IN-SEASON APPLICATION OF SWINE MANURE TO CORN

M.L. Wilson, E. Alto, S. Cortus
University of Minnesota, Saint Paul, MN
mlw@umn.edu (612)625-4276

ABSTRACT

In agricultural areas with cool climates, application of livestock manure for crop production can be challenging. For example, spring in the upper Midwest can be short and is increasingly wet due to climate change, making it difficult to apply manure and plant crops in a timely manner. This results in a significant amount of manure applied in the fall after the cash crop is harvested. The nitrogen in fall-applied manure has ample time to mineralize and leave the root zone before next season's crop can utilize the nutrients. This excess nitrogen outside of the growing season can end up in ground and surface waters. Applying manure to corn (*Zea mays*) during the growing season, referred to as sidedressing, could provide farmers with another window of opportunity to apply their manure, maximize nutrient uptake efficiency, and protect water quality. Replicated, on-farm studies were initiated in 2018 to evaluate sidedressing liquid swine manure to corn using tanker or drag hose application systems. Both systems were able to inject the manure between corn rows to reduce ammonia volatilization. In the first study using a drag hose applicator, liquid manure was compared to sidedressed anhydrous ammonia, 32% urea ammonium nitrate, and a no-sidedressed-nitrogen control. All sidedressed N sources resulted in similar corn yield in 2018 (approximately 206 bu ac^{-1}) but not 2019. In 2019, yield was significantly lower in the manured plots than the other N sources (171 vs approximately 218 bu ac^{-1}). This is likely because the application rate was lower than expected due to operator error, applying only 90 lb N ac^{-1} instead of 140 lb N ac^{-1}. In the second study using the tanker applicator, manure application timing was the experimental factor. Manure was applied when the fourth and seventh corn leaf collars had emerged (V4 and V7 growth stages) and compared with anhydrous ammonia sidedressed around V4 (the farmer's standard practice). Corn sidedressed with swine manure by tanker decreased yield in both years compared to the sidedressed anhydrous ammonia. This may have been due to compaction issues from the tanker or perhaps the manure N did not release quickly enough during these growing seasons.

INTRODUCTION

Spring application of manure prior to planting corn is often difficult to fit into a farmer's schedule in the upper Midwest, as the growing season is shorter than other parts of the country. Fall and winter applications give the farmer more time, but run the risk of losing nutrients through runoff, erosion, leaching, and denitrification. There is growing interest in sidedressing manure in place of chemical fertilizers to reduce costs and increase the window of opportunity for application. In Ontario, corn yields were higher than the long-term average when sidedressed swine manure was injected but

were variable for topdressed manure (Ball Coelho et al. 2005). In Ohio, a four-year study showed a yield increase in corn sidedressed with 200 pounds of plant available nitrogen per acre of swine manure compared with the same rate of 28% urea-ammonium nitrate (Arnold 2015). Both studies used swine manure from finishing operations, as this is more nutrient dense than other types of swine operations. The researchers in Ohio have recently expanded from using manure tankers to apply the manure to using dragline systems, with positive results. They also did a study dragging a line over corn at various growth stages and found that corn yields were not diminished if the corn was draglined at stage V3 (about 3 inches high) or earlier (Arnold 2017). This practice has not been evaluated in the upper Midwest, however.

MATERIALS AND METHODS

Replicated, on-farm studies were initiated in 2018 in second-year corn to evaluate sidedressing liquid swine manure to corn using tanker or drag hose application systems. Both systems were able to inject the manure between corn rows to reduce ammonia volatilization. In the first study using a drag hose applicator, liquid manure was compared to sidedressed anhydrous ammonia, 32% urea ammonium nitrate, and a no-sidedressed-nitrogen control. At planting, 40 lb ac^{-1} of nitrogen (N) was applied to the whole field. The remaining 140 lb N ac^{-1} was applied at sidedress with the different nutrient sources. For manure, about 3,500 gal ac^{-1} was applied to reach the targeted first year available N rate. Each treatment strip was replicated four times in the field. The farmer harvested the corn and yield data was verified with a weigh wagon. Moisture content was measured and used to standardize yield to 15.5% moisture content.

In the second study using the tanker applicator, manure application timing was the experimental factor. Manure was applied when the fourth and seventh corn leaf collars had emerged (V4 and V7 growth stages) and compared to the farmer's traditional practice – applying anhydrous ammonia around the V4 growth stage. At planting, 40 lb ac^{-1} of N was applied to the whole field. The remaining 155 lb N ac^{-1} was applied at sidedress. For manure, about 4,000 gal ac^{-1} was applied. Each treatment strip was replicated three times in the field. The farmer harvested the corn and yield data was verified with a weigh wagon. Moisture content was measured and used to standardize yield to 15.5% moisture content.

RESULTS AND DISCUSSION

In the first study using a drag hose applicator, we observed that N-deficient striping had occurred in the corn in the swine manure plots due to possible issues with flow distribution or soil compaction (Figure 1). At harvest time, all sidedressed N sources resulted in similar corn yield in 2018 but not 2019 (Figure 2). In 2019, we found out afterwards that the application rate had been much lower than expected, applying only 90 lb N ac^{-1} instead of 140 lb N ac^{-1}. This likely explains lower yield in the manured plots compared with commercial fertilizer plots. More details can be found in Pfarr et al. (2020).

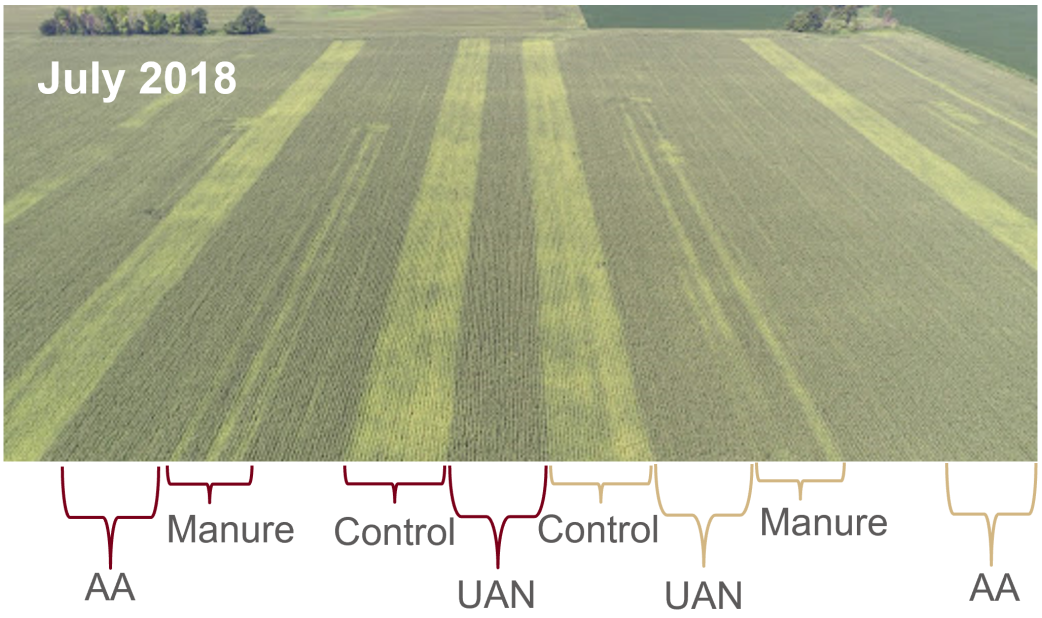

Figure 1. An aerial photo of maize taken mid-season approximately one month after sidedressing in 2018. Treatments include anhydrous ammonia (AA), swine manure, 32% urea ammonium nitrate (UAN), and a no-sidedressed N control.

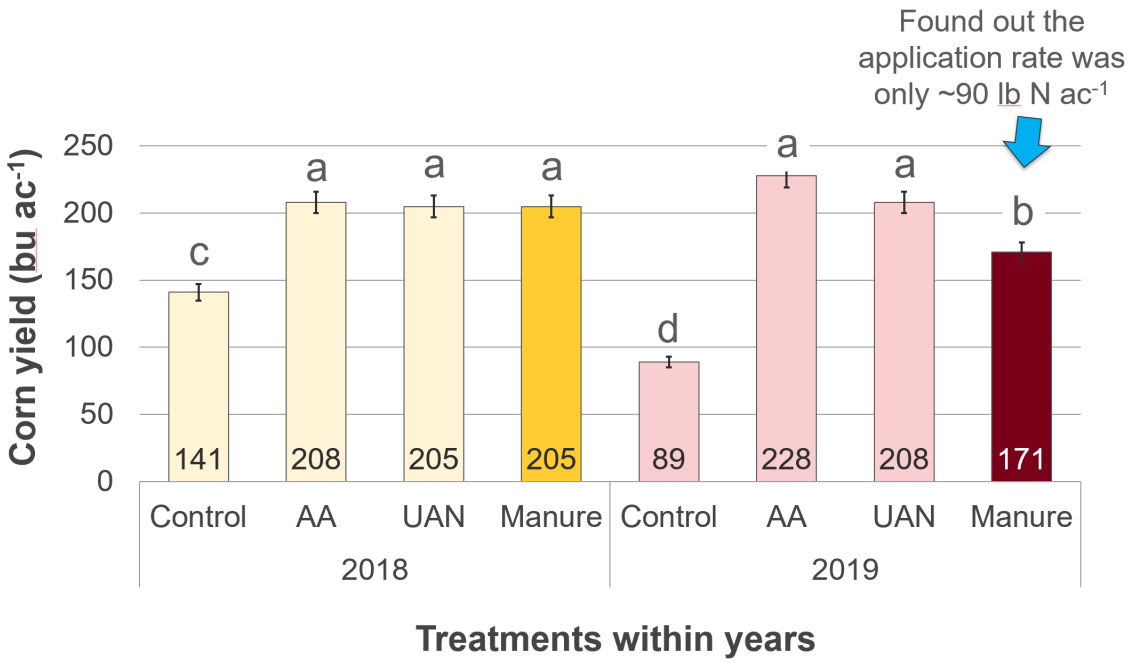

Figure 2. Corn yield following different sidedressed N sources: Control (no N beyond 40lbs N applied at planting across entire field), anhydrous ammonia (AA), liquid urea-ammonium nitrate (UAN), and liquid swine manure applied with a dragline application system (manure). All N sources were applied to supply an additional 140 lb N ac^{-1}. Bars with different letters were significantly different ($P < 0.05$).

In the second study using a tanker applicator, corn sidedressed with swine manure resulted in a 6 to 15% yield decline compared with the anhydrous ammonia treatment (Figure 3). This may have been due to compaction issues as the manure tanker system

is much heavier than a dragline system. The narrow-row tires that were used to fit between rows of corn, compared to the much wider flotation tires used during the non-growing season, may have enhanced compaction, thus affecting crop growth and nutrient uptake.

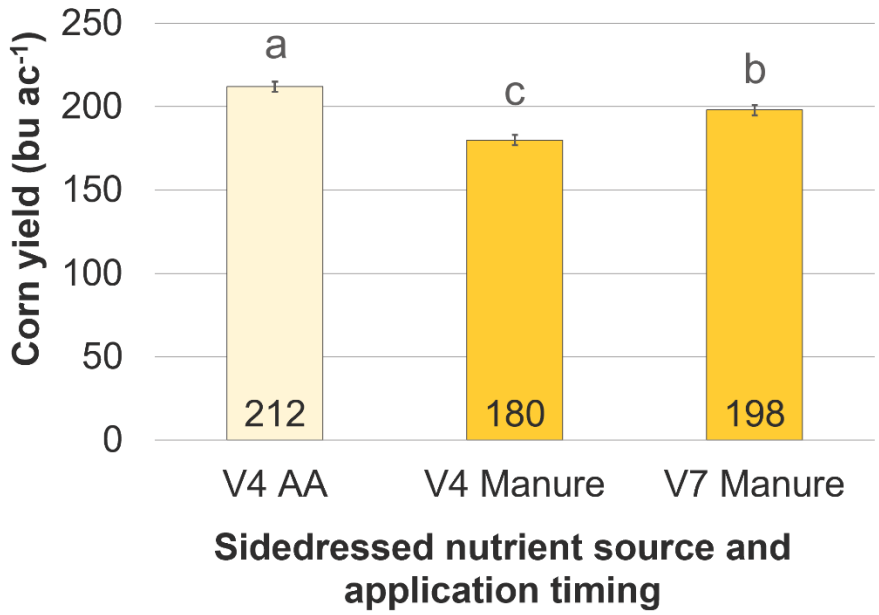

Figure 3. Corn yield following different sidedressed N sources at different times: Anhydrous ammonia (AA) applied at the 4th leaf collar (V4) growth stage and liquid swine manure applied with a tanker application system (manure) at the V4 and seventh leaf collar (V7) growth stages. All N sources were applied to supply an additional 155 lb N ac-1 (40 lb N ac-1 was applied over the entire field at planting). Bars with different letters were significantly different (P < 0.05).

Overall, swine manure was a good nutrient source for sidedressing corn during the growing season, particularly when applied with a dragline hose system. A tanker application system, however, may have caused too much compaction during application, leading to reduced corn yield. More research is needed to determine if there are adjustments to the implements that can be made to reduce compaction issues.

ACKNOWLEDGEMENTS

This work was supported by the AFRI Foundational and Applied Science Program [grant no. 2020-68008-31410] from the USDA National Institute of Food and Agriculture.

REFERENCES

Arnold GJ. 2015. Corn yield results from sidedressing with liquid livestock manure. Journal of the NACAA 8(2); [accessed 6 May 2017]. http://www.nacaa.com/journal/index.php?jid=329.

Arnold GJ. 2017. Replacing commercial sidedress nitrogen with liquid livestock manure on emerged corn using a drag hose system. In: North American Manure Expo; Arlington (WI). 23 Aug 2017.

Ball Coelho BR, Roy RC, Bruin AJ. 2005. Agronomy Journal 97:1322-1332; [accessed 6 May 2017]. http://www.prairieswine.com/pdf/3469.pdf.

Pfarr, C.J., et al. 2020. Liquid swine manure as a sidedressed nitrogen source for corn. Agron. J., 112, 5206–5221.