Responses of Soil Microbial Biomass and N Availability to Transition Strategies from Conventional to Organic Farming Systems

Cong Tu[1], Frank J. Louws[1], Nancy G. Creamer[2], J. Paul Mueller[3], Cavell Brownie[4], Ken Fager[2], Melissa Bell[3], and Shuijin Hu[1]
Departments of [1]Plant Pathology, [2]Horticultural Science, [3]Crop Science, and [4]Statistics, North Carolina State University, Raleigh, NC 27695

Organic farming can enhance soil biodiversity, alleviate environmental concerns and improve food safety through eliminating the applications of synthetic chemicals. However, yield reduction due to nutrient limitation and pest incidence in the early stages of transition from conventional to organic systems is a major concern for organic farmers, and is thus a barrier to implementing the practice of organic farming. Therefore, identifying transition strategies that minimize yield loss is critical for facilitating the implementation of organic practices.

Soil microorganisms play a dominant role in nutrient cycling and pest control in organic farming systems, and their responses to changes in soil management practices may critically impact crop growth and yield. Here we examined soil microbial biomass and N supply in response to several strategies for transitioning from conventional to organic farming systems in a long–term field experiment in Goldsboro, NC, USA. The transitional strategies are described by Creamer et al. (this volume) and included one fully organic strategy (ORG), and four reduced–input strategies (withdrawal of each or gradual reduction of major conventional inputs—synthetic fertilizers, pesticides (insecticides/fungicides), and herbicides), with a conventional practice (CNV) serving as a control.

Microbial biomass and activity showed divergence among different strategies in the second year, whereas soil total C and N concentrations were essentially similar among different treatments at the end of the third year. In the first two years, the ORG was most effective in enhancing soil microbial biomass C and N among the transition strategies, but was accompanied with the highest yield losses. By the third year, soil microbial biomass C and N in the reduced–input transition strategies were significantly greater than those in the CNV (averaging 32 and 35% higher, respectively), although they were slightly lower than those in the ORG (averaging 13 and 17% lower, respectively). Soil microbial activity and net N mineralization in all transitional systems were significantly higher than those in the CNV (average 83 and 66% greater, respectively), with no differences among the various transition strategies. These findings suggest that the transitional strategies that partially or gradually reduce conventional inputs can serve as alternatives that could potentially minimize economic hardships as well as benefit microbial growth during the early stages of transition to organic farming systems.

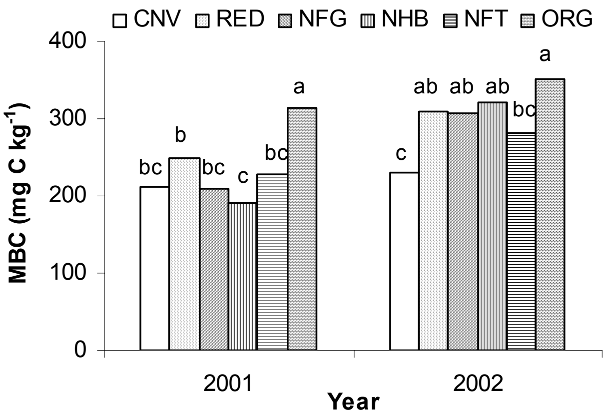

Fig. 1. Effects of organic transition strategies on soil microbial biomass C (MBC) in 2001 and 2002. CNV: Conventional practice, RED: Gradually reduced synthetic inputs, NFG: No fungicides/insecticides added, NHB: No herbicides added, NFT: No synthetic fertilizer added, and ORG: Organic practice. Bars with the same letter within a year are not significantly different at $P < 0.05$ (LSD).

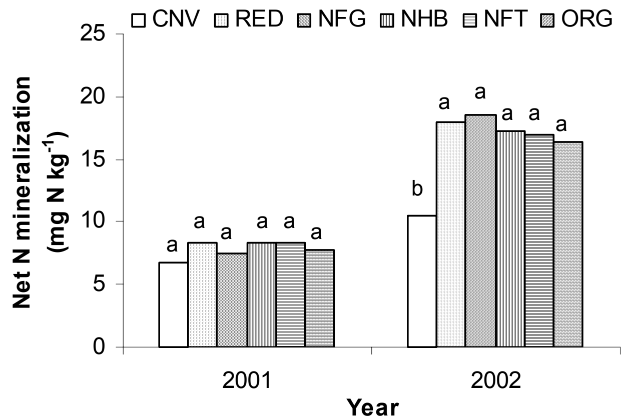

Fig. 2. Net nitrogen mineralization (NNM) as influenced by transition strategies in 2001 and 2002. CNV: Conventional practice, RED: Gradually reduced synthetic inputs, NFG: No fungicides/insecticides added, NHB: No herbicides added, NFT: No synthetic fertilizer added, and ORG: Organic practice. Bars with the same letter within a year are not significantly different at $P < 0.05$ (LSD).