Summary of Soil Issues and Solutions at Demo Garden, Summer 2014

In 2014, the Multnomah Demo Garden had 3 beds that showed poor germination, poor growth, and discolored foliage (see "Description of Crop Symptoms" at end of this document). No signs or symptoms of insects or diseases were found and the symptoms did not seem to be caused by weather extremes, drought, or herbicides. Some of the symptoms, such as interveinal chlorosis, looked somewhat like nitrogen deficiency. We suspected that soil fertility (or lack thereof) might be the problem. Here are the steps we took to diagnose and correct the problem.

1. We examined recent (fall 2013 and spring 2014) soil test results from the 3 affected beds (Beds D, N, and P) plus 2 unaffected beds (Beds L and M). All 5 beds had very high levels of organic matter and phosphorus that were above recommended levels, low levels of nitrogen (to be expected in fall and early spring since N is very soluble), and medium to high levels of potassium. Other nutrient levels were variable from bed to bed and the affected beds did not show more similar nutrient levels to each other than to unaffected beds. The pH of beds varied from 7.4 to 6.4, but again, the affected beds' pH's were not uniformly higher or lower than the unaffected beds'.
2. We noticed un-decomposed wood chips on the soil surface of Beds D, N, P (photo below on left). There were no un-decomposed wood chips on the soil surface of Beds L and M (photo below on right).

3. To further compare the amount of wood chips, we did the following:
   Three-quarters cup of soil (from surface to 4" deep) from each of the 5 beds was pressed through a 1/8"-mesh screen. Beds D, N, P all had some un-decomposed wood chips that did not pass through the screen. Beds L and M had no wood chips remaining on the screen. These screening results were consistent with visual observations of the beds where small wood chips are visible on soil surface of D, N, and P but not L and M.

   Note: several other beds at the garden also had visible wood chips on the soil surface: Beds C, F, G, H, and J.
4. We took soil samples from each of the affected beds (D, N, P) as well as unaffected beds L and M. Each sample was a composite of 6 subsamples spaced throughout the bed, 0-6" deep (after top debris scraped away). The samples were delivered to A& L labs for a full analysis the third week of September, 2014.
5. We looked at fertilizer and amendment history for each of the 5 beds. Two things stood out:
   a. 2 of the 3 symptomatic beds (D and P) had received a substantial amount of Mt Scott's 4-way mix in early spring of 2014. Mt Scott's 4-way mix consists of equal

parts of topsoil, composted cow manure, composted yard debris, and sand. The yard debris was likely the source of the un-decomposed wood chips. Although application of 4-way mix was not recorded for Bed N, we suspect that it had been added but not recorded due to the un-decomposed wood chips in it. Garden records show that Beds C, F, G, and H also had 4-way mix added; as with Bed N, we suspect that 4-way mix had been added to Bed J but was not recorded. All 5 of these beds had visible wood chips on surface.

b. No mid-season fertilizer applications were made to Beds D and P. Various mid-season high N fertilizer applications were made to some of the crops in Bed N but no crop got more than one mid-season application. Fertilizer was applied at the time of planting to all crops in these beds.

6. Soil test results were received about one week after sending in soil samples. Most (91%) nutrient levels remained in the same category (Very Low, Low, Medium, High, Very High) or only moved one category, up or down. Levels changed up or down two categories only 7% of the time. No levels changed more than 2 categories. Recommendations on the test results were to apply nitrogen, limit applications of micronutrients where high, add potash where K low, add sulfur where sulfur low, and raise soil pH where low. The following statement was made regarding high levels of organic matter: "High levels of un-decomposed material may cause temporary nitrogen and phosphorus starvation. Feed extra readily-available nitrogen to avoid this."
7. We had several follow-up conversations with Darcy Peebles, agronomist at A&L Labs as well as with Claudia Groth and Weston Miller. These conversations are documented in a separate document ("Follow-up Discussions Demo Garden Soil"). As stated in the lab report, the most likely cause of symptomatic plants in our affected beds was unavailability of nitrogen – because soil microorganisms were using any available N to break down un-decomposed organic matter (OM). So, our questions to him revolved primarily around how to speed up the decomposition of the woody OM, what form of nitrogen to apply, and when. We asked additional questions about application of sulfur and phosphorus, about soil tests – when is the best time to take them, causes of variability in results, how best to sample - and how organic matter is measured.
8. Based on these soil test results and the follow-up conversations, we will be implementing the following actions at the demo garden (some already completed):
    a) Add fast-acting nitrogen to beds with un-decomposed wood chips this fall. We decided to use urea since it readily converts to the ammonium and nitrate forms of N which can be used by microorganisms to break down the wood. We expect some break down to occur this fall and more in the spring (activity of microorganisms will decrease in winter with drops in soil temperature). After applying the urea, beds must be covered with plastic since nitrate N leaches readily.
    b) Do not add OM to beds where OM is greater than 10% (ideal is 5-10%) – probably don't need to add OM for several years.
    c) Use topsoil rather than compost to raise the soil level in a bed. It is better to do this in the fall rather than in the spring.
    d) Test soils in all beds this fall – have the complete analysis performed which includes OM, nitrogen (N), phosphorus (P), potassium (K), micronutrients (such as sulfur, boron, zinc, etc), and pH. Level of pH will tell us if we need to lime certain beds (in the fall).

e) Test soils in veggie beds in the spring (within 1-2 weeks of sowing or at sowing) – have the simpler basic analysis performed. This will give us a recommendation for key nutrients such as N, P, K, and S and to see if lime was effective in raising pH in beds where applied in fall. We will also be able to track levels of organic matter in all beds (hopefully percentage of OM will start to drop).
f) Do not apply P to any beds where P is greater than 30-60 ppm (Weak Bray test). Fertilizers for these beds should not have any P in them! The EB Stone products that we have typically used have as much or more P as N (Sure Start is 4-6-2; All Purpose is 5-5-5) and have a variety of N sources with varying rates of N release.
g) Add readily available N to soil at time of sowing or planting. Our preferred fertilizers are organic. However, few organics have high N, no or very low P, and are fast-acting. Feathermeal has no P (12-0-0) but has only a moderate rate of N release. Blood meal and fish emulsion have rapid rate of N release but both have some P; blood meal is 15-1-1 and fish emulsion is 5-1-1. We may want to consider a combination of organic and synthetic N products.
h) Add N at a couple points during growing season for most crops (see A&L recommendations as well as crop-specific info on fertilization needs).
i) Be aware that rain and watering can leach N, so it is best to not over-apply and to apply when plants can use it immediately. Organic forms of N are released more slowly so there is less to leach if it is not immediately taken up by the plant. If applying N to fallow beds, tarping will prevent leaching.
j) Test any amendments that we bring into the garden (topsoil or compost) and then cover until used. We can ask the supplier for analysis results but the results may not be current and may not represent the load we purchase.
k) Use compost with a carbon to nitrogen ratio of 20 to 1, or lower; if the ratio is any higher (more carbon), then N will need to be added. Chicken manure is about 10:1; cow is 10-30:1; horse is 20-50:1. We should look at compost before we buy to make sure it is well-decomposed and has no big un-decomposed chunks.
l) Consider doing tissue tests on a few crops to monitor N-content of plant through the growing season.

Description of Crop Symptoms in Beds D, N, P

Bed D – 2014 showed poor growth of lettuce, beets, chard, and spinach in the first planting; and slow germination and poor growth of beans in 2nd planting. Currently pole beans are showing some yellow leaves at bottom and mid-height (photo below on left) and bush beans are small with small and off-color leaves.

Bed N – 2014 showed delayed pea germination and slow growth with foliage a silvery green (not seen on same variety in one Master Gardener's community garden bed on same site); slow growth, shorter growth, and lower productivity (66% less) of Emerite and French Gold pole beans than those planted 1 week later in the community garden bed; poorer growth of cabbage at N end of bed; smaller plants with fewer fruit of Paul Robeson and Isis Candy tomato varieties than seen in same varieties in the community garden bed. In 2013, beets grown in this bed were extremely stunted.

Bed P – 2014 showed poor germination of root crops, particularly beets. Poor growth of all veggies in this bed except carrots and chard (chard was actually started in Bed D in April and then transplanted to Bed P in early June). Beet foliage was chlorotic and stunted (photo below on right).