

## Scouting for Freeze Injury in North Carolina Winter Wheat

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Winter wheat becomes more and more susceptible to injury the more mature it becomes. It is most susceptible in the flowering stage when it cannot withstand temperatures below 30°F without being injured. At jointing winter wheat cannot withstand temperatures below 24°F without being injured. For more information on temperature tolerances of winter wheat at varying growth stages see [Kansas State publication C-646](#) (Shroyer et al. 1995).

Start your scouting efforts 5 to 7 days after a freeze event and begin with varieties that have the most advanced maturity.

### Leaf Injury

Leaf tip damage after freezing temperatures is a common symptom in winter wheat. It does indicate that the entire tiller probably froze overnight. But it usually does not significantly contribute to yield losses. Leaf tips may turn purple, yellow, gold, or bronze depending on variety and the severity and duration of the freeze (Fig 1A). Transverse bands of yellow or white tissues may show up several days following freeze events (Fig. 1B).



*Figure 1. A) Whole plot in Rowan County where wheat leaf tips are bronzed and necrotic from freeze injury. B) Varying degrees of leaf injury following 5 nights of freezing temperatures.*

New leaves may emerge twisted yellow and necrotic, or even pinched. Many of these symptoms will show some recovery over time and new leaves and tiller growth following the

freeze will usually compensate for this type of tissue damage. In contrast to leaf tip damage, injury to the flag leaf during freeze can be detrimental to yield.

### Flag Leaf Injury

A completely yellow flag leaf following freeze indicates severe injury to the growing point and the head from that tiller is unlikely to produce normal grain if any at all (Fig. 2). Flag leaves appearing normal following a freeze may still have damage in the form of a pinch. Where the cold air settles in the wheat canopy the tissues expand and some of the cells will die. In that layer of the canopy a tight band of frozen cells will occur on almost every leaf including the flag leaf. Later when the developing head tries to push through that layer, awns will become trapped and the wheat head will emerge deformed, twisted, or kinked. These heads can still fill grain but the grains do not have the normal space or proper orientation to fully form. This can result in lower test weight and shriveled grain. This is not as pronounced in beardless and short-awned varieties.



*Figure 2. Flag leaf, indicated by the black arrow, emerging completely yellow in color indicating the growing point has died.*

### Stem Injury

Injuries to the wheat stem can be more damaging than those in leaf tissues. Stem symptoms include stem splitting (Fig. 3, left), browning at the crown (Fig. 3, right), darkening of internodes (Fig. 5), stem softening or weakening, and swollen nodes. In cross section the tissues just below a joint (node) which has frozen will turn brown approximately 7 days following a freeze (Fig. 4). These tissues will continue to deteriorate and limit water and nutrient uptake by that particular tiller. Depending on the length and severity of the freeze stem injuries like this can greatly reduce or eliminate grain production from that tiller. Leaf sheaths may split at a joint (Fig. 3, left) which has frozen due to expanding tissues when freezing occurs. The split leaf sheath does not cause a problem, but indicates the joint has likely frozen and you should continue to scout looking for brown transverse bands in the split stem as shown in Figure 4.



Some stems may be damaged by freeze but not show signs of outward discoloration. Damage can manifest simply as a weak point in the stem contributing to lodging later in the season. It may feel soft and flimsy to the touch and may be water-soaked in appearance but not darkly discolored.



*Figure 3. Left image depicts leaf sheath splitting at a swollen joint (node); right image depicts brown transverse discoloration at the crown where the stem has frozen.*

These stems will bend easily and not stand back up. As grain begins to fill, the heads will become too heavy for the stem to hold and they fall over at the weak point damaged by the freeze. In very tall wheat, lodging may appear within 2 weeks after a freeze. In shorter wheat it may not occur until later during grain fill. No management practice can correct standability issues due to freeze once it occurs.



*Figure 4. Left: Stem is partially opened to show extensive tissue damage and brown discoloration of stem below the joint which has frozen. Right: stem cut in cross section showing transverse band of brown, necrotic tissue just below the joint.*



*Figure 5. Left: Brown lesions appearing on the lowermost internode and just below the first joint. These freeze lesions may be a single layer or multiple layers deep. Right: Healthy wheat stem cut in cross section.*

### Growing Point Injury

Injury to the growing point and developing head are most detrimental to yield in winter wheat. A normal growing point and developing wheat head is shown in Figure 6B. Normal heads should be white to green and stand up on their own when slipped out of the stem. They should appear turgid and floral structures should

look full, translucent to white and glossy. Off-white to tan heads indicate the developing head has frozen and is starting to deteriorate. Affected heads will progress from light tan to brown and mushy 7 to 10 days following the freeze. Figure 6A & B depicts a healthy wheat head and a completely dead wheat head. These heads are at the same growth stage, are the same variety, and came from the same field.



*Figure 6. Left: A) Developing wheat head killed by freeze. B) Healthy wheat head of the same variety from the same field.*

*Figure 7. Right Developing wheat head with 30% blasted florets circled in red. This image is prior to heading.*





Sometimes the entire head is not affected as in Figure 7. Here only the upper third of the head has frozen. Flowers in that portion of the head will be sterile and not produce a grain. Awns connected to empty florets will be straw colored instead of their normal green and may appear twisted or in disarray. Normally they would be upright and uniformly spaced. See also Figure 8.



*Figure 8. Sterile “blasted” kernels on freeze damaged heads that were emerged from the boot at the time of freeze. Sometimes only partial heads are sterilized depending on the timing, length and severity of a freeze event.*

It is important to scout each field location. Yield losses due to freeze injury are relative to the duration and severity of the event **at a specific site**. Aside from developmental growth stage, topography, soil moisture, nutrient content of the plants, and wind speed and direction at a site during a freeze event can all impact potential yield losses. To assess yield potential after the freeze wait 5 to 7 days allowing damage to manifest. Count the number of viable tillers remaining in one square foot. Any tillers with severe symptoms as described in this guide should not be counted as viable.

### Other Small Grains

Similar scouting methods can be used for barley, oats, triticale, cereal rye and ryegrass. Symptomology of freeze injury is similar in all of these small grain crops and will again depend on severity and duration of freeze coupled with the developmental stage of the crop. However, Table 1 is an estimate only for wheat. Recent observations indicate that much of NC’s barley and triticale crop was severely affected.

## References

Shroyer, J.P., M.E. Mikesell, and G.M. Paulsen. C-646. Spring Freeze Injury to Kansas Wheat, Kansas State University, March 1995.

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