# CROPPING SYSTEMS CONTROLLING MYCORRHIZAL STUNT OF BURLEY TOBACCO AS AN ALTERNATIVE TO SOIL FUMIGATION

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The concept that mycorrhiza fungi are mutualistic with their hosts is based primarily on responses of seedlings of a few highly dependent plant species grown on sterilized soil or media devoid of mycorrhizal propagules and inoculated with a highly effective mycorrhizal isolate. However, there are far more crops which consistently grow better on methyl bromide (MB) fumigated soil than are stunted by fumigation-induced mycorrhizal deficiency.

Mycorrhizal stunt of tobacco is the first well documented case of a major disease caused by a Glomales fungus, and the finding that soil fumigation controls the disease provided a tool for study. Affected plants appear normal except for being stunted. There is no resistance to mycorrhizal stunt disease. Root systems are reduced in size, notably root length per unit volume of soil.

Glomus macrocarpum was identified as the tobacco stunt pathogen via all the components of Koch's Postulates. G. macrocarpum was present in soils on which stunt occurred in the field. Associated with presence of G. macrocaroum on roots of plants inoculated with sievings from land with a history of tobacco stunt were smaller root and shoot mass and heavy mycorrhizal colonization of roots, compared with noninoculated plants or those inoculated with sievings from land without a history of tobacco stunt. Stunting of these plants was correlated with sporulation by G. macrocarpum, presence of extramatrical hyphae, and colonization of roots with arbuscules but not vesicles. In the field, G. macrocarpum was prevalent, reproduced on tobacco, and, with stunt disease, was controlled by soil fumigation. Height of plants was negatively correlated with populations of spores of G. macrocarpum. Spores from these plants, or spores sieved directly from soil, were isolated, and reisolated, by inoculation of plants with single spores. These isolates produced stunt disease in greenhouse experiments, and the extent of colonization was related to the degree of stunting. An independent indication that G. macrocaroum is the pathogen was the finding that benomyl, the only fungicide usually found inhibitory to mycorrhizal fungi, prevents stunt.

Tobacco farmers know that continuous production of tobacco results in decline in productivity of soil. Farmers who seek maximum yields of tobacco use fescue as a rotation crop with tobacco. Tall fescue colonized by the Acremonium coenophialum endophyte inhibits G. macrocarpum more than endophyte-free fescue. Rotation of tobacco with fescue for

two years and fumigation of soil with 67% MB-33% chloropicrin controlled tobacco stunt disease when tobacco was planted on all plots the third year. Effects of rotation with fescue and of soil fumigation were not additive, indicating that both controlled the same disease agent. Rotation with sorghum-sudangrass hybrid ("sudex") and corn do not maintain productivity of soil for tobacco, and rotation with soybean produced yields intermediate between that on land rotated with corn and fescue. corn, soybean, and sorghum-sudangrass hybrid all are good hosts of G. macrocaroum.

The relationship of G. macrocarpum to effects of cropping history on productivity of land for tobacco was pursued by conducting parallel experiments on adjacent tracts of land which varied in long-term cropping history. One had been in fescue for 30 years, the other in sudex 5 years. In the first year of the experiment, stunt disease was much more severe on land previously in sudex. Of 17 species present, populations of only G. macrocarpum were related to stunt disease. When tobacco was planted on all plots the third year, stunt disease was greatest on plots with a history of sudex and tobacco, lowest on land with a long- and short-term history of fescue, and intermediate on land with long- or short-term histories of fescue. Colonization of roots by mycorrhizal fungi and populations of G. macrocarpum at the end of the season were proportional to disease. Monocropping of tobacco reduced diversity within the mycorrhizal fungal community and increased the proportion of the community which is pathogenic, the result being lower productivity of soil. Rotation of all crops we have examined disrupted mycorrhizal fungal communities associated with monoculture.

Our research on tobacco stunt-has been conducted over nearly 20 years. While similar studies of other crops would take much less time, no one with expertise with mycorrhizal fungi has made the major commitment toward this end that would be required for a period of several years. Thus, there is no clear answer to the question of how frequently diseases caused by Glomales fungi occur. However, there are field observations published on several crop or native grasses, white clover, corn, strawberry, and soybean suggesting that Glomales fungi cause diseases.

It is essential that the roles of the 20 or so mycorrhizal fungal species present in all soils, and of other components of the rhizosphere, be understood if we are to find MB alternatives rapidly. For decades, MB and other fumigants have been used and the beneficial effects enjoyed with little concern for the mechanisms. Beneficial effects of broad spectrum pesticides such as MB may be credited to control of a known pathogen, while control of an unrecognized pathogen causing more damage goes unnoticed. MB is scheduled to be phased out long before the empirical methods used in the past will be able to develop new controls.