ANAEROBIC SOIL DISINFESTATION IMPACT ON NUTRIENT DYNAMICS IN FRESH-MARKET TOMATO

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Background Anaerobic soil disinfestation (ASD) is considered a promising sustainable alternative to chemical soil fumigation (CSF) for the control of several soil-borne phytosanitary issues. Suitable for both organic and conventional growing systems, ASD is applied in pre-transplanting by i) amending the soil with a labile carbon (C) source, ii) mulching the soil with totally impermeable film (TIF), and iii) irrigating the soil to saturation. The soil amendment with organic material and its anaerobic decomposition cause a temporary variation of the soil redox potential, pH, and microbial population which in turn may impact the soil fertility, the nutrient dynamics, the plant growth and nutritional status, and the overall crop system environmental impact.

Objective A field study was conducted on fresh-market tomato (*Solanum lycopersicum* L.) to evaluate the effects of ASD applied using different rates of composted poultry litter (CPL) and molasses as amendments, on soil nutrient content, plant biomass and nutrient accumulation, nitrous oxide (N_2O) emissions, and potential nutrient leaching.

Method The study was conducted at the University of Florida/Institute of Food Science and Agriculture/South West Florida Research and Education Center located in Immokalee, FL, in the spring of 2015. The standard CSF with Pic-Clor 60 (1,3-cichloropropene + chloropicrin) applied at the rate of 224 kg ha^{-1} was compared with two ASD treatments applied using a mix of CPL at the rate of 22 Mg ha^{-1}, and molasses at two rates [13.9 (ASD1) and 27.7 m^3 ha^{-1} (ASD2)], respectively. Soil nutrient analyses were performed before treatment application, 21 days after treatment application (DATA), and at the end of the crop, 92 days after planting (DAP). Soil solution samples were collected at 7, 14, and 21 DATA, using suction samplers (model SSAT, Irrometer Company Inc., Riverside, CA) installed to a depth of 30 cm in each experimental plot. N_2O gas emissions were monitored from the top of the sealed, mulched beds (BT) 1, 2, and 4 DATA, and at crop planting (21 DATA, while punching holes in the polyethylene bed mulch), using custom made static chambers made from 4.7 L stainless steel bowls. N_2O

concentrations in the samples were measured by gas chromatography (GC). Plant growth was measured at 57 DAP on two plants per plot, and oven-dried leaves, stems and fruit samples were analyzed to determine macro- and micronutrients concentration by inductively coupled plasma atomic emissions spectrometry.

Results Soil amendment with molasses and CPL in ASD plots increased soil nutrient content, thus, increasing the risks of N, P, and K losses into the environment. Therefore, the amount of nutrients added to the soil with the molasses and CPL should be accounted, and the pre- and post-planting fertilization program should be adjusted accordingly.

N_2O emissions from intact polyethylene mulched beds were not affected by soil treatment and ranged from 0 to 0.378 µg m^{-2} h^{-1}. At transplanting (21 DATA), after punching holes in the polyethylene film, N_2O emissions were at least one order of magnitude higher and ranged from 1.56 to 4.83 µg m^{-2} h^{-1}, but were not influenced by soil treatment.

Soil disinfestation treatments had no influence on plant fresh and dry weight. However, plants grown in ASD plots, and especially those from ASD2 plots had higher nutrient accumulation compared to plants grown in CSF plots. Regardless of the molasses rate, ASD plants accumulated 24.4%, 30.3%, 23.6%, 34.3% and 39.0% more N, K, Ca, Mg, and Fe in their leaves than CSF plants, respectively.

At the end of the crop cycle, regardless the molasses rate, ASD plots had higher N, P, Zn, and Mo than CSF plots, while no differences were observed for the other nutrients analyzed. These results suggest that the ASD treatment may have a residual fertility effect even after the first crop cycle. Therefore, residual nutrients may be exploited in a double cropping system or should be properly managed for example introducing a catch crop in order to minimize risks of nutrient loss.

Conclusions ASD applied using CPL and molasses at the doses tested, increased soil fertility and nutrient availability, thereby improving tomato plant nutrient accumulation and nutrition status. Nevertheless, nutrients added to the soil with the CPL and the molasses may be subject to losses by leaching, especially during the three-week treatment period, before crop establishment. N_2O emissions were not influenced by soil treatments. These should be considered as preliminary results, and further studies are required to assess the potential environmental impact of the ASD technique.