Diagnosing Nutrient Deficiencies *in the Field*

Visual symptoms are an excellent diagnostic tool to determine nutrient limitations in crop fields. Visible nutrient deficiency symptoms in field crops, however, can be confused with other problems, such as diseases and damage due to climatic factors. It is essential to look for specific symptoms indicative of particular nutrient limitations.

Nutrient deficiencies in field crops generally occur because of low nutrient levels in the soil. Consider nutritional problems in relation to all conditions affecting plant growth, not exclusively in terms of the amounts of nutrients contained in or added to the soil.

The presence of adequate quantities of plant nutrients in the soil is no guarantee that they will be absorbed by the plant roots. Nutrients may be present in forms not available to the plants, or other factors may prevent plant uptake. Unusually low or high soil pH levels can affect nutrient availability. Poor growing conditions, excessively wet or dry soils, cold weather, or soil compaction can significantly restrict root growth and access to soil nutrients.

Nutrient mobility in the plant

Plant nutrients can be classified as mobile and immobile within the plant. This classification provides an indication of the possible nutrient in question when deficiency symptoms appear in the plant. When uptake is limited, mobile nutrients are usually translocated to the growing parts, leaving the older leaves with deficiency symptoms. Conversely, immobile nutrients cannot be translocated within the plant, and deficiencies appear in the younger leaves.

Mobile Nutrients: These nutrients can be translocated from old tissues to young tissues within the plant. Symptoms of nutrient shortage are noticeable first on lowest, oldest leaves.

- nitrogen
- phosphorus
- potassium
- magnesium

Immobile Nutrients: These nutrients are not easily transferred within the plant. Therefore, symptoms of nutrient deficiency occur first on upper, youngest leaves.

- iron
- sulfur
- calcium
- copper
- zinc
- manganese
- molybdenum
- boron

Possible causes of nutrient deficiencies:

- Low soil levels of the nutrient.
- Unusually low or high soil pH levels.
- Roots are unable to access sufficient amounts of nutrients. This can be due to poor growing conditions, excessively wet or dry soils, cold weather, or soil compaction.
- Root injury due to mechanical, insect, disease, or herbicide injury.
- Genetics of the plant.

Differences in soil conditions within a field can provide additional evidence of the possible limiting nutrient. Both soil testing and tissue analysis should be used to corroborate nutrient levels in the soil and the plant. Nutrient deficiencies are caused not only by low soil nutrient concentrations but also by root growth restrictions; therefore these possibilities should be considered.

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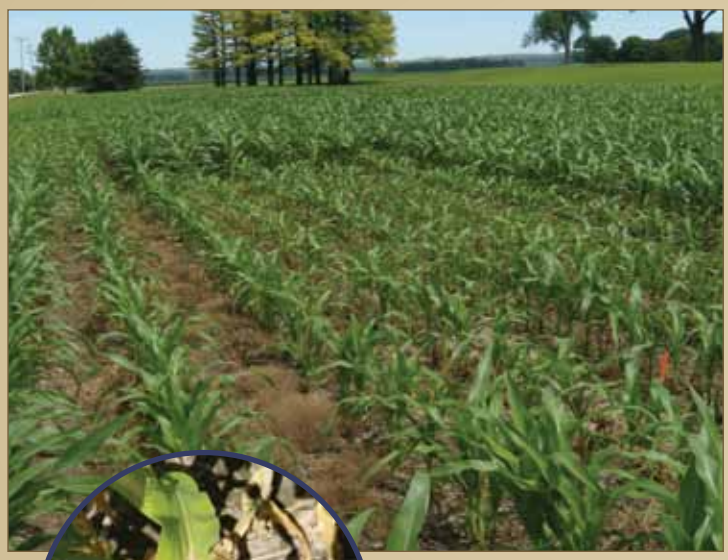
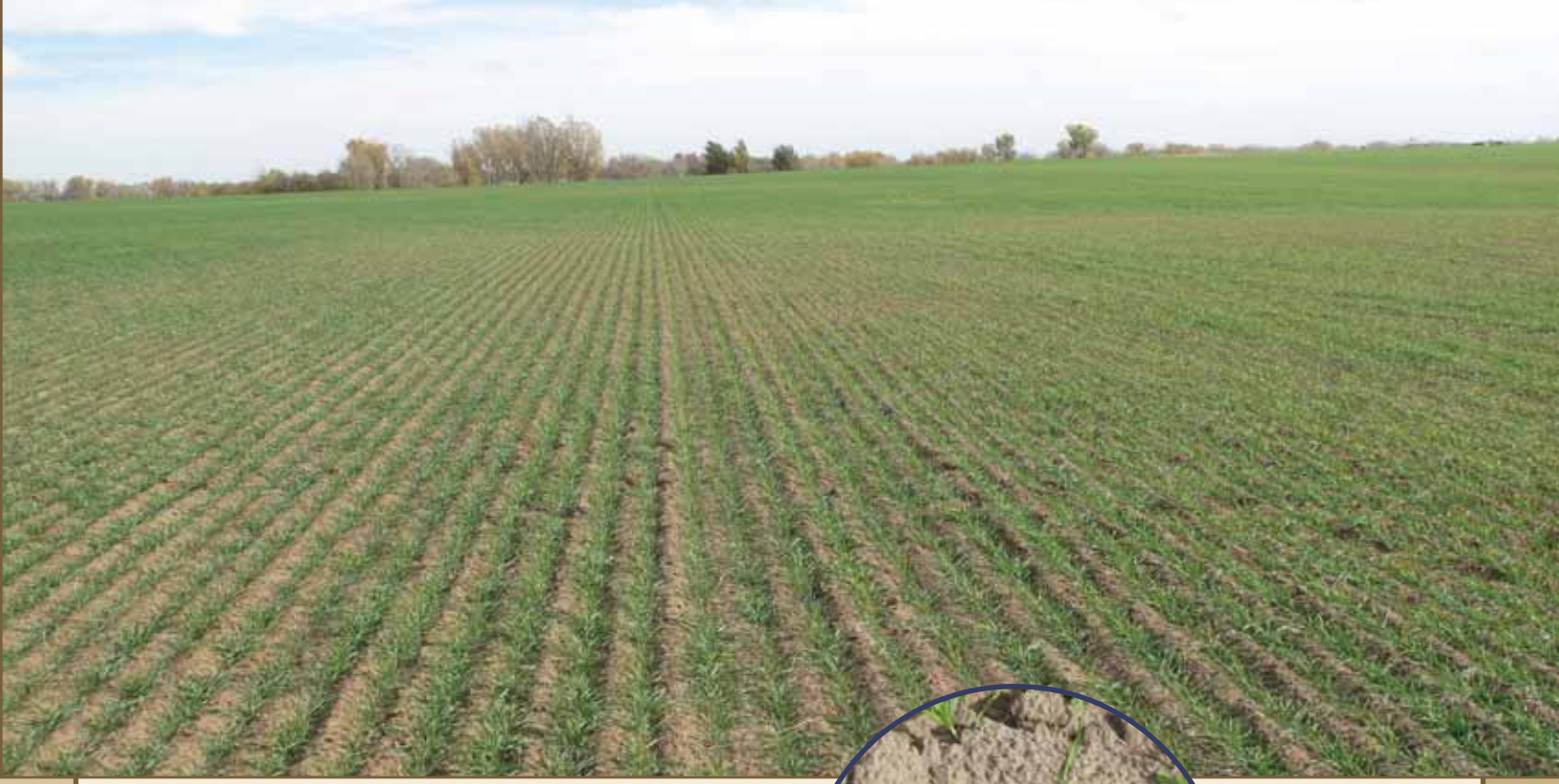
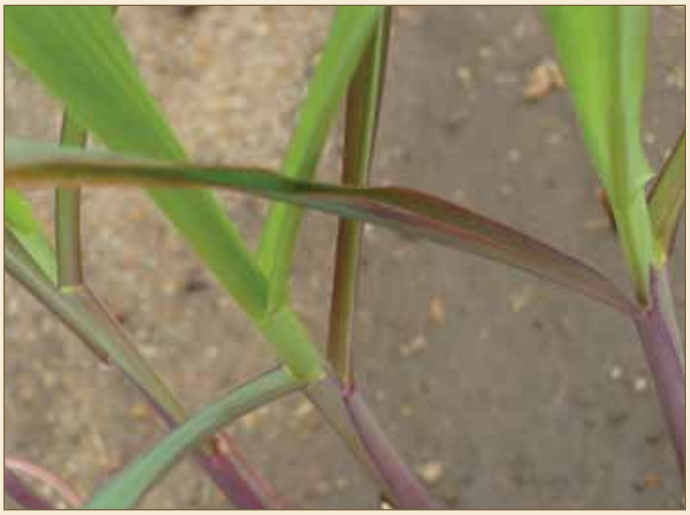


Nitrogen (N)

Since nitrogen is a mobile nutrient in the plant, symptoms begin on the oldest, lowest leaves and progress up the plant if the deficiency persists. Nitrogen deficiency causes pale, yellowish-green corn plants with spindly stalks or stems. In summer crop grass crops (e.g. corn and grain sorghum), symptoms appear on leaves as a v-shaped yellowing, starting at the tip and progressing down the midrib toward the leaf base. In small grain grass crops (e.g. wheat), nitrogen deficiency appears as a general pale yellowish-green plant with slow growth and reduced tiller development. If the deficiency persists, the stand appears thin and plants have reduced growth and remain pale green.

Nitrogen deficiency is advanced by cold or saturated soil; dry soil when the plants require large amounts of nitrogen; large amounts of low-nitrogen residue; sandy soil; inadequate fertilization; leaching from heavy rainfall; and flooded or ponded soil during periods of higher temperatures.





Phosphorus (P)

Phosphorus deficiency is usually visible on young plants. Phosphorus readily mobilizes and translocates in the plant. Deficient plants are dark green with reddish-purplish leaf tips and margins on older leaves. Newly emerging leaves will not show discoloration, only the older leaves.

Phosphorus-deficient plants are smaller and grow more slowly than plants with adequate phosphorus. Deficiency symptoms often disappear when plants begin canopy closure.

Phosphorus deficiency is advanced by cold soils that are too wet or too dry; phosphorus applied where plant roots cannot absorb it; restricted root growth in compacted soils; and roots injured by insects, herbicides, fertilizers, or cultivation.

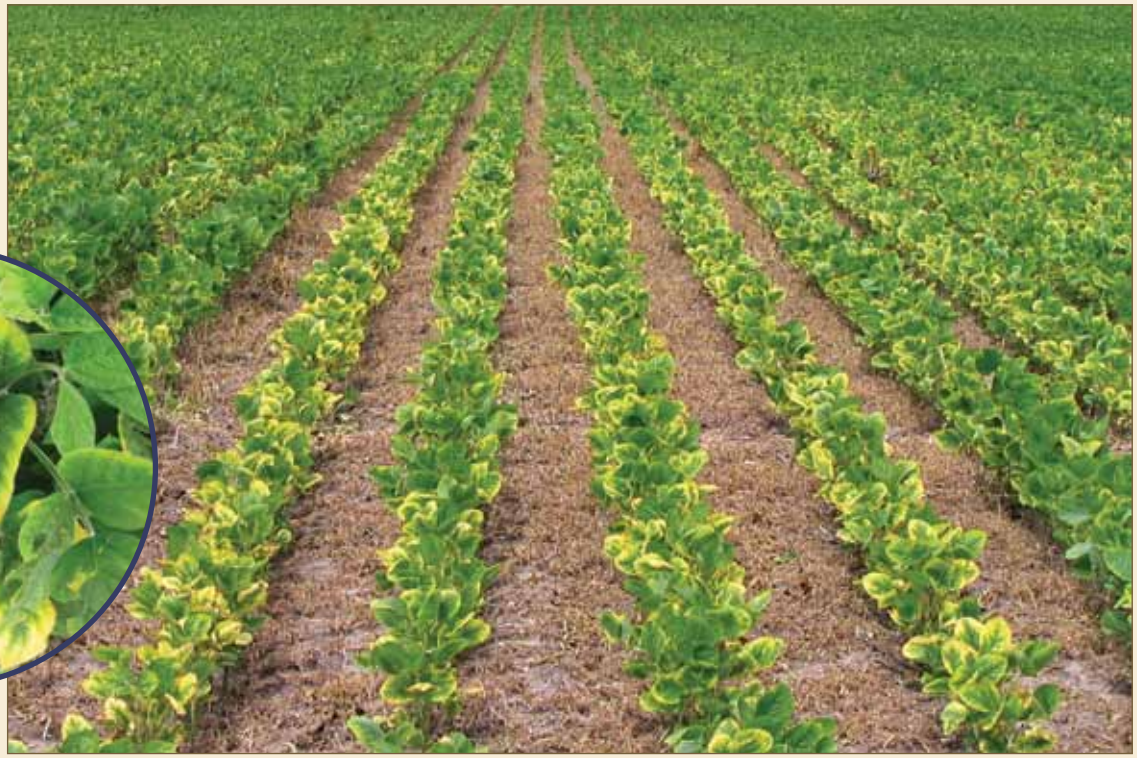
In wheat production, reduced tiller production can be related to phosphorus deficiency. Deficient soybeans display many of the same characteristics, but also may have necrotic spots on the leaves and may lead to delayed blooming and maturity.

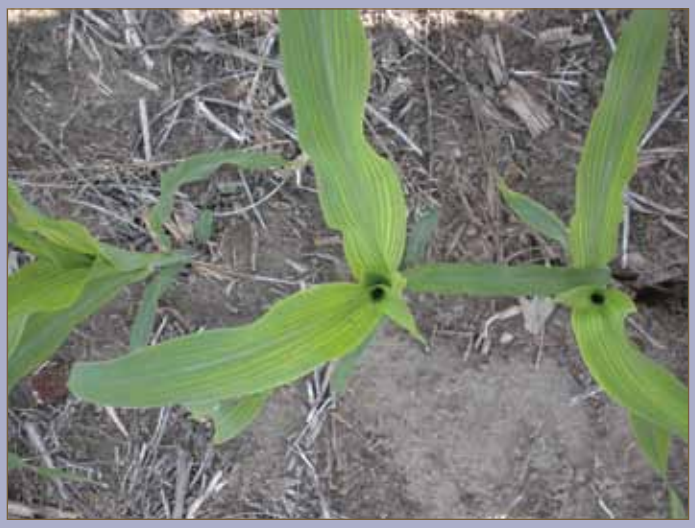
Potassium (K)

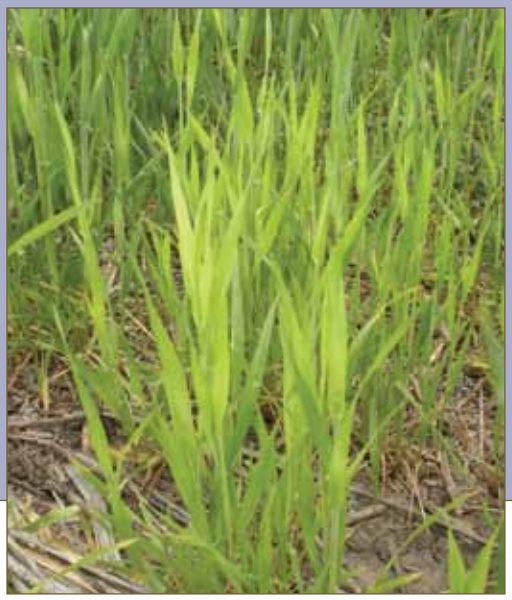
Most crops require large amounts of potassium. The deficiency is first seen as a yellowing and necrosis of the leaf margins, beginning on the lowest leaves. Symptoms usually do not appear for some time after planting (about 4 to 6 weeks, around the V6 growth stage in corn).

If the deficiency persists, symptoms progress up the plant because potassium is mobile in the plant and translocates from old to young leaves. When potassium deficiency is severe, older leaves turn yellow with tissue necrosis along leaf margins, but upper new leaves may remain green. Potassium-deficient crops tend to lodge late in the growing season because of poor stalk strength.

Potassium deficiency is advanced by conditions that limit early root growth, development, and activity – root pruning, dry soil, compacted soil, wet soil, sandy soil, organic soil, weathered soils; potassium applied where plant roots cannot absorb it; large amounts of potassium removed by a preceding crop; and some tillage systems such as ridge-tillage and no-tillage, especially in a dry year and on soil with low levels of subsoil potassium.



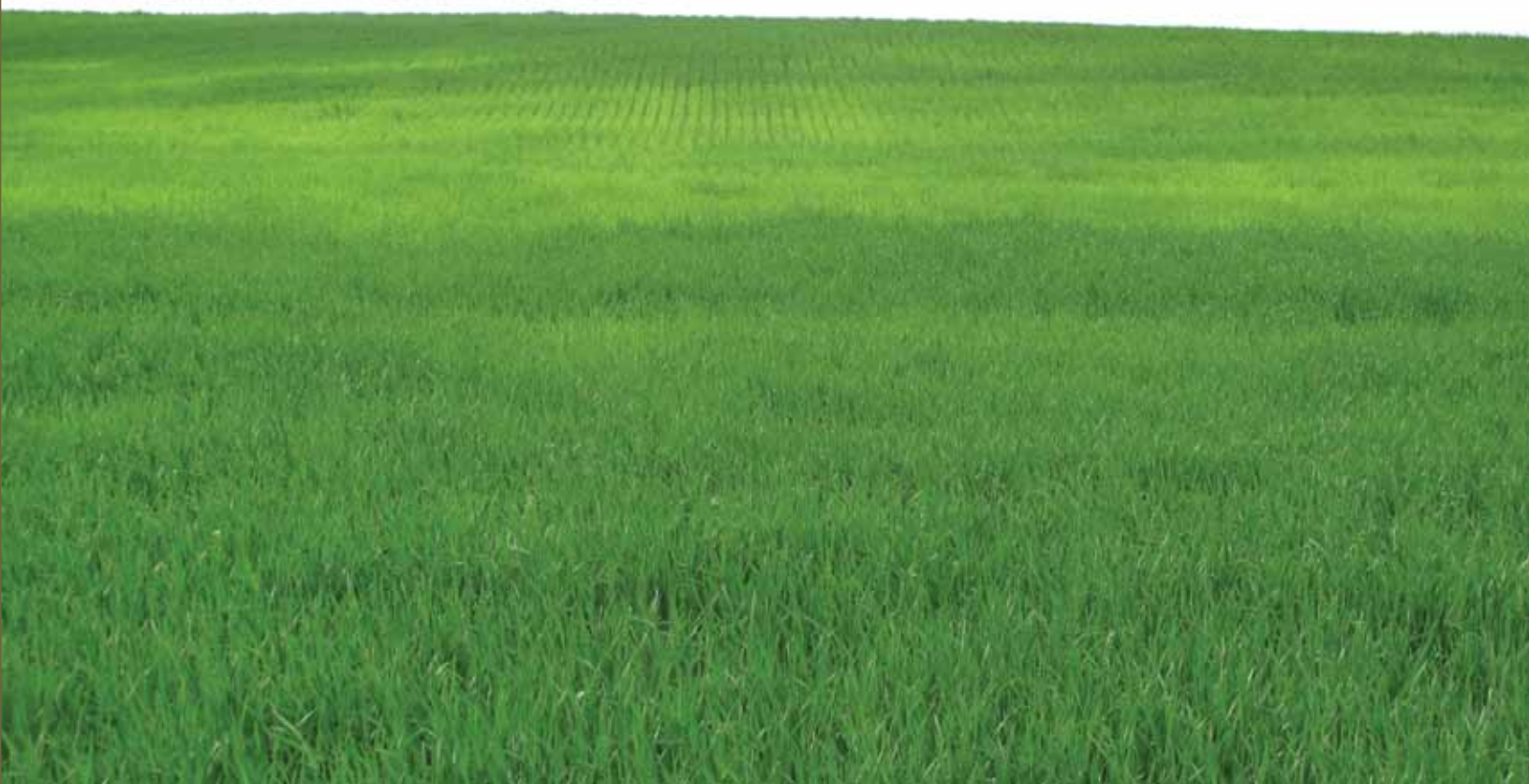


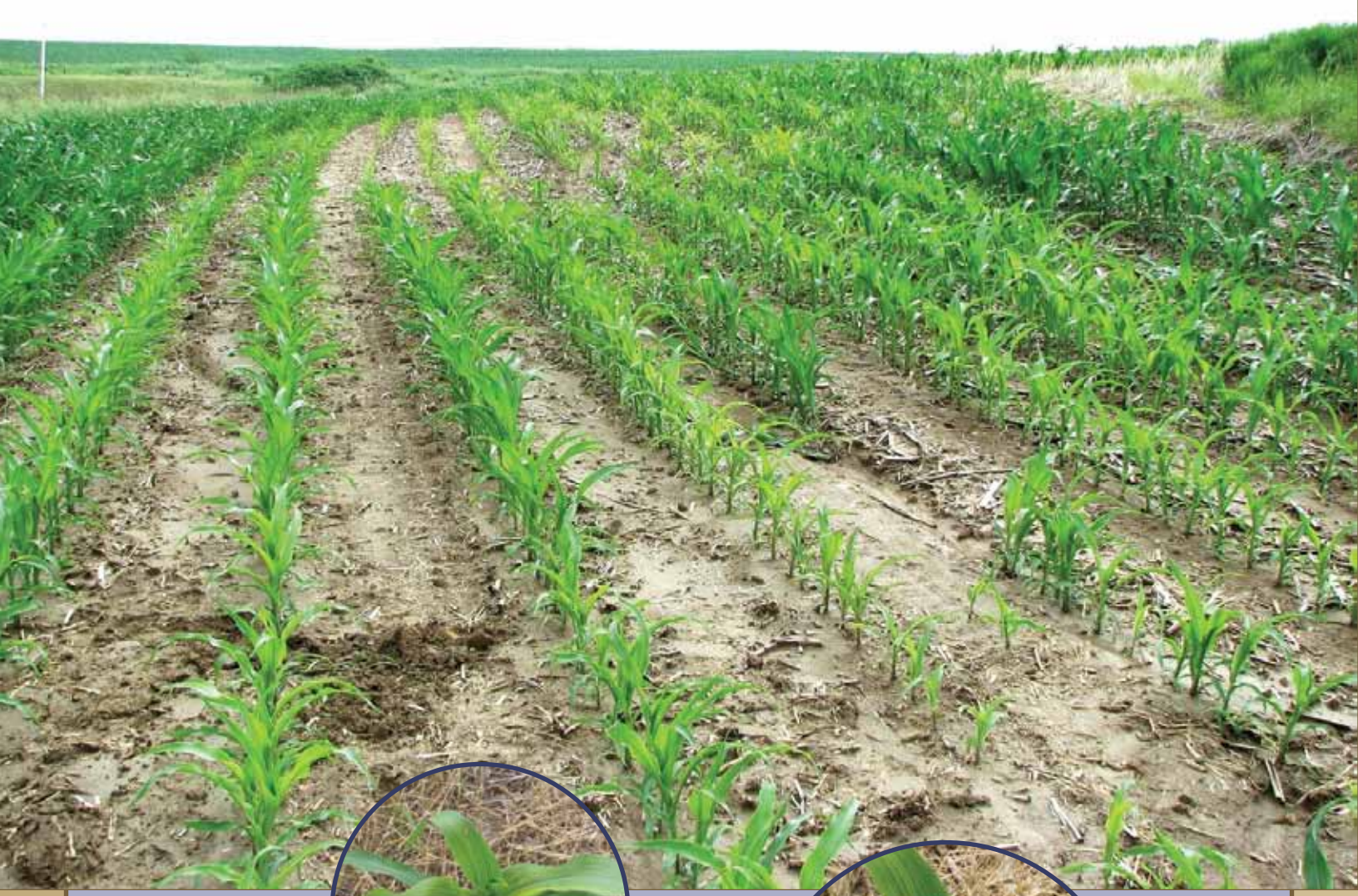


Sulfur (S)

Sulfur deficiency causes a general yellowing of the foliage, similar to nitrogen deficiency, and may appear during rapid plant biomass accumulation. Yellowing of the younger upper leaves is more pronounced with sulfur deficiency than with nitrogen deficiency because sulfur is not easily translocated in the plant. Stunting of plants and delayed maturity are also symptoms. Interveinal chlorosis of the youngest leaves may occur.

This deficiency is advanced by low pH sandy soils; low soil organic matter; and cold, dry soils in the spring that delay the release of sulfur from organic matter. Symptoms may disappear as temperature and moisture conditions improve for mineralization of sulfur from organic matter, or roots reach plant-available sulfate contained within the soil profile.





Zinc (Zn)

Zinc deficiency causes interveinal chlorosis, light striping, or a whitish band beginning at the base of the leaf and extending toward the tip. The margins of the leaf, the midrib area, and the leaf tip usually remain green. Plants are stunted because internodes are shortened. Zinc is relatively immobile in the plant. Severe zinc deficiency may result in new leaves that are nearly white. Plants frequently outgrow zinc deficiency unless it is severe.

Zinc deficiency is advanced by high soil pH; low organic matter soils with high soil pH; cool, wet soil; and high phosphorus fertilizer applications on soils that are marginal in zinc availability, although high soil phosphorus levels alone do not create zinc deficiency. Corn, soybeans, and sorghum may suffer from zinc deficiency, but wheat and sunflowers typically do not respond to zinc fertilization.

Iron (Fe)

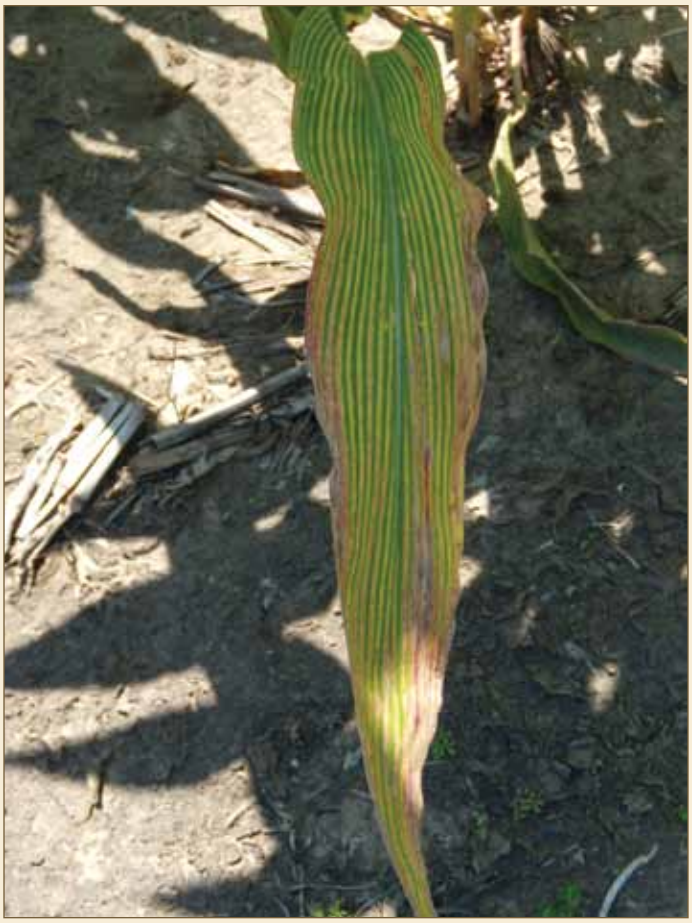
Iron deficiency turns the interveinal area along the length of the upper leaves pale green to nearly white. Iron is immobile and is not translocated from old to young plant tissue. This deficiency is rare on corn because of its low iron requirement, and it only occurs on high pH soils.

Iron deficiency is advanced by calcareous soils with a high soil pH in the surface soil and by cold, wet, poorly aerated soils. The extent of iron deficiency may depend on the crop or variety/hybrid. Corn naturally has a relatively low iron requirement, and the deficiency is rare, but, iron deficiency is common on grain or forage sorghums. Other crops, such as soybeans, are sensitive to iron deficiency and easily show similar characteristics to corn, with yellowing between the veins of young leaves.

A side effect of iron deficiency in soybeans can be nitrogen deficiency, since iron is necessary for nodule formation and function in soybeans. If iron is deficient, nitrogen fixation rates may be reduced. Iron deficiency occurs on calcareous soils because at high levels of calcium, iron molecules become tightly bound to the soil particle and unavailable for plant uptake.

Magnesium (Mg)

Magnesium deficiency is expressed first in the lowest, oldest leaves. Early symptoms appear as yellowing of leaf tips and move intervenally toward the base and midrib, giving a typical herringbone appearance. With severe deficiencies, symptoms can be confused with potassium deficiency, with necrosis in the border of leaves starting from the tip. In crops such as cotton, a reddening of leaves may be more common than intervenial chlorosis.



Chloride (Cl)

Chloride deficiency is often a problem in wheat, but can occur in corn and sorghum. Deficiency symptoms are also referred to as physiological leaf spot. The symptoms are similar in appearance to tan spot or septoria, with no associated pathogen. Chloride has been shown to suppress leaf spot, leaf rust, tan spot, and common root rot in wheat.

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