Soil temperature impact of stubble critical for soil and plant health

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In conditions like those of last summer, with mean temperatures reaching 46°C, three degrees hotter than average, how can farmers keep their soils cool enough to keep soil micro-organisms alive and maintain healthy biological activity in their soils?

According to Paul Jasa, an Extension Engineer at the University of Nebraska-Lincoln and speaker at this year's SANTFA Conference, soil temperatures of 40°C or above slow the growth of microorganisms in the soil. If soil temperatures reach 60°C or more, the microorganisms will die.

"Soil microorganisms start slowing down at about 40 degrees, some are dying at 50 degrees and most all die above 60 degrees," Jasa said. "It's simply too hot for them to reproduce, function, or live. Consider food safety recommendations; they say to keep hot food above 60 degrees when serving to prevent bacteria formation and spoilage. Likewise, milk is pasteurised by heating it above 60 degrees to kill the bacteria. The same happens in the soil when it gets hot."

Soil organisms including bacteria, actinomycetes, moulds, fungi, algae, protozoa, nematodes, worms and arthropods are all vital for soil nutrition.

"In the natural progression, each of these groups of organisms is eaten by bigger ones, which cycle what they eat back into the soil system.

SURFACE COVER CAN KEEP SOILS COOL ENOUGH TO KEEP MICRO-ORGANISMS ALIVE AND ACTIVE.

"They are important for soil health in cropping systems because they break down crop residues and roots, recycling the organic materials back into the soil system. The beneficial ones eat harmful organisms and pests. They all cycle nutrients from other organisms and the residue back into the soil system.

Jasa says farmers can keep their soils cool by ensuring they are covered with residue and stubble retention. Bare soils allow the soil to heat up quickly but residue keeps the sun and wind off the soil surface, reducing evaporation and keeping the soil cooler.

"Producers should always keep the soil surface covered with residue or growing plants. Keeping the sun and wind off the soil surface will keep the soil cooler and reduce evaporation to help keep it moist. The thicker the layer of residue, the more insulating value it has to help keep the soil cooler. Plastic sheeting or mulches may be economical on high-value crops like fruits and vegetables, but usually not on commodity crops like wheat or canola.

"Farmers should leave their crop residue standing as tall as possible. This keeps the wind higher off the soil surface and provides more shade on the surface. Keeping a thicker layer of residue on the soil surface helps keep the soil surface cooler and reduces evaporation by providing an insulating barrier.

"Soil was meant to be covered. When producers remove the residue or till it

A GOOD COVER OF CROP RESIDUE SUPPRESSES WEEDS AS WELL AS CONSERVING MOISTURE.

RESIDUE EFFECTS ON TEMPERATURE, °C			
	Field 1	Field 2	Field 3
Air temperature	39	37	43
Bare soil (no residue)	73	67	71
Top of residue layer	67	61	52
Soil surface below residue layer	50	47	28
50 mm soil depth	27	27	26

under, Mother Nature tries to cover the soil with something, usually weeds. Crop residue also absorbs the energy of raindrops, reducing soil crusting and allowing more water to infiltrate into the soil, keeping it cooler," he said.

Keeping soil cool reduces the amount of moisture lost to transpiration and evaporation and allows for healthy plant growth.

"When it comes to soil water evaporation, warm soils lose more moisture than cool soils. When the temperatures are below 20 degrees, almost all the soil moisture is used for plant growth. At 38 degrees about 85% of the soil moisture is lost to transpiration and evaporation, leaving only 15% for plant growth. Above 54 degrees, all the soil moisture is lost to evaporation and transpiration and none is available for growth. Yield suffers when the plant has to use water for transpiration to cool itself off rather than for growth. Water lost to evaporation is never available for plant growth," he said.

Jasa says tell-tale signs of hot soils include cracking, a reduced worm activity in the surface layers and soil that is hot to touch.

"Cracking, especially in clay soils that shrink as they dry, is a sign of drying soil, not a direct indicator of heat. Producers can tell when their soils are too hot because they dry out and the plants begin to suffer. When you notice fewer bugs, worms, beetles and other creatures on or near the soil surface, the soil is getting too hot. The biological life is either dying or hiding deeper in the soil profile. When the soil is too hot, snails crawl up onto the plants to escape the heat of the soil. This creates problems with contamination at harvest. If you cannot walk on a soil in bare feet, the soil is too hot.

"The time required for soil temperature to change depends on the temperature difference between the air and the soil and the wind speed across the soil surface. Bare soil warms up much faster because it directly absorbs the heat of the sun. Cloudy days slow up soil heating. Wet soils heat up and cool down slower because the water changes temperature, as well as the soil," he said.

By using no-till farming methods and the appropriate machinery, farmers can reduce the risk of their soils drying and cracking.

"Tillage opens the soil up and dries it out. A dry soil warms up much faster than a wet soil because the heat has to warm only the soil, no water. Wet soils are cooled slightly by evaporation as they dry but I'd rather leave a complete residue cover on the soil surface to reduce evaporation.

"Keep the soil cooler by keeping the sunlight energy off the soil surface with residue, standing stubble, and growing crops."