Topsoil Depth Effects on Phosphorus and Potassium Nutrient Dynamics on a Claypan Soil

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Introduction

- Increasing amounts of variable rate P and K applications will require site-specific fertilizer recommendations to reach maximum profitability.
- Current University of Missouri (MU) fertilizer recommendations rely on a single buffering capacity for P and are modified only by CEC for K.
- This research aimed to determine if soil nutrient buffering on claypan soils was dependent on cropping system (CS) and/or depth to claypan (DTC).
- P and K fertilizer was applied at MU recommended levels based on soil tests to plots with variable DTC.
- We studied the relationship between DTC and actual soil test values achieved after five years.

Objectives

- Evaluate the effect of DTC and annual grain vs. perennial grass CS on temporal changes in STP and STK
- Determine if MU Recommendations should be modified for DTC

Materials and Methods

Plot Design

- 16 DTC plots ranging from 0-75 cm arranged in a RCBD design on a Mexico silt loam.
- 3 treatments per plot including:
  - Corn/Soybean Rotation: (C-S)
  - Soybean/Corn: (S-C)
  - Switchgrass (var. Kanlow): (Sw)

Fig. 1 Corn (C-S), soybean (S-C), and switchgrass (Sw) plots located near Columbia, MO.

Fertility

- All plots soil sampled in 2009 (0-15 cm)
- Fertilizer applied in 2009 based on MU recommendations
  - P: Target STP = 50 kg ha^{-1}
  - K: Target STK = 246 + (5*CEC) kg ha^{-1}
- All plots soil sampled in 2015 (0-15 cm)
- 6 plots deep sampled in 2015 (0-100 cm)

Fig. 2 Soil sampling unit used to take deep cores.

Conclusions

Phosphorus

Greater P buffering on soils with deeper DTC suggests adjusting MU recommendations may enhance accuracy, although DTC did not directly affect the amount of P_2O_5 needed to raise STP. Regardless of DTC, MU recommendations should likely increase for P on claypan soils. (Fig. 3 & 4)

Potassium

Adjusting MU recommendations for K to account for DTC may improve accuracy. However, they still performed well, only slightly overestimating K recommendations for most observations. (Fig 4 & 5)

Profile STP and STK

High nutrient levels below the argillic horizon of shallow DTC plots could be a significant nutrient source for perennial crops, such as switchgrass, that may be able to better penetrate the claypan (Fig. 7). However, switchgrass required more P_2O_5 and K_20 to raise STP (Fig. 4) and STK (Fig. 6) than grain crops, suggesting it would not reduce P and K inputs on claypan soils.

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Results

Phosphorus

DTC influenced how closely STP reached expected levels (MU Rec) across CS

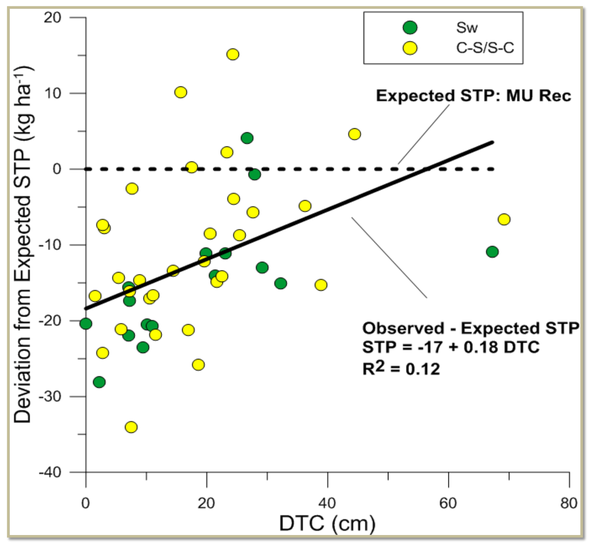


Fig. 3 Deviation from expected STP (based on MU recommendations) vs. observed STP.

CS affected the amount of P_2O_5 required to raise STP 1 kg ha^{-1} across DTC

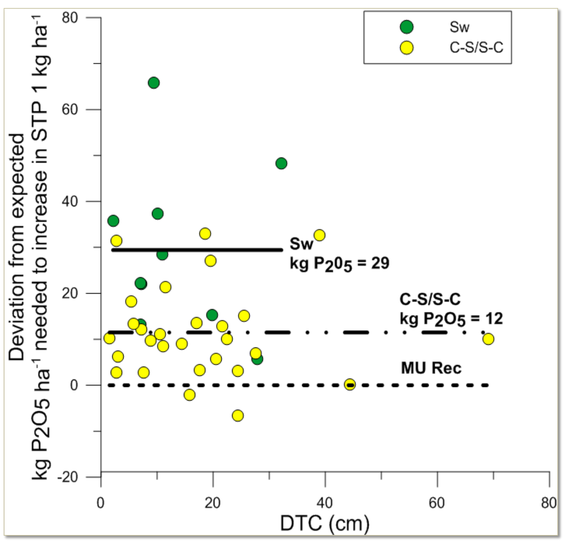


Fig. 4 Deviation from expected and actual kg P_2O_5 required to raise STP 1 kg ha^{-1}.

Potassium

CS influenced how closely STK reached expected levels (MU Rec) across DTC.

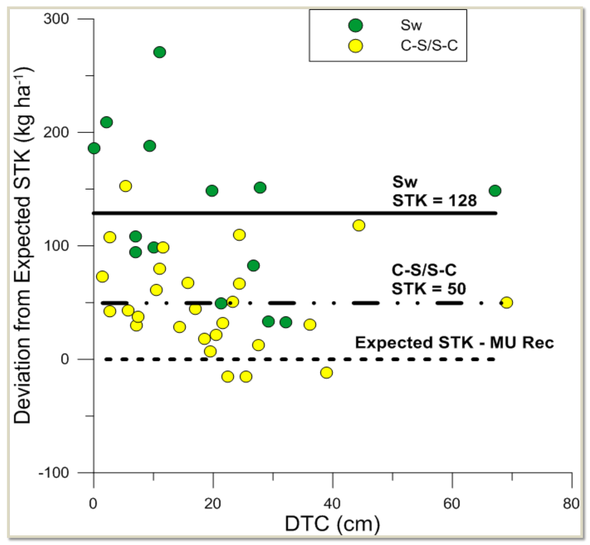


Fig. 5 Deviation from expected STK (based on MU recommendations) vs. observed STK.

DTC affected the amount of K_2O required to raise STK kg ha^{-1} across CS.

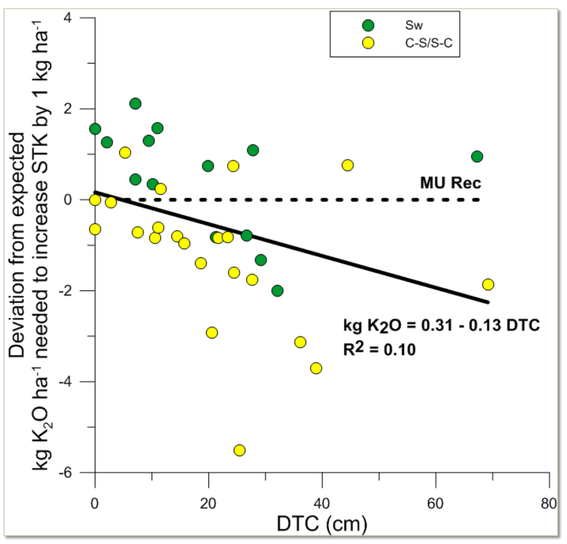
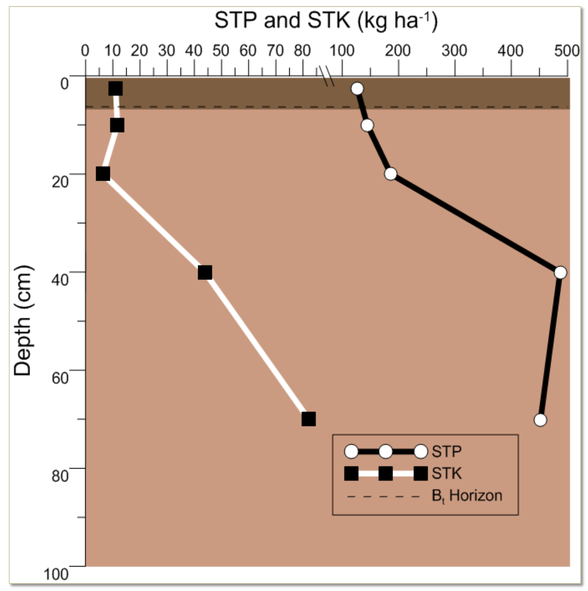


Fig. 6 Deviation from expected and actual kg K_20 required to raise STK 1 kg ha^{-1}.

Shallow DTC Profile STP and STK



Deep DTC Profile STP and STK

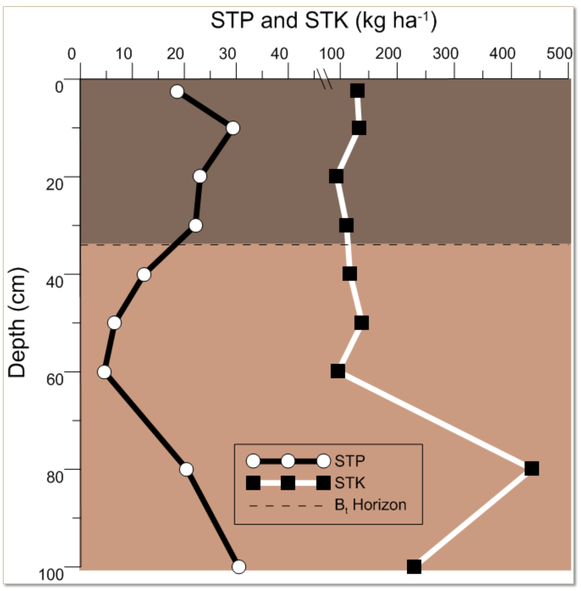


Fig. 7 Soil profile STP and STK for shallow and deep DTC plots. The horizontal dashed lines illustrate the average depth of the B_t horizon.