Integrated Pest & Crop Management

Decision Points While Estimating Grain Yield before Harvest

By Bill Wiebold

A search on the Internet for estimating corn/soybean yields returns more than 750,000 results, so there is obviously much interest in attempting to estimate grain yields before harvest. Reasons for this interest range from making grain marketing plans to just plain curiosity. The interest in an accurate method increases in years like 2012 because drought has reduced yields and farmers are attempting to determine what to do with the damaged crop: wait and harvest for grain, harvest as a forage, or abandon the field. The word "accurate" is highlighted in the previous sentence because accuracy is important to all persons involved in the decision, but regardless of the procedure used, an estimate is only an estimate, and an estimate is almost never accurate.

Yield in the U.S. uses the unit "bushels per acre". Bushel is actually a volume measurement (2150.42 cubic inches). Since it is awkward to use a volume measurement for commerce, sensible people decided to define a bushel as standard weights that differ among crops. Because grain contains moisture and moisture adds weight, they also set standard grain moistures. So, a bushel of corn is 56 pounds at 15.5% moisture and a bushel of soybean is 60 pounds at 13% moisture.

Because weight is the unit of yield, we estimate grain weight in a small land area and use that number to estimate a field average for yield in bushels per acre. Most common methods of estimating grain yields before harvest involve calculating yield components. In their simplest terms, there are only two yield components: number of seeds and weight per seed. Our ability to estimate those two components impact how close a calculated yield estimate will be to actual yield. To estimate seed number, things such as numbers of plants, numbers of pods or ears, and numbers of seeds per pod or kernels per ear are counted. Seeds are usually not weighed to calculate weight per seed because yield estimates are often made before seeds have obtained their full size. Instead, we use an estimation of seed size (weight per seed) to calculate yield.

Procedures used to estimate yield involve compromises between ease of making the estimate and the accuracy of that estimate. Small errors at several steps in the procedure can result in large errors in the final estimate. There are several decision points during most yield estimation procedures. Understanding the impacts from those decisions can help narrow the difference between estimated and the actual yields.

Decision point 1: What should the size and shape of the small areas be?

Most procedures recommend using a sample area equal to 1/1000 acre. This recommendation is purely for convenience because it makes the math easier. Using a larger area would reduce error, but the area would have to be increased considerably to have much effect. In the compromise between ease and accuracy, using 1/1000 acre makes sense. Most grain crops are planted in rows. Row length equal to 1/1000 acre can be calculated as Row Length (in feet) = 43.56/Row Width (in feet). Remember to convert the fraction of a foot to inches

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for easy measurement. Some examples of row lengths required for 1/1000 acre are: 30-inch rows = 17 feet 5 inches, 15-inch rows = 34 feet 10 inches, and 7.5-inch rows = 69 feet 8 inches.

A single row is easier to mark and count than multiple rows, at least for rows 30 inches apart or greater. However, as row spacing narrows, the row length for 1/1000 acre becomes nearly unworkable. Following a single row of drilled soybean for 69 feet is difficult, at best. Dividing required row length by 2, 3, or 4 and measuring that number of rows will be much easier. Even in 30-inch rows it might be better to count plants in more than one row. Sometimes planter operation may not be uniform across all rows on a planter. Counting plants in more than one row decreases the chances of selecting an odd row related to planter operation.

Decision point 2: How many areas should be sampled?

This is a difficult decision because sampling more areas decreases error, but adding areas greatly increases effort. Clearly, a compromise has to be made. Fields are seldom uniform. The greater the variability for yield in the field the greater the number of sample areas should be used. Drought usually accentuates in-field variability for yield because of variability for compaction, soil texture, and surface or subsurface water movement. If the sample areas are properly selected, increasing the number of areas to greater than 8 will have only a small impact on error.

Decision point 3: How should sample areas be selected?

It may seem appropriate to select areas in a completely random scheme. However, selecting areas at random without restriction might result in a clustering of sample areas, and this could increase the error of the yield estimate. A better alternative is to make sure that areas are selected throughout the entire field. Sampling throughout the field is not easy. It may be difficult to reach distant areas in large fields. But, management decisions may be based on the yield estimate, so it is in the interest of all parties to reduce error as much as possible. If management decisions can be made to separate regions of a field it may make sense to divide large fields into subunits and estimate yield in each subunit.

Human beings often exhibit biases when selecting areas for sampling to estimate yields. It is common to over sample weak or strong areas. A person may have a preconceived idea about the field's yield potential or even a vested interest in the outcome. Using methods for selecting areas similar to those used during scouting fields for pests will help reduce bias. Two common patterns of crossing a field are zigzag or M-shaped. It is best, but usually not done, to draw a map and select the areas for sampling before arriving at the field.

Decision point 4: What should be counted and what should be ignored when estimating plant population or ear number?

For soybean, the number of plants is counted because that number is required to calculate the number of seeds. Within the sample areas, there may be weak plants, plants with few or no pods, or plants exhibiting disease symptoms. Many procedures recommend ignoring these plants. Counting these plants will inflate yield estimates if weak plants are used to calculate plant population, but ignored when calculating number of pods per plant. There are situations, such as the drought of 2012, when weak plants with few pods are representative of the field. In those instances, these weak plants should be counted. But, if weak plants are counted for estimating population, they must also be selected when counting pods.

For corn, the number of ears is counted and that number is used to calculate number of kernels. Plant population is not needed, but a decision must be made as to which ears to count. Even under good conditions, ear size may vary considerably. Second ears on a plant are usually small, but weather, nutrients, and pests may also affect ear size. Commonly used procedures recommend not counting "nubbins" or small ears. The definition of nubbin is usually left open to interpretation. Ears that are likely to be missed by the combine should not be counted. If small ears are counted while estimating ear number, but ignored when estimating number of kernels per ear, yield estimate will be inflated. Count small ears if they represent the field, and make sure that small ears are selected in the same proportion when ear size is estimated.

Decision point 5: How many plants or ears should be used to determine seed number?

For soybean, the number of pods per plant is required before seed number can be calculated. Pod number per plant is highly variable, even under good weather conditions. Error of the pod number estimate can be reduced by counting more plants. Unfortunately, counting number of pods is tedious, especially if plants are highly branched. Most procedures recommend counting a minimum of 10 plants. A 1/1000 acre may have 150 plants, so 10 plants represent about 7% of the population. This is probably an adequately sized subsample. If plant to plant variation seems large, average pod number for the first 8 plants and then continue to calculate an average after 9 and 10 plants. If the average does not change much from 8 plants to 10 plants, then a 10-plant sample is appropriate. If the average changes too much, then count an additional two plants. Plant variation for pod number will be greater in fields with sparse populations than in fields with dense

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populations because of branching. A need to increase the number of plants chosen for counting pods is more likely in fields with sparse or uneven populations.

Some procedures recommend randomly selecting the soybean plants for which pods will be counted. It is nearly impossible to be unbiased while selecting plants in this manner. Other procedures recommend counting 10 consecutive plants. Although this method reduces bias while selecting plants, it places all plants in a portion of the row that may not be representative of that row. And, it is easy to be biased when selecting the location in the row to start counting. Consider dividing the number of plants in the small area by 10 (e.g. 150 plants/10 = 15 plants). In this example, count pods on every 15th plant in the row. This will force selection plants from the entire row length. Count pods on the selected plant if you used that plant to determine population. If you did not use it, then count pods on the next plant in the row. Count all pods with seeds large enough not to be lost during harvest. Ignore flat or twisted pods with no seeds.

Decision point 6: Should numbers of seeds per pod and kernels per be counted or estimated?

The number of seeds per pod is also required to calculate seed number. Most procedures recommend using a standard 2.5 seeds per pod instead of actually counting and calculating number of seeds per pod. Study the plants used to count the number of pods. An average of 2.5 seeds per pod means about 60% of the pods possess 3 seeds, 30% of the pods possess 2 seeds, and 10% of the pods posses 1 seed. If plants appear to differ from this ratio, then use a slightly higher or lower number.

For corn, number of kernels per ear is calculated using number of kernel rows and number of kernels per row. Since counting actual numbers is not time consuming, it makes sense to count and not to estimate number of kernels per ear. Several procedures recommend using every 5th ear to estimate size. This is an adequate number, and will also force ear selection from the entire length of row. If the count for the number of ears included the second ear on a plant, then that ear must be one of the 5 ears in the intervals for counting. In other words, one plant might be used for two of the five counts. Count the number of rows of kernels. This number should be an even number. Drought, nutrient deficiency, herbicide damage, or pests may result in atypical row patterns or twisted ears. For those ears, estimate average row number.

Count the number of kernels in several rows. Some procedures recommend that you ignore kernels at the butt and tip ends of the ear. Kernels near the butt are often large and contribute to yield. In most instances, they should be counted even if including them results in an unequal kernel number among rows. Kernels near the tip are often small. Do not count kernels that have obviously aborted or development was not complete. In most instances, these kernels will be less than half of the size of the other kernels on the ear. Stress during pollination may have resulted in unfertilized kernels in the middle of the ear – ignore these when counting. For several reasons, kernel number may vary among the kernel rows, so estimate an average number of kernels per row.

Decision point: What is the appropriate seed size?

Seed size is actually weight per seed and is used to convert seed number per acre to bushels per acre. Both genetics and environment effect seed size. Variation among seeds is large, and may vary more than 40% from smallest to largest seeds. Using the wrong seed size can result in a large error in final yield estimate.

Seed size for soybean is often given in number of seeds per pound. Often, seed size is provided on the seed tag, but that number may only slightly influence seed size in field. Most procedures use a standard number between 2500 and 3000 seeds per pound. Under normal conditions, 2700 or 2800 seeds per pound is appropriate. Most procedures used to estimate yield for corn use kernel number per bushel in the calculations. Under normal conditions, there are about 85,000 kernels in a bushel, which translates into seed size of about 1500 kernels per pound.

Unfortunately, environment, including weather conditions, can have a large effect on seed size. Most procedures recommend using a smaller seed size (more seeds per pound or more kernels per bushel) under poor conditions. But, poor conditions reduce seed size only if they happen during mid to late seed filling. Poor weather conditions during pollination of corn or pod set in soybean may actually increase seed size if stress is relieved during seed filling. Adjust seed size estimate based on actual conditions the field has experienced. Adjusting seed size more than 10% is usually not warranted.

Final thoughts

Estimates of yield are estimates. Even when great care is used to select areas for sampling and the plants within those areas, estimates very seldom match actual yield. Errors in opinion polls are often 3 to 4%. Errors in yield estimates are likely to be 20% and may be greater. Careful attention to these decision points will reduce, but not eliminate error. Be judicious when using yield estimates to make crop management decisions.

Use the worksheets on pages 84 & 85 for corn and soybean.

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Worksheet for Estimating Corn Yields

Notes:

1. Read "Decision Points While Estimating Grain Yield before Harvest" found online on the IPM website.
2. Column 1 assumes sample area is 1/1000 acre. Examples of row lengths required for 1/1000 acre are: 30-inch rows = 17 feet 5 inches and 15-inch rows = 34 feet 10 inches. If some other area size is used, adjust default in column 5.
3. Include small ears in column 1 only if represent sample area. Do not count ears likely to be missed by combine.
4. Count kernel rows on at least five ears in each sample area and record actual average in column 2.
5. Count kernels in several rows on each of the ears used in column 2 and record average in column 3. Do not count kernels that are less than half the size of other kernels on ear.
6. The default kernel number per bushel is 85,000. Adjust number in column 5 if warranted.
7. Field average is the average of estimates made in 8 to 10 sample areas.

Example

1. Number of ears in 1/1000 acre		2. Average number of kernel rows		3. Average number of kernels per row		4. Kernels per 1/1000 acre		5. Number of kernels per bushel / 1000 (default is 85)		6. Estimated yield (bushels/acre)
23	X	16	X	33	=	12,144	÷	85	=	143

1. Number of ears in 1/1000 acre		2. Average number of kernels rows		3. Average number of kernels per row		4. Kernels per 1/1000 acre		5. Number of kernels per bushel / 1000 (default is 85)		6. Estimated yield (bushels/acre)
______	X	______	X	______	=	______	÷	______	=	______
______	X	______	X	______	=	______	÷	______	=	______
______	X	______	X	______	=	______	÷	______	=	______
______	X	______	X	______	=	______	÷	______	=	______
______	X	______	X	______	=	______	÷	______	=	______
______	X	______	X	______	=	______	÷	______	=	______
______	X	______	X	______	=	______	÷	______	=	______
______	X	______	X	______	=	______	÷	______	=	______
______	X	______	X	______	=	______	÷	______	=	______
______	X	______	X	______	=	______	÷	______	=	______
								Field average	=	

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Worksheet for Estimating Soybean Yields

Notes:

1. Read "Decision Points While Estimating Grain Yield before Harvest" found online on the IPM website.
2. Column 1 assumes sample area is 1/1000 acre. Examples of row lengths required for 1/1000 acre are: 30-inch rows = 17 feet 5 inches, 15-inch rows = 34 feet 10 inches, and 7.5-inch rows = 69 feet 8 inches. If some other area size is used, adjust default in column 5.
3. Include plants with few pods in column 1 only if they represent sample area.
4. Count number of pods on 10 plants (more if warranted) in each sample area and record average in column 2.
5. Default number of seeds per pod is 2.5. Adjust if warranted and record in column 3.
6. Default number of seeds per pound is 2800. Adjust as warranted and record number divided by 1000 in column 5.
7. Bushel weight for soybean is 60 pounds. Do not adjust.
8. Field average is the average of estimates made in 8 to 10 sample areas.

Example

1. Number of plants in 1/1000 acre		2. Average number of pods per plant		3. Number of seeds per pod (default is 2.5)		4. Number of seeds per 1/1000 acre		5. Number of seeds per pound / 1000 (default is 2.8)		6. Pounds per bushel (60)		7. Estimated yield (bushels/acre)
135	X	22	X	2.5	=	7,425	÷	2.8	÷	60	=	44.2

1. Number of plants in 1/1000 acre		2. Average number of pods per plant		3. Number of seeds per pod (default is 2.5)		4. Number of seeds per 1/1000 acre		5. Number of seeds per pound / 1000 (default is 2.8)		6. Pounds per bushel (60)		7. Estimated yield (bushels/acre)
______	X	______	X	______	=	______	÷	______	÷	60	=	______
______	X	______	X	______	=	______	÷	______	÷	60	=	______
______	X	______	X	______	=	______	÷	______	÷	60	=	______
______	X	______	X	______	=	______	÷	______	÷	60	=	______
______	X	______	X	______	=	______	÷	______	÷	60	=	______
______	X	______	X	______	=	______	÷	______	÷	60	=	______
______	X	______	X	______	=	______	÷	______	÷	60	=	______
______	X	______	X	______	=	______	÷	______	÷	60	=	______
______	X	______	X	______	=	______	÷	______	÷	60	=	______
______	X	______	X	______	=	______	÷	______	÷	60	=	______
										Field average	=	

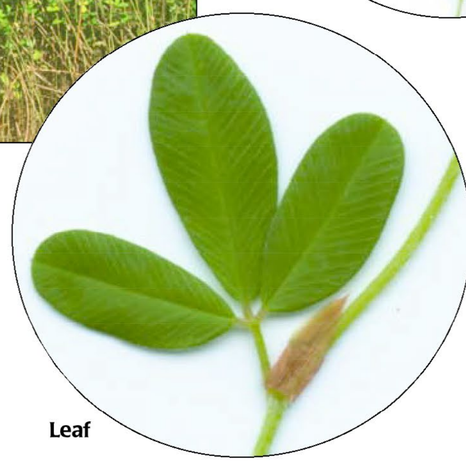
Forage of the Month: Lespedeza, annual

By Rob Kallenbach

Annual lespedeza is primarily used as a pasture legume, although it is sometimes cut for hay. It provides high-quality forage in midsummer when other cool-season grasses and legumes are struggling. It also grows better than other legumes on infertile or shallow soils. Like birdsfoot trefoil, it does not cause bloat. However, it is not problem-free. Its annual yield is lower than that of other legumes, and it does not have as broad a window of forage production. Korean types have proven susceptible to a number of foliar diseases. Annual lespedeza can be valuable in July and August.

Annual lespedeza

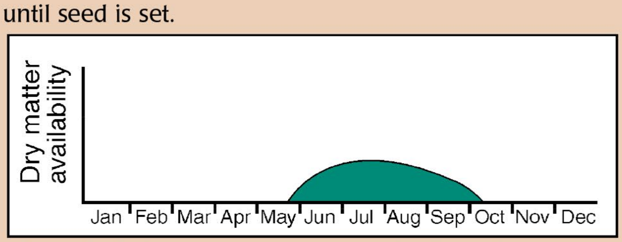
Flower



Leaf

Origin: Eastern Asia
Adaptation to Missouri: Statewide
Growth habit: Semi-erect, annual.
Leaf: Palmately trifoliolate, leaflet on a short petiole, easily visible veins. Lower leaves spread, upper leaves erect.
Stems: Fine stems with hairs pointing down on *K. striata* and pointing upward on *K. stipulacea.*
Stipules: Small for *K. striata;* large and prominent for *K. stipulacea.*
Flowers: Flowers and sets seed in late summer and early autumn, florets are borne in short, axillary racemes; florets are reddish purple to white.
Fertilization: No N needed if nodulated. Maintain 20 lb P/acre and 200 lb K/acre.

Timing of production: 70 percent of annual production between June 15 and Aug. 31.
When to begin grazing: Often based on the height of the grass in the mixture.
When to cut for hay: Half to full bloom
Lowest cutting or grazing height: 4 inches
Fall management: Avoid severe grazing from Sept. 15 until seed is set.



Yield distribution of annual lespedeza in Missouri.

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Aflatoxin in Corn and Crop Insurance

By Laura Sweets

The July 31, 2012 issue of the Integrated Pest & Crop Management Newsletter contained an article entitled "Drought May Result in Aflatoxin Contaminated Corn". In this article Dr. Wrather explained why aflatoxin might be a problem in this year's corn crop and offered some harvest and storage strategies which might minimize contamination. He also referenced the MU Guide G4155, "Aflatoxins in Corn" which contains more detailed information concerning Aspergillus flavus, aflatoxin, FDA levels for corn used for food and feed, testing procedures and handling procedures (http://extension.missouri.edu/p/G4155).

Since Dr. Wrather's article appeared in the IPCM Newsletter, there have been a number of questions related to crop insurance and claims related to aflatoxin in this year's corn crop. If aflatoxin is suspected and the grower has crop insurance, the crop insurance agent should be contacted immediately, i.e. prior to harvest. The crop insurance agent should be able to give directions on how to proceed in establishing if aflatoxin is a problem in the field and the process to document damage and initiate claims. But this needs to be done before the crop is harvested. The Risk Management Agency's web site has additional information on this at http://www.rma.usda.gov/fields/ks_rso/2012/aflatoxintesting.pdf

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Consider Herbicide Carryover Potential before Planting Wheat or Forage Grasses this Fall

By Kevin Bradley

With the extreme drought we have experienced throughout the state this season, there is no question that the risk of herbicide carryover to fall-seeded crops will be higher than normal this year. Due to the poor corn and soybean crop, many are considering planting more winter wheat this fall, while others are enquiring about the possibility of a fall-seeded forage grass crop as an alternative feed source. While it is difficult to predict exactly when or where herbicide carryover injury might occur, there are several factors that will influence the likelihood of herbicide carryover occurring to these crops. These include the type of herbicide applied, the rate of herbicide applied, the time during the season that the herbicide was applied, the soil pH, and most importantly the amount of rainfall received since the time of the initial herbicide application.

The amount of rainfall received during the course of the growing season is perhaps the most important factor that will influence the likelihood of herbicide carryover injury to wheat or forage grasses planted this fall. Soil moisture is critically important for herbicide degradation, especially in the first few weeks after herbicide application. If adequate rainfall is not received during this time period, then the chemical and microbial processes responsible for herbicide degradation are reduced significantly and the herbicide molecules are more likely to become bound (adsorbed) to soil particles. All of this results in less herbicide degradation and increases the likelihood of herbicide carryover injury. Some herbicides are also degraded chemically in a process called hydrolysis. Hydrolysis is a reaction of the herbicide in question with soil water; therefore when soil water is limited, chemical hydrolysis of the herbicide is also reduced.

Another very important factor that influences the likelihood of herbicide carryover is the type of herbicide applied. As a general rule, corn or soybean herbicides with residual soil activity have the highest potential for causing carryover injury to wheat or forage grasses that may be planted in the fall. This is because residual herbicides are designed to remain in the soil profile for a specified period of time in order to prevent weed seedling germination. Tables 1 and 2 provide a list of some of the most common herbicides applied in corn and soybean production and their corresponding rotational intervals before planting wheat or forage grasses in Missouri.

In fields where corn was the previous crop, triazine herbicides are of the greatest concern in terms of herbicide carryover injury to wheat. These include atrazine or any of the many prepackaged herbicide mixtures that contain atrazine as one of the active ingredients (Bicep II Magnum, Degree Xtra, Guardsman Max, Harness Extra, Lumax, Lexar, etc.). As illustrated in Table 1, it is important to note that atrazine or any of the atrazine-containing products DO NOT allow wheat or forage grasses to be planted in the fall following a spring application, although in some years and in some areas of Missouri certain farmers choose to plant wheat following their corn crop. With the extreme drought we have experienced this year, any

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Consider Herbicide Carryover Potential before Planting Wheat or Forage Grasses this Fall

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wheat planted after a corn crop that has been treated with atrazine this season will be at risk for atrazine carryover injury.

In fields where soybeans were the previous crop, the likelihood of carryover injury to wheat is lower, but still possible in a year with as little rainfall as we have experienced. There are generally fewer residual herbicides applied in soybean, but that trend is changing. Also, as a result of our glyphosate-resistant waterhemp problem throughout the state, the herbicide fomesafen , which is the active ingredient in Flexstar, Flexstar GT, Rhythm, and Prefix, has now become a very common post-emergence herbicide of choice in soybean. Fomesafen-containing products have a 4-month wheat replant interval and in areas that have received little to no rainfall following application, fomesafen carryover injury to wheat or other forage grasses can be a concern this year.

The rate of herbicide applied and the timing of the herbicide application are other factors that influence the likelihood of herbicide carryover injury to wheat or other rotational crops. Simply put, the higher the rate of herbicide applied and the later the herbicide application was made, the greater the chance that some of the herbicide will remain to cause carryover injury to wheat. For example, if Flexstar or Flexstar GT applications were made later in the season to control glyphosate-resistant waterhemp in soybean, these sites are more at risk for herbicide carryover this fall.

The soil pH can also influence the likelihood of herbicide carryover injury. This is most often a concern with ALS-inhibiting herbicides, especially those containing chlorimuron or Classic (Valor XLT, Envive, etc.). With soils that have a high pH, some ALS-inhibiting herbicides as well as atrazine are more likely to persist and carryover.

In fields where there is a high degree of concern and/or uncertainty about herbicide carryover, one way to obtain more information is to conduct a soil bioassay. This is a simple test that can be done to ensure you don't waste a lot of money by planting an entire field and then observe that the entire stand is injured as a result of herbicide carryover. To conduct a soil bioassay, gather several soil samples from across the field in question several weeks before you intend to plant your fall-seeded crop at that location, then take those soil samples and mix them together and place the soil in some kind of greenhouse flats or pots. Plant your wheat or forage grass seed into these pots and wait for the seedlings to germinate in order to observe any signs of herbicide carryover injury that may be present. In order to have a comparison, it will be important to follow this same procedure at the same time with soil from a location where you know there are no concerns with herbicide carryover.

Ultimately the best practice is always to follow the label of the herbicide product(s) that you have applied, but this year with the drought we have experienced it will also be important to consider each of the factors discussed above in relation to the field(s) in question. If several of these factors indicate a high probability of herbicide carryover, then it is a good idea to abandon the field until next spring and rotate to another location where the probability of herbicide carryover is not as high.

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Table 1. Rotational intervals required between application of corn herbicides and planting of winter wheat or forage grasses.

Herbicide	Winter Wheat	Forage Grasses
	Replant Interval Following Application	
Accent	4 months	10 to 18 months, depending on soil pH
Aim	none	none
Atrazine	following year	following year
Balance Flexx	4 months	18 months
Beacon	3 months	18 months
Bicep II Magnum/ Cinch ATZ	following year	following year
Buctril	30 days	30 days
Cadet	none	none
Callisto	4 months	18 months
Callisto Xtra	following spring	18 months
Capreno	4 months	18 months
Corvus	4 months	17 months
Define	12 months	12 months
Degree	4 months	18 months
Degree Xtra	4 months	18 months
Distinct	120 days or if ≤4 ozs is used, 30 days with at least 1" of rain	120 days
Dual II Magnum/Cinch	4 ½ months	12 months
Gramoxone	none	none
Guardsman Max	following year	following year
Halex GT	120 days	18 months
Harness	4 months	18 months
Harness Xtra	4 months	18 months
Hornet	4 months	26 months
Ignite	70 days	180 days
Impact	3 months	28 months
Keystone	15 months	15 months
Laudis	4 months	18 months
Lexar	following spring	18 months
Liberty	70 days	180 days
Lumax	4 ½ months	18 months
Northstar	3 months	18 months
Outlook	4 months	following spring
Parallel	4 ½ months	12 months
Peak	None	24 months
Prowl/Pendimethalin	4 months	following year
Permit/Sandea	2 months	2 months

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Table 2. Rotational intervals required between application of soybean herbicides and planting of winter wheat or forage grasses.

Herbicide	Winter Wheat	Forage Grasses
	Replant Interval Following Application	
Assure II	120 days	120 days
Authority Assist	4 months	30 months
Authority First	4 months	30 months
Authority MTZ	4 months	18 months
Authority XL	4 months	36 months
Boundary	4 ½ months	12 months
Canopy	4 months	30 months
Canopy EX	30 months	30 months
Classic	3 months	3 months
Cobra	none	none
Command	12 months	12 months
Dawn	4 months	18 months
Dual II Magnum/Cinch	4 ½ months	12 months
Extreme	4 months	40 months
Encompass	4 months	12 months
Enlite	4 months	30 months
Envive	4 months	30 months
FirstRate	4 months	18 months
Flexstar/Flexstar GT	4 months	18 months
Fusilade DX	60 days	60 days
Gangster	3 months	30 months
Gramoxone	none	none
Harmony	none	45 days
Ignite	70 days	180 days
Liberty	70 days	180 days
Op-Till	4 months	40 months
Op-Till Pro	4 months	40 months
Outlook	4 months	following spring
Phoenix	none	none
Prowl/Prowl H2O	4 months	following year
Prefix	4 ½ months	18 months
Pursuit	4 months	40 months
Python	4 months	9 months
Raptor	3 months	18 months
Resource	30 days	30 days
Rhythm	4 months	18 months
Roundup/other glyphosates	none	none
Scepter	3 months	18 months
Select Max	30 days	30 days
Sencor/Metribuzin	4 months	18 months

Consider Herbicide Carryover Potential before Planting Wheat or Forage Grasses this Fall

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Table 1. Rotational intervals required between application of corn herbicides and planting of winter wheat or forage grasses.

Herbicide	Winter Wheat	Forage Grasses
Prequel	4 months	18 months
Princep/Simazine	following year	following year
Python	4 months	9 months
Realm Q	4 months	18 months
Resolve	3 months	18 months
Resource	30 days	30 days
Roundup/other glyphosates	none	none
Sencor	4 months	18 months
Sharpen	4 months	4 months
Shotgun	following year	following year
Spirit	3 months	10 months
Status	120 days or if ≤5 ozs is used, 30 days with at least 1” of rain	120 days
Steadfast	4 months	10 to 18 months depending on soil pH
Surpass/Topnotch	4 months	following spring
Stinger	none	none
Touchdown	none	none
TripleFlex	4 months	26 months
Verdict	4 months	following spring
WideMatch	none	none
Yukon	2 months	2 months

Table 2. Rotational intervals required between application of soybean herbicides and planting of winter wheat or forage grasses.

Herbicide	Winter Wheat	Forage Grasses
Sequence	4 ½ months	following spring
Sharpen	4 months	4 months
Sonic	4 months	30 months
Storm	40 days	100 days
Synchrony XP	3 months	3 months
Treflan	5 months	12 months
Touchdown HiTech	none	none
Ultra Blazer/Blazer	40 days	100 days
Valor SX/Encompass	up to 3 oz/A = 30 days and 1” of rainfall/ irrigation between application and planting	6 months if soil is tilled prior to planting, 12 months if no-till
Valor XLT	4 months	30 months
Verdict	4 months	following spring
Warrant	4 months	following year

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Black Corn Fields

By Laura Sweets & Rob Kallenbach

This year's Missouri corn crop has had a difficult season and the challenges just seem to keep coming. Portions of fields or entire fields have died prematurely from the heat and drought stress of the last three months. A number of different saprophytic fungi may come in on this senescing, dying or dead plant tissue. These fungi give the plants a black cast or appearance. Add some rain and the black may become quite obvious. Areas of northwest Missouri had significant rainfall Sunday, August 26, and by Tuesday plants, portions of fields or entire fields were "black". This black appearance is obvious from the road. From a closer perspective, the leaves, stalks and husks appear to be coated with black mold growth. With the possibility that much of the state may receive rain over the Labor Day weekend from the remnants of Hurricane Isaac, there is a very real likelihood that the following week will see many more fields of black corn.

Black corn occurs when any of a number of saprophytic or weakly parasitic fungi grow on corn plants in the field. *Alternaria, Cladosporium, Aureobasidium* and other species are frequently found on these discolored or black plants. Since the affected plants may have a sooty appearance these fungi are sometimes called sooty molds. These sooty molds or secondary fungi tend to develop on plants which have died prematurely, when wet or humid weather occurs as the crop is maturing or after it has matured, or if harvest is delayed because of wet weather. Typically these fungi come in on plants that are shaded, undersized, weakened or prematurely ripened and on senescing foliage. Plants that are lodged or that have been stressed by nutrient deficiencies, plant diseases or environmental conditions may be more severely affected. Although many of these fungi produce dark or black mold growth, the color of the mold growth can range for dark or black to olive green or even pink to white.

These secondary fungi tend to develop on senescing plant tissues, primarily leaf, stalk and husk tissue, but under favorable conditions can cause infection of the kernels. Infected kernels might show a black discoloration.

It is possible that these sooty molds or secondary fungi could contribute to stalk deterioration or stalk rot. Lodging could become a problem in these fields, especially if there are high winds or strong storms before harvest.

Care should be taken when combining fields with high levels of black mold or sooty mold. Cab and engine filters should be kept clean. These black molds produce large quantities of spores. It is not uncommon to see dark clouds of spores around combines moving through fields with high levels of black mold or sooty molds. Individuals especially those with respiratory problems or mold allergies should be careful to avoid excessive exposure to mold spores.

Grain from fields with high levels of sooty molds should be treated with care if it is stored. Grain should be thoroughly cleaned to remove lightweight, damaged or broken and moldy kernels. Grain should be stored at the proper moisture content and temperature and checked on a regular basis during storage.

Due to the shortage of pasture and hay for livestock, producers are asking about whether black corn residue is safe to bale and feed. Though the parasitic fungi mentioned are not likely to be toxic to livestock, the palatability of blackened corn stalks will be low. In addition, even under ideal circumstance the crude protein of corn stalks is less than 5%, and total digestible nutrients (TDN) less than 45%. Given the low nutritive value of corn stalks and the low palatability of a mold covered corn stalk, feeding losses will likely exceed 60%. Supplemental protein and energy will be needed to meet the nutrient requirements of nearly any class of livestock.

If producers do dry bale black corn stalks, a few tips follow. First, corn stalks are difficult to bale. They often are more moist than they appear; allow the stalks to fully dry (16% moisture or less) before baling. Additionally, the dusty stalks do not feed easily into many large round balers and most producers find them difficult to wrap with twine. At harvest, attention needs to be given to the density of the bales. In general, tighter and larger bales stand up to outside storage better than looser or smaller bales and the use of net wrap preserves more feed than does twine tying.

Second, corn stalks and other coarse crops do not store well outside when compared to typical grass hay. This is because they do not form the same kind of thatch over the top of the bale, thus allowing water penetration during hard rain events. Because of this, we recommend that this material be protected from the elements by stacking in a barn or covering with a tarp. If bales must be stored outside, the sooner the stalks are fed this winter, the better the feed quality will be.

Third, the nitrate levels in corn stalks could still be high. Leaving a 12 or even 18 inch stubble in the field helps avoid baling the parts of the plant likely to be highest in nitrates, but it is not guarantee that the feed will be safe. Prior to feeding, the forage should be tested for nitrates by a qualified laboratory. A few dollars for a nitrate test could have thousands in livestock losses.

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Impact of the Drought on Next Year's Fertilizer Rates

By John Lory & Peter Scharf

Reduced yields can have implications for fertilizer need in the year after a drought. Intuitively farmers recognize that substantially reduced yield can lead to less removal of nutrients from a field. When nutrient use is reduced there is an opportunity to estimate a *drought nutrient credit* from the stricken crop that can be used to reduce fertilizer need in the year following drought.

Farmers have used a range of strategies to deal with drought stricken corn and soybean. How they managed fields this year will directly affect the amount of fertilizer carryover to the next year. This year, corn and soybean fields have been harvested for grain (with substantially reduced yield), mechanically harvested (as green chop, baled forage or silage), grazed as forage, or been abandoned with no removal of any crop material.

Each of these scenarios has implications for how many nutrients applied from this year can be credited to next year's crop. In some cases these strategies may actually increase fertilizer need next year by removing more nutrients than would have been in the planned grain harvest.

Table 1 summarizes our expectation for the impact of selected strategies on fertilizer need in next year's crop. The table assumes that your yield goal for corn was 150 bushel/acre (B/A) and for soybean was 50 B/A. Equations are provided later in the article if you want to calculate drought nutrient credits for different yield goals.

Drought nutrient credits can be important particularly on fields where little or no material was harvested in 2012. Recognize that chopped corn can increase potash requirements for next year's crop.

Also recognize that there is potential for nitrogen estimated in by the drought nitrogen credit to be lost through leaching or denitrification if we have excessively wet conditions between now and next-year's crop. The final section of this article, "Other Considerations", details strategies to manage this and other risks associated with using drought nutrient credits.

Table 1. Estimated impact on next year's fertilizer need (drought nutrient credits) for selected harvest strategies for drought stressed corn or soybean. Assumes fertilizer applied this year was based on 150 B/A yield for corn and 50 B/A yield for soybean. Arrow down means recommended fertilizer rate for next year should decrease by the associated value.

	Corn			Soybean		
Harvest Management	N	Phosphate	Potash	N	Phosphate	Potash
	- - - - lbs/acre - - - -			- - - - lbs/acre - - - -		
No crop harvested	145	50	40	0	40	65
Harvested as grain (40% of yield goal)	70	30	25	0	24	40
Grazed	40	50	40	0	40	65
Chopped and removed[1]	0	15	60	0	20	25

[1] Assumes most growth stopped at R1 for corn and R3/4 for soybean.

Calculating the drought fertilizer credit: grain crop harvested

The simplest cases are fields where a grain crop was planted and the field is harvested for grain only at a reduced yield.

Phosphorus and potassium calculations for corn and soybean are similar. The drought credit will be the difference between the expected phosphate and potash removal based on the yield goal used to determine fertilizer rate and the actual yield. Use Table 2 and the example to estimate nutrient removal values for corn and soybean.

The nitrogen calculation for corn is slightly different. The credit should be calculated as a percentage of applied fertilizer in 2012. Soybean has no fertilizer N applied so there is no drought N credit if it is harvested for grain.

An example: A corn field had phosphate and potash applied based on a 150 B/A yield goal. The drought affected yield was 70 B/A. The crop received 145 lbs of fertilizer N.

Drought phosphate credit: (150 B/A – 70 B/A) X 0.32 lbs phosphate/B = 26 lbs phosphate/A

Drought potash credit: (150 B/A – 70 B/A) X 0.25 lbs potash/B = 20 lbs potash/A

Drought nitrogen credit: = ((150-70)/150) X 145 lbs nitrogen/A = 77 lbs nitrogen/A

These results estimate that reducing the 2013 fertilizer recommendation for phosphate by 26 lbs/A will maintain soil phosphorus status as if there had been no drought. Similarly, potash can be reduced by 20 lbs/A and nitrogen by 77 lbs/A. This represents a potential savings of almost $20/A in P and K. If a nitrogen needing crop such as corn is planted next year there is an additional potential savings of approximately $35/A. Actual savings will depend on fertilizer prices.

If nothing was harvested from the field in 2012 the entire removal rate could be credited to next year's crop (phosphate = 150 B/A X 0.32 = 48 lbs/A; potash = 150 B/A X 0.25 = 38 lbs/A; nitrogen = 145 lbs N/A).

Calculating the drought fertilizer credit: green chop, baled or silage harvested

Many farmers have harvested drought-stressed soybean and corn crops as a forage crop. There are no easy rules about nutrient removal in corn and soybean forage compared to what was expected with the grain crop. Harvesting your corn or soybean grain crop as forage can lead in some cases to removal of nutrients in excess of

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Table 2. Estimated removal values for selected crops.

Crop	Nitrogen	Phosphate	Potash
	- - - - - - lbs/A - - - - - -		
Corn	0.74	0.32	0.25
Soybean	3.5	0.8	1.25

what would have been removed by the grain crop and for others a drought nutrient credit.

To predict the impact of harvesting forage one needs to compare nutrient status of the plant when harvested for forage compared to what it would have been if it had made a full grain crop.

Table 3 compares the nutrient harvest index of the grain crop with nutrients accumulated as the percentage of total nutrient uptake at early reproductive growth stage (R1 for corn and R3/4 for soybean).

When the values are equal there is no difference between the amount of nutrient removed in the grain and the amount of nutrient removed in the harvested forage. For example, when you harvest corn at R1 you remove the same amount of nitrogen as if you had harvested the full crop as grain.

When the harvest index value is greater than early reproductive content than fewer nutrients are removed by forage harvest; there will be drought nutrient credit for the crop. For example, when you harvest whole corn plants at R1 your remove less phosphorus than you would have with the full grain crop.

When the harvest index value is less than early reproductive content than more nutrients are removed by forage harvest; harvesting the forage will remove more nutrients than the grain crop. For example, when you harvest whole corn plants at R1 your remove more potassium than you would have with the full grain crop.

In soybean the harvest index is always greater than the percentage of total nutrient uptake at R3/4 so there is always a potential drought nutrient credit if the crop is harvested as forage at this stage of growth.

An example: A soybean field had phosphate and potash applied based on a 50 B/A yield goal. The field was harvested as green chop with limited pod set.

Drought phosphate credit: [1-(40/80)] X 50 B/A X 0.8 lbs phosphate/B = 20 lbs phosphate/A

Drought potash credit: [1-(37/58)] X 50 B/A X 1.25 lbs potash/B = 40 lbs potash/A

Note that less nitrogen was removed by the soybean plant than with grain harvest; but no nitrogen fertilizer was applied to the soybean crop. So it is not appropriate to take a drought credit for nitrogen. We do recommend taking the rotation nitrogen credit for soybean of 30 lbs N/A despite the drought if corn is grown following soybean.

Corn crops in particular have been harvested as forage at various points during the growing season. Some have harvested the crop soon after silking (near R1). Others have waited until the crop dropped in moisture content to a point it could be ensiled or baled. There are others who are realizing that there is little grain in a mature field and are baling it as a source of roughage to be mixed with other higher quality feeds such as distiller's grains. Table 3 also reports the growth stage of corn and beans for N, P and K where above-ground nutrient removal as forage equals nutrient removal from the full grain crop. This point is within a growth stage or two of early reproductive growth, with the exception of potassium in corn. This emphasizes the advanced the stage of growth when harvesting corn or beans as forage, the less appropriate a drought nutrient credit. The one clear effect of removing corn or beans as forage is that this practice will increase potash removal from the field. Green chopping a corn at R1 for a field fertilized based on a 150 B/A yield goal increases potash removal by 62 lbs/A ([1-(90/34)] X 150 X 0.256 = -62; the negative sign indicates increased fertilizer demand compared to the grain crop).

Table 3. Estimates of the nutrient harvest index (HI), percentage of above-ground nutrient uptake at early reproductive phase of growth and an estimate of the phase of growth where above-ground uptake equals nutrient exported in the grain for non-drought stressed corn and soybean.

	Nitrogen			Phosphorus			Potash		
	HI[1]	Early reprod. Uptake[2]	Uptake = HI[3]	HI[1]	Early reprod. Uptake[2]	Uptake = HI[3]	HI[1]	Early reprod. Uptake[2]	Uptake = HI[3]
	- - % - -			- - % - -			- - % - -		
Corn	67	67	R1	75	54	R2/3	35	91	V12
Soybean	67	36	R5	80	40	R5	58	36	R4/5

Calculating the drought fertilizer credit: grazing

If a drought stricken field is harvested by grazing cattle most of the nutrients in the crop will remain in the field. Nearly 100% of the nutrients consumed in the soybean or corn forage will be excreted back onto the pasture. Consequently, the drought credit for phosphate and potash will be similar to a field where no harvest took place (see discussion above for calculation).

Nitrogen availability will be much reduced compared to no harvest. Over 50% of the nitrogen will be excreted in the urine and prone to volatilization. The remaining nitrogen will be in organic compounds that will not be fully available to the crop. In pasture systems a conservative

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estimate is that 37% of the excreted nitrogen can have fertilizer value. Consequently the drought nitrogen credit on grazed grain fields will be just over one third of what was applied to the field that year.

The nutrient value of grazed nutrients is dependent on animals doing a good job of distributing those nutrients across the field. Better distribution of manure is facilitated by practices such as strip grazing that forces animals to fully graze an area within a day before giving them access to another strip of feed.

Other considerations

Some farmers may question if the calculated drought credit is really available. This can be a real concern, especially for nitrogen where there is the potential for the excess nitrogen from this year's drought stricken corn to be lost over winter or in spring from excess moisture. Given the exceptionally dry condition of the soil in late August it is less likely we will have substantial leaching of nitrogen over winter. The potential for losing the drought nitrogen credit to excess moisture is much lower if the next crop is wheat compared to corn. A cover crop may also serve to limit nitrogen losses under high moisture conditions.

Farmers may also be concerned that fewer nutrients were taken up in the crop by a specific growth stage because of the drought. For example, potassium deficiency is sometimes observed in drought stressed corn which would indicate reduced uptake. If this occurs our estimate of the drought nutrient credit will be low. Failing to take the phosphate or potash drought nutrient credit or under-estimating the credit will lead to an increase in soil test level in the field that, if significant, will be accounted for next time you soil sample your fields.

Crop uptake of nitrogen during a drought will be less affected than phosphorus and potassium. Soil nitrogen enters crops primarily as an ion as mass flow with soil water entering the roots. The continued uptake of nitrogen coupled with the failure to make grain leads to the concentration of nitrate in the stalk that leads to danger of nitrate poisoning in livestock eating forage corn or beans.

If farmers are planning to grow wheat or corn and think there is a drought nitrogen credit but want a quantitative test to measure the nitrogen in the soil they can use the Soil Nitrogen Test. This test is fully explained in the MU Extension Publication *Preplant Nitrogen Test for Adjusting Corn Nitrogen Recommendations* (MU Guide G9177). This test requires taking multiple cores to a depth of at least two feet in spring.

In Missouri many farmers rotate from corn to soybean. Such a rotation will not effectively capture the value of any unused nitrogen from this year's corn crop. The value of nitrogen in the soil can be substantial on fields where little grain and no forage were removed. Many factors must be balanced when considering growing corn after corn including the expected 12% or greater yield penalty for continuous corn. This yield penalty will be equal to or greater than the value of any residual nitrogen in the soil. There is significant value in crediting residual soil N after drought years if you grow corn after corn next year; but the decision to grow corn or beans must be based on an analysis that considers factors beyond the potential value of excess fertilizer nitrogen in the soil.

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Something New to Look for in Soybean Fields- Soybean Vein Necrosis Virus

By Laura Sweets

Vein clearing and reddish-brown discoloration of veins

Over the last week to ten days symptoms of a relatively new virus disease of soybean, soybean vein necrosis, have begun showing up in many soybean fields in various regions of the state. Initially, small light-green to yellow patches develop near main leaf veins. These patches then develop a mottled light green-yellow-brown pattern. The veins in these areas of the leaflet may become clear to almost translucent which is referred to as vein clearing. As the disease progresses these areas turn reddish-brown with a browning of the veins. The reddish-brown areas may have a scaly or scabby appearance. On more

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Something New to Look for in Soybean Fields- Soybean Vein Necrosis Virus

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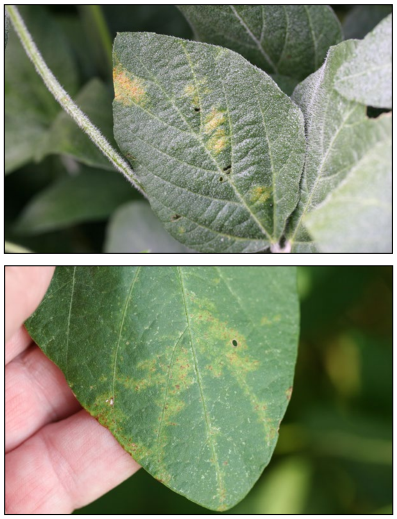


Initial symptoms of soybean vein necrosis

susceptible varieties the brown areas may expand killing larger areas of leaf tissue and giving a scorched appearance to the leaves.

Although these symptoms had been observed on soybeans for several years in Mid-South and Midwest states, it was not until 2008 that Dr. Ioannis Tzanetakis, University of Arkansas, discovered a new tospovirus in symptomatic leaf tissue. This new virus was named soybean vein necrosis virus (SVNV). The first identification of the virus was in a sample from Tennessee and in following years the virus was reported in Arkansas, Delaware, Kentucky, Kansas, Illinois, Maryland, Missouri Mississippi, New York, Pennsylvania, and Virginia. Until this season the reports of soybean vein necrosis in Missouri were primarily from seed production fields in southeast Missouri. But this season, symptoms suggestive of this virus disease can be found in fields throughout the state.

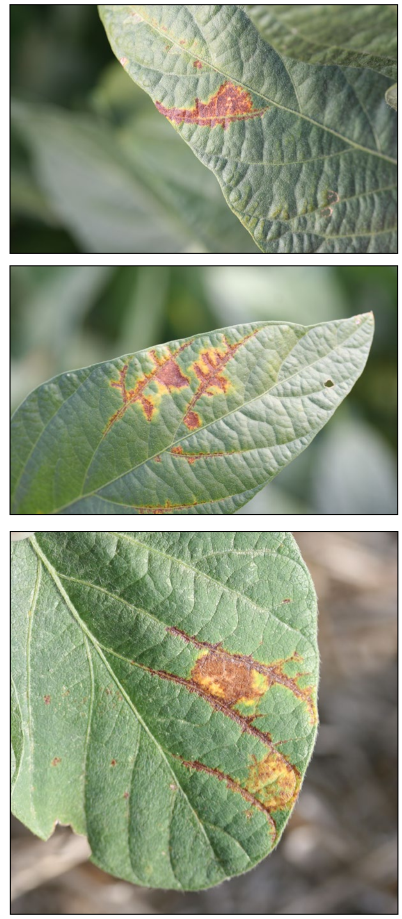
On August 23, I received digital images of soybean leaves with symptoms typical of those caused by this virus disease. August 24 and 25 I traveled through central and east central Missouri trying to stop in at least two soybean fields per county. Then August 27-29, as I traveled to field days in northwest Missouri, I stopped in fields in west central, northwest and northern Missouri. I was able to find plants with symptoms suggestive of soybean vein necrosis virus in Boone, Cole, Osage, Gasconade, Montgomery, Callaway, Howard, Chariton Carroll, Holt, Atchison, Nodaway and Harrison counties. I checked fields in Schuyler, Adair and Macon counties but was not able to find symptomatic leaves in those fields. I have also received digital images showing symptoms indicative of soybean vein necrosis virus from Ste. Genevieve county.

Symptoms on lower leaf surface

Samples have been submitted for virus assay but I have not yet received the results of those assays. So at this point, from visual symptoms it appears as though this virus may be quite widespread in Missouri this season. But until the assay results are available the diagnosis is unconfirmed.

Certainly other neighboring states (Illinois, Indiana, Kentucky, Tennessee and Arkansas) are reporting widespread occurrence of this virus disease this season.

The virus which causes soybean vein necrosis belongs to a group of viruses called tospoviruses which are spread by thrips. At this point the disease is still a relatively new disease and there are more questions about it than answers. It appears that the virus is spread from soybean to soybean by thrips but which species(s) of thrips is unknown. Other hosts, especially weed hosts, have not been confirmed. And there are many questions related to the disease cycle, possible yield losses and appropriate management strategies.



Characteristic symptoms of soybean vein necrosis

Varieties seem to vary in their susceptibility to this virus disease and symptoms may vary with varieties. In the fields I checked the incidence of infected plants (plants showing symptoms) ranged from a trace to almost 100% of the plants. The majority of the fields had less than 5% of plants showing symptoms. Symptoms were evident in the upper canopy or upper to mid-canopy. Of the plants showing symptoms, most had small, light-green to yellow blotchy patches near main veins, some vein clearing and some patches in which the veins had turned reddish-brown with a scaly or scabby appearance. Severity in all fields I checked was <10%. More severe symptoms may

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Something New to Look for in Soybean Fields- Soybean Vein Necrosis Virus

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Vein clearing, vein discoloration and scabby appearance of lesions

Symptoms scattered on leaves in upper and mid-canopy

develop with larger areas of the leaflet turning reddish-brown and premature defoliation occurring.

At this time there isn't enough known about the virus and disease to make effective management recommendations. As more information becomes available on this disease, management strategies can be formulated and recommendations made. Overall, disease symptoms of soybean vein necrosis have been low to moderate across fields in all states in which the disease has been reported this season. So for this season no control measures are recommended.

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Field Crop Disease Update - August 31, 2012

By Laura Sweets

Corn: With the hot, dry conditions over most of the state this season, corn foliage diseases have been minimal. There have been a few reports of pockets of southern rust and gray leaf spot but these diseases have not been as prevalent as the last few years.

The incidence of common smut has been slightly higher this year. Some of the smut galls on ears are quite large.

Ear and kernel rots have been the most prevalent of the corn diseases this season. Penicillium sp., Aspergillus flavus, Aspergillus niger, and Fusarium graminearum have all been found in corn fields throughout the state. Drought stressed corn, corn that died prematurely and corn with insect damage may have higher levels of these ear and kernel rot fungi. Rain over the Labor Day weekend may increase the incidence and severity of these fungi.

Black corn is showing up in many parts of the state and, again, rain over the Labor Day weekend may increase this problem. See article on "Black Corn" in this issue of the newsletter.

Corn stalk rots could also be a problem this fall. Fields should be checked for evidence of stalk rots and fields with stalk rot should be harvested as quickly as possible to prevent losses from lodging.

Soybean: The hot, dry conditions have also limited the development of soybean foliage diseases such as frogeye leaf spot, Septoria brown spot, bacterial blight and bacterial pustule. Cercospora blight causing the reddish-purple discoloration of leaflets from the tip in is showing up in low levels in some fields.

Symptoms of bean pod mottle can be seen on the young foliage of scattered plants in some fields. It is not as prevalent as the last few years. The soybean vein necrosis virus disease is quite widespread- see accompanying article in this newsletter.

There have some reports of SDS but both incidence and severity of this disease are low this season. In some fields there will be single, scattered plants showing the typical symptoms of SDS.

Damage from soybean cyst nematode may be more severe when soybean plants are stressed by hot, dry conditions. This fall would be a good time to sample fields and have samples tested for SCN population levels.

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Weather Data for the Week Ending August 30, 2012

By Pat Guinan

Station	County	Weekly Temperature (ºF)						Monthly Precipitation (in.)		Growing Degree Days‡	
		Avg. Max.	Avg. Min.	Extreme High	Extreme Low	Mean	Departure from long term avg.	August 1-30	Departure from long term avg.	Accumulated Since Apr.1	Departure from long term avg.
Corning	Atchison	87	65	94	62	76	+1	*	*	3182	+393
St. Joseph	Buchanan	89	67	99	64	78	+4	1.07	-3.01	3430	+658
Brunswick	Carroll	91	63	96	60	76	+1	0.59	-3.70	3369	+557
Albany	Gentry	90	62	98	59	75	+1	2.89	-0.80	3294	+561
Auxvasse	Audrain	95	65	100	60	79	+5	0.30	-3.20	3451	+604
Vandalia	Audrain	93	65	98	60	79	+4	0.20	-3.57	3432	+627
Columbia-Bradford Research and Extension Center	Boone	93	64	98	61	78	+3	0.20	-3.93	3424	+506
Columbia-Capen Park	Boone	96	61	102	57	77	+1	0.11	-3.98	3303	+285
Columbia-Jefferson Farm and Gardens	Boone	93	67	98	65	79	+4	0.09	-4.04	3544	+619
Columbia-Sanborn Field	Boone	93	69	99	64	80	+4	0.05	-4.09	3723	+700
Columbia-South Farms	Boone	93	67	99	63	80	+5	0.11	-4.06	3538	+617
Williamsburg	Callaway	94	64	99	61	78	+3	0.25	-3.66	3475	+682
Novelty	Knox	92	64	99	60	77	+3	0.60	-2.78	3204	+454
Linneus	Linn	2	65	99	62	78	+4	0.73	-3.04	3313	+600
Monroe City	Monroe	93	64	98	60	78	+3	0.84	-2.77	3323	+514
Versailles	Morgan	93	67	98	61	79	+3	0.93	-2.71	3714	+724
Green Ridge	Pettis	92	67	98	60	79	+7	1.33	-1.97	3552	+741
Lamar	Barton	89	66	95	62	77	0	3.99	+0.88	3654	+543
Cook Station	Crawford	89	60	96	54	75	-1	2.17	-1.24	3311	+320
Round Spring	Shannon	89	60	94	54	73	-2	2.37	-0.87	3191	+322
Mountain Grove	Wright	86	65	91	59	75	0	2.45	-0.24	3373	+538
Delta	Cape Girardeau	92	64	96	59	77	0	0.96	-1.99	3527	+233
Cardwell	Dunklin	88	65	91	58	76	-3	1.23	-0.85	3754	+191
Clarkton	Dunklin	91	65	93	59	76	-2	1.98	-0.13	3780	+271
Glennonville	Dunklin	90	67	93	61	78	0	0.94	-1.24	3787	+293
Charleston	Mississippi	92	66	94	62	78	+1	0.15	-2.25	3746	+425
Portageville-Delta Center	Pemiscot	91	69	95	64	79	+1	2.07	-0.03	3959	+423
Portageville-Lee Farm	Pemiscot	92	68	94	64	79	+1	1.70	-0.53	3914	+406
Steele	Pemiscot	92	68	95	62	78	0	1.01	-1.44	3987	+449

‡Growing degree days are calculated by subtracting a 50 degree (Fahrenheit) base temperature from the average daily temperature. Thus, if the average temperature for the day is 75 degrees, then 25 growing degree days will have been accumulated.

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