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The effect of frosts on cereal crops from a quality point of view.

The growth cycle of winter cereals is completed under a range of environmental conditions, imposing various stresses at different stages of plant development. Over the years, there has been extensive research into the physical basis of frost tolerance during the vegetative growth stage but very little research has looked at the effect of grain quality and tolerance to frost during the reproductive growth stages. So the short answer is, the effect that a frost will have on yield and quality is very much dependant on the severity of the frost and the timing of the frost in relation to crop development.

During the vegetative growth phase, the growing points of the plant are close to the soil surface and therefore relatively protected. Leaf tissue can become damaged, but generally temperatures of up to -11^{o}C are required and the damage caused is generally low to moderate depending on the plants ability to recover and produce more leaves.

During the reproductive stage, particularly stem elongation, the growing point of the plant is well above the soil surface and although not exposed directly can be subjected to frosting at much lower temperatures. The degree of damage is dependent on the development stage of the secondary tillers.

At booting, irreversible damage can be caused by frosts as water can collect in the boot above the last node and disrupt the development of the stigma and anthers, resulting in reduced or absent nutrient flow to the developing spiklet.

During head emergence, temperatures as high as -1^{o}C can cause floret sterility and this can have a significant impact of final grain yield because the number of spikes and florets has been determined by this stage and no further compensation can be made.

During the grain fill stage, frost can stop grain development causing a shrivelled-pinched appearance at maturity. Grain contents will become watery and dilute and may appear a greyish-blue colour. The biggest economic impact is that the grains (particularly barley and wheat) have reduced milling and malting quality and are downgraded.

For wheat, quality defects arising from frost damage include a reduction in the flour milling process, flour yield and poor flour colour. In addition, the grains can be extremely hard resulting in the requirement to use more energy during the milling process. Flour produced from frosted wheat also has less than satisfactory dough properties that result in a substandard end product. Currently there are no objective measurements at grain receival sites for assessment of frosted grain. Subjective assessment includes visual assessment and comparison against photographic standards. By definition, there is a maximum allowable count of 1% frosted grain per sample. Counts above 10%

are downgraded and may be used in some stock feeds. Affected wheat will usually also have a low test weight.

For barley, premium prices are paid for malting varieties as they have the necessary qualities used to produce malt extract for brewing purposes. Some of these qualities include grains that are free from frost damage and protein levels between 11 and 12.5%. Frost damage affects grain size and quality and as such, germination of frost damaged grains is reduced. Germination during the brewing process is critical to the malting process. If barley can't germinate, it cannot be processed into malt. Similarly, barley with high protein contents results in lower extracts for the brewer. It also slows down water uptake during steeping (soaking) affecting final malt quality. Grain that is low in protein lacks the enzymes required to break down the starch during the brewing process. Protein level in grain is predominately determined by growing conditions – early planting and high yields usually results in lower percentage of protein.

Research to date has found that severely frosted cereal grains may have slightly lower ME and digestibility levels than unfrosted grains, however, the results for the frosted grains were still within the acceptable range for stockfeed values. Research at Wagga on wheat grain found that frosted wheat was 0.8 MJ ME/kg DM lower compared to unfrosted wheat. Results from other feed testing laboratories (unpublished data) indicate that barley affected by frost still had ME and digestibility figures within the season average range of 10.9 -13.5 (NSW DPI Prime Fact 373).

Research I have conducted on cereal grains over the past 2 years (2013/14) agrees with the abovementioned data. I have found that 'pinched' grains (either affected by frost or from lack of moisture at grain filling) tend to have higher crude protein figures compared to 'normal grains'. This is thought to be caused by the frost affecting grain fill, resulting in less starch accumulation in the grain and resulting in an overall higher proportion of protein to starch (energy).

A severe frost during grain fill may prevent the sugars from being converted to starch, therefore feed analysis reports may indicate a lower than usual starch content. Fibre and Ash parameters may also be higher in frosted grains due to a higher proportion of seed coat and lower proportion of endosperm.

Frosted grains usually have a lower test weight due to the fact that the grains are pinched or 'shrivelled', and therefore are not the first choice for stockfeed manufacturers' because of the requirement to change the milling equipment settings for processing. In my opinion, these types of grains can represent good value for money for buyers. First, consider the cost on an energy basis rather than $/t, remembering that on average, frosted grains may be 1MJ lower in energy compared to unfrosted grains but frosted grains should be discounted.

Normal (non-frosted grain)
F1 Barley @ $220/t (ex GST, ex delivery)
@ 11.7MJ ME (as fed)
22c/kg
= 1.9c/ME

Frosted grain
F1 Barley at $205/t
@ 10.7 MJ ME
20.5c/kg
=1.9c/ME

Based on the above exercise (assuming frosted barley will be 1 MJ ME lower/kg compared to unfrosted barley), as a buyer you would expect a minimum discount of $15/t for the frosted barley compared to unfrosted barley.

Talk to Dynamic AG about feeding cereal grains to livestock and preparation of suitable rations for production on (03) 5571 1760.