Integrated Pest & Crop Management

Corn Pollination, the Good, the Bad, and the Ugly

Part 1: The Male Role

By Bill Wiebold

Figure 1. Fully emerged corn tassel. Tassel branches have not displayed normally, perhaps because of hot and dry weather.

Corn is unique among grain crops in that it is monoecious. This means that it possesses flowers that have only male sexual parts and flowers that have only female sexual parts on the same plant. Also unique among grain crops, these flower types are separated on a plant by a distance of several feet. To compensate for this physical separation of male and female flower parts, the corn plant produces copious amounts of pollen and its pollen is easily moved by wind.

Male flowers are borne on the tassel. When the corn plant is only 4 or 5 weeks old and about knee-high, the growing point changes from a place for cell division into a reproductive structure – the embryonic tassel. At this point in the growing season, the tassel is at or near the soil surface. The young tassel is pushed through the whorl of leaf sheaths as nearly 20 stem internodes elongate. During these five weeks of stem elongation, the tassel becomes increasingly "tassel-like" in appearance. Inside the anthers of the developing tassel special cells produce pollen grains. These pollen grains mature and are ready to perform their role of producing male gamete cells as plant development approaches the end of this period of rapid stem elongation. The last stem internode, or the peduncle, elongates and pushes the tassel out of top leaf sheath (Figure 1). VT is the last vegetative stage and occurs when the last (bottom) tassel branch is visible.

Normal tassels have a central stalk (rachis) and several branches. Grass flowers are called florets, and each of the nearly 2000 florets on the tassel produces three stamens composed of an anther and a

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Figure 2. Tassel branch with several anthers visible.

filament. The filament elongates and pushes the anther out of the floret, which exposes the anther to the air (Figure 2). Weather parameters, including temperature, humidity, and wind speed influence the timing and the amount of pollen shed. Under normal conditions, temperature rises and relative humidity decreases as the morning progresses. This triggers the anthers to dehisce, which allows pollen grains to spill from pores located near one end of each anther (Figure 3). A slight breeze may be necessary for pollen shed, or at least it helps with pollen dispersal.

Pollen shed begins shortly after the tassel emerges from the top leaf sheath and lasts about 8 days for an individual tassel. Because of differences among plants in a field for maturity, pollen shed within a field may last two weeks. This "flowering period" for corn is relatively short, and corn yield can be highly influenced by stresses that occur during it.

Although the science is a little foggy, it appears that both heat and drought can damage pollen. Some reports state that temperatures above 95°F kill corn pollen. It is not clear to me if pollen death is a reaction solely to temperature or from dehydration. This year central Missouri experienced 12 consecutive days with high temperatures above 100°F during pollen shed. This is highly unusual and outside the parameters of most research protocols. It is clear that pollen grains are highly susceptible to dehydration. Pollen grains are small, have a large surface area to volume ratio, and thin walls. They begin to lose water immediately after their release from anthers. Even with normal summer temperatures and humidity, pollen grains will lose most of their water in less than 4 hours. Under conditions common in most of Missouri's cornfields this year, nearly complete dehydration will take less than an hour.

Figure 3. Figure 3. Anthers with closeup of opening from which pollen grains exits athers. Source of picture: Aylor et al. 2003.

Tassels are relatively large inflorescences and produce many flowers. Estimates of pollen grain production range from 2 to 25 million pollen grains per tassel. Under normal summer conditions, most tassels in Missouri corn fields should produce at least 5 million pollen grains. Since a common ear size is nearly 1000 female flowers there are at least 2000 pollen grains for every silk and maybe as high as 25,000. Some corn seed companies use male sterility in producing their hybrids. So for some hybrids, not every tassel in a field will be fertile. Because so many pollen grains are produced by male fertile tassel under all but extreme weather conditions, there is usually plenty of pollen for all receptive silks in a field.

In Part 2 of this series I'll discuss the role of the female flowers, and in Part 3 I'll discuss factors that influence the fertilization process.

Sources

Aylor, DE, NP Scultes, and EJ Shields. 2003. An aerobiological framework for assessing cross-pollination in maize. Agricultural and Forrest Meteorology 119:111-129.

Nielsen, RL (Bob). 2010b. Tassel Emergence & Pollen Shed. Corny News Network, Purdue Univ. [On-Line]. Available at http://www.kingcorn.org/news/timeless/Tassels.html.

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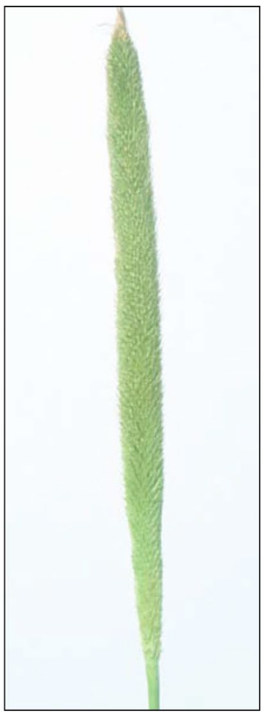
Forage of the Month: Pearlmillet

By Rob Kallenbach

Pearlmillet is an annual warm-season grass that produces most of its forage during midsummer. Other millets, such as proso, foxtail, Japanese or German, are often used in silage or hay mixtures, but they produce less forage and have a shorter grazing season than pearlmillet. Pearlmillet is an excellent choice for warm-season pasture in the Ozarks because it tolerates acidic soils and drought. Pearlmillet can produce 8,000 to 12,000 lb/acre of forage when harvested to a 6- to 10-inch stubble after accumulated growth reaches a height of 18 to 30 inches. Unlike sorghum-sudangrass, it does not contain prussic acid. It responds well to split applications of nitrogen at establishment and then again after the first grazing. Pearlmillet is a nitrate accumulator when water is lacking. It should be tested for nitrate levels before grazing during or immediately after a drought.

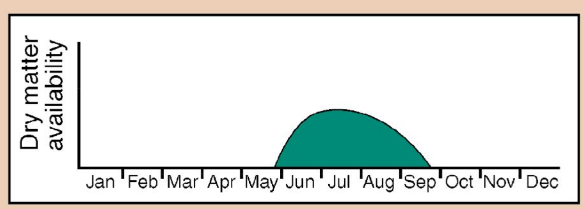


Seed head

Collar region

Pearlmillet

Origin: North-central Africa
Adaptation to Missouri: Statewide
Growth habit: Tall, erect, annual.
Blade: Flat, long, scabrous, and slender, with smooth to pubescent surface, prominent midrib, lanceolate.
Sheath: Purplish, split, open and pubescent.
Ligule: Short and pubescent.
Auricles: Absent.
Seed head: Compact, conical, spike-like panicle.
Fertilization: 60–90 lb N/acre at establishment. Thereafter apply 40–60 lb N/acre after each cutting or grazing. Phosphorus and and potassium to soil test.
Timing of production: 90 percent of production occurs in June, July and August
When to begin grazing: When it reaches 18–30 inches
When to cut for hay: When it reaches 36 inches
Lowest cutting or grazing height: 8 inches



Yield distribution of pearlmillet in Missouri.

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Corn Pollination, the Good, the Bad, and the Ugly

Part 2: The Female Role

By Bill Wiebold

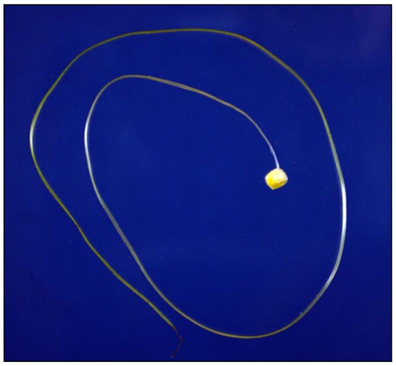

Figure 1. A single female corn flower composed of ovary, style and stigma. The silk on this flower was 11.5 inches long.

As I stated in Part 1 of this series, corn is unique among grain crops in that it is monoecious. This means that it possesses flowers that have only male sexual parts and flowers that have only female sexual parts on the same plant.

Female flowers are borne on the ear. The female sexual organ in flowers is called the pistil, and the pistil is composed of an ovary, a style, and a stigma (Figure 1). For corn, the ovary will mature to become the kernel, and the ovary wall becomes the outer "skin" of the kernel. Like all grass plants the corn ovary contains only one ovule (a seed is a mature ovule), so when the kernel matures there will be one seed inside each kernel. And, the seed coat fuses tightly to the ovary wall so they cannot be easily separated. The style is highly elongated and called the silk. The stigma is found at the end of the silk and is about one half inch long. The stigma looks like the rest of the silk except that it usually possesses more hairs (trichomes). Although these are technical terms, each of these parts play a role in successful corn fertilization.

Ear development begins early in the life cycle of the corn plant. Ear shoots are microscopic at first and located at stem nodes. Ear shoot growth occurs hidden within the leaf sheaths. If you remove all corn leaves including the sheaths as many as 8 to 10 ear shoots are large enough to be seen without a magnification. Most modern corn hybrids produce a single large ear because the topmost ear shoot dominates all of the other ear shoots.

Figure 2. A corn ear several days after growth stage R1. All husks have been removed.

Between growth stages V5 (5 leaf collars visible) and R1 (silking), primary ear shoot development coincides with tassel development and rapid stem elongation. First, the number of rows of flowers is determined. This number will always be even (e.g. 14, 16, 18) unless a mutation or some odd weather condition had occurred. Second, the number of flowers in each row is determined. Flowers are added to the tip of the ear in response to conditions the plant perceives at this time. Good nitrogen nutrition, high light levels (few weeds), and plentiful sugar production from photosynthesis (good weather) all lead to more flowers per row, and thus, larger ear size.

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Figure 3. Intact corn ear at growth stage R1.

Silks begin to elongate at about growth stage V12. Silks from flowers near the butt of the ear (closest to the stem) begin to elongate first. Silk from flowers near the tip of the ear begin elongation last. Silk elongation rates also differ among flower positions on the ear, so that silks from flowers near the butt emerge from husks several days before silks from the ear tip. Remember that there is one silk for each flower, so as many as 1000 silks push their way along the ear and within the husks (Figure 2).

The driving force for silk elongation is water pressure. The female flower absorbs water from the cob and the resulting pressure pushes the tip of the silk (stigma) forward. With 1000 silks all elongating at same time the "traffic" often is hectic. The time sequence of silk elongation – from base to tip –, the nearly straight rows of flowers, and small channels on the inside of the husks all give order to the elongation process. And, it works almost flawlessly most of the time. Sometimes silk traffic jams occur and the silks tangle leading to a condition called "silk balling". When this occurs, some to most of the silks on the ear will not be able to position themselves so that they intercept pollen. Fortunately, this occurrence is rare.

Elongation causes the ends of the silks to emerge outside the husks. One end of each silk is attached to an ovary and one end is visible outside the husks. Growth stage R1 occurs when silks are visible outside of husks (Figure 3). A silk will continue to elongate until at least one pollen grain lands on the silk and a pollen tube enters the silk. If pollination does not occur, silk growth will usually stop after about 10 days, probably because of dehydration. Unusually long silks that hang from the end of an ear is a sign that lack of pollination occurred.

In Part 1 of this series I discussed the role of the male flowers, and in Part 3 I'll discuss factors that influence the fertilization process.

Sources

Aylor, DE, NP Scultes, and EJ Shields. 2003. An aerobiological framework for assessing cross-pollination in maize. Agricultural and Forrest Meteorology 119:111-129.

Nielsen, RL (Bob). 2000. Silk Development and Emergence in Corn Corny News Network, Purdue Univ. Online at http://www.agry.purdue.edu/ext/corn/news/timeless/silks.html.

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None Like It Hot

By Bill Wiebold

This summer is shaping up to be one of the most stressful to Missouri crops in recent years. The combination of low precipitation and high atmospheric demand for water makes 2012 feel much like 1988. One of the driving forces for increased atmospheric demand is air temperatures much higher than normal. These high temperatures often have direct effects plants on plants, as well as aggravating water stress.

It is important to remember that plants react to temperature differently than humans. Humans must evaporate water to dissipate heat. High humidity reduces evaporation and greatly affects the way a particular temperature feels. Thus, weather stations report heat indices that are an attempt to estimate how air temperature "feels" to humans. High humidity translates into heat indices that are often five or more degrees above air temperature. Heat indices have little relationship to the direct effects of temperature on plants.

Sometimes leaf temperature is more important to plants then air temperature. Leaves function as solar collectors, that is, they are designed to absorb light energy. They do this in order to build sugars and produce other products necessary for life (and yield). However, very

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None Like It Hot

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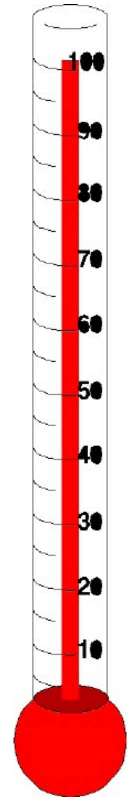
little of the light energy is actually used to do this work (photosynthesis). Light energy not used for photosynthesis causes leaf temperature to rise.

Plants dissipate heat through water evaporation from cell surfaces, convection, and conduction. Changing liquid water to water vapor requires substantial energy and this energy loss causes the cooling effect. Conduction means that the warm leaf surface gives energy to the air touching the leaf if the air temperature is less than the leaf temperature. Convection means that cooler air is moved closer to the leaf surface and displaces warmer air. These three methods of heat dissipation are very much interrelated, and without them the leaf temperature would quickly rise to the point where plants could not survive.

During the day it is not uncommon for leaf temperature to be higher than air temperature, especially on bright sunny days with little wind. With good moisture supply, evaporation will be fast enough to keep leaf temperatures fairly close to air temperature. With limited moisture, however, water evaporation may not be fast enough to cool the leaf.

Our crop plants have several mechanisms to reduce the amount of sunlight energy hitting their surfaces. Leaves of grass plants, such as corn, roll into a cylinder. This reduces leaf effective surface area and tilts leaves upward. Broad-leafed plants, such as soybean, move their leaves so that they are parallel with the incoming sunlight. Sometimes they will flip leaves so that their lighter colored bottom surfaces face upward. Although we see these responses during water stress, it is actually an attempt to reduce sunlight absorption, and thus, leaf temperature. Of course, the reason to reduce leaf temperature is to reduce water evaporation so the two factors are interrelated.

Nearly all of the chemical reactions necessary for the life of plants are controlled by enzymes (proteins). The rates of these chemical reactions increase with temperature, so, for example, plant growth and weight gain are greater at 80° than at 50°. These enzymes have a three-dimensional shape and can warp (change shape) at high temperatures. An extreme example of temperature affecting protein is the frying of an egg. The heat causes the egg protein to change its shape and become solid. The effect of temperature on plant enzymes isn't nearly that dramatic, but temperatures of 100 to 105 degrees can affect the shape of plant enzymes. When the shapes of the enzymes change, they no longer work as well. In other words, the reaction rate decreases. That is why 86° is often given as the optimum temperature for corn and soybean growth. Although the optimum is fairly flat for about 10 degrees, temperatures above the optimum slow many of the important reactions including those involved in photosynthesis.



So, high temperatures can harm crop plants and reduce yield. This direct affect from high temperature is probably small in most years, but when temperatures top 100° as they have too often this summer, yield was reduced even in those few areas of Missouri where precipitation has been close to adequate.

Unfortunately, high temperatures have other effects on plants. One almost hidden effect from increased temperature is the differential effects it has on photosynthesis and respiration. Photosynthesis is "income" for the plant world and respiration is an "expense". The difference between the two, net photosynthesis, is "net income". Within reason, high amounts of net photosynthesis often translate into high yield.

Some respiration is essential, just as some expenses are essential. Respiration oxidizes ("burns") sugars to produce energy that is needed for many of the life processes. However, some respiration is wasteful because it burns away or oxidizes sugars that could have been stored in seeds as yield. Hot temperatures stimulate respiration more than photosynthesis and reduce the plant's net income. This is particularly true during night when there is no photosynthesis. Warm night temperatures can decrease yield without showing any visible effects on the plants. Although high humidity can be beneficial to plants because water evaporation is reduced and this reduces water stress, high humidity also slows the rate by which temperatures cool at night. It is not uncommon for temperature to remain above 80° during summer nights if humidity is high (dew point above 65°). So, although plants do not "feel" a high heat index, they are affected by the slow temperature decline during nights of high humidity through increased respiration.

It is difficult to separate the effects of high temperature from the effects of water stress. Often these two stresses occur together and magnify the effects from each other. But, high temperatures can reduce yield even if plants exhibit no symptoms of water stress.

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Making Silage from Drought-Damaged Corn

By Rob Kallenbach

Dry conditions around the state have many corn producers wondering about making silage from drought-damaged corn. Although silage made from drought-damaged corn is usually not as good as that made from unstressed corn, drought-damaged corn can make good livestock feed.

As a rule, drought-damaged corn will have 85 to 95 percent of the feeding value of normal corn silage. Ideally, corn silage would be 60 to 70 percentage moisture at harvest. If drought-damaged corn contains less than 60 percent moisture, producers could add some water at the silo.

However, when drought slows plant growth and delays maturity, the moisture content is often higher than is suggested by the appearance of the crop. Taking the time to check the moisture content before harvesting could save a lot of trouble later. MU publication G3151 (http://extension.missouri.edu/p/G3151) contains detailed information on how to measure the moisture content of silage using a microwave oven.

Drought-damaged corn should be chopped to 3/8 to 1/2 inch in length. This length of chop should help in packing the silage to exclude as much oxygen as possible. Producers should also sharpen the knives on their equipment before making silage.

Other tips include filling the silo quickly and packing the silage as tightly as possible. Remember, to make good silage, oxygen should be excluded at all points. One concern with drought-damaged corn is high nitrate levels in the silage. High nitrate levels are frequently found where high levels of nitrogen fertilizer were applied and where drought-damaged corn is chopped a few days after a rain. Other factors that contribute to high nitrate levels in corn silage are cloudy weather, extremely high plant populations and shortages of soil phosphorus and potassium.

Ensiling drought-damaged corn is preferred to greenchop because during the fermentation process, the nitrate content can be reduced by 20 to 50 percent. If a producer suspects that the crop may have high nitrate levels, they should have it analyzed before harvest, if possible.

One word of caution: corn with high nitrate levels produces more silo gas (mainly nitrogen dioxide and nitrogen tetroxide) than normal corn silage. During the fermentation process, a portion of the nitrate in corn silage is converted to nitrogen dioxide or nitrogen tetroxide; the higher the nitrate levels in the plant, the more silo gas that is produced. The reddish-yellow fumes of silo gas often smell like chlorine bleach, and silo gas is toxic to humans. Remember that silo gas is heavier than air and thus tends to accumulate in low areas.

Most often, this is a problem for producers with upright silos, as the silo gas tends to accumulate in feed rooms at the bottom of silo chutes. Silo gas can be a problem for other silage storage systems as well and one should exercise caution around silos during the filling and fermentation process.

If producers have corn with high nitrate levels, there are a few things they can do.

First, they might delay harvesting until the plant begins to "outgrow" the nitrate accumulation. Usually, drought-damaged corn will have normal levels of nitrates after 10 days to two weeks of normal growth (once the drought ends!).

Second, producers might increase the cutting height to 8 or 10 inches. Nitrate levels are usually highest in the lower part of the stem, so increasing the cutting height can help lower nitrate levels in silage.

Finally, if they have high nitrate corn silage in the silo, they could dilute the silage in the ration with other low-nitrate feedstuffs.

Several producers have asked about making "big round bale silage" or baleage from drought-stressed corn. For those not familiar with the practice, this is simply baling high moisture forage and then wrapping the bales with plastic film to exclude oxygen. This could be a way to store the crop if typical silage-making equipment is not available, though corn is difficult to run through a standard round baler. Balers that have recutters to reduce particle length will make better silage out of corn than will balers without this equipment. Even for balers with recutters, corn stalks are prone to poking holes in the plastic film and thus spoiling silage. While 4 mil plastic thickness is recommended for normal grass silage, drought damaged corn made should be wrapped to a 6 mil thickness.

Harvesting drought-damaged corn for silage can be a way to salvage an otherwise useless crop. Paying close attention to moisture content, length of cut, packing and nitrate levels in drought-stressed corn cut for silage will help make the most of a bad situation.

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Drought May Result in Aflatoxin Contaminated Corn

By J. Allen Wrather

Corn harvest for most farmers in the upper Mississippi Delta Region including southeast Missouri will begin near August 1 to 15, and farmers need to beware of aflatoxin contaminated grain. Aflatoxin contaminated corn may develop this year because drought was severe, and damage to corn by drought can enhance the development on corn kernels of the mold that produces aflatoxin. All corn farmers even those that irrigated their crop should take some precautions to avoid problems with aflatoxin.

Here is the situation. The problem occurs when a mold named Aspergillus flavus feeds on the starch inside corn kernels and produces a chemical called aflatoxin that is a poison to many animals and to humans. This mold gets to the starch through cracks in the kernel hull caused by drought and through wounds caused by ear worm feeding. I don't know the reason this mold produces aflatoxin as it feeds, but it does. Aflatoxin will be produced as long as the mold feeds on corn in the field, on a truck after harvest, or in a grain storage tank, and it will not stop until the corn is at or below 13% moisture.

Aflatoxin is a poison to humans and animals, and the U. S. Food and Drug Administration designed methods to protect humans and animals from contaminated corn and corn products. One of the methods designed by FDA to protect us is to prevent grain merchants from buying corn containing 20 parts per billion or more aflatoxin. This is good because it minimizes availability of aflatoxin contaminated products that we eat such as corn meal.

This mold can grow on corn kernels in the field and on corn kernels stored in a truck or grain tank. The mold prefers to grow on 18-20% moisture corn kernels at around 85°F. It grows slowly on 15% moisture corn and will not grow or grows very slowly on 13% moisture corn. Farmers should dry freshly harvested corn to 15% moisture within 24 hours of harvest and dry corn to 13% for long term storage to stop growth of the mold and aflatoxin production.

What should farmers do this year? I suggest they first harvest some dryland corn and have the grain tested for aflatoxin. If it is not contaminated, then the irrigated corn will probably not be contaminated. If the dryland corn is contaminated, farmers should then harvest some irrigated corn and test it for aflatoxin. If the irrigated corn has no aflatoxin, farmers should first harvest and sell the healthy corn or store it in separate bins and then harvest the contaminated corn and store it separate from the healthy corn. Don't blend contaminated and toxin free corn in a truck or grain bin because this may result in contamination of the entire truck load or bin of corn.

What should farmers do to avoid aflatoxin problems next year and beyond? I suggest they only plant corn in fields that can be irrigated and treat growing corn for earworm if necessary. They may also consider planting corn varieties resistant to earworm, but the corn may still be contaminated with aflatoxin if not irrigated aggressively.

Again, corn farmers should beware of this problem and always dry corn to 15% moisture within 24 hours of harvest. More information is available on the web at http://extension.missouri.edu/publications/DisplayPub.aspx?P=G4155.

Following these suggested procedures will give corn farmers a better chance of producing aflatoxin-free corn during 2012. For more information, you may call me at 573-379-5431 or visit the web at http://aes.missouri.edu/delta/croppest/aflacorn.stm.

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Considering Your Grazing, Haying, and Silage Options for Herbicide-treated Corn and Soybean

By Kevin Bradley

With the drought we are currently experiencing in Missouri and throughout much of the Midwest, many farmers are starting to consider using at least some portion of their corn and soybean crop for livestock feeding purposes. Before making this decision, one of the most important considerations is the forage and feeding restrictions of the herbicides that have already been sprayed for weed control in these fields. In other words, it will be critical to know the waiting period that must be followed between application of a given herbicide and the grazing or harvesting of that crop for use as a forage. Tables 1 and 2 contain this information for some of the most common herbicides utilized for weed management in corn and soybeans in Missouri. In corn, the majority of herbicide labels allow for some type of grazing or forage use following application. As illustrated in Table 1, corn herbicide forage restrictions may vary from as little as 0 to as many as 60 days after application. In soybeans however, most of the product labels DO NOT allow soybeans to be grazed or harvested for forage or hay following herbicide application, so it will be critical to consult the individual product label of the herbicide(s) applied before deciding to utilize this crop as a forage.

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Considering Your Grazing, Haying, and Silage Options for Herbicide-treated Corn and Soybean

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Table 1. Waiting period before utilizing herbicide-treated corn for grazing or forage (silage) use.

Herbicide	Grazing Restriction	Forage (silage) Restriction
	Time After Application	
2,4-D	7 days	7 days
Accent	30 days	30 days
Aim	none	none
Atrazine	60 days	60 days
Balance Flexx	none	none
Banvel	after milk stage	after milk stage
Beacon	30 days	45 days
Bicep II Magnum/Cinch ATZ	30 days	30 days
Buctril	30 days	30 days
Cadet	90 days	30 days
Callisto	do not graze	45 days
Callisto Xtra	do not graze	60 days
Capreno	45 days	45 days
Clarity	after milk stage	after milk stage
Corvus	45 days	45 days
Define	none	none
Degree	21 days	21 days
Degree Xtra	21 days	21 days
Distinct	32 days	32 days
Dual II Magnum/Cinch	30 days	30 days
Gramoxone	none	none
Guardsman Max	40 days	40 days
Halex GT	45 days	45 days
Harness	21 days	21 days
Harness Xtra	21 days	21 days
Hornet	85 days	45 days
Ignite	70 days	60 days
Impact	45 days	45 days
Keystone	21 days	21 days
Lariat/Bullet	21 days	21 days
Lasso/Micro-tech	none	none
Laudis	45 days	45 days
Lexar	45 days	45 days
Liberty	70 days	60 days
Lumax	45 days	45 days
Northstar	30 days	45 days
Outlook	60 days	60 days
Parallel	30 days	30 days
Peak	30 days	40 days
Prowl/Pendimethalin	21 days	21 days

Table 2. Waiting period before utilizing herbicide-treated soybean for grazing or haying.

Herbicide	Label Statement Pertaining to Interval Between Application and Grazing, Haying, or Feeding Herbicide-treated Soybean
2,4-D	Consult individual label as product labels can vary. Do not cut for feed treated hay, forage, or fodder or graze treated soybeans to livestock.
Alert	Do not allow livestock to graze on treated soybean vines or feed treated vines or vine trash to livestock.
Assure II	Do not graze treated fields or harvest for forage or hay.
Authority Assist	Do not feed treated soybean forage, soybean hay or soybean straw to livestock.
Authority First	Do not feed treated soybean forage or soybean hay to livestock.
Authority MTZ	Do not graze treated soybean or harvest for forage or hay.
Authority XL	Do not feed treated soybean forage or soybean hay to livestock.
Basagran	Do not graze or cut treated soybean fields for forage or hay for at least 30 days after the last treatment.
Boundary	Do not graze or feed treated soybean forage for 40 days after application.
Butyrac 200/2,4-DB	Do not feed/graze soybean forage or harvest hay for 60 days following any 2,4-DB application.
Canopy	Do not graze treated fields or harvest for forage or hay.
Canopy EX	Allow 14 days after application before grazing or feeding forage or hay.
Classic	Do not graze treated fields or harvest for forage or hay.
Cobra	Do not graze treated fields or harvest for forage or hay.
Command	Do not allow livestock to graze on treated soybean vines or feed treated vines or vine trash to livestock.
Dawn	Do not graze treated areas or harvest for forage or hay.
Dual II Magnum/Cinch	Do not graze or feed treated soybean forage, hay, or straw to livestock 30 days following treatment.
Extreme	Do not graze or feed treated soybean forage, hay or straw to livestock.
Encompass	Do not graze treated fields or feed treated forage or hay to livestock.
Enlite	Do not graze treated fields or harvest for forage or hay.
Envive	Do not graze treated fields or harvest for forage or hay.
FirstRate	Do not apply within 14 days before harvest for forage or hay.
Flexstar/Flexstar GT	Do not graze treated areas or harvest for forage or hay.
Fusilade DX	Do not graze or harvest for forage or hay.
Gangster	Do not graze treated fields or feed treated forage or hay to livestock.
Gramoxone SL	Preplant or Pre-emergence: Do not graze or harvest for forage or hay before the R3 stage of soybean development (early pod). Spot Spray and postemergence directed sprays: 46 day forage or hay interval.
Harmony	Allow at least 7 days between application and grazing of treated forage. Allow at least 7 days between application and feeding of forage (green chop) from treated areas to livestock. Allow at least 30 days between application and feeding of dried hay from treated areas to livestock.

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Considering Your Grazing, Haying, and Silage Options for Herbicide-treated Corn and Soybean

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Table 1. Waiting period before utilizing herbicide-treated corn for grazing or forage (silage) use.

Herbicide	Grazing Restriction	Forage (silage) Restriction
	Time After Application	
Permit/Sandea	30 days	30 days
Prequel	30 days	30 days
Princep/Simazine	do not graze	none
Python	85 days	85 days
Realm Q	45 days	45 days
Resolve	30 days	30 days
Resource	28 days	28 days
Roundup/other glyphosates	50 days	50 days
Sencor	60 days	60 days
Sharpen	80 days	80 days
Shotgun	21 days	21 days
Spirit	30 days	40 days
Status	32 days	32 days
Steadfast	30 days	30 days
Steadfast ATZ	60 days	60 days
SureStart	45 days	45 days
Surpass/Topnotch	21 days	21 days
Stinger	40 days	40 days
Touchdown	50 days	50 days
TripleFlex	45 days	45 days
Verdict	80 days	80 days
WideMatch	47 days	47 days
Yukon	after milk stage, at least 30 days	after milk stage, at least 30 days

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Table 2. Waiting period before utilizing herbicide-treated soybean for grazing or haying.

Herbicide	Label Statement Pertaining to Interval Between Application and Grazing, Haying, or Feeding Herbicide-treated Soybean
Ignite	Do not graze the treated crop or cut for hay.
Liberty	Do not graze the treated crop or cut for hay.
Op-Till	Do not graze or feed treated soybean forage, hay or straw to livestock.
Op-Till Pro	Do not graze or feed treated soybean forage, hay or straw to livestock.
Outlook	Do not graze or feed forage, hay, or straw to livestock.
Phoenix	Do not graze animals on green forage or stubble. Do not feed treated soybean silage (ensiled soybeans) to cattle. Do not utilize hay or straw for animal feed or bedding.
Poast/Poast Plus	Only processed meal from seed or hay may be fed to animals.
Prowl/Prowl H2O	Livestock can graze or be fed forage from treated soybean fields
Prefix	Do not graze treated areas or harvest for forage or hay.
Pursuit	Do not graze or feed treated soybean forage, hay or straw to livestock.
Python	Do not graze or feed treated soybean forage, hay or straw to livestock.
Raptor	No grazing or forage restrictions listed.
Resource	Do not graze treated fields or harvest for forage or hay.
Rhythm	Do not graze treated areas or harvest for forage or hay.
Roundup WeatherMax/ other Roundup labels/ other glyphosate labels	Roundup WeatherMax - Allow a minimum of 14 days between final application and harvest of soybean grain or feeding of soybean grain, forage or hay. Consult individual glyphosate and Roundup product labels. There are individual differences among labels.
Scepter	Do not graze or feed treated soybean forage, hay or straw to livestock.
Select Max	Do not graze treated fields or feed treated forage or hay to livestock.
Sencor/Metribuzin	Treated vines may be grazed or fed to livestock 40 days after application.
Sequence	Do not feed treated soybean forage or hay for 30 days after application.
Sharpen	Soybean forage may be fed or grazed 65 or more days after application.
Sonic	Do not feed treated soybean forage or soybean hay to livestock.
Storm	Do not allow livestock to graze on treated forage. Do not feed treated vines.
Synchrony XP	Do not graze treated fields or harvest for forage or hay.
Treflan	Consult product labels. No apparent grazing or forage restrictions when applied in soybeans.
Touchdown HiTech	Do not graze or harvest for forage or hay.
Ultra Blazer/Blazer	Do not use treated plants for feed or forage.
Valor SX/Encompass	Do not graze treated fields or feed treated forage or hay to livestock.
Valor XLT	Do not graze treated fields or feed treated forage or hay to livestock.
Verdict	Do not graze or feed forage, hay, or straw to livestock.

Corn Pollination, the Good, the Bad, and the Ugly

Part 3: Boy Meets Girl

By Bill Wiebold

As I described in Parts 1 and 2 of this series, corn is unique among grain crops in that it is monoecious. This means that it possesses flowers that have only male sexual parts and flowers that have only female sexual parts on the same plant. Also unique among grain crops, these flower types are separated on a plant by a distance of several feet.

Successful kernel formation is dependent upon both flower types developing in sync with each other (nick), pollen grains landing on exposed silks (pollination), the joining of a male gamete with a female gamete to form the kernel embryo (fertilization), and the joining of another male gamete with two other female nuclei to form the endosperm (second fertilization). This double fertilization is truly a miracle and happens millions of times in our cornfields. Unfortunately, the weather events that most of Missouri has experienced this summer can interfere with each of these events.

Nick

In Parts 1 and 2, I described the development of the male and female flowers. Under normal conditions the growth and maturing of these two flower types prepare them so that pollen shed occurs within a day or two after silk emergence from husks. This timing is given a colloquial term – nick. Pollen shed and silk receptivity to that pollen last for at least six days, so some leeway is built into corn plant development to help ensure that pollen is shed when silks are available to catch the pollen. But, several factors, including our unprecedented weather events, can interfere with the timing and lead to "poor nick".

Water pressure (turgor) drives silk elongation. Silks are highly susceptible to water loss and loss of turgor pressure. They are highly elongated so their surface area to volume ratio is extremely large. They appear to lack much ability to regulate the amount of dissolved molecules in their cells. Dissolved molecules, like sugars, is one way that plant cells can cause water to flow from outside the cell to inside the cell. And, they must elongate a long distance from their source of water.

Water enters silks from the ovary to which they are attached. The ovary receives water from the cob, and the cob receives water from the stem through the shank. Silks must compete with nearly all other plant parts for water. They are at the end of a long chain of these plant parts. So, they are at a competitive disadvantage when water becomes scarce. Fortunately, the place where the silk attaches to the ovary and nearly the entire length of the silk is covered by multiple layers of husks. This helps protect them from harsh environments. But, when water availability is limited silks are often affected first and to a greater amount than other plant parts, such as leaves.

When soil moisture content is low or heat causes increased water loss from plants, silk turgor pressure decreases and silk growth slows. In fact, there are clear diurnal growth patterns for silk. Most rapid elongation of 1.5 to 2.0 inches per day occurs at night or in the morning when water status in the plant is at its greatest. During the afternoon, when plant water status decreases, silk elongation also decreases – sometimes to zero. Drought will extenuate this pattern, and if drought stress lasts through the night, silk growth may be nearly zero for the entire day. Elongation rate changes with days after initial silk growth. Under adequate water levels, the fastest growth rate is on the first two days and growth slows with each succeeding day until by day 10 when growth is quite slow.

Drought affects silk growth far greater than pollen development. Under most commonly experienced droughts, pollen development and pollen shed will continue on schedule. Slow silk growth means that fewer silks will have emerged from the husks while pollen is being shed. Silks that emerge after pollen shed is completed will not capture pollen, an essential step to producing a kernel. With extreme drought, it is possible that nearly all of the pollen grains are released from the tassels by the time most of the silks have emerged. This results in a few kernels being produced on an ear rather than the normal 600. Most of the yield loss from poor nick is permanent because corn has little capacity to compensate for small seed number by increasing seed size – even if adequate precipitation returns.

Figure 1. Pollen and empty anthers caught in leaf collar.

This year's drought was more intense than most and accompanied by

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high temperatures. Water evaporation rates from soil and plant leaves were much greater than usual because of high temperatures, low humidity, and fast wind speeds. Plant water status dropped much lower than we've experienced in recent droughts. Water pressure also drives stem cell elongation. With low water pressure, stem cells remained small and plants remained short. In 2012, it is not uncommon to see corn plants 2 to 3 feet shorter than normal. In fact, in some fields tassels did not emerge or only partially emerged from the leaf whorl. Pollen grains released from tassels still covered by leaf sheaths have no chance to fall onto silks. Often when drought causes a poor nick it is because of the effects of drought on female flowers. But, in 2012 there were some instances of poor nick caused by drought effects on the male flowers.

Pollination

Pollination is defined as pollen grains landing on silks. For the process to work, silks must intercept pollen grains and retain those pollen grains. Corn pollen is carried by wind, but the individual grains are relatively heavy. Because of their weight, most pollen grains are carried less than 50 feet from the plant producing them. But, a few pollen grains may travel 500 or more feet, especially if winds speeds are fast.

Pollen grains are released into the air and fall toward the ground. Since silks cannot move; they must be located in the path of these falling pollen grains. Other plant parts often block the movement of the pollen. LAI is the ratio of leaf area to land area. A productive corn field may have an LAI of 6. That means that for every acre of land area there are 6 acres of leaf area. Unfortunately, silk surface area is small in comparison to leaf area. The silk area index (SiLI) is only 0.003. Each individual silk is small, and although an ear may produce 1000 silks, the opportunity for a pollen grain to land on leaf material is far greater than landing on silk (Figure 1). Although a tassel produces at least 2000 pollen grains for each silk, most of those pollen grains will land somewhere other than on a silk.

Figure 2. Closeup of corn silks. Notice small hairs that help capture pollen grains.

Silks possess hairs (trichomes) that help them catch and hold onto pollen grains (Figure 2). Hairs on the silks are stickier than hairs located on other plant parts, such as leaves. So, pollen grains may bounce or roll off of leaves, but if they land on silks they are usually retained. Both pollen grains and silks are small and their small sizes reduce the probability that they will meet each other. The diameters of pollen grains are about one-fourth the size of silks, but nearly three times the size of the hairs on the silks.

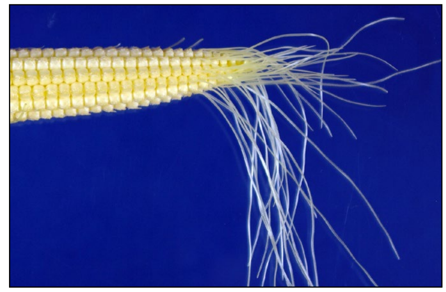

Figure 3. Short silks from flowers near the ear tip. Most of the other silks have been removed to expose tip silks.

One other characteristic of ears can lead to poor pollination of some kernels. As described in Part 2, silks from flowers near the tip of the ear start to elongate later and elongate slower than other silks. As the nearly 1000 silks emerge from husks, silks from the tip ovaries are often late to emerge or buried within mass of other silks (Figure 3). So, even with adequate water, silks from tip kernels may not be pollinated.

Figure 4. Tip of corn ear that developed under drought. Most tip flowers were not fertilized. Some fertilized kernels show arrested development.

Fertilization

Once pollination has occurred and at least one pollen grain has stuck onto a silk, several important steps are necessary to complete fertilization. The pollen tube "germinates" and the pollen tube emerges from the pollen grain. This requires water and that water comes from the silk. So, water flows from the silk and into the pollen grain.

Figure 5. Center of corn ear that developed under drought. The remains of several flowers that were not fertilized are apparent. Notice how kernels become round in shape when not bordered by other fertile kernels.

The pollen tube must find an entry point into the silk. Pollen tubes can grow along the outside surface of silks, but the longer they remain on the outside, the greater their vulnerability to dehydration and death. Silks have a waxy cuticle just like other plant parts, and pollen tubes

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Figure 6. Corn ear that developed under drought. Although most unfertilized flowers were near ear tip, alos occurred at other regions throughout the ear. This ear has about 225 kernels instead of 500 to 600 of a normal ear.

may not be able to go through the cuticle. Fortunately, there are breaks in the cuticle especially on the hairs. Pollen tubes usually find places to enter the silks and begin elongating down the inside of the silks.

There are pathways within silks that help direct the elongating pollen tubes. It is possible for more than one pollen tube to enter a silk, but only one pollen tube will grow down the entire length of the silk and enter the ovule for fertilization. The water to drive pollen tube elongation comes from the silk. It takes about 24 hours for the pollen tube to grow the entire silk length and if the silk loses water during that time the pollen tube may not complete its journey. One common result of reduced water status is a collapse of the silk near the ovary. If this happens, pollen tube growth is prevented. Anything that prevents the pollen tube from entering the ovule will prevent fertilization and a kernel will not form (Figures 4, 5, 6).

Three nuclei (plural of nucleus) move from the pollen grain and into the pollen tube. One of the three nuclei directs pollen tube growth and will be not involved in fertilization. The other two nuclei travel down the pollen tube and enter into the ovule once the pollen tube completes its journey. One male nucleus combines with the female gamete to form the embryo within the kernel. The other male gamete joins with two female nuclei to form the endosperm of the kernel. These two events are called double fertilization and are required for the kernel to form and begin growth. A day or two after fertilization occurs, the silk separates from the kernel and changes color as it dries.

Conclusions

Corn is an amazingly productive plant. One kernel planted returns 600 kernels at harvest. Its unique reproductive characteristics have allowed for an efficient and profitable breeding industry to develop. But, a chain of events must occur in the correct sequence and be properly timed for farmers to reap the benefits of corn's high productivity. The summer of 2012 has taught us, again, how important Mother Nature is in determining corn yield and the economic viability of Missouri's farmers. Lack of precipitation affected silk elongation and the ability of pollen tubes to grow through the entire length of the silk. High air temperatures may have had some direct effects on pollen viability, but the primary effect of temperature was increased water evaporation that accentuated the problems related to scarce water availability.

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Field Crop Disease Update - July 31, 2012

By Laura Sweets

This season has been an extremely challenging one for corn and soybean crops in much of Missouri and it doesn't look like there is any relief in sight. Both corn and soybean are showing symptoms of drought and heat stress. In some cases diseases may be compounding the damage.

Corn: We have received several samples of corn leaves showing firing from the tip towards the base of the leaf. In most cases the discoloration is a fairly uniform light brown to pinkish-brown in color and may cover more than half of the leaf. Individuals have asked if this is Goss's wilt or drought and heat stress. Samples have been checked for bacterial streaming (the Goss's wilt pathogen is a bacterium) and have been tested using the immunostrip assay. So far all samples received this year have been negative for Goss's wilt. The symptoms are more suggestive of those caused by hot, dry conditions.

Goss's wilt typically begins as a water-soaking of the tissue. The lesions may turn yellow-green and eventually brown to reddish brown. Lesions may form along leaf margins, at the tips of leaves or in the center of leaves. So there is more variation in lesion color and shape than with heat and drought stress injury. A key symptom of Goss's

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wilt is the presence of dark green specks or "freckles" in the lesion or close to the edge of the lesion. Glistening droplets of bacterial ooze on the lesion surface would be another sign that Goss's wilt is the problem. The University of Nebraska Extension Guide on Goss's wilt may be found at the following site and has more detailed descriptions and pictures of this disease. http://www.ianrpubs.unl.edu/epublic/pages/publicationD.jsp?publicationId=679

Corn Ear and Kernel Rots: Several fungal ear and kernel rots are showing up on corn, especially on ears damaged by insects or ears showing damage from drought and poor pollination. Dr. Allen Wrather has provided an article focusing on Aspergillus flavus and aflatoxin. In addition to Aspergillus flavus, Penicillium species, Fusarium graminearum and Aspergillus niger have been present on ears collected in central Missouri. In fact some ears have had all four of these ear and kernel rot fungi present. Mold growth tends to be prevalent around sites of insect damage, at the tips of ears and around areas where kernel set was poor. At this point in the season there are no control measures for the ear and kernel rots of corn. Growers should scout fields to determine if ear and kernel rots are prevalent and then take precautions at harvest (see Dr. Wrather's article).

Soybeans: There have been few reports of foliage diseases in soybean fields this season. Scattered fields are showing symptoms of sudden death syndrome but weather conditions have not been conducive for widespread development of this disease. Most questions are related to wilting, stunting and premature death of soybean plants. In most cases the stunted plants have poor root systems with possible Fusarium root rot and/or Rhizoctonia root rot. So far there have not been many samples with charcoal rot but would expect this disease to show up as the season progresses. But much of the damage to these stunted, wilted or dead plants is due to the unusually hot, dry weather pattern the state has endured for the last three months. The root rot pathogens are taking advantage of the weakened plants.

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End-of-Season Corn Stalk Nitrate Challenge Postponed Until 2013

By John Lory

The end-of-season Corn Stalk Nitrate Challenge will not be held in 2012 because of the effects of the drought on the Missouri corn crop.

The Corn Stalk Nitrate Challenge is a joint program of the University of Missouri Extension Commercial Agriculture Program, the Missouri Corn Growers Association and the Environmental Resources Coalition. For the past three years the program has paid the cost of end-of-season corn stalk nitrate samples submitted to the University of Missouri soil and Plant Testing Service in Columbia Missouri if farmers provided information about nitrogen fertilizer management on their field.

The corn stalk nitrate test can be used as an end-of-season analysis of nitrogen management in a corn crop. This test is taken at the end of the growing season close to black layer formation in the corn grain. The concentration of nitrate the corn stalk in a eight-inch segment cut six inches above the ground is correlated with the sufficiency of nitrogen fertilizer used during the growing season. The test can be used to determine if the fertilizer rate was low, marginal, optimal or excessive.

The extreme drought in Missouri has dramatically reduced yield potential on most corn fields. Under these extreme conditions the usefulness of the end-of-season stalk nitrate test for assessing nitrogen management is limited. Consequently, the Missouri end-of-season corn stalk nitrate challenge will not be held in 2012.

"We look forward to working with farmers and the Missouri Corn Growers Association in future years on the end-of-season Corn Stalk Nitrate Challenge" said John Lory, Nutrient Management Specialist at University of Missouri. "The program provides valuable information to farmers about nitrogen management on their field and provides an important assessment of nitrogen management across Missouri corn fields."

If you have questions about the end-of-season Corn Stalk Nitrate Challenge contact John Lory (LoryJ@missouri.edu).

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Drought Damaged Soybean for Hay or Silage

By Rob Kallenbach

Given the dry weather across much of Missouri, many farmers are considering harvesting drought-damaged soybean for hay or silage. Soybean is a good alternative or emergency source of livestock feed if a managed correctly. A few tips on how to handle soybean for forage are offered below.

Ideally, soybean hay or silage should be harvested when 50% of the pods have immature beans. Under severe drought conditions, the pods may never develop or develop erratically. Fortunately, soybean makes decent quality hay or silage at any stage before the beans fully develop. Quality of soybean hay is quite variable but typically contains 16 to 19% crude protein and 50 to 55% TDN if harvested when 50% of the pods have immature beans. Once leaf-drop starts, forage quality drops rapidly and soybean probably should not be harvested for forage after this point.

A common problem with soybean hay is that the immature beans dry slowly in the pods and often mold inside the hay. Crimping the hay with a mower conditioner will make the drying more even, but the pods are still the slowest drying part of the plant. Waiting to bale until the pods dry fully reduces this problem, although more leaves will be lost. Chopping soybean for traditional silage or making them into baleage (bale silage) will minimize this problem. If making soybean into silage, the ideal moisture content for storage is 55%.

Another problem with soybean hay is that it does not weather well when stored outside. Large round bales of soybean hay left unprotected from the rain deteriorate much more rapidly than grass hay. It is common to lose 50% of the forage to weathering if the hay is left unprotected. Storing soybean hay in a well-drained and covered stack or in a barn is imperative. Net wrap helps keep the bales in better shape for feeding than does twine.

Often, soybean hay is stemmy and may be refused by livestock. Typically, 10-20% of soybean hay is wasted during feeding due to the coarse stems. If soybean is harvested for silage, or if soybean hay is chopped in a tub grinder, cattle will eat almost all of it. However, the stem contains high levels of fiber and low amounts of digestible nutrients. It may be more economical to simply feed more hay and let the cows leave the stems.

A word of caution: soybean treated with many herbicides can NOT be used for livestock feed. If in doubt, READ THE LABEL! A recent ICPM newsletter article by Kevin Bradley outlines the label restrictions for many commonly used herbicides http://ipm.missouri.edu/IPCM/2012/7/Considering-Your-Grazing-Haying-and-Silage-Options-for-Herbicide-treated-Corn-and-Soybean/

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Weather Data for the Week Ending July 28, 2012

By Pat Guinan

Station	County	Weekly Temperature (°F)						Monthly Precipitation (in.)		Growing Degree Days‡	
		Avg. Max.	Avg. Min.	Extreme High	Extreme Low	Mean	Departure from long term avg.	June 1-28	Departure from long term avg.	Accumulated Since Apr.1	Departure from long term avg.
Corning	Atchison	*	*	*	*	*	*	*	*	*	*
St. Joseph	Buchanan	97	73	103	64	85	+8	0.38	-3.81	2559	+624
Brunswick	Carroll	95	71	101	61	83	+7	0.85	-3.01	2560	+586
Albany	Gentry	98	68	105	61	83	+6	1.99	-2.58	2488	+588
Auxvasse	Audrain	99	71	105	62	85	+8	0.86	-2.74	2564	+563
Vandalia	Audrain	98	71	104	61	84	+7	1.03	-3.00	2557	+612
Columbia-Bradford Research and Extension Center	Boone	98	71	105	63	85	+7	0.44	-3.17	2536	+485
Columbia-Capen Park	Boone	101	67	107	60	84	+6	0.79	-3.30	2438	+317
Columbia-Jefferson Farm and Gardens	Boone	98	72	104	65	86	+8	0.53	-3.08	2616	+560
Columbia-Sanborn Field	Boone	98	75	104	67	87	+9	0.56	-3.19	2763	+637
Columbia-South Farms	Boone	99	72	104	64	86	+8	0.68	-2.99	2609	+556
Williamsburg	Callaway	99	71	106	62	85	+8	0.64	-3.13	2581	+634
Novelty	Knox	97	71	104	61	84	+8	0.25	-3.61	2383	+461
Linneus	Linn	96	70	102	61	83	+7	4.14	-0.28	2463	+574
Monroe City	Monroe	97	70	105	61	84	+8	1.69	-1.91	2482	+512
Versailles	Morgan	102	73	106	62	87	+9	0.46	-3.28	2752	+648
Green Ridge	Pettis	99	73	104	64	86	+9	0.72	-3.09	2636	+615
Lamar	Barton	99	72	102	65	86	+7	0.52	-3.77	2710	+529
Cook Station	Crawford	101	68	104	58	85	+7	1.80	-1.37	2480	+373
Round Spring	Shannon	100	66	103	59	82	+5	1.83	-1.58	2384	+363
Mountain Grove	Wright	99	69	100	61	84	+7	2.53	-1.05	2523	+553
Delta	Cape Girardeau	94	70	96	64	82	+3	3.39	+0.66	2658	+285
Cardwell	Dunklin	93	72	95	70	82	+2	2.89	-0.10	2874	+283
Clarkton	Dunklin	94	72	98	70	83	+3	2.70	-0.46	2878	+330
Glennonville	Dunklin	94	72	96	70	83	+3	2.29	-0.87	2879	+340
Charleston	Mississippi	96	72	100	69	84	+5	1.92	-1.27	2824	+437
Portageville-Delta Center	Pemiscot	95	73	98	71	84	+4	2.03	-0.82	3010	+437
Portageville-Lee Farm	Pemiscot	94	73	98	71	84	+4	4.01	+0.91	2973	+417
Steele	Pemiscot	95	74	99	72	84	+4	2.93	+0.01	3031	+445

‡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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