Effect of Cover Crop or Compost on Potassium Deficiency and Uptake, and on Yield and Quality in French Prunes

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Objectives:

1. Design and lay out an experiment to test the hypothesis that certain management practices within a prune orchard can affect potassium deficiency;
2. Determine the effects of the eight treatments on potassium content of leaf tissue;
3. Determine the effects of the eight treatments on soil solution potassium and on soil exchangeable potassium;
4. Determine the effects of the eight treatments on potassium deficiency symptoms in the leaves;
5. Conduct educational / outreach sessions on potassium deficiency and on this research project, as part of U.C. Cooperative Extension Field Days, the new U.C. Environmentally Sound Prune Systems (ESPS), the Biological Prune Systems (BPS) Project in cooperation with CSU, Chico, through prune cooperatives and processors and handlers, and through the outreach activities of commercial fertilizer suppliers and Pest Control Advisors;
6. Determine the effects of the eight treatments on soil water relations in prune orchards;
7. Determine the effects of the eight treatments on fruit yield and quality.

Summary:

Nutrient deficiencies can be caused by either a deficit of the nutrient in soil, an inability for the soil to supply the nutrient to the crop, or an inability of the crop to take the nutrient up in large enough quantities to meet its demands. To design effective fertilizer

regimes, it is crucial to understand the causes of nutrient deficiency. Potassium (K) deficiency is very pronounced on French Prune trees growing in the Sacramento Valley. The deficiency is especially apparent in heavy-crop years and in heavy-textured soils. Long-term studies have shown that banding K at rates of up to 2,500 lb/acre will increase yields in prune orchards for 3-4 years and will decrease foliar die-back during the heavy-crop years.

Banding of fertilizer is appropriate if a nutrient has the potential to be fixed by the soil. Potassium fixation by soils is dependent on the quantity of vermiculite, and to a lesser extent, illite, present in the soil. These minerals are derived from granitic parent materials. The soils of the upper Sacramento Valley are forming on volcanic parent material which contain no mica or vermiculite and thus it would be predicted these soils have little potential to fix K. Heavy clay soils may cause poor root distribution. If poor root growth is limiting K uptake, management practices that increase root exploration of the soil should help to ameliorate K deficiency.

We will conduct experiments on alternatives to banded K applications at high rates. In our study, we will determine:

1) Whether these soils have the capacity to fix potassium by performing mineralogical analyses and K absorption and release studies in the laboratory; and
2) Whether cover crops and compost application (management practices that encourage root growth in the upper portion of the profile) enhance K uptake and reduce K deficiency.

These parameters will be determined by the following measures: leaf K, exchangeable K, soil-solution K, foliage symptoms, and fruit yield and quality. A replicated field trial will be undertaken on an established planting of French Prunes in an area subject to K deficiency. Factors investigated will include orchard floor management and method of application of K.

Work Description
PROJECT YEAR 1
<u>Pretreatment Sampling, Experimental Design and Layout</u>
Initiate project
Sample leaves
Send leaf samples for analysis
Sample soil
Send soil samples for analysis
Score trees for potassium deficiency symptoms (Method 1)
Score trees for potassium deficiency symptoms (Method 2)
Assess experiment layout

<u>Mineralogy and Potassium Absorption and Release Study</u>
Sample soil
Send soil samples for analysis

Determine mineralogy of clay fraction

<u>Project Reporting</u>
Submit interim report
Submit annual report

PROJECT YEAR 2
<u>Experiment Installation</u>
Prepare site for experiment

Results, Discussion and Conclusions:
<u>Pretreatment Sampling, Experimental Design and Layout</u>
Initiate project
At the initiation of the study, experiment was laid out, trees were tagged to identify the various treatments, and a map of the field was prepared.
Sample leaves
In mid-July, leaves were sampled from spurs at three different heights (5, 8 and 11 ft) from eight designated trees within each proposed treatment block. The 24 leaves from each tree were pooled with the 24 leaves from each of the other seven trees in each treatment block to comprise a 192-leaf sample. The same sampling procedure was then carried out for all 35 treatment blocks.

Send leaf samples for analysis
Composite leaf samples collected in Subtask 1.2 were sent to A & L Laboratories for analysis of potassium content. Requested method of analysis was Flame emission spectophometry.

Sample soil
In mid-July, soil samples were collected from each treatment block as described in the Statement of Work.

Send soil samples for analysis
Soil samples collected in Subtask 1.4 were sent to A & L Laboratories for analysis of solution and exchangeable potassium content, total nitrogen, and Bray phosphorus.

Score trees for potassium deficiency symptoms (Method 1)
In June, July and August, trees were scored for potassium deficiency symptoms on the basis of whole-tree scoring, as described in the Statement of Work. Analysis of variance of resultant data failed to reveal any significant differences due to either treatment or rep, on any of the three sampling dates.

Score trees for potassium deficiency symptoms (Method 2)
In June, July and August, trees were scored for potassium deficiency symptoms on the basis of shoot die-back, as described in the Statement of Work. Analysis of variance of resultant data failed to reveal any significant differences due to either treatment or rep, at any of the three sampling dates.

Assess experiment layout
Based on recommendations from the grower, and on observations of irrigation patterns, a decision was made to distribute the 35 treatment units over 20 tree-rows in the orchard, rather than over the initially-designated 12 rows, in order to avoid edge effects at the tops and bottoms of the rows. (The familiarity with the site that we had gained over the first season allowed us to recognize the likelihood of irrigation irregularities with the flood-irrigation system.) This decision had the added advantage that the cover-crop treatments would be distributed over two different areas in the orchard. A map representing this new layout was generated, and is attached (Fig. 1).

Mineralogy and Potassium Absorption and Release Study
Sample soil
Soils were sampled for the potassium release study in June. Potassium was applied and samples were incubated as described in the Statement of Work.

Send soil samples for analysis
Samples were submitted to A&L Laboratories for solution and exchangeable potassium analysis, and Ca/Mg ratio. Results of these analyses have recently been received. Statistical analysis is underway.

Determine mineralogy of clay fraction
Mineralogy of the clay fraction of the five soil samples collected in June 1999 has not yet been completed. We have contacted a laboratory on our campus with the capability to do this work, and are making arrangement for this portion of the work to be completed.

PROJECT YEAR 2
Experiment Installation
Prepare site for experiment
Following harvest, preparations were made to apply fertilizer and orchard-floor treatments as previously described for Project Year 2 in the Scope of Work. On October 1999, potassium treatments were applied (either banded or broadcast). Because the grower did not want his orchard floor disturbed and the feeder roots cut, we decided to band the Konto the soil surface instead of shanking it into the ground. Since this is the more common mode of application in this area anyway, this seemed to be an improvement in the experiment's design.

Also in October 1999, a plow-down legume cover-crop mix was selected for the site and was planted in those plots designated to receive the cover-crop orchard-floor treatment. Seed was broadcast by hand, then incorporated by shallow cultivation with a no-till drill.

In early spring, two additional measurements were taken in the orchard: 1) trunk diameter of each tree was determined, to provide a base-line estimate of tree size; 2) orchard-floor biomass was estimated by collecting and weighing samples of vegetation in both legume-cover-crop treatments and in the native-vegetation rows within the orchard.