

One Tillage Pass Can Produce Highly Effective Tilled Summer Fallow

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This article presents a collection of findings that support a change in perspective on tilled soil mulch in Pacific Northwest summer fallow systems. Our focus is on millions of acres in the driest portions of the Inland Pacific Northwest where tilled fallow is generally considered necessary for profitable winter wheat production. Some of the data presented here are from completed, published research projects and the rest from recent data not yet published. The ideas and principles are a work-in-progress, but the evidence and conclusions are sound enough and important enough to begin an earnest discussion.

Tillage-based fallow generally retains adequate seed-zone moisture for early (late August – early September) establishment of winter wheat, whereas sufficient seed-zone moisture is generally not present in no-till fallow by late summer. Given the variability in soil types and precipitation patterns across the region, it is often difficult to assign clear cause and effect relationships between changes in tillage and resulting seeding success. Many questions remain about what soil conditions result in the least evaporation and the best seed-zone moisture by late summer.

In many locations, wind erosion is the biggest environmental problem related to tilled fallow systems. Significant advances have been made in developing tillage systems that retain 30% or more crop residue cover on the soil surface. It is generally acknowledged that these “trashy” fallow systems produce as good a result as the older method of more intensive tillage, although farmers often have difficulty passing through high amounts of surface residue with existing deep-furrow drills. It is still commonly believed, however, that a relatively fine soil (“dust”) mulch is needed to provide a barrier to stop moisture loss during the summer months prior to seeding. A growing body of research has demonstrated that this is not true.

Extensive experiments at Lind, WA in the 1990s on a Shano-Ritzville soil (Schillinger, 2001) showed that undercutting plus nitrogen injection to a depth of five inches in the spring followed by rodweeding as needed provided a tillage mulch that consistently retained: (i) 30% surface residue cover, (ii) more surface clods, and (iii) more clods within the tillage mulch compared to traditional tillage. There were never any differences in seed-zone moisture or subsequent winter wheat grain yield between the undercutter tillage and traditional tillage systems.

A recent study conducted at Lind (Schillinger) and at Moro, OR (Steve Petrie) established that a single, low disturbance undercutting operation consistently produced seed-zone moisture and winter wheat yields equivalent to undercutting plus repeated rodweeding operations. The presence of more and larger soil clods both on the soil surface and within the tilled soil mulch (Figure 1) did not reduce the insulating effect. In addition, an average of slightly more than 30% residue cover was retained on the surface after seeding with the undercut-only and 1x-rodweeding treatments. This 30% residue cover after seeding has extremely important

implications for farmers who participate in the EQIP program because they are required to retain this amount of residue cover to receive government payments.

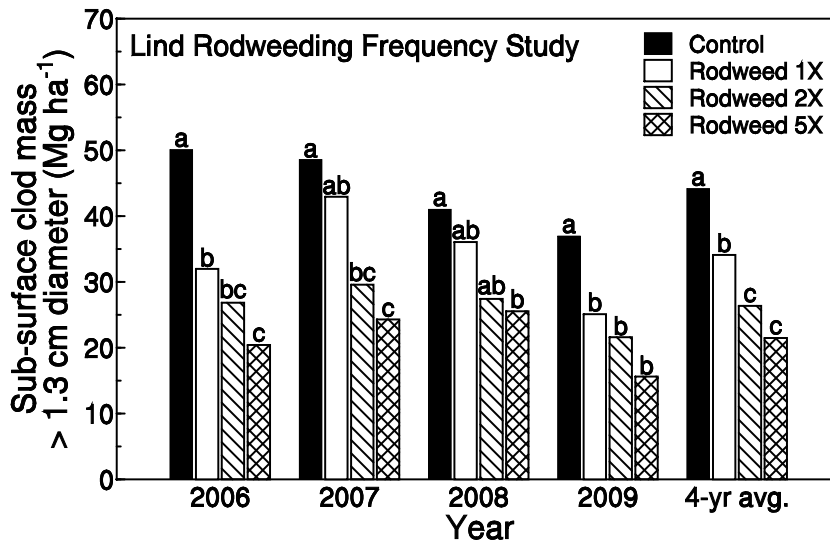


Figure 1. Sub-surface mass of soil clods larger than 1.3 cm (0.5 inch) in diameter as affected by four rodweeding frequency treatments in late August of 2006, 2007, 2008, and 2009.

One of the challenges in comparing different tillage systems for their effect on soil water evaporation is making consistent, unbiased measurements in soil where the surface bulk density has been changed. The instant a soil is tilled, the surface is “fluffed up”, and this means that a soil sample 12 inches deep from the surface of the fluffed up soil will not penetrate as deeply or recover as much soil as from the original untilled soil. More soil means more soil water, so there is a tendency for seed-zone moisture comparisons to be biased toward the most compact soils. Inspired by recent international interest in accurate measurement of soil carbon and our local need to better understand evaporation during summer fallow, we have developed unbiased methods for comparing soils with bulk density differences (Wuest, 2009).

When data from the recent rodweeding frequency experiment at Lind were analyzed using the new method, we found that the undercutter without any rodweeding actually performed better than when rodweeded immediately after undercutting, or rodweeded later in the season, or rodweeded several times (Figure 2). In this experiment weeds were controlled by herbicides in the undercut only treatment, so we are examining the effect of the soil mulch without consideration of how to control weeds. In August 2006 the improvement was substantial. In August 2007 and 2008 the soil was drier in general, but there was still an advantage to less rodweeding.

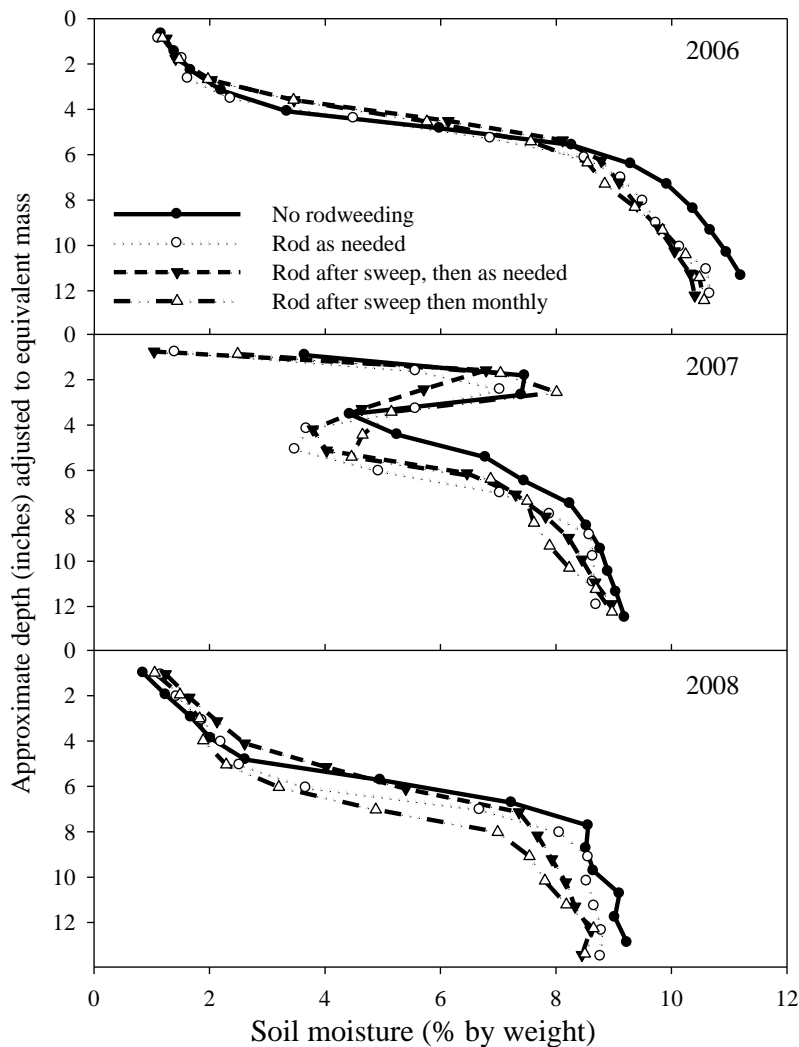


Figure 2. Four tillage intensity treatments on a Shano-Ritzville soil at Lind, WA (same plots as Figure 1). All treatments started with an undercutter sweep in April. The data is plotted and analyzed at equivalent mass depths to avoid bias due to different soil bulk densities. For the average of the three years, at about 7 inch depth, the no-rod and as-needed rod treatments had significantly greater moisture than the two-rod- and five-rod-after-undercutting treatments ($p > F = 0.07$; average soil moisture: no rod, 9.1%; as needed, 8.5%; sweep and rod then rod as needed, 8.3%; sweep and rod, then rod monthly, 7.5%).

The Shano-Ritzville soils at Lind are some of the lightest and most fragile, so a single tillage operation results in fewer clods than in heavier soils. The soils near Wasco, OR are in a heavier Walla Walla series. Over the past two years we measured late summer seed zone moisture profiles in four tilled-fallow fields (Figure 3). The fields were far enough apart to differ somewhat in soil texture and rainfall, so direct comparisons would be difficult (the research is designed to compare tilled and non-tilled fallow), but we have made some observations. In both years, the two fields having the best seed-zone moisture had more residue and less tillage, whereas the two fields with less seed-zone moisture were closer to traditional “black” fallow. In

fact, the fields marked 7 and 8 in Figure 3 were never rodweeded. Residue was mowed with a Schulte rotary cutter, chiseled with 12" sweeps, cultivated with 9" sweeps, and fertilized with a commercial anhydrous applicator. Weather conditions did not lead to a summer flush of weeds, so weed escapes were removed by hand. Figure 4 shows conditions after seeding in a field under similar tillage. Note the sharp shoulder on the moisture profiles in fields 1, 2 and 8 in Figure 3. This is typical of highly effective soil mulches (Wuest, 2010), and is probably related to cloddy, trashy conditions that produce a mulch with very low bulk density. Further rodweeding pulverizes the mulch, which makes it fine and flowable, but actually increases its bulk density and reduces its thickness ("brings the moisture line up").

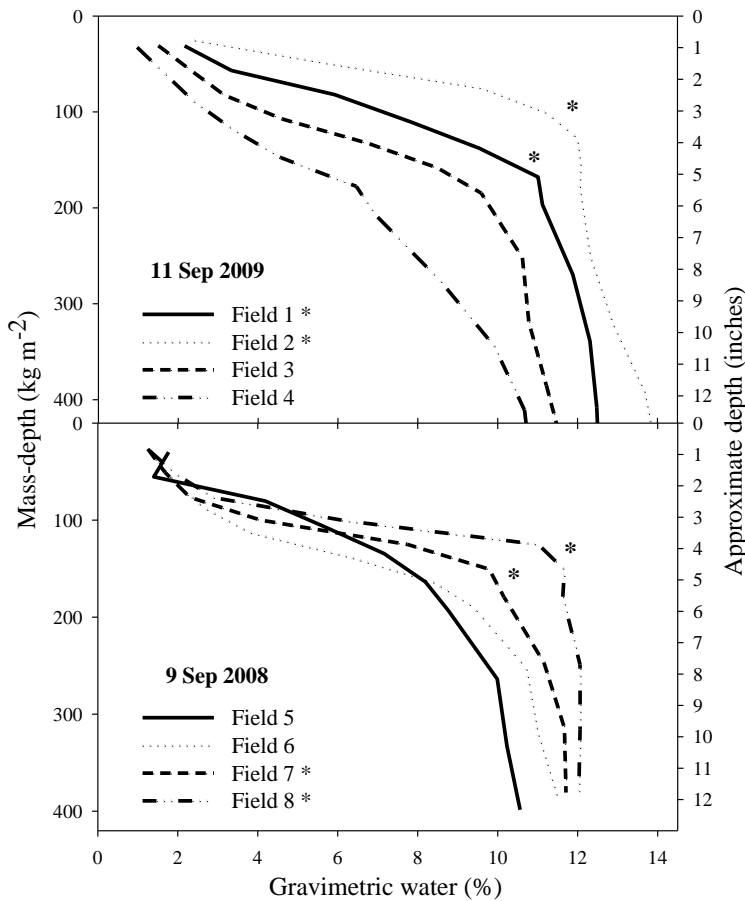


Figure 3. Seed-zone soil water profiles in tilled fallow fields near Wasco, OR. Fields marked with asterisks had the most surface residue during the summer.



Figure 4. Conditions after seeding in a field under summer fallow tillage similar to fields 7 and 8 in Figure 3. Rows are on 14 inch centers.

A set of data where several tillage types can be directly compared using stringent statistical methods comes from an on-farm test near Helix, OR (Wuest and Corp, submitted to Soil Science Society of America Journal). Four of the treatments are shown in Figure 5. The figure shows the average of 2007 and 2008. The sweep (Sunflower with 5-ft blade) in May, followed by one rodweeding in early July, had the best moisture retention. Next was the sweep-coil pack treatment (Sunflower with 5-ft blade in May with attached coil packer) and “traditional” treatment (disk in April, cultivated in May, rodweeded if necessary in June and July). The sweep treatments have better moisture. The sweep, rodweed treatment and the traditional treatment are statistically different at four and five inches ($p > F = 0.07$).

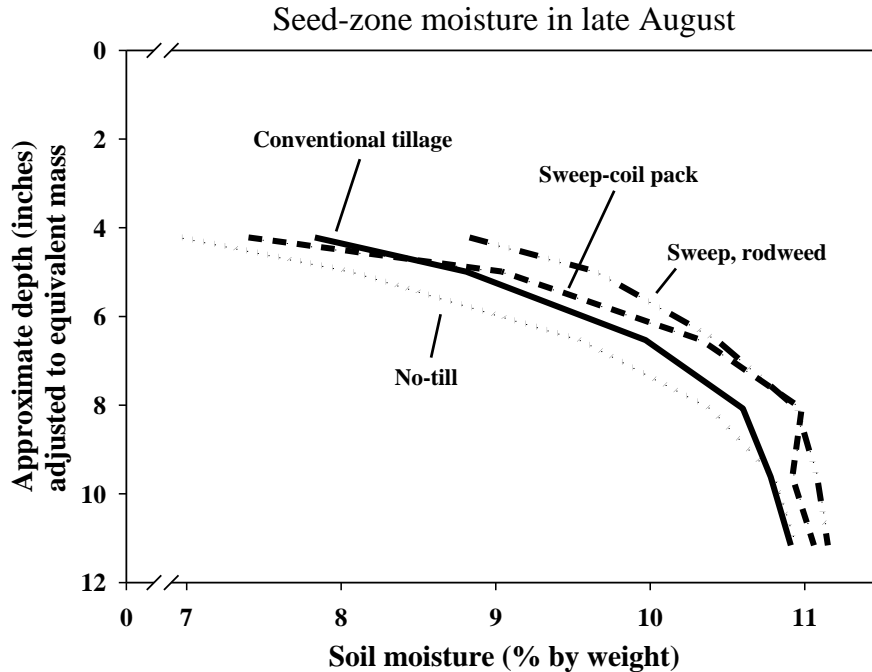


Figure 5. Effect of tillage treatments at an on-farm test near Helix, OR. Average of two years of data. Sweep, rodweed has significantly greater moisture than conventional tillage at 4 and 5 inch depths ($p > F = 0.07$). Sweep, rodweed treatment: 5-ft blade Sunflower in May, followed by rodweeding if necessary in July and August. Sweep-coil pack treatment: 5-ft blade Sunflower in May with attached coil packer. Conventional treatment: disk in April, cultivate in May, rodweed if necessary in June and July.

Attaching a coil packer to the sweep was intended to help with the problem of seeding into the low density mulch left by a single sweep operation. This is one obstacle to adoption of single-pass summer fallow systems. A single undercutting, or chisel and cultivate system, leaves a relatively thick, low-density mulch which can be difficult to seed into with standard deep furrow drills. On the other hand, the soil may hold furrows better as it has less of a tendency to flow. A cloddy, trashy surface will also have less possibility of crusting. Some seedlings are prevented from emerging because they are impeded by a clod, but such stand reductions at Lind has not reduced grain yield compared to traditional tillage. It seems clear from available data that a low bulk density, cloddy, high residue soil mulch reduces evaporation compared to a finer mulch. We don't have a lot of measurements on the effect of single-pass tillage on total water storage, but it appears that the reduction in evaporation improves water storage. This should help with stand establishment and yield potential in marginal years.

How do we control weeds without summer rodweeding? A few farmers are using suspended boom sprayers to reduce dust problems and avoid rodweeding. While a single rodweeding may be somewhat detrimental to mulch effectiveness, in many cases it may be the best weed control solution. Ultimately, we would like to see drills designed to seed into high residue levels and low density, cloddy soils to take full advantage of the benefits of soil water conservation, better seed-zone moisture, and excellent erosion control. Regional farmers and researchers are currently working on developing such a deep-furrow drill. Tilled fallow research is ongoing. We would

like to clearly define the depth, porosity, and surface characteristics of highly effective tillage mulches on different soil types. We also need to understand optimum timing for mulch creation, and how this might be influenced by fall undercutting for Russian thistle control. The longer we can delay tillage, the better the penetration of spring rains. No-till allows the best penetration of rain, and we recommend no-till over tilled fallow wherever timely rains allow good winter wheat establishment. We do have some indications, however, that single-pass tillage fallow has much better rain penetration than more intensely tilled fallow, which has very poor penetration.

Despite questions regarding mid-summer weed control and a design for more suitable seed drills, the prospects of a very low disturbance, erosion resistant summer fallow system with excellent seed-zone moisture and water conservation make further efforts in the driest winter wheat regions imperative. A more accurate understanding of the physics of tilled mulches promises to improve both profitability and sustainability.

Acknowledgements

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