THE USE OF NATURAL NITRATE FOR ORGANIC CORN PRODUCTION

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INTRODUCTION

Natural Nitrate, containing16% nitrogen (N), is also known in the trade as sodium nitrate or Chilean nitrate, and is a natural product obtained from the Caliche ore in the Atacama Desert of Chile by mechanical and hydraulic processes. The caliche ore, a "nitrogenous rock" undergoes physical processing at low temperatures similar to those of the surrounding environment. Natural Nitrate does not require transformations in the soil to become part of the soil solution and be available for plant uptake. According to the USDA National Organic Program (NOP) (USDA-AMS, 2009), this rapidly mobile source of natural nitrogen can be used to provide no more than 20% of the N required by the organic crop. This fertilizer can be applied at different times during the early growing season, or at least until the last cultivation. Because of these two characteristics, Natural Nitrate can be used to synchronize available soil N with crop demand during the important early growth stages.

Working with SQM, S.A. (Atlanta, GA), we investigated the use of Natural Nitrate (NN) to complement the nitrogen supplied by organic sources (manure) to provide 20% of the N required by organic corn. This research was conducted on the Scott Shriver Farm in Jefferson, Iowa, in 2008. This product was particularly important in the 2008-growing season because of the excessive rains and flooding that occurred in June, as low temperatures and heavy rains during the early growing season were thought to reduce available soil nitrogen by limiting N mineralization rate and by increasing nitrate leaching, respectively.

MATERIALS AND METHODS

The Natural Nitrate (NN) was supplied by SQM, S.A., along with the Soda-Flo™ side-dress box with applicator tubes, which was attached to a tractor to apply the NN to each row (see photos).

Soda-Flo applicator for NN

Applying NN with Soda-Flo attachment

Soils were tested at a 6-inch depth prior to the experiment by taking 12 random samples over a 1-acre area. All soil analysis was conducted at the ISU Plant and Soil Testing Lab, Agronomy Dept. (Ames, IA). The experimental design consisted of eight plots of six rows each, with two treatments randomly assigned, and four replications:

1. Corn crop cultivated following the normal practices for organic corn (check plot) and,
2. Corn crop cultivated following the normal practices plus the application of Natural Nitrate (NN) to supply 20% of N crop demand (Natural Nitrate plot).

The experimental design and layout consisted of 48 contiguous 30-inch rows, 388 feet long, with a total trial width of 120 feet. Manure (liquid swine manure) was applied on December 12, 2007, at a rate of 5,800 gal/acre to the entire experimental area. Corn was planted on 15 May 2008 at 32,000 seeds/acre.

Soil analysis (late spring nitrate test) was conducted on 11 June at a 6-inch depth in all plots prior to NN application. Natural Nitrate was applied on 20 June 2008. We assumed a target corn yield in the range of 160 to 180 bushel/acre and a total N demand of 180 lb N/acre, so the 20% N applied as Natural Nitrate corresponded to 36 lb N/acre. The equivalent application rate of Natural Nitrate (16% N) was 225 lb/acre.

On 2 July 2008, an ear leaf was randomly selected from 3 plants per plot and analyzed for N content in the ISU Agronomy Dept. A Minolta SPAD reading was also taken as an estimate of N content in leaves. Corn plant height was measured on 3 plants per plot.

An additional SPAD reading was taken on 23 July 2008, along with height measurements and a check for corn borer damage. Another leaf sample was taken on 23 August for N content. Corn stalk nitrate sampling occurred on 1 October by collecting corn stalk samples from 3 random plants per plot. . Before harvest, on 16 October, plant height was taken again.

Each plot was harvested on 16 October with S. Shriver's combine and weighed in a precision weigh wagon supplied by Banks Seed Company, Boone, IA. Corn ear growth was also compared at harvest by selecting 3 random ears per plot and measuring ear length, width, rows of grain, number of kernels per row, and ear weight. Corn grain quality was analyzed at the ISU Dept. of Food Science Grain Quality Laboratory.

RESULTS

Prior to the experiment, soils at the site averaged a pH of 7.1, 0.1149% N, 269 ppm K, and 33 ppm P. At the late spring nitrate test 26 days after planting (DAP), soils showed equivalent NO_3-N in all plots: 4.1 ppm in the check plots and 4.8 ppm in the NN plots

Ear leaves at 32 DAP from the check plot leaves averaged 3.1% N, while the NN leaves had significantly greater N content at 3.7%. The NO_3-N concentration in NN leaves also was significantly greater than the control: 2336 ppm vs. 1113 ppm in the check leaves.

SPAD readings also were significantly greater in the NN leaves compared to the check: 49.5 in the check vs. 54.4 in the NN plots. Corn plant height averaged 88.5 cm in the check and was significantly greater in the NN plots at 97.6 cm.

No corn borer damage was detected in any plots. At 53 DAP, SPAD readings in the check plots averaged 52.0 vs. 56.0 in the NN plots. Plant height averaged 1.89 m in the check plots vs. 2.11 m in the NN plots. Leaf content averaged 2.33% in NN plots vs. 2.09% in the check plots.

Nitrate content in corn at the end of the season was lower in the check plots, averaging 131 ppm compared to 751 ppm in the NN plots. The plant height in the NN plots averaged 2.50 m compared to 2.44 m in the check plots.

Corn yields were significantly greater in the NN plots, averaging 139.4 bu/acre in the NN plots compared to 123.3 bu/acre in the check plots.

Corn ear length and width did not differ between treatments, with ears averaging 22 cm in length and 15 cm in width. Number of rows of grain did not differ between treatments, with 17 rows in the NN corn and 18 in the check. Number of kernels per row was also similar at 41 in the check and 44 in the NN corn. Weight of individual ears was similar at 226 g/ear in the NN plots and 200 g/ear in the check.

Protein content averaged 6.63% in the NN plots compared to 6.11% in the check plots (significant at $p = 0.07$). Oil content was not different, averaging 3.26%. Starch content was also similar at 62%.

SUMMARY

The use of NN on the Shriver Farm in 2008 proved extremely beneficial, in terms of enhancing plant growth, N content in leaves, yield and grain protein content. There was an average 16 bu/acre increase in plots fertilized with the NN. This amounted to a $160/acre increase in income. Natural nitrate can be particularly important after heavy rains, as were experienced in 2008, when pre-plant manure applications may suffer from leaching and/or run-off. We will repeat this experiment with NN in 2009 based on the success of this initial trial.