EFFECTS OF AMMONIUM LIGNOSULFONATE ON SOIL MICROBIAL POPULATIONS, VERTICILLIUM WILT, AND POTATO SCAB.

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Ammonium Lignosulfonate (ALS) is a waste by-product of pulp and paper industry with a high nitrogen and carbon content and has the potential to be used as a organic matter in soils. The addition of organic materials to soil invariably alters soil microbiology. Those organisms that can utilize the energy of the incorporated organic product increase in populations. Under ideal conditions the microorganisms that grow are either directly beneficial to plant growth or are indirectly beneficial, in that they displace detrimental organisms such as plant pathogens. Therefore, soil health can be manipulated by Afeeding@ it the right substrate. We have been studying the effects of ALS on soil microbial populations and control of Verticillium wilt and potato scab.

Verticillium wilt is caused by the fungus *Verticillium dahliae* in association with various nematodes (4) and potato scab is caused by bacteria belonging to the genus *Streptomyces* (3). Earlier studies by our lab have shown that both these pathogens are excellent models for studying the effects of soil amendments on control of diseases caused by soilborne pathogens.

METHODS

Laboratory experiments: Soils used for this experiment were from a potato field near Alliston, Ontario. Potatoes grown in this field have had a high incidence of Verticillium wilt and potato scab. Soils were mixed with 3 ALS concentration rates, 0.5, 1.0, and 2% (v/w), and an untreated control. Nine test tubes (22 x 150 mm) were filled with 20 g of each ALS-soil mixture and closed with plastic caps which allowed air exchange in the tubes. The test tubes were incubated in a completely randomized design at 25°C in the dark. The moisture levels were adjusted to the initial level of 50% holding capacity, weekly. Three test tubes per treatment were sampled at day 7, 14, and 28. Soil pH and total bacteria, fungi, and *Streptomyces* were determined by plating soil extractions onto selective media. The Verticillium bioassay (2) consisted of sealing microsclerotia (MS) of *V. dahliae* in nylon mesh bags which were buried in the soil mixtures. The bags were removed at day 7, 14, and 28 and MS plated out on selective media (SPT). Colonies of *V. dahliae* were evaluated 2 weeks after plating and percent germination were determined. This experiment was carried out twice and the data were pooled together.

Effects of ALS on soil nematode populations were studied by treating soils previously described with the same treatments tested for microbial bioassay. Soils

were then incubated at 25°C in the dark for 6 weeks. Three samples were taken from each treatment and soil lesion nematode population was determined using the Baerman funnel extraction method. Nematodes counted included lesion and rootknot nematodes.

Greenhouse and field experiments: Soils previously described were mixed with 4 mixtures of ALS (0.25, 0.50, 1.0, and 2.0% v/w) and an untreated control. The soils for each treatment were then placed in 15 cm diameter plastic pots (1800 g/pot; 3 replicates/treatment). Six week-old potato explants (cv. Kennebec) were planted into each pot. The pots were then placed in the greenhouse in a completely randomized design and were watered every 2-3 days. To assess the incidence of *V. dahliae*, a leaf petiole from the lower portion of each plant was harvested every week starting from flowering date. The petioles were surface sterilized for 2 min in 1.5% sodium hypochlorite. Three sections cut from each petiole were plated onto SPT media and the plates were incubated at 25°C in the dark. After 2 weeks, colonies of *V. dahliae* were evaluated. Potato scab severity was determined visually by examining tubers for scab lesions. This experiment was carried out twice and the data were pooled together.

Field plots were set up in April, 1998 at a farm near Delhi, Ontario where the potato crop in the previous year had a severe scab problem. Treatments included a control and 2 concentrations of ALS (0.5 and 1.0% v/w). ALS was watered into each plot and rototilled to a depth of 15 cm. Plots were 4 x 7.6 m and there was a 3 m buffer zone between each of the blocks. Plots were set up in a completely randomized block design with 3 replications for each treatment. Seed tubers of potatoes (cv. Yukon Gold) were planted approximately 4 weeks after the treatment application. There were 4 rows of potatoes from which only the 2 middle rows were considered for data collection. All plots received the same recommended fertility. Verticillium wilt and potato scab were assessed as previously described.

Results and Discussion:

Soils treated with ammonium lignosulfonate generally had lower pH than untreated control soil (Fig. 1A). The pH reduction was greater with 0.5 and 1.0%, than with the 2.0% ALS mixture. All ALS treatments caused an increase in total soil bacterial population (Fig. 1B). In general, after 14 days of incubation the total bacterial population in 2% ALS mixture soils increased from 300 million to more than 100 billion bacteria/g of soil. Ammonium lignosulfonate increased the total fungal populations (Fig. 1C). There was a linear increase in fungal population as the mixture concentration of ALS was increased. The 2% ALS mixture increased fungal populations by more than 2 log units. All mixtures of ALS caused a 10-100 fold decrease in *Streptomyces* populations on selective media (1) by day 28 (Fig. 1D). All concentrations of ALS decreased germination of *V. dahliae* microsclerotia (Fig. 1E). The germination rate decreased with the increase in the mixture concentration of ALS. More than half of the microsclerotia recovered from soils treated with 2% ALS were killed after 14 days of incubation. These results were confirmed by studies of the Verticillium wilt incidence of potatoes cultured in a greenhouse

experiment. Plants growing in ALS treated soil showed significantly lower Verticillium wilt incidence than control plants. Verticillium wilt was detected in the control treatment 6-8 weeks earlier than in any of the ALS treatments. None of the tubers in the greenhouse study, including the controls, showed any scab lesions. All mixtures of ALS significantly reduced the number of nematodes (Fig. 1F). The 0.5% ALS mixture reduced nematode numbers by more than 60% while the 1.0% mixture reduced the nematode population by more than 95%.

Field trial results indicate that at the concentrations used, ALS had a phytotoxic effect on potatoes. This phytotoxicity, however, was transitory at rates below 0.5% and the plants recovered and caught up to the plants in untreated soil. Current studies are focussed at finding those rates that provide disease control but do not have any phytotoxic effects. Disease assessment results from the field experiments are not complete at this time, but preliminary data from a few plants taken from the guard rows indicate that scab was effectively controlled. These results will be available after September 1998.

Laboratory and greenhouse experiments indicate that ALS, while increasing soil microorganisms by 10-100 fold, reduces populations of important soilborne pathogens of fungal and bacterial species. This suggests that ALS could become a component for plant disease control and an alternative to fumigants for the control of soilborne plant pathogens. The mode of action of ALS is unknown but the indication is that the product contains bactericidal, fungicidal, nematicidal, and phytotoxic components. We have found that not all plants are equally sensitive to the phytotoxic material. ALS has a fertilizer component as it contains 6-8% nitrogen and is also a valuable reservoir of sulphur. Work is continuing toward development of ALS into a formulated product for agricultural use.

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