RUNOFF WATER DYNAMICS IN CONSERVATION COTTON SYSTEMS

Charles Coufal
Paul DeLaune
Partson Mubvumba
Anthony Pennartz
Texas A&M AgriLife Research
Vernon, TX

Abstract

Conserving soil moisture is paramount in semi-arid cropping systems. We evaluated the effect of cover crops and no-till on water quality and infiltration in continuous cotton systems. Evaluated treatments included conventional tillage, no-tillage and no-tillage with wheat, Austrian winter pea, hairy vetch, or mixed species cover crops. The effect of cover crops on measured parameters varied by species. Hairy vetch, Austrian winter pea, and wheat were the most effective cover crops in prolonging time to runoff initiation for a runoff event occurring two weeks after cover crop termination. Hairy vetch had the most substantial lingering effects on time to runoff, runoff and infiltration rates for each storm event. There was no difference between conventional till and no-till without cover crops for infiltration and runoff rates. However, conventional tillage significantly increased total solids and organic C over all treatments during the first storm event. Implementing cover crops in continuous no-till cotton systems has the capability to enhance runoff water dynamics.

Introduction

Cover crops have been shown as a proven technology that can provide several ecosystem services. However, these significant benefits can vary by location and season. Mutchler and McDowell (1990) found that wheat or hairy vetch cover crop following cotton could significantly reduce annual soil loss compared to conventionally tillage and no-till cotton. Within semi-arid environments, efficient capture and storage of precipitation is advantageous for subsequent crop performance. Cover crops can provide more efficient capture of water, although concerns exist if this may be offset by water used by actively growing cover crops. Blanco-Canqui and Ruis (2018) summarized that no-till increased infiltration in 15 of 24 studies, ranging from 17-86%. Adding cover crops to no-till systems could enhance the capability of no-till systems, particularly in low residue systems. Touchton et al. (1984) found increased infiltration rates in NT cotton when crimson clover and common vetch cover crops were grown compared to fallow on a fine sandy loam soil. The objective of our study was to determine runoff water dynamics from winter cover crops in a continuous cotton cropping system.

Materials and Methods

Runoff studies were conducted at the Texas A&M AgriLife Chillicothe Research Station (CRS) near Chillicothe, TX. Six treatments were evaluated: 1) conventional tillage without a cover crop; 2) no-till without a cover crop; and no-till with cover crops consisting of 3) Austrian winter pea; 4) hairy vetch; 5) wheat, and 6) legume/grass mixture. Cover crops were first implanted in Fall 2011. Cover crops were chemically terminated 20 April 2017. Rainfall simulations were conducted on 5 and 17 May 2017. Portable rainfall simulators were used to deliver a 7 cm/hr storm event for a total of 35 minutes. Runoff plots were 1.5 x 2 m that were placed within 8 row (40 inch spacing) x 40 ft whole plots. Each treatment was replicated three times in a randomized complete block design. Time to runoff, runoff volume, and water quality parameters were quantified.

Results and Discussion

Time to runoff initiation for each runoff event is provided in Figure 1. Hairy vetch resulted in the highest time to runoff for each runoff event. All cover crop treatments resulted in greater time to runoff compared to the non-cover crop treatments in no-till and conventional till. Time to runoff was nearly doubled due to hairy vetch compared to conventional till for the second runoff event. Except for hairy vetch, time to runoff was similar among treatments for the second runoff event.

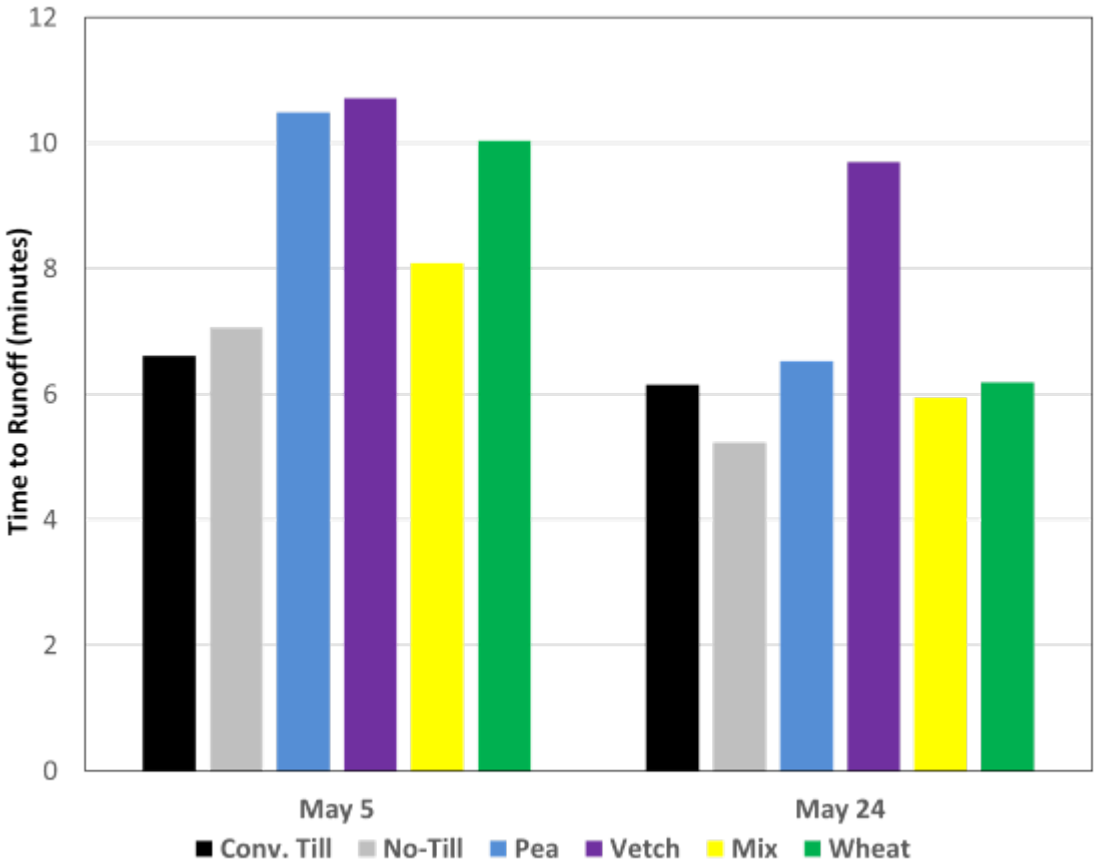

Figure 1. Time to runoff initiation for rainfall simulation trials on May 5 & 24, 2017.

Total runoff and infiltration varied among treatments (Table 1). Compared to no-till without a cover crop, runoff was significantly reduced by hairy vetch, wheat, and Austrian field peas for the first runoff event. Hairy vetch and Austrian winter pea significantly increased infiltration compared to no-till without a cover crop for the first runoff event. While not significant, hairy vetch had the highest infiltration rates and lowest runoff rates for the second runoff event. The first runoff event occurred when residue from cover crops remained on the soil surface. By the second runoff event, residue had decomposed, particularly for legume species.

Conventional tillage significantly increased totals solids in runoff water for each runoff event (data not shown). There were no significant differences among other treatments. Total organic C mass loss was significantly higher from conventional tillage with the exception of the wheat cover crop for the first runoff event (date not shown). Total organic C was significantly higher for conventional tillage during the second event than hairy vetch, mixed species, and wheat cover crops.

Summary

Water runoff dynamics varied among cover crop treatments and timing of storm event after cover crop termination. Hairy vetch has the greatest impact on runoff and infiltration for each runoff event. Conventional tillage resulted in higher sediment losses and total organic losses in runoff water. No-tillage without a cover crop was similar to conventional tillage in regard to runoff and infiltration rates. Adding cover crops to no-till cotton could provide enhanced water infiltration and reduced runoff rates. However, compared to conventional tillage, no-till without a cover crop improved sediment and organic C loss.

Table 1. Runoff volume and infiltration for rainfall simulation trials on May 5 & 24, 2017. Numbers within a column followed by different letters are significantly different at P < 0.05

	Runoff (cm)	Infiltration (cm)	Runoff (cm)	Infiltration (cm)
	May 5, 2017		May 24, 2017	
Conv. Till	2.34ab	2.32bc	2.03	2.05
No-Till	2.39a	2.28c	1.86	2.23
Pea	1.51bc	3.16ab	1.47	2.61
Vetch	1.32c	3.35a	0.94	3.14
Mix	1.81abc	2.86abc	1.20	2.88
Wheat	2.31ab	2.36bc	1.56	2.52

References

Blanco-Canqui, H., and S.J. Ruis. 2018. No-tillage and soil physical environment. Geoderma 326:162-200.

Mutchler, C.K. and L.L. McDowell. 1990. Soil loss from cotton with winter cover crops. Transactions of the American Society of Agricultural Engineers 33:432-436.

Touchton, J.T., D.H. Rickert, R.H. Walker, and C.E. Snipes. 1984. Winter legumes as a nitrogen source of no-tillage cotton. Soil Till. Res. 4:391-401.