

The Effect of Crop Size, Soil Moisture, and Potassium Availability on Concord Nutrition and Crop Development

Final Report to Viticulture Consortium and New York Wine and Grape Foundation
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Terence R. Bates¹, Alan Lakso, Richard Dunst

¹Dept. of Horticultural Sciences, Cornell University Vineyard Laboratory, 412 East Main St., Fredonia, NY 14063

Objectives of Project:

- 1) Measure the effect of crop size, irrigation, and potassium availability on Concord vineyard potassium supply and demand and vine performance.
- 2) Investigate the effect of crop size and vine water status on fresh berry weight development in Concord.

Experimental Plot:

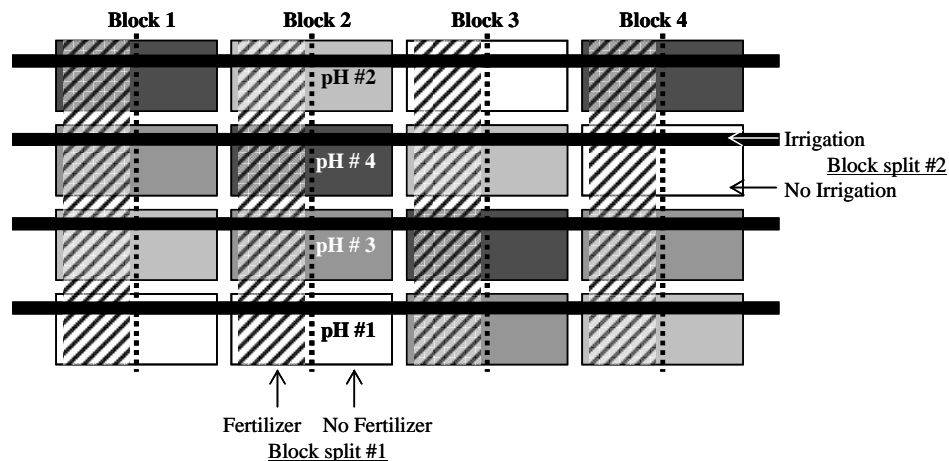


Figure 1 – the vineyard block. The vineyard block in the 2005-2006 experiment was a continuation of the vineyard block used in the previous project: The Response of ‘Concord’ Grapevines to Soil pH. Three factors (soil pH, supplemental fertilizers, and irrigation) were used alone and in combination to manipulate soil nutrient availability with specific attention to base cations (figure 1). Each soil pH plot was split for fertilizer and irrigation. Therefore, each block had 16 treatment combinations (4 soil pH x 2 fertilizer x 2 irrigation) replicated in four blocks. In 2006, vines were changed from balanced pruning to 120 fixed node pruning to achieve high crop size. Two vines within each of the 16 treatment combinations were crop adjusted to 0%, 50%, or 100% crop level.

Measurement of imposed treatments:

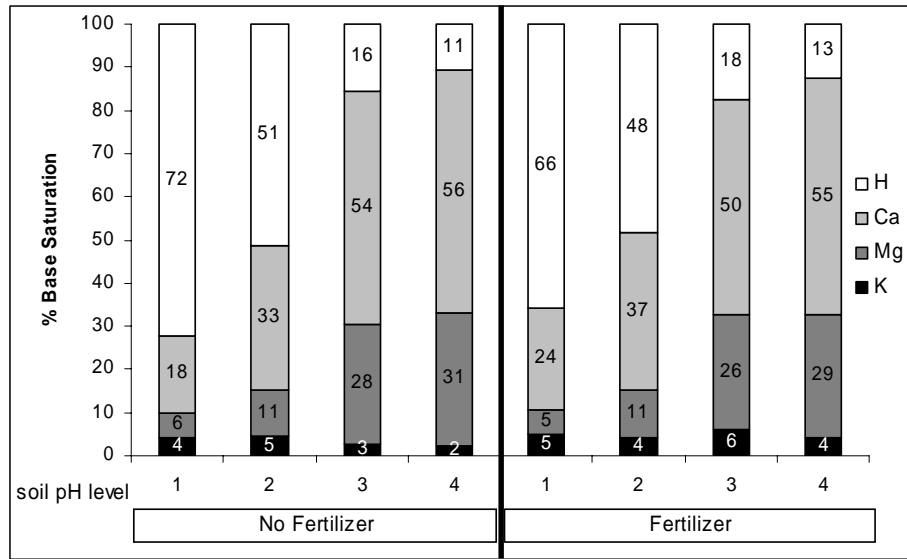
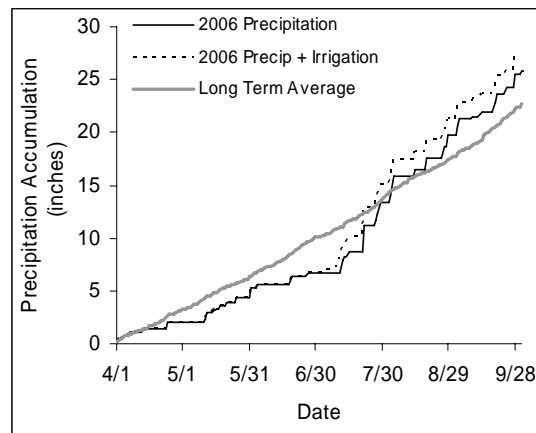
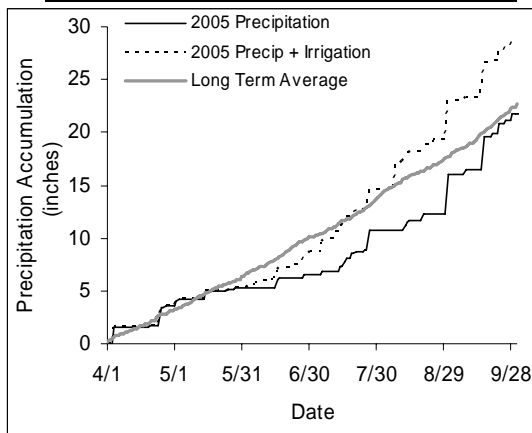


Figure 2 – soil pH, CEC, and Cation distribution. Soil pH amendments and fertilizer applications over the past eight years have established differences in 2006 cation nutrient availability similar to what was previously reported. Soil pH levels 1, 2, 3, and 4 correspond to measured soil pH of approximately 4.5, 5.2, 6.0, and 6.5 with cation exchange capacity (CEC) of 3.8, 5.6, 8.4, and 9.0, respectively. Therefore, the soil pH amendments changed soil pH and overall nutrient holding capacity through CEC. More importantly for the purpose of this project, the soil treatments changed the amount and distribution of cations. Increasing soil pH increased soil CEC, increasing the overall cation nutrient holding capacity. In addition, increasing soil pH decreased the relative amounts of H and K and increased the relative amounts of Mg and Ca. Fertilizers did little to change nutrient availability and distribution at soil pH level 1. Potassium fertilizers at pH levels 3 and 4 did increase (or at least maintain) the relative amount of K in the CEC profile.

Figure 3 - precipitation and irrigation (below). The 2005 growing season was drier than average until after veraison. Irrigation was used 14 times in 2005 and a clear separation was made between irrigated and non-irrigated treatments. Irrigated vines in 2005 produced vines with larger vine size and fruit with larger final berry weight than non-irrigated vines, irrespective of soil pH or fertilizer (see the 2005 report). The 2006 growing season started similar to 2005 with below average precipitation and irrigation was used 4 times in July. However, heavy precipitation in July and August brought precipitation accumulation to above average amounts and there was no need for supplemental irrigation. Consequently, we were unable to establish a meaningful soil moisture treatment separation in 2006.

Supplemental Irrigation		
2005 Date	gal/vine	equivalent inches/acre
6/3	9.6	0.21
6/6	11.2	0.25
6/9	10.4	0.23
6/14	10.4	0.23
6/23	13.6	0.30
6/27	24.0	0.53
6/30	12.8	0.29
7/1	6.4	0.14
7/6	24.0	0.53
7/7	17.6	0.39
7/12	24.0	0.53
7/14	12.8	0.29
8/8	115.2	2.57
8/25	24.0	0.53

Supplemental Irrigation		
2006 Date	gal/vine	equivalent inches/acre
7/5	12.8	0.29
7/7	12.8	0.29
7/10	36.8	0.82
7/20	12.8	0.29



Results for Objective 1:

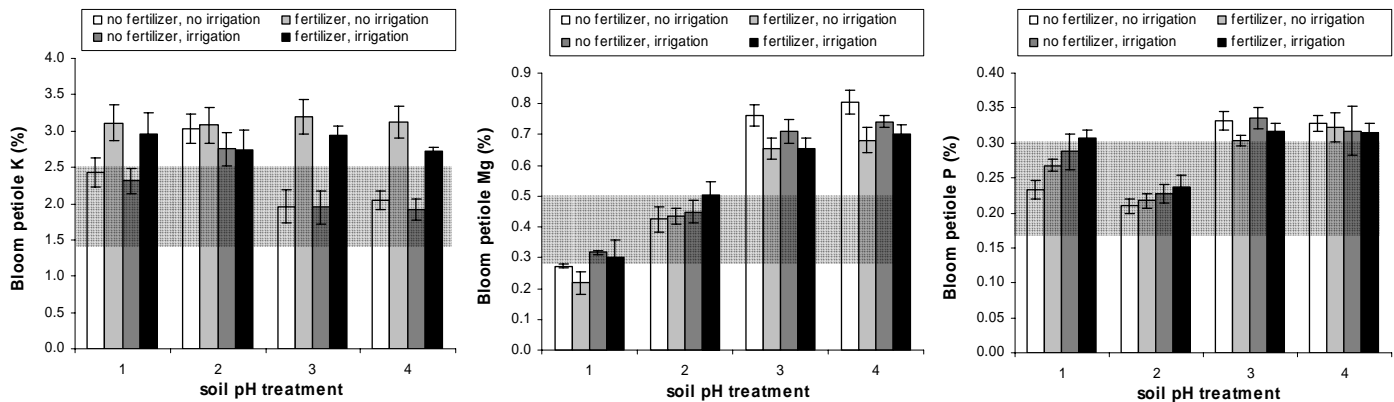


Figure 4 – Bloom petiole values. Soil pH, fertilizers, and irrigation had an effect on bloom petiole nutrient values, especially the target nutrients of K and Mg. In 2006, petioles and leaf blades were collected at bloom and petioles were collected at veraison for analysis. Bloom petioles appeared to be the best indicator of vine nutrient status, were easy to collect, and provided information, which could be used in the current season to correct deficiencies, if necessary. At the lowest soil pH, bloom petioles were adequate in K and deficient in Mg (the

shaded boxes indicate target values for each nutrient). Soil pH level 2 was adequate in both K and Mg but borderline for P despite the use of P fertilizers. Although no visual P deficiency was evident by foliar visual observations or vine productivity, P deficiency may be a possible risk in these soils. Vines in soil pH levels 3 and 4 were all high in bloom petiole Mg, which corresponded with high soil Mg availability. Vines fertilized with K also had sufficient K bloom petiole values but non-fertilized vines had significantly lower bloom petiole K values. Although target values indicate potential K sufficiency, unfertilized vines showed significant deficiency symptoms (next figure), indicating that recommended target K values for high producing Concord may need to be raised.

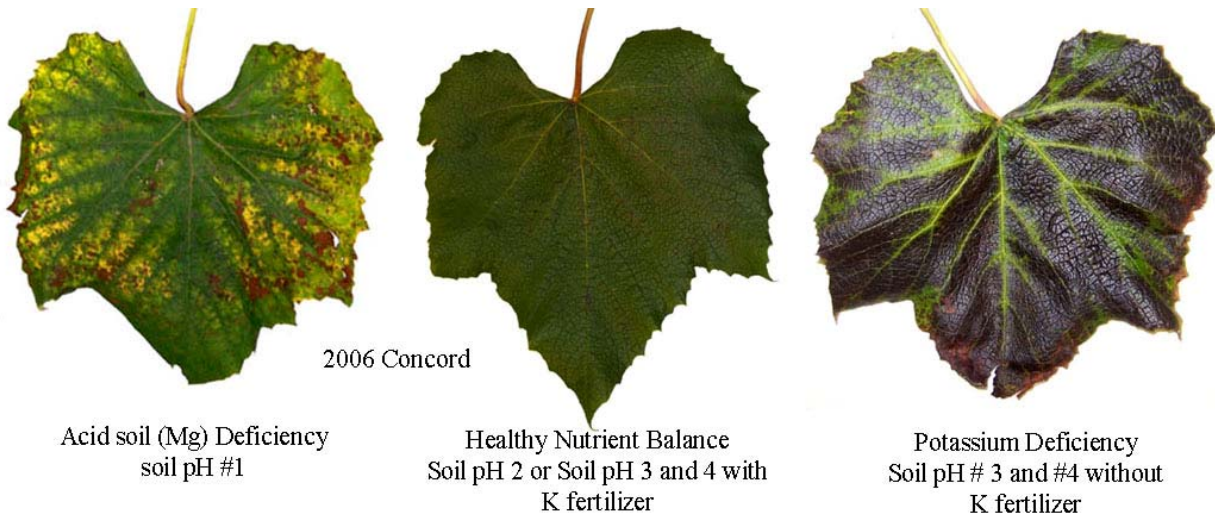
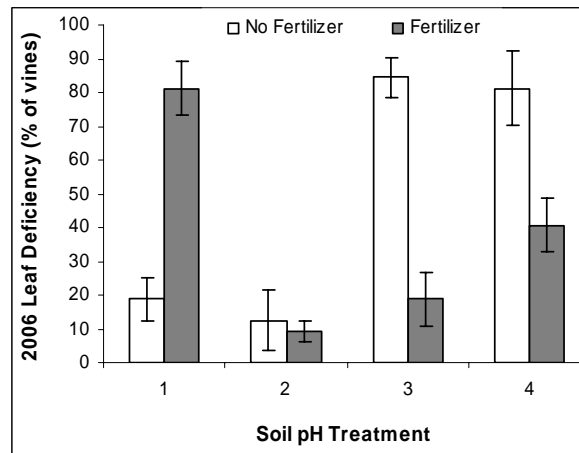


Figure 5 – Visual deficiency symptoms. Leaf health was visually evaluated at veraison in 2006 and the percent of vines showing nutrient deficiency was recorded. At soil pH level 1, non-fertilized vines had lower vine size but maintained healthy green leaves. In past years, fertilized vines at level 1 received P, K, and Ca fertilizers based on tissue nutrient values. The extra K fertilizer further decreased vine Mg, which gave visual symptoms. Soil pH level 2 vines all showed healthy green leaves. Soil pH level 3 and 4 vines, which were not fertilized, showed

severe potassium deficiency. This deficiency could be alleviated with potassium fertilizers. Interestingly, the same treatments in previous years did not show significant visual deficiency symptoms. The difference in 2006 was in the switch from balanced (20+20) pruning to 120 pruning with higher crop load. Vines where the crop was reduced at one month after bloom did show leaf deficiency symptoms but at a much lower severity (data not shown).

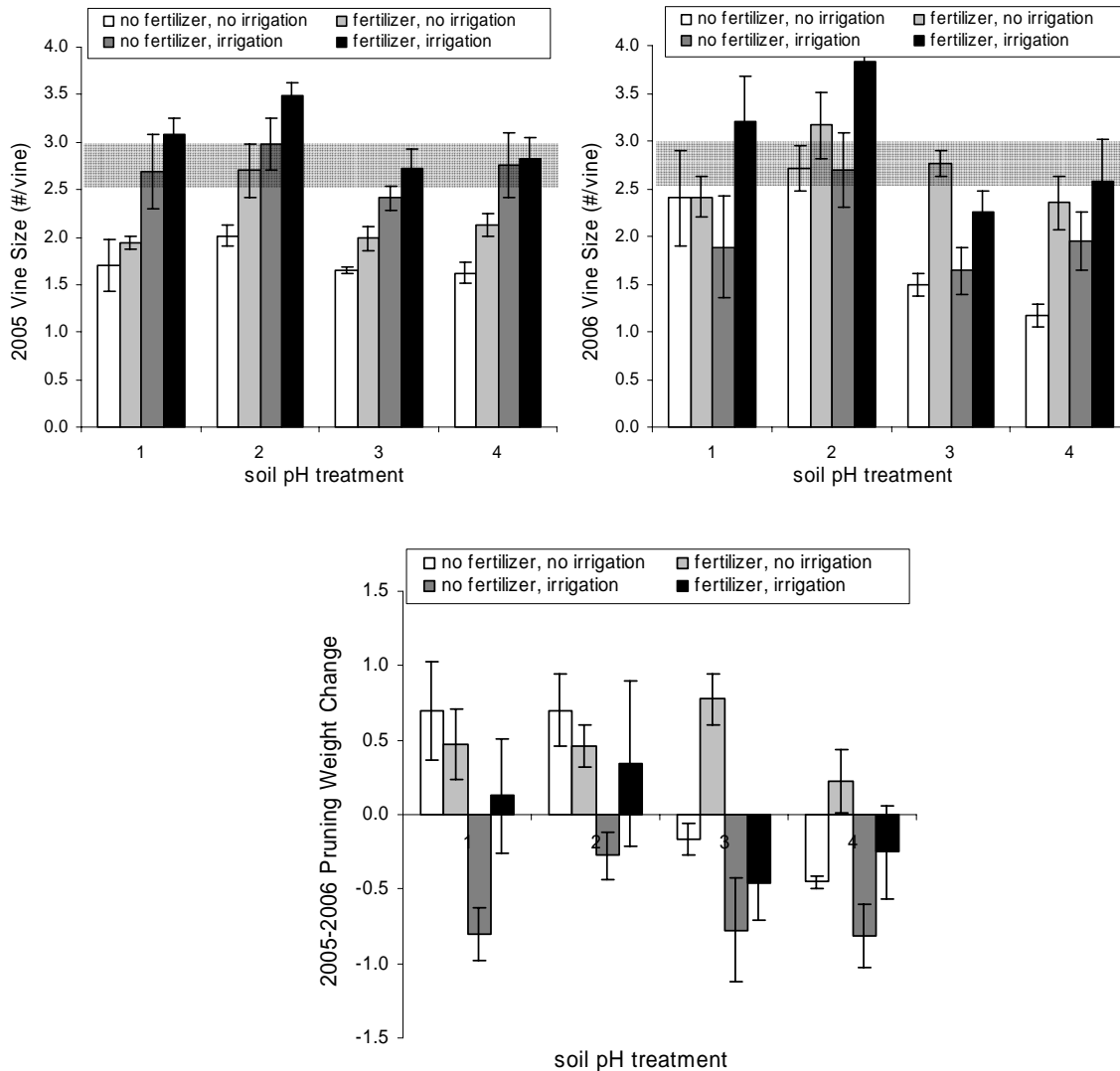


Figure 6 – 2005 and 2006 vine size and the change in pruning weight. The 2005 report indicated that vines with appropriate K-Mg balance had greater vine size and productivity. In addition, irrigation (in a dry season) had a greater influence on vine size than either soil pH or fertilizer (the gray box indicates a target vine size). The vine size pattern was less clear in 2006 (a wet year). Soil pH level 2 continued to have the highest vine size with balanced K and Mg nutrition. Interestingly, all irrigated and non-fertilized treatments lost vine size in 2006 while the irrigated and fertilized vines maintained vine size. This suggests that the larger vine size created by irrigation in 2005 could not be maintained in 2006 without the supporting fertilizers. Conversely, non-irrigated and fertilized vines made the largest jump in vine size in 2006. This

suggests that water was the limiting factor to vine size in 2005 (a dry year) while nutrients were the limiting factor in 2006 (a wet year).

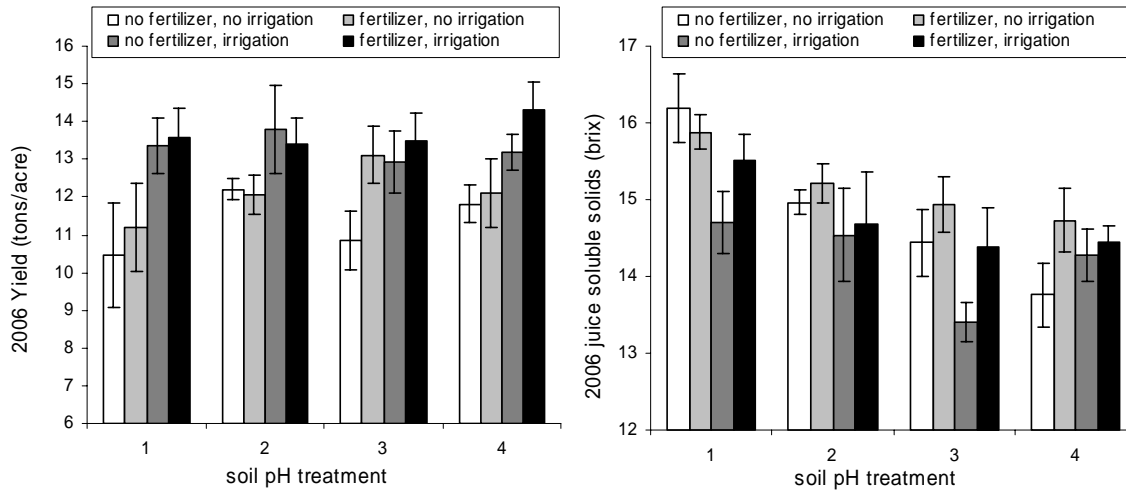


Figure 7 – 2006 yield and brix on 100% crop vines. In general, there was a direct positive relationship between 2005 vine size and 2006 yield on vines with no crop adjustment. Since the vines were pruned to 120 nodes, yield potential was maximized and the 100% crop vines ranged from 10 to 13 tons/acre. Furthermore, there was a direct negative relationship between yield and harvest juice soluble solids. An exception to the general yield-brix relationship was in the vines with severe nutrient imbalances and foliar nutrient deficiency symptoms (i.e. high soil pH without supplemental K fertilizer).

Results for Objective 2:

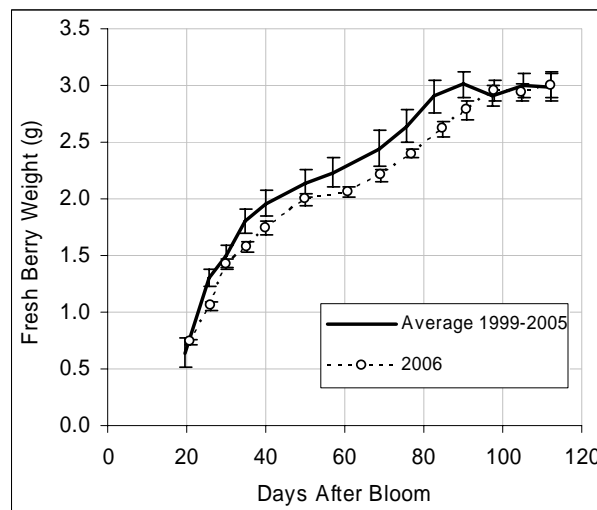


Figure 8 – The 2006 berry curve. The dry spring weather in 2006 led to a slight decrease in fresh berry weight at 30 days after bloom in vines with 100% crop level. However, the late summer wet conditions led to a final fresh berry weight equal to the seven-year average.

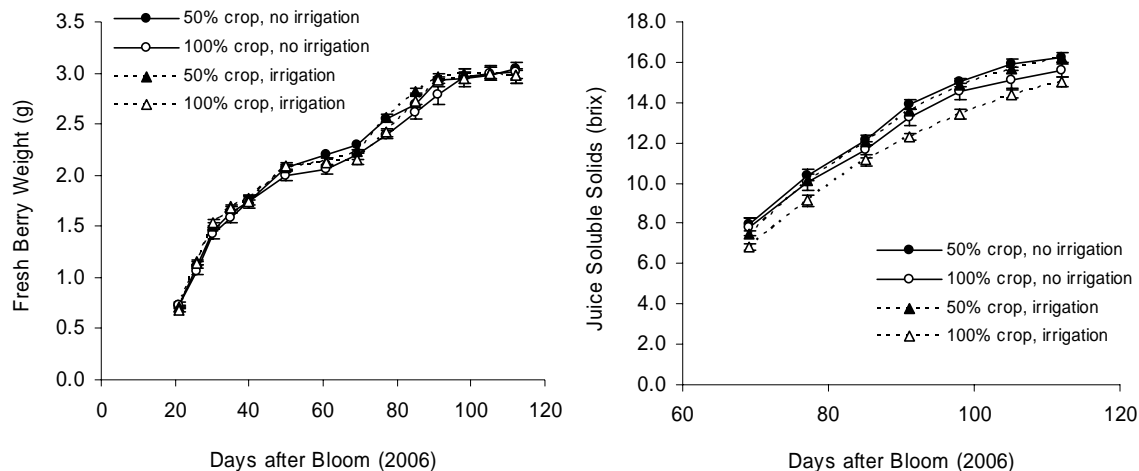


Figure 9 – The 2006 berry weight and brix. The objective in 2006 was to use irrigation and crop adjustment to create a separation in the berry curve. However, the high precipitation in 2006 negated any effect of irrigation on soil moisture or vine water status. Vines with 100% crop and irrigation tended to have slightly lower juice soluble solids because these were the largest vines with the largest crops. The other treatments had lower crop levels because of mid-season crop adjustment (50% crop), low vine size (no irrigation in 2005), or both.

Conclusions:

The previous experiment investigating the effect of soil pH on Concord growth and productivity showed differences in vine size and vine nutrient status. However, the vines were balanced pruned (20+20) and crop stress was not a factor, which is not the case in commercial Concord vineyards. In 2006, vines were pruned to 120 nodes and crop adjusted to 100%, 50%, or 0% crop. High crop stress exaggerated K and Mg deficiencies in this experiment and were measured by bloom petiole nutrient concentrations, visual foliar nutrient deficiencies, and changes in vine size.

The Concord berry curve is used in crop estimation and adjustment procedures and understanding the berry curve is important in increasing the accuracy of the procedures. Irrigation in the dry 2005 growing season led to an increase in final berry weight over non-irrigated vines. High precipitation in 2006 maintained high vine water status for most of the growing season. Therefore we were unable to create any separation in the 2006 berry curves.