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Determining fertilizer requirements of filberts

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SUMMARY

Studies conducted by the Agassiz Research Station (1974-1982) indicate fertilizer requirements of Fraser Valley filbert nut orchards can be objectively determined by comparing leaf nutrient concentrations with "target" values derived from local research and literature reports. This bulletin presents guidelines for uniform annual leaf sampling and periodic soil sampling, the "target" leaf N, P, K, S, Mg, Ca, K, Cu and Zn concentrations, maintenance rates for N, P and K application, and a discussion of visual nutrient deficiency symptoms. Each orchard's fertilizer rates can be tuned by keeping accurate long-term records of leaf and soil analyses results, management practices, measured crop yields and visual observations.

RÉSUMÉ

D'après des études réalisées à la station de recherches d'Agassiz (1974-1982), il est possible de déterminer avec objectivité les besoins en engrais des vergers d'aveliniers de la vallée du Fraser en comparant les concentrations en éléments nutritifs avec des valeurs "cibles" obtenues à partir d'études locales et de rapports scientifiques. Le présent bulletin donne des directives sur la façon de faire l'échantillonnage annuel et uniforme des feuilles ainsi que l'échantillonnage périodique du sol, les concentrations "cibles" de N, P, K, S, Mg, Ca, K, Cu et Zn dans les feuilles et la dose de maintien pour les applications de N, P et K; il comprend aussi une étude sur les symptômes visibles de carence nutritionnelle. On peut adapter la dose d'engrais aux besoins de chaque verger en tenant des registres précis et à long terme des résultats obtenus par l'analyse des feuilles et du sol, des méthodes culturales, du rendement mesuré de la culture et des observations visuelles.

DETERMINING FERTILIZER REQUIREMENTS OF FILBERTS

C.G. Kowalenko

Commercial filbert or hazelnut production is possible in the moderate coastal climate of southern B.C. Although experimental plantings of filberts were set out at the Agassiz Research Station in the 1880's, the first commercial plantings were not set out until the late 1920's. Since that time there has been slow but sporadic growth in the industry with several of the earliest plantings in the Chilliwack area remaining in commercial production to date.

In the early 1970's there were about 120 hectares of mature filberts in the Fraser Valley, chiefly in the Chilliwack area. Recently there has been a renewed interest in the filbert industry and the acreage devoted to the crop has almost doubled. The 1980 crop was estimated to be 250,000 kg and as the new orchards start bearing the production should increase significantly.

Very little research has been conducted in Canada on filberts largely because it is a minor crop, particularly in the national context. With the increased interest in this crop in the Fraser Valley of British Columbia and the potential for the creation of a significant industry some work was conducted on this crop by the Research Station at Agassiz between 1974 and 1982. The work focused on establishing an objective method for determining the fertilizer requirements of filbert orchards. This bulletin attempts to summarize and interpret the work for practical application.

BACKGROUND INFORMATION

Acknowledgement of the authority for a recommendation is always important and this is no exception. The recommendations in this report are based on research on local orchards and research conducted elsewhere (largely in Oregon). Local research involved two different approaches. One approach was to fertilize filbert trees with a range of nutrients and evaluate the effects on yield and nutrient concentrations in the leaves and soil. However, this approach takes a large amount of resources to examine a wide range of soils, under varying environmental conditions, for numerous fertilizer elements, at several rates of application. The other approach was to survey leaf and soil nutrient concentrations of commercial orchards over several years and to evaluate these data with reference to literature results, response to changes of fertilizer application, and visual evaluation. Consistent relationships among various nutrients were derived. These relationships and critical values for leaf nitrogen and potassium concentrations from literature reports were used to derive "target" concentrations. Although these derived "target" concentrations were not evaluated against yield, the assumption was made that a proper balance of nutrients was established, and that maximum production would result. Boron is one nutrient often deficient

in Fraser Valley soils but for which a "target" concentration was not derived. Levels of boron appears to be quite variable in filbert leaves (concentrations fluctuate throughout the growing season probably in response to water relationships in the soil-plant system) and hence a "target" or "critical" concentration could not be determined.

Leaf sampling and handling methods which would affect interpretation of the results were also examined. Almost all nutrient concentrations (except for boron) were quite stable from mid-August to mid-September. Leaf samples taken within that time interval would therefore largely reflect the nutrient status of the plant. Properly washing of the leaves so that surface contaminants would not interfere with the reliability of the analytical results is also important. Filbert leaves are pubescent (covered with fine hair-like projections) and therefore are very subject to surface contamination which could change the results sufficiently to give false or inaccurate readings.

SAMPLING METHODS

Both soil and leaf tissue samples were examined for their ability to reflect the nutrient status of the orchard. Leaf tissue is preferred since target concentrations were derived by correlating literature and local survey data. Leaf nutrient concentrations are more universally applicable than soil samples. Literature reports of leaf nutrient concentration ranges are often transferable. Only limited success was achieved in correlating soil nutrient extraction measurements with plant response to that nutrient. Additional work is required before a completely satisfactory system can be developed using soil sample analyses.

Immobile fertilizer nutrients such as phosphorus and potassium are frequently applied as narrow bands at the dripline of each tree. It is difficult to interpret data from samples that may or may not have come from the band or may have been some combination on and off the band. Despite these problems, periodic soil analyses are recommended to supplement orchard nutrient evaluation by leaf analyses. A soil analyses may help determine whether or not a nutrient is accumulating or decreasing in the soil under the fertilizer conditions used. Interpretation of analysis data should consider how soil samples are taken in banded orchards. Certainly a soil sample is required to monitor soil pH or acidity. Soil pH for filbert orchards should be maintained between 5.5 and 6.5. This pH range has been found to be suitable for similar crops in the Fraser Valley and suitable for filberts in Oregon.

Leaf sampling should be yearly and soil sampling every 2 to 4 years.

A. Leaves

Leaves should be collected from branches growing upward and outward at about 45^{o} around the edge of the tree at shoulder height or higher between mid-August and mid-September. Choose healthy fully developed leaves from the middle of the current season's terminal growth. The

petiole (leaf stem) should remain with the leaf. At least 50 leaves should be included for each sample, however large orchards would require more leaves than a small orchard to adequately represent the orchard.

The leaves should be refrigerated and kept in an air-tight container (plastic bag) to reduce drying as much as possible if there is a delay before washing. It is extremely difficult to wash dry leaves. All laboratories offering tissue analysis services are equipped to offer leaf washing services.

B. Soil

Soil samples should be taken and prepared according to procedures given by the soil testing laboratory. It is important that the soil sample represents the orchard. Surface samples (0-15 cm) are generally sufficient for determining the need for lime and boron but subsurface samples may enhance the information on which to evaluate the efficiency of fertilizer usage.

TARGET LEAF NUTRIENT CONCENTRATIONS

The following leaf nutrient concentrations are recommended as targets for both mature and immature trees of all currently grown cultivars:

Nitrogen (N)	- 2.2%
Phosphorus (P)	- 0.14%
Potassium (K)	- 0.8%
Sulfur (S)	- 0.14%
Calcium (Ca)	- 1.44%
Magnesium (Mg)	- 0.27%
Copper (Cu)	- 9 ppm
Zinc (Zn)	- 20 ppm

As discussed earlier, critical or target concentrations cannot easily be defined for boron. Observations on leaf boron (B) concentrations of local orchards and literature reports suggest that trees with leaf concentrations below 30 ppm B would probably benefit from an application (soil or foliar spray) of boron. Leaf boron concentrations greater than 150 ppm are considered to be approaching excessive levels which could result in damage to the tree.

FERTILIZER APPLICATION RATES

Fertilizer application rates vary depending on the nutrient status of the orchard, variety of tree and soil type. It is recommended that orchard owners calibrate their orchards' requirement using yearly tissue sampling, periodic soil analyses, accurate records of management practices (type, rate and timing of fertilizer application, pruning, pesticide applications), weather conditions and accurate yield measurements. The fertilizer rate may have to be increased or decreased depending on the leaf analyses results in comparison to the target concentrations. Once

the target concentration is reached in a mature orchard a yearly maintenance application would probably be adequate with small adjustments. The following maintenance rates of the three major nutrients for mature trees, derived from the survey study, are presented as guidelines:

Nitrogen - 250-500 g N/tree
Phosphorus - 0-350 g P/tree (or 0-800 g P_2O_5/tree)
Potassium - 100-350 g K/tree (or 120-420 g K_2O/tree)

The other nutrients should be added in proportion to the deviation from the target concentrations. Only very small rates of boron are required; 1 kg B/ha as a foliar spray may be the most convenient method of application.

Banding immobile nutrients such as phosphorus and potassium at the dripline of the tree results in more efficient use by the tree and is the recommended method of application.

VISUAL SYMPTOMS OF NUTRIENT DEFICIENCY

Insufficient work has been done to give good descriptions of visual symptoms of nutrient deficiencies of filbert trees. Symptoms usually do not become evident until the deficiency is quite severe. In most cases deficiencies are not visible (subclinical) but can adversely affect yields.

Visually evaluating an orchard could be a valuable supplementary tool to evaluate fertilizer effectiveness. Some symptoms to watch for include: small and pale-green leaves (possible nitrogen or sulfur deficiency), leaves (small or large) that are beginning to turn brown at the outer edges (probably potassium deficiency), leaves that have brown spots between the veins radiating out from the mid-rib (probably magnesium deficiency) and die-back of terminal branches (possibly boron or zinc deficiency). Boron has been implicated at times with poor flower set. Other factors such as physical, insect, weather and pesticide damage must be considered as well when visually evaluating the orchard. Excessive levels of nutrients can sometimes result in symptoms similar to those of deficient levels.

In many cases, visual symptoms will occur only in part of the orchard or on some of the leaves on a tree. When such deficiencies are seen or suspected, visual evaluation should be supplemented with leaf and soil analyses. Corrective action should be taken if these areas are large enough to justify special management practices.

GOOD RECORDS KEY TO SUCCESS

A fertilizer recommendation system, whether by leaf or soil analysis for perennial crops, is difficult to derive. Even though correlations between nutrient concentrations and yield response can be determined similar to that for annual crops, the long term health of the tree must

also be considered. The effect of fertilizer practices on long term health is much more difficult to research. However, filbert growers have the advantage that the crop is a very long term crop affording the opportunity for annual "fine tuning" of fertilizer usage. Fertilizer applications can be determined quite precisely by keeping an accurate log over the years of visual evaluations and leaf and soil analyses results in addition to all management practices and yields. Change in leaf and soil nutrient concentrations from year to year are as important if not more important than one single year analysis result. Leaf and soil sampling and analyses methods should be kept as uniform as possible from year to year (same area and way of taking samples, consistent sample preparation, etc.) to make interpretations of changes as meaningful as possible. Consistency of sampling and accuracy of records are the key ingredients in providing information for optimum fertilizer utilization.

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