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Effect of Drought and Recovery on Microbial, Fungal, and Crop Response in a Diverse Multi-Crop Rotation

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Soil nutrient availability is essential for adequate crop production and drought conditions that result in abnormally low amounts of precipitation for extended periods of time have a substantial impact on soil microbial activity and therefore nutrient cycling. The northern Great Plains region of the USA suffered an extended period of time in which effective precipitation for crop production was severely reduced and based on the USA Drought Monitor the drought during the growing season from April through October 2017 was classified as exceptional drought. At the NDSU – Dickinson Research Extension Center, a long-term integrated system that includes a diverse multi-crop rotation (spring wheat, cover crop, corn, pea-barley intercrop, and sunflower), beef cattle grazing of the pea-barley, corn, and a 13-specie cover crop within the rotation, is being utilized to monitor the effects soil microbial and fungal activity have on production over time and space in this crop and animal production system. Moreover, the overall effects of increased soil health indices on production are being monitored. Research results have previously been reported showing that soil organic matter (SOM) mineralization has resulted in reduced nitrogen fertilizer application. Regression analysis of SOM and potential nitrogen mineralization suggests that 8.4 mg N/kg are mineralized for each 1% increase in SOM. However, during periods of restricted precipitation on rain-fed crops, soil microbial respiration and fungal activity are negatively impacted, and crop production and animal grazing days are sharply reduced. Soil microbial biomass was correlated to overall production with the exception of spring wheat in rotation which may be due to increased water use by the previous crop (sunflower). Further analysis indicated that most soil microbial organisms recovered two years post drought with the exception of Rhizobia spp. populations which did not recover two years post drought. However, compared to the pre-drought 2016 production year, overall crop production yields had not fully recovered by 2019. Compared to the 2016 crop production, overall crop production in the rotation was reduced 64% in 2017, recovered to 54% of 2016 in 2018, and recovered to 66% of 2016 by the 2019 crop year. Whether crop yields are on par with 2016 by the end of the 2020 crop year is still to be determined. These yield observations point to the amount of time needed to fully recover from the long-term effects of exceptional drought on crop production.