In this presentation, I comment on some of the things I have learned over the years about diagnosing plant problems including, monitoring, submitting good samples and some of the more difficult to diagnose conditions.

**What is monitoring?**

Monitoring is the regular inspection of plants to detect the presence of damaging insects, weeds, diseases, nematodes, or other adverse environmental conditions (Raupp 1985). Monitoring provides the information to pinpoint the location of pests and apply controls in the most effective and timely way. Monitoring also provides information on the presence and activity of beneficial organisms that may eliminate the need for other controls, and tells the manager how effective previous controls have been. Monitoring is accomplished by visual inspections and a variety of trapping devices and may be facilitated by recording environmental data, such as temperature, rainfall and humidity. Recording of cultural information such as fertilizer applications, leachate analysis and water quality evaluations may also be important. It is usually best to have one person assigned to maintaining a scouting and monitoring program. However, every staff person should be trained to be on the lookout for signs of pest activity and occurrence.

**Number of Visits**

Work done in a similar zonation to Michigan concluded that an effective IPM program for landscapes requires a minimum of 10 plant-monitoring visits each season. At least two visits each month from May through August plus one in late winter or early spring and one in the fall. This schedule is best suited to a site where deciduous plants prevail. On sites where conifers are most abundant, a few extra early season and late season monitoring visits are advised, as these plants are attacked by several species of cold-tolerant pests. The fall visit should include observations for large for large populations of over wintering stages such as spider mite eggs. The late winter visit is needed to look for scale insect infestations before foliage obscures the branch of deciduous plants. Dormant spray oils can be applied at this time.

For most Michigan nursery sites, which contain some coniferous stock, a minimum of 20 plant-monitoring visits each season are required. These visits should include at least two per month in February to March, three each month in April and May, two in June, July and August and two each month in November to December. Ideally,
nurseries, pest should be monitored for once a week, however, the above offers some guidelines as to peak times to be looking for pests.

**Abiotic versus Biotic.**

Abiotic disorders usually cause *uniform* patterns of injury. Abiotic means the causal organism is not alive. Biotic problems cause *non-uniform* patterns of injury and causal organism is alive. Some common non-infectious or abiotic disorders are physiological disorders like graft incompatibility, chemical injuries, nutritional deficiencies or excesses, planting problems, environmental injuries or salt damage.

A good example of a abiotic or uniform injury is Sunscald or Southwest (SW) Injury. This type of injury occurs *uniformly* on the Southwest side of the tree, on southwest exposures and with thin barked trees. Sunny days with below freezing temperatures result in the greatest damage. The southwest side heats up, absorbing the heat of the sun. When the sun sets, or goes behind a cloud, there is a sudden freezing in the heated up tissue. Snow cover, resulting in a reflection off the snow surface, and more extensive heating on the southwest side often aggravates this rapid freezing and thawing. Sunscald results in death of the exposed bark. The area subsequently dries out and dies, causing a large open wound on the southwest side of the tree. Years of repeated southwest injury will weaken the trunk of the tree significantly making it susceptible to breakage. To protect a tree from sunscald, shade the southwest side of the main trunk and large branches. This can be done by using plastic trunk guards on young trees, by allowing low branches to develop on the southwest side, by erecting a shading barrier and even by painting with latex paint to reflect the sun’s rays.

A good example of biotic injury can be found with an infection of *Phytophthora* root rot. *Phytophthora* infections in nursery plants will usually become noticeable to the grower, when about 20% of the plants are infected. This is a general “rule-of-thumb” that can be used. If 20% or less of the plants are affected, it is usually a biotic injury. With *Phytophthora* root rot the plant appears to be lacking water because the fungus is destroying their water conducting ability. The addition of water, however, only adds to the spread of the fungus. In some cases, internal symptoms can be observed by removing the bark near the ground line. Diseased tissue is red-brown in color and sharply contrasted to healthy, whiter tissues.

Another good example of a abiotic injury is any kind of nutritional injury. The visual symptoms of nutritional problems is so uniform that it can be classified into three groups, older tissue affected first, young tissue affected first or terminal buds affected (Table 1). One of the most common symptoms of nutritional problems is the loss of green color caused by breakdown of or interference with synthesis of chlorophyll, which
is commonly caused by a deficiency of N, Fe, Mn or Mg. Sometimes sensitive tissues develop in tufts or rosettes, needles of conifers become fused, and various other abnormalities in shape and color develop that enable experienced observers to diagnose the cause. Other visible symptoms include dieback of stem tips and twigs, lesions in the bark, and excessive gum formation.

Table 1: A key to nutrient deficiencies of ornamental plants
A. Older leaves affected first
A1. General chlorosis progressing from light green to yellow; stunting of growth, excessive bud dormancy; necrosis of leaves, followed by abscission in advanced stages -- Nitrogen.
A2. Marginal chlorosis or mottled leaf spots which occurs later; tips and margins may become necrotic, brittle and curl upward -- Magnesium.
A3. Interveinal chlorosis with early symptoms resembling N deficiency; leaf margins may become necrotic and may roll or curl -- Molybdenum.
A4. Leaf margins may become brown or mottled and curl downward -- Potassium.
A5. Leaves accumulate anthocyanins causing blue-green or red-purple coloration; lower leaves may turn yellow -- Phosphorus.

Youngest leaves affected first
B1. Light green color of young foliage, followed by yellowing; tissue between veins lighter colored -- Sulfur.
B2. Distinct yellow or white area between veins; initially veins are green becoming chlorotic under severe deficiency, followed by abscission -- Iron.
B3. Necrotic spots on young chlorotic leaves, with smallest veins remaining green -- Manganese.
B4. Chlorotic leaves abnormally small; shortened internodes in severe cases, becoming rosetted -- Zinc.
B5. Young leaves permanently wilted, becoming chlorotic, then necrotic -- Copper.

C. Terminal bud dies
C1. Brittle tissue, young or expanded leaves becoming chlorotic or necrotic and cupped under or distorted; terminal and lateral buds and root tips die -- Boron.
C2. Growing points damaged or dead; tips and margins of young tissue distorted; leaves may become hard and stiff -- Calcium.


One important aspect of a plant-monitoring program is to know how to submit a good sample for outside consultations and/or confirmations. When samples are submitted to a plant diagnostic laboratory you are looking to confirm or refute the presence of an infectious disease. Sixty percent or more, however, of what is presented to most diagnostic laboratories is abiotic in origin. Being able to determine
the difference between an abiotic disorders and biotic infections in the field is not always easy. Sometimes submitting a sample to the diagnostic laboratory, even when you are fairly sure the primary cause of the problem is abiotic is a good idea. In some situations secondary pathogenic invaders may come in after an abiotic injury and you may want to ensure that your not missing something that will cause problems later on.

**Collecting and Submitting Samples**

When you decide a sample submission is necessary here are some points to remember. First, put the fresh sample in a plastic bag and add paper towel or newsprint if the sample is wet. A dried out sample or a rotten musty sample leaves little to work with. Second, keep the sample refrigerated or cool and send to the diagnostic laboratory as soon as possible. Third, if you suspect a canker or dieback organism check where the healthy tissue ends and the dead tissue begins. Send in a sample that includes both. The edge of the dead/green tissue is where the diagnostician is most likely able to culture fungal and bacterial pathogens. Fourth, if browning leaves are the symptom you may suspect a stem canker, crown necrosis or root rot, check for these things before sending in only the leaves. Fifth, observe and describe the “pattern” of the problem. Including such information as the age of the plant or crop. If it has been transplanted, when did that occur? When were symptoms first observed? Where is the problem located, near a ditch or roadway? How many plants are affected? Are the symptoms on lower or upper branches, or dispersed all over the crown. Is the old growth affected more than the new growth?

**Viruses**

Virus problems can be very difficult to diagnose in the field. Many diagnostic laboratories, field consultants or extension agents will often suggest a nutrient test of both soil and leaf tissue be conduct if a virus is suspected. Many flowering ornamentals are susceptible to virus diseases. Necrotic ringspot on rhodo’s and rose leaf mosaic are common. These will not usually do any damage to the plant unless it is severely pruned or grown under stressful conditions. They do not spread to other species. Some viruses, such as Rhodo ringspot and rose mosaic are easily identified by the symptoms on the leaves.

**Conclusion.**

These are some of the things I have learned about the Aand B’s of –iotic and I hope they are useful to you in your crop scouting activities. However, the thing that I find most helpful when I’m trying to diagnosis a plant problem is keeping an open mind. Don’t be swayed by other people’s opinions or previous consultants’ recommendations. Try to get as complete a picture as you can before making a decision, which may include a submission to the plant clinic.