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Field Management Effects on Damping-Off and Early Season Vigor of Crops in a Transitional Organic Cropping System

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ABSTRACT

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Transitioning farmland to certified organic vegetable production can take many paths, each varying in their costs and benefits. Here, the effects of four organic transition strategies (i.e., tilled fallowing, mixed-species hay, low-intensity vegetables, and intensive vegetable production under high tunnels), each with and without annual compost applications for 3 years prior to assessment, were characterized. Although transition cropping strategies differed in soil chemistry ($P < 0.05$), the magnitude of the changes typically were marginal and pairwise comparisons were rarely significant. In contrast, the compost amendment had a much greater impact on soil chemistry regardless of cropping strategy. For example, percent C and total P increased by 2- to 5-fold and K increased from 6- to 12-fold. Under controlled conditions, damping-off of both edamame soybean (cv. Sayamusume) and tomato (cv. Tiny Tim) was reduced from 2 to 30% in soils from the mixed-hay transition. In the field, damping-off of both crops was also significantly lower in plots previously cropped to hay ($P < 0.05$). Although not always significant ($P < 0.05$), this pattern of suppression was observed in all four of the soybean experiments and three of the four tomato experiments independent of compost application. The compost amendments alone did not consistently suppress damping-off. However, plant height, fresh weight, and leaf area index of the surviving seedlings of both crops were greater in the compost-amended soils regardless of the transitional cropping treatment used ($P < 0.05$ for most comparisons). These data indicate that mixed-hay cropping during the transition periods can enhance soil suppressiveness to damping-off. In addition, although compost amendments applied during transition can improve crop vigor by significantly enhancing soil fertility, their effects on soilborne diseases are not yet predictable when transitioning to certified organic production.

Additional keywords: soilborne disease suppression, transition treatment.

Small and midsized family farmers are under intense pressure to remain profitable, particularly in peri-urban areas. Increased sprawl, shrinking agricultural infrastructures, low commodity prices, and less tolerance for some conventional farming practices constrain agricultural systems near urban centers. The higher market value of organic produce and their proximity to large urban centers encourage some farmers to transition to organic vegetable production. The National Organic Standards Act (NOS) allows for certification only after 3 years have passed since the last use of a restricted substance. Growers approach the mandated 3-year transition period in different ways. Their options are coarsely defined based on time constraints, markets, and land, labor, equipment, and other costs. Published studies of transition experiments have shown that there is often a period of lowered yields similar to conventional production (21,22). This "transition effect" has been attributed, in part, to changes in the soil biological, chemical, and physical properties governing nutrient cycling, plant growth, and development (40,28). In the second and fifth years after conversion, Doran et al. (8) showed that microbial populations and activities in surface soil of organic and conventional treatment systems were influenced primarily by type of crop grown and, to a lesser extent, by soil physical properties. Sahs and Lesoing (30) reported significantly higher soil organic matter and total N in the organic than the conventional treatment 5 years after establishment of the experiment. These studies indicate that management practices applied during the transition period can have a substantial effect on the health and productivity of subsequent organic crops.

Management of soil organic matter to enhance soil quality and supply nutrients is a key determinant of successful organic farming. This involves balancing two ecological processes: mineralization of carbon and nitrogen in soil organic matter for short-term crop uptake, and sequestering carbon and nitrogen in soil organic matter pools for long-term maintenance of soil and environmental quality (6,18). Tillage, rotation, mulches, cover crops, and organic amendments are all known to influence soil organic matter composition and the structure and activity of microbial communities (11,19,20,27,34,37). Thus, nutrient transformations and soilborne disease suppression catalyzed by microbes are closely linked to turnover of biologically active soil organic matter (14,26). Composted animal manures have long been known to provide benefits to soil systems by improving soil structure and nutrient availability and are part of the foundation of organic fertility management (7). Another benefit of composts can be the suppression of soilborne plant diseases. Compost products are particularly effective in the suppression of *Pythium ultimum* and *Rhizoctonia solani*. These fungi represent different types of plant pathogens and may be affected differently by compost amendments (14). The vegetable production system may influence the efficacy of suppressive composts. Organic production systems use plant and animal manures to provide regular inputs of organic matter. In some cases, organic systems have been shown to result in disease-suppressive soils, based on the research measures of microbial activity and disease incidence (38).

The 3-year transition from conventional to organic crop production is considered to be potentially risky to farmers, because

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