Residual-Year Corn Response to Liquid Swine Manure Nitrogen Applied to Soybean

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INTRODUCTION

Approximately one-third of total U.S. swine production is in Iowa, and liquid swine manure (LSM) has been a valuable plant nutrient resource for crop production. However, over application of LSM can result in increased environmental risk and economic loss. Farmers must either find cropland planted to corn, if available for manure application, or consider application to soybean. Research on the effect of LSM-N applied to soybean on the succeeding year corn N fertilization requirement does not exist. Objectives of this study were to evaluate the effect of LSM-N applied to soybean on succeeding-year N supply and N response in corn.

MATERIALS AND METHODS

- LSM was applied to soybean on eight farmer fields in 2000–2003.
- Field-length LSM strips were applied in a randomized complete block design with three replicates; a control (no LSM), two LSM rates (112 kg total-N (TN) ha^{-1} for low and 224 kg TN ha^{-1} for high).
- LSM was obtained from confinement swine finishing facilities, with under-building pits.
- Manure application equipment were calibrated at the time of LSM applications.
- Pre-application LSM samples were collected 2–3 wk before application, analyzed for TN, and used to determine LSM application rates.
- LSM samples were collected during each application and analyzed for TN. These samples were used in conjunction with applicator rate calibration to determine total LSM-N applied.
- Post-soybean harvest profile soil samples (30-cm increments to 120-cm depth) were collected for NO_3-N determination.
- Residual-year crop supply of LSM-N in corn was studied at seven of the eight sites that had LSM applied to soybean. Subplots of fertilizer N (FN) rates were positioned within each of the prior-year LSM treatment strips.
- Four FN rates (0, 45, 90, and 135 kg N ha^{-1}) were randomly assigned to subplots with ammonium nitrate surface broadcast within 2 wk after corn planting.
- Soil was sampled (0–30 cm) from subplots to determine late spring soil NO_3-N test concentrations (LSNT).
- Chlorophyll meter (CM) readings collected at the corn R1 growth stage and relative CM (RCM) values calculated.
- Lower corn stalk samples were collected at plant maturity for NO_3-N concentration determination (CSNT).
- Corn grain yield (GY) was measured for each subplot.

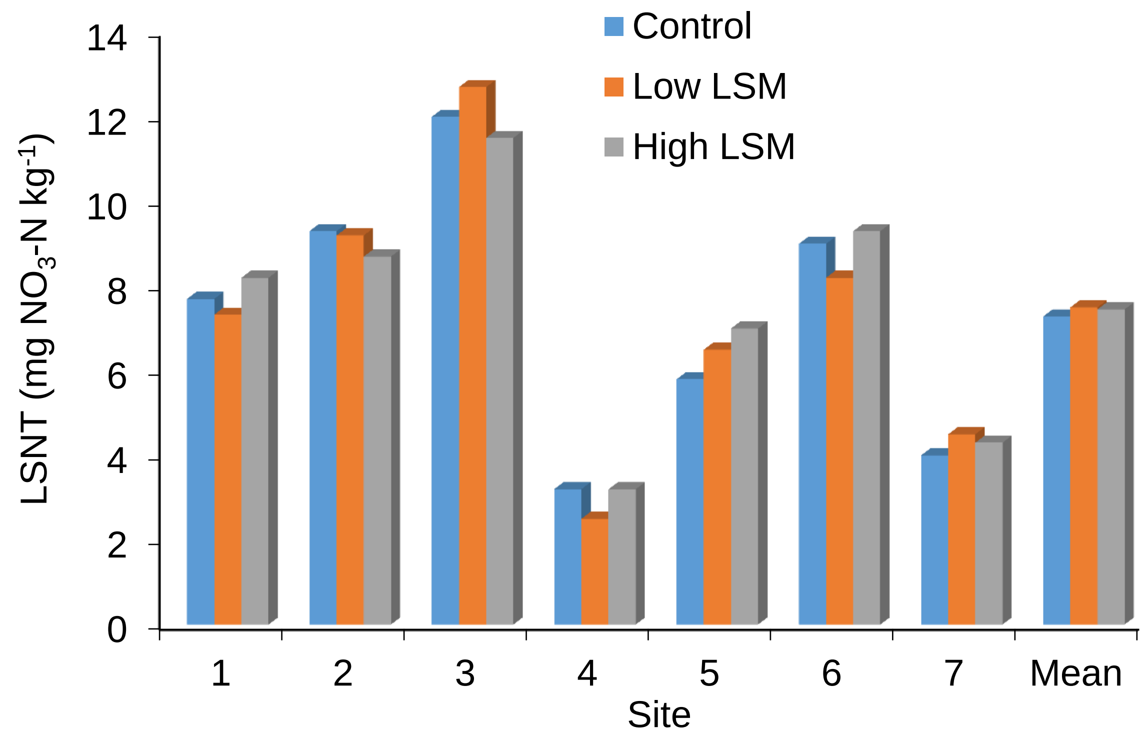

Fig. 1. Late spring NO_3-N test (0-30) concentration response to applied LSM rate without FN application in the residual-year corn. No significant differences (P < 0.10)

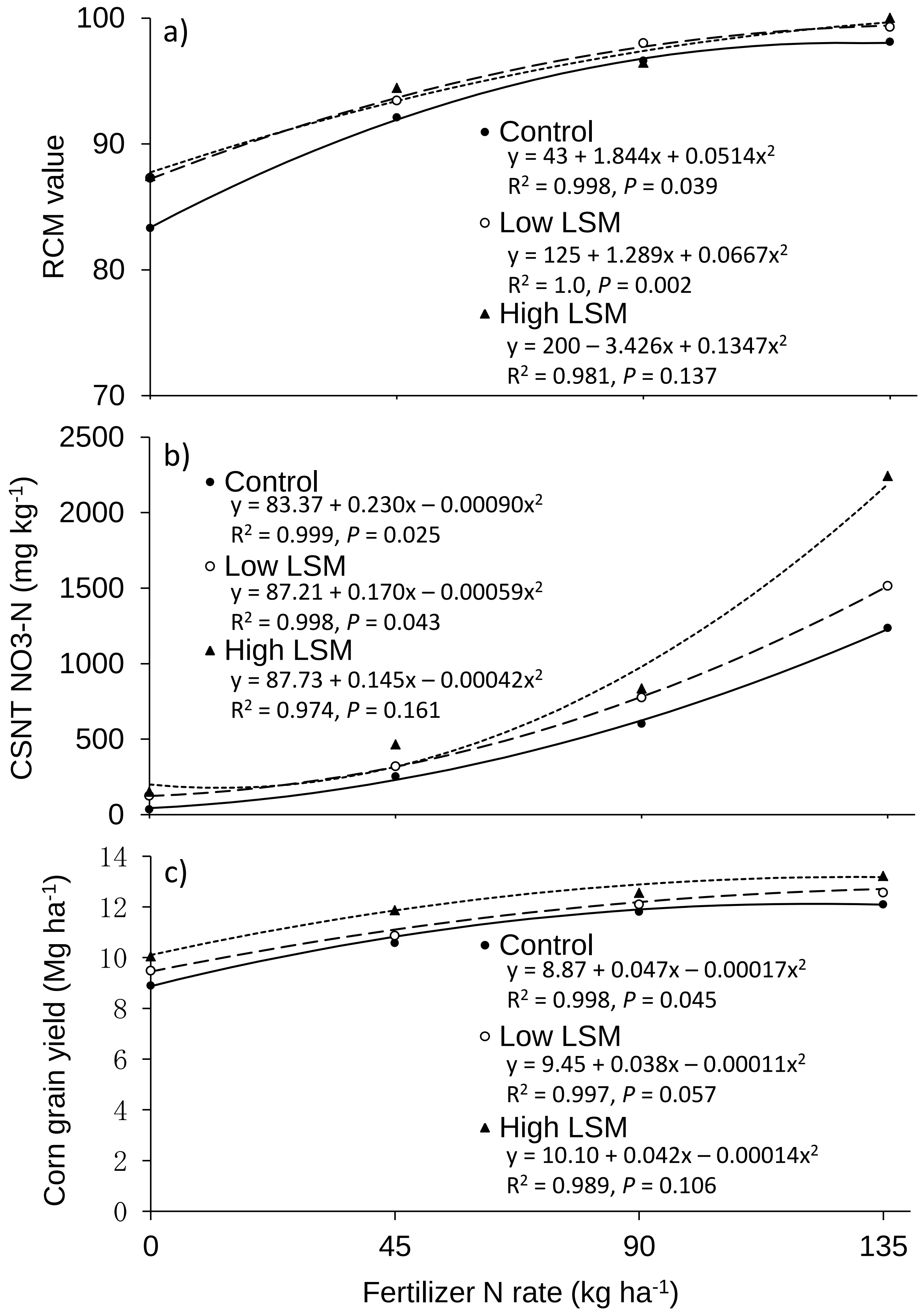

Fig. 2. (a) Mean across-site effect of LSM rate and FN rate in the residual-year corn on relative chlorophyll meter (RCM) value, (b) lower corn stalk NO_3-N test (CSNT) concentration, and (c) corn grain yield.

RESULTS AND DISCUSSION

- LSM significantly increased soybean GY at five of the eight sites with both the low and high rates (data not shown); across site mean 0.17 Mg ha^{-1} (4.8%) increase.
- Post-soybean harvest profile NO_3-N increased at four sites with LSM application, with an across-site mean 12 and 24 kg NO_3-N ha^{-1} increase with low and high LSM rates, respectively (data not shown).
- The LSNT concentrations in the corn were not increased by the prior-year LSM application to soybean for either rate, at any site, or across sites (Fig. 1).
- With no FN applied, the prior-year LSM applications increased the corn RCM values (Fig. 2). The response to FN rate was similar for the control, low, and high LSM rates, but RCM values across FN rates were numerically highest with the prior-year LSM applications.
- Based on the mean LSM-N rates, and the RCM values for each LSM rate with no FN applied, the estimated residual N supply or carryover FN equivalence was 14% and 8% for the low and high LSM-N rate, respectively.
- The CSNT concentrations increased with the prior-year LSM-N applications, but only when FN was also applied (Fig. 2).
- The high prior-year LSM rate had the highest CSNT concentrations across FN rates, especially with the highest FN rate.
- The increase in corn RCM and CSNT from each LSM rate indicates plant available N supply from the prior-year application to soybean.
- The mean effect of the prior-year LSM-N application on the corn GY across all FN rates was significant at five of seven sites, and for the mean across sites (data not shown).
- Compared to the control with no LSM application, corn GY increased with each prior-year LSM rate for all FN rates (Fig. 2), with largest increase for the high LSM rate.
- Since the corn GY response to FN rate did not plateau, it is evident that additional N would have increased yield.
- Based on the modeled GY response to FN rate, the estimated residual-year FN equivalence of the LSM-N averaged 11% for both LSM rates. The amount of carryover N from the prior-year LSM, based on that equivalence, was 14 and 27 kg NO_3-N ha^{-1} for the low and high LSM rates, approximately the mean amount of post-soybean harvest profile NO_3-N with each LSM rate.

SUMMARY AND CONCLUSIONS

Liquid swine manure application to soybean increased soybean GY at 63% of sites, and increased residual-year corn GY at 71% of sites (mean 0.6 and 1.1 Mg ha^{-1} corn GY increase with the low and high prior-year LSM rates, respectively). The apparent residual-year FN equivalence of the LSM total-N was 11% based on RCM and GY. LSM application to soybean can be a viable nutrient management practice; however, total-N application should be at a rate to minimize residual NO_3-N buildup and carryover to future crops.

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This research was partly supported by the Iowa Department of Agriculture and Land Stewardship, Division of Soil Conservation through funds appropriated by the Iowa General Assembly for the Integrated Farm and Livestock Management Demonstration Program. We would like to thank the many farmers and cooperators for allowing us to work on their farms and assisting with the LSM applications and crop harvest.