HOW MUCH PHOSPHORUS FERTILIZER IS REALLY NEEDED?

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Phosphorus is required by plants to grow and reproduce. Phosphorus can also be an environmental contaminant. Phosphorus is frequently the limiting factor in the growth of algae in freshwater lakes and impoundments. Substantial algal growth contributes to the eutrophication of water bodies. Cranberry production is intimately tied to surface water. Cranberry growers may use as much as six acre-feet of water per acre of planted vines during the course of a season. The concentration of phosphorus in water exiting cranberry farms is generally acceptable, around 40 µg/liter. However, given the large quantity of water used in cranberry production the total load of phosphorus leaving a property may be significant.

Cranberries are grown in suitable locations in central and northern Wisconsin. Typical sites have either organic soils comprised of decomposed peat or coarse sand mineral soils. The soils and water in these areas are frequently slightly acidic and high in iron and aluminum. When phosphorus fertilizer is applied, phosphate ions form insoluble bonds with the iron and aluminum ions thus becoming unavailable for immediate plant uptake. Over time the phosphate may be released slowly and become available for plant uptake.

Contrary to long held wisdom, cranberry tissue tests typically are in the sufficient range for phosphorus (Figure 1). Cranberry growers usually apply complete fertilizers to provide a constant supply of phosphorus for plant uptake. 6-24-24 has been a favorite because of its low N value that allows easy application. However with an N:P ratio of 1:4 phosphorus is overapplied with each application.

Previous work in Massachusetts had shown that there was no yield response to application of phosphorus in excess of 20 pounds of actual phosphorus or 45 pounds P_2O_5/acre/year (DeMoranville & Davenport 1997). This was the lowest fertilizer rate in their study. We wanted to examine lower rates to see if that was the critical value or if even less phosphorus could be applied while still maintaining yields.

Plots were established at two cranberry marshes, one on peat soils and the other on sand based soils. Plots were 3 x 5 meters in size. Fertilizer was applied in a split application at three stages of development; roughneck, bloom and fruit set. Phosphorus was applied as either triple super phosphate (TSP) or as a slow release product (Polyon). Phosphorus ranged from 0 to 30 pounds of actual phosphorus per acre per year. Nitrogen and Potassium were supplied at equal rates to all plots. Tissue samples were collected in September each year and analyzed for total minerals, except nitrogen. Just prior to commercial harvest a single square foot sample was harvested from each plot. Fruit were counted and weighed.

There were no treatment effects of the rate of phosphorus fertilizer applied on total yield or fruit weight in any year at either marsh (Tables 1-3). Yield and fruit count varied significantly by year across most treatments. That is not surprising as high yields one year are frequently associated with lower yields the following year. Weather is also a significant variable. These data underscore the biennial bearing nature of individual cranberry uprights. The sand based bed had higher yields than the peat based bed, but the peat based bed had a severe infestation of dewberries and this would have served to limit yield rather than some intrinsic difference between sand and peat.

There were significant treatment effects for tissue phosphorus concentrations (Table 4). In the sand bed there was a trend towards higher tissue P with higher rates of fertilizer applied. In the peat bed the same trend was evident, but less so than on sand. This supports the notion that peat soils are able to retain and exchange phosphate ions better than sand. However, what is most significant is that after four years of receiving no phosphorus fertilizer the tissue phosphorus concentration in the control plots were still in the adequate range. However, by the fourth year the control plots were barely in the sufficient range. This suggests that growers can apply minimal phosphorus fertilizer and still maintain adequate tissue P.

The previous research showed that yields were not affected at P rates in excess of 20 pounds of actual phosphorus per acre. That was the lowest rate in that study. Our study shows that the actual P requirement to maintain tissue sufficiency of phosphate may be much lower. In this research 5 pounds of actual phosphorus per acre provided the same tissue concentration as 20 or 30 pounds. While the control plots had lower tissue phosphorus concentrations these were not significantly different than treatments receiving phosphate fertilizer.

The results reported here strongly suggest that Wisconsin cranberry growers are applying more phosphorus than is required to maintain tissue phosphorus in the sufficient range. In practice growers can reduce applications of P containing fertilizers while still maintaining adequate tissue P and ensuring that phosphorus is not limiting crop yields. By limiting P application, growers will reduce the prospect of environmental regulations on their ability to use phosphorus containing fertilizers.

Figure 1. Distribution of 281cranberry tissue samples taken between 2002 and 2004 and analyzed by the UWEX Soil and Plant Analysis Lab. The critical value for tissue P is shown.

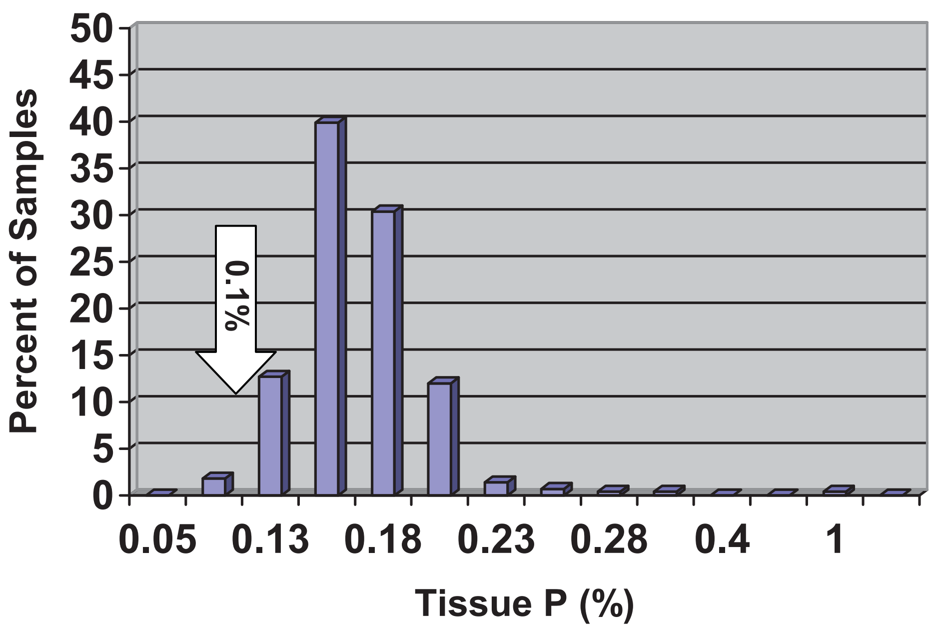

Table 1. Yield in sand based cranberry beds treated with different rates of phosphorus fertilizer for three years in Wisconsin. n=8.

Treatment	Yield (g/ft^2)			
Rate (lb P/a)	**2001**	**2002**	**2003**	**2004**
Control	116.7	274.5	215.9	128.7
5 TSP	116.7	248.9	230.1	140.0
10 TSP	112.2	273.3	268.6	117.6
15 TSP	118.9	276.5	221.9	126.2
20 TSP	126.9	242.7	269.4	157.4
30 TSP	130.3	261.6	216.6	131.3
10 Polyon	117.6	266.9	238.6	106.0
15 Polyon	122.2	243.8	238.7	145.9
20 Polyon	117.7	226.5	207.2	96.4
30 Polyon	101.8	261.4	227.7	116.0
Significance	ns	ns	ns	ns

Table 2. Fruit number in sand based cranberry beds treated with different rates of phosphorus fertilizer for three years in Wisconsin. n=8.

Treatment	Fruit Number			
Rate (lb P/a)	**2001**	**2002**	**2003**	**2004**
Control	87	188	143	109.3
5 TSP	85	167	146	114.7
10 TSP	82	187	173	100.8
15 TSP	85	182	144	101.0
20 TSP	91	167	181	127.8
30 TSP	94	183	139	112.8
10 Polyon	74	181	158	88.3
15 Polyon	87	169	152	125.0
20 Polyon	86	149	134	83.5
30 Polyon	75	168	146	104.5
Significance	ns	ns	ns	ns

Table 3. Yield and fruit number in peat based cranberry beds treated with different rates of phosphorus fertilizer for three years in Wisconsin. n=8.

Treatment	Yield (g/ft^2)			Fruit Number		
Rate (lb P/a)	2001	2002	2003	2001	2002	2003
Control	46.9	170.4	74.3	43	111	53
5 TSP	52.8	122.2	63.2	48	86	48
10 TSP	54.0	159.2	84.4	49	106	60
15 TSP	57.2	131.9	68.0	54	87	47
20 TSP	60.6	123.0	63.2	56	81	47
30 TSP	68.1	172.3	57.2	62	123	41
10 Polyon	53.2	131.0	51.6	48	89	38
15 Polyon	68.4	162.1	68.6	62	107	48
20 Polyon	52.6	139.5	49.5	50	92	35
30 Polyon	53.7	168.2	46.2	52	111	36
Significance	ns	ns	ns	ns	ns	ns

Table 4. Tissue phosphorus concentration of cranberry vines at two Wisconsin marshes over 3 years. N=4.

Treatment	Sand bed			Peat Bed	
Rate (lb P/a)	2001	2003	2004	2001	2003
Control	0.127 f	0.126 f	0.105 d	0.150 cde	0.140 e
5 TSP	0.143 cdef	0.131 ef	0.127 bc	0.159 abcde	0.146 de
10 TSP	0.144 cdef	0.138 def	0.126 bc	0.164 abcd	0.153 cde
15 TSP	0.145 bcdef	0.157 bcd	0.130 bc	0.155 bcde	0.159 abcde
20 TSP	0.147 bcdef	0.142 cdef	0.131 bc	0.167 abc	0.158 abcde
30 TSP	0.170 ab	0.143 cdef	0.142 b	0.158 abcde	0.156 abcde
10 Polyon	0.153 bcde	0.135 def	0.126 bc	0.162 abcd	0.155 bcde
15 Polyon	0.139 def	0.128 f	0.121 cd	0.163 abcd	0.159 abcde
20 Polyon	0.166 abc	0.147 bcdef	0.131 bc	0.156 abcde	0.163 abcd
30 Polyon	0.191 a	0.158 bcd	0.175 a	0.176 a	0.175 ab

References.

DeMoranville, C.J. and J.R. Davenport. 1997. Phosphorus forms, rates, and timing in Massachusetts cranberry production. Acta Hort. 446:381-388.