Effects of conservation tillage equipment configurations on soil disturbance and seedling vigor

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INTRODUCTION

- Conservation agriculture involves constant soil cover, crop rotation, and minimum tillage. It is meant to improve the productivity and lessen the environmental impact of agriculture.
- Minimum tillage is of interest because it can better soil health and decrease erosion.
- There should be strong evidence for the use of minimum tillage in the Valles Altos region of Central Mexico before it is widely promoted.
- Farmers may be resistant to adopting no-till practices, but may find strip tillage, which is a slightly more disruptive type of minimum tillage, to be more acceptable.
- Most existing studies of soil disturbance have been conducted in soil bins, which lack the irregularities of real farmland. Few studies have evaluated tillage in-field.

OBJECTIVES

- Design and implement a systematic method to evaluate soil disturbance due to tillage.
- Use soil disturbance and seedling vigor data to evaluate strip tillage versus three other configurations of conservation tillage equipment.

METHODS

- Soil properties (density, humidity, resistance to penetration, residue cover [**Figure 1**]**,** and crop residue biomass density) at time of planting were characterized.

METHODS, CONTD.

- 16 lines of maize were planted using four configurations of conservation tillage equipment: cutting disk + chisel tine + planter, cutting disk + planter, planter, and strip tiller → planter.
- 8 lines of maize (2 lines of each configuration) were completed with the press wheels of the planters removed to allow measurement of soil disturbance. The other 8 lines were completed with the press wheels intact to observe seedling growth.
- Soil furrows were filled with liquid plaster, which was then allowed to dry and harden before being scanned in 3D. The scans were then analyzed in SolidWorks to compare the mean volumes of soil disturbed using each equipment configuration (**Figure 2**).
- A seedling vigor index (SVI) defined using seedling emergence after ten days (S_gE_{10}), stem height, stem diameter, and mean root mass was utilized to compare the success of the equipment configurations.

$$S_gE_{10} = \frac{N_{sgE10}}{N_{sp}}$$

$$SVI = \frac{H}{D} * M * S_gE_{10}$$

RESULTS

- Preserving fragile plaster casts was difficult (resulted in a loss of data).
- Only the cutting disk + planter configuration had low soil disturbance and high seedling vigor.
- Suggests that minimum tillage can be successful in the Mexican highlands at relatively low cost (using only a planter and an accessory instead of a strip tiller and a planter).

FURTHER QUESTIONS

- What are local farmers' attitudes towards the various equipment configurations included in this experiment?
- What are the long-terms costs and environmental impact of the equipment configurations tested?
- Where do the machinery of the different equipment configurations experience stress? How does this stress impact maintenance and fuel consumption?
- Do the results of seedling vigor trials depend on the crop?

Figure 1. Original and analyzed field images to estimate percentage of residue cover.

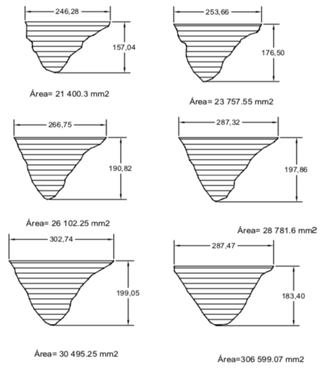

Figure 2. Analyzed cross-sections of plaster 1.

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