RESIDUE MANAGEMENT AND PARATILLAGE EFFECTS ON RAIN INFILTRATION

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ABSTRACT

Dryland winter wheat (*Triticum aestivum* L.) and grain sorghum [*Sorghum bicolor* (L.) Moench] are grown on the semiarid North American Great Plains using the wheat-sorghum-fallow (WSF) cropping sequence. When used with WSF, no-tillage (NT) or stubble mulch tillage (SM) management reduces evaporation and increases yields. However, soil consolidation with NT, increases runoff compared to SM. Our objectives were to characterize the effects of paratill (PT) on rain infiltration into a Pullman clay loam soil (fine, mixed, superactive, thermic Torrertic Paleustoll) with either NT or SM management. Six contour-farmed level-terraced watersheds were dryland cropped using a WSF rotation with NT or SM management and divided into subplots (four replications) that were paratilled to a 0.35-m depth at 0.75-m intervals following sorghum harvest. Approximately 8 months later (before planting wheat), steady infiltration of rainwater was determined for each tillage combination using a rotating disk rainfall simulator with a 48 mm h^{-1} intensity. Cumulative infiltration was 32.4 ± 3.9 mm for SM compared with 21.9 ± 2.5 mm for NT, but PT caused no significant increase in infiltration, i.e., infiltration with PT was 26.7 ± 5.7 compared to 27.5 ± 7.4 mm without PT. Measured cone penetrometer resistance and bulk density decreased with PT to treatment depth with NT management; however, the SM sweep operations may have consolidated PT soil. We conclude that because rain infiltration was rapidly regulated by the formation of a soil surface crust, PT will not increase infiltration into clay loam soils managed with SM or NT residue systems.

INTRODUCTION

Stubblemulch tillage (SM) and no-tillage (NT) crop residue management are effective means of reducing evaporation and, thus, conserving precipitation for dryland crop production (Steiner, 1994; consistently retained by the soil. Cumulative ponded infiltration was increased with PT (Mukhtar et al., 1985; Clark et al., 1993), but these effects may not apply under raindrop impact conditions associated with natural or simulated rain.

We hypothesized that PT performed

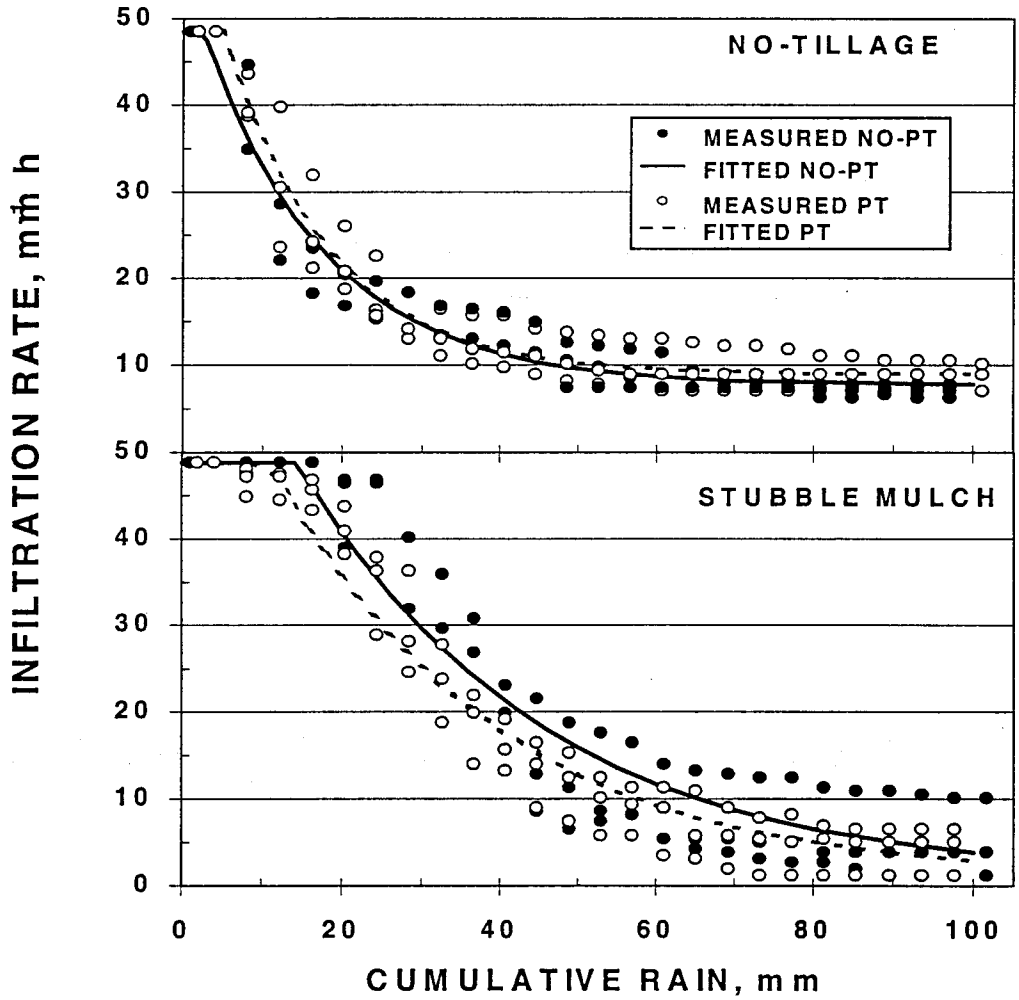

Fig. 4. The infiltration rate into stubble mulch, SM, or no - tillage, NT, soil with

and resulted in no significant differences in infiltration rates for PT compared to NO-PT. While the use of profile loosening tillage, PT, resulted in significantly lower bulk density, the expected large differences in the initiation of runoff from the plots or infiltration rate were not observed. The corresponding measured cumulative infiltration after applying 48 mm rain with PT was 26.7 ± 5.7 compared to 27.5 ± 7.4 mm without PT. The resulting non-significant difference between PT treatments suggest that rain infiltration was not governed by the soil profile characteristics, unlike that reported for ponded infiltration (Mukhtar et al., 1985; Clark et al., 1988). During infiltration measurements into chisel tilled soil, Baumhardt et al. (1993) reported reduced infiltration due to rapid formation of surface crusts and soil profile reconsolidation.

Infiltration rate declined more rapidly with NT than with SM tillage, resulting in runoff with NT after application of about 3 mm of rain compared to about 15 mm of rain with SM. The delay in runoff for the SM tillage plots may have been due to the increased porosity of the less dense surface. Once runoff began, however, the mean infiltration rate in both SM and NT plots declined to quasi steady final infiltration rates of 8 mm h^{-1} for NT compared to 5 mm h^{-1} for SM plots.. The significant difference in cumulative infiltration of 32.4 ± 3.9 mm for SM compared to 21.9 ± 2.5 mm for NT was measured after the application of about 60 mm rain. We attributed this difference, primarily, to the infiltration before runoff began. Because of the similar final infiltration rates, we conclude that infiltration was regulated at the soil surface by the presence of or the rapid formation of a soil crust.

SUMMARY AND CONCLUSIONS

The effect of PT in NT or SM residue management systems was to reduce soil density and penetration resistance. Penetration resistance with depth in the SM plots was largely unaffected by PT after 9 months, which was attributed to recompaction of the soil below the SM tillage depth. Paratillage did, however, reduce penetration resistance in the NT plots. Differences in soil bulk density were similarly dependent on the position relative to the tillage depth, that is, the soil density was reduced in the tillage zone. While the PT treatment decreased penetration resistance and soil bulk density, it did not increase infiltration rate or amount of simulated rain. Rain infiltration into SM residue management system plots, however, was greater than in NT plots, which developed a soil crust shortly after rain application began. We conclude that because rain infiltration was rapidly regulated at the soil surface by the formation of a crust, PT will not increase infiltration into clay loam soils managed with SM or NT residue systems.

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