IMPACT OF LAND MANAGEMENT PRACTICES ON SOILBORNE PESTS AND PRODUCTIVITY OF TOMATO

Dan O Chellemi[1]*, E.N. Rosskopf[1], T.Wu[2], J. Graham[2] and K. Martin[3].
[1]USDA, ARS, Subtropical Plant Pathology. Ft. Pierce, FL 34945.
[2]University of Florida, Citrus Research & Education Center, Lake Alfred, FL
[3]University of West Florida, Pensacola, FL

In July 2000, a field experiment was initiated in Fort Pierce, Florida to measure the impacts of agricultural land management practices and alternative tomato production systems on parameters of soil health and yields of fresh market tomato. Five land management treatments were arranged in a randomized complete block design with 6 replications. The size of each replicate plot was 0.16 ha. Land management treatments were: 'Conventional' – an annual crop of tomato produced in the fall using conventional production practices including soil fumigation with 1,3-dichloropropene plus chloropicrin; 'Disk fallow' – soil was cultivated monthly and kept free of weeds; 'Weed fallow' – plots were left undisturbed and vegetation allowed to regenerate naturally; 'Organic production' – cover crops of Sunn hemp and Japanese millet were combined with an annual application of poultry manure (broiler litter) and urban plant debris; and 'Bahiagrass pasture' – an improved stand the perennial pasture grass was established.

In the fall of 2003 and 2004, a crop of fresh market tomato was cultivated in sections of each replicate plot. Organic crop production procedures, including the use of soil solarization, were adhered to in the organic land management treatment. Strip-tillage techniques were used to produce tomatoes in the bahiagrass pasture treatment. Conventional tomato production practices were incorporated in the remaining land management treatments except that soil fumigation was omitted from the disk fallow and weed fallow treatments. Data collected included measurements of soil fertility, composition of soil microbial communities, the incidence of soilborne diseases, damage from rootknot nematodes (*Meloidogyne* spp) and marketable yield of tomato.

Fusarium wilt, caused by *Fusarium oxysporum* f.sp. *lycopersici* Race 3, was the principal soilborne disease of tomato observed in the plots. Following a 3 or 4 year rotation under the various land management programs, disease was lowest in the organically managed plots, where it remained below 3%. In the bahiagrass plots, disease incidence ranged from 1% to 10%. In the plots maintained in conventional tomato production, disease incidence ranged from 1% to 19%. In the disk fallow plots, the incidence of Fusarium ranged from 11% to 24%. Disease incidence was highest in the weed fallow plots, where it ranged from 14% to 30%. When tomatoes were grown for two consecutive years following a 3-year-rotation under the different land management programs, disease remained below 3% in the organic plots. Dramatic increases in disease were observed in the second year in weed fallow and bahiagrass land management treatments.

Damage to the tomato crop from root-knot nematodes was determined by measuring the percentage of root systems with gall formation. Damage remained low in plots belonging to the organic, conventional, and disk fallow land management treatments, where the percentage of roots with galls was less than 2%. The severity of root galling in the bahiagrass treatments ranged from 3 to 7%. Damage was highest in the weed fallow plots where the severity of galling ranged from 17% to 85%. No significant changes in the severity of root galling were observed when tomato was cultivated in the same soil for consecutive years following rotation under the different land management treatments.

Total marketable yields were lowest in the bahiagrass treatment, intermediate in the organic treatment and weed fallow treatments and highest in the disk fallow and conventional treatments. Total marketable yields declined significantly in the second year when tomato was cultivated consecutively in the same soil. The largest declines were observed in the bahiagrass, disk fallow and weed fallow treatments. Early harvests (1^{st} pick) were greatest in the organic, disk fallow and conventional treatments.

Using DNA obtained from the Internal Transcribed Spacer (ITS-1) region of fungal ribosomal DNA, three distinct fungal communities were identified in soil collected from the different land management systems. One fungal community occurred in soil collected from land management systems with frequent disturbance events (conventional and disk-fallow). A second community occurred in soil from land management systems that minimized soil disturbance events (weed fallow and bahiagrass). A third, distinct fungal community occurred in soil subjected to the organic land management treatment. Fungal communities in each land management treatment became distinct following activities to prepare soil for tomato production. However, at end of the tomato production cycle, fungal communities in the conventional, disk fallow and weed fallow treatments were similar in composition.

Results from this project demonstrate that long-term agricultural land management practices can have a profound effect on soil microbial communities and the productivity of subsequent crops of fresh market tomato. Allowing land to remain undisturbed and vegetation to regenerate naturally in a weed fallow system led to significant increases in damage from soilborne disease and plant parasitic nematodes and lower marketable yields. While minimizing the impact from plant parasitic nematodes, keeping the soil free of vegetation in a disk fallow system did not mitigate the impact of plant disease. Significant disease reductions did occur after rotation with a perennial pasture grass (bahiagrass) but the rotational affect lasted only one season. The most consistent control of soilborne pests was achieved in the organic land management system. However, total marketable yields were consistently higher in the plots that had remained in conventional tomato production and included the annual fumigation of soil. The structure of soil fungal communities is correlated to the magnitude of soil disturbance and the nature of inputs applied to the agro-ecosystem. The relationship of soil fungal communities to incidence and severity of damage from soilborne pests is being studied.