# *North Central Ohio Agronomy Report*
## *Erie Basin Extension Education & Research Area*

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THE OHIO STATE UNIVERSITY EXTENSION

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Dear Agricultural Producer:

Wheat quality has certainly been an unfortunate experience in most of central Ohio. With much of the earlier planted corn now tasseling, the recent rains have been a real benefit. While there are a lot of very good uniform corn fields, there are many that are "up and down" and lack the color and root system to recover and make average yields. Tasseling and silking in some fields will be extended over 2 to 3 weeks within a field. This can create concerns about complete pollination.

Soybeans are benefitting from the current stretch of drier weather. Foliage color of soybeans is improving and the benefits of nodulation are becoming apparent.

Some soybean fields will need a final pass with the sprayer. Weed issues are likely to be an ongoing issue the rest of the summer in some fields because of the thin stands in some cases and drowned out areas.

Best regards,

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## Q and A: Vomitoxin, Health, and Safety

Pierce Paul, Katelyn Willyerd, Plant Pathology
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Ohio's wheat harvest is in full swing and concerns about vomitoxin are being raised, especially in areas hit by head scab. Data from our field survey showed that this year's scab incidence ranged from 3 to 60%, so fields with the highest incidence will likely be the ones with the highest levels of vomitoxin. However, scab levels in the field are not always the best predictor of toxin levels in harvested grain. Vomitoxin can only be determined by appropriate sampling and testing. Harvesting, sampling, and testing expose combine operators and grain handlers to moldy grain and vomitoxin. Early reports coming in from across the state indicate that in some of the worst areas, vomitoxin levels are as high as 9 ppm, and close to 3 ppm in less affected areas. The following Q and A explains the risk of vomitoxin to humans and highlights safety precautions.

**Why is vomitoxin harmful and how toxic is it?** Vomitoxin research on humans is prohibited for legal and moral reasons, but we do know the effects of vomitoxin on animals with similar body systems to humans (such as pigs and primates). Low levels of vomitoxin (0.05 to 0.1 mg/kg body weight) can cause vomiting in pigs – this would be similar to exposing a 175lb person to 0.0003 ounces of vomitoxin (a VERY small amount!). In humans, scabby grain has been associated with food poisoning symptoms (nausea, abdominal pain, dizziness and fever) 30 minutes after consumption. Long-term and continuous exposure to even lower levels of vomitoxin may cause dangerous reduction in appetite, weight loss, damage to the gastro-intestinal tract and impair the immune system.

**Does vomitoxin cause cancer?** Vomitoxin has not been reported to cause cancer. However, scabby wheat (and moldy corn) may contain other toxins that are just as harmful as or even more harmful to humans and animals than vomitoxin. Some of these other toxins do cause cancer.

**What are the precautions for harvesting grain with scab?** An air-conditioned combine cab with appropriate filters cuts down exposure to dust, and consequently, vomitoxin at harvest. It is important to note that the chaff and other parts of the wheat head contain much higher levels of vomitoxin than the grain itself. The scab fungus infects and spreads through these tissues first as the grain is developing in the field. Dust from chaff containing vomitoxin may be more harmful than dust from ground grain.

**Do I still need to use gloves and masks in the seed house?** Yes. It would seem reasonable to think that the problem will decrease once you leave the field, since lots of scabby kernels and most of the contaminated chaff, straw, and dust are left out there. However, if we consider the time spent in the seed house handling scabby grain, the exposure to mold and vomitoxin may be just as high, if not higher.

**How do I know if I am being affected by vomitoxin?** Quite often scabby grain will contain multiple molds and toxins. As such, symptoms of mycotoxicosis (disease caused by mycotoxins in humans and animals) usually result from the combined effects of these toxins, and are often due to the ingestion of contaminated food products. Skin and eye irritations are definitely topical symptoms of over-exposure, but for more serious concerns, laboratory exams and a medical doctor's opinion will be needed. Some symptoms can be confused with allergic reactions.

**What about inhaling vomitoxin?** Vomitoxin is not found "freely floating" in the air. However, it is present in dust particles from wheat chaff and grain present in elevators, bins, seed houses, grinding facilities, etc. A dust mask should be worn whenever handling contaminated grain. Read the article by Jepsen and Fleming, Dust Mask Protection from Wheat Dust, (in this issue of C.O.R.N) for information on the health effects associated with the inhalation of dust particles.

**Handling scabby grain with bare hands?** Although mycotoxins are of greatest concern when ingested with contaminated food products, some toxins, including vomitoxin, can be absorbed through the skin. And remember, vomitoxin may not be the only toxin present in moldy grain. Gloves (preferably latex/nitrile) should be worn and handlers should wash hands and other exposed skin thoroughly after handling molds grain. The biggest danger is bringing hands that have touched scabby grain to your mouth.

**What about straw from scabby fields, will it contain mycotoxins?** Yes. Straw from scabby fields does contain vomitoxin and other mycotoxins. Results from studies done at the University of Illinois (with laboratory tests done at North Dakota State University) confirmed that vomitoxin levels may exceed 2 ppm in wheat straw, even in field treated with fungicide. As a result, the same caution exercised when handling and feeding scabby grain should be exercised with dealing with moldy straw. Get the straw tested before using it for silage or bedding. The risk of contamination is much lower when straw is used for bedding; however, you should still avoid straw with very high levels of vomitoxin, since it is impossible to tell how much the animals will munch on the straw.

## Crop Insurance and Vomitoxin in Wheat: What are Farmers Options

Chris Bruynis, Extension Educator, Wyandot County
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Producers that carry multi-peril crop insurance policies subsidized and reinsured by the Federal Crop Insurance Corporation (as overseen by the Risk Management Agency (RMA)) may be eligible for quality loss adjustments if the reason for the loss in value is due to a covered event such as the excessive precipitation received this spring. Reports coming from the elevators on harvested wheat indicate that not only are wheat yields lower than expected but vomitoxin levels are high, ranging from 5 – 10 ppm in Northwest Ohio.

In order for producer's to protect their rights, it is imperative to report any damage in the required time frame and seek advice from the insurance company before proceeding with harvest or destruction of the damaged crop. Failure to do so may jeopardize the claim. Crop insurance policies require that farmers notify their company within 72 hours of noticing a loss. It is important that farmers be proactive in checking their fields to determine if there is any damage to the crop before harvest. Quality adjustments are available for loss in value for conditions such as low test weight, damaged kernels, and shrunken or broken kernels. Discounts made for crop loss purposes may not be the same as those seen at the elevator. For example, quality discounts begin when the test weight is less than 50 pounds, defects are above 15% or grade is U.S. No. 5 or worse.

Any production of extremely poor quality wheat that has a value not located on the discount factor charts in the Special Provisions of Insurance ("off the discount tables") is adjusted by taking the actual sale price based upon the Reduction In Value divided by the local market price to equal the discount factor for the production. In the event that the production has a Zero-Market Value Production, RMA loss procedures require insurance providers to make every effort to find a market for the production before declaring a zero value. Therefore, insurance providers will not be making declarations of zero market value until they can firmly establish that there is no market for poor quality grain.

Quality adjustments are based on samples obtained by the adjuster or other disinterested parties authorized by the insurance provider, such as an elevator employee. Harvested and delivered production samples taken from each conveyance and then blended may be accepted under certain conditions. If vomitoxin is suspected, the sample must be collected before the grain is placed in storage to be eligible for quality adjustment. The samples should be placed in a heavy paper bag for delivery to an approved laboratory for a determination of whether vomitoxin is present. There is a minimum number of samples required based on acreage. For a field of 10 acres or less 3 samples are required: 40 acres or less 4 samples and the one additional sample for every additional 40 acres or fraction thereof. Examples: 9 acres = 3 samples; 13 acres = 4 samples; 63 acres = 5 samples; 110 acres = 6 samples.

There are special problems that arise when examining quality adjustments such as vomitoxin in wheat. The first problem is the elevator's discounts that are applied to the wheat. They may not align with the calculations determined by RMA, resulting in a discrepancy between the discounts taken by the elevator and the coverage provided from the indemnity payment. The second problem is the adjustment that occurs to the proven yield for this year's crop that becomes part of the farm's 10 year actual production history (APH). Since price is fixed at the planting or the harvest price, the quality loss adjustment is attributed to the yield. In the example below, a producer has purchased 4,500 bushels of coverage (45 bu/a) on his 100 acres of wheat. At harvest 40 bu/a were harvested with an average vomitoxin level of 10 ppm. If no quality adjustment is made, the APH for 2010 is 40 bu/a and the indemnity payment is for 500 bushel. If quality adjustments are made, the APH becomes 20 bu/a in this example and the payment would be for 2,500 bushels. This difference in yield might lower the farms APH enough to make the increased indemnity payment less attractive, especially if the discount taken at the elevator was significantly less than the calculated loss.

**Example of coverage calculation:**

Producer has actual production history (APH) of 60 bu/acre

Producer plants 100 acres; elects 75% coverage level

60 bu/acre X 100 acre X 75% = 4,500 bu coverage

**Example with no quality adjustment**:

Producer harvested 4,000 bu Production to Count (PTC)

4,500 bu coverage – 4,000 bu PTC = 500 bu shortfall

Indemnity based upon 500 bu X price election

**Example with quality adjustment:**

Producer harvested 4,000 bu Production to Count (PTC)

Production is quality adjusted to 2,000 bu PTC

4,500 bu coverage – 2,000 bu PTC = 2,500 bu shortfall

Indemnity based upon 2,500 bu X price election

Farmers also need to think about the implication on ACRE and SURE in claiming the quality adjustment for crop insurance purposes. SURE payments are 60% of the difference between the SURE guarantee and all crop revenue. All crop revenue includes insurance indemnities, prevented planting payments, other federal aid for same loss, 15% of direct payments, all ACRE, counter cyclical, and market loan program payments, and the estimated actual crop revenue from farm. Taking the quality adjustments would increase the insurance indemnities while lowering the estimated actual crop revenue for a net sum of zero (or close to zero). In the event there is a 2010 SURE payment, taking the quality adjustment should have minimal impact on the SURE payment.

If the producer has enrolled in ACRE, the farm's five year Olympic average is used to set the farm trigger. There is nothing in the literature that would indicate that the quality adjustment would affect the 2010 crop yield used in this calculation. Producers can still use elevator receipts to verify yield so the actual yield before quality adjustments would be used. Even if the 20 bushel yield in this example was used in calculating the Olympic average, it would be the low year and excluded from the average. This only becomes problematic if there is another very low year in the past five years or in the future.

As a final comment, producers should contact their crop insurance provider as soon as possible to discuss potential losses and receive the correct procedures to follow. This will help insure that the producer can collect an indemnity payment if the conditions warrant. Just because a producer contacts their crop insurance provider, does not require them to file a claim, if they choose not to following harvest.

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## Vomitoxin and Other Disease Damage in Wheat -Legal Ramifications for Producers and Buyers

Robert Moore, Attorney
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The unusually wet spring has predictably caused disease problems in Ohio's wheat crop. In addition to head scab and other more common diseases, vomitoxin is being found in this year's crop. Vomitoxin is a mycotoxin that causes suppressed appetite in livestock and can be harmful to people as well.

**Producers with a Contract:** Producers who have a contract with a buyer must look to the contract to determine their rights. All provisions, including any small print on the back of the contract, must be read entirely before assessing legal rights. The language of the contract is what matters; any verbal agreements made outside the contract have very little effect in enforcing legal rights. Even if the producer and buyer agree to certain terms, if the terms do not find their way onto the contract then the parties are probably not bound by the terms.

In regards to Vomitoxin, the key terms are those describing the quality of the wheat required to be delivered. Contracts usually require No.2 wheat to be delivered. No. 2 wheat is a grade established by the USDA and may have up to 4% damaged kernels. The USDA defines damaged kernels as "Kernels, pieces of wheat kernels, and other grains that are badly ground-damaged, badly weather-damaged, diseased, frost-damaged, germ-damaged, heat-damaged, insect-bored, mold-damaged, sprout-damaged, or otherwise materially damaged." Therefore, if the only grade standard in the contract is No. 2 Soft Red Wheat, a producer's wheat should not be rejected or discounted solely for Vomitoxin unless more than 4% of the kernels are diseased or otherwise damaged. The 4% threshold is the accumulation of all damaged kernels and not just a single type of damage.

Some contracts will include more restrictive grade terms such as "must be suitable for human consumption" or "must meet all FDA guidelines." The FDA has not established a minimum threshold for raw wheat for human consumption. The milling and manufacturing of wheat can reduce vomitoxin levels. Finished wheat products like flour and bran must contain less than 1 ppm if used for human consumption. The FDA has established a 5 part per million (ppm) threshold for hogs and 10 ppm threshold for cattle and poultry. Therefore, a miller that requires wheat to meet FDA standards can reject wheat if the flour or other final product would contain more than 1 ppm vomitoxin. It is important to note that wheat could have less than 4% damaged kernels but have more than 1 ppm vomitoxin. That is, the USDA No.2 wheat grade is a completely different standard that the FDA's ppm standard.

Producers that have wheat rejected can have the dual problem of having wheat rejected and still being obligated to fulfill the contract. A worse case scenario would see a producer not being able to sell his wheat due to high vomitoxin levels while still being required to fulfill his contract obligations for untainted wheat with the elevator. Typically a buyer will reject the wheat without requiring the producer to fulfill the contract.

**Producers without Contracts:** A producer who intends to sell a load of wheat to a buyer without a contract has very little legal protection from the corn being rejected. The buyer is under no obligation to buy the wheat and can simply opt not to buy the wheat for any reasonable reason. Without a contract, the buyer is not bound to any predetermined grade standards. Even the smallest amount of vomitoxin in the wheat could cause it to be rejected.

**Disputed Grain Samples:** Producers have the right to appeal the grain grading determination performed by the elevator. The Federal Grain Inspection Service (FGIS) oversees grain grading procedures and methods and also provides inspection and appeal services. A producer who disputes the elevator's grading can send a sample to FGIS and FGIS' determination will be binding on both parties. A FGIS office is located in Toledo. For more detail - - .

**Crop Insurance:** Some crop insurance policies cover Vomitoxin damage. The wheat must be checked by an adjuster while still in the field to avoid tainted wheat from being mixed with untainted wheat in bins. Many producers opted to not file a claim on their corn crop due to the significant impact on APH.

**Future Implications**: Will we see grain contracts move away from the USDA No.2 Wheat standard and towards the FDA ppm standard for vomitoxin and other mycotoxins? Buyers relying on the USDA standard could get stuck buying grain that exceeds the FDA's ppm standards. Unless blended with non-tainted grain, this grain would seemingly be unmarketable as it could not be used for human consumption, livestock consumption, and/or export. Producers should anticipate possible changes to grading standards in contracts offered by elevators and other buyers. A careful reading of all new grain contracts should be a must for producers to make sure they fully understand the quality and grade of grain they are expected to deliver to the buyer.

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## Roundup Ready Alfalfa Likely to Return


Bill Curran, Weed Specialist
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On June 21, the US Supreme Court lifted a nationwide ban on the planting of glyphosate-resistant alfalfa. In a 7–1 vote, the court reversed a federal appeals court ruling that prohibited the selling of Roundup Ready alfalfa, which is resistant to the herbicide Roundup or glyphosate. Lower courts ruled the USDA did not properly test the biotech crop, and its release violated environmental law, but the Supreme Court disagreed. The Supreme Court reversed the trial court and the Ninth Circuit Court of Appeals and ruled that both Monsanto and the organic alfalfa farmers had justification to complain about what had happened. The Supreme Court ruled in favor of Monsanto, contending that a 2004 ban on the product was not proper. The Court ruled that the trial judge did not have the authority to impose a national ban on the sale and planting of the seed, and the organic farmers were not seriously at risk. Additionally, the Supreme Court said the initial ruling that halted USDA's environmental assessment of the product did not serve any interest. The ruling doesn't immediately clear farmers to plant the biotech seed, but it could allow the USDA to permit interim planting of Roundup Ready alfalfa, with some restrictions, while the agency completes an environmental impact study. You can review the complete US Supreme Court ruling at http://www.monsanto.com/pdf/rralfalfa_supreme_court_decision.pdf .

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## Dust Mask Protection from Wheat Dust


Mary Fleming, Agriculture Health Nurse Grady Memorial Hospital
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Besides the adverse marketing opportunities, moldy grains can also be problematic to the health of the farm operator. Grain that has gone out of condition can contain multiple types of molds and mycotoxins. It can also contain insect parts, aerosols from soil particles, and chemicals. Similar to an allergic reaction, grain dust can trigger different reactions in different people – some are just more susceptible to dusts and molds than others.

Over accumulation of grain dust is also hazardous to the performance of the human lungs. As a person continues to accumulate agricultural dusts over multiple seasons, the less effective their lung capacity becomes. Compare the human lungs to a shop vac – a person's lungs can only tolerate so much dust before it starts to become slow and inefficient. Agricultural dusts come in multiple sizes, and it's the fine grain dust that can penetrate deep into the lung cavity and cause the blockage.

Protection from wheat harvest dust is important for everyone. Respiratory protection provides a barrier from the molds and mycotoxins, as well as the other particles that compose grain dust. The good news is that this recommended respiratory protection is not complicated to find or even use. It's a dust mask.

There may be several dust masks available at the local farm supply or hardware stores, however not all of them are recommended for agricultural use. The best protection is provided by the two-strap dust masks that are labeled as N95. They should also be identified as NIOSH or MSHA approved (National Institute for Occupational Safety Health and Mine Safety and Health Association). The N95 models mean that 95% of the smallest particles - ones that can get into the lungs where they cause damage - are prevented from going through the mask.

Wearing a mask requires the body to breath differently, and often times can cause trouble for the user. Also, wearing the mask in hot weather can add additional strain on the user. To alleviate some of these problems, manufacturers have added an exhale valve. Look for this feature on the N95 dust mask.

Not all workers can wear a dust mask. Some individuals may already have lung disease and find it impossible to breath through a mask. A person with facial hair cannot obtain an adequate seal around the face, and would need a powered air supply (not self contained). Likewise, persons with glasses need to adjust the straps so they don't compromise the seal around the nose and cheeks. A physician evaluation will assess the ability to wear a mask, and the trained physician or a nurse can do the fit testing.

Wearing the mask in high exposure areas is recommended. The mask will need replaced after several hours of use in high dust situations, or it may last several days in low dust use. Store the mask in a clean area when not in use – a ziplock plastic bag offers good storage space.

The N95 respirator will protect workers from most of the common agricultural dusts. Like other farm chores, wearing the respirator may take some adjustment. The wearer may need to pace themselves and take more frequent water breaks. However, the initial extra strain it places on the body is a trade off for the protection the mask is offering to the long-term health capacity of the lungs. Protection from molds and dusts is more of an immediate concern than the inconvenience of wearing the mask.

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## Nutrient Removal of Wheat Straw by Baling

Robert Mullen, Keith Diedrick, Soil Fertility
Ohio State University Extension

As wheat harvest continues in some areas, and is just getting going in others, the question has once again come up regarding the plant nutrient value of wheat straw.

From a pure fertilizer standpoint, wheat straw contains very little in terms of phosphorus ($P_2O_5$) but moderate amounts of nitrogen (N) and potassium ($K_2O$). The actual amounts of N, $P_2O_5$, and $K_2O$ contained in a ton of wheat straw are 11, 3, and 20 pounds, respectively (or an analysis of 0.55-0.15-1.00 if it were printed on a fertilizer bag). Actual nutrient content can vary based upon environmental conditions during the growing season and soil nutrient supply, so if one really wants to know the actual value, straw analysis can be conducted by any lab that processes plant samples.

How much is that straw worth from a nutrient perspective? Well, it obviously depends upon the current market value of nutrients. Using today's prices, a pound of N, $P_2O_5$, and $K_2O$ costs $0.50, $0.50, and $0.41, respectively. Thus a ton of straw will contain $15.20 worth of nutrients. Again, this number can be variable, but it gives you a starting point for your own economic analysis.

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## New Reference Book Available: Wild Urban Plants of the Northeast – A Field Guide

Mena Hautau, Extension Educator
Crop Management Extension Group (CMEG)
Penn State University

Professional agronomists and farmers cannot have enough weed identification books in their possession! Cornell University Press recently published **Wild Urban Plants of the Northeast: A Field Guide.** This 374 page book includes many of the invasive plants that **Weeds of the Northeast** does not. It also includes some interesting pictures of the environments weeds have managed to conquer. The book opens with ferns, woody plants, then continues with broadleaves and finishes with the grasses.

Go to this site for description and ordering information: http://www.cornellpress.cornell.edu/cup_detail.taf?ti_id=5580

# *North Central Ohio Agronomy Report*

## A Few Weed Control Reminders

Aaron Hager, Weed Science Extension Specialist
University of Illinois Extension

**Table 1. Maximum per-application glyphosate rates based on formulation.**

| Glyphosate formulation (lb ae/gal) | Product rate (fl oz) equivalent to: | |
|---|---|---|
| | *1.1 lb ae/acre* | *1.5 lb ae/acre* |
| 3 | 48 | 64 |
| 4.17 | 35 | 48 |
| 4.5 | 32 | 44 |

Plentiful and frequent precipitation has caused some delays in the application of postemergence herbicides. Weed size (both broadleaf and grass weeds) increases rapidly with warm air temperatures and adequate soil moisture, so be sure to scout before spraying to determine if the herbicide application rate should be adjusted for optimal control of larger weeds. The following are a few simple reminders with respect to postemergence herbicides.

- The maximum amount of glyphosate that can be applied in any single application varies between corn and soybean. Applications to corn cannot exceed a maximum of 1.1 lb ae glyphosate, while 1.5 lb ae is the maximum rate for soybean. Table 1 lists the product rates (fl oz/acre) of various glyphosate formulations (lb ae/gallon) that are equivalent to these maximum single application rates.
- Glyphosate can be applied to soybean from cracking through flowering (R2 growth stage). Glyphosate can be applied broadcast to corn through the V8 stage or up to 30 inches tall. Applications to corn between 30 and 48 inches tall must be made using drop nozzles. The risk of malformed ears later in the growing season is increased if these growth stage restrictions are not followed.
- Several herbicides can be tank-mixed with glyphosate to improve control of certain weed species (such as glyphosate-resistant biotypes and species more tolerant of glyphosate) or to provide residual weed control. If you are tank-mixing to improve control of weeds present at the time of application, be sure to consult the product label for application rates and additive recommendations. In soybean, contact herbicides are sometimes tank-mixed to try to improve control of species such as morningglory. Keep in mind that these tank-mix partners can increase soybean injury/leaf burn and can antagonize glyphosate's activity on normally susceptible species.
- Glufosinate may be applied to glufosinate-resistant soybean varieties from emergence up to the bloom stage. Applications allowed by label include sequential in-crop applications (each at 22 fluid ounces of Ignite) at least 10 to 14 days apart or a single application of 29 to 36 fluid ounces. Do not apply more than 22 fluid ounces to soybean beyond V3 to V4 growth stages.

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## Sulfur Deficient Corn

Darryl Warncke and Laura Bast, Crop and Soil Sciences
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The question being asked around the North Central Region is whether sulfur deficiency is becoming more common. Responses from soil fertility specialists from some of the North Central states indicate that sulfur deficiencies are occurring in localized spots more frequently. This is to be expected since sulfur depositions have continued to decrease as industrial smokestack emissions have been cleaned up. Here in Michigan, there have been observations of yellowish-wheat (one of the more sulfur sensitive crops) this spring that may have been a temporary sulfur deficiency until the soils warmed and adequate sulfur was mineralized from the soil organic matter and crop residues.

Sulfur deficiency may also be affecting first cutting alfalfa growing on low organic matter sandy soils. Bright yellow stripping of the leaves of corn is the indication of sulfur deficiency (see photo). Sulfur deficiencies are most likely to occur on low organic matter sandy soils. Leaves of corn in this picture had a sulfur concentration of 0.12 percent compared to 0.21 percent in adjacent good corn. With the excess rain that has been occurring in many areas, sulfur could very well have been leached out of the root zone in low organic matter loamy sand and coarse sand soils. In some situations, these soils also have a pH in the mid- to low 5's with marginal magnesium levels. In these situations, spraying the affected corn with 20 lbs magnesium sulfate (Epsom salts) per acre (supplies 2.1 lbs Mg and 2.8 lbs S/a) in about 30 gallons water per acre will improve plant growth. To better document the occurrence of potential sulfur deficiencies, it is important that farmers, consultants and educators collect leaf tissues for analysis of sulfur and other essential elements.

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## Corn: Nutrient Uptake

Article from: How a Corn Plant Develops
Iowa State University Extension

Most of the dry weight of the plant consists of organic carbonaceous materials resulting from photosynthesis and subsequent processes. At least 12 nutrient elements must be taken up for the corn plant to grow and develop normally. An adequate supply of each nutrient at each stage is essential for optimum growth at all stages.

The seasonal pattern of nutrient accumulation in the plant is similar to that of dry matter accumulation. However, nutrient uptake begins even before the plant emerges from the soil. The amounts of nutrients taken up early in the growing season are small, but the nutrient concentrations in the soil surrounding the roots of the small plant at that stage often must be high.

Uptake of potassium is completed soon after silking, but uptake of the other essential nutrients such as nitrogen and phosphorus continues until near maturity. Much nitrogen and phosphorus and some other nutrients are translocated from vegetative plant parts to the developing grain later in the season. This translocation can result in nutrient deficiencies in the leaves unless adequate nutrients are available to the plant during that period.

A large portion of the nitrogen and phosphorus taken up by the plant is removed in the grain that is harvested. But most of the potassium taken up is returned to the soil in the leaves, stalks, and other plant residues, unless these plant parts are removed for silage or other forms of feed.

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## Corn: Roots , Growth and Nutrient Uptake

Dave Mengel, Extension Agronomist
Purdue University Extension

**Table: Shoot weight, root weight and nutrient content of corn at various stages during the growing season**

| Growth Stage days after | Shoot Weight | Root Length | Nutrient Content N | P | K |
|---|---|---|---|---|---|
| | lb./acre | miles/acre | | lb./acre | |
| Seeding | 14 | 0 | 0.2 | 0.04 | 0.03 |
| 4 leaf 21 days | 29 | 54 | 0.9 | 0.16 | 0.8 |
| 9 leaf 34 days | 400 | 4,400 | 19 | 2 | 19 |
| Shoulder high 49 days | 3,300 | 15,700 | 116 | 12 | 143 |
| Tassel 71 days | 9,500 | 32,200 | 199 | 28 | 231 |
| late silk 79 days | 11,200 | 38,100 | 218 | 29 | 222 |
| 93 days blister | 14,200 | 38,000 | 221 | 34 | 217 |
| 113 days grain fill | 19,800 | 20,700 | 262 | 39 | 269 |
| 132 Black layer | 20,800<br>9,650 grain (204 bu/acre) | 13,700 | 274 | 37 | 235 |

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## Corn Growth & Development: Tasseling - Growth Stage VT (Last Tassel Branch Visible)

Purdue University Extension

1. Plant is nearing its full height
2. Most vulnerable to hail at this stage (100% leaf loss = 100% yield loss)
3. Pollen is contained in anthers of the tassel
    - a. Anthers are the gizmos that look like the double-barrel of a shotgun
        - 1) Sometimes mistaken for the pollen itself
    - b. Pollen grains are dispersed through pore at anther tip
        - 1) Outer covering is very thin membrane
        - 2) Once dispersed into the atmosphere, pollen grains remain viable for only a few minutes before they dissicate
    - c. Pollen grain number per tassel between 2 and 5 million
4. Pollen shed usually begins towards center of central spike, then progresses upward, downward, and outward over time
    - a. Peak pollen shed usually occurs mid-morning
        - 1) onset of pollen shed may be delayed by
            - a) heavy dew
            - b) cool, humid conditions
        - 2) pollen shed does not occur during rainfall
            - a) therefore, pollen is not washed off tassel by rain
    - b. all pollen from an individual anther may be released in as little as 3 minutes

**Tassel and Ear Development Prior to Pollination:**

**A. Tassel Initiation**

1. Production of leaf primordial is usually complete by about V6
2. Tassel then begins to form at the apical meristem.
    - a. A small tassel can be visually detected in a dissected stalk section as early as growth stage V7.

**B. Ear Initiation**

1. There are as many potential ears as there are leaves on the plant since every stalk node has an axillary bud associated with it.
    - a. Normally, ear shoots are detectable only at the first 8-10 stalk nodes above ground.
        - 1) While axillary buds exist at the upper 6-8 nodes of the stalk, they normally never become active.
        - 2) Initially, the lower ear shoots are bigger than the upper ones because the lower ones form first. Later on, the upper one or two ear shoots take priority over the others and become the harvestable ears.
2. **Kernel row number** determination is completed by growth stage V12.
    - a. Row number **is determined strongly by plant genetics** rather than by environment. Exceptions include…
        - 1) Deep row cultivation after growth stage V8 may prune root system severely enough to hinder row number determination.
        - 2) Late application of Accent herbicide can decrease yield potential by altering row number determination.
        - 3) Nearly complete defoliation by hail prior to growth stage V12 my photosynthetically “shock” the plant and affect row number determination.
3. **Kernel number per row** is determined from about V12 until about 1 week before silk emergence occurs.
    - a. Kernel number (ear length) is **strongly affected by environmental stresses**.
        - 1) Severe stress can greatly reduce potential kernel number per row.
        - 2) Conversely, excellent growing conditions can encourage unusually high potential kernel number.

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## Silk Emergence

Bob Nielsen, Agronomy Dept.
Purdue University Extension

- Corn produces individual male and female flowers on the same plant.
- The ear represents the female flower of the corn plant.
- Severe soil moisture deficits can delay silk emergence and disrupt the synchrony of pollen shed and silk availability, resulting in poor kernel set.

As important as the process of pollination is to the determination of grain yield in corn, it is surprising how little some folks know about the details of cornfield sex. Rather than leaving you to learn about such things "in the streets", take the time to read this article and the accompanying one on tassels and anthers (Nielsen, 2007b) that describe the ins and outs of this critical period of the corn plant's life cycle.

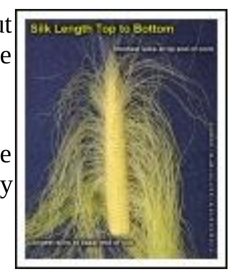
The corn plant produces individual male and female flowers (a flowering habit called monoecious for you corny trivia fans.) Interestingly, both flowers are initially bisexual (aka "perfect"), but during the course of development the female components (gynoecia) of the male flowers and the male components (stamens) of the female flowers abort, resulting in tassel (male) and ear (female) development.

The silks that emerge from the ear shoot are the functional stigmas of the female flowers of a corn plant. Each silk connects to an individual ovule (potential kernel). A given silk must be pollinated in order for the ovule to be fertilized and develop into a kernel. Up to 1000 ovules typically form per ear, even though we typically harvest only 400 to 600 actual kernels per ear.


Technically, growth stage R1 (Ritchie et al., 1993) for a given ear is defined when a single silk strand is visible from the tip of the husk. A field is defined as being at growth stage R1 when silks have emerged on at least 50 % of the plants.

**Silk Elongation and Emergence http://www.agry.purdue.edu/ext/corn/news/timeless/silks.html**

Silks begin to elongate from the ovules about 10 days prior to growth stage R1. Silk elongation begins first from the basal ovules of the cob, then proceeds sequentially up the ear. Similarly, silks from the basal (butt) portion of the ear typically emerge first from the husk, while the tip silks generally emerge last. Complete silk emergence from an ear generally occurs within four to eight days after the first silks appear.




As silks first emerge from the husk, they lengthen as much as 1.5 inches per day for the first day or two, but gradually slow over the next several days. Silk elongation occurs by expansion of existing cells, so elongation rate slows as more and more cells reach maximum size. Once pollinated, elongation of an individual silk will stop.

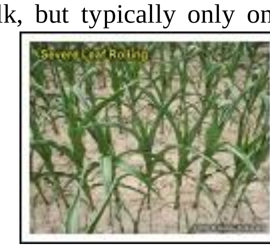

Silk elongation stops about 10 days after silk emergence, regardless of whether pollination occurs, due to senescence of the silk tissue. Unusually long silks can be a diagnostic symptom that the ear was not successfully pollinated.

Silks remain receptive to pollen grain germination up to 10 days after silk emergence, but to an ever-decreasing degree. Natural senescence of silk tissue over time results in collapsed tissue that restricts continued growth of the pollen tube. Silk emergence usually occurs in close synchrony with pollen shed, so that duration of silk receptivity is normally not a concern. Failure of silks to emerge in the first place, however, does not bode well for successful pollination.

**Pollination and Fertilization**

For those of you serious about semantics, let's review two definitions relevant to sex in the cornfield. Pollination is the act of transferring the pollen grains to the silks by wind or insects. Fertilization is the union of the male gametes from the pollen with the female gametes from the ovule. Technically, pollination is almost always successful (i.e., the pollen reaches the silks), but unsuccessful fertilization (i.e., pollen tube failure, silk failure, pollen death) will fail to result in a kernel.

Pollen grain germination occurs within minutes after a pollen grain lands on a receptive silk. A pollen tube, containing the male genetic material, develops and grows inside the silk, and fertilizes the ovule within 24 hours. Pollen grains can land and germinate anywhere along the length of an exposed receptive silk. Many pollen grains may germinate on a receptive silk, but typically only one will successfully fertilize the ovule.



**Silk Emergence Failure**

**Severe Drought Stress.** The most common cause of incomplete silk emergence is severe drought stress. Silks have the greatest water content of any corn plant tissue and thus are most sensitive to moisture levels in the plant. Severe moisture deficits will slow silk elongation, causing a delay or failure of silks to emerge from the ear shoot. If the delay is long enough, pollen shed may be almost or completely finished before receptive silks are available; resulting in nearly blank or totally blank cobs. Severe drought stress accompanied by low relative humidity can also desiccate exposed silks and render them non-receptive to pollen germination.

The severity of drought stress required for significant silk emergence delay or desiccation can probably be characterized by severe leaf rolling that begins early in the morning and continues into the early evening hours. Such severe leaf rolling is often accompanied by a change in leaf color from "healthy" green to a grayish-tinged green that may eventually die and bleach to a straw color.

**Silk Clipping by Insects.** Although technically not defined as silk emergence failure, severe silk clipping by insects such as corn rootworm beetle or Japanese beetle nonetheless can interfere with the success of pollination by decreasing or eliminating viable or receptive exposed silk tissue. Fortunately, unless the beetle activity is nonstop for days, continued elongation of silks from the husk will expose undamaged and receptive silk tissue at the rate of about one inch or more per day.

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## Tassels That Think They Are Ears


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Ears where tassels should be or tassels that exhibit partial ears in addition to tassel branches always occur somewhere every year. While a tassel-ear is indeed an odd sight, its occurrence is simply a reminder that the flowers of the corn plant have the physiological capability to be perfect (male and female flowers in the same floral organ).

Most of the time, the plant's hormonal activity dictates that tassels develop male flowers exclusively. Certain situations alter the hormonal control such that female flowers (ovules or potential kernels) develop as well as male flowers (the pollen-containing anthers). Tassel-ears most often occur on tillers (suckers) and rarely on main stalks. The occurrence of tassel-ears, therefore, merely reflects the presence of tillers in a field. The occurrence of tillers does not signal the presence of other problems in the field. On the contrary, tiller production is usually the result of favorable growing conditions during early vegetative growth and development.

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# *North Central Ohio Agronomy Report*

## Water Use Rates for Corn at Different Growth Stages

The Ohio State University Extension

| Growth Stage | Water Use Rate, Inches/Day |
|---|---|
| Prior to 12-leaf stage | <0.20 |
| 12-leaf | 0.24 |
| Early Tassel | 0.28 |
| Silking | 0.30 |
| Blister Kernel | 0.26 |
| Milk | 0.24 |
| Dent | 0.20 |
| Full Dent | 0.18 |

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## Soybean Growth and Development: R2 Stage – Full Flowering and R3 Stage – Beginning Pod

Iowa State University Extension


**R2 Stage (Full flowering) – Open flower at one of the two uppermost nodes on the main stem with a fully developed trifoliolate leaf node (Figure 12).**

Plants at R2 are 17 to 22 inches tall and are in the V8 to V12 stage. At this stage, the plant has accumulated only 25 percent of its total mature dry weight and nutrients, attained about 50 percent of its mature height, and produced about 50 percent of its total mature node number. This stage marks the beginning of a period of rapid and constant daily dry weight and nutrient accumulation rates, by the whole plant, which will continue until shortly after the R6 stage. This rapid accumulation of dry weight and nutrients by the whole plant initially occurs in the vegetative plant parts (leaves, stems, petioles, and roots) and gradually shifts into the pods and seeds as the plant continue to develop and the vegetative parts finalize their development. In addition, the rate of N-fixation by the root nodules is also increasing rapidly by theR2 state. Figure 7 shows that a large number of root nodules may develop on a single plant.


Figure 7. Roots showing nodules.

At R2, roots completely cross the inter-row space of 30 inch rows and growth of several major lateral roots has turned downward by this time. These major lateral roots, along with the taproot, continue to elongate deeply into the soil until late in the R6 stage.

Fifty percent defoliation at this stage reduces yield about six percent.

**R3 Stage (Beginning Pod) – Pod is 5mm (3/16 inches) long at one of the four uppermost nodes on the main stem with a fully developed trifoliolate leaf node (Figure 13).**

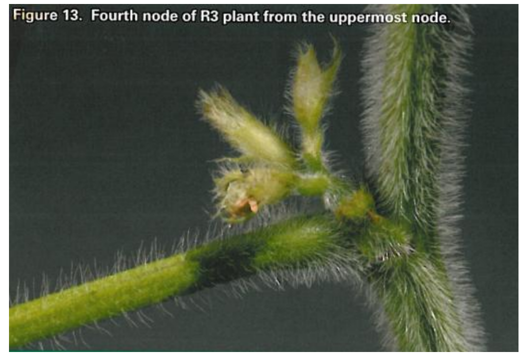
Figure 13. Fourth node of R3 plant from the uppermost node.

Plants at R3 are 23 to 32 inches tall and are in the V11 to V17 stage. It is not uncommon to find developing pods, withering flowers, open flowers, and flower buds on the same plant at this time. Developing pods are located on the lower nodes, where flowering first began.

Yield (total seed weight) can be divided into three major components: the total number of pods produced per plant, the number of seeds produced per pod, and the weight per seed (seed size). Yield increases or decreases may be described as increasing or decreasing one or more of these yield components.

Large yield increases most often result from increases in the number of seeds per pod and the seed size. The upper limits of the number of seeds per pod and seed size are genetically determined; however, these two yield components can, because of environmental conditions, still fluctuate enough to produce significant yield increases. Stressful conditions such as high temperature, moisture deficiency, and poor management practices decrease yield due to reduction of one or more of the yield components. Reduction in one component may be compensated for by another component so that yields are not significantly changed. Which yield component decreases or increases depends on the R stage of the plant when the stress occurs. As the soybean plant ages from R1 through the middle of R5, its ability to compensate after a stressful condition decreases, and the potential degree of yield reduction from stress increases.

**Management guide:** In the Midwest, 60 to 75 percent of all soybean flowers produced abort and never contribute to yield. About half of this abortion occurs before the flowers develop into young pods. The overproduction of flowers and pods and the extended period of flowering (from R1 to R5) seem desirable because they offer a degree of escape from short periods of stress. Stressful conditions (which cause even higher abortion rates) in stages R1 through R3 generally do not significantly reduce yields because some flowers and pods can still be produced until R5 to compensate. In addition, stress at these stages may result in an increase in the number of seeds per pod and seed size, which also help compensate for the aborted flowers and young pods.

Scientists and producers have to learn how to take full advantage of the soybean plant's potential. Practices such as fertilization, narrow rows, proper planting rates, irrigation, and weed control are attempts to reduce the amount of floral and pod abortion, and thus, increase yields. Numbers as high as 300-400 pods per plant have been observed.

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## Water Use Rates for Soybeans

The Ohio State University Extension

The highest yields will be achieved with uniform moisture throughout the season. For every bushel of soybeans produced, about 13,500 gallons of water are required. Table 1 shows the water use rates of soybeans at different growth stages. Note how water use at the third node stage is only 0.06 inch per day. This increases to 0.25 inch per day at beginning bloom and 0.29 inch per day at beginning pod. Water use then declines to 0.16 inch per day by full maturity.

Table 1.
**Water Use Rates For Soybeans**

| Water Use Rate | | Growth Stages |
|---|---|---|
| in./day | mm/day | |
| .04 | 1.0 | V1 First Node |
| .06 | 1.5 | V3 third Node |
| .16 | 4.0 | V5 Fifth Node |
| .22 | 5.6 | V6 Sixth Node |
| .25 | 6.4 | R1 Beginning Bloom |
| .29 | 7.4 | R3 Beginning Pod |
| .28 | 7.1 | R6 Full Seed |
| .24 | 6.1 | R7 Beginning Maturity |
| .16 | 4.1 | R8 Full Maturity |

## Soybean Root Facts

The Ohio State University Extension

- Because of the physical resistance to root extension in most soils, the root system eventually takes on a fibrous system appearance similar to grasses.
- The length of a soybean root increases for about 70 days after planting, remains constant for about 30 days, and then declines.
- The majority of roots and the root mass are confined to the upper 1 to 2 feet of soil, with over 60% in the top 6 inches.
- In soils having coarse to medium texture and low bulk density, soybean roots can grow extensively up to 6 feet in depth.
- The average life of a root hair is about five days. Only new roots have root hairs, and only root hairs take in water and nutrients.
- Only about 2% of the total soil pore space in penetrated by soybean roots. However, water and nutrients from the remaining pore space can move to the root hairs by a process called diffusion. Diffusion is the movement of a nutrient due to a difference in concentrations. Nutrients move from an area of greater concentration to an area of lesser concentration until a state of equilibrium is reached.



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