Changes in soil properties and vegetable growth/quality during the transition toward organic farming in Hawaii

Nguyen V. Hue

Cabbage (above) and eggplant (below) are ready for harvest.

Organic farming has expanded rapidly in recent years and is seen as a good alternative to chemical-based conventional farming systems. Before being qualified as organic, a farm must undergo at least 3 years (in the US or 5 years in the European Union) without chemical fertilizers and synthetic pesticides. Thus, nutrient management in organic farming systems has to rely on soil fertility building via nitrogen (N) fixation, crop rotation, and nutrient recycling from organic materials, such as farmyard manure and crop residue. During the transition from conventional to organic farming, N availability may decrease due to a shift in biological activities and N sources that could not be immediately available for plant use. Consequently, crop yields may be lower than those under conventional practices. Despite such a short-term decrease in crop production, the applications of organic soil amendments usually improve soil quality over time. The benefits include (i) an increase in soil microbial activity; (ii) a decrease in soil bulk density and an increase in water holding capacity and infiltration rate; and (iii) a slow but steady increase in soil organic matter and nutrient retention capacity. Predictably, total soil N would increase with organic amendments, but other plant nutrients, such as phosphorus and potassium often increase as well.

Perhaps because of improved soil quality, organically grown crops often contain more vitamins (especially vitamin C), phenolic compounds, and carotenoids than conventionally grown crops. That partially explains the premium prices that organic vegetables could command in the market.

Anticipating a strong movement toward organic farming in Hawaii, we recently conducted a study to quantify changes in properties of a tropical, nutrient-poor soil of Hawaii, where vegetables (Chinese cabbage and eggplant) were grown organically.

The trial was at the Poamoho Experiment Station (21°32'11" N - 157°56'24" W) of the University of Hawaii. The treatments consisted of a control (no soil nutrients added), a treatment with 500 lb/acre as urea (chemical fertilizer for comparison), and two types of (compost + chicken manure) amendments, which provided approximately 300 lb/acre total nitrogen (N). Chinese cabbage (*Brassica rapa*, Chinensis group) and eggplant (*Solanum melongena*) were grown sequentially as test crops.

Weeds, especially Guinea grass (*Panicum maximum*), and leaf insects were problems for crop production if not controlled.

Figure 1. Young cabbage was being grown organically on an iron oxide-rich soil (Oxisol) of Oahu, Hawaii. (Corn was used as wind breaker.)

Figure 2. Without some kind of mulch, weeds would overgrow the crop.

Soil quality as measured by hot-water soluble carbon, microbial enzyme (dehydrogenase) activity and nutrient retention capacity was increased by compost amendments. Nitrogen nutrition seemed to be the main factor that improved growth and carotenoid content in cabbage. The treatment with urea promoted better growth in the first crop (cabbage), whereas a good-quality compost, made of grass-clippings/tree trimmings, lime and rock phosphate, gave the best growth in the second crop (eggplant), suggesting N mineralization from organic inputs requires time (at least 3-4 months) in field conditions before N became most available to crops.

In conclusion, switching from conventional to organic farming provide opportunities as well as challenges in getting good crop yields and making profits. These challenges include weeds, insects, and plant nutrient requirements. Amending the soil with good quality composts (characterized by low C/N ratio, high N, P, K and micronutrients) is essential to providing adequate nutrients in organic farming. Synchronization between crop demands and nutrient release from soil amendments is important. On the other hand, soil quality was improved by adding organic amendments, especially to low-fertility soils of the Tropics.

For detailed information, visit http://www.ctahr.hawaii.edu/huen/nvh/ortiz-escobar_hue.htm

FMI: Dr. Nguyen Hue
Email: nvhue@hawaii.edu