Can We Increase Crop Productivity under Fargo Clay Soils with the Adoption of Subsurface Tile Drainage?

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Study Objectives

Corn (*Zea mays*) and soybean (*Glycine max L.*) productivity are severely limited in clay soil due to the excess water in the beginning of spring. Achieving target yield goal depends on interactions among climate, crop and soil management. Due to repeated wetting cycles, tile installation is becoming popular across the Red River Valley. However, there are many questions regarding the corn and soybean production under tile with a Fargo Clay soil.

First, is it possible to adopt conservation tillage practices under tile drain?

Second, is it continuous corn (CC) or corn-soybean (CS) rotation, the best option under tile?

Third, what is the best combination of tile spacing (30 ft, 40 ft, and 50 ft) and depth (3 ft or 4 ft) for Fargo Clay?

Long-term on-farm subsurface tile drain experiment was established in 2013 to determine (i) interactions among tile, tillage, and rotation, and (ii) effect of tile spacing and depth combination on corn, soybean and sugar beet production.

Methods

This on-farm experiment is located at Casselton, North Dakota (N 46°49'23.7972", W 97°13' 4.949") (Figure 1). Soil type is Fargo silty clay.

Table 1. Basic soil properties of experimental site

Soil properties	
pH	6.4
EC (ds m^{-1})	0.70
NO_3-N (lb/ac)-2 feet	19
Olsen-P (ppm)	48
K (ppm)	470
Ca (ppm)	4720
Mg(ppm)	900
Na (ppm)	14
CEC (Meq/100g)	29.6

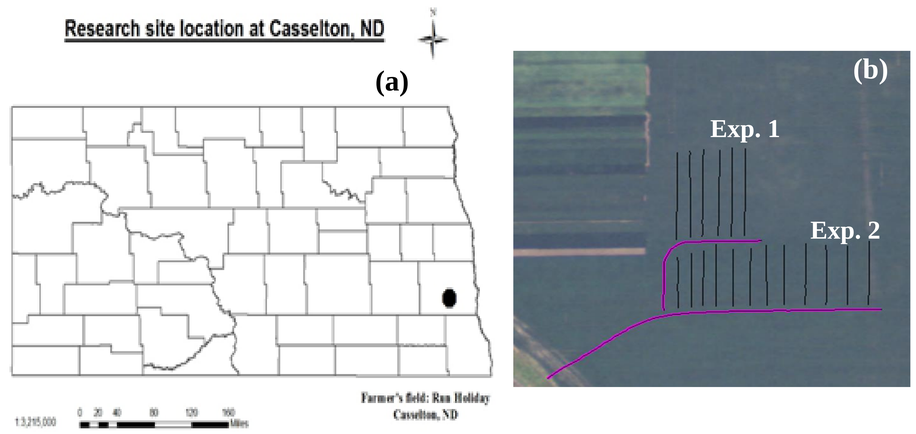


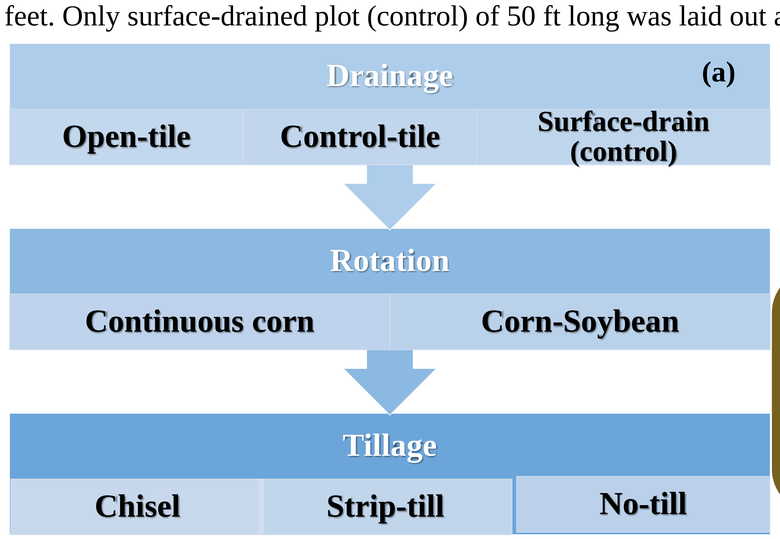
Figure 1. (a) Experimental site location and (b) tile drain lines for both studies

Experiment-I. Interactive effects of tile drainage, tillage and crop rotation

Three drainage systems, (1) surface drained only (SD), (2) open-tile (OT)-without control box), and (3) control-tiled (CT) - with control box, were placed in three strips, as main plot. Under each strip, three tillage practices, (1) chisel (CH), (2) strip-till (ST), and (3) no-till practices (NT) were randomized as sub-plot, and under each sub-plot, two rotations, (1) continuous-corn (CC) and (2) corn-soybean (CS), were randomized with four replications. Corn and soybean were planted every year. Three drainage treatments were 30-feet apart. Individual plot size is 30-feet by 11 feet wide with 22-inch row spacing. Recommend fertilizer and cultural management practices were followed. Fertilizers were applied in fall.

Experiment II. Tile depth and spacing combinations

Corn-sugarbeet-soybean rotation were followed along three strips. Under each strip, we have 4 replications of six rows (22 inch row spacing). Two tile lines were installed at three tile spacing, 30-, 40-, and 50-feet and at two depths, 3-feet and 4-feet. Only surface-drained plot (control) of 50 ft long was laid out at the end of each strip.



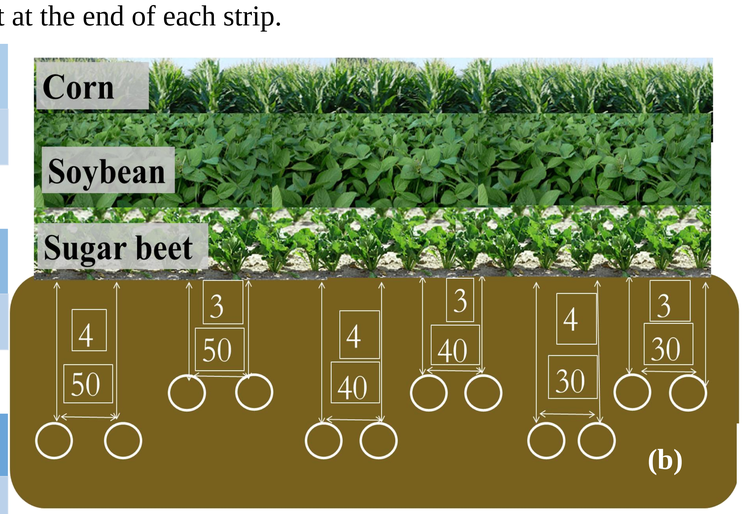


Figure 2. Treatment layout for the (a) tile drainage-tillage-rotation and (b) depth and spacing experiments

Conclusion

- Tile drainage and tillage had significant effects on corn yield than soybean. Corn-soybean rotation had higher corn yield than continuous corn. Annual rainfall pattern (cumulative, intensity and duration) probably had influence on treatment interactions.
- Tile depth and spacing combinations had significant effect on soybean and sugar beet production. Sugar beet yield was increased with tile drainage than control. However, corn did not show any response to tile. No significant variation was observed among tile spacing and depth combinations in terms of yield.
- At early growing season, soil N mineralization rate was significantly ($P<0.10$) controlled by tile drain particularly for corn and soybean. For these crop, soil N availability was reduced under control plot. Under soybean, soil mineralizable Nwas decreased with increasing spacing and depth. Poor aeration and significant denitrification loss (N_2O-N) might reduced the soil N availability under control, whereas, tile removes excess water and facilitates soil N mineralization process.

Results

Experiment-I

Table 2. Main plot (Tile), sub plot (rotation) and sub-sub plot (tillage) and their interaction effect on yield (Mg ha^{-1}) at 95% significance level during 2015-2016

Effect	Corn		Soybean	
	2015	2016	2015	2016
Rotation	<.0001*	<.0001*	-	-
Tile	NS	NS	NS	NS
Tillage	NS	0.001*	NS	NS
Rotation*Tile	0.0276*	NS	-	-
Rotation*Tillage	NS	NS	-	-
Tile*Tillage	0.008	NS	NS	NS
Rotation*Tile*Tillage	0.101	NS	-	-

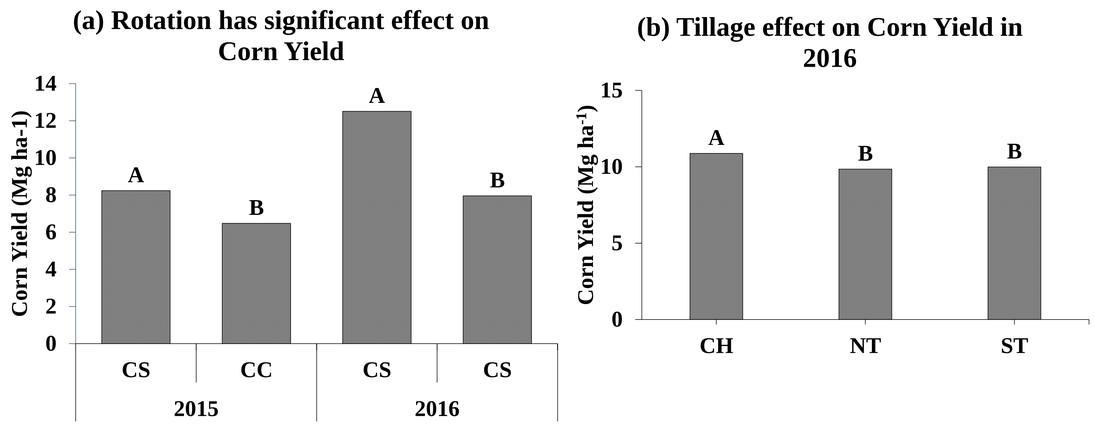


Figure 3. (a) Main rotation effect on corn yield (Mg ha^{-1}) during 2015-16 and (b) main tillage effect on corn yield (Mg ha^{-1}) during 2016 growing season

Experiment-II

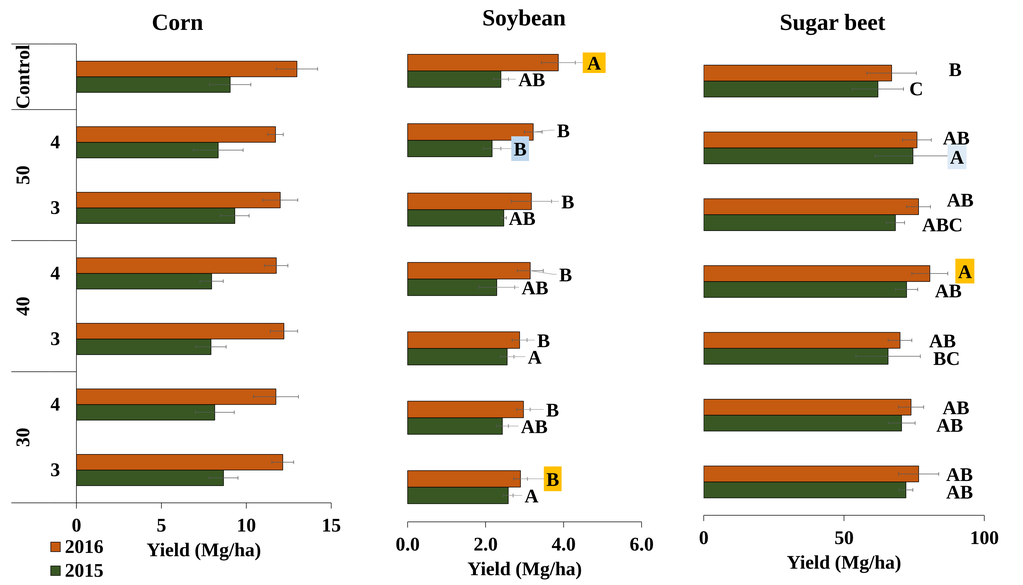


Figure 4 . Effect of different tile spacing (30-, 40- and 50-ft) and spacing (3- and 4-ft) on corn, soybean and sugar beet yield (Mg ha^{-1}) during 2015-16 growing season. Different capital letters indicate significant difference in means for particular year

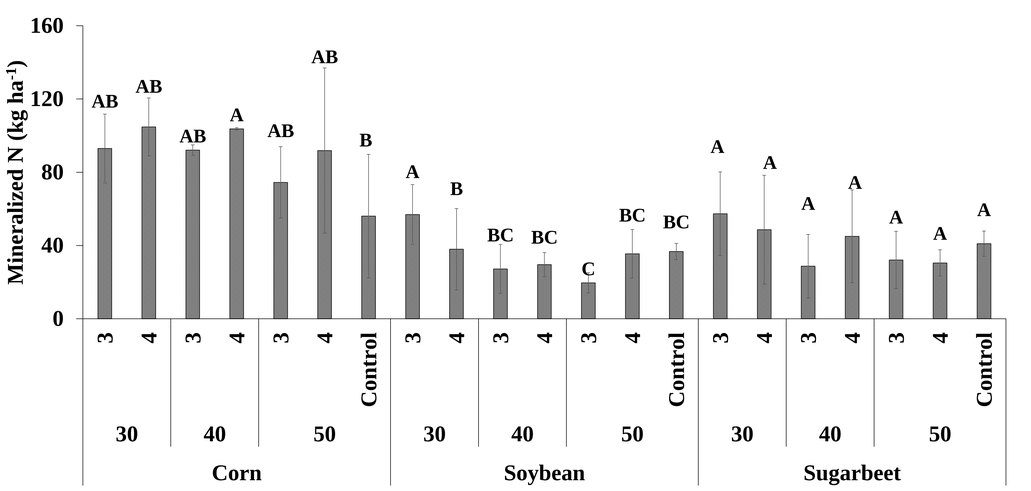


Figure 5. In-situ soil nitrogen (N) mineralization rate (kg N ha^{-1}) from soils under different crops and tile spacing and depth during 2016 growing season (resin bag incubated May 23-June10, 2016)