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Precision Application of Manure and Promising Pollutant Mitigation Options

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Field and lab experiments were conducted in 2021 and 2022 at the University of Saskatchewan's Livestock Forage Center of Excellence (LFCE) near Clavet, southeast of Saskatoon and Agriculture and Agri-Food Canada (AAFC) – Saskatoon's Lowe Farm, Saskatchewan, Canada. The main objectives of the study are to assess mitigation potentials of nutrient losses (1) from fields managed under precision application of manure in comparison to flat rate manure and synthetic fertilizers, and (2) reduction of contaminants using biochar and gypsum. Nine micro – watersheds and three fertilizer management practices (i.e., precision variable rate application of solid cattle manure – precision manure, flat constant rate application of solid cattle manure – flat manure, flat constant rate application of anhydrous ammonia – flat synthetic) were applied at the contrasting micro-watersheds. Within each of the micro-watershed an East - Depression - West transect was established. In total, twenty-seven custom-made runoff collection frames (RCF) with the size of 1 m^2 were installed, and runoff (water and sediment) was funneled to containers. Three Teros-12 moisture sensors and associated ZL6 data loggers (Meter Environment, Pullman WA, U.S.A.) were mounted in the immediate vicinity of the RCF in three micro – watersheds. Arrow Gold GNSS GPS unit (EOS Positioning Systems, Terrebonne QC, Canada) were used for geo - referencing, and the surface slope and aspect were determined by a Brunton Transit Clinometer (Brunton GEO F-5010, Riverton WY, U.S.A.). In-season rainfall simulations using a portable Mini Rainfall Simulator (Eijkelkamp, Wilmington NC, U.S.A.) were conducted nearby the frames. Biochar was prepared from solid cattle manure and wheat straw mixed at a ratio of 3:1 $_{ww}$, by the process of pyrolysis at 450 ^{0}C, in the absence of oxygen. The final biochar product was ground, and dry sieved. Runoff, collected from the RCF of the precision manure and flat manure fields, was passed through amended soil columns contained in suspended polyvinyl chloride (PVC) tubes (i.e., control, soil + solid manure / straw derived biochar 10% $_{ww}$, soil + gypsum 0.25% $_{ww}$). Volumes of leachate were determined after 1, 5 and 24 hours and cumulated water samples were analysed for phosphorus (dissolved organic P, soluble reactive P, total P), available nitrogen (NH_4-N, NO_3-N), other micro and macro nutrients (K, SO_4-S, Mg, Ca, Na), and trace elements. Preliminary results from 2021 showed that effect of the soil amendments was statistically significant ($P < 0.001$) but water source treatments were not. Biochar significantly ($P < 0.001$) reduced infiltration rate and cumulative leachate, however, gypsum treated columns were not significantly different ($P = 0.094$) from control. Biochar reduced Al, Co, Pb, Ni, Mo and Mn concentration in leachate and gypsum significantly reduced Se and V. In contrast, the addition of biochar and gypsum to soil increased the concentrations of NH_4-N, SO_4-S, Mg, Ca, and K. While the growing season of 2021 was exceptionally dry, near normal moisture conditions occurred for 2022. A summary of the two years (2021 and 2022) results will be presented.

Keywords: Micro-watershed, Biochar, Gypsum, Precision manure application