Low Disturbance Shallow Manure Injection In Winter Wheat

Purpose:
Utilizing manure as a nitrogen source for winter wheat has proven to be challenging. Nitrogen losses from surface applied manure can be substantial. Uniformity of application is a constant challenge. Micro ponding and soil “sealing off” when manure is applied all add to the challenge of maximizing manure utilization and reducing environmental losses. This project examines methods to reduce nitrogen volatilization and improve utilization by enhancing uniformity of application, when applying manure into existing wheat stands. The concept being investigated is the European methodology of “Low Disturbance Shallow Injection” technology.

Methods:

Two replicate field scale trials were completed at 9 locations (4 in 2012, 5 in 2013). The treatments are as follows:

1. Check (no manure or fertilizer)
2. Full rate manure shallow Injection
3. Full rate surface band applied manure
4. Full rate splash plate applied manure
5. 2/3 rate manure injection and 1/3 rate fertilizer
6. Full rate Fertilizer

Manure was applied on winter wheat fields in late March in 2012 and early May in 2013. Treatment 2 was injected using a Veenhuis Injection unit with V style press wheel openers at 7.5 inch spacing in 2012, and a modified coulter injector on 10” centres (Nuhn Industries) in 2013. Veenhuis openers create a narrow trench 1-2 inches deep into which the manure is applied, while the Nuhn toolbar was considerably more aggressive, running up to 4” deep to create a void for the manure to be delivered into. For Treatment 3, the surface band manure treatment was applied by raising the openers out of the ground and applying the manure on the surface via the same band applicator used in Treatment 2 so that the manure was applied in 7.5 inch spaced bands. The manure did not cover the entire soil surface. For Treatment 4 the manure was applied broadcast via a splash plate that resulted in the entire soil surface being covered. Due to equipment limitations in the early season the splash plate treatment was included at only one location in 2012 and 4 of the 5 sites in 2013. The #5 treatment had manure injected in the same manner as treatment 1 but the rate was cut by 1/3. Urea fertilizer was then broadcast on the soil surface using a Valmar airflow applicator at a rate to replace the N not available in the lower manure rate. This low rate of fertilizer N should help overcome any manure application uniformity issues. With Treatment 6, urea fertilizer was broadcast to match nitrogen levels on manure treatments. Potash and phosphorus applied from manure were not matched in the full fertilizer treatment.

Ammonia loss was measured across all treatments via dosimeter tubes and pails adapted to allow for airflow after ammonia movement was measured. Soil nitrates were taken at heading and post-harvest to track soil nitrogen status and monitor potential environmental impact post-harvest. Disease levels were monitored throughout the

growing season. Harvest measurements included yield, moisture, test weight, thousand kernel weights, lodging and protein.

Results:

Yield data is summarized in Table 1. Yields in the check strips were somewhat above expectations, likely due to high residual soil nitrate levels from repeated manure applications on these farms in previous years. Yields increased significantly with added nitrogen (>20 bu/ac). The manure application method had minimal impact on yield. Injected manure increased yields by ~3 bu/ac compared to banding the manure on the surface. This may be due to the relatively minimal amount of soil disturbance created by the Veenhuis opener to incorporate the manure and reduce volatilization, and by injury to the wheat crop caused by the Nuhn toolbar. The fertilizer treatments consistently resulted in top yields, but on average there was little difference between injected manure and fertilizer. In previous research (209-2011) treatment 5 (2/3 of the nitrogen from manure with 1/3 from fertilizer) was the top yield. While this trend continued in 2012, it was not the case in 2013. We speculate that fertilizer application in 2013 occurred just prior to manure application, and urease enzyme in the manure may have "blown off" some of the fertilizer N. In future, timings of manure and fertilizer applications should be kept apart.

Table 1: 2012-13 Yield Results from 8 locations (bu/ac)

Treatment	2012	2013	Trial Average
Check	73.6	69.0	71.3
Manure Injection	98.4	97.4	97.9
Banded Manure	95.5	93.9	94.7
2/3 Manure 1/3 Fert	102.5	96.0	99.3
Full Fert	101.9	97.1	99.5

The 4 sites containing the splash plate treatment are summarized in Table 2. On average the splash plate treatment had similar yield to the banded manure treatment but results varied across locations. At the Milverton and Listowel locations, full fertilizer treatments did not contain as much nitrogen as the manure applications. This explains the relatively poor showing of the full fertilizer at these locations. The Milverton location clearly shows the potential gain from low disturbance shallow injection, but it is the inconsistency of the manure treatments that has yet to be overcome.

Table 2: Manure Application Method Winter Wheat Yield (bu/ac)

Treatment	Milverton	Listowel	St.Thomas	Mount Forest	Average
Check	87.2	75.8	51.5	81.9	74.1
Manure Injection	119.8	105.0	79.6	89.3	98.4
Banded Manure	102.6	101.6	80.2	89.3	93.4
2/3 Manure 1/3 Fert	117.7	100.6	80.0	86.9	96.3
Full Fert	108.2	95.0	83.7	92.3	94.8
Splash Plate	110.9	103.7	76.0	84.5	93.8

Figure 1: Picture of Wheat after Shallow Injection (Nuhn toolbar)

Leaf disease levels were low across all locations. Treatments 2 through 6 did not have a significant impact on most diseases but Treatment 1 (check) had significantly less leaf disease. Low leaf disease levels are easily explained as the stand in the check treatments was very thin due to a lack of nitrogen.

Summary:

Shallow manure injection has shown some potential for increasing wheat yields, due to reduced nitrogen losses. Over the 2 years of this trial shallow injection increased wheat yields by 3 bu/acre on average compared to surface applied manure. However, at individual locations the yield gain was up to 10 bu/ac. The shallow injection systems used in this trial had minimal impact on plant health following application. Treatments including fertilizer averaged a 5 bu/acre advantage over surface applied manure but only a slight yield increase over injected manure. Yields were variable across plots, showing the impact of weather on manure utilization. Shallow injection was successful in removing some of this variability at specific sites, but across all treatments was not statistically different.

Dosimeter readings measuring ammonia loss were variable across locations and are being summarized. Soil nitrate samples were taken at heading and post-harvest to monitor soil nitrate levels but results are still pending.

Figure 2: Manure Tanker with Nuhn Toolbar

Next Steps:

This project is now complete.

Acknowledgements:

We are indebted to our many co-operators, many of whom stick with us year after year. Thanks to all the summer assistants. Special thanks to technician Shane McClure, administrator Marian Desjardine, and statistician Ken Janovicek. This project would not be possible without the financial support of the Best Management Practices Self Directed Research Program of the Ontario Ministry of Agriculture and Food, the Grain Farmers of Ontario and their staff with ongoing support, the many Soil and Crop Improvement Associations that work with us, both as cooperators and with financial support, along with many agribusiness' that support this work. Dr. David Hooker, Scott Jay, Gerald Backx and the wheat research team at the University of Guelph are valued contributors to many of our projects as well. Heartfelt thanks to you all!

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