CROP INSIGHTS

Monitor Corn Fields for Stalk Quality Problems

Steve Butzen, Agronomy Information Manager

Summary

- Stalk lodging problems occur on some corn acres every year in North America, due to a variety of stresses that affect stalk quality.
- Drought, low sunlight, insect and disease pressure, and low fertility are major stresses that reduce the photosynthetic rate or leaf area of the corn plant.
- If photosynthesis is unable to supply the demands of the developing kernels, the plant redirects root and stalk carbohydrates to the ear. Stalk rot organisms can then invade weakened and dying plant tissues.
- Careful scouting and harvesting fields according to crop condition can help prevent field losses due to low stalk quality.
- DuPont Pioneer researchers focus on stalk quality as a top priority, selecting against stalk lodging and susceptibility to stalk diseases.
- This *Crop Insights* will explain the causes of stalk rot problems in corn, and how to prevent stalk problems from reducing harvestable yield.

Many different stresses to the corn plant can lower stalk quality, with the result that stalk problems occur in some fields each year throughout the major corn-growing areas of North America. Drought stress, reduced sunlight, insect and disease pressure and hail damage are stresses that can result in poor stalk quality. Even good growing conditions can lead to stalk problems, when followed by a less favorable environment. Many additional factors, including cropping history, soil fertility, hybrid genetics, and micro-environment effects can heighten the problem in particular fields. Growers should monitor their fields as harvest approaches, to identify stalk quality problems and prepare to harvest before field losses occur. This *Crop Insights* will discuss the causes and management of stalk rot problems in corn.

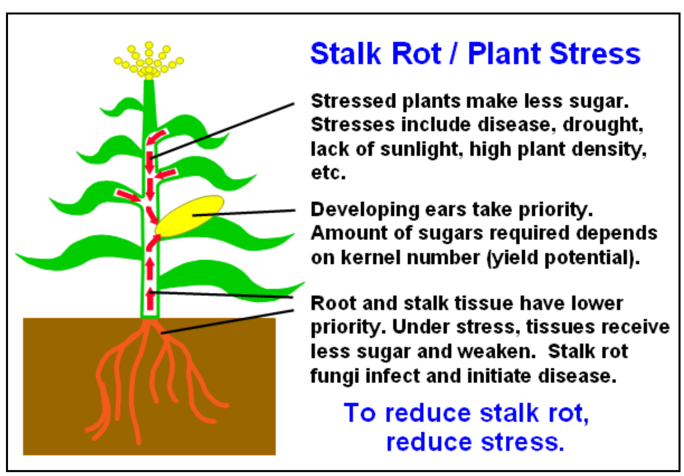
Photosynthesis and Carbohydrate Movement in the Corn Plant

Through photosynthesis, the leaves of the corn plant capture sunlight and carbon dioxide to produce sugars (photosynthate). These sugars are directed to the actively growing organs of the plant. Early in plant development, sugars move to the roots, where they are converted to structural carbohydrates and proteins in the developing root tissues. As the plant continues to grow, photosynthate is directed to the stalk for temporary storage.

Photosynthesis by corn leaves produces sugars.

Upon successful pollination, ear development places a great demand on the plant for carbohydrates. When the carbohydrate demands of the developing kernels exceed the supply produced by the leaves, stalk and root storage reserves are tapped. University studies indicate that during grain fill, about 60 to 70% of the non-fiber carbohydrates in the stalk are moved to other parts of the plant, but primarily the ear (Daynard et al., 1969; Jones and Simmons, 1983). This stalk depletion begins approximately two to three weeks following silking. Environmental stresses which decrease the amount of photosynthate produced by the plant can force plants to extract even greater percentages of stalk carbohydrates, which preserves grain fill rates at the expense of the stalk.

Many environmental conditions can decrease the amount of photosynthate produced by the plant. Drought stress and low available sunlight are two such conditions. Factors which reduce functional leaf area, such as disease lesions, insect feeding or hail damage also reduce photosynthate production.



Corn stalk infected with both Gibberella and anthracnose rot.

As carbohydrates stored in the roots and stalk are mobilized to the ear, these structures begin to decline and soon lose their resistance to soil-borne pathogens. High temperatures at this time increase the rate at which the fungi invade and colonize the plant. Though pathogens play a key role in stalk rot development, it is primarily the inability of the plant to provide sufficient photosynthate to the developing ear that initiates the process.

Stalk Rots Often Begin as Root Rots

Stalk-rotting fungi inhabit the soil in the root zone of corn plants, surviving on discarded cells and nutrients excreted by the roots. They are prevented from invading the roots and stalk by metabolites produced by the plant. Though not sufficiently virulent to overcome healthy living tissue, these opportunistic fungi rapidly invade weakened and dying roots. This occurs as the plant directs carbohydrates to the kernels during ear fill, and the roots begin to languish. After the roots are colonized, the infection spreads to the stalk (Dodd, 1983).

Root rot beginning in basal stalk region.

As vascular tissues in the plant become plugged by fungal mycelial growth, water supply to the plant becomes restricted. Wilting and premature death of the plant eventually follows. External discoloration of the lower stalk becomes evident as deterioration of the inner stalk tissue progresses. The structural integrity of the stalk is diminished by this decay, and the plant is susceptible to lodging. Storms and high winds provide the forces needed to topple the weakened stalks.

The Growing Environment

The growing environment has a critical effect on the ability of the plant to provide sufficient photosynthate to the developing ear. Almost any stress applied to the plant will reduce photosynthesis and resultant sugar production in the leaves.

Drought Stress

The decrease in photosynthetic rates due to drought stress has been well documented in research studies. Water relations within the plant and CO_2 and oxygen exchange are directly affected. In addition, if leaf rolling occurs during drought, the effective leaf surface for collection of sunlight is reduced.

In research studies in which water was withheld from plants beginning at the mid-grain-fill stage, photosynthesis was eventually shut down (Westgate and Boyer, 1985). Subsequent grain development depended entirely on stalk carbohydrate reserves.

Reduced Sunlight

Photosynthesis is most efficient in full sunlight. Studies show that the rate of photosynthesis increases directly with intensity of sunlight. One experiment indicated that photosynthesis rates are reduced more than 50% on an overcast day compared to a day with bright sunshine (Moss et. al., 1960). Prolonged cloudy conditions during ear fill often result in severely depleted stalk reserves.

Reduction of Leaf Area

Any reduction in leaf area will limit total photosynthesis. Leaf area may be reduced due to hail, frost, disease lesions, insect feeding or mechanical injury. Whenever functional leaf area is reduced prior to completion of ear fill, stalks will be weakened.

Favorable Conditions Early, Stress During Ear Fill

Even favorable growing conditions can have a negative effect on stalks. If favorable growing conditions exist when the number of kernels per ear is being established (V10-V17), the eventual demand for photosynthate will be large. Each potential kernel represents an additional requirement for translocatable sugars from the plant. If stress conditions develop during ear fill which render the plant unable to produce enough sugars, stalks will suffer.

Research has demonstrated that the number of kernels per ear on stalk-rotted plants is often greater than that of adjacent healthy plants (Table 1). The additional demand for carbohydrates by larger ears often results in greater depletion of the stalk and eventual stalk rot.

Table 1. Comparison of kernel numbers between plants with rotted stalks and adjacent plants with healthy stalks.*

Year	No. of Hybrids	No. of Pairs	Rotted Stalks	Healthy Stalks	Diff.
			No. of Kernels / Plant		
Year1	40	112	562	495	67**
Year2	30	65	648	587	61**

* From Dodd, 1980.

** Significant at the .001 probability level.

Soil Fertility

Research studies have documented that soil fertility has a profound effect on stalk quality. Most notable are studies which show that a combination of high nitrogen and low potassium can severely reduce stalk quality. Researchers suggest that yearly applications of N and K (actual N, K as K_2O) should be approximately in the ratio of 1 to 1 for favorable balance in the corn plant and to reduce the risk of stalk rots and stalk breakage.

High nitrogen is associated with greater kernel number, which increases the demand for carbohydrates to the ear. Higher nitrogen also aids the movement of these carbohydrates out of the stalk and into the ear by increasing the rate of translocation within the plant.

The role of potassium in preventing premature plant death has long been established. Potassium functions in the building of leaf and stalk tissue, and in regulating water movement within the plant. Increases in potassium have been associated with increased photosynthetic rate.

Hybrid Differences

Hybrid genetics are an important influence on stalk lodging potential. Some hybrids naturally partition more carbohydrates to the stalk. Though useful in a poor stalk quality year, that trait may limit yield potential in a more normal environment. In the hybrid development process, researchers must be careful to select hybrids with highest harvestable yield potential across many years and environments. Too much emphasis on stalk quality alone could result in lower yield potential most years. Many carefully selected hybrids with very good stalk quality may appear inadequate during a one-year-in-ten stalk-lodging event.

Certain plant characteristics other than stalk strength *per se* can influence a hybrid's potential for lodging. Hybrid maturity determines the plant's developmental stage when environmental stresses occur, which impacts stalk quality. Hybrids prone to leaf diseases may lose significant leaf area, weakening the stalks. Susceptibility to specific stalk rot pathogens also increases the stalk-lodging risk.

Other Effects

Micro-environments

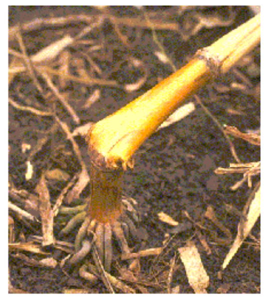
Oftentimes, small differences between fields, or between areas in the same field can determine whether corn stands or lodges. Differences in soil fertility, soil moisture, plant-to-plant spacing, insect feeding, or wind gusts can push plants past the lodging threshold. These effects are difficult to predict, but scouting fields in the fall can identify problem areas, and early harvest can reduce field losses.

Plant Population

Multi-year research studies show that stalk lodging is increased only slightly at higher plant populations. For example, a summary of Pioneer research from 35 high-lodging environments from 2004 to 2007 showed that percent stalk lodging increased only about 0.5% for each 1000 plant/acre increase in population (Paszkiewicz and Butzen, 2007.)

Reducing Harvest Losses Due to Stalk Lodging

Careful scouting and harvesting fields according to crop condition can help prevent field losses due to low stalk quality**.** Corn loss potential should be weighed just as heavily as grain moisture in deciding which fields to harvest first. Scouting fields approximately two to three weeks prior to the expected harvest date can identify fields with weak stalks predisposed to lodging. Fields with high lodging potential should be slated for early harvest.



Collapsed corn stalk.

Weak stalks can be detected by pinching the stalk at the first or second elongated internode above the ground. If the stalk collapses, advanced stages of stalk rot are indicated. Another technique is to push the plant sideways about 8 to 12 inches at ear level. If the stalk crimps near the base or fails to return to the vertical position, stalk rot is indicated. Check 20 plants in five areas of the field. If more than 10 to 15% of the stalks are rotted, that field should be considered for early harvest.

DuPont Pioneer Research Emphasizes Stalk Quality

Pioneer corn breeders use aggressive techniques to weed out hybrids with poor stalk quality, including manual and mechanical push tests which mimic the forces of wind on corn plants. In addition, plants are inoculated with stalk rot organisms where appropriate to ensure that susceptible genotypes do not escape detection. Pioneer plant pathologists monitor disease incidence and assist breeders in their efforts to inoculate, screen and characterize products. Research trials conducted by Pioneer corn breeders are designed to measure product performance for all important traits across a wide range of growing conditions.

DuPont Pioneer IMPACT™ plots further test product performance, including characterization of stalk quality, thus determining proper placement of new product releases. DuPont Pioneer uses information from both breeder and IMPACT plots to develop stalk lodging ratings on all its hybrids to aid customers in selecting appropriate hybrids for their fields.

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