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Special Wheat Freeze Damage Issue

WHEAT RESEARCH UPDATE FROM UK SPECIALISTS

Articles in Issue:

Probable Effect of the Recent Freeze on Wheat Diseases

Don Hershman—Extension Plant Pathologist

The recent freeze damage sustained by much of the wheat crop in Kentucky is a much-discussed topic at present. Over the next week or so, growers will decide to either keep their wheat crops or destroy the damaged fields and plant either corn or soybean. Numerous producers have asked me how the freeze might impact disease development should they decide to keep their crops.

The two points to consider are the effects of the freeze on the disease organisms and on crop development. First, let's consider the disease organisms. Those organisms that were systemic in plants prior to the freeze, or that were present in root and crown tissues, will probably be unaffected by the freeze. Consequently, diseases such as take-all, wheat soil-borne mosaic, wheat spindle streak mosaic, loose smut, and (in fall-infected fields) barley yellow dwarf, will not be affected by the freeze. Those organisms that were active in green tissue at the time of the freeze should be present at reduced levels. As a result, we should see less incidence of leaf rust and powdery mildew. The fungi that causes these diseases are obligate parasites and once active in green leaf tissue, the fungi will die if the leaf is killed. Even if the leaves do not die outright, the fungi can be frozen out and their levels reduced significantly. This situation happened in 1990; the region was braced for a leaf rust epidemic, but the epidemic never occurred because of an April freeze which greatly lowered populations of the rust fungus. That same year, powdery mildew levels were also lower than expected. That situation was also attributed to the April freeze. Similarly, post-freeze transmission of barley yellow dwarf virus by aphids may be reduced because of a reduction in aphid populations. Other disease organisms, such as those that cause speckled leaf blotch (*Septoria tritici) , Stagonospora nodorum* leaf blotch and tan spot may be initially reduced by the freeze, but their levels should rebound as the season progresses. The leaf blotch fungi, in particular, may actually be worse than normal because they can colonize dead and injured leaf tissue readily. The same is true for the bacterium that causes bacterial leaf streak and black chaff. Finally, organisms that were dormant at the time of the freeze, such as the fungus that causes head scab, will probably be little affected by the freezing temperatures. So, in the end, the effect of freezing conditions on disease organisms is a "mixed bag".

Major effects of freezing temperatures on crop development is to thin stands and delay crop maturity. The former condition will help keep fungal populations down because of increased air circulation and light penetration into the crop's canopy. Of course, thinner stands also mean less yield, so that is not much help. The latter condition, delayed

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maturity, will likely increase the prevalence of late-season fungal diseases. This is due to the fact that wheat will be maturing during warmer and, possibly, wetter weather. Warm, wet weather favors development of head scab, late-season leaf and glume blotch, tan spot, leaf rust and black chaff. We may see increased levels of some or all of those diseases except, perhaps, leaf rust which will probably be at reduced levels as described above. In addition, late-maturing crops will be stressed and this might encourage additional damage by diseases such as take-all and barley yellow dwarf, among others.

Bottom line, I wouldn't base my decision to keep or destroy my wheat crop according to how the freeze might alter the disease situation. However, if you should decide to keep your crop, this article has, hopefully, brought to your attention several "red flags" that bear watching.

Effect of Temperatures on Wheat Insects

Doug Johnson—Extension Entomologist

This spring's freezing temperatures may well have a huge affect on this year's wheat crop. So much so that insect problems will be very secondary in importance. However, if you have wheat which you feel will make a crop, and you plan to continue your management of that crop, then you must also continue to manage the insect pests.

In general terms, temperature affects insects in much the same way it affects plants. Any insects that were out and active when low temperatures arrived are probably dead. Remember, we are talking biology, so nothing is absolute. However, any active populations would have been reduced severely.

Some insects that were still in the overwintering stage may have been killed, but in general, the mass of them probably survived. Remember, late winter freezes are not the exception. This happens quite often, so many insects have adapted to this type of weather.

Control of aphids for BYDV is probably a moot point, though I am sure aphids have survived. Cereal leaf beetle and armyworms will perhaps be delayed due to cool temperatures, but you will still have to watch for them. The English grain aphids that often feed on heads in cool wet springs are harder to predict. They are not very cold-adapted and, thus, are hard hit by cold snaps. However, this is a bit early for them to be active, so they may still have been overwintering and thus protected. My guess is that weather from here on will be more important in deciding their population's size.

Wheat Freeze Damage Situation

Jim Herbek—Extension Grain Crops Specialist

Recent freezing temperatures that occurred from March 10-12, 1998 has caused much concern regarding the extent of the damage to the wheat crop. Three basic conditions must be present for freeze damage to occur to the wheat crop. These are: The wheat plant must be at a sensitive growth stage (i.e. jointed); temperatures must drop to a certain critical level; and the temperature must remain at the critical level for at least 2-3 hours.

All of the three criteria needed were present during the period of March 10-12th. A mild winter and above normal temperatures since late January caused wheat to break winter dormancy early, resume growth, and continue rapid growth and development virtually uninhibited for the past 1 1/2 months. This resulted in the wheat crop being about 2-3 weeks ahead of normal in development by early March. Thus, much of the wheat crop was at a sensitive growth stage when the freezing temperatures occurred.

In west Kentucky, particularly the southern and western regions (Pennyrile and Purchase Areas), the majority of the wheat had jointed. These areas had the most advanced wheat growth stages. Much of the wheat crop was at late Feekes 6 (1st node or joint) or early Feekes 7 (2nd node). The most extensive freeze damage would be expected and did occur in these areas. In a normal year, the wheat crop would not have been as advanced in growth (not jointed) and we would not have been concerned about damage from the freezing temperatures on March 10-12th.

In the northern regions of west Kentucky (Green River Area) and in the central and eastern portions of the state, the majority of the wheat had not yet jointed (Feekes 4-5). It has been estimated that 20-25% of the wheat acreage, or even less, was jointed in these areas when the freezing temperatures occurred. Thus, the majority of the acreage (not jointed) sustained little, if any, freeze damage. However, for the wheat that had jointed, freeze damage did occur and was severe in a few fields.

The temperature criteria for freeze damage to occur was easily met during the period of March 10-12th. If wheat has jointed (Feekes stages 6-7), temperatures of 24° F or below for a period of 2 or more hours can injure wheat by killing the growing point and causing stem damage. Temperatures of 20° F or below (high teens) were recorded on March 10th, mid to low teens on March 11th and 10° F or below on March 12th. Temperatures stayed at these low levels for more than 3 hours. With these low temperatures exceeding the critical level of 24° F and with much of the wheat crop having developed to sensitive

growth stages, freeze damage did occur (and in some fields it was quite severe).

Assessment of Freeze Damage Symptoms:
I feel it is important to assess the extent of damage for each wheat field in question to erase any doubt. We can make predictions about expected freeze damage based on guidelines, previous experience, criteria, etc.; however, variation from the expected norm can occur. To make a freeze damage evaluation based on the overall visible symptoms of a field, can sometimes be misleading. You need to inspect plants closely for head and stem damage to get a more valid freeze damage assessment. Fields that visibly appear to have minor freeze damage (little leaf burn, good color, plants standing well, etc.) can have extensive head damage and also stem damage upon closer inspection (as has been the situation this year in some fields that have been inspected).

The most important criteria for assessing freeze damage will be the damage to the growing point (developing wheat head) and also stem damage. How soon can a freeze damage assessment be made? I feel you cannot get a true assessment of the damage until warmer temperatures have occurred for wheat growth to resume. This allows you to make a more definitive assessment if plant tissue has been damaged or not damaged. Wait at least 5-7 days after the freeze to make a valid assessment. This year with the extremely cold temperatures followed by a rapid warmup, an earlier assessment was possible. However, there were still situations where tissue damage was questionable if an assessment was made too early. A more definitive, visible damage assessment can be made if you wait a week to 10 days after the freeze. In some cases you may need to wait up to two weeks to make an evaluation to allow growth differentiation between damaged and undamaged plant tissue. This is particularly true if growth stage sensitivity was marginal or if critical freezing temperatures were marginal.

Head Damage. To inspect for damage to the developing wheat head, you will need to cut into the stem lengthwise to find the growing point or you can carefully unroll the leaves surrounding the growing point. Splitting the stem is a quicker method and can be successfully done, with some experience, without damaging the head. The developing wheat head will be located just above the uppermost node. You can locate the uppermost node by sliding fingers along the stem or removing the lower leaves. A magnifying glass or hand lens will be helpful for observation since the developing wheat head is very small. An undamaged head will be yellow-green, turgid (firm), glossy in appearance, and plump. A damaged (killed) head will be white (initially), then becoming a pale white, tan or cream color, limp, dehydrated, a flatter shape, and not developing in size. Stems that have killed growing points will stop growth. By the end of two weeks following the freeze (particularly if warm temperatures have occurred to resume growth), growing point damage in stems is more readily and visibly detected. If a stem (tiller) has a live growing point (developing head), new green tissue (leaves) will have emerged at the top of the stem. For stems with a dead growing point, the young growth in the whorl at the top of the stem will be chlorotic and necrotic or will have no new growth emerged in the leaf whorl.

Stem Damage. Usually occurs to the lower stem area and can be best observed by removing the lower leaves. Symptoms include discoloration, lesions, rotting, splitting, collapse of internodes, bending of stems and lodging. Enlargement of nodes often occurs along with brown discoloration. Bent elbow (bending of the stem at the lowest node forming an elbow) is another symptom of freeze damage.

Severely damaged stems will bend over and lodge within a few days after the freeze. The stems will be soft, rotting, collapsed and highly discolored (brown to bleached and no green tissue). Even if the growing point was not directly killed by the low temperatures, severely damaged stems will cause death of the growing point because translocation of nutrients and water to the developing wheat head is stopped.

Less severely damaged stems may not lodge immediately and lodging may not occur for 2 to 3 weeks. They will appear initially whitish to bleached in color, but turn a brownish to darker discoloration as stems deteriorate. They will also have collapsed stems (flat appearance).

Stems with slight damage may or may not be immediately noticeable. These plants usually do not recover well and the stem usually continues to weaken and deteriorate. Lodging may occur after a few weeks or as the plants mature. These stems initially will appear firm with smaller areas of discolored lesions on internodes and nodal discoloration. Injured stems are also more likely to become infected with micro-organisms which can cause further deterioration of the stem. If these injured stems continue to weaken and deteriorate, they can eventually cause death of the developing wheat head or interfere with translocation of nutrients and water to the developing grain.

Leaf Damage can occur to wheat at all stages of growth, but is more evident and pronounced on wheat that has had lush, rapid growth. Leaf damage symptoms are very visible and can be recognized shortly after a freeze. At very low temperatures,

leaves have a dark, water-soaked appearance; whereas, at marginal temperatures they may have a whitish cast. Leaves become chlorotic (light green to yellow), twisted, crinkled, and are necrotic ("burned") at the tip within a few days. Leaf injury may slow growth temporarily but growth of new leaf tissue and new leaves resumes with warmer temperatures if the growing point has not been damaged. Leaf burn itself usually has slight or no effect on yield, particularly at less advanced growth stages, because of new leaf growth that will emerge. If damage has been extensive at the top of stems (where leaves and new growth are emerging), new leaves may appear to have difficulty emerging; however, new growth should break through the damaged tissue. Leaves will appear to be crinkled.

The new wheat publication (ID-125) contains a discussion on wheat freeze damage and also has wheat freeze damage pictures.

Freeze Damage Evaluation:

There is a wide range of freeze damage being reported in the state, which has varied from fields with no damage to fields with severe damage.

Those wheat fields that had advanced stages of growth (late Feekes 6 or Feekes 7), where the growing point was 3-6 inches above the soil surface, have had the severest damage. These fields were planted early (prior to mid-October) and had an early N application or high amounts of N applied prior to the freeze. Heads were usually killed in the main stem, most of the primary tillers, and even secondary tillers. Stem damage was also extensive. These fields were lodging badly within a few days of the freeze. Leaf burn was also severe in most, but not all cases.

Fields in early Feekes 6 (joint one inch or less above the soil) have had variable damage. Some fields have had damage to the main stem head while other fields have shown no head damage. Some stem damage has also occurred in these fields. The reason fields in early Feekes 6 may have escaped severe damage can be attributed, at least in part, to the warm soil temperatures that existed. The heat energy from the soil buffered the cold air temperature by creating a warmer micro-climate just above the soil surface. No-till planted fields, where the residue would inhibit the heat movement from the soil, appeared to visibly have more damage.

Fields that had not jointed showed no freeze damage except for some leaf burn.

Overall, it is estimated that 25-30% of the wheat crop had severe damage; 30-40% had slight, but variable damage; and 30% had no freeze damage.

Yield potential will be reduced for those fields that have had head damage and stem damage. If main stem growing points or even primary tiller growing points have been killed, undamaged tillers can compensate somewhat (but not completely) for the yield loss from the killed heads.

Tiller Compensation:

The big question is how much can tillers compensate for yield loss caused by damage to the main stem and/or primary tiller heads. The compensation can be quite variable and inconsistent and will be dependent on which stems (main, primary and/or secondary) were killed; how many of each were killed; and also very highly dependent on how favorable the weather is for development of the tillers.

In Kentucky, it is estimated that the main stem (primary tiller) will contribute over half (~60%) of the yield potential and the tillers will contribute the remaining yield (~40%). This would be under normal conditions and a full stand. In this situation, plants would normally have 3-4 head-bearing stems (main stem, primary and secondary tillers) with also a few additional, smaller tillers that would not normally develop heads.

If the main stem and/or primary tiller(s) have been damaged, the field will not necessarily be a total loss because undamaged tillers can compensate partially for yield loss of the main stem or primary tillers. The loss of the primary head-bearing stems will result in the undamaged tillers yielding more than normal; can also release the smaller, later tillers to develop that would not have normally developed a head prior to the freeze; and can also result in initiation of new tillers on severely damaged plants.

So how much can undamaged tillers compensate for yield loss from damaged stems (tillers)? There is no definite answer and the outcome can be quite variable depending on the situation and conditions previously mentioned. It is difficult to predict a final outcome when you are dealing with a biological system (wheat plant) that can be influenced by so many variables and also the fickleness of mother nature. Yield compensation from tillers could range from 20-30% or less to as high as 80-90%.

With damage only to the main stem and no damage to existing tillers and with favorable weather (temperatures below normal and no moisture stress) for the next 8-10 weeks to allow for maximum development and a favorable grain-filled period, tillers could compensate for 80-90% or more of the yield potential for a wheat crop. However, if several stems (tillers) have been severely damaged and weather is unfavorable (moisture stress periods and hot temperatures or temperature above normal), remaining tillers will not compensate

as well and the crop may yield only 30-40% or less of its yield potential. Also, development of later tillers would likely cause a delay in maturity for harvest resulting in a later planting date for double-crop soybeans. Growth from later developing uninjured tillers may also obscure damage. Partial freeze damage injury may also cause a mixture of normal tillers and later tillers, resulting in uneven maturity.

If freeze damage has occurred, it can be a difficult decision to abandon or to keep the wheat crop. If a wheat crop is kept that has been freeze damaged, there will still be uncertainty of how well the tillers will compensate for yield loss because we cannot accurately predict what the conditions for tiller development will be in the next two months.

Conclusions:

The final outcome of the freeze damaged wheat crop in Kentucky is highly speculative. There is no doubt there are severely damaged fields as well as fields with no damage. It is those fields with partial injury that decisions will be difficult in trying to predict their final outcome. Either way (keeping the wheat crop or abandoning it) will be a gamble since we cannot accurately predict how the wheat crop will compensate in yield (favorably or unfavorably) for the freeze damage. Listed below are some of my thoughts and guesstimates regarding the freeze damage situation:

1) For fields that have had extensive head damage in the main stem, primary tillers, and even secondary tillers, I would expect yield compensation from any remaining tillers (small, later tillers or re-initiated tillers) to be minimal. The probability of these tillers developing under favorable weather conditions is also reduced. I would not expect these tillers to compensate more than 50% of the yield potential (30-40% yield compensation or less seems more reasonable). Stems have also been extensively damaged in these fields. I would also expect these fields to be delayed in maturity (depending on the weather) by 7-10 days because of the late tillers. This harvest delay would also delay planting of double-crop soybeans and further reduce the soybean yield potential. For these severely damaged fields, it might be best to abandon the wheat crop and plant corn or soybeans.

2) For fields that were in early joint at the time of freeze and had the head killed only in the main stem, the remaining uninjured primary and even secondary tillers have a greater chance of yield compensation for loss of the main stem. Yield compensation could be as high as 80-90% under favorable conditions or 40-50% under unfavorable conditions. I think we can normally expect at least 60-75% yield compensation. Also, there may be a slight delay in maturity.

3) For fields that have had head damage to the main stem and also some of the primary tillers, this will be a difficult decision. We will have to rely on the secondary tillers and remaining primary tillers for yield compensation. I would not expect yield compensation under normal conditions to be much more than 50%. You could expect a delay in maturity and also uneven maturity (mixture of normal and late tillers) at harvest.

4) Fields that were not jointed at the time of the freeze should have minor effects from the freeze and you can expect a yield potential of 90-100% from these fields.

5) Stem damage is a concern with me. Severely damaged fields had direct, noticeable damage within a week following the freeze. However, I have also noticed minor stem damage in fields that has not had immediate, direct effects. This stem damage could have prolonged effects and lead to further deterioration of the stem resulting in eventual stem death, lodging, and further yield loss.

6) With freeze damaged wheat fields, a producer will need to decide whether to abandon the crop or keep the crop and gamble on what the yield compensation may be from the tillers. If he keeps the wheat crop, he should formulate whether his goals are to just recoup his variable costs or if he needs to recoup his costs plus a profit considering the alternatives that may be available.

7) If a producer abandons his wheat crop and plants soybeans, he should consider that his soybean yield potential will be increased (~5 bu/acre) if he plants prior to early June.

8) Patience is a virtue. If an immediate decision concerning the wheat crop is not needed, it is best to wait. Damage becomes more apparent as wheat is allowed to resume growth. By waiting, a more visible, definitive damage assessment can be made and it would also allow a better determination of how well tiller development is progressing in damaged fields.

Nitrogen Decisions

Lloyd Murdock—Extension Soils Specialist

Nitrogen availability is important to the plant in its recovery process from the freeze damage. The following guidelines may be helpful in making decisions on the use of nitrogen during this process.

1) Wheat with little or no lower stem and head damage, but considerable leaf burn.

In this case, the wheat needs nitrogen to be readily available to it for the regrowth of the leaves. If all the nitrogen has not been added, it should be added soon. The amount of nitrogen should be applied at the full recommended rate and sometimes an extra 10 to 15 lbs/ac. of N is helpful to the crop. If leaf burn is minimal, then the extra 10 to 15 lbs/ac. of N may not be needed.

2) Wheat with some lower stem and head damage, but still has a good yield potential.

If nitrogen has not been added, it should be added soon at the full rate of recommended nitrogen. This would help recovery and the yield may be greater than the projected yield at this time.

3) Wheat with considerable lower stem and head damage.

It would be questionable in most cases if this stand should be kept. If a farmer wants to gamble, nitrogen at the full rate could be applied soon to help recovery, realizing that this may be throwing good money after bad. The other possibility would be to delay any nitrogen application until a clear decision can be made and then apply nitrogen at the full recommended rate or at a reduced rate depending on yield potential. The farmer may sacrifice a little on yield because of a slower recovery, if the ultimate decision was to keep the wheat crop, but would reduce the economic risk of a bad decision.

4) Nitrogen applied to abandoned wheat for corn and soybeans.

<u>Corn:</u>

Assuming there are no monsoon rain storms, one could possibly count on 50 percent of the N applied to the wheat to be available to the following corn crop. Most of this would be immediately available.

<u>Soybeans:</u>

Any nitrogen applied to the wheat should not be a consideration for the planting of soybeans. The soybean plant will compensate for any or no nitrogen previously added and it will have almost no effect on it except for a little faster growth the first 2 to 3 weeks after emergence.

Controlling Wheat Before No-Till Corn

James R. Martin—Extension Weed Scientist

The recent freeze damage to wheat has been severe enough in some cases where it is not feasible to salvage the crop. Although wheat is damaged, it is not dead and will need to be controlled before planting no-till corn. The following burndown herbicide options may help in preparing for no-till corn plantings.

GRAMOXONE EXTRA: Wheat that is in the jointing stage is sometimes difficult to control with Gramoxone Extra. Adding atrazine will improve control of wheat, however, rainfall soon after application is needed to ensure root uptake of the triazine herbicide.

Since Gramoxone Extra is a "contact herbicide", good spray coverage will be essential to achieving optimum control of wheat. A minimum spray volume in the range of 15 to 20 GPA will probably offer better control than a spray volume of 10 to 15 GPA.

Gramoxone Extra at a rate of 2 pt/A applied with Atrazine at 1.5 to 2 lb ai/A has afforded effective control of wheat. Although similar results have occurred when Gramoxone was applied at 1.5 pt/A, the 2 pt/A rate is preferred for most cases.

Gramoxone Extra tends to offer rapid control and degradation of wheat vegetation; consequently, Gramoxone Extra may be preferred over other burndown herbicides for early no-till corn plantings.

ROUNDUP ULTRA and TOUCHDOWN 5 are translocated herbicides and generally do not need the help of a triazine herbicide to control wheat that is in the jointing stage. Control with Roundup Ultra or Touchdown 5 tends to be slow and will require several days before wheat is dead. The unusually warm temperatures that has occurred recently should speed up the control from these herbicides.

Roundup Ultra and Touchdown 5 are translocating herbicides, consequently applicators may have some flexibility in using a less water/A compared with Gramoxone Extra. In my instances, a volume of 10 to 15 GPA will probably be adequate for Roundup Ultra and Touchdown 5.

Much of the UK research involving these herbicides has shown successful control of wheat when these herbicides are applied at rates ranging from 1 to 1.5 lb ai/A. Antagonism can sometimes occur when Roundup Ultra or Touchdown are tank mixed with other herbicides. Increasing the rate of the burndown herbicide usually helps overcome this antagonism.

Guidelines for specific rates of Roundup Ultra and Touchdown 5 are indicated below:

	Wheat Height	
	6”	12”
Roundup Ultra *		
Alone	2 pt/A	2 pt/A
Tank Mixed	2.5 pt/A	3 pt/A
Touchdown 5 *		
Alone	1.6 pt/A	1.75 pt/A
Tank Mixed	2 pt/A	2.4 pt/A

* Observe the herbicide label for directions on using ammonium sulfate as an additive. A nonionic surfactant may be included with Touchdown 5 but should not be included with Roundup Ultra.