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Anaerobic soil disinfestation benefits soil health while at a high environmental cost in solar greenhouse vegetable production systems

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Vegetable production in solar greenhouses in Eastern China generally suffers from over-fertilization and unreasonable irrigation, which result in severe soil degradation and soil-borne pathogens occurrence. Anaerobic soil disinfestation (ASD), as a newly developed economic technique, can combat pathogens in greenhouse vegetable soils. The ASD can create strong reductive conditions through the decomposition of added fresh C sources (crop residues or livestock manure) under saturated irrigation and warm conditions induced by plastic coverage to kill soil pathogens. However, ASD-induced organic matters application may increase N leaching and greenhouse gas (GHG) emissions, which remains unknown. Here, we investigated the effects of combined application of two crop residues (rice shells/maize straw) with different amounts of dry chicken manure (0, 300, 600, 1200 kg N ha^{-1}) on N leaching and GHG emissions losses in greenhouse vegetable production systems adopting ASD technique in Eastern China. Our results showed that seasonal N leaching and N_2O emissions ranged from 144-306 kg N ha^{-1} and 3-44 kg N ha^{-1}, respectively, which both significantly increased with manure application rate. Approximately 56-91% of seasonal N_2O emissions occurred during the ASD period (5 weeks before vegetable transplantation), whereas 75-100% of total N leaching occurred in the following vegetable-growing season after ASD. The incorporation of crop residues significantly increased N_2O emissions by 33-47% while decreasing N leaching by 26-27% compared with CK treatment. The application rate of chicken manure did not affect vegetable yield while significantly increasing the greenhouse gas intensity (GHGI) and reactive N losses intensity (NrI), with reducing 75% manure application significantly decreased 40-45% and 33-38% in GHGI and NrI, respectively. Our results demonstrate that overfertilization with conventional irrigation will not benefit the yield but at a high cost in environment N losses. Overall, current ASD schemes combined with additional manure and irrigation schemes need to be adapted to avoid GHG emissions and N leaching for reducing environmental pollution and improving the sustainability of greenhouse vegetable production systems.