Late Season Nutrient Stress in Corn

- Identifying the causes of late-season corn nutrient deficiency symptoms can help determine management options for next season.
- There are usually more than one causal factor that contributes to nutrient deficiency symptoms.
- Advanced agronomic traits, breeding, and production practices for new corn products requires a re-evaluation of fertility practices and monitoring of the plant nutrient status to achieve maximum yield potential.

Diagnosing nutrient stress effects on corn ears, leaves, and stalks can help determine the effects of management decisions for the current corn crop and any adjustments to consider for the next season. Environmental conditions play a big role in determining the nutrient status of corn plants and corn yield potential even under high fertility management programs. Many late-season symptoms may have multiple causal factors.

Stalk Symptoms

Nitrogen deficiency can cause stalks to weaken when the demand for carbohydrates to fill kernels cause the plant to remobilize or cannibalize nutrients from stalk tissues. Potassium deficiency can result in weak stalks that are prone to lodging. Potassium also plays a role in helping prevent stalk rot diseases and maintain photosynthesis. Potassium increases root growth, improves drought tolerance, maintains turgor pressure that helps reduce water loss and wilting, builds cellulose, reduces lodging, helps translocate sugars and starches and helps retard the diseases and nematodes.

Ear Symptoms

Patterns of aborted or missing kernel and other ear abnormalities reflect nutrient, sugar, and protein limitations to the kernels during grain fill.[1] Tip dieback/tip back is incomplete kernel development at the tip of the ear, due to poor pollination or kernel abortion.[2] Stress conditions (heat, moisture, hail, foliar, insects, disease, or nitrogen deficiency) may cause a shortage of nutrients that lead to kernel abortion. Kernels at the tip of the ear are most sensitive to stress. Kernel abortion may also be caused by intervals of cloudy conditions after pollination or plant shading from very high plant populations. Aborted kernels are yellowish in color while poor pollination can be distinguished by kernels or ovules appear dried up and shrunken.

Figure 1. Symptoms of N deficiency.

Figure 2. Symptoms of K deficiency.

Favorable growing conditions can result in an ear setting greater than normal number of potential kernels per row. Although all the ovules, particularly those at the ear tip, may not be filled, the total number of kernels per ear may be greater than the normal number. If ears are consistently filled to the tip it may be an indicator that plant populations should be pushed higher to maximize yield potential.[2]

Late-season nitrogen (N) deficiency symptoms include firing or dropping of lower leaves which will appear first on lower leaves as yellowing and tissue necrosis in a V pattern (Figure 1). Phosphorus (P) deficiency can interfere with pollination, resulting in incomplete kernel set. Potassium (K) deficiency can cause lightweight ears with poorly filled, shrunken kernels. Potassium deficiency symptoms on corn leaves appear first on lower leaves as chlorotic and necrotic leaf margins, in contrast to the V pattern associated with nitrogen deficiency (Figure 2).

A good diagnostic resource to identify potential causes of ear abnormalities is the article Abnormal Corn Ear Development at http://www.roundupreadyplus.com/Pages/Article.aspx?article=Abnormal-Corn-Ear-Development.

Late Season Nutrient Uptake

Recent research on nutrient uptake and utilization in corn indicates that current corn products take up nearly 30% more nitrogen (N) from the soil after flowering than older products.[3] New research also shows that the timing of nutrient uptake in high management corn systems differs between nutrients and may have implications for nutrient management.[4] Two-thirds of the total plant N and K is taken up by silking (R1). In contrast, more than one-half of the P and sulfur (S) were taken up during grain-filling stages (R2 to R5). N and P, remobilized from leaf and stalk tissue, provides a significant portion of the grain N and P. Conversely, most of the S supplied in the grain is supplied by the soil. During the late vegetative and reproductive corn growth stages 71% of zinc and 65% of

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boron were also taken up by the plant. Recent fertilizer use studies indicate that nutrient removal from the soil by corn and soybean production systems may need to be adjusted to provide adequate season-long supplies of macro- and micro-nutrients.[4]

Potential Causes of Foliar Symptoms

Some late-season nutrient deficiencies may show diagnostic symptoms earlier in the season rather than near maturity. It is a good idea to look for causes of deficiencies throughout the season:

- Slowed metabolism and photosynthesis from environmental conditions, including a combination of cool nighttime temperatures, cloudy weather, and saturated soils.
- Rapid plant growth triggered by warm temperatures that followed slow growth during cool weather.
- Less microbial activity and release of nutrients in cool, saturated soils.
- Compacted soils that can restrict root growth and cause poor drainage.
- Plants deficient of sulfur (S), magnesium (Mg), or zinc (Zn) are more likely to occur in soils that are: low in organic matter (S), acidic (Mg), or have a high pH (Zn).

Investigating Nutrient Deficiencies

By late in the season, there is nothing that can be done to lessen the impact of nutrient deficiencies. However, it is the perfect time to rate your current nutrient management program and consider if changes may be necessary for next season. The end-of season cornstalk test can be used to evaluate whether the crop had too much or too little N for optimal yields. Soil testing should also be performed to assess total nutrient availability and indicate whether additional fertilizer is needed to maximize crop growth next season.[5]

Fall is also a good time to sample for soil nitrate and assess nitrogen management practices. Soil samples should be taken from representative areas of each field and to a depth of two feet to adequate measure residual nitrate.[6]

Monitoring the nutrient status of corn with in-season plant tissue sampling can help identify nutritional deficiencies. Generally, the corn ear leaf at silking should be sampled when N, S, Mg, and Zn levels are tested.[7]

Table 1. Diagnosing corn problems from tasseling to maturity.

Symptoms	Possible Causes
No silks visible or delayed several days after tasseling	Nutrient deficiency or imbalance (N, P), heat, drought, cold nights just prior to silking, corn leaf aphid, fall armyworm, or spider mite, excessive plant population for conditions
Tassels fail to emerge	Nutrient deficiency (Boron), drought or heat stress, insects
Stalk broken below ear	Excessive N or insufficient K, stalk and root rots, drought/heat/any stress limiting photosynthesis, wind/greensap, southwestern corn borer
Stalks leaning, but not broken (root lodged)	K deficiency, stalk and root rots, wind and wet soil, improper fertilizer placement, soil compaction, low soil pH, poorly drained soil, drought, corn rootworm, growth regulator herbicides
Poorly filled ear tips	N or K deficiency, drought, interaction between plant population/corn product/ environment, foliar disease reducing photosynthetic area, very favorable growing conditions, shading or temperature reducing photosynthesis during kernel fill
Small, malformed, light kernels	N or P deficiency, ear-feeding insects, leaf blights, stalk and ear rots, virus, excessive plant population, soil compaction, drought/heat stress
Dropped ears	Nutrient deficiency or drought weakens ear shanks, insect damage, corn product
Scattered kernel set	Nutrient deficiency, insects feeding on silks, lack of pollen, heat/drought at pollination, herbicide injury
Lower leaves firing or dropping	N deficiency, drought stress, root damage

Sources:
[1] Thomison, P and A. Geyer. 2007. Abnormal corn ears ACE-1. Ohio State University. [2] Thomison, P. 2010. "Tip dieback" and "zipper ears" in corn. C.O.R.N. newsletter. Ohio State University. [3] Ciampitti, I.A., Camberato, J.J., Murrell, S.T. and T. J. Vyn. 2013. Maize nutrient accumulation and partitioning in response to plant density and nitrogen rate: macronutrients. Agronomy Journal 105:3 783-795. [4] Bender R.R., Haegele J.W., Ruffo M.L., Below F.E. 2013. Modern corn hybrids' nutrient uptake patterns. Better Crops With Plant Food (94:7-10). [5] Laboski, C. 2010. Considerations when using the end-of-season stalk nitrate test. Wisconsin Crop Manager 17(26):113-114. [6] Rehm,G., Schmitt, M., Eliason, R. 2007. Using the soil nitrate test in Minnesota. [7] Kaiser, D. E., J. A. Lamb, Rosen, C. 2013. Plant analysis sampling and interpretation FO-3176-B. University of Minnesota.

For additional agronomic information, please contact your local seed representative.

Individual results may vary, and performance may vary from location to location and from year to year. This result may not be an indicator of results you may obtain as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible.