Cover crop impacts on runoff hydrographs and edge-of-field surface water quality

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Background and Justification

Cover crops are a potential conservation practice to improve the quality of surface runoff water from agricultural lands. Because cover crop growth and biomass change throughout the year, the effects of cover crops on runoff and water quality are dynamic. Many studies have investigated cover crop impacts on runoff using simulated rainfall, which provides a good snapshot of a single point in time. Additional information is needed to determine cover crop impacts on runoff throughout multiple seasons.

Objectives

i) Determine cover crop impacts on natural runoff volume.

ii) Determine cover crop impacts on hydrograph characteristics.

Methods

Location

This study was conducted at the Kansas Agricultural Watershed field laboratory near Manhattan, KS from 2015 to 2017 (k-state.edu/kaw).

Field Instrumentation and Cropping System

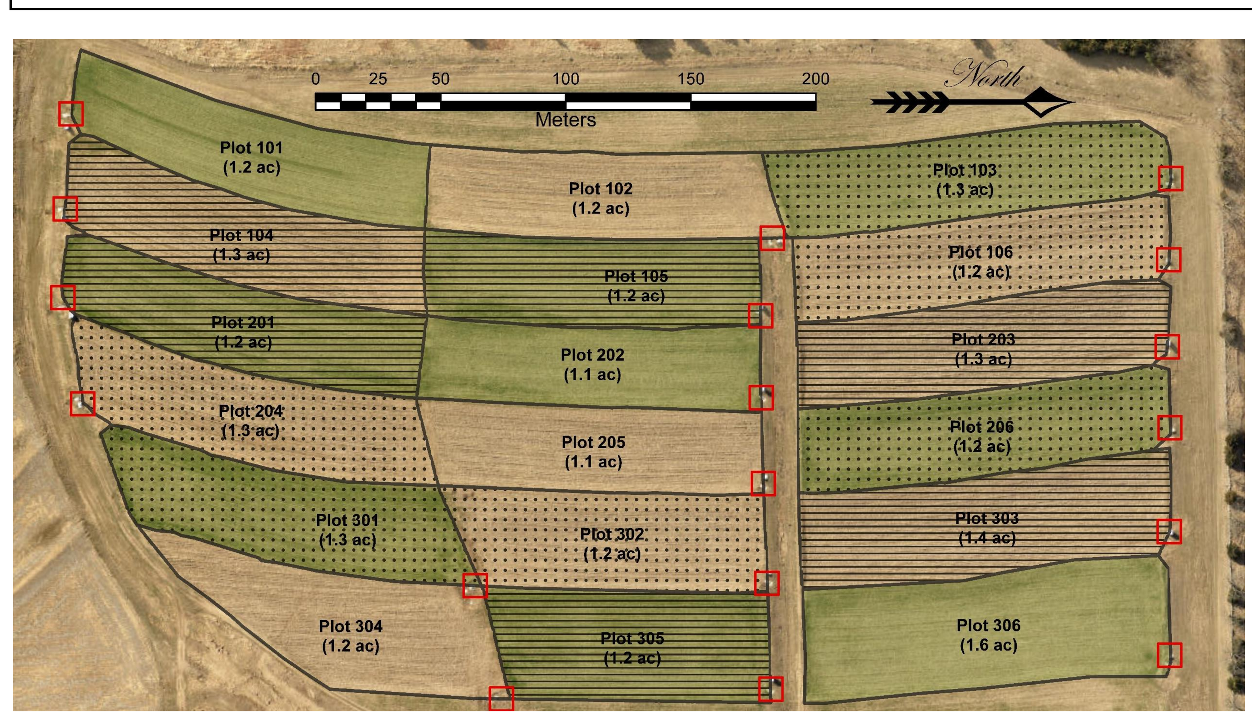
- 18 0.5-ha watersheds equipped with 0.46-m H-flumes and ISCO 6700 and 6712 automated water samplers.
- Water depth in H-flume recorded year-round at 1-min. intervals using ISCO 730 bubbler modules.
- Flow-weighted composite water samples collected for each runoff event. One 200-mL sample collected for each 1 mm of runoff.
- No-till corn-soybean cropping system. Corn planted in 2015 following conventional-till soybean. Last tillage operation in November 2014 prior to cover crop planting.

Experimental Design and Treatments

- 3x2 factorial treatment arrangement in a randomized complete block design with three replications
  - 3 levels of fertilizer management
    - Control - 0 kg P/ha
    - Fall Broadcast – 24 kg P/ha broadcast annually on soil surface in the fall.
    - Spring Injected – 24 kg P/ha injected 4 cm below and 4cm to the side of the seed at planting.
  - 2 levels of cover crop management
    - no cover crop
    - winter cover crop consisting of small grain (winter wheat or triticale) and brassica (rapeseed).

Data Analysis

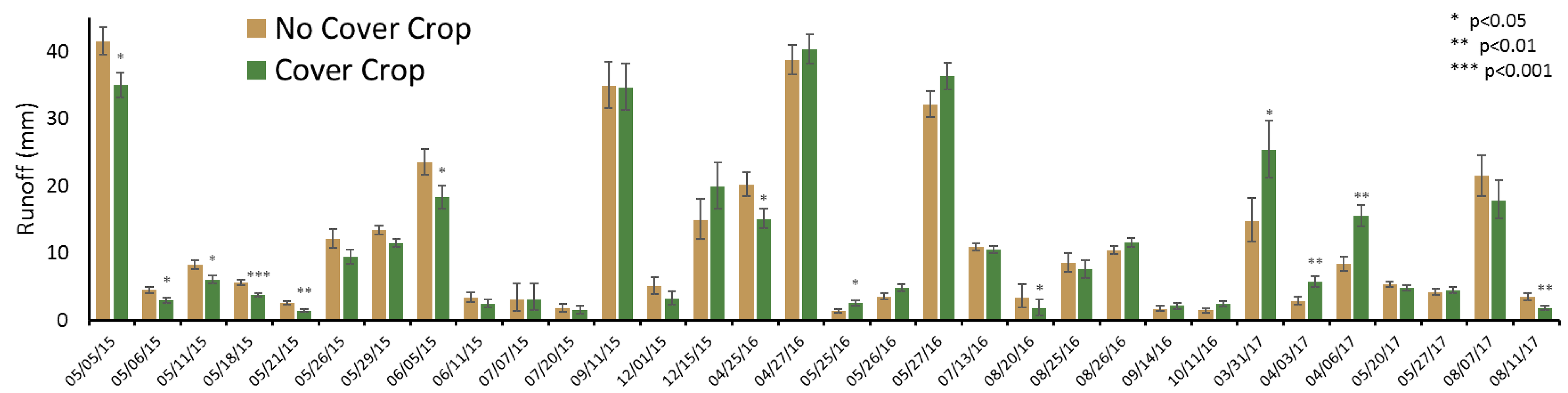
- The main effect of cover crop on runoff volume was determined with ANOVA by event using SAS proc glimmix for all runoff events > 2 mm (n=32). Data required square root transformation to normalize residuals. Results are presented as back-transformed means.
- Hydrograph characteristics of time to initiation of runoff, peak runoff rate, time to peak runoff, and duration of runoff were determined from hydrographs for events in 2016 and 2017 (n=18) and analyzed by the same statistical procedures as described above.



Site map and treatments for the Kansas Agricultural Watershed Field Laboratory.

Results and Discussion

Figure 1. Runoff by event (asterisks indicate significant differences within an event). Cover crops tended to reduce runoff during 2015, when the no-cover crop treatment did not have any residue. As the site transitioned to no-till (2016 and 2017), cover crops had a more variable effect on runoff, where they decreased runoff for some events and increased it for others. Cover crops did not affect cumulative 3-year runoff (p>0.05).



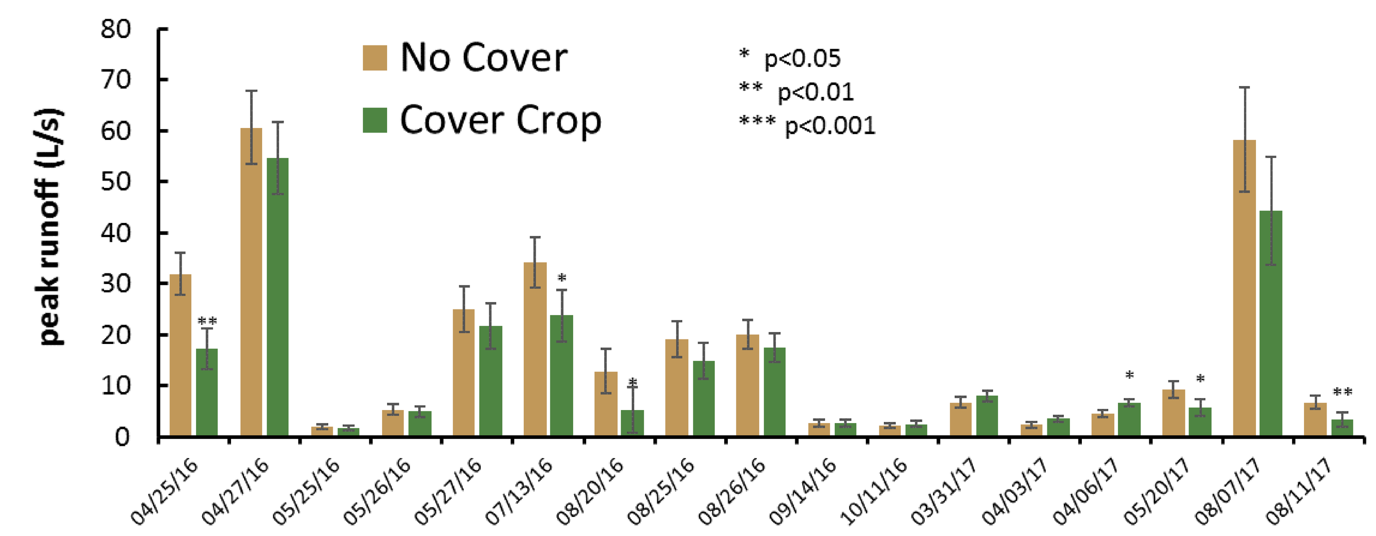


Figure 2. Peak runoff rate by event for 2016 and 2017 (asterisks indicate significant differences within an event). Cover crops tended to decrease the peak runoff rate in 2016 and 2017, with significant decreases in 5 of 17 events and a significant increase in only one.

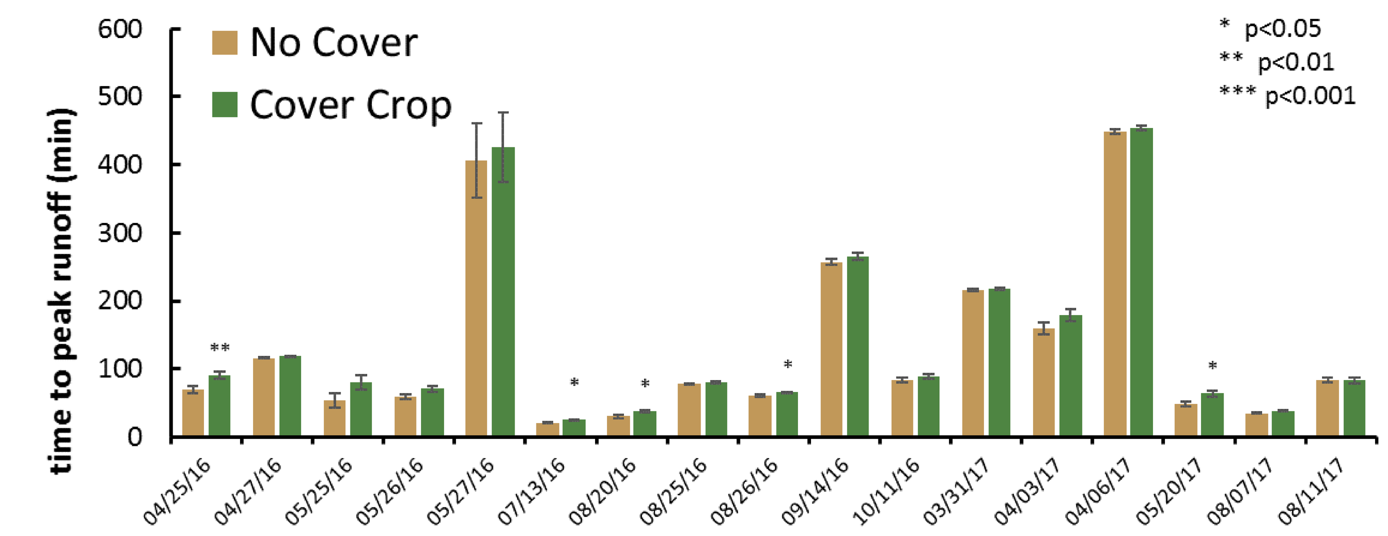


Figure 3. Time to peak runoff by event for 2016 and 2017 (asterisks indicate significant differences within an event). Cover crops tended to increase the time to peak runoff, with significant increases in 5 of 17 events. Cover crops had very little impact on time to initiation of runoff (data not shown).

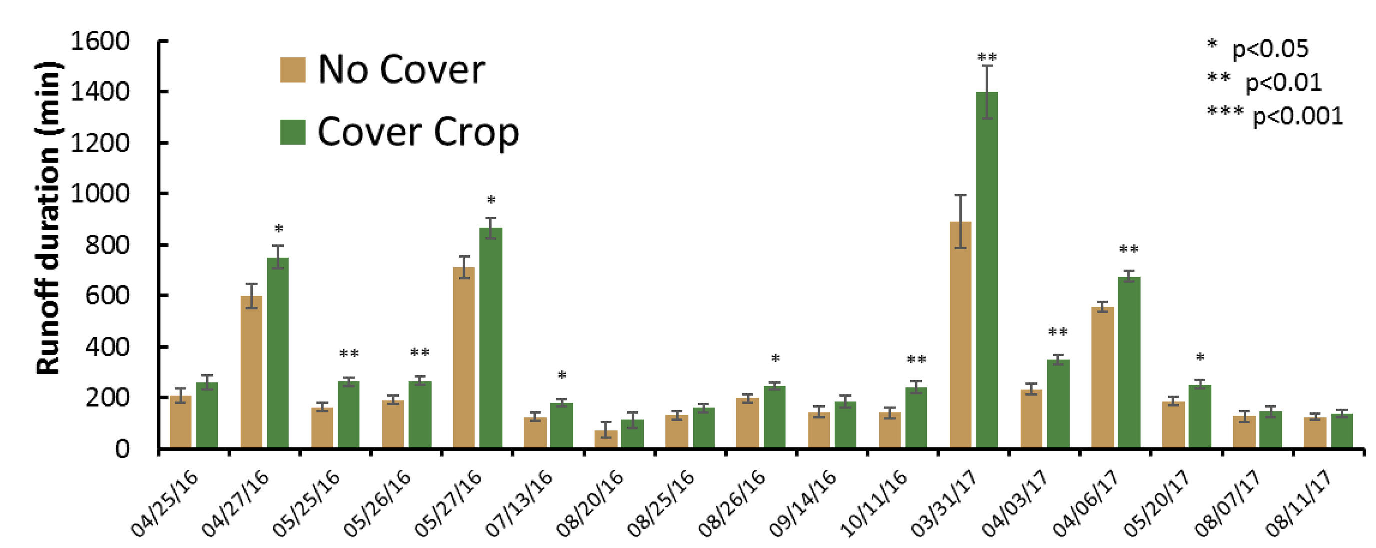


Figure 4. Runoff duration by event for 2016 and 2017 (asterisks indicate significant differences within an event). Cover crops tended to increase the duration of runoff, with significant increases in 10 of 17 events.

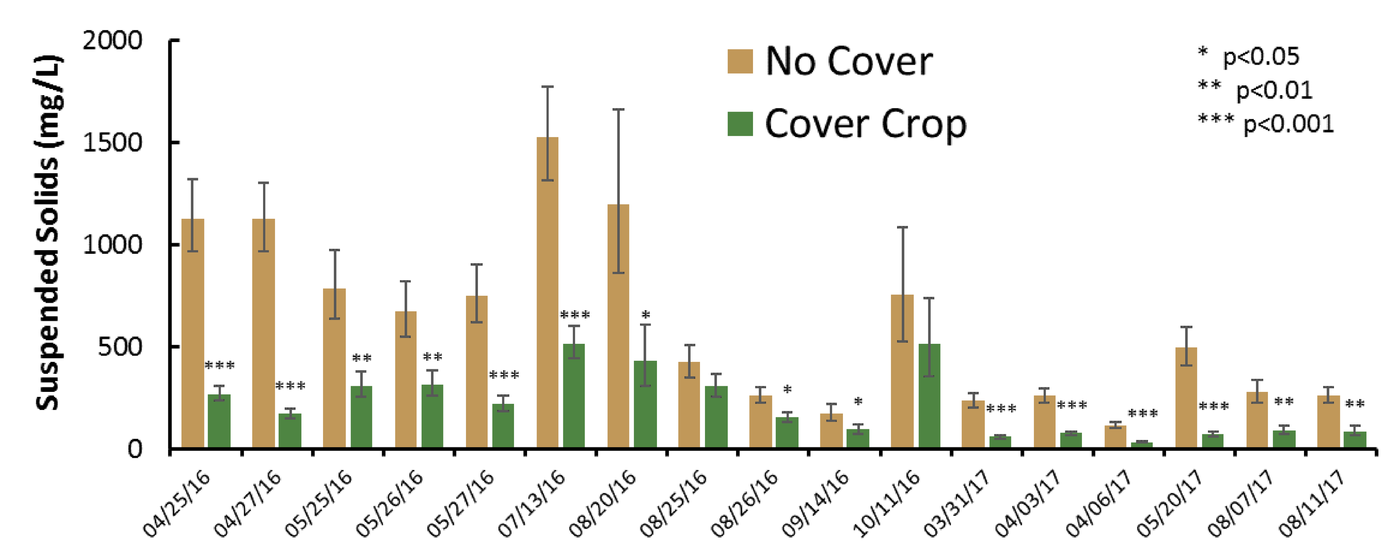
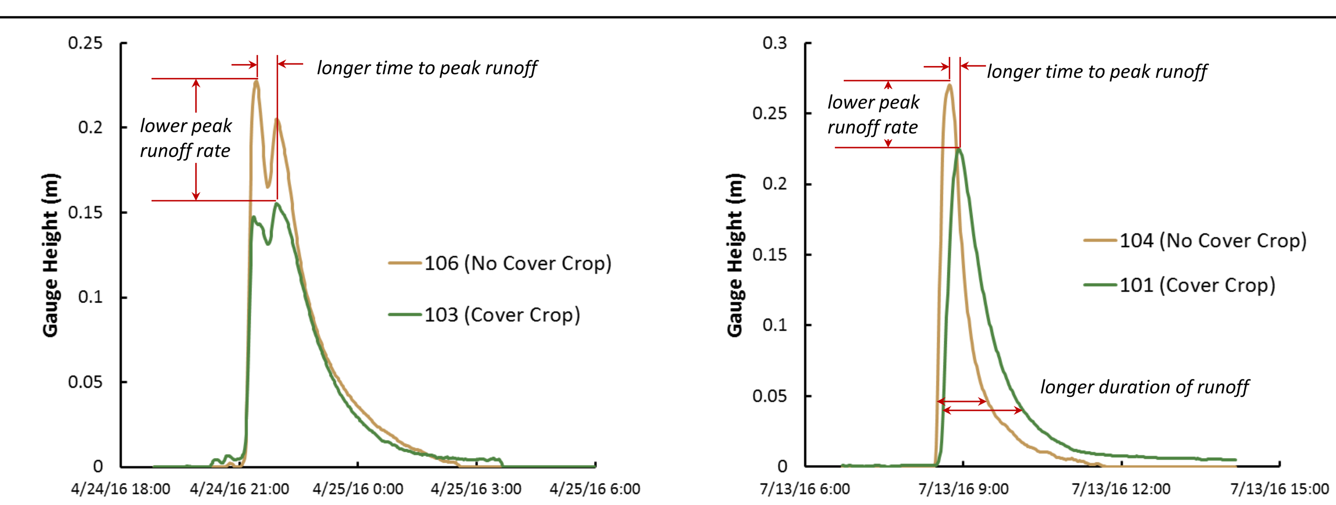


Figure 5. Total suspended solids concentrations for runoff events event in 2016 and 2017 (asterisks indicate significant differences within an event). Cover crops decreased total suspended solids concentrations consistently throughout the study, with significant decreases in 15 of 17 events.



Example hydrographs illustrating decreases in peak runoff, delayed peak runoff, and extended duration of runoff from cover crops.

Runoff from watersheds 104 (left) and 201 (right) for the 05/20/17 event.

Conclusions

- Although cover crops can influence the volume of runoff for an individual event, the effect is not consistent, sometimes increasing or decreasing runoff
- Cover crops tend to extend the time to peak runoff and reduce the peak runoff rate, which would reduce erosive force of runoff.
- Cover crops tend to increase the overall duration of runoff, which explains the lack of effect on runoff volume or occasional increase in runoff volume.
- Changes in hydrograph characteristics could help explain cover crop effects on water quality parameters.

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