storage efficiency ranged from 33% for 1x NTF to 40% for TF. We conclude that for the low-precipitation winter wheat-summer fallow region of the Inland Pacific Northwest: (i) Cumulative water loss during the summer from NTF generally exceeds that of TF; (ii) there is more extensive and deeper over-summer drying of the seed-zone layer with NTF than with TF; (iii) increased quantities of surface residue in NTF slow the rate of evaporative loss from late-summer rains, and (iv) large quantities of surface residue from April through August will marginally enhance total-profile and seed-zone water in NTF, but will not retain adequate seed-zone water for early establishment of winter wheat except sometimes during years of exceptionally high precipitation or when substantial rain occurs in mid-to-late August.

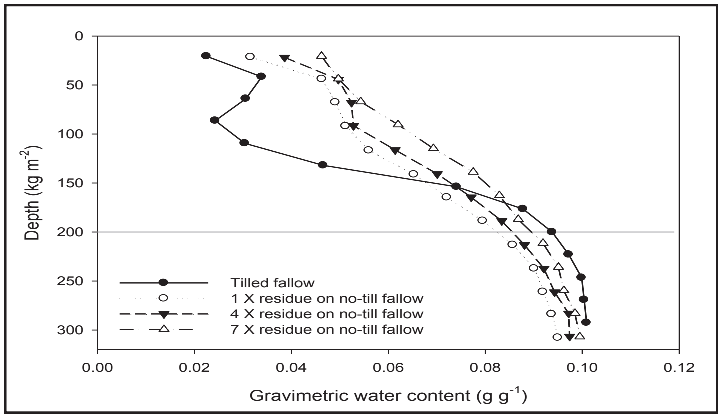

Fig. 1. Average seed-zone water content over the six-year period (each point is the mean of six years and four replications). Treatments are significantly different at 200 kg m^{-2} (which is five inches below the surface, a typical seeding depth). All non-adjacent means at 200 kg m^{-2} (i.e. five inch depth) are significantly different at $P < 0.04$. The year by treatment interaction was not significant.

Predicting Seed-zone Water Content for Summer Fallow in the Horse Heaven Hills

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The Horse Heaven Hills in south-central Washington contains the world's driest rainfed wheat production region. The climate is Mediterranean with average annual precipitation as low as six inches. The cropping system is winter wheat-summer fallow. Tillage is used in the spring of the 13-month fallow to establish a dry soil mulch to help retain seed-zone water to establish winter wheat planted deep into fallow in late August. However, the Horse Heaven Hills is often so dry that even tillage-based summer fallow (TF) cannot retain adequate seed-zone water, and farmers must then wait until the onset of rains in mid October or later for planting. In such dry years, farmers would be better off practicing no-till fallow (NTF) to protect the soil from wind erosion; but no predictive tools are available to assist in these decisions.

The objectives of our study were (1) to predict seed-zone water contents and water potentials in late August or early September based on soil water content measured in early April, and (2) to compare seed-zone water in TF and NTF. Experiments were conducted for five years at each of two sites. Soil water content was measured in both early April and late August. Soil properties and residue loads were characterized to calibrate the Simultaneous Heat and Water model (SHAW). Seed-zone water was simulated in late August based on measured soil water contents made in early April and compared with observed water contents. The SHAW model correctly predicted seed-zone water content 80% of the time. The amount and timing of rainfall occurring in April, May, and June proved to be the most important factor controlling the seed-zone water content in late August, suggesting that farmers should delay their decision on whether to practice TF or NTF until late in the spring.

Fig. 1. Scientists and a research technician measure surface soil bulk density in a no-till fallow plot on the Mike Nichols farm in the western portion of the Horse Heaven Hills.

Our data suggest that farmers should consider delaying their decision on whether to practice TF or NTF until as late as mid June. If at that time, their measured soil water at the 6 to 7-inch depth exceeds 15% by volume, farmers should practice TF and if water content is less than this amount they should practice NTF. There are, however, some practical limitations to our recommendations. Average farm size in the Horse

Heaven Hills is approximately 7500 acres, with half in winter wheat and half in summer fallow. Given that a farmer can cover about 160 acres per day with a primary tillage implement, it takes approximately 24 days to complete primary spring tillage. If the farmer waits until mid June to begin primary spring tillage, substantial evaporative soil loss may occur on non-tilled ground by mid July.

Data from our study also suggest that farmers in the extreme dry western region of the Horse Heaven Hills should practice NTF in all but very wet years as they rarely have adequate seed-zone water for late-August planting, even with TF. The widespread practice of NTF would dramatically reduce wind erosion and likely save on operating costs compared to TF. In addition, farmers committed to practicing NTF in the long term could receive monetary payments from federal farm programs that reward environmental stewardship.

Residue Protects Emerging Winter Wheat Seedlings from Rain-Induced Soil Crusting

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Farmers in the low-precipitation region of the Pacific Northwest practice a 2-year tillage-based winter wheat- summer fallow rotation. Winter wheat is planted deep into moisture in late August or early September and seedlings emerge through 4 to 6 inches of dry soil cover. Rain showers that occur after planting create fragile soil crusts that the emerging first leaf often cannot penetrate. A rainfall simulator was used to conduct a 5 -factor factorial laboratory experiment to evaluate emergence of WW planted deep in pots. Factors were: (i) rainfall intensity and duration (0.05 inch per for 3 hours, and 0.10 inch per hour for 2 hours); (ii) timing of rainfall after planting (1, 3, and 5 days after planting + controls); (iii) variety (standard-height vs. semi-dwarf), (iv) residue on the soil surface (0, 750, and 1500 lbs/ acre); and v) air temperature (70^0 and 86^0F). The high-intensity rain caused a 2.3-fold reduction in emergence compared to the low-intensity rain. Emergence improved proportionally with increasing quantities of surface residue (Fig. 1). The standard-height cultivar had four times greater emergence than the semi-dwarf. Air temperature and timing of rainfall had no significant effect on WW emergence. Results show that planting a WW cultivar with long coleoptile and first leaf as well as maintaining high quantities of surface residue to intercept rain drops will enhance WW stand establishment after rain showers to benefit both farmers and the environment.

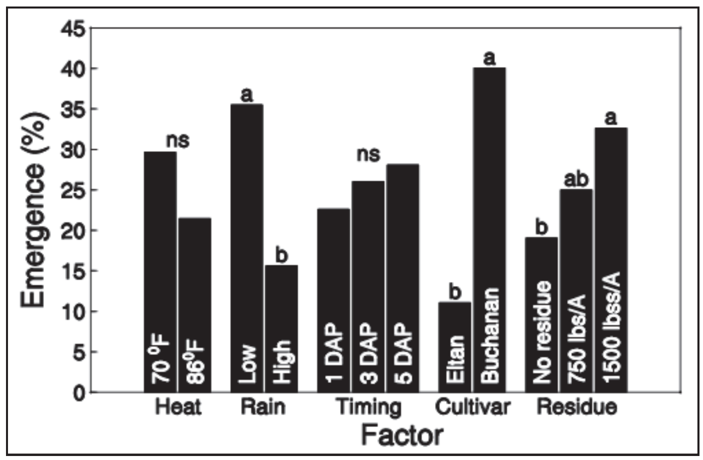

Fig 1. Percent emergence of Eltan and Buchanan winter wheat varieties planted deep into pots as affected by rainfall intensity and duration, residue cover, timing of rainfall, and heat. Data are the average from three runs. Data are combined for the two varieties. DAP = days after planting

No-till Summer Fallow is a Good Fit in the Western Horse Heaven Hills

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Blowing dust from excessively tilled summer-fallowed fields in the Horse Heaven Hills (HHH) is a major air quality concern in the Tri-cities, Washington. We conduct a 5-year on-farm field experiment at two HHH sites to determine the effects of no-till summer fallow, conservation tillage summer fallow, and traditional tillage summer fallow on: i) seed-zone moisture in late August, ii) wheat plant establishment, iii) wheat grain yield, and iv) dust emissions.

Beginning in March 2006, replicated experiments were established on the David Pearson and Mike Nichols farms. The Pearson