# Turf Applications of N-Fortified Poultry Litter and Biosolids Fertilizers Affect Runoff Water Quality

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## ABSTRACT

Processing fresh poultry litter (PL) and municipal biosolids (BS) into fertilizers with additives may reduce environmental risks compared to turfgrass inorganic fertilizers. We manufactured 12 granular PL fertilizer formulations, including granules with and without BS, with and without a nitrification inhibitor [dicyandiamide (DCD)] and bound with three different binding agents (lignosulfonate, urea formaldehyde and water). Granular fertilizers were compared to fresh PL, dried BS, Milorganite, urea + triple super phosphate (TSP), and a no-fertilizer control under simulated rainfall. Treatments were applied to a turfgrass golf fairway on a total P (TP) basis of 20 kg P ha$^{-1}$. Biosolids additions decreased TP loss compared to granules composed primarily of PL (6.7 and 12.6%, respectively). Triple super phosphate applications resulted in 24.7% of TP being lost in runoff water while granular fertilizers had TP losses similar to PL (10.4%) but higher than BS (2.4%). Dissolved reactive P (DRP) runoff concentrations were lower if BS were added to formulations (2.7 vs. 3.0 mg L$^{-1}$ for granules with and without BS, respectively). Formulations with DCD had more total N (TN) loss (3.8 vs. 5.3% for granules without and with DCD, respectively). Binding agents did not impact nutrient losses in runoff water. Granulating PL and BS into fertilizers is a viable method for recycling PL and BS nutrients on turfgrass without increasing risks to nearby waterways.

## INTRODUCTION

Fig. 1. Arkansas Poultry Litter Production

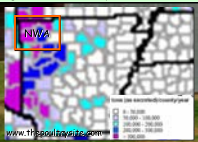
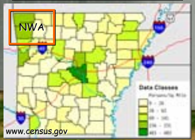



Fig. 2. Arkansas Population Density




Phosphorus has accumulated in Northwest Arkansas (NWA) soils due to poultry operations applying PL near the production unit (Fig. 1). Extensive population growth (Fig. 2) in the region has reduced land for PL applications and increased BS production. Court ordered actions to improve water quality mandated removal of PL from sensitive watersheds and resulted in municipal BS being land filled. Granulation of PL and BS produces a uniform product with more desirable characteristics than fresh PL and BS. User friendly formulations will increase their desirability as urban fertilizer sources. During granulation, additional N can be added to raise fertilizer analysis, a nitrification inhibitor can decrease N losses resulting from leaching and denitrification, and different binding agents may change nutrient release characteristics during the growing season and rainfall events. However, the granulation process requires grinding raw materials into a fine powder and exposure to high heat during the drying process. Preliminary research suggested that granulated fertilizers may contain 5 times more DRP concentrations than fresh PL; therefore, environmental risks may be increased.

## OBJECTIVE

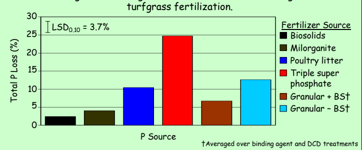
- Evaluate the relative turfgrass application risk of N-fortified PL and BS granular fertilizers on water quality compared to traditional urban fertilizer sources.

## MATERIALS AND METHODS

- Location description.
  - Arkansas Agricultural Research and Extension Center in Fayetteville, AR.
  - Captina silt loam (Fine-silty, siliceous, active, mesic Typic Fragiudult).
    - Water extractable P = 36 kg P ha$^{-1}$.
    - Mehlich-3 soil test P = 278 kg P ha$^{-1}$.
    - Total P = 1183 kg P ha$^{-1}$.
    - Total N = 3900 kg N ha$^{-1}$.
  - Bermudagrass (*Cynodon dactylon*) sod fairway.
- Fertilizer rate = 20 kg total P ha$^{-1}$.
- Rainfall simulation to generate runoff.
  - Portable rainfall simulator using 1.5 m × 2.0 m plots.
  - Water passed through cation-anion-cation filters to simulate natural rainfall (pH ~ 4 and low buffering capacity).
  - Rainfall intensity = 6.7 cm ha$^{-1}$.
  - Composite runoff sample collected for 30 min.
- Runoff water quality analysis.
  - Dissolved reactive P.
    - Filtered through 0.45 $\mu$m filter paper.
    - Analyzed colorimetrically on spectrophotometer.
  - Total P.
    - Digested with $HNO_3$ and $H_2SO_4$.
    - Analyzed using inductively coupled argon plasma spectroscopy.
  - Total N.
    - Digested with $K_2S_2O_8$ and NaOH using autoclave.
    - Analyzed using flow injection analysis.
- Fertilizer sources.
  - Nitrogen-fortified granular fertilizer (2 × 2 × 3 factorial).
    - With and without BS.
    - With and without DCD.
    - Bound with lignosulfonate, urea formaldehyde or water.
  - Dried BS used in formulations from Stuttgart, AR.
  - Milorganite, commercially available dried BS from Milwaukee, WI.
  - No-fertilizer control.
  - Poultry litter.
  - Triple super phosphate + urea.
- Data analyzed using the PROC GLM procedure with SAS and means separated using least significant difference (LSD) at an alpha level of 0.10.


## RESULTS AND DISCUSSION

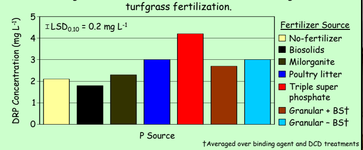
Fig. 3. Percentage fertilizer total P loss following turfgrass fertilization.




### Total Phosphorus

- Total P fertilizer loss (Fig. 3).
  - Highest TP loss occurred with inorganic TSP fertilizer (24.7%).
  - Lowest TP loss was from fertilizer applications of BS and Milorganite.
  - Granular fertilizer treatments without BS (made only from PL) were similar to fresh PL.
  - Grinding PL into powder to form granules did not increase TP loss.
  - Total P loss was decreased proportionally as BS were added to formulations.
  - Biosolids and Milorganite total P loads (0.5 and 0.8 kg P ha$^{-1}$, respectively) were similar to no-fertilizer (0.7 kg P ha$^{-1}$) treatments.
  - Dicyandiamide and binding agent treatments did not impact TP loss.

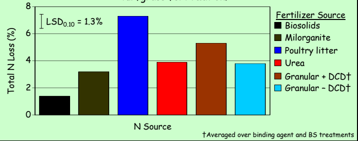
Fig. 4. Runoff water DRP concentrations following turfgrass fertilization.




### Dissolved Reactive Phosphorus

- Dissolved reactive P runoff water concentration (Fig. 4).
  - Triple super phosphate had highest runoff water concentrations (4.2 mg DRP L$^{-1}$).
  - Biosolids treatments (1.8 mg DRP L$^{-1}$) had lower runoff water DRP concentrations than any other treatment and the no-fertilizer control (2.1 mg DRP L$^{-1}$).
  - Granules with BS (2.7 mg DRP L$^{-1}$) had lower DRP runoff water concentrations than granules without BS (3.0 mg DRP L$^{-1}$) and fresh PL (3.0 mg DRP L$^{-1}$).
  - Runoff DRP concentrations from granules were not higher than fresh PL even though granule DRP concentrations were 5 times higher.
  - Dicyandiamide and binding agent treatments did not impact runoff DRP concentrations.
  - Dissolved reactive P loads were not significant and averaged 0.6 kg DRP ha$^{-1}$.

Fig. 5. Percentage fertilizer total N loss following turfgrass fertilization.




### Total Nitrogen

- Total N fertilizer loss (Fig. 5).
  - Fresh PL (7.3%) had highest TN loss.
  - Lowest TN loss was from BS fertilization (1.4%).
  - Granular fertilizers without DCD (3.8%) had lower TN losses than granules with DCD (5.3%) and similar losses as urea (3.9%).
  - Granular fertilizers had lower TN loss than fresh PL.
  - Grinding PL and BS into powder prior to granulation did not increase overall TN loss.
  - Binding agent and BS treatments did not impact TN loss.

## CONCLUSIONS

- Nitrogen-fortified PL and BS fertilizers did not increase environmental risks over fresh PL, BS or other fertilizers commonly used for turf fertility.
- Biosolids additions to granular fertilizer formulations reduced total P loss and DRP runoff water concentrations.
- Dicyandiamide increased TN runoff water losses, but overall TN loss was lower than fresh PL treatments.
- Binding agents did not have any impact on total P, DRP or total N losses.
- Granulation may provide environmentally sound alternatives for nutrient cycling of PL and BS.