Cover Crop Water Consumption in Southeastern Washington Palouse

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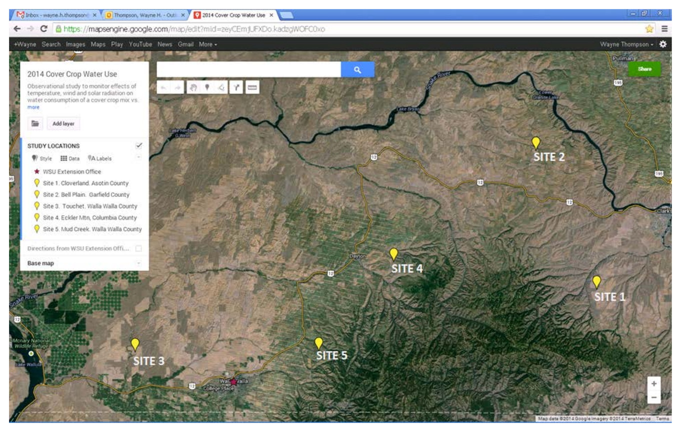
Abstract. Water use by a 2014 spring-planted cover crop mix versus three fallow systems: 1) bare soil, 2) wheat straw residue cover, and 3) full shade. Cover crop as a replacement for, or supplement to fallow systems is not well documented for the PNW and is considered to be luxurious use of a scare water resource. Historically, most precipitation events in the PNW occur during the winter months when temperatures are low, with infrequent and minor events during the season when temperatures support rapid plant growth. Under PNW dryland cropping systems, precipitation is stored as soil water and reserved for consumption by the crop during the subsequent growing season. In addition, fallow cropping is commonly practiced in these lower rainfall areas to extend the period of water sequestration. Cover crop soil water consumption is reported and contrasted with evaporative water loss under three fallow systems relative to evapotranspiration (ET) for four locations in Southeastern Washington State.

Background

Five producers with interest in examining the feasibility of growing cover crops were recruited by NRCS conservationists to host the observational trial. Each site was soil sampled to measure gravimetric moisture status before planting, and again at the time of crop removal. *Refer to climate data charts for dates.* Each site was equipped with a portable weather station to record full spectrum solar radiation, wind speed and direction, air temperature and relative humidity, 0-10 cm soil moisture under two of the four cover treatments, and soil temperature (15, 30 and 45 cm depths) under three soil cover types: 1) bare soil; 2) wheat straw residue; 3) full shade; and 4) cover crop. A popular cover crop mix was selected for each site – producing mixed results.



Goal

Determine amount of water consumed per unit of cover crop biomass produced as affected by soil water status, solar radiation and daily temperatures.

Three Cover Crop species planted:

- tillage radish (large, deep taproot),
- sorghum sudangrass (high biomass warm-season grass),
- sun hemp (tropical legume).

Weather Instruments at each site:

- Spectrum Technologies 4-port data logger with internal air temperature and relative humidity,
- full spectrum silicon pyranometer, leaf wetness sensor; Wind101 anemometer and wind vane; rain gauge; 12 Lascar temperature data loggers with waterproof stainless steel case

Soil Samples:

Collected before planting (hand samples) and at time of crop removal (Giddings Probe truck) to measure gravimetric soil moisture were collected at 7.5 cm increments to 30 cm, 15 cm increments from 30 to 90 cm, and 30 cm increments from 90 cm 180 cm. Actual depth of sampling varied with soil condition at each site.

Biomass Samples

Hand sampled at time of site removal, solar-dried

Sites

Four of five sites. Site three was excluded as soil moisture conditions during the trial period were too low to support crop growth. Cover mix planted, dominant species for each site is listed.

1 **Cloverland, Asotin County**
Olical. Coarse-silty, mixed, superactive, mesic
Calcic Haploxerolls
Elev 2,936 ft (895 m),
20-22 in rainfall zone
Long-term No-Till
Cover Crop: *Raphanus sativus*

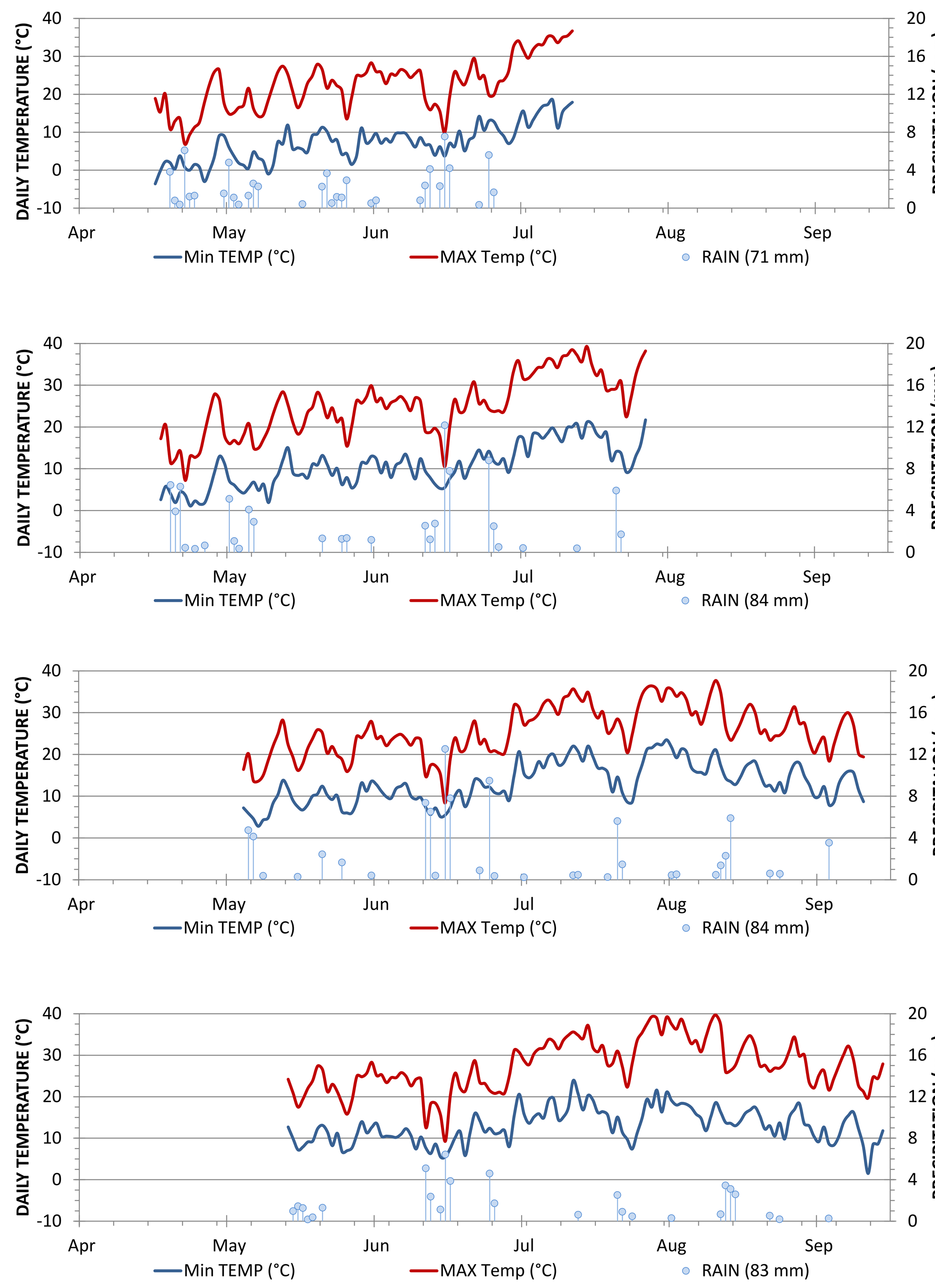
2 **Bell Plain, Garfield County**
Athena. Fine-silty, mixed, superactive, mesic
Pachic Haploxerolls
Elev 2,394 ft (729 m)
16-18 in rainfall zone
Long-term No-Till
Cover Crop: *Pisum sativum*

4 **Eckler Mountain, Columbia County**
Palouse. Fine-silty, mixed superactive, mesic
Pachic Ultic Haploxerolls
Elev 2,997 ft (913 m)
18-20 in rainfall zone
Long-term No-Till
Cover Crop: *Raphanus sativus*

5 **Mud Creek, Walla Walla County**
Palouse. Fine-silty, mixed superactive, mesic
Pachic Ultic Haploxerolls
Elev 2,538 ft (773 m)
25-28 in rainfall zone
Long-term No-Till
Cover Crop: *Avena fatua*

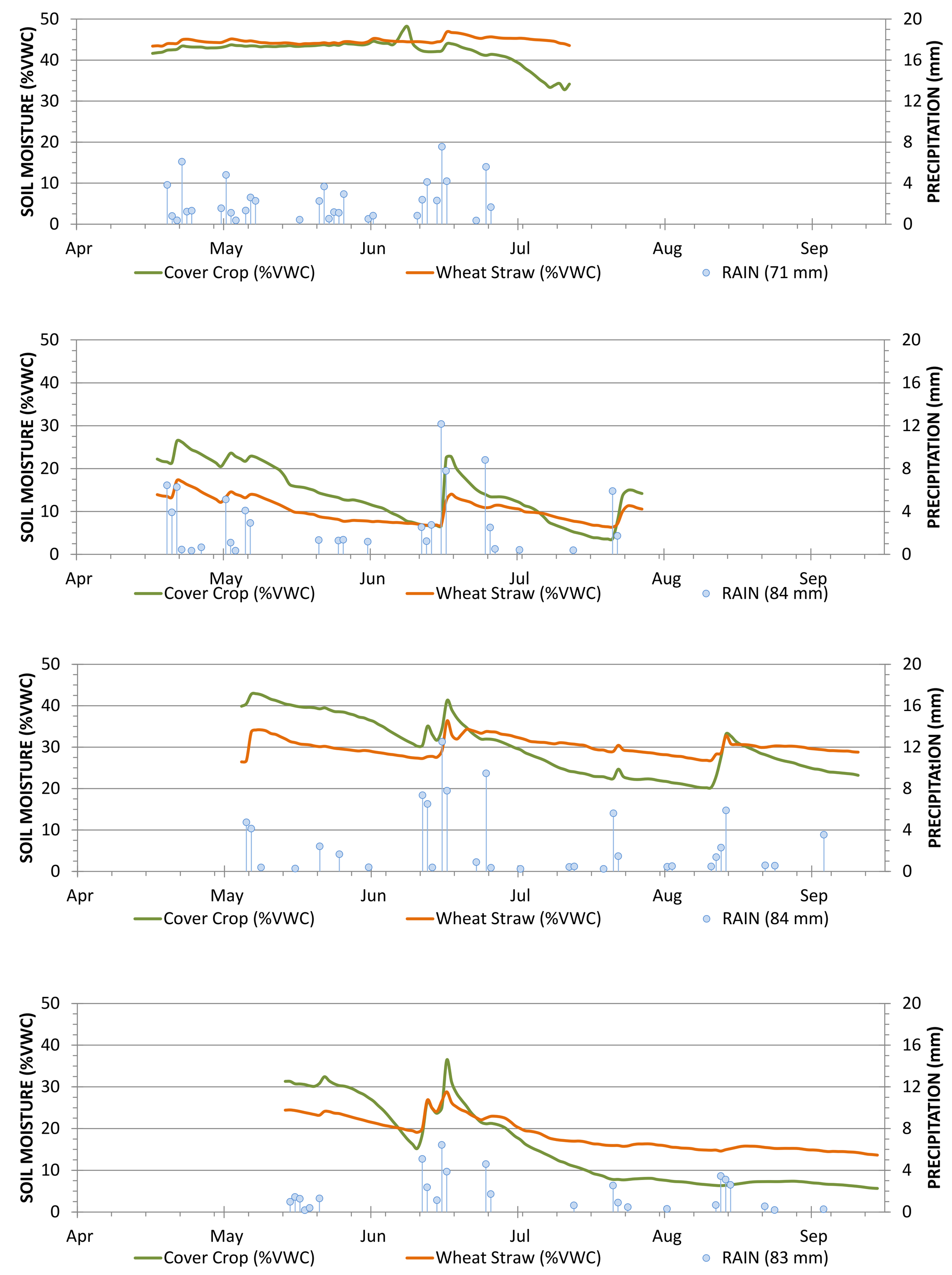
Daily Temperature

Daily maximum (red) and Minimum (blue) versus precipitation estimates (blue dots). 2014 season was exceptionally cool. Range of dates presented correspond to timeline of trial for each site.

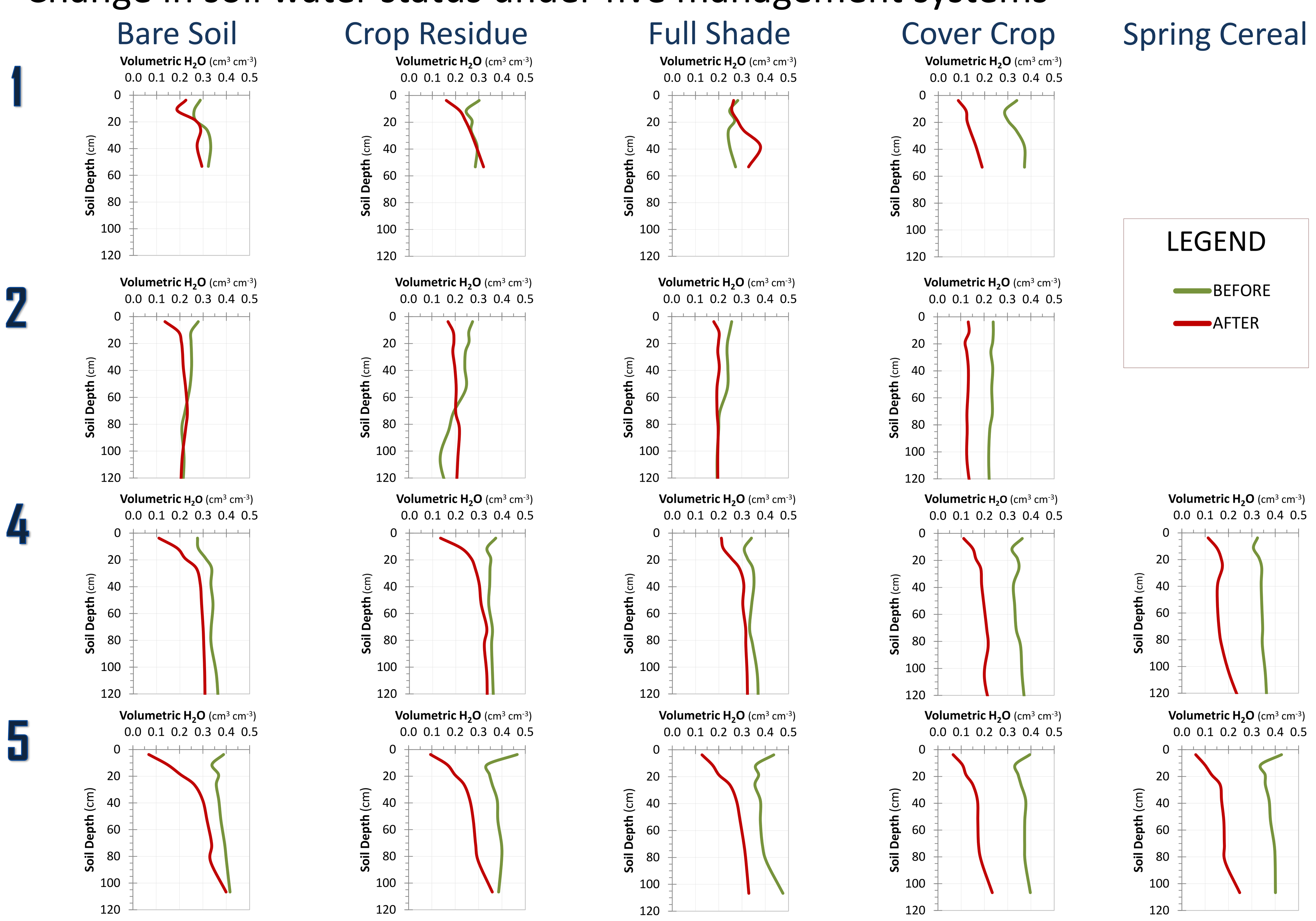


0-10 cm Soil Moisture

Volumetric soil moisture 0-10 cm, under cover crop (green) versus a fallow system with wheat straw residue cover. Soil moisture under cover crop declined rapidly after senescence (most pronounced at sites 1).



Change in soil water status under five management systems



Summary of Preliminary Results

Treatment Effects. Our data shows a minor difference in soil water consumption (ET) by cover crop versus spring cereal crop. We observed numerical differences in evaporative water loss among the three fallow systems, and statistically significant differences across trial sites.

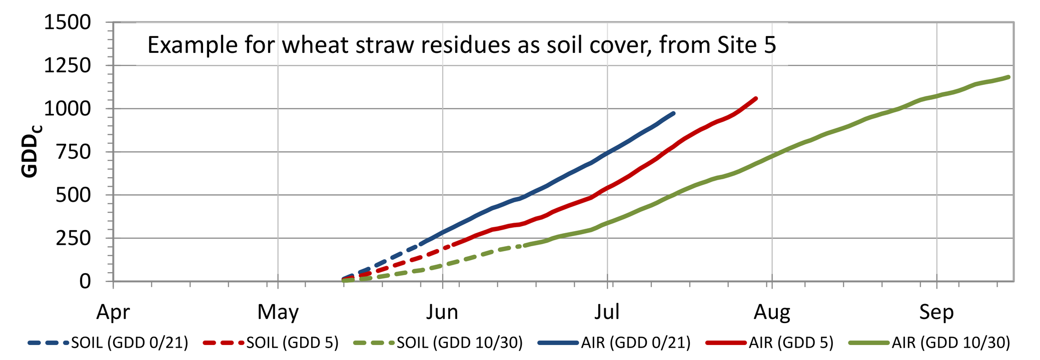
Cover Type	Water Loss (cm^3) 0-60 cm	60-120 cm
Cover Crop (ET)	10.4 a	8.5 a
Spring Cereal (ET)	10.1 a	9.1 a
Straw Residue (E)	5.0 b	0.8 b
Bare Soil (E)	4.4 b	1.6 b
Full Shade (E)	2.9 b	3.0 b

Evaporative water loss tends to increase with increasing proximity to the soil surface (refer to profile charts). Due to harvest delay, this was exaggerated at site 5.

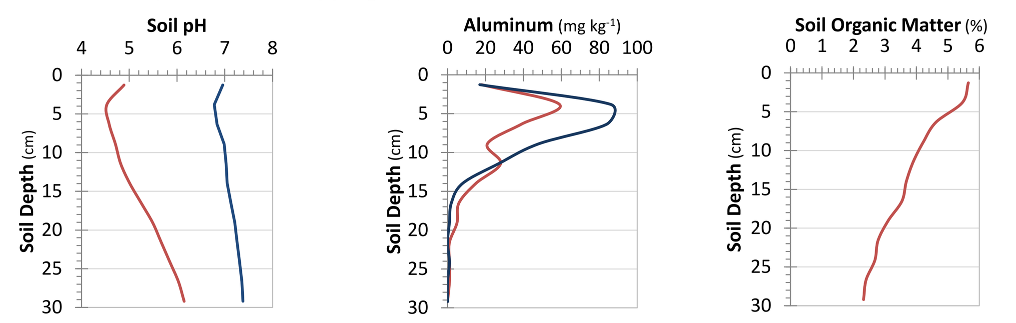
Cover Type	Depth (cm)	Mean	Std Dev
Bare Soil	0-60 cm	4.4	2.4
	60-120 cm	1.6	1.5
Straw Residue	0-60 cm	5.0	3.6
	60-120 cm	0.8	3.6
Full Shade	0-60 cm	2.9	4.9
	60-120 cm	3.0	3.5

Measured evapotranspiration and calculated transpiration. Water removal from lower soil profile (60-120 cm) by transpiration is both numerically and proportionately higher under crops than evaporation under all fallow systems.

Crop	Depth (cm)	Evapotranspiration	Transpiration
Cover Crop	0-60 cm	10.4	6.3
	60-120 cm	8.5	6.7
Spring Grain	0-60 cm	12.4	8.2
	60-120 cm	10.5	8.7



Growing Degree Day (°C) calculated for cool season (blue), brassica (red), and warm season (green) species. For illustration purposes we assume that 0-10 cm soil temperature drives germination through emergence (e.g., 200 GDD_C). Note that subtropical cover crop species recommended for mid-western cover cropping systems suffer significant delays in the PNW. Delayed germination/emergence and exceptionally slow GDD accumulation rates provide evidence that warm season species are not suitable for PNW dryland cover cropping systems.



Stratification of Soil pH. A confounding factor found to decrease cover crop establishment and growth. It is common to find soil strata with pH below 5.0 with correspondingly high [Al] in the PNW. The acidified strata is typically associated with the position of nitrogen fertilizer placement under minimum tillage systems. Also, note that soil organic matter levels are relatively high where soil erosion is controlled.

Conclusions

- Water removal rate by a spring-planted cover crop is approximately equal to that of a spring cereal crop.
- Plantings of mixed cover crops following a primary harvest may not be practical due to soil moisture deficit.
- Additional research is needed to evaluate cool season species as a potentially reliable winter cover/forage crop option where access to grazing livestock is practical.

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