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Seasonal Soil Nitrogen Mineralization within an Integrated Crop and Livestock System in Western North Dakota, USA

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Protecting natural resources while maintaining or maximizing crop yield potential is of utmost importance for sustainable crop and livestock production systems. Since soil organic matter and its decomposition by soil organisms is at the very foundation of healthy productive soils, systems research at the North Dakota State University Dickinson Research Extension Center is evaluating seasonal soil nitrogen fertility within an integrated crop and livestock production system. The 5-year diverse crop rotation is: sunflower (SF) – hard red spring wheat (HRSW) – fall seeded winter triticale-hairy vetch (THV; spring harvested for hay)/spring seeded 7-species cover crop (CC) – Corn (C) (85-90 day var.) – field pea-barley intercrop (PBY). The HRSW and SF are harvested as cash crops and the PBY, C, and CC are harvested by grazing cattle.

In the system, yearling beef steers graze the PBY and C before feedlot entry and after weaning, gestating beef cows graze the CC. Since rotation establishment, four crop years have been harvested from the crop rotation. All crops have been seeded using a JD 1590 no-till drill except C and SF. Corn and SF were planted using a JD 7000 no-till planter. The HRSW, PBY, and CC were seeded at a soil depth of 3.8 cm and a row width of 19.1 cm. Seed placement for the C and SF crops was at a soil depth of 5.1 cm and the row spacing was 0.762 m. The plant population goal/ha for C, SF, and wheat was 7,689, 50,587, and 7,244 p/ha, respectively. During the 3rd cropping year, soil bulk density was measured and during the 4th cropping year, seasonal nitrogen fertility was monitored throughout the growing season from June to October. Seasonal nitrate nitrogen (NO_3-N), ammonium nitrogen (NH4-N), total season mineral nitrogen (NO_3-N + NH4-N), cropping system NO_3-N, and bulk density were measured in 3 replicated non-fertilized field plot areas within each 10.6 ha triple replicated crop fields. Within each plot area, 6 – 20.3 cm x 0.61 m aluminum irrigation pipes were pressed into the soil as enclosures to restrict root access to soil nitrogen. Soil samples were taken as close to 2-week intervals as possible from both inside and outside the enclosures. The crop rotation N values were also compared to triple replicated perennial native grassland plot areas (predominate sp. Western wheatgrass - Pascopyrum smithii, Blue grama - Bouteloua gracilis, Little bluestem - Schizachyrium scoparium, Switchgrass - Panicum virgatum).

Trends identified for both NH4-N and NO_3-N indicate that the values are relatively similar with respect to seasonal change over time. There was a greater amount of soil nitrogen accumulation inside the enclosures indicating that outside the enclosures roots scavenge nitrogen for plant growth and production. Seasonally, comparing the cropping system crops, NO_3-N declined mid-July and then rebounded by mid-August and continued to increase until leveling off in September. Corn NO_3-N, however, did not follow this pattern, but increased from early June to the end of June and remained high until the first of September. We will present the results of bulk density data and seasonal N fertility data providing evidence for the impact of previous CC on corn production. Probable explanation for the mid-summer nitrogen decline will be presented and justification for reduced fertilizer application will be discussed.