard range. See timing recommendations in chart book and handout.

- Do not apply P to saturated soil
BMP Phosphorus

-The best fertilizer choices have 1N:1P or more than 1N:1P

  -If you use less than 45 lb/acre N, P will be less than 20 lb/acre

-Example more than 1:1 18-8-18
  -With this, 45 lb/acre N gives ~8.5 lb/acre P
Why P reduction?

- Pollution concerns for fresh water
- Clean Water Act mandated TMDL process
Tissue P in normal range

Tissue P below normal range
Tissue P
(2006 regression data)
Summary – recent field plots

- Trends indicate that some P may be better than no P, although not much of a rate response
- At one location P in the tissue was below the standard range and there was a response to >20 lb P/acre
- Further justification for a target P rate of no more than 20 lb P/acre and some justification for lower rate consideration
## Fertilizer and yield – whole bog comparison

(P in lb·a⁻¹; Yield in bbl·a⁻¹)

<table>
<thead>
<tr>
<th>Year</th>
<th>Site 1 P rate</th>
<th>Site 1 Yield</th>
<th>Site 2 P rate</th>
<th>Site 2 Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>17.8</td>
<td>117</td>
<td>24.9</td>
<td>117</td>
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<tr>
<td>2003</td>
<td>14.4</td>
<td>119</td>
<td>22.3</td>
<td>119</td>
</tr>
<tr>
<td>2004</td>
<td>5.6</td>
<td>172</td>
<td>17.3</td>
<td>196</td>
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<tr>
<td>2005</td>
<td>16.5</td>
<td>190</td>
<td>24.0</td>
<td>121</td>
</tr>
<tr>
<td>2006</td>
<td>6.4</td>
<td>163</td>
<td>5.7</td>
<td>244</td>
</tr>
<tr>
<td>2007</td>
<td>10.4</td>
<td>156</td>
<td>11.4</td>
<td>136</td>
</tr>
<tr>
<td>2008</td>
<td>5.9</td>
<td>221</td>
<td>7.6</td>
<td>272</td>
</tr>
</tbody>
</table>

**Pre-reduction**
- Site 1: 17.8, 117
- Site 2: 22.1, 138

**Post-reduction**
- Site 1: 9.9, 170
- Site 2: 8.2, 217
### Fertilizer and yield – whole bog comparison

(P in lb·a⁻¹; Yield in bbl·a⁻¹)

<table>
<thead>
<tr>
<th>Year</th>
<th>Site 3</th>
<th>Site 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P rate</td>
<td>Yield</td>
</tr>
<tr>
<td>2002</td>
<td>28.8</td>
<td>221</td>
</tr>
<tr>
<td>2003</td>
<td>19.8</td>
<td>136</td>
</tr>
<tr>
<td>2004</td>
<td>21.2</td>
<td>218</td>
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<tr>
<td>2005</td>
<td>26.1</td>
<td>134</td>
</tr>
<tr>
<td>2006</td>
<td>7.1</td>
<td>256</td>
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<tr>
<td>2007</td>
<td>14.7</td>
<td>197</td>
</tr>
<tr>
<td>2008</td>
<td>19.2</td>
<td>220</td>
</tr>
<tr>
<td>pre-reduction</td>
<td>28.8</td>
<td>221</td>
</tr>
<tr>
<td>post-reduction</td>
<td>18.0</td>
<td>194</td>
</tr>
</tbody>
</table>

*Insect infestation at this site in 2002*
Highlights of field research – Reduced P

All except ‘No fertilizer’ received 25 #N
Highlights of field research – Reduced P

All except ‘No fertilizer’ received 25 #N
New Plantings

- Roots take up nutrients
  - Plugs can be fertilized right away but...
    - May look dormant in first 2-3 weeks
  - Cuttings, all slow after a week or wait ~3 weeks
- Use slow release N
- Limit use of complete N-P-K
- Do not use high P materials
  - Use 1N to 1P or less than 1P
  - Limit to 30 lb P/acre in year 1
Highlights of field research – New Plantings

- Organic 47N, 10P
- Chart (TSP, slow, alt) 62N, 17P
- Polyon Slow 40N, 5P
- Organic then chart 50N, 10P
- Chart (less slow) Nutrelease 43N, 15P

Percent vine cover

Cuttings May 20
Plugs June 30
Reactive Layer/Polymer

- Controlled and Slow
- Release: Osmotic Diffusion

Factors Effecting Release:

- Coating
- Temp
Resin Coated

- Osmocote

Release: Fissure Movement / Diffusion

Factors Effecting Release:

- Coating
- Water
- Temp
Sulfur-Coated Urea

- Controlled release, faster than others
- Release: Catastrophic Eruption, Microbial, H₂O penetration

Factors Effecting Release:
- Microbial
- pH
- Water
- Temp
Natural Organics

- **Release**: Microbial; SLOW

- **Factors Effecting Release**: Microbial, pH, Water, Temp
Water quality (N)

- If some is good – more is NOT better
  - Disease
  - Overgrowth
  - Poor production
  - AND increased risk to coastal waters

The Physiology of Cranberry Yield
Figure 11.—Yield, tissue N, and rot of cranberries with various N fertilizer rates.*

*Massachusetts-grown ‘Stevens’
Keep fertilizer out of water

- Don’t apply to ditches
- Drop ditch levels
- Divert water pathways or impound
- Avoid applications before heavy rain or irrigation
### CES/ SMAST Field Study

**Cranberry Bog Nitrogen Loss**

<table>
<thead>
<tr>
<th>Bog ID --&gt;</th>
<th>EH</th>
<th>PV</th>
<th>BEN</th>
<th>WS</th>
<th>M-K</th>
<th>ASH</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nitrogen Inflow to Bog</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigation</td>
<td>0.4</td>
<td>1.5</td>
<td>0.6</td>
<td>0.2</td>
<td>1.7</td>
<td>2.4</td>
</tr>
<tr>
<td>Groundwater</td>
<td>0.0</td>
<td>0.0</td>
<td>1.0</td>
<td>0.3</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Frost Protection</td>
<td>0.8</td>
<td>1.8</td>
<td>1.4</td>
<td>0.5</td>
<td>1.6</td>
<td>2.0</td>
</tr>
<tr>
<td>Pest Management</td>
<td>0.0</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Harvest</td>
<td>1.3</td>
<td>3.4</td>
<td>4.5</td>
<td>1.2</td>
<td>4.2</td>
<td>2.9</td>
</tr>
<tr>
<td>Winter Protection</td>
<td>3.0</td>
<td>3.7</td>
<td>5.2</td>
<td>1.4</td>
<td>4.8</td>
<td>4.0</td>
</tr>
<tr>
<td><strong>Total IN</strong></td>
<td>5.5</td>
<td>10.5</td>
<td>12.8</td>
<td>3.6</td>
<td>12.4</td>
<td>11.3</td>
</tr>
<tr>
<td><strong>Nitrogen Outflow from Bog</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drainage/Infiltration</td>
<td>5.7</td>
<td>6.7</td>
<td>10.5</td>
<td>4.6</td>
<td>7.7</td>
<td>7.2</td>
</tr>
<tr>
<td>Harvest</td>
<td>2.1</td>
<td>5.3</td>
<td>9.4</td>
<td>4.3</td>
<td>4.5</td>
<td>2.8</td>
</tr>
<tr>
<td>Winter</td>
<td>4.0</td>
<td>4.6</td>
<td>6.4</td>
<td>1.7</td>
<td>4.0</td>
<td>5.2</td>
</tr>
<tr>
<td><strong>Total OUT</strong></td>
<td>11.9</td>
<td>16.5</td>
<td>26.3</td>
<td>10.5</td>
<td>16.2</td>
<td>15.2</td>
</tr>
<tr>
<td><strong>Net Nitrogen Loss (lb/a/yr)=</strong></td>
<td>6.4</td>
<td>6.0</td>
<td>13.5</td>
<td>7.0</td>
<td>3.7</td>
<td>3.8</td>
</tr>
</tbody>
</table>

**Nitrogen Output to Downgradient Systems (lb N/acre/yr)**

- Pine-Oak Forest | 0.4
- Cranberry Bog Nitrogen Output | 6.4 (Flow Through Bog = 8.6)
- Residential (density 1 per 2.5 acres) | 5.7
- Direct Precipitation on Bay | 9.8
How can we reduce N output?

- Practice BMPs regarding rate, timing, split applications
- Look at it more as a water problem
  - Amount of flow
  - Direction of flow
  - Pathway of flow
Amount of flow

- Follow recommendations on flooding, drainage, and irrigation

- Research on looking at how to limit groundwater upwelling
  - Compare 2 upwelling sites (10 lb/a/yr) vs.
  - 4 not upwelling sites (5 lb/a/yr)
Direction of flow

- Diversion
  - Tail water recovery
- Can also relate to attenuation

Research on how to limit flow-through situations – by-pass canals?
  - Compare flow-through (8.6 lb/a/yr)
  - To all other types (6.4 lb/a/yr)
Pathway of flow

- Attenuation function of ponds, steams, and wetlands
- Vegetative channels or retention ponds between the bog and the final discharge point
  - research planned on how to best accomplish this
Attenuation

Mill Brook watershed (Howes and Millham, 1991)
- TDN leaving the bog was 0.99 ppm
- Downstream the load had decreased to 0.71 ppm
April 2007 report to DEP
(Woods Hole Group and Teal Partners)
Literature review - attenuation

Denitrification in wetlands is the most effective at attenuating N
- NO₃ to N₂

Denitrification in ponds and streams next best

Uptake by vegetation less effective
Models and Lit. review

MEP conservative estimates

- **Ponds** – 50% attenuation
  - 2 studies: 39-95% and 84-96%

- **Streams** – 30% attenuation
  - 30-40% observed in riverine systems

- **Salt marshes** – 40% attenuation
  - Range of 40-50% in previous Howes work
Water Quality P

More is not better
- We saw this in the field experiments earlier

Again think of it as a water problem
- Also think about oxygen
Fig. 1. Time course of phosphate release from flooded soils excised from natural cranberry bogs (unmanaged, A) and commercial cranberry bogs in MA receiving either 12-20 kg ha\(^{-1}\) (B) or greater than 22 kg ha\(^{-1}\) (C) applied P fertilizer per season. Note that the Y-axis on A is \(\sim 10^{-1}\) those of B and C. Bars represent S.E., n = 6 (A) or 12 (B and C).
Laboratory results were similar to those in water collected from a harvest flood.
BMP recommendations

- Apply 20 lb P/a OR LESS
  - Based on the laboratory study, highest risk for P mobilization - bogs receiving >20 lb P

- Allow particles to settle prior to discharge of harvest flood but do not hold the flood for more than ~10 days
Fall fertilizer is not recommended

- Most danger of water quality issues due to saturation

- If indicated by tissue test or vine appearance, use low or no P formulations and limit N to 5 lb/acre.