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SPECIAL ISSUE: HEAD SCAB CONCERNS

ARTICLES IN THIS ISSUE:

FUSARIUM HEAD BLIGHT OF WHEAT

A.J. Stewart, Plant Pathologist

There are many diseases of wheat in Kentucky but one of the most destructive is Fusarium Head Blight (FHB) or scab. The pathogen *Fusarium graminearum* causes FHB. This fungal disease affects wheat and other small grains found in both temperate and semi-tropical regions of the world.

The FHB disease cycle often starts in cornfields. Because the corn-wheat – soybean rotation is prevalent in Kentucky, there is always inoculum present. Corn can be infected by *Gibberella zeae* (a form of *F. graminearum*) developing Gibberella ear rot or Gibberella stalk rot. The residue from the infected stalks remains on the soil as overwintering structures for the fungus. When the weather conditions are favorable (warm and wet) the fungus develops structures called perithecia that produce spores. The spores are released into the air where wind and rain can move them. Infection risk is the highest when warm and wet conditions are present near the time of wheat flowering. As pollination occurs, the individual flowers of each spikelet on the wheat head are opened.

This provides an opportunity for the spores to infect the plant. If the spores do not infect the plant the variety has Type 1 resistance to *F. graminearum* (so far, no variety with Type I resistance has been developed). If the head has one infected spikelet but the fungus does not spread, the plant has Type 2 resistance. The plant is not considered resistant if there are symptoms on several spikelets.

Once the disease is established, FHB symptoms include bleached spikelets, poor seed fill, and reduced seed quality. Seeds affected by FHB are shrunken and discolored (pink or chalky "white" tombstones). Yield and test weight may be severely reduced. The most serious result of FHB damage is the production of deoxynivalenol (DON) from *F. graminearum*. DON or vomitoxin is a toxin which inhibits protein synthesis in wheat and other plants. In animals, the toxin can induce programmed cell death of white blood cells or disruption of cell functions. When DON poisoning occurs, vomiting is one of the results. DON levels determine whether grain can be sold to millers and grain elevators. In most years, the process of milling the wheat reduces DON levels. The thresholds are 1 ppm for finished grain products for human diets and 2 ppm in grain at elevator. Feed thresholds are 5-10 ppm, varying among swine, poultry and livestock. Once DON has been accumulated in the seed the toxin level is not reduced over time in stored grains.

In the 2003 wheat crop in Kentucky, the southern corn belt and the mid-Atlantic states, conditions were right for a scab epidemic and very high DON levels were observed. Furthermore, DON levels were not reduced significantly when the grain was milled, for reasons that are not well understood. This caused problems for millers and had an impact on prices received for wheat produced in this region. These issues will be discussed at our January 6 meeting in Hopkinsville.

SELECTING WHEAT VARIETIES WITH RESPECT TO SCAB RESISTANCE

Dave Van Sanford, Wheat Breeder

In the September newsletter I wrote "choosing wheat varieties is frequently the most important management decision the Kentucky wheat producer will have to make." This decision is complicated by a consideration of a variety's resistance to head scab (or FHB). The real question is "how important is head scab resistance?" One answer is that in a bad head scab year, it is very important, and in a year with little or no head scab, it is not very important. This means that we must try and guess how frequently the bad head scab years will occur. We know that we are always likely to have the potential for plenty of inoculum (see A.J. Stewart's article, this issue). We don't know if it will be raining during the flowering period, and most of the scab prediction models that scientists are working on are still not very accurate. Therefore, it is reasonable to assume that we will always have a chance of seeing FHB, in the same way that we will always have a chance of observing glume blotch. The thing that sets FHB apart, however, is the toxin (DON) that is produced by the fungus. For that reason alone, we need to take FHB seriously.

Resistant Varieties

The best known resistance comes from Sumai 3, a Chinese spring wheat. Pioneer Brand 25R18 is a SRW variety that has the Sumai 3 resistance. This is Type II resistance, or resistance to spread in the head. This means that under heavy FHB pressure, there might be many heads that are infected, but the severity of infection on each head will be low. In addition to Sumai 3, there are other sources of resistance. KAS Allegiance, released last year by the University of Kentucky, has moderate resistance to FHB, but the genetic source of the resistance is unknown. Truman SRW wheat, released this fall by the University of Missouri, had good scab resistance that is not derived from Sumai 3. FHB resistance is getting a lot of attention from breeders, so we can expect to see an increased number of resistant varieties released in the next few years.

FHB Symptoms vs. DON

Generally the characteristics of an FHB-resistant variety include low severity of infection and well-filled kernels with no yield reduction. In 2003, however, it became very clear that low severity of FHB infection and plump kernels did not necessarily mean low levels of DON. In our scab screening nurseries at UK, we saw the correlation between DON and scab severity range from 0.10 to 0.72; a perfect correlation would be 1.0. This makes it very difficult for the farmer growing a variety in which there appears to be little scab, if the grain tests high for DON when taken to the elevator. The conditions in 2003 that allowed this to happen may not occur again for many years. Nonetheless it is clear that we need to focus on developing resistance to DON accumulation. This and other issues pertaining to varietal resistance will be discussed at the January 6 meeting in Hopkinsville.

FOLIAR FUNGICIDES: ANOTHER "TOOL IN THE TOOLBOX" FOR MANAGING FUSARIUM HEAD BLIGHT?

Don Hershman, Plant Pathologist

Severe Fusarium head blight (FHB) in many wheat fields last spring, and elevated DON (deoxynivalenol) levels in much of the harvested grain, have brought FHB/DON management strategies to the forefront for 2003-04. One possible strategy, use of foliar fungicides, is the subject of this article.

Historically, foliar fungicides have been considered to be more or less ineffective for managing FHB and DON. For example, in 1994 E. Milus, a FHB researcher in Arkansas and current Chair of Chemical and Biological Control Committee of the US Wheat and Barley Scab Initiative (USWBSI), concluded that "prospects for chemical control of head blight (and DON) are poor" (Plant Dis. 78:697-699). Previously, other scientists had come to the same conclusion. However, due to a series FHB/DON outbreaks in several spring wheat states (i.e., SD, ND, MN) and elsewhere in the mid-1990s, scientists persisted in testing fungicides for FHB/DON management. A result of this work was the finding that Folicur 3.6F (tebuconazole), applied at beginning flowering, consistently reduced both FHB and DON compared to non-treated wheat. This finding eventually led to several states (MI, MN, ND and SD) receiving an emergency exemption (section 18) for Folicur use in 1999; these states have had their section 18's renewed each year since 1999. An additional state, Montana, was granted a section 18 in 2003.

Michigan remains the only state that grows predominately winter wheat to have a section 18 for Folicur. For a variety of reasons, other winter wheat states have not followed suit. One reason I have heard mentioned is the perceived, or real, lack of a consistent FHB/DON problem from year to year. It is important to remember that section 18's are only appropriate when an emergency situation exists or is imminent. Another reason for inactivity is the belief by key decision-makers that Folicur does not provide an acceptable level of FHB/DON control to justify seeking a section 18. I will stress here that there are varied opinions among wheat scientists and others as to how well Folicur performs in managing FHB and DON. Some think it works great and others say it does not. Much of the "controversy" revolves around the highly variable research results through the years, confounding effects of other foliar and head diseases in FHB fungicide trials, lack of specific data to confirm grower testimonials, and individual opinions as to what constitutes an "acceptable" level of disease control by a fungicide.

To help address some of my own questions, I reviewed the results of 66 research reports from 1998-2003 where Folicur was applied at early flowering for FHB/DON control in multiple states, and across various wheat classes. Most of the reports were by wheat scientists participating in the National FHB Uniform Fungicide Trials, sponsored by the

USWBSI. The results of this review are summarized in the following table.

Table 1. Average Percent control of FHB and DON by Folicur as gleaned from 66 research reports, 1998-2003.

	% CONTROL*				
Wheat Type	Incidence	Head Severity	Plot Severity	FDK	DON
Winter & Spring	**19.7**	**22.5**	**39.4**	**26.7**	**27.4**
Winter Only	17.8	19.3	30.9	21.8	23.9
Spring Only	21.6	25.7	47.9	31.6	30.9
Spring Advantage	**+3.8%**	**+6.4%**	**+17.0**	**+9.8**	**+7.0**

*Percent control relative to the non-treated check; FDK = Fusarium-damaged kernels; DON = deoxynivalenol

The above table indicates that across wheat types, FHB and DON are reduced by about 20-40%, depending on the FHB parameter, when Folicur is sprayed at early flowering. Of course, these are averages from all reports combined. In actuality, there was a tremendous range in results (in both directions). Nonetheless, I feel very comfortable with the 20-40% range as being realistic when Folicur is applied for FHB/DON suppression. I say disease suppression since the industry standard for control by fungicides is 90% and higher. The Folicur label also uses the term "suppression" rather than control for FHB.

Note that there was a trend towards greater Folicur activity in spring wheat. This is not the first time I have run across this possibility. In fact, overall results from the 2003 National Uniform FHB Trials had the same trend. More research is needed before we can say this trend is a fact. However, it would not be surprising if fungicides were more effective against FHB/DON in spring wheat. Spring wheat tends to have a shorter grain fill period than winter wheat because of generally higher temperatures when heads are filling. The result may be greater demand on fungicides in winter wheat crops due to the fact that the heads need to be protected for a longer period. The only reason this really matters is that it may help to explain why some states are more excited than others about using Folicur for FHB/DON management. It also helps us to have more realistic expectations should Folicur ever become available to growers in Kentucky.

This brings me to my final point. Various key members of the wheat industry in Kentucky have decided to seek a section 18 for Folicur use in 2004. The determination has been made that 20-40% FHB/DON suppression with Folicur is far superior to nothing, which is what we have now. Certainly, industry-wide, 20-40% suppression, especially for DON in grain, could make a big difference in the wheat market. It might also positively impact the economy of many farms. Our plan is to have the section 18 application submitted to EPA by early January, 2004.

USE OF MULTIPLE VARIETIES AND PLANTING DATES

Jim Herbek & Chad Lee
Extension Grain Crop Specialists

Susceptibility of wheat to Fusarium Head Blight (FHB) infection, also known as wheat head Scab, is favored if warm, moist weather occurs when wheat heads are in flower. An effective way to reduce the risk of FHB is to have wheat flower when weather conditions are not favorable for the disease. There is not much, if anything, we can do to control the weather. However, wheat producers can reduce the risk of FHB favorable weather occurring on their whole wheat crop by using management practices that will result in different "heading dates" for portions of their wheat acreage. Fields or portions of fields with staggered head emergence and flowering reduces the chances that weather conditions will be conducive to a severe FHB problem developing in all the wheat acreage on a farm-wide basis.

Two of the most practical management practices to stagger heading dates are the use of multiple varieties (with different maturity dates) and multiple planting dates. For example, one wheat variety planted on the total wheat acreage for a farm over a short period of time would be a very uniform crop in terms of heading/flowering time and disease susceptibility. If this single variety is in flower during FHB favorable weather, there is a very good chance that FHB will be a severe problem. However, if multiple varieties of varying maturity and multiple planting dates are used, the resulting diversity in heading dates would reduce the risk that FHB would be a serious problem on more than just a portion of the total wheat acreage.

There was a difference of eight days in heading date between the earliest and latest maturity varieties that were tested in the University of Kentucky Wheat Variety trials in 2003 when averaged across all tests (locations). Of those varieties tested, there was a seven day difference in heading date among the highest-yielding varieties; indicating that you can spread out heading dates without sacrificing yield. The actual time of heading and heading date differences among wheat variety maturities can fluctuate from year to year or location to location depending on environmental conditions that affect plant growth and development. For example, there was a range of 8-13 days difference in heading date among wheat varieties at individual test locations in the 2003 University of Kentucky Wheat Variety Trials. Thus, planting multiple wheat varieties of different maturity will result in diversified heading dates that should reduce the risk of severe FHB infection occurring on your whole wheat acreage.

Use of multiple planting dates will also result in diverse heading/flowering dates and reduce the chances that weather conditions will be favorable for FHB to develop on all your wheat acreage. There is not a direct day-to-day correlation between planting date and heading date (i.e., a 20 day difference in planting date will not result in a 20 day difference in heading date). As a general rule, a five-day difference in planting date results in a one-day difference in heading date (i.e. a 20 day difference in planting date would likely result in a four day difference in heading date). Heading date differences due to planting date can fluctuate from year to year depending on environmental (climatic) differences that affect plant growth and development. Thus, warmer or cooler temperatures in the fall, winter or early spring can shorten or lengthen the time span between heading dates among different planting dates.

Use of multiple varieties and/or planting dates will diversify heading dates and make it less likely that FHB will be a serious problem on all your wheat acreage. Heading date differences of up to two weeks on portions of your wheat acreage could be realized by using a combination of multiple wheat variety maturities and staggered planting dates.

EFFECT OF TILLAGE ON HEAD SCAB (FUSARIUM)

Lloyd Murdock, Don Hershman, and Dottie Call

Since head scab is a Fusarium fungal organism that is common on decaying corn stalks, many plant pathologists and wheat experts in the U.S. feel that no-till wheat planted after corn would greatly increase the incidence of head scab when the conditions are right for the expression of the disease in wheat because of the large inoculum base. Some pathologists feel that this is not true because the spores are easily transported by the wind and there are enough corn stalks and other sources of Fusarium available that both tilled and no-tilled what are about similarly vulnerable when the conditions are right for infection. Previous results on small plots have indicated that the severity of the disease is not highly related to tillage. However, many have argued that since the data comes from small plots and the tillage treatments are close to each other, the data is not a true representation of what actually happens in the field.

The severity of head scab disease was worse in Kentucky in 2002 and 2003 than it has been since 1991. This, coupled with a project that was comparing tilled and no-tilled wheat on very large plots (about 20 acres in each treatment) on farmers fields, gave us an opportunity to evaluate the effects of this disease in a side by side comparison of no-till and tilled wheat behind corn in a large acreage situation. Since the comparisons are on about 20 acre blocks, the data should more closely represent a field situation.

The data found from this study for the 3 farms sampled in 2002 is in Table 1 and for the one farm sampled in 2003 is in Table 3.

In 2002 the results of the 3 farms are averaged together. There is not much difference between tillage treatments in number of heads with scab in the fields or the severity of scab found in the fields. There was also little difference in the number of kernels with visible scab on them in the samples taken from the combine. The differences really occurred in seed germination and the DON (vomitoxin). Without seed treatment, the seed germination was low with both tillage treatments but lower with the no-till. Treating the seeds prior to germination brought the germination to acceptable levels in both cases (data not shown). The vomitoxin levels were above the critical 2 ppm level with both tillage systems but was significantly higher with no-till.

In 2003 the results from the one farm show very little difference between the two tillage systems. There is a trend for more heads with scab and a little higher field severity with the tilled wheat. However, there was a little higher number of kernels with visible head scab in the no-tilled systems. Again, the DON was above the 2 ppm critical limit with both tillage systems but both were similar.

If these measurements on these farms during years of moderate disease occurrence are typical of what other farmers have, then we can say that sometimes there is a difference in tilled and no-tilled wheat after corn but that is not always the case. If a difference occurs, it will most probably be in the germination of untreated seed and in DON (vomitoxin). Treatment of the seed with appropriate fungicides will probably increase the germination to acceptable levels. The vomitoxin levels may be elevated some in the no-tillage wheat and may require additional treatments to reduce these levels during years with excessive wetness during flowering.

Table 1. 2002 Comparison of Yield, Test Weight and Some Head Scab Measurement in Tilled and No-Tilled Wheat After Corn from Three Farms.

Measurement	No-Tilled	Tilled
Yield (bu/ac)	69.4	72.5*
Test Wt (lbs/bu)	57.9	58.4
Head Scab Incidence (%)	18.5	19.4
Field Severity (%)	6.6	5.7
VSK (%)**	22.9	18.7
Seed Germination (%) Untreated	56.5	67.0*
DON (ppm)	4.0	2.2*

*Significantly different at the 0.1 level. ** Visual scabby kernels.

Table 2. 2003 Comparison of Yield and Some Head Scab Measurements in Tilled and No-Tilled Wheat After Corn from One Farm

Measurement	No-Tilled	Tilled
Yield (bu/ac)	91.7	91.4
Head Scab Incidence (%)	24.0	39.7
Field Severity (%)	2.4	7.4
VSK (%)*	25.2	20.1
Seed Germination (%) Untreated	78.6	79.0
DON (ppm)	2.2	2.5

*Visual scabby kernels.

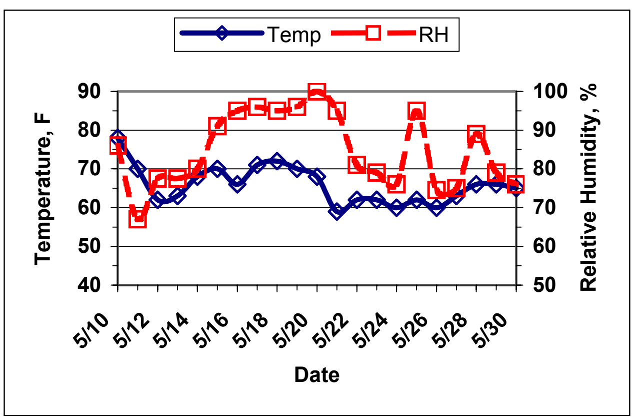
HANDLING AND STORING DAMAGED WHEAT

Sam McNeill
Extension Agricultural Engineer

Pre-harvest reports for the 2003 wheat crop indicated that Kentucky growers were looking at high yields and quality. While the yield prediction generally held true, adverse late spring weather challenged the quality aspect. Throughout much of Kentucky, a fungal disease known as "head scab" developed in many fields. Unfortunately, this fungus can produce a toxin called "vomitoxin" (also called DON) which wasn't detected by many growers until the crop was delivered for sale. One reason the toxin went unnoticed was because wheat kernels that are infected while the head is developing are usually smaller and even appear shrunken. However, if heads become infected near maturity, which was the case this year, there is a possibility of toxin contamination without affecting kernel size, so visible detection is not likely.

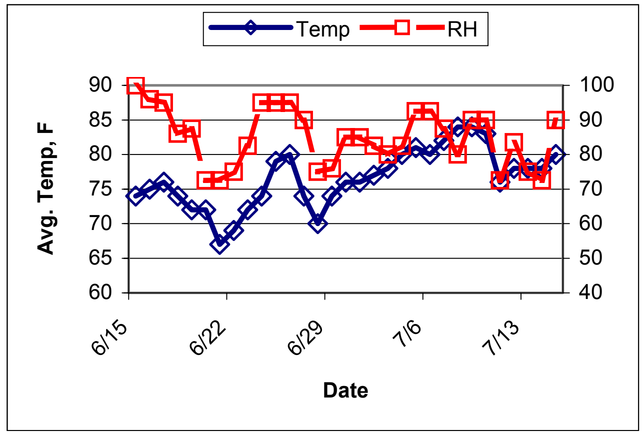
The graph in Fig. 1 illustrates the average temperature and relative humidity for Princeton, KY during mid- to late May when much of the wheat crop was developing. Note the mild and humid 7-day period beginning on May 15 when the average temperature and relative humidity was 68 degrees and 95 %, respectively. The graph in Fig. 2 shows the same data for mid-June to mid-July. Note the humid 4-day period beginning on June 24 that was followed by a 12-day warming trend when the average temperature was 80 degrees. Unfortunately, the conditions during both periods were nearly ideal for fungal growth and the development of head scab.

Figure 1. Daily average temperature and relative humidity levels in Princeton, KY during mid- to late May in 2003.



These observations point to the importance of using extra care when handling and storing wheat that has been exposed to conditions that favor fungal growth. Otherwise poor quality wheat or (worse case) excessive toxin levels could lead to price discounts or rejection by potential buyers. One lesson learned this year was that similar problems might be managed in the future by closely monitoring weather conditions and fields from post-flowering to pre-harvest to estimate the potential and extent of disease in the grain head and to plan harvest strategies accordingly.

Figure 2. Daily average temperature and relative humidity levels in Princeton, KY during wheat harvest in 2003.



In past years when the fungal activity occurred early and plump healthy kernels turned into small, shriveled/"tombstone" kernels, combines were adjusted to sieve and clean the crop aggressively. However, a common problem this year was that infected kernels were the same size and weight as healthy ones, so combine adjustments were not as effective, nor were conventional post-harvest units even when set for aggressive cleaning because too many sound kernels were removed.

Future similar problems may be managed by harvesting wheat early if sufficient drying capacity is available on the farm or commercially. Also consider segregating wheat by field or variety to prevent mixing sound grain with diseased loads. It may be best to harvest diseased wheat last to avoid the time consuming task of cleaning out the combine, carts/wagons, trucks, conveyors and other handling equipment between fields.

Storage

Table 1 shows the moisture content that soft winter wheat will approach with sufficient exposure to the temperature and relative humidity conditions shown. Conversely, this information can be used to predict the relative humidity of air in the void space between wheat kernels held in storage, which strongly impacts insect activity and mold growth. By keeping wheat dry enough to suppress these pests (and in turn keeping the air in the bin below 65% humidity) we can reduce the risks of spoilage. If wheat is held at 12.3% moisture during the summer when grain along the outside of the bin warms to near 80 degrees, the air inside the bin will be dry enough to suppress insect and mold activity. When holding contaminated wheat a drier environment reduces the risk of further mold and toxin development. Thus, storing contaminated wheat at 11.5 to 12.0% moisture during the summer provides an extra margin of safety for an already stressed crop.

Table 1. Equilibrium moisture content of soft wheat at different air temperatures and relative humidities.

Temperature F	Relative Humidity, %				
	20	35	50	65	80
40	9.3	10.8	12.1	13.7	15.7
60	8.4	9.9	11.3	12.9	15.0
80	7.7	9.3	10.7	12.3	14.4
100	7,1	8.7	10.1	11.7	13.8
120	6.6	8.2	9.6	11.3	13.4

The following suggestions are offered to help producers manage stored wheat that may be contaminated with vomitoxin:

- review/learn how to safely monitor stored grain,
- inspect stored wheat often to prevent further losses,
- collect representative grain samples from bins and screen them for contamination before delivery,
- handle and hold contaminated wheat separately to avoid contaminating sound wheat,
- market diseased loads separately; or blend with sound wheat to safe levels; or carefully feed to livestock at safe levels for normal performance.

Screening of wheat for vomitoxin is provided for Kentucky producers free of charge, courtesy of the Kentucky Small Grain Growers Association. Farmers can send a two-pound sample to: UK Grain Quality Lab (Attn: Mike Montross) at 128 C.E. Barnhart Building, Lexington, KY 40546-0276.

More detailed information on harvesting, drying and storing wheat (publication ID-121) and precautions on handling and feeding wheat with low levels of vomitoxin (publication ID-125) are available at county extension offices and on the Internet at www.ca.uky.edu/agc/pubs/agpubs.htm.

"Dealing With Head Scab"

UK Wheat Science Winter Wheat Workshop
Tuesday, January 6, 2004
9:00 a.m. - 3:30 p.m. (CST)

Christian County Extension Office – 2850 Pembroke Rd. Hopkinsville, KY

These CEU Pesticide Credits will be available from the Division of Pesticide:
3 general hrs & 1 specific hr: Category 1A, 4, 10 & 12

CCA CEU Credits available: 4 hrs. Crop Management & 1 hr. Integrated Pest Management

Welcome - *Todd Barlow, CEO KY Small Grain Growers Association*

9:00 **A Tale of Two Seasons** - *Dr. Chad Lee*, *University of Kentucky*

9:15 **Breeding for Head Scab Resistance: An Update -** *Dr. Dave Van Sanford, University of Kentucky*

BREAK

10:00 **Risk Management Plans - Panel Discussion**
Chris Bowley, Wheat Tech
Phil Needham, Miles Opti-Crop
Dr. Don Hershman, University of Kentucky

11:00 **Harvesting, Handling and Storage Consideration/Tips -** *Dr. Sam McNeill, University of Kentucky*

LUNCH (Provided by KY Small Grain Growers Association)

12:30 **Grain Handling Aspects** - *Jerry Good, Hopkinsville Elevator*

1:00 **Miller Panel**
Carl Schwinke, Seimer Milling
Dan Cayce, Hopkinsville Milling

2:00 **Impact of Seed Quality on the Economics of the Next Wheat Crop**
Charles Petty, CEO KY American Seed
Jim Long, Wheat Producer, Hilliard Farm & Seed Co. Clinton, KY

2:30 **The Market Outlook for Wheat** - *Dr. Steve Riggins, University of Kentucky*

3:00 **Wheat Scab Overview: Conclusions, Considerations & Recommendations**
Dr. Jim Herbek, *University of Kentucky*

For More Information Contact: Jay Stone, Christian County Agriculture Agent (270-886-6328) or Dottie Call, Wheat Science Group Coordinator (270-365-7541 ext. 234)

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