1-1-2003

Manure Matters, Volume 9, Number 5

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Reducing Spatial Variability of Soil Carbon and Phosphorus by Site-Specific Manure Application

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Spatial variability can significantly influence crop performance across a field. Manure, a renewable resource, is an excellent source of nutrients that can be substituted for synthetic types of fertilizers. The carbon (C) and nutrients in manure can enhance the physical and chemical properties of soils, especially infertile soils, hence reducing soil spatial variability. Organic C constitute about 58% of organic matter in the soil (%OM = %OC x 1.724). Manure application not only provides nutrients for crops but also improves soil quality since the organic matter in manure improves soil physical and chemical properties. Manure also contains lime that will increase soil pH in areas with acidic soil pH. Therefore one would expect more positive effects of manure application on crop yield than chemical fertilizer application. The objective of this study was to evaluate the effects of C and nutrients in manure on soil C and P variability.

The experiment was conducted from 1998 to 2000 on a private farm in Hamilton County near Phillips, Nebraska on a center pivot irrigated field with continuous corn. A ridge-till system, consisting of stalk chopping, cultivation, and ridging was utilized. The experimental area consisted of Hord silt loam, Invale loamy sand, Thurman fine sandy loam, Ortello fine sandy loam, Uly silt loam, and Alda loam soils. Treatments included strips (40 ft wide and 2200 ft long) of site-specific manure, uniform manure, uniform commercial fertilizer, and a no-treatment check. Each year, organic C levels were determined by grid sampling of the area, with two samples taken, 20 to 30 inches apart, to a depth of 6 inches at each grid point. Samples were collected every 80 ft in the middle of each strip. Each point was geo-referenced using a differential global positioning system (DGPS). In the site-specific manure treatment, manure was applied to areas within the strips that had a soil C concentration < 1.4% (2.4% organic matter). Fertilizer was applied to areas within site-specific strips that did not receive manure. Manure was applied to provide 170 lb N/acre. The cooperator

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applied anhydrous ammonia at a rate of 190 lb N/acre for the fertilizer treatment.

Soil organic C in the soil was increased from 1.17% to 1.52% (2.01 to 2.62% organic matter) with site-specific manure application (Fig. 1). The increase was significant when compared to the original soil C level in 1997 or synthetic fertilizer application. There were about 2.8 tons per acre C sequestered in the soil when site-specific manure was applied. Soil C coefficient of variation (CV), an indicator of variability, was reduced from 29.3% to 22.7% by site-specific manure application. About 50% of the field had soil C concentrations < 1.1% in 1997 (Fig. 1). However, by 2000 when three manure applications had been made, the areas with soil C concentrations < 1.1% were located in a small pocket (< 1% of the field) in the north part of the field. The highest organic C level was 1.847% in 1997 and 2.177% in 2000. This indicates that site-specific manure application not only increased soil C level but also reduced variability of soil organic C and therefore of organic matter.

There was a significant correlation between soil C levels and plant-available P concentrations. Therefore, the low soil C areas also had low P levels (Fig. 1 and 2). Site-specific manure application increased soil P level from a field average of 23 ppm to 61 ppm (Fig. 2) and most of the increase was in the low P areas. Even though the field P average before manure application in 1997 was 23 ppm, about 53% of the field had soil P levels that were less than 15 ppm. A soil Bray and Kurtz P level < 15 ppm is considered deficient for corn and P application will be recommended by the University of Nebraska fertilizer recommendation. As is indicated in Fig. 2, the P deficient areas (< 15 ppm) were located in a small area (about 10% of the field) in the south central part of the field after only two years of site-specific manure application. The CV of P distribution in the field was reduced from 86% to 42%, a reduction of 51%. The soil P increase in the deficient areas caused a significant grain yield increase for site-specific manure application as compared to uniform fertilizer application. Averaged across five years (1998 to 2002), corn grain yield was 180 bu/acre for site-specific manure, 169 bu/acre for uniform manure, 172 bu/acre for chemical fertilizer, and 116 bu/acre for the untreated check.

Site-specific manure application strategy is not only an effective method of manure utilization but also can significantly reduce soil spatial variability and hence increase crop yield and improve soil quality. By site-specific manure application less productive sites within a field are improved and the productive sites would not receive excess nutrients, especially P, that can cause water quality concerns.

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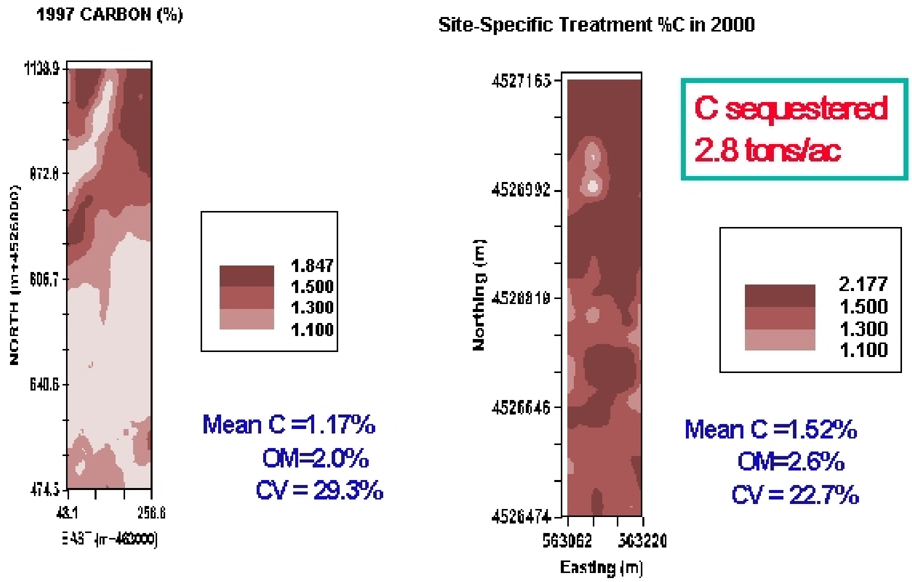
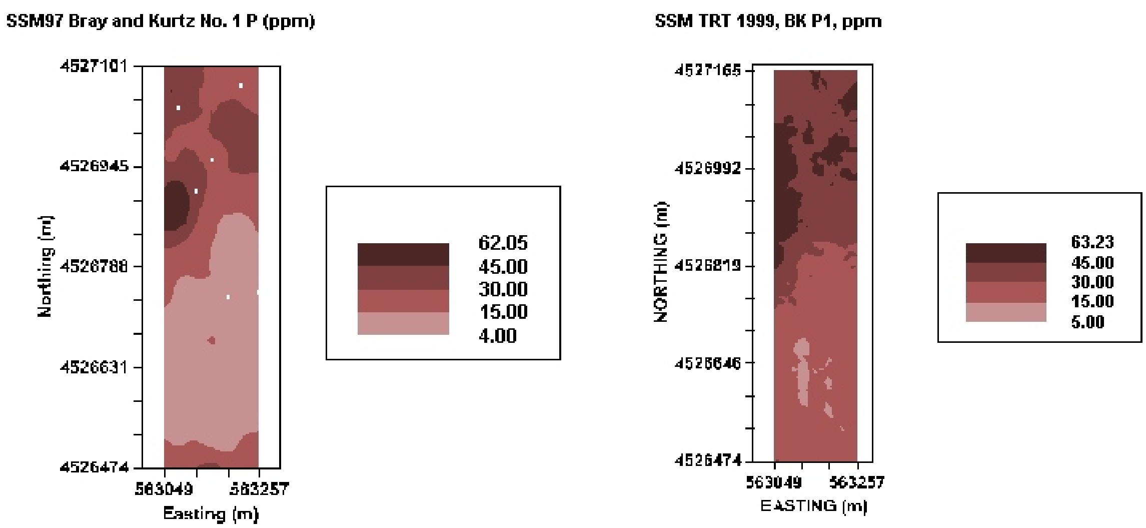


Figure 1. Soil organic C before (1997) and after 3 years (2000) of site-specific manure application. The light color areas represent C concentration < 1.1%.



Mean P = 22.7 ppm; CV=86%

Mean P = 61 ppm; CV=42%

Figure 2. Soil P level before (1997) and after 2 years (1999) of site-specific manure application.