Cornell University
School of Integrative Plant Sciences

Soil Health Manual Series Fact Sheet Number 16-13

Add-on Test: Root Health Bio-assay

The Root Health Bio-assay test is a measure of the degree to which sensitive test-plant roots show symptoms of disease when grown for a set time in controlled conditions. It is assessed by visual inspection for root size, color, texture and the absence or presence of damage potentially from root pathogens. Pathogen pressure is given a rating from 2 to 9, with higher numbers indicating greater pathogen-induced damage.

Commonly found soil pathogens include the fungi *Fusarium*, *Rhizoctonia*, and *Thielaviopsis*, and the oomycete *Pythium*. High pathogen pressure identified by the assay indicates that disease-causing organisms are present, and that other members of the microbial community are not successfully suppressing them. Lower pressure indicates either that few pathogens are present, or that the rest of the microbial community is able to prevent them from successfully colonizing the roots.

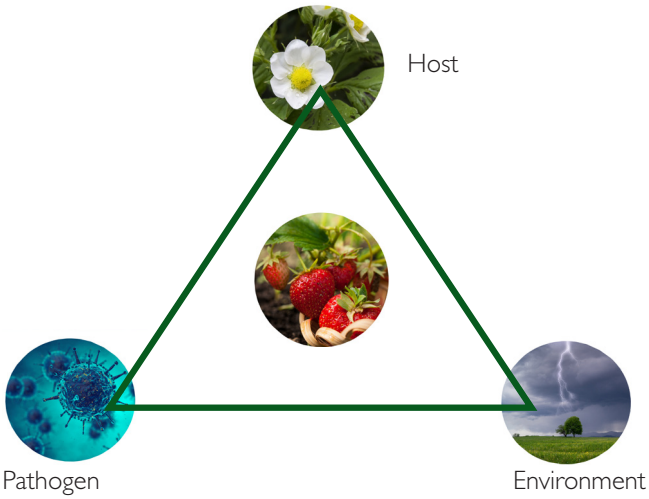

FIGURE 1. Disease Triangle, illustrating the interaction between susceptible host, compatible pathogen, and conducive environmental conditions necessary for the development of plant disease.

How root pathogen pressure relates to soil function

Pathogen pressure refers to the degree to which plants encounter potentially growth-limiting attack by disease causing organisms. Known as the disease triangle (Fig. 1), it is a function of the presence of pathogens; the compatibility between pathogens and the plants that are growing; and the environmental conditions including soil physical and chemical characteristics, weather and local microbial communities.

Healthy roots are essential for vigorous plant growth and high yield as a large root mass can efficiently obtain nutrients and water from soil. Root pathogenesis negatively impacts plant growth and root effectiveness, as well as limiting interaction with beneficial root associated microbiota.

FIGURE 2 a and b. Root Pathogen Pressure test using (a)'Hystyle' snap bean seed, (b) grown in the greenhouse.

Managing constraints and maintaining low pathogen pressure

To manage root pathogen pressure constraints in the field, make sure to evaluate rotations and cover crops for their ability to suppress pathogens, and especially avoid consecutively planting hosts of the same pathogen. Some cover crops (e.g. sorghum-sudangrass, mustards) can be used to effectively biofumigate against certain pests and pathogens. Plants differ in their effectiveness as hosts for various pests. Some produce compounds that inhibit or suppress pathogens, or may stimulate microbial communities that are hostile or parasitic to crop pathogens.

Organic matter inputs from rotational and cover crops, green manures, and composts have a major impact (both positive, and negative if poorly chosen) on populations of soilborne microbial pathogens, plant parasitic nematodes, and other pests. Plant residues remaining from previous crops that have been diseased can harbor pathogens and serve as a source of inoculum in following seasons, allowing disease to spread. This makes rotation all the more important. It is also important to alleviate physical and chemical plant stressors such as poor drainage, high compaction, poor irrigation practices, or nutrient deficiencies.

Add-on Test: Root Health Bio-assay

Add-on tests

The suite of soil analyses in the Cornell Assessment of Soil Health packages are all available as individual tests. Certain analysis, such as the Root Health Bio-assay, are not part of the Basic or Standard packages but are available as add-ons or as individual tests. A complete list of the packages we offer in addition to the add-on tests is available on our website at bit.ly/CSHLPackages.

Basic protocol

- Approximately 200 ml of fresh soil is placed in each of 4 cone-tubes which have cotton balls placed in the bottom to prevent soil loss through the drainage holes.
- Each tube is planted with one green bean (Hystyle) seed (Fig. 2a). Commercially available, treated seeds are used to more closely represent on-farm conditions.
- The hilum (curved) side of the seed is placed flat, horizontally, to encourage successful seed germination and emergence (straight vertical shoots).
- The plants are maintained in a greenhouse under supplemental light and watered regularly for 4 weeks (2b).
- The plants are removed from their containers and the roots are washed and rated as described in the examples shown below:

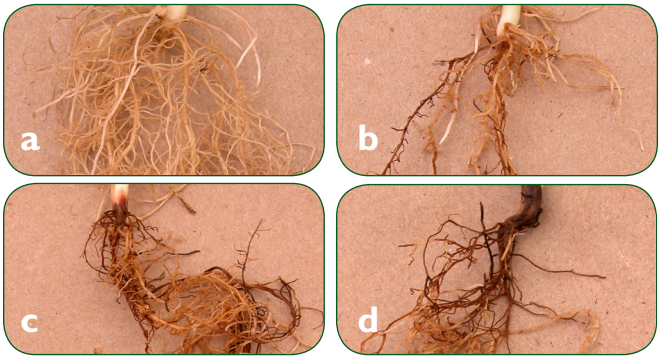

FIGURE 3 a - d. Root Pathogen Pressure Rating System.

Rating system

2 = White and coarse textured hypocotyl and roots; healthy (Fig. 3a).

4 = Light discoloration, with lesions covering up to a maximum of 10% of hypocotyl and root tissues (3b).

6 = Moderate damage, with lesions covering approximately 25% of hypocotyl and root tissue, with tissues remaining firm (3c).

7 to 9 = Advanced damage and decay, with 50 to 75% (or more for higher ratings) of hypocotyl and roots showing lesions and severe symptoms of pathogen damage (3d).

Scoring function

Figure 4 below depicts the Root Health Bio-assay rating scoring function and upper value limits for coarse, medium, and fine textured soils. Scoring functions were combined for all textural classes because no effects due to texture were observed in the data set.

The red, orange, yellow, light green and dark green shading reflects the color coding used for the ratings on the soil health report summary page.

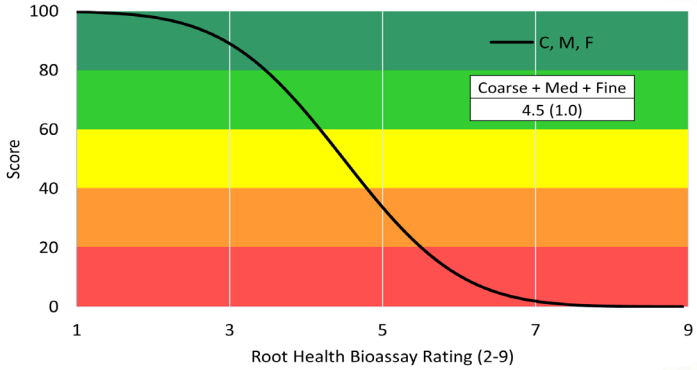

FIGURE 4. The Root Health Bio-assay Rating scoring function and upper limits for Coarse (C), Medium (M) and Fine (F) textural classes. Mean and standard deviation (in parenthesis) is provided. In this case, a lower score is better and indicates there is little pathogen pressure in the field.

Our Root Health Bio-assay Rating Standard Operating Procedures (CSH 09) can be found under the 'Resources' tab on our website.

NOTE: Due to APHIS regulations we cannot perform the bio-assay in certain areas of the country. Please visit bit.ly/CASHRegulatedCounties for a complete list of states and counties that fall into this category.

For a more comprehensive overview of soil health concepts including a guide on conducting in-field qualitative and quantitative soil health assessments, please download the Cornell Soil Health Manual at bit.ly/SoilHealthTrainingManual.

Acknowledgement

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This fact sheet represents the best professional judgment of the authors and does not necessarily reflect the views of the funders or reviewers.

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