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Effect of Drought on Yield, Soil Microbial Biomass, C:N Ratio, Water Infiltration, Wind Erodibility, Water Stable Aggregates, and Nitrogen Mineralization in an Integrated Crop-Livestock System

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In the northern Great Plains region of the United States, the state of North Dakota is located centrally along the border between Canada and the United States. The western North Dakota climate is continental and semi-arid, and is characteristically known for cold winters (Record Low: -47.9ºC) and hot summers (Record High: 45.6ºC). Long-term 119-year (1892-2010, Manske, 2010) average growing season precipitation from April to October is 407.2 mm, and plant drought stress occurred 32.6% of the years. Long-term precipitation for May-June-July is 206.5 mm. Precipitation for 2017 was 72.39 mm; 64.9% less than the long-term average for May-June-July. Conventional agricultural production methods in the United States frequently lack plant diversity focusing on a simple corn-soybean rotation, which relies heavily on expensive capital outlays for fertilizer, chemical, fuel, labor, and depreciation. Crop production methods that lack diversity are less sustainable. Alternative production methods that replace tillage with no-till and utilize multi-specie cover crops within a diverse multi-crop rotation, in which livestock harvest a portion of the rotation crops, are more sustainable. Comparing the 5-year crop yields (2011 to 2015) to 2017 crop yields, a 64.9% reduction in rainfall reduced cool- and warm-season crop production. Warm-season crop production was reduced more than cool-season crops and germination problems compounded yield reduction. Crop yields for spring wheat (control), spring wheat (rotation), field pea-barley intercrop, cover crop, corn, and sunflower were 82, 67, 62, 28, 33, and 37% of long-term yields, respectively. Cool-season cereal and legume crop production was supported by stored soil moisture that was progressively depleted and unavailable for summer crop production resulting in the sharp yield decline observed. Tests for microbial community phospholipid fatty acids (PLFA) are useful for estimating a soil's living microbial biomass. Functional groups are influenced by drought and other environmental conditions. Functional group diversity index for 2017 ranged from average to excellent and the water extractable Carbon: Nitrogen ratio average was 8.7 (Range: 6.9 to 12.2). Water infiltration, wind erodibility and water stable aggregates were also evaluated during the 2017 growing season. No significant differences were observed between any of the crops evaluated. However, numerically higher water infiltration, wind erodible fraction and water stable aggregate values for the rotation spring wheat may be indicating that the crop rotations are having an impact on the soil quality in that more stable aggregates, although likely smaller in diameter, are found in the rotational wheat. Continuous wheat soil aggregation appears to be more massive (or not aggregating at all) contributing to the results observed. Evaluation of effects of short-term N mineralization indicate that each increase of 1% OM can result in nearly 15 ppm N being mineralized in soils with more than 3% OM.