# How Much Does a Rye Cover Crop Deplete Soil Moisture - 2018 Research Results

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**Introduction**

Rye use for a cover crop prior to soybeans is a new trend that is being adopted in North Dakota. Rye makes up for a lot of weaknesses that soybeans have in a cropping system. Some of the primary benefits include reducing soil erosion, increased weed control, additional grazing/forage material, utilization of excess soil moisture by rye allowing soybean to be planted timely, and allowing soybeans to be planted further into former saline regions. The concept of this system is that winter rye is planted the fall before soybeans. The rye is terminated prior to or shortly after soybean planting. In the spring, prior to soybean planting, the rye is suppressing weeds, reducing wind and water erosion (after soybean planting too), and putting out roots and using water (in saline areas). Rye is best terminated with glyphosate.

Rye provides selective weed suppression, meaning that it is more effective against some species than others. Rye is particularly effective at suppressing kochia (up to 70% control in a heavy kochia infestation), and also does well against pigweed species, ragweed, and yellow foxtail. Rye has very little or no suppression of mint species (like lanceleaf sage), or most legumes. Thus, soybeans are not influenced by the presence of rye, except when moisture is limiting. We have seen in past studies that when soil moisture conditions are limiting and the rye is left growing too long, the soil profile can be depleted enough to seriously harm the soybean crop. In 2017 a producer came to us with the question that cuts to the heart of this issue. He simply asked: how much water is the rye using?

For this reason, in 2018 we started a trial that was designed to monitor soil moisture status in growing rye plots using a hydroprobe. This is an indirect method of monitoring crop water use because by themselves values obtained like this do not tell us what the cause of the change in moisture status is. In order to be able to attribute soil moisture depletion to crops we used rainfall data from the nearby NDAWN station and moisture data collected from bare ground plots scattered throughout the trial area. The data from the bare ground plots was meant to establish a baseline soil moisture status whose changes were affected only by climatic factors and soil physical properties. In this trial we had plots that were planted to rye or soybean only, and we also had plots where soybean was planted into growing rye, which was terminated at different dates.

For simplicity's sake and because we only have one year of data, detailed discussion of results are confined to the soil moisture changes attributable to rye in comparison with bare ground and soybean only plots.

**Description of trial area**

Bare ground at field capacity held 6.89 inches of water per 2 feet. Soil moisture at the end of season in soybean plots was 3.23 inches per 2 feet. It is safe to say that the soil profile was depleted of available water at that time by the soybean since the optimum soybean water use exceeds what our local climate can supply. The estimated field capacity and permanent wilting point volumetric moisture content values for a loam soil are estimated at 28% (6.72 in/2ft) and 14% (3.36 in/2ft) respectively (Saxton and Rawls 2006). These estimates are very close to the values obtained from our trial area.

**Rye crop water use**

At the first moisture reading in the spring, the soil under bare ground held 5.4 inches of moisture (22.5% volumetric water content) in the 2-feet soil profile. That corresponds to around 55% of the plant available water that the soil of that trial area is capable of holding. This means that we already started the spring with a moisture deficit. Rye plots were very similar in moisture status, because the rye was too young to significantly contribute to moisture depletion. Rye plots held 4.18 inches of moisture when the rye stopped using water. Rainfall during the rye growth period was 2.726 inches. The bare ground plots held 6.47 inches of water at rye maturity. Which means that 1.65 inches of water would have been lost from the profile despite the absence of crops. It is assumed that in the rye-planted plots some of the amount of water that was lost from the bare ground plots, due mostly to evaporation, would have been captured by the rye plants. For this reason, using bare ground as a reference and looking at starting and end points of the rye's life cycle can only give us a range of how much water the rye has used this growing season. On the low end, if we assume that all of the 1.65 inches of water that was lost from the bare ground plots was also lost from the rye plots we get a crop water use of 2.29 inches. On the high end if we assume that those 1.65 inches were entirely used by the rye, we get 3.94 inches of water use. So to sum it up our **rye used somewhere between 2.3 and 4 inches of water this year**. While we can only provide a range for the physiological crop water use of the plants with our methods, we can provide exact values regarding the soil's moisture status and plant-available water content. The maximum plant available water is the difference between how much the soil can hold at field capacity and how much water is held at the permanent wilting point, which is a value at which water is no longer accessible to the plants. There is a visual demonstration of the following results in Figure 1. **At the time when the rye had reached maturity and stopped using water, the soil had 26% plant available water. As a comparison, soybean plots at the same time had 76% and bare ground had 89%.** The soybean at that time was at the beginning stages of its growth. Ultimately soybeans depleted the soil much more than the rye, but peak water use didn't start for those plants until sometime after the rye growth period. On a wet year the rye and soybean can be allowed to grow together with no yield reduction. However in our graph we can see that 2018 was not such a year. Rye-planted plots maintained their water deficit throughout the season, well after the rye was harvested. There was a series of rain events around rye maturity that brought the bare ground areas up to field capacity but not the rye plots. This does not mean rye should not have been used as a cover crop this year. On the graph we can see that major crop water use of rye didn't start until soybean planting. Our yield data also showed that terminating at or before soybean planting did not significantly affect yields. This trial will run for at least another year, after which yield data will be reported in detail.

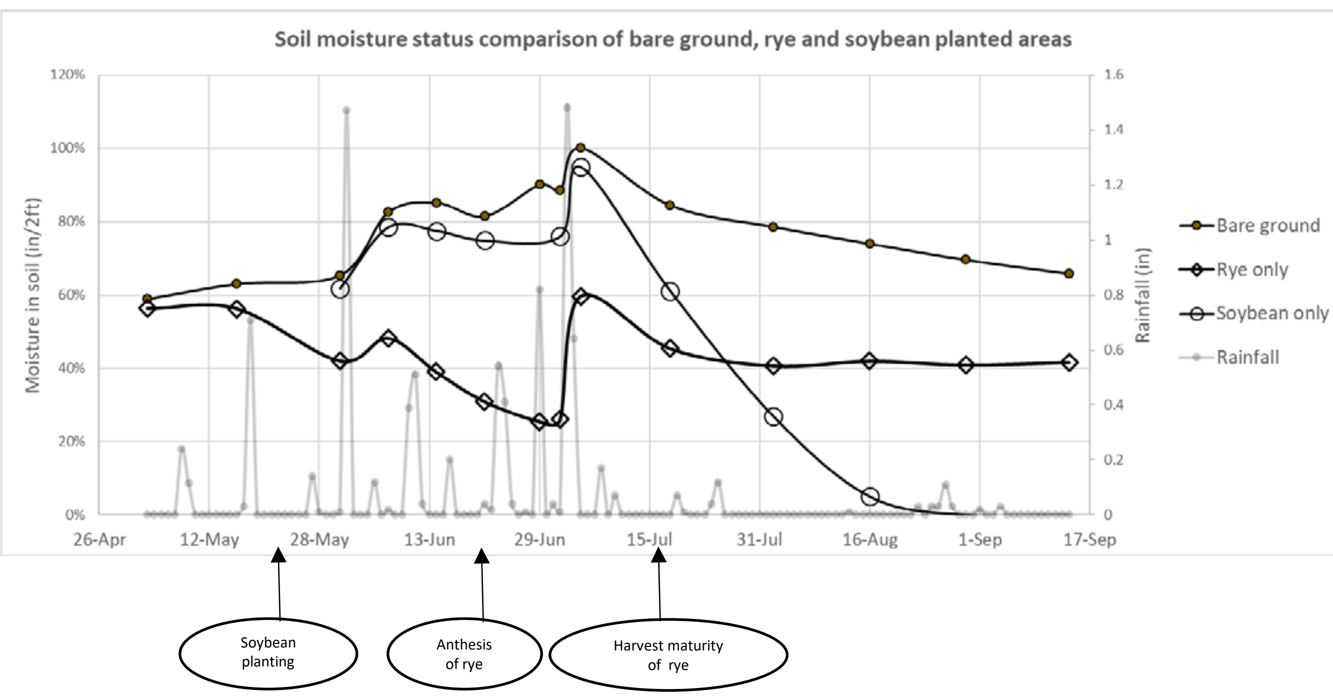


**Figure 1. Plant available water status comparison of bare ground, rye and soybean planted areas**

## Literature Cited

Saxton, K.E. and Rawls, W.J. (2006) Soil Water Characteristic Estimates by Texture and Organic Matter for Hydrologic Solutions. Soil Science Society of America Journal, 70, 1569-1578.