

MEASURE AND MANAGE

Brown Colored Wheat - Fall 2005

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Cold Acclimation

There are some winter wheat fields exhibiting chlorotic if not necrotic leaf symptoms. Popular opinions range from Nitrogen and manganese or magnesium deficiency to frost damage. We have just performed a set of 20 plant tissue analyses courtesy of Wayne Wheeler at Howson and Howson in Blyth. Wayne took paired samples from various areas and all 20 analyses have normal nutrient levels, as a matter of fact Manganese can be considered to be very high (60 to 90 ppm) well above the critical range of 15-20 ppm. All the major and secondary elements are above critical levels. I feel safe in declaring that these samples rule out any nutrient problems. That leaves other abiotic factors mainly climate, in particular soil and air temperatures.

As you know, winter wheat winters over in the seedling stage. When growth starts in the fall winter wheat plants will not survive low temperatures any better than a spring cereal experiencing frost in early spring. As fall growth progresses the winter wheat plant will "cold acclimate" or harden off. In the beginning of the growth cycle the wheat plant may survive temperatures as low as -3 C and at the end of the fall growth period temperatures as low as -19C. Soil temperature decline often lags behind air temperature by several days if not weeks so looking at the thermometer at eye level is not necessarily the temperature you need to know, temperature at crown depth is more important.

The first 4 to 5 weeks are active growth periods and growth continues until a critical soil temperature is reached at which point growth slows and plants harden off for winter. Usually soil temperature at crown depth (2 inches) of 5C, start the acclimation process. A Tran locatable substance (phospholipids) is produced in plant parts as the temperature declines. The result of this activity is an increase in sugar concentrations in cell sap effectively binding free water and lowering freezing temperature.

The cold hardiness of different plant parts stems, leaves and crown is determined by the temperature that each part was exposed to at time of development. The crown contains the tissue necessary to start growth in the spring therefore the critical temperature at the crown level often determines survivability.

The soil temperature at the crown determines the cold acclimation rate. The process to harden off is twice as fast at 0C as at 5C. At any time the wheat crown experiences temperature >5 C the plant becomes **dehardened** and subject to temperature damage.

Hardening will resume when plants experience temperatures $<5^{\circ}\text{C}$. Unfortunately dehardening is 3 times faster than the rate of hardening.

I am hypothesizing that the upper leaves were not exposed long enough to the critical temperature of $<5^{\circ}\text{C}$ to harden off before experiencing a freezing temperature. The soil temperature at the crown is not low enough to cause damage. Once the soil temperature at crown depth is below 5°C it may take 3 to 5 weeks before the crown is sufficiently hardened off to prevent winter injury. So the current damage I believe is to leaves only and the crown is still healthy, unless across the field, soil moisture differences have allowed the crown to experience low temperatures.

Last week we were doing soil temperature readings for nitrate modeling and found 10°C differences at 4 inch depth across the landscape in a single field. It makes one wonder if the black hole theory has more to do with sufficient hardening off of the crown at $<5^{\circ}\text{C}$ more so than planting date.

No doubt there are fields and areas within fields that have other stresses such as nutrient, compaction and drainage issues that create additive stresses that only serve to make cold temperature stress even more pronounced.

Whether or not these damaged plants are predisposed to further winter damage will depend on how many additional days this wheat crop is exposed to temperatures $>5^{\circ}\text{C}$ that cause dehardening or delayed hardening between now and growth resumption in the spring.

Often times winter temperatures, snow cover and ice formation in late winter early spring determines winter kill in fields.