UC Davis Student Farm Market Garden Soil Fertility Management Strategy

History and Background

The fields in the Market Garden have been farmed organically since 1977. The goals of fertility management on the farm have been to provide plants with the nutrients they need to grow and to add organic matter to the soil. The most important nutrients needed by plants are nitrogen, phosphorus, potassium, calcium, sulfur, and magnesium. Over the years we have used the main fertility practices of organic farming: cover cropping, compost applications (at a rate of approximately 10 tons/acre), and supplemental applications of and organic fertilizer (pelleted feather meal 12-0-0).

Compost contains macro and micro nutrients often absent in synthetic fertilizers, but is only a moderate source of nitrogen, usually containing between 1 and 2%. Compost also improves the soil. It helps retain nutrients by increasing the cation exchange capacity (CEC--the potential of a soil to absorb and exchange chemical nutrient ions), which means less runs off to pollute waterways. Compost buffers the soil, neutralizing both acid & alkaline soils, bringing pH levels to the optimum range for nutrient availability to plants. Adding compost makes soils easier to work, improves drainage and water holding capacity, improve soil structure which reduces erosion. It is also beneficial for its microbes, which can help suppress disease organisms.

Leguminous cover crops, on the other hand, are a good source of nitrogen (can add up to 150 lbs./acre), but add no other nutrients. They do, however, contribute considerable organic matter, which helps increase organic matter levels in the soil, which likewise helps with drainage, water holding potential, and the cation exchange capacity .

Using compost and cover crops as plant fertilizers is more complex than using synthetic fertilizers. When compost is added to the soil, only 15 to 20% of the N may be available the first year because the organic matter must be acted upon by microbes and changed into a mineralized form before they can be taken up by plants. Leguminous cover crops break down faster and can release up to 50% of the nitrogen content in the next 2-3 months following incorporation. The Market Garden soils have about 2.5% organic matter. Since most of this is in the top foot of soil (4,000,000 lbs), and organic matter is composed of roughly 7% nitrogen, and an average rate of mineralization during the warmer months is 2%, then about 140 lbs of nitrogen is available for plant growth during the summer growing season. The Market Garden is farmed intensively, with 2 to 3 crops grown in same ground each year, and the demand for nutrients is continuous and high. Non-leguminous vegetables require 100 to 200 lbs./acre of N.

Supplemental organic fertilizers: These include processed animal wastes like poultry manure, poultry feather, fish by-products, blood meal, bone meal etc. We having been using pelleted feather meal, 12-0-0, to provide nitrogen for our crops without adding more P and K. Most of these products also require mineralization by microbes before the nutrients are available to the plants.

Nitrogen mineralization is also accelerated by soil solarization (covering soil with clear plastic for six weeks over the summer to kill weed seed.). One of the effects of solarization is to kill the

microbial population in the top inch and half of soil. Microbe death results in a release of nutrients.

Soil Testing: What nutrients are needed can be determined in part by soil nutrient testing. This year we tested the solarized beds to evaluate, in particular, whether the 12-0-0 applications were providing sufficient Nat the time of planting. Test results and future actions follow below.

Nitrogen(N): Combining the nitrogen from existing organic matter N mineralization with the 12-0-0 and the release from solarization clearly resulted in more than adequate N availability at the time of planting. These solarized beds are being planted to root crops, which require 150 lbs. N/acre. The test indicates nitrate nitrogen (mineralized) in these beds is 43 ppm, which equals 172 lbs./acre. Next step: Take a soil test for non-solarized beds to see how it compares. The solarized beds are also due for a cover crop. Cowpeas could be planted next summer. Also, take a soil test before the next crop and see how nutrient levels, have changed.

This table provides estimates of N, P, K losses to the harvested crop. A typical tomato crop is 40/tons/acre, so 100 lbs. of N, 40 lbs. of P, and 227 lbs. of K could be removed by the harvest.

Vegetable Crops-amount of N, P, K removed by crop.

		N	P	K
Broccoli	lb/cwt	0.44	0.17	0.42
Cabbage	lb/cwt	0.39	0.09	0.36
Celery	lb/cwt	0.19	0.11	0.50
Lettuce	lb/cwt	0.24	0.08	0.50
Potatoes	lb/cwt	0.35	0.15	0.56
Squash	lb/cwt	0.42	0.10	0.60
Sweet potatoes	lb/cwt	0.52	0.23	1.00
Tomatoes		2.50		5.70
	lb/ton		0.92	

Phosphorus (P): The soil test indicates that phosphorus levels are very high. This is probably the result of years of compost applications (compost contains 0.3 to 3.5% P) and inherently P-rich soil. At a soil pH of 7.9, P is not very soluble and should not leach out of the soil. Soil erosion could transport P-rich soil into surface waters, but given our level fields and distance from Putah Creek, this is very unlikely. In recognition of the high P levels, we have in recent years substituted leguminous cover crops and 12-0-0 feather meal pellets for compost, to add N without adding P. Next step: While it is not clear that high P levels are a problem, we plan to reduce the application of compost to 3 tons/acre to reduce compost making and spreading costs, but continue it's use for microbial and soil building effects, and micronutrient inputs..

Potassium(K): The soil test indicates very high potassium levels. Next step: Minimize the application of compost to 3 tons/acre for microbial and soil building effects.

Magnesium and Calcium(Mg and Ca): Magnesium levels are very high and calcium levels are low. We have been adding calcium sulfate (gypsum) to soil, mostly on tomatoes and peppers, which are very susceptible to blossom end rot, a physiological condition due to a lack of Ca. Next step: We should increase applications of calcium. Three hundred lbs./acre of gypsum should be applied this year.

Sodium (Na): Levels of Na are moderate. Our compost is made from animal manures which can be high in Na. Minimizing compost use should help to keep Na levels in the low to moderate range.

Overall Strategy: Continue to use leguminous cover crops and 12-0-0 to provide N for crops. Apply minimal compost for microbes and soil building. Apply calcium in the form of gypsum to increase levels in soil. Expand soil testing to monitor different areas of field. Use soil tests during the season to manage N.

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