Field and Laboratory Evaluation of Nitrogen Release from Poultry Litter

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Introduction

- Poultry is Alabama’s number one agricultural industry generating 1.66 million tons of poultry litter (PL) year\(^1\).
- Due to its nitrogen (N) value and steady increases in fertilizer prices, interest in using PL as an alternative N source has renewed among row crop producers.
- However, unlike conventional fertilizers, N in PL is mainly present in organic forms.
- Plant N availability from PL is dependent on the rate of N mineralization i.e., conversion of organic N to inorganic N (\(\text{NH}_4^- + \text{NO}_3^-\)).
- Laboratory incubation studies are often used to estimate mineralizable N. However, they do not reflect true fields conditions.

Objectives

- To determine the rate of mineralizable N from PL applied at three rates under field conditions.
- To study the N release pattern from PL using a 7-step sequential extraction with water.

Materials and Methods

Mesh Bag Technique

- Three different soil types and production environments:
  - Compass loamy sand at E.V. Smith Research Center (EVS) near Shorter, AL.
  - Dothan fine sandy loam at Wiregrass Research and Extension Center (WREC) near Headland, AL.
  - Decatur silty clay loam at Tennessee Valley Research and Extension Center (TVREC) near Belle Mina, AL.
- Treatments included PL application at 67, 168, and 336 kg total N ha\(^{-1}\) with three replications.

Results and discussion

- Mesh bags were placed on the soil surface and collected after 20, 50, 70, and 90 days.
- The residual total N in the PL samples was determined by dry combustion method (\(\text{Nelson and Sommers, 1982}\)).
- The rate of N release was calculated from the differences in N contents between the incubation periods.

7-step Sequential Extraction

- 0.3 g of PL was shaken with 30 ml of de-ionized water (1:100) for 1 hour followed by centrifugation at 4000 rpm for 20 minutes, and filtration through a 0.45\(\mu\)m filter (step one).
- A 30 ml volume of de-ionized water was added to the PL residue from step one. The extraction procedure was repeated as described above for a total of 7 times.
- Filtrate solutions from each step were measured for inorganic N by colorimetric method (\(\text{Keeney and Nelson, 1982}\)).

Figure 1: Color variations of the filtrates from the 7-step sequential extraction of poultry litter with de-ionized water.

Figure 2: Nitrogen (N) released (%) from poultry litter applied at three N rates over 90-days of field incubation in a Compass loamy sand.

Figure 3: Nitrogen (N) released (%) from poultry litter applied at three N rates over 90-days of field incubation in a Dothan fine sandy loam.

Figure 4: Nitrogen (N) released (%) from poultry litter applied at three N rates over 90-days of field incubation in a Decatur silty clay loam.

Figure 5: Inorganic N (\(\text{NH}_4^- + \text{NO}_3^-\)) released (mg/kg) from poultry litter in the repeated extraction cycles using deionized water.

- Initial PL N content was 4% or 40,000 mg/kg.
- After 7 repeated extractions of PL with water, cumulative inorganic N released was 4134 mg/kg indicating release rate of 10%.
- Total N content in the PL decreased 35% (from 4% to 2.61%) after 7 repeated extractions.

Conclusion

- Under field conditions, the release rate of N from PL was highest (averaged 32%) in the first three weeks.
- After 90 days of field incubation, about 40% of the poultry N had been released to the soil.
- Up to 10% of litter N is water mineralizable.

References