

INFLUENCE OF ORGANIC AMENDMENTS ON VEGETABLE DISEASES

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Introduction

Use of paper mill residues in vegetable production holds promise for improving soil quality, particularly in course-textured sandy soils where increases in organic matter content can greatly impact soil chemical, biological, and physical properties. Few studies have evaluated the intermediate to long-term effects of repeated organic matter additions on soil quality and crop health, particularly in irrigated sand-based vegetable production. One of the primary objectives of this project is to determine the influence of fresh paper mill residues (PR) and composted PR on crop disease incidence and severity and ultimately crop yields and quality. Our evaluation of PR amendment effects on crop diseases should help us develop strategies for reductions in pesticide use.

We are working with large volume, locally available organic waste streams; fresh and composted paper mill residues. Both of these organic amendments have been successfully applied to Wisconsin soils for soil improvement and crop yield enhancement (Bowen et al., 1995). Wisconsin vegetable growers in regions of sandy soils are now utilizing a variety of paper mill residues to improve soil physical properties and for crop nutrient supply. Composting of paper mill residues and its effects on potato growth and yield in sandy soils has previously been investigated (Bowen et al., 1995).

Our Field Experiment

We initiated a field trial at the UW Hancock Agricultural Research Station in 1998 to investigate the effects of annual applications of three organic amendments applied at two rates on naturally occurring diseases in two crop rotation cycles (6 years total) of potato-snap bean-cucumber. The amendment treatments include fresh PR, composted PR alone (PRC) and with bark (PRB), and no-amendment (the "conventional practices" control). Treatments are replicated five times in plots 15' X 25' in a randomized complete block design. Organic amendments are applied in April three to six weeks before planting to field plots at two rates: fresh PR is applied at 50 and 100% of crop N requirements while PRC and PRB are applied at double the PR rates.

Effects of Annual Soil Amendments on Crop Disease over 4 Years

The ability of PR and composted PR amendments to suppress disease varies with crop and type of disease. In our first year of study (potato, 1998), fresh and composted PR amendments significantly influenced soil-borne and foliar disease incidence. All PR amendments produced lower incidence of *Pythium* leak (storage rot) relative to the no-amendment control. However, early blight incidence was significantly higher in fresh and composted PR plots as compared to non-amended plots, which may have resulted from enhanced susceptibility due to an apparent nitrogen deficiency in amended treat-

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ments. In our second year (snap bean, 1999), incidence of aerial *Pythium* was reduced dramatically in fresh and composted PR treatments. Yields were enhanced in plots receiving the organic amendments compared to the no-amendment control. Bean pod quality was greatly enhanced because of the significant reduction in pod brown spot (a foliar disease) severity and incidence in the PRC treatment. In our third year (cucumber; 2000), plots amended with the high rate of PRC contained five-fold fewer plants exhibiting angular leaf spot, another foliar disease.

Cucumbers grown in fresh and composted PR-amended soils produced yields comparable to the conventional control. In our most recent season (potato, 2001), environmental conditions were favorable for development of potato early dying (PED). Over the growing season, both rates of the two PR composts (PRC and PRB) produced 1.5-2 times greater severity of PED than the no-amendment control treatment. Early-season nitrogen deficiency may have been associated with enhanced PED severity in the amended plots, although midseason leaf nitrate levels were not correlated with the amount of disease exhibited by the plants in amended plots. Superficial and pitted scab incidence was highest (but not statistically significant) in the high rate of fresh PR compared to all other treatments. Despite the higher PED disease severity in plots amended with the high rate of the fresh PR amendment, this treatment yielded significantly more US #1 (Grade A) tubers compared to the no-amendment control. Overall, tuber specific gravity was relatively low for this year, but significant reductions occurred in both compost treatments (with and without bark) as compared to the no-amendment control.

Conclusions

Four years of experience with annual additions of PR amendments present us with a complex picture of soil quality benefits and concurrent effects on crop diseases, quality and yields. Fresh PR provides greater nutrient value than composted PR, but does not build soil organic matter to a great extent. Paper mill residual composts add more total and active fraction carbon to the soil in the short term (2-3 yrs.) compared to fresh PR and this has benefits in terms of enhancing water holding capacity and reducing nitrate leaching. In contrast, crop disease response to added organic matter differs for foliar diseases compared to soil borne diseases. PR composts negatively affected complex diseases like potato early dying (nematode / fungus interaction), while they suppressed diseases like root rots and bacterial foliar diseases. In general, PR amendment effects on crop quality and yield were similar to conventional practices, except for enhanced snap bean yield with PR amendments. The emergent picture indicates that amount of organic matter may be important for soil functions like nutrient and water retention, but that quality of organic matter may be more important for suppressing specific plant diseases. For example, annual additions of PR amendments might be needed to maintain increased water availability, yet large amounts of “very active” organic matter might increase host susceptibility to certain diseases.

Citation

Bowen, B.D., R. Wolkowski, and G. Hansen. 1995. Comparison of the effects of fresh and composted paper mill sludge on potato growth. Proceedings of the National Pulp and Paper Society.