Impact of manure-based biochars on ammonia volatilization from soil

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Ammonia (NH3) volatilization is one of the most important sources of nitrogen (N) loss in soil-plant systems worldwide. It is estimated that between 10 and 30% of N fertilizers may be lost through NH3 volatilization after application. In recent years, carbon-based materials such as biochar have created research interest because of its ability to increase soil fertility and reduce pollutants. Studies have also identified that the addition of biochar can reduce NH3 volatilization in soil. Laboratory-based incubation experiments were carried out using urea as an N source (at a rate of 300 kg ha-1) to investigate the influence of feedstock's (poultry manure, green waste compost and wheat straw), pyrolysis temperature (250, 350, 450, 500 and 700 ˚C), and application rates (1 and 2%) on NH3 volatilization in different soils with pH ranging from 6.0 to 8.5. An acid trap (sulphuric acid, 0.5 M H2SO4) was used to capture NH3 gas. The captured NH3 was determined by back titrating the unconsumed H2SO4 with 0.1 M sodium hydroxide (NaOH). The experiments were carried out for 30 days in a temperature controlled room at 24 ˚C. The study identified that biochar properties, pyrolysis temperature and application rates played an important role in reducing NH3 volatilization. For instance, the addition of PM-BC 350 (2%, pH 7.39), GW-BC 450 (2%, pH 8.03) and WS-BC 450 (2%, pH 8.01) to soils reduced NH3 volatilization by 53.03%, 37.89% and 34.93%, respectively. In contrast, the addition of PM-BC 350 (1%, pH 7.90), GW-BC 450 (1%, pH 8.03) and WS-BC 450 (1%, pH 8.13) to soils reduced NH3 loss by only 37.73%, 25.66% and 7.98% respectively. Reduction of NH3 volatilization through the application of biochar is either due to changes in pH or through NH3 sorption. Soil pH is reduced after biochar addition and due to the presence of carboxylic and phenolic functional groups biochar can reduce loss by trapping NH3 on its surface. This study underpins the enormous potentiality of biochar from manures and highlights the importance of pyrolysis temperature and feedstock in terms of decreasing NH3 volatilization from soils.