Healthy: Leaves shine with a rich dark green color when adequately fed.

Phosphate: Shortage marks leaves with reddish-purple, particularly on young plants.

Potash: deficiency appears as a firing or drying along the tips and edges of lowest leaves.

Nitrogen: hunger sign is yellowing that starts at the tip and moves along middle of leaf.

Magnesium: deficiency causes whitish strips along the veins and often a purplish color on the undersides of the lower leaves.

Drought: causes the corn to have a grayish-green color and the leaves roll up nearly to the size of a pencil.

Disease: heminthospoium blight, starts in small spots, gradually spreads across leaf.

Chemicals: may sometimes burn tips, edges of leaves and at other contacts. Tissue dies, becomes whitecap.
140 F  Soil bacteria die
130 F  100% moisture is lost through evaporation and transpiration
113 F  Some bacteria species start dying
100 F  15% moisture is used for growth
  95 F  85% moisture lost through evaporation and transpiration
  70 F  100% moisture is used for growth

J.J. McEntire, WUC, USDA SCS, Kernville TX, 3-58 4-R-12198. 1956
COTTON ROOT GROWTH RESTRICTION DUE TO ACID SUB-SOIL AND ALUMINUM TOXICITY

Magruder Plots 3.16.18
Stillwater Oklahoma
How soil pH affects availability of plant nutrients

<table>
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<th>Soil pH</th>
<th>Strongly Acid</th>
<th>Medium Acid</th>
<th>Slightly Acid</th>
<th>Very Slightly Acid</th>
<th>Slightly Alkaline</th>
<th>Medium Alkaline</th>
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Optimum soil pH range: 6.2 - 7.3
Nitrogen in atmosphere ($N_2$) is assimilated by plants. Decomposers (aerobic and anaerobic bacteria and fungi) convert dead organic matter into ammonia ($NH_4^+$). Nitrogen-fixing soil bacteria and nitrogen-fixing bacteria in root nodules of legumes fix nitrogen from the atmosphere. Nitrifying bacteria convert ammonia to nitrites ($NO_2^-$) and then to nitrates ($NO_3^-$). Denitrifying bacteria convert nitrates back to nitrogen gas ($N_2$), completing the nitrogen cycle.
Plants and grass need nutrients:

N - Nitrogen
Good for:
- Growth
- Color
- Density
- Chlorophyll formation
Deficiency symptoms:
- Pale color, yellowing
- Stunted growth

P - Phosphorus
Good for:
- Growth of new roots & shoots
- Seedling root growth
- Seedling plant vigor
Deficiency symptoms:
- Rarely seen
- Yellowing or purple cast to leaves

K - Potassium
Good for:
- Overall plant health
- Stress resistance
- Cold hardiness
- Disease resistance
Deficiency symptoms:
- Rarely visible
- Pale color or no symptoms

Fe - Iron
Good for:
- Chlorophyll formation
Deficiency symptoms:
- Yellowing
Simple Plant Deficiency Guide

**Calcium**
- New leaves misshapen or stunted.
- Existing leaves remain green.

**Iron**
- Young leaves are yellow and white with green veins. Mature leaves are normal.

**Nitrogen**
- Upper leaves are light green where lower leaves are yellow.
- Bottom or older leaves are yellow and shrivelled.

**Carbon Dioxide**
- White deposits on leaves.
- Stunted growth, and plant die back.

**Phosphate**
- Leaves are darker than normal and loss of leaves.

**Potassium**
- Yellowing at the tips and edges, usually in younger leaves.
- Dead or yellow patches develop on leaves.

**Manganese**
- Yellow spots and or elongated holes between veins.

**Magnesium**
- Lower leaves turn yellow from outside going in, veins remain green.

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Deficiency Chart of Micronutrients

**Boron:** Discoloration of leaf buds. Breaking and dropping of buds.

**Sulphur:** Leaves light green. Veins pale green. No spots.

**Magnesium:** Paleness from leaf edges. No spots. Edges have cup shaped folds. Leaves die and drop in extreme deficiency.

**Phosphorus:** Plant short and dark green. In extreme deficiencies turn brown or black. Bronze colour under the leaf.

**Calcium:** Plant dark green. Tender leaves pale. Drying starts from the tips. Eventually leaf buds die.

**Iron:** Leaves pale. No spots. Major veins green.

**Manganese:** Leaves pale in color. Veins and venules dark green and reticulated.

**Copper:** Pale pink between the veins. Wilt and drop.

**Zinc:** Leaves pale, narrow and short. Veins dark green. Dark spots on leaves and edges.

**Molybdenum:** Leaves light green/lemon yellow/orange. Spots on whole leaf except veins. Sticky secretions from under the leaf.

**Magnesium:** Paleness from leaf edges. No spots. Edges have cup shaped folds. Leaves die and drop in extreme deficiency.

**Potassium:** Small spots on the tips, edges of pale leaves. Spots turn rusty. Folds at tips.

**Nitrogen:** Stunted growth. Extremely pale color. Upright leaves with light green/yellowish. Appear burnt in extreme deficiency.

**THE COLOUR REPRESENTED ARE INDICATIVE. THEY MAY VARY FROM PLANT TO PLANT**