CORN

CROP NUTRITION - 1

Larry Zibilske, Ph.D.

Corn is a staple of American agriculture. In recent years the incentive to grow corn has increased dramatically. As interest in the biofuel market increases, many farmers have increased corn acreage, or shortened rotation plans, and modified production practices to grow more corn. Intensification of corn production is placing much higher demands on soil fertility to keep up with the demand for corn, both grain and stover, for ethanol production. Removal of stover for cellulosic ethanol production means that few nutrients are returned to the soil in the form of crop residues, placing further demands on limited soil reserves of carbon and nutrient pools. Corn has always had high nutrient demands and already puts a great strain on soil and fertilizer nutrient sources. Large quantities of N, P, K, Ca, Mg, and S are removed with the grain and stover. Trace elements are also removed and must be replaced. Trace elements are essential for producing a healthy crop and should be included in soil and plant tissue testing.

Nutrients Removed by Corn Grain and Stover *

Grain

Yield (bu./A)	N	P_2O_5	K_2O	Ca	Mg	S	Mn	Zn	Fe	B
100	110	40	35	2.1	6	7	0.06	0.10	0.37	0.010
150	135	65	50	2.7	10	11	0.10	0.17	0.61	0.015
200	175	80	70	3.0	15	14	0.13	0.21	0.75	0.030

Stover

Yield (Tons/A)	N	P_2O_5	K_2O	Ca	Mg	S	Mn	Zn	Fe	B
3	72	26	104	21	14	29	1.00	0.21	0.33	0.030
5	115	44	162	30	24	47	1.71	0.36	0.57	0.054
7	160	57	220	40	32	63	2.31	0.48	0.78	0.083

* IMPORTANT NOTES ABOUT THIS TABLE

- The numbers shown were compiled from several different sources and are **approximate** only. The table is presented for rough planning purposes.
- Actual demands for some of the nutrients shown can vary dramatically and be ***reduced***, depending upon ***the timing of applications,*** soil and irrigation water chemistry, and growing conditions.
- To achieve best crop quality and yields, regular ***ASK THE PLANT***® leaf testing at critical stages of physiological plant development during the growing season is crucial.
- To achieve yield goals, it is essential to accommodate the plants' changing nutritional demands by providing adequate amounts of only those nutrients that are needed ***when*** they are needed.

4915 West Monte Cristo Road ♦ Edinburg, Texas 78541
Telephone: 956-383-0739 ♦ Facsimile: 956-383-0730
TPSLab.com • AskThePlant.com

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Corn grows rapidly and careful planning for nutrition must be done to prevent nutrient deficiencies. Soil testing is necessary to ensure that adequate amounts of nutrients are present in the soil to provide complete nutrition during the critical stages of corn development. Soil testing and fertilization can be done ahead of planting, but if liming is to be done, that's best done in the fall before a spring planting.

Once plants emerge, close monitoring should be done to see how well the nutrient needs are being met. At three weeks, 8-9 weeks (beginning silk), and at pollination, leaf testing should be done to determine how well nutrient needs are being met. Levels of nutrients determined at each of the stages can tell you whether the crop is on track to meet your yield goal. If a deficiency shows up in the analysis, there is time to remedy the condition before yield losses will occur. Plant testing reveals deficiencies before yield losses occur, and before visual symptoms can be seen. By the time visual symptoms are seen, yield or quality losses are inevitable, but they can be minimized by prompt application of the deficient nutrients. Growers should be acquainted with the common visual symptoms of nutrient deficiencies and scout their fields for problems as the crop develops.

Nitrogen (N) deficiency is a very common problem because corn needs so much of it and because several mechanisms in the environment can lead to large nitrogen losses. Denitrification and ammonia volatilization can lead to tremendous losses of Nitrogen before the crop can use it. Nitrogen is used in many plant processes and structures, principally in protein production, and any shortage will affect all the other processes. This corn *(right photo)* is in need of supplemental Nitrogen. Yield losses have already been set by the time these symptoms appear. Prompt application of Nitrogen now will help minimize the loss. Remember that the number of kernels per row that the ear will produce is set early in plant development, so ensuring good fertilization early is the best.

Nitrogen deficiency symptoms start on older leaves

Iowa State Universit

Drought damage

R.L. Croissant, Bugwood.org

Weather is also a determin-ing factor. Too much, or more commonly lately, too little rain can reduce growth and nutrient uptake, exposing the plants to greater disease and insect pressures. Drought has taken a terrible toll on corn crops in the past few of years. Maintaining good nutrition will help minimize losses due to drought, but water is always the most crucial factor. Plant water uptake is the main path by which nutrients are taken up, if water is in deficit, or if it is of low quality, i.e. salty irrigation water, nutrient uptake will be affected, causing several related nutrient and soil problems.

Nitrogen fertilizer burn

John D. Byrd, Mississippi State University

Water shortage can also lead to fertilizer burn when fertilizer salts cannot be dispersed sufficiently and moved away from plants roots. This concentrates the fertilizer salts around the roots and results in burning.

Phosphorus (P) deficiency occurs frequently because it is needed in relatively large amounts and in the soil, it tends to become chemically tied-up, which reduces its availability to plants. Soil pH is an important factor in predicting whether P will be a nutrition problem. Near neutral pH (6.5-7) is best, less than that, P solubility may be a problem and above 7.5 may also range into P solubility problems. Phosphorus is essential for root development and function. Plants put much energy into finding phosphorus and taking it up from the soil. Soil testing will determine whether your soil pH is a potential problem for P availability, and will estimate how much P your crop will need. Phosphorus chemistry is affected by soil organic matter and humus. In a good crop residue program, more P can be maintained in plant-available forms than in organic matter-depleted soils.

Severe Phosphorus deficiency. Note pronounced purpling.
Mary Ann Hanson, Virginia Polytechnic Institute and State University, Bugwood.org

Biomass harvesting will cause a loss of native organic matter because crop residues are largely removed from the land. This aggravates the tendency of P to become chemically fixed in the soil and require adjustments to the customary corn fertilization recommendations.

Potassium (K) is needed in large amounts by corn. This is especially true for silage corn. Silage corn can remove 120 pounds of K_2O for 15 ton yields. Therefore, much K is removed with the silage and must be replaced in larger amounts than needed for field corn. Potassium is absorbed into plants with the movement of water into roots. This is a "mass flow" mechanism that is very susceptible to drought. Making sure plants have enough K helps them resist other problems in a drought year. Deficiencies of K can be detected and remedied using the results of soil testing.

Because it is usually very mobile in the soil, remediation of K deficiency detected in plant tissue tests can be done quickly, during the season, to reduce yield loss and also reduce problems with the uptake of other nutrients. Once again, K deficiency can be detected before much damage is done, and before visual symptoms appear.

Potassium deficiency symptoms. Note brown leaf margins
Iowa State University

Sulfur (S) is a required plant nutrient, but is often overlooked as a source of yield problems. Sulfur is needed for protein production in all plants, and a deficiency impacts both yield and quality. Plants need about as much Sulfur as Phosphorus. Before the advent of clean coal technologies, and improved fertilizer and pesticide manufacturing processes, Sulfur entered agricultural soils from those amendments and through deposition from the air. In some locations, irrigation water contains some Sulfur. Inputs from these sources, except for irrigation water, are much smaller now, and Sulfur deficiencies are much more common than in the past.

Sulfur deficiency symptoms. Note pale green color with striping on younger leaves
Iowa State University

Sulfur deficient plants are a pale green at first, and as the severity of the problem increases, leaves can become almost white. The trouble is that Sulfur deficiency mimics other nutrient problems, especially during periods of high rainfall. Periodic plant tissue testing will determine whether heavy rains have reduced Sulfur availability. Foliar sprays can fix a deficiency. A Soil Test, particularly for corn, should certainly include Sulfur, together with recommendations for correcting any deficiency. Sulfur is very mobile in the soil and it is readily leached. In Sulfur-deficient plants, the top leaves begin to pale because Sulfur is not as easily moved around in the plant as is Nitrogen. Sulfur deficiency can be one of the causes of *"**hidden hunger**"* in your crop, and the best way to ensure adequate amounts in the crop is to follow up the soil test with plant testing during the season.

Calcium deficiency. Note striping and "ribs" along leaves
University of Massachusetts

Calcium (Ca) is used by plants to form sturdy cell walls and functions in N uptake, for proper enzyme activities, and for flowering and reproduction. Soil Calcium has a

rôle in buffering pH to ensure other nutrients, especially trace elements, are available to the plant in a "balanced diet". It plays a major role in improving soil structure and drainage. Calcium deficiency in plants is visually determined by misshapen leaves, and by development of "ribs" along leaf margins. It is not easy to remedy deficiencies in the growing season, so soil testing in the fall, and applying the recommended amount of lime, is the best preventative for Calcium problems next year.

Calcium sprays can be used to supplement plant Calcium as recommended in a plant tissue test. Low CEC (Cation Exchange Capacity) soils that are usually very sandy and commonly have low pHs, and need a lot of Calcium to keep plants healthy and productive. Calcium performs important rôles in plant nutrition and soil quality. Monitoring soil and plant Calcium contents, and keeping them in optimum ranges will help fix a number of problems or potential problems in corn production.

Magnesium (Mg) is a structural part of the chlorophyll molecule; that alone warrants close attention to the amount in soil and plant tissue. Without it, photosynthesis is impaired and crop yields and quality are reduced. It also functions in root development. Determining the amounts of Mg in soil and plant tissue is important to ensure good early season growth. Magnesium, as Sulfur, is often neglected in lieu of Calcium in crop nutrition. Calcium and Magnesium behave similarly in soil and by adding agricultural limestone alone, Magnesium deficiencies can develop. In many cases, dolomitic lime that contains Mg can be used to supplement Ca lime to ensure sufficient Mg is present for healthy plant development.

Trace Elements are the real controllers of plant function. The ones that draw the most attention for corn are **Manganese (Mn), Iron (Fe), Zinc (Zn), Copper (Cu) and Boron (B)**. These have vital roles in plant growth and function, and can become deficient in soil due to pH problems, or to mere depletion by growing crop after crop without soil testing. Soil and plant tissue testing are vitally important for these trace elements because they are normally present in such small amounts in the soil, problems can arise quickly during rapidly growing crops such as corn.

Manganese deficiency. Note pronounced leaf striping.
Clemson Univesity

It is important to not only know the quantity present but how much is *plant available* during the season. Soil tests that most accurately assess plant availability are most reliable in keeping deficiencies from occurring, and in determining how much needs to be applied to fix a problem.

Zinc deficiency. Note striping of leaves
IPNI

By the time deficiencies are detected by visual symptoms, plant impairment has already occurred to multiple plant processes. This makes it imperative to monitor the amounts of these elements in your cropping system, and remedy any deficiencies.

An underlying principle in plant tissue testing is that any problems detected are determined rapidly, when sprays can be applied quickly to fix the problems. This assures that minimal or no damage to crop yields will occur. Waiting for visual symptoms to appear before treatments are applied will compromise both yield and quality of the crop.

The **SOIL TEST** - A representative composite sample of the soil from the root zone is essential for a good soil test. Be sure to take a slice or core of soil 0-12" from several areas in the field, mix thoroughly and send 1/2 pint to the lab. The lab can only analyze what is in the sample, **make it representative of the plant root zone**. Subsoil (12-24") should also be tested when ***Maximum Economic Yield*** is expected from ***Best Management Practices***. When top and subsoil are tested as a pair, the subsoil fee is about 1/2 of topsoil fee.

Copper deficiency. Note ragged leaves.
NCSU

Iron deficiency. Note striping
R.L. Croissant, Bugwood.org

Testing programs cost only about 1 to 2 bu/ac depending on the level of management and goals.

PLANT TESTING - Three Critical Stages in Corn.

1. **Less than 12"-** (*V4 to V5 Stage - 21 days after emergence*) analyze entire plant for nitrogen plus the minerals, P – K – Ca - Mg – Na [**Sodium**] and the Micronutrients, Zn – Fe – Mn – Cu – B – S) and Mn.

♦ We most often see **Zinc deficiency** in corn at this stage of development. Sufficient **Zinc** is very important at this stage for the plant to develop its maximum Genetic Potential, as it is at this stage when the rows of grain are formed.

♦ Take 15 plants - wash off all dirt before wilting - air dry and place in paper (NO plastic) sacks for shipment to the lab.

♦ Take plants from a representative area of the field, one plant from every 5th row in a diagonal pattern across field, start at least 50' inside fields, away from edges, do not mix problem areas. Sample problem areas separately.

♦ At this critical period, before plants form the embryo of the ear and determine how many rows of grain will be on the ear, needed nutrients (**especially Zinc**) can be adjusted to affect yield potential.

♦ Foliar apply a balanced formula fortified with deficient nutrients such as Zn-Mn-P-Mg-etc. plus adjuvants (growth aids, humic acid, microbes, energy (molasses), etc.).

♦ Also help overcome weather stress with plant growth hormones and enzymes in sprays. Only minimal rates are needed when sprayed directly on plants.

♦ By the 5-6 leaf stage, the embryo of the ear is forming – balanced nutrition adds rows of grain.

2. **AT BOOT –** (*R1 Stage – Silking – 63-68 days after emergence*) less than 15% of tassels or heads peaking out.

♦ Take 12 leaves from most recently mature leaf – (full dew lap (sheath) showing) - cut at dew-lap for entire leaf including base of mid rib - mature leaves will have most of the sheath showing.

♦ Take samples from the same area and pattern of field as before. At this point, the plant is entering maximum usage period of moisture and all nutrients.

♦ Apply foliarly or in water any deficient nutrient **especially Zinc** for Nitrogen use efficiency and the proper plant growth. Hormones can stimulate root and grain growth.

3. **AT POLLINATION -** (*R2 Stage-corn silks turning dark 10-14 days after R1*) major need is nitrate or urea Nitrogen for grain filling.

♦ Take12 ear leaves - same pattern and area as before – full leaves.

♦ NITROGEN, FOLAIR or WATER applied at this stage has increased yields - 15 to 20 bushels per acre when needed, only soil nitrate or urea (Soil and Foliar) works this late.

♦ This test evaluates how well this crop has been fed and is a tool for adjusting next year's fertility program.