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INFLUENCE OF RECENT ACIDIFICATION ON SOIL TEST PHOSPHORUS AND P SORPTION

By Kyle E. Bair and Joan R. Davenport — Washington State University

A common side-effect from continued ammonium fertilizer applications is the production of acidity and a decrease in soil pH. In Eastern Washington State and other low precipitation regions in the Western United States, soil pH values of 5.0 or less are not uncommon. This change in soil pH raises the question of whether the Olsen phosphorus (P) extraction can be used reliably on low pH soils because the method was developed for neutral to alkaline soils.

Soil testing laboratories continue to use the Olsen P extraction on recently acidified soils regardless of soil pH. Extraction methods of plant available P for acidic soils includes: Bray, BP1; Mehlich-III, M3P; Morgan, MMP. Data for use in recently acidified soils are lacking for these methods. For this reason the OP method continues to be the preferred method regardless of soil pH.

The extraction procedures for P in this study are availability indices. In other words, an amount of P that is assumed to be directly related to plant availability is extracted and is dependent on soil properties and plant requirements. Therefore, we wanted to compare how recently acidified soils relate to their high pH counterparts in terms of how much P is extracted (using the extraction methods listed) following a fertilizer application and the amount of P sorbed by the soil.

For this evaluation, 10 soil samples from the Columbia Basin were collected in bulk from 0-12" representing three soil pH ranges (<6.0, 6.2-6.8, >7.0) and three

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SUITABILITY OF COMPOSTS FOR AN ACID-LOVING PLANT: HIGHBUSH BLUEBERRY

By D.M. Sullivan, R.C. Costello, D.R. Bryla, B.C. Strik, and J.S. Owen, Jr. —Oregon State University

Highbush blueberry (Vaccinium corymbosum L.) is adapted to soils with high organic matter and pH of 4.5-5.5. Coniferous sawdust is the blueberry industry standard soil amendment and mulch in the Pacific Northwest, USA. However, sawdust prices are increasing, and its availability is becoming limited. Therefore, many blueberry producers are interested in compost as an alternative to sawdust, which might also reduce the need for nitrogen (N) fertilizers. Our objectives were to: (i) estimate elemental S (S^o) rate needed to acidify compost to target pH for blueberry, and (ii) evaluate diverse composts vs. sawdust as soil amendments in plant growth trials under low and adequate N fertilization regimes.

The compost feedstocks were animal manures (horse or dairy manures; solids + bedding) or plant materials [yard debris (grass + woody prunings from urban landscape maintenance), deciduous tree leaves (from street sweeping), mint (leaves and stems recovered after steam distillation of peppermint oil) or bark (aged conifer bark composted with fine sawdust and municipal wastewater treatment biosolids)]. Finished compost pH was usually 7.5-8.5, except for the bark compost, which had a pH of 5.2.

Composts were titrated with dilute sulphuric acid to determine their capacity to buffer pH (Fig. 1). Compost acidification to pH 5 required an average of 10 g S^o/kg across all feedstock categories. Dairy and mint composts had the highest S requirement, and the most variable compost acidification requirements (within a feed-

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Suitability of Composts for an Acid-Loving Plant: Highbush Blueberry, continued from pg. 1

stock) were found among dairy manure (8-28 g *S*/kg; n = 5) and horse manure composts (4-12 g *S*/kg; n = 4). Yard debris compost had moderate *S* requirement (9 g *S*/kg). Bark compost did not require acidification.

To evaluate compost suitability, two plant growth trials were conducted in pots in acid mineral silt loam soil (pH 5) amended with a high rate of compost or sawdust (30% by volume). Trials were performed in winter in a greenhouse (4-L pots; Jan-May) and outdoors in summer (14-L pots; May-Sept). Soil pH (after compost amendment) was predicted by the pH buffering capacities of composts. Plant growth was strongly affected by soil pH. Shoot and root growth decreased as soil pH increased from 5 (acidic) to 7 (neutral). Plants usually grew better in plant-derived composts (bark, yard debris, or deciduous tree leaf, but not mint) than in manure-derived composts (dairy or horse). Acidification of composts with finely ground S° increased plant growth (Fig. 2). At low levels of N fertilizer addition (Greenhouse Trial), plants grew better with compost than with sawdust. At a higher N fertilizer rate (Outdoor Trial), plant growth with the best performing composts was equivalent to sawdust. Composts with C:N near 20 produced good growth in both trials. Plant growth response to compost was not related to compost NO_3-N analyses and was good in compost treatments with relatively low NO_3-N. Most composts contained soluble salt (EC) levels considered high for blueberry. Yard, leaf, and bark composts had the lowest EC (< 1), while EC in horse, dairy, and mint composts averaged 1.8. 2.5, and 6.1, respectively (1:10 compost: water method). However, compost EC did not appear to be of primary importance in determining plant response to compost. In fact, plants grew better in composts that had been acidified with *S*, even though compost EC was elevated by S° oxidation to sulphate. Salts were rapidly leached from pots in our trials, limiting the duration of plant exposure to high EC.

We conclude that composts with pH < 6 and EC < 2 are ideal soil amendments for blueberry. Composts with higher EC may be acceptable when leaching of salts is assured, or when compost is applied as mulch. Composted woody plant materials (C:N near 20), acidified with finely ground *S*, are the most promising composts for blueberry. Finely ground *S* dust reacted quickly in compost, achieving full reaction in 2-4 weeks. The S° application rate can be customized to match compost buffering capacity using our quick test method (3-d incubation with dilute sulphuric acid).

Contact: Dr. Dan M. Sullivan, Dept. Crop & Soil Science, Oregon State University, 3017 Agriculture and Life Sciences Bldg., Corvallis, OR 97331. 001-541-752-3267. Dan.Sullivan@oregonstate.edu

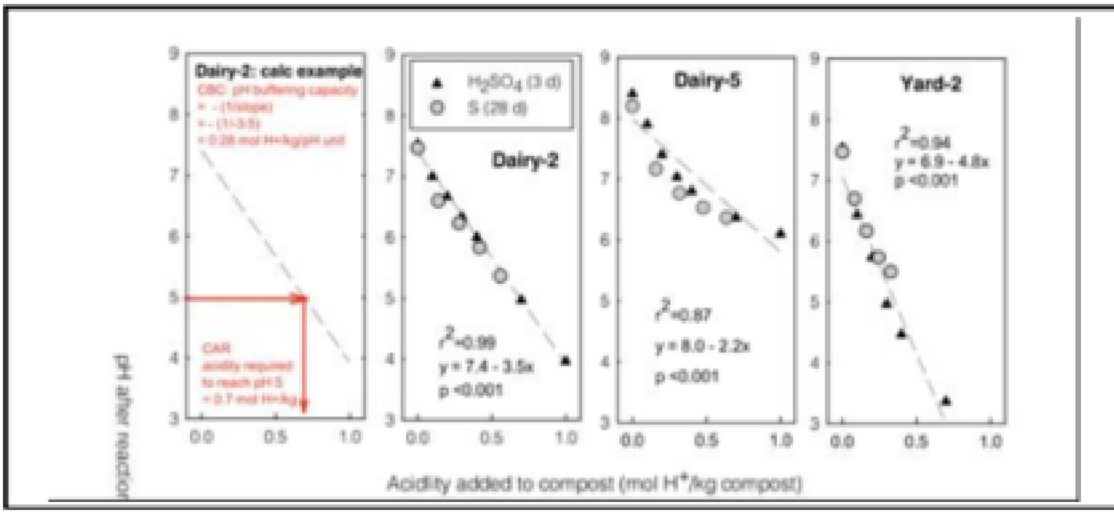

FIGURE 1. Compost pH buffering capacity was measured by titrating compost with dilute sulfuric acid. Compost pH was measured 3-d after acid addition. Left: Illustration of calculation for Compost pH Buffering Capacity (CBC) and Compost Acidification Requirement to pH 5 (CAR). Linear regression was used to determine the slope of pH change per unit of acid addition, and the result was expressed in units of mol H+/kg compost dry matter per pH unit. Middle and right: Titration data used to estimate compost pH buffering capacities for Dairy-2, Dairy-5 and Yard-2 composts. Values obtained in the short term titration (3-d) were also confirmed by adding fine S° dust to compost. The compost pH resulting from S° addition was measured after 28 d at 22 °C.

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Suitability of Composts for an Acid-Loving Plant: Highbush Blueberry, continued from page 2

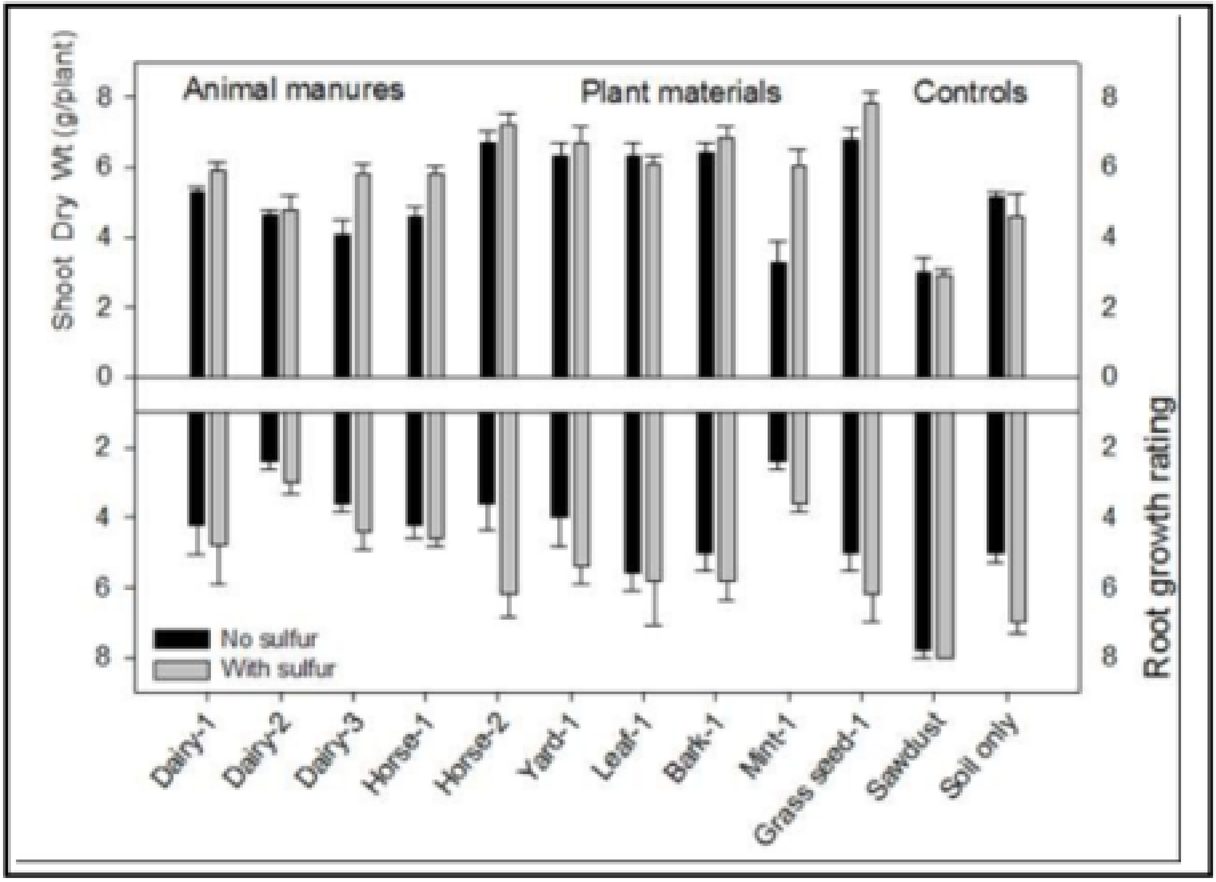

FIGURE 2. Compost effects on blueberry shoot and root growth for acidified compost (with *S*) and non-acidified compost (no *S*). Greenhouse Trial. Root growth rating (1 to 7 scale). 1 = no root growth; 7 = roots extended across pot diameter. Error bar = SE of mean. Plants grown in sawdust-amended soil suffered from N deficiency. Fertilizer N rate used in this trial was low (<0.1 g/plant). "With *S*" = elemental *S* (32 g *S*/kg compost-C) was allowed to react with compost for 70 d prior to potting. Average compost pH reduction with acidification was 1.9 units. Contrasts between feedstock categories (P= 0.05): Shoot growth was greater with compost (n = 10) than with sawdust. Plants produced greater shoot and root growth with composts derived from plant materials (n = 5) than with composts derived from animal manures (n = 5).

Influence of Recent Acidification, continued from pg. 1

Olsen P levels (<10, 15-25, >30 ppm) within each pH range. Soil samples were moistened and fertilized with 0, 92, 184, 276 lbs P_2O_5 per acre (as MAP, 11-52-0). Following a 6-week incubation the samples were extracted with Olsen P, Bray, Morgan, and Mehlich-III. Additionally, the untreated (no P fertilizer added) samples were analyzed for P sorption. Briefly, the soil samples were added to solutions of known P concentration and shaken for 24 hours and then the solution is measured for P. The difference between what is analyzed following shaking and the initial known P concentration is the P sorbed.

Figure 1 shows the change in tested P for each extraction method vs. the P fertilizer application. In practical terms the slope of this line is the expected change in tested P (ppm) for each pound of P_2O_5 applied per acre. For each extraction method the line slope is given for soils grouped as low (L) pH (< 6.0, acid), medium (M) pH (between 6.2 and 6.8, neutral) or high (H) pH (pH > 7.0, alkaline). Of the four extraction methods tests, Olsen P shows the least amount of slope variability (0.14—0.17) across soil pH while Morgan (0.06—0.16) exhibited the greatest differences.

Sorption data can be found in Figure 2. Separating the data by soil pH, it is apparent that soil pH was not a factor in P sorption capacity for the soils tested. The lines shown in Fig. 2 are calculated using the Langmuir Isotherm equation. Comparisons of the terms in this equation further show that sorption maxima across soil pH levels are comparable.

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Influence of Recent Acidification, continued from pg. 3

The results from this study showed that in the context of extraction consistency, the Olsen P extraction proved the most reliable method across the soil pH range tested while MMP was the least reliable. Phosphorus sorption maximum was very similar for the range of pH tested. This is likely a result of the P chemistry existing as predominantly Ca-P form even when the soil pH low or if Fe/Al-P complexes exist, the amount of P extracted is similar to the assumed Ca-P state. The Olsen P method appears to be a viable test for soils that have become acidified over time that are traditionally thought of as calcareous.

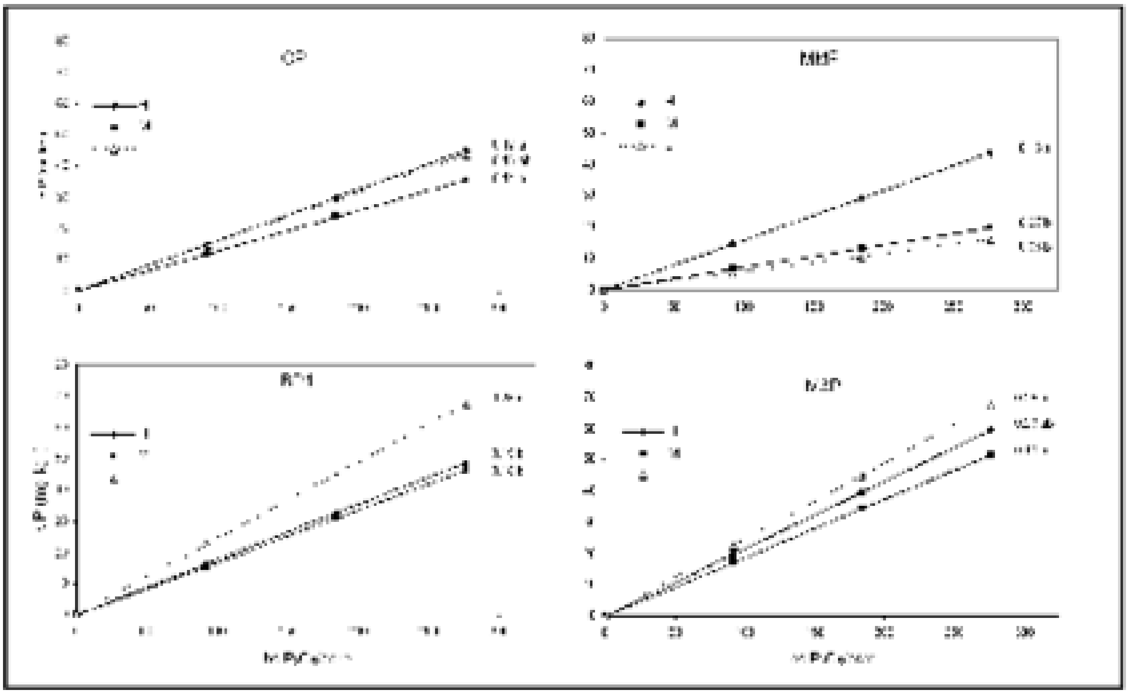

Figure 1. Change in tested P for Olsen P (OP), MMP, Bray (BP1), and M3P extraction methods given the addition of P_2O_5 fertilizer. The calculated slope for low (L), medium (M) and high (H) pH soils represents the expected change in tested P for each pound of fertilizer applied.

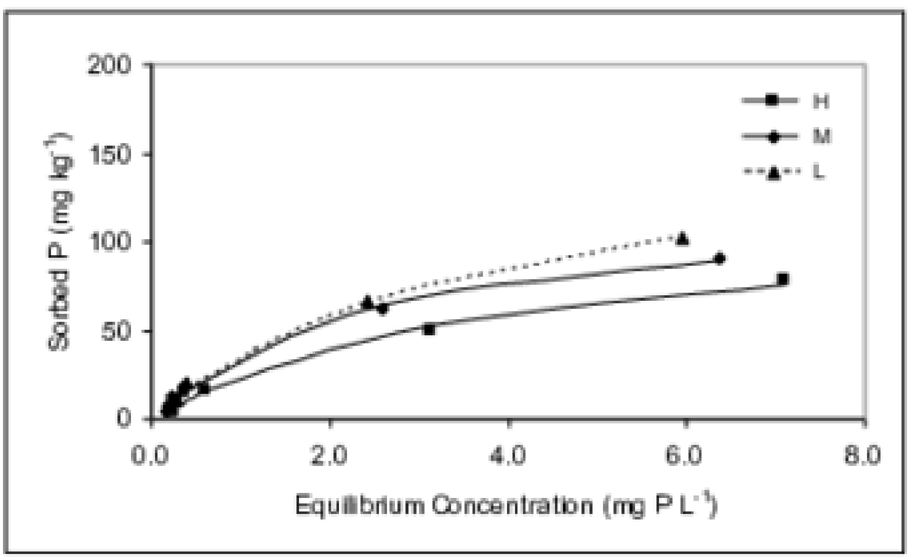

Figure 2. This figure shows the P sorbed vs. the equilibrium P concentration for soils with as low (L) pH (< 6.0, acid), medium (M) pH (between 6.2 and 6.8, neutral) or high (H) pH (pH > 7.0, alkaline). The lines represent the calculated Langmuir Isotherm equation.

SELECTED WINE GRAPE MACRO NUTRIENT DEFICIENCIES

By Joan R. Davenport — Washington State University

Grapes are grown throughout the world, yet curiously absent is a complete pictoral guide to nutrient deficiency symptoms. Thanks to grant funding through the Washington Wine Advisory Board, we were able to induce nutrient deficiencies on pot grown red and white wine grapes and develop a photographic record of symptom development over a 2 year period.

The wine grapes we planted were Cabernet *Sauvignon* (red) and *Semillion* (white). Immediately at the start of the study, we noticed that the leaf color of the two varieties was very different and that the red grape variety had leaves which were much darker green than the white variety (Fig. 1). This is true of field grown vines and is visible when a vineyard block has red and white grape varietals adjacent to each other. However, it is not as apparent when looking at a vineyard block of red only or white only grape vines.

Of the macro-nutrients, the deficiency symptoms that were the most pronounced were nitrogen (N), phosphorus (P), sulfur (*S*), and calcium (Ca). This article will focus on N, P and *S*, and some of the changes based on time of the growing season as well as difference between the cultivars.

Nitrogen deficiency symptoms were apparent early in the growing season. Both the Cabernet *Sauvignon* and *Semillion* plants that were N deficient were stunted early in the season, but leaf discoloration was more apparent in the Cabernet Sauvignon than in the Semillion . As the season progressed, the N deficient plants remained stunted with pale leaves and were visually distinct from the control (full nutrient compliment) plants.

Foliar symptoms from inducing P deficiency in the vines did not become apparent until the middle of the growing season. The leaves were a darker green
than the control

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Figure 1. Cabernet *Sauvignon* (left) and *Semillion* (right) vines early in the 2011 growing season. Note the lighter leaf color of the *Semillion* (white variety) leaves.

Selected Wine Grape Macro Nutrient Deficiencies,
continued from pg. 5

plants regardless of cultivar. Later in the growing season, the red Cabernet Sauvignon vines developed red discoloration on their leaves as well, but only a very trained eye could detect a slight "pink" cast on the leaves of the white Semillion vines (Fig. 2, d).

Compared to N and P, S deficiency was more evident on the red Cabernet Sauvignon vines and difficult to detect on the Semillion. Sulfur deficiency symptoms did not appear in Cabernet Sauvignon vines until later in the growing season, and were first evident through leaf reddening (Fig. 2,b). Comparing the symptoms of the low N, low P, and low S leaves in Cabernet as well as in Semillion was the best way to provide a visual overview of the differences between the nutrient disorder symptoms (Fig. 2,a-d). While both P and S deficient plants both showed red discoloration on the Cabernet Sauvignon leaves, the P deficient leaves were darker green and the S deficient leaves were lighter green than the control leaves (Fig. 2, b).

This information is helpful for use in scouting grapes for pests and disorders. Concord grape and red table grapes symptoms most likely would resemble red wine grapes, whereas white table grapes are more likely to resemble the white wine grapes. In addition, leaf roll virus symptoms are similar to those of low P. Thus, routine soil and tissue testing should be practiced to guide nutrient management and avoid the occurrence of visual deficiency symptoms. Recent guidelines for the inland Pacific Northwest are to sample whole leaf samples at veraison (the onset of berry ripening) to asses vine nutrient status (Davenport and Horneck, 2011).

Davenport, J. R., and D. Horneck. 2011. Sampling Guide and Nutrient Assessments for Irrigated Vineyards of the Inland Pacific Northwest. PNW622.

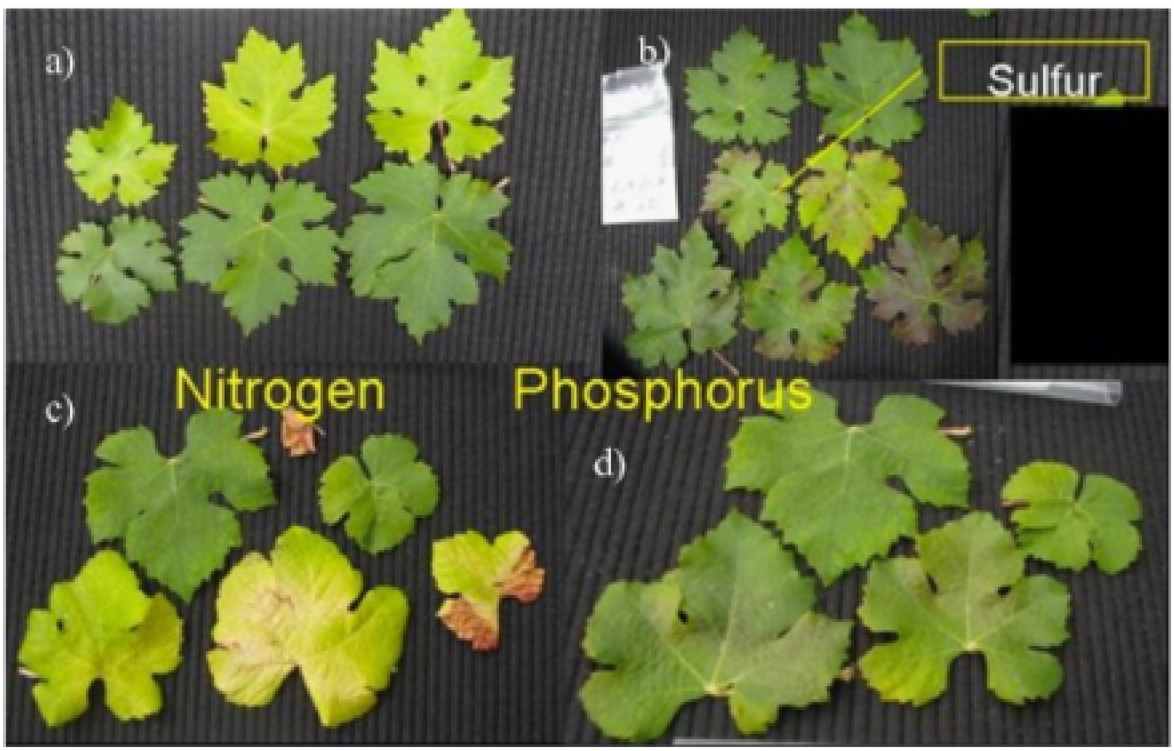

Figure 2. Wine grape leaves of varying nutrient deficiencies in late season, September, 2010. a) Cabernet Sauvignon leaves without N (top row) or with complete nutrient solution (bottom row). b) Cabernet Sauvignon leaves with complete nutrient solution (top row), without S (middle row), or without P (bottom row). c) Semillion leaves with complete solution (top row) or without N (bottom row). d) Semillion leaves with complete nutrient solution (top row) or without P (bottom row).