

Initial Evaluation of Ripper and Tillage Methods on Reclaimed Heavy Mineral Mine Soils¹

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Abstract. Heavy mineral sands mining in prime farmland of the upper Coastal Plain in Virginia generates mine soils that limit return to intensive rowcrop production if compaction and other physical and chemical limitations are not ameliorated. Typical reclamation includes initial deep-ripping, topsoil return, and shallow final surface tillage; but, significant subsoil compaction often persists to ~90 cm, and reapplied topsoil may be massive and compact, which limits rooting, lowers crop yields and rainfall infiltration/percolation, and enhances runoff. In 2016, a study was installed to evaluate ripping and tillage practices to alleviate compaction-related limitations. Five initial soil profile pits were excavated and characterized to 1.5 m. Bulk density (Db) cores and bulk soil samples were collected from the surface and at 35 – 65 cm for physical and chemical analyses. The subsequently installed study includes four replicate complete blocks (64 x 64 m) with five main treatments (9 x 64 m) bordered by untreated alleys (3 x 64 m), and three cross-rip treatments (9 x 64 m; perpendicular to the main treatments). The main treatments were: 1) control, no ripping/tillage; 2) dozer deep-rip, one pass with 1.2 m shank centers; 3) dozer deep-rip, two passes with 50% offset creating 0.6 m shank centers; 4) chisel-plow topsoil to ~5 cm below subsoil contact; and 5) agricultural no-till ripper. The cross-rip treatments were: 6) dozer deep-rip, one pass; 7) chisel-plow topsoil to 5 cm below subsoil contact; 8) no-till ripper. During installation, soil samples were collected from 0 – 15 cm and 38 – 53 cm to evaluate moisture content, pH, texture, and acid-extractable nutrients. The plots were seeded with cereal rye and a pasture mix in Sept 2016; vegetation assessments were completed in Nov 2016, Apr 2017, and Sept 2017. In Nov 2017, twenty soil profiles, representing five treatments per block, were described and fully characterized. Prior- and post-installation, surface soil textures were sandy loam and loamy sand; subsoil textures ranged from sand to clay. Prior to plot installation, Db was relatively high (1.46 – 1.72 g/cm³) in massive surface soils and subsoils, few to no roots were observed in the subsoils, surface pH was 5.3 – 7.0, subsoil pH was 4.4 – 6.9, and extractable nutrients were low. One year after installation, Db was slightly lower with average surface Db = 1.48 g/cm³ and average subsoil Db = 1.52 g/cm³, and rooting was more prevalent through the subsoils. Over time, significant differences in total vegetative cover developed among the blocks. Few significant differences were observed among main treatments (without a cross-rip), but were more apparent with the inclusion of cross-rip plots. The dozer deep rip treatment with two passes typically yielded the highest vegetative cover for all sampling dates.

Additional Key Words: Bulk density, compaction, titanium mining, revegetation.

¹. Oral paper presented at the 2018 National Meeting of the American Society of Mining and Reclamation, St. Louis, MO: June 3 – 7, 2018. Published by ASMR, 1305 Weathervane Dr. Champaign, IL 61821.

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