Quantifying Crop Fertilizer Needs

Years of research on the major crops: corn, wheat, soybeans, cotton, etc. have resulted in volumes of information on critical levels of nutrients, crop response, and high yields. Attention to fertilization practices focused on the economic balance between yields, costs, and net income. Now with the many side effects of intensive agriculture: insect & disease resistance, pollution, high energy use and quality considerations, more attention to the whole system is warranted. however, many cropping systems will not necessarily support the economics of 'perfect' soil building programs. I believe the agronomic facts must be reported then sound fertilizer practices formulated with economic considerations. There are many ways to accomplish balanced soil fertilty - I have outlined the basic concepts and methods. A method to quantify local crop needs without the years of research for crop response studies (which usually only study yields) is needed. Most fertilizer recommendations are made from a combination of theory, practice and research. A simple, quantifiable model for minimum fertilization levels is needed.

To quantify actual crop removal requires analyses of the nutrients removed from the soil in the harvested portions. This provides good minimum figures for fertilization - simply replace the nutrients removed. Early researchers such as Hilgard (1893), Wickson (1919), and van Slyke (1932) considered only the nutrients removed in the fruit. Continued production of trees and. vines, however, is not that simple. Nutrients are tied up in the wood, and best considered permanently removed as long as the orchard or vineyard stands. Other nutrients are removed from soil, then returned through drop of fruit, leaves and prunings. Most of these are decomposed and returned within a year. More recently, researchers such as Rogers, Batjer and Billingsley (1955) considered total amounts of nutrients removed annually by trees and vines to be important. With the knowledge that vegetative plant parts can compete with fruit for deficient nutrients, the term `nutrient budget' has been used to keep track of losses and inputs in agro-ecosystems (Haynes & Goh, 1980).

I propose using crop nutrient utilization - the annual requirements of the fruit and vegetative parts - to quantify nutrient needs. By averaging the various

studies, I compiled Table 7, which shows annual nutrient utilization of orchards and vineyards. When used with a standard soil analysis, limiting factors can be identified and the minimum amounts of fertilizers needed can be determined.

Table 7

Nutrient Utilization by Tree Fruits & Vines

Crop	Yield	N	P_2O_5	K_2O	Ca	Mg
Apple	20 tons	118	48	202	88	36
Apricot	15 tons	129	42	206	114	24
Cherry	12 tons	118	35	160	91	19
Grape	6 tons	59	17	62	46	13
Peach	15 tons	116	30	150	101	24
Pear	20 tons	120	40	174	132	28
Prune	12 tons	101	35	168	91	20

Note. Nutrients contained in fruit, seeds, skins, & woody parts, in pounds/year. From: Abdalla & Childers (1973), Batjer, Rogers, & Thompson (1952), Bennett (1993), Cahoon (1985), Haynes & Goh (1980), Neilsen & Edwards (1982).

If the amount of a given nutrient removed by the crop is not present in adequate amounts in the soil, or is not replaced through fertilization, the soil is being "mined". For instance, if a soil is low in P and a crop removes 50 pounds P per acre every year, that nutrient will be limiting production, quality, or pest & disease resistance. After 10 years that soil will have lost 500 pounds of available P. The minimum fertilization program should be the maintenance of such nutrients at crop removal levels; a soil building program would obviously provide more.

While removing more nutrients than one replaces seems logically unsound, the practice is common in northern California agriculture and around the world. Remember, nitrogen is the most commonly applied nutrient; N-P-K sales the last 20 years were 62.3%, 22.8% and 14.9% respectively. Comparison with the crop

removal figures for the major area crops show that most crops remove more potassium than any other nutrient. The pounds of nitrogen removed is usually next, followed closely by calcium.

A vineyard fertilized for the last 20 years with N alone would have removed 340 pounds of P_2O_5, 1240 pounds of K_2O, and 920 pounds of Ca per acre. A pear orchard over that same period would need replacement of 800 # P_2O_5, 3480 # K_2O, and 2640 # Ca. This same pear orchard planted to grapes would start out with a serious potassium, phosphorus and calcium deficit. This does not consider the additional losses from leaching or erosion. Magnesium, sulfur, and several micronutrients will be depleted in similar fashion if not replaced. I have discussed the observed and documented relationship of fertility to pest & disease problems; how many more subtle relationships exist? How much impact does this trend have on quality, flavor, storage life, and ultimately, pesticide use? Is this sustainable economically and agronomically?