Clubroot is an increasing problem on Willamette Valley vegetable farms. Most cultivated brassica crops (broccoli, cauliflower, cabbage, etc.) are highly susceptible to the disease, which is caused by the soilborne fungus *Plasmodiophora brassicae*. In severe cases it can cause significant crop losses, and heavily infested fields may be taken out of production. Once a field is infected, eliminating the pathogen is difficult if not impossible because its thick walled resting spores have been shown to remain viable in soil for up to 20 years (although half die within 4 years). As a result, once pathogen populations have developed to economically damaging levels, the goal is to manage rather than eradicate the disease. Our research is focused on finding effective and economic control measures.

**Disease Cycle**
As a brassica crop grows, its roots release chemicals (root exudates) that stimulate the germination of resting spores. Once germinated, the pathogen becomes mobile (zoospore), swimming to and infecting root hairs in a first cycle of infection. In a second infection cycle, zoospores infect the interior of the root and develop clubs (Fig. 1), reducing the plant’s ability to grow. When these clubs decay, resting spores are released back into the soil.

**Control methods**

*Liming:* The most effective and practical method for controlling clubroot is liming the soil to a pH > 6.8 or 7.0. In the Salinas Valley of California, a major fresh market brassica growing region, clubroot has been almost completely controlled through liming (Steve Koike, Monterey County plant pathologist). Liming does not kill the spores, but rather prevents their germination. Liming has been shown to be most effective when the pH is increased to ≥7.0 (Myers and Campbell, 1985). In a 2013 greenhouse trial we showed that liming a heavily infected soil to a pH ≥7.2 reduced infection rates by 89% compared to an unlimed control and also significantly reduced disease severity. By reducing the infection rate, there are fewer clubs to supply the soil with spores, potentially reducing disease severity in the future. Hydrated lime has been shown to be effective, however as far as we know, no companies currently apply it.

*Boron:* There is some evidence that boron can reduce root hair infections and overall disease severity in the brassica crop canola (Deora et al., 2011). However, there is a fine line between disease suppression and phytotoxicity when using boron.

**Biological control:** Serenade (Bayer CropScience; *Bacillus subtilis* strain QST 713) soil drenches have been reported to reduce clubroot severity (Lahlali et al., 2013).
2014 Research

This year we set up several on-farm clubroot trials looking at the relationship between infection rate, disease severity, and the use of the control methods listed above (lime, boron, and Serenade Soil). Only results from the first trial (Sauvie Island, liming only) are discussed below as the others are ongoing.

Sauvie Island field trial

A field trial was conducted on an organic farm on Sauvie Island located just west of Portland. We placed our research plots in a field that had a complete crop loss of broccoli from clubroot in 2012. The soil was a fine sandy loam with an initial pH of 6.0. On April 2, 6.8 ton/acre of Microna Access lime (a very fine, highly reactive calcitic lime) was applied to plots and incorporated to a depth of 8 inches with the goal of raising the pH to >7.0. Broccoli (cv. Batavia) was transplanted the following day. Total plant weight was measured 80 days after transplanting. pH was measured 11, 55 and 80 days after liming; on all dates pH was 6.5 - 6.8. Disease severity was reduced in the limed plots and total plant weight was more than twice that of the unlimed control (Fig. 2).

Figure 2. The plant on the left was from the unlimed control (pH 6.0) while the plant on the right was grown in limed soil (pH 6.5 - 6.8). Average plant weight from the limed treatment was significantly greater than the unlimed control. Error bars represent the standard error of the mean (n=4).

Resources and references


