HIGH NITROGEN containing ORGANIC AMENDMENTS FOR THE CONTROL OF SOILBORNE PLANT PATHOGENS.

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Organic soil amendments, including animal and green manures and wastes from processed animal products such as blood meal, bone meal, have been used for centuries as soil supplements. In the chemical era the impact of amendments on plant diseases was ignored, although in the past, the use of amendments was a recognized means for disease control. Wilhelm (2) showed that blood or fish meal incorporated into soil at 1% (w/w), inhibited wilt of tomatoes caused by Verticillium *dahliae.* Our laboratory has confirmed the ability of high nitrogen containing materials to kill Verticillium microsclerotia (MS) (1). The efficacy of disease control by organic materials however, has never been extensively examined. Our primary objective was to determine the capacity of high nitrogen containing organic amendments to reduce the populations of the Soilborne plant pathogens including the fungus V dahliae (potato early dying), the bacterium *Streptomyces scabies* (potato scab), plant pathogenic nematodes (root lesion) and weed pests.

Methods:

Bioassay: **Laboratory assays:** A spectrum of organic materials were tested under laboratory conditions for reduction of the pathogens including: feather meal (FeM), meat & bone meal (MBM), hydrolyzed pig hair, blood meal (BM), fish byproducts (FM) etc. A number of compost and manures including, liquid swine, beef cattle, and poultry manures were also tested. Laboratory experiments involved mixing various amounts of material into soils from potato fields, placing 20 g amounts into test tubes, adjusting the moisture levels to 50% holding capacity (0.33 bars pressure) and burying bags of Verticillium microsclerotia (MS) into them. The tubes were incubated for various times and the bags recovered and MS plated for assessment of survival (1). Colonies of Verticillium were evaluated 2 weeks after plating.

Microplot and field experiments: The amendments were also tested in microplots using soil from potato fields in Ontario (Alliston and Simcoe Res. Station) with a history of scab and wilt and at commercial farm locations (Site M and B, Alliston, Ont.). For microplots, the organic materials (1-2% w/w) were mixed with the soil in a cement mixer and placed into the microplots of 2 m^2 to a depth of about 45 cm. Each treatment was replicated three times in two soils arranged in a randomized block design. One set of microplots was set up in the spring of 1994 and the other in 1995. The field experiments, which also had three blocks in a randomized design (50 m^2) was set up in the spring of 1996. The organic amendments were spread over the surface and rototilled into a depth of 15 cm. In all cases samples of amended soils were brought back to the laboratory, placed in test tubes, and bags of MS were then buried in the soil. In the field, bags of MS were buried by gluing them on to plastic stakes and lowering them to a depth of 10 cm. The bags from the field sites were recovered at the same time as the laboratory samples and survival was determined as above. Populations of *Streptomyces,* as well as other bacteria and fungi were determined by plating serial dilutions of soils onto various agar media (Conn et al. in preparation). Crops were planted about a month after adding the amendments. The plots were replanted yearly with potatoes (cultivar Snowden). In each crop we determined Verticillium wilt incidence by plating petioles at two times

during the growing. season. All ten plants per microplot were sampled. From field sites, up to 50 plants from the middle two rows of the plot were tested. After harvest, the middle two rows of potatoes from each plot was harvested and scab incidence determined from visual inspection of 100 tubers. Yield was categorized by tuber weight and size.

Comparison of results obtained in the laboratory for inactivation of Verticillium MS demonstrated that laboratory assays were in agreement with the results from the field (and disease incidence) 93% of the time. In about 4% of the time, laboratory assays underestimated the efficacy of control under field conditions. These laboratory tests require only a few grams, of soil allowing the evaluation of hundreds of combinations of soils/amendments quickly and cheaply. In instances where we found that an amendment reduced Verticillium MS viability we also found reductions in S scabies populations, lower scab incidence, reduced populations of pathogenic nematodes and fewer weed species. In such instances however, populations of soil bacteria and fungi were found to increase by 100-1000 fold.

Verticillium wilt incidence in four and three consecutive crops grown in soils which had received a single application of organic amendment (MBK, FeM or SM) were significantly lower than that found in control plots. Amended plots also had lower scab incidence. Yield increases in treated plots were often more than double than those in control plots. The most clear yield differences were usually obtained in the second season after adding the amendments likely because the residual high nitrogen was found to occasionally cause initial phytotoxicity in the first crop.

Results of field experiments, (Bsite and Msite) showed that the products, SM, MBM and fresh poultry manure (PK, all reduced wilt and scab incidence, as well as numbers of parasitic nematodes. The rates applied however, were somewhat phytotoxic in the first season. Swine manure reduced scab and wilt, but not to the same went as the other materials. Solid cow manure reduced disease at one site but not at the other. Cellulosic biosolids, and several composts did not have any measurable impact on disease incidence when used at one specific rate. Disease incidence of the second crop at the Msite was 50% in early Aug in control soils, whereas plants grown in MBM, SM, and PM treated soils it was 6%, 9% and 11% respectively. At the Bsite 3 1% of the plants were infected in untreated plots and in BM, SM, and PM treated plots disease incidence was 2%, 5%, and 2% respectively. Cow manure, swine manure, various composts, some chemicals treatments did not reduce disease incidence or increase plant vigor, although some had an affect at one of the two sites. The efficacy of organic amendments is soil specific and very much rate dependent.

Preliminary experiments in progress indicate similar benefits for disease control for tomatoes and fruit trees. Thus organic amendments are good candidates as a replacement for methyl bromide. Before these products can be used however, the soils should be tested for evaluating their capacity to render the material bioactive. Indications are that for sandy type soil such materials will be ideal replacements for chemical fumigants. The effect of organic treatments persist for several years and this would make it cost competitive with methyl bromide treatment. Organic amendments, unlike fumigants, reduce populations of pathogens while increasing those of most other soil microorganisms. Studies in progress are designed to reduce the quantity of material required and to make the material more universal in its activity.

Literature cited
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(2) Wilhelm, S. 195 1.. Phytopathology 41: 684-690.
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