Erosion and Crop Response to Contour-Ripped Planted-Wheat in Seasonally Frozen Soil of the Pacific Northwest:

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ABSTRACT

Soil erosion in the dryland farming region of the Pacific Northwest occurs predominantly in conjunction with low intensity rainfall falling on thawing soil. Fields susceptible to erosion under these conditions have long, steep slopes and minimal green or residue cover. These conditions are common to winter wheat-summer fallow cropping practices. We review here literature discussing the conservation practice of contour ripping frozen soil planted to winter wheat in the Pacific Northwest. This practice breaks slope length by opening channels through the frozen soil and plow pan. The channels detain water on the slope, reducing runoff and erosion, and allow infiltration, increasing water stored in the soil profile. Contour ripping serves as an effective erosion control without significant deleterious effects to crop yield or pathogen infestation. However, the conservation effectiveness decreases rapidly with each storm following contour trenching; and conditions of steep slopes or shallow soil however, caution must be used with the prescription and application of this conservation treatment.

Key words: Frozen soil erosion, summer fallow-winter wheat, steep slopes, low intensity rainfall, conservation tillage

INTRODUCTION

Seasonally frozen soils combined with cultural tillage practices create conditions that lead to 90% of the erosion in the inland Pacific Northwest farm region occurring on less that 20% of the landscape during 1% of the year (McCool et al. 1976). Rainfall on frozen soil, with or without snow cover, or rapid snowmelt on frozen soil create the most damaging flood and erosion events in this region. These events are exacerbated by mechanical fallow practices and long, steep slopes with minimal green or residue cover following fall seeding. One of the most effective conservation methods developed in recent years is contour ripping, which entails the creation of deep channels, 300-600 mm deep spaced 3-6 m depending on slope and soil depth, in planted wheat (Wilkins et al 1991, Pikul et al. 1996, Schillinger and Wilkins 1996). Contour ripping is accomplished using shanks up to 1 m long and 50 mm wide; equipment specifically for this use has been developed by farmers/producers (Harold Clinesmith, pers. com., Benge, Washington 1988), and by researchers (Wilkins et al. 1991).

Contour ripping serves two major conservation functions: firstly it shortens slope length of impermeable frozen soil, and secondly it increases infiltrability on the slope by creating flow pathways through the concrete frost that typically forms in this cropping system (Pikul et al. 1992). Contour channels are created shortly after fall seeding or during the first frozen soil event sufficiently deep to support the equipment. Moderately recharged soil water and surface soil with good structure are ideal conditions for contour ripping immediately after seeding (Schillinger and Wilkins 1996). This set of conditions increases the likelihood that contour channels will remain open longer through the winter. Unfortunately, in September and October the top 50 mm of soil is often dry and dust-mulched as a result of rod-weeding. Under these soil conditions, contour channels are prone to filling with loose, unconsolidated material.

Contour ripping is an effective soil and water conservation method as demonstrated by research in the Pacific Northwest (Wilkins and Zuzel 1994, Wilkins et al. 1996, Schillinger and Wilkins 1996) and eastern Montana (Pikul et al. 1996), and by producer/farmer experience. Harold Clinesmith has used this technique for some years on his farm and found it extremely effective. Figures 1 and 2 show Mr. Clinesmith's ripper and the confluence of two, similar small watersheds. Mr. Clinesmith has observed, in 47 years of farming, similar runoff and erosion from these watersheds. However, the watershed to the right was contour ripped the year of Figure 2, halting runoff. Trench spacing specifications are available to optimize time and equipment requirements (Pikul et al. 1996). Field-scale crop yield, crop disease, and weed infestation were not negatively influenced by contour ripping (Wilkins et al. 1991, Schillinger and Wilkins 1996, Wilkins et al. 1996).

Contour ripping is a successful conservation treatment, and contributes an important tool to the triad of mechanical, chemical, and biological methodologies necessary for successful winter wheat production and soil and water conservation. The purpose of this poster is to examine the relationship between the time of contour ripping with the general effectiveness of the treatment, and present conditions under which contour ripping should not be used.

METHODS, RESULTS AND DISCUSSION

We examined data presented by Schillinger and Wilkins (1996) and Wilkins et al. (1996). Comparisons between ripped and nonripped fields revealed a decreased effectiveness of contour ripping to reduce runoff after a single rain or frozen soil event. Eroded soil filled the contour trenches in 1993, and the soil was not transported any further downslope (Wilkins et al. 1996). Contour trenches, in effect, change source or transport zones into deposition zones and decrease the number of rills (Table 1). This effect is demonstrated by the change in soil erodibility index (ratio of soil loss in the tilled treatment to the control) in the winter of 1995 by Schillinger and Wilkins (1996) (Fig. 3). With each subsequent frozen soil and runoff event, the erosion ratio (ripped:non-ripped) increased, indicating diminished erosion control effectiveness in the ripped treatment.

Table 1. Soil loss from 24 Jan.-28 Feb. 1995.

Tillage	Change in rills (no. per plot)	Soil loss ($t\ ha^{-1}$)
Control	2.2	6.5
Ripped	-0.8	-0.2

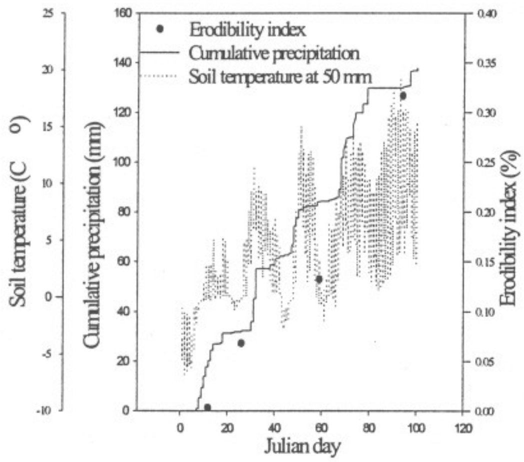

Fig 3. Daily range in soil temperature, cumulative precipitation, and erodibility index for ripped and control treatments (Schillinger and Wilkins 1996).

Our experience shows that contour ripping is most effective in a well structured soil with moderately high soil moisture immediately after seeding or during the first frozen soil event of the season. Channels ripped under these conditions provide a open channel into the soil profile capable of providing an infiltration pathway for water flowing over frozen soil. Soil freeze/thaw events occur from 1 to 7 times per year in the Pacific Northwest (Zuzel 1986). Schillinger and Wilkins (1996) measured soil loss following four freeze/thaw rain events (Fig. 4). Soil loss doubled from the first to last event in the control treatment, but increased 20 times in the ripped treatment, although it never reach the level of soil loss in the control.

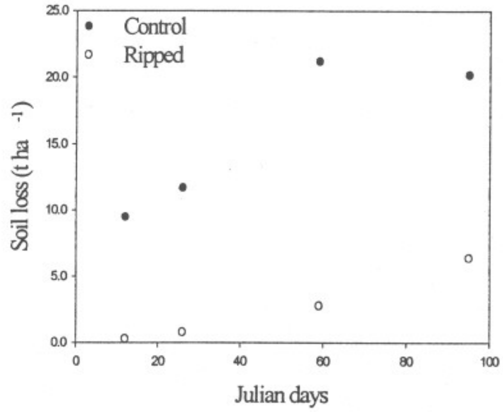

Fig. 4. Soil loss from control and ripped treatments following rain on frozen soil events (Schillinger and Wilkins 1996).

Ripping in frozen soil requires additional power, but decreases the possibility of loose, unconsolidated soil quickly filling the trenches. Slopes up to 52% are farmed in the Pacific Northwest. Conservatively 7% of the most erodible cropland is on slopes greater than 20 % (Johnson and Makinson 1988). For safety reasons, we do not recommend contour trenching on slopes greater than 20% when the soil is frozen. Care must be taken, of course, to rip the trenches on the contour to prevent formation of concentrated flow or development of piping in the soil. Contour ripping does not provide effective erosion control without sufficiently deep soil for additional soil water storage. Contour trenching into shallow soil might lead to profile saturation and soil loss through mass movement. Producers should be aware of impermeable or clay layers in deeper soils that create conditions ideal for rotational slumping associated with increased soil water. Soil moisture increases within 1 m of ripped contour trenches and is believed responsible for increased grain yields adjacent to the trenches (Schillinger and Wilkins 1996). However, in dry winters that occur occasionally in the Pacific

Northwest and regularly in the upper Great Plains (Pikul pers. comm.), we would expect no enhancement of soil moisture.

CONCLUSION

Research and farmer/producer experience support the use of contour ripped channels for soil and water conservation in seasonally frozen soils. Application of this conservation tool will enhance soil and water conservation, despite a gradual filling in of the trenches with subsequent storm events throughout the winter. On many summer fallow-winter wheat farms in the Pacific Northwest, the risk of accelerated soil erosion or yield loss is low if the precautions outlined above are considered.

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Figure 1. Clinesmith ripper used in production agriculture (photo by Harold Clinesmith).

Figure 2. Mouth of paired watershed on Skyline Wheat Ranch (photo by Harold Clinesmith).