THE UNIVERSITY OF GEORGIA
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Colleges of Agricultural and Environmental Sciences & Family and Consumer Sciences

GEORGIA
Corn Diagnostic Guide

A Comprehensive Guide for Troubleshooting Problems in Corn

Acknowledgments

The original manuscript of this guide was a result of a cooperative project in 1983 among South Carolina, Georgia, Florida and North Carolina. It was developed by Joseph Zublena, Joseph Krausz, Randall Griffin, Franklin Congleton, David Wright and John Anderson. It has been extensively revised, and photographs have been added to enhance the quality and utility of the publication. The model for this guide and others originated from Samuel R. Aldrich and Earl R. Leng, Modern Corn Production, F&W Publishing Co., 1965.

Other publications have been developed since by several seed companies. Each provides different photographs but similar diagnoses and can serve as useful references. Growers are encouraged to obtain a copy(s) for reference in correctly diagnosing problems the encounter in the season.

Contributing Authors

University of Georgia:

Dewey Lee, Extension Agronomist
Eric Prostko, Extension Weed Scientist
Steve Brown, Extension Entomologist
Randy Hudson, Extension Entomologist
Bob Kemerait, Extension Plant Pathologist

University of Florida:

Greg McDonald, Weed Scientist

Mississippi State University:

Richard Baird, Plant Pathologist

Auburn University:

Paul Mask, Extension Agronomist
Kathy Flanders, Extension Entomologist

The Georgia Corn Diagnostic Guide

A comprehensive guide for troubleshooting problems in corn

Edited by R. Dewey Lee

This guide was prepared to help growers and crop advisors identify problems found in corn fields so that proper corrective measures can be taken to insure as successful production as possible. For any corrective action to be successful, early detection is essential. This publication was not intended to be used as the sole source of information to identify a problem but as an aid to assist an individual as they seek help from professionals such as county extension agents, agronomist, entomologist or plant pathologist.

The field is a complex environment with many factors that can interact to influence the growth of a corn plant. These factors can be living in the form of insects, diseases, nematodes and weeds; or, they can be non-living such as weather, nutrients, or chemicals. In the proper combination of factors, corn can produce more than 200+ bushels per acre in the southeast; or in totally unfavorable combination, every corn plant can die. When a problem is identified, it is important to determine the extent and severity of the problem to decide whether corrective measures are necessary or available. Use this guide and other technical information before implementing any management decision.

Before going to the field:

1) Before going to a field make sure to have the appropriate equipment such as: a small shovel, bucket, soil test tube, knife, camera, small magnifying glass, and a tape measure.
2) Obtain a plant analysis kit or soil test bag from your local county extension office. Remember to study the instructions prior to taking a sample.
3) Check any records that are available for the field in question. Sometimes previous inputs may carry over to the next year.
4) Enter the field and observe and note any patterns.
5) Take into account factors affecting plant growth such as soil type, slope, drainage, fertility, seedbed preparation, previous crop and management, pest control, planting rate and depth. Obtain a seed tag if possible to identify the lot number and hybrid.
6) If a camera is available, take pictures of both affected and unaffected areas. Equipment such as digital cameras or camcorders are becoming popular with access to the internet. Today images can be transmitted over the internet to other individuals or institutions for help in identifying problems and developing corrective measures.

Preparing diagnostic soil And plant samples.

1. When preparing plant or soil sample(s) from affected areas and unaffected areas, remove any excess soil or unnecessary plant materials.
2. Place leaves between paper towels or sheets; compress with cardboard. Wrap roots in a moist paper towel, place roots into a plastic bag. Bind around the stalk and place sample in a paper bag or box. **Do not place the whole sample in plastic.**
3. Place any soil in plastic bags or soil test analysis bag and clearly identify the sample(s).
4. Bring the sample(s) to your county extension office for diagnosis or ship in a sturdy envelope or box.
5. Do not send sample(s) in the mail when it is likely the sample(s) will remain unshipped over a weekend or holiday.
6. Provide the following information to help in identifying and diagnosing the problem.
   a. crop and hybrid identification
   b. farm and/or field location
   c. history of previous crop or cropping system
   d. date that problem was first noted
   e. all agronomic practices such as: planting date, rate, fertility practice, pesticide applications/ rates
   f. soil type and moisture and topography

g. plant symptoms and how area affected
h. any available weather records such as rainfall, temperature, etc

Diagnosis via the internet

Today the internet provides access to an incredible amount of information and tools for diagnosing problems. The "Distance Diagnostics Through Digital Imaging" system at the University of Georgia College of Agriculture and Environmental Sciences uses the internet to provide rapid access and diagnosis of problems. Information and digital images taken with cameras or microscopes can be submitted directly from Georgia County Extension Service offices for access by resource professionals. This vastly improves the convenience of seeing the information and materials by professionals and reduces the amount of time between identifying a problem and diagnosing it. It is available in most counties in Georgia.

Before Using the Guide

It is important as you enter a field to recognize the growth stage of corn as it may give clues to diagnosing problems in the field. This diagnostic guide is divided into four broad categories for corn development: **Emergence, Emergence to Knee-High, Knee-High to Tassel, Tassel to Maturity.** The following information, Identifiable Growth Stages, is to help acquaint you with the development of the corn plant.

Identifiable Growth Stages

Growth Stage	Diagnostic Characteristic
Before emergence	Seed planted
Emergence	Coleoptile visible
Two leaf	2 leaves fully open, collar visible
Early whorl	4-6 leaves fully emerged
Mid whorl	8-10 leaves fully emerged
Late whorl	12-16 leaves fully emerged
Tassel	Tassel emerging
Early silk	Silks emerging, pollen shedding
Mid silk	50% of plants silking
Late silk	Plants pollinated, silks green to brown
Blister stage	Brown silk, cob full size, watery kernels
Soft dough	Kernels milky with some starch
Hard dough	Few kernels with dents
Physiological Maturity	Black layer formed, grain mature and drying

General Plant Appearance Key

Corn Diagnostic Guide

I. Before Emergence

General Appearance	Specific Symptoms	Possible Cause(s)
A. Skips in rows where plants fail to emerge	No seed planted.	Planter malfunction. Empty planter box.
	Seed not sprouted.	Seed not viable. Anhydrous ammonia injury. Excessive fertilizer (nitrogen and/or potash placed too close to seed. Soil too dry or water logged.
	Seed swollen, but not sprouted.	Seed not viable. Soil too cold (50ºF or lower). Chemical injury (too much fertilizer too close.) Phytotoxic chemicals.
	Rotted seed or seedlings.	Fungal seed rots or seed blights. Anhydrous ammonia injury. Wireworms. Cold injury. [Figures 52, 73]
	Sprouts twisted or leaves expanded underground.	Soil crusted. Compacted soils. Cloddy soil allowing light to reach seedling prematurely. Seeds planted too deep in cold, wet soil. Herbicide injury: alachlor (Lasso), acetochlor (Surpass) metolachlor (Dual), dimethanamid (Frontier). Generally, associated with excessive rates or cool, wet soils. Excessive soil insecticide dosage. Anhydrous ammonia injury.
B. Seed or sprout eaten or dug up.	Seed hollowed out.	Seed corn maggot. Wireworms.
	Unemerged seedling dug up and/or entire plant eaten.	Wildlife such as mice, hogs, rats, crows, blackbirds, etc.

II. Emergence to Knee-High

General Appearance	Specific Symptoms	Possible Cause(s)
A. Scattered problem; spots of dead or poorly growing plants.	Uneven growth of corn.	Drainage problems. Soil compaction problems. Variation in planting depth, soil moisture, etc. [21] Poor growing conditions (cold, wet, dry, etc.) Seed bed not uniform (cloddy). Fertilizer injury. Nematodes. Low soil pH. [1]
	Plants stunted, wilted and/or discolored.	Low fertility. Nematodes: sting, stubby-root, lesion, lance, and ring are the more common corn nematodes. [2] Damping-off and seedling blight. Fertilizer injury. Herbicide injury: Thiocarbamates - Sutan, Eradicane Plus Acetanilides - Lasso (alachlor) [3] - Dual (metolachlor) [4] - Frontier (dimethanamid) - Surpass (acetochlor) Dinitroanilines - Prowl [5] Herbicide carryover – see Section C
	Plants cut off above or below ground.	Cutworms. [6]
	Sudden death of leaves or plants.	Frost in low areas of field – leaves first appear water-soaked, then gray or whitish; if growing point of seedling is still underground or not affected and only top growth killed, plant should recover. [7] Lightning – both corn and weeds killed, usually in a circular-shaped area with clearly defined margins; affected area does not increase in size. Nitrogen burn. [8]
	Plants with rough, gouged-out feeding damage at or just below the soil surface.	Sugarcane beetle. [11] Carrot beetle.

General Appearance	Specific Symptoms	Possible Cause(s)
B. Wilting	Upper leaves roll and appear dull or sometimes purple; stunting of plants; plants may die.	Drought conditions. [9] Chinch bugs found in large number near the base of the stalks, behind leaf sheaths, or in the soil round the base of the plants. [10] Black cutworms may chew a hole in the stalk below soil surface resulting in plant wilting and dying. White grubs chew off roots, do not tunnel into them. Southern corn rootworm bores through base of stalk. Wireworms may chew off or bore into roots. [13] Corn root aphids suck the juices from roots; always attended by brown ants. Mechanical pruning of roots, plowing too close.
	Whorl dead.	Wireworm, cutworm, stalk borer. [12]
	Crown roots not developing.	Dry surface soil, shallow planting, very high temperatures, compacted sidewalls.
	Plants appear weak and sickly, wilting may occur; tunneling or girdling is apparent.	Lesser corn stalk borer. [53]
C. Plants discolored	Leaves appear sandblasted; leaves pale green or whitish in color.	Wind or sand damage. Thrips. [14] Spider mites: primarily on underside of leaves; produce fine webbing across leaf surfaces; most destructive during hot, dry weather.
	Leaf edges yellow or dead.	Potassium deficiency.
	Yellowing or browning beginning from the tips.	Excessive herbicide rates – linuron (Lorox), ametryn (Evik), cyanazine (Bladex), post emergence with oil, atrazine (Aatrex, Atrazine) and other photosynthetic inhibitors – in severe cases, plants may die. Postemergence herbicides applied with excessive oil or with liquid fertilizer.
	Lower leaves dead, tips on upper leaves dying.	Fertilizer injury.
	General yellowing of upper leaves.	Sulfur deficiency.
	General yellowing of lower leaves, beginning at tip.	Excessive moisture. Nitrogen deficiency.

General Appearance	Specific Symptoms	Possible Cause(s)
C. Plants discolored ***(continued)***	Purpling or reddening of leaves from tip backward; affects lower leaves initially, leaf tips may later turn dark brown and die.	Phosphorus deficiency – severe. [15] Compacted soil. Cold weather. White grubs. Injured leaves. Low soil pH.
	Leaves slowly turn yellow to white to tan and die. Plants severely stunted.	Glyphosate (Roundup), herbicide injury. [16]
	Irregular light gray or silvery blotches on both sides of leaves on the east side of affected plants.	"Sunscald" – usually occurs when chilly, dewy nights are followed by clear, sunny, hot mornings. Frost.
	Light streaking of leaves which develops into a broad band of bleached tissue on each side of the mid-ribs; leaf midribs and margins remain green; sometimes stalks and leaf edges appear to be tinted red or brown.	Zinc deficiency. [17, 18]
	Bright yellow to white stripes with smooth margins running the length of leaves; may appear on scattered plants throughout the field and sometimes, only on one side of a plant.	Genetic stripes.
	White or yellow stripes between leaf veins.	Excessively acidic soil. Magnesium, iron, manganese, boron or sulfur deficiencies. (Conduct plant analysis.)
	Distinct bleached bands across leaf blades; leaf tissue may collapse at discolored bands, resulting in the leaf folding downward at this point.	Certain diphenyl ether herbicides. Cold banding. [19]
D. Plants discolored and stunted.	Leaves yellow; plants spindly and stunted. Lower leaves may die.	Nitrogen deficiency. Water logged soils.
	Upper leaves yellow, plants spindly.	Sulfur deficiency – more pronounced on upper younger leaves than nitrogen deficiency. [20]

General Appearance	Specific Symptoms	Possible Cause(s)
D. Plants discolored and stunted. ***(continued)***	Lime green to yellow leaves, some turning purplish – with purplish discoloration, roots are "bottle brush" shape.	Imidazolinone herbicide injury: imazaquin (Scepter), imazethapyr (Pursuit) , imazapic (Cadre) – generally carryover from soybeans or peanuts.
	Purple or red discoloration of leaves, especially leaf margins; stunting; stubby, malformed roots and droughty appearance.	Dinitroaniline herbicide injury: trifluralin (Treflan), pendimathalin (Prowl), usually results from excessive rates; causes stubby roots with tips swelling and restricted secondary root development. [72]
	Bleach white leaves, stunted plants	Command herbicide carryover, possible drift. [22]
	Associated with yellowish white:	
	Associated with some pink or purplish discoloration.	Zorial herbicide carryover. [23]
	Whitish to yellowish striping along leaf veins.	Sulfur deficiency.
E. Plants discolored, malformed, and/or stunted.	Excessive tillering; stunting.	Crazy top – infrequent fungal disease.
	Slight yellow-green tint; severely stunted; inability of leaves to emerge or unfold-leaf tips stick together giving plants a ladder-like appearance.	Calcium deficiency. [25] Herbicide injury: amide herbicides (Lasso, Dual, etc.), thiocarbamate herbicides (EPTC, Sutan), others (Broadstrike). [26]
	Leaves yellow and not fully expanded; roots sheared off or dried up	Over-application of anhydrous or aqua ammonia. [27]
F. Plants stunted and/or malformed	Leaves fail to unfurl properly, some leafing out underground; plants may be bent, lying flat on the soil surface or show "buggy whip" effect.	Excessive amide herbicide rates: Lasso, Dual, etc., or phenoxy herbicide damage: dicamba (Banvel), 2,4-D [30, 31] Stink bug. [28, 29]
	Leaves stunted – twisted, and may appear knotted or hooked over.	Thiocarbamate herbicide injury: butylate (Sutan+), EPTC (Eradicane), or amide herbicide injury: alachlor (Lasso), acetochlor (Surpass) metalachlor (Dual), dimethanamid (Frontier)
	Shoots and roots malformed; general stunting of plants.	Excessive rates of soil applied phenoxy herbicides (2,4-D) or dicamba (Banvel). [32]

General Appearance	Specific Symptoms	Possible Cause(s)
F. Plants stunted and/or malformed ***(continued)***	Excessive tillering.	Stink bug damage. [33]
	Onion-leafing (leaves remain wrapped in a tall spike). Stalks slightly curved.	Excessive herbicide rates applied "over the top": dicamba (Banvel) – leaves may be narrower than normal; 2,4-D herbicide injury – may cause temporary (7-10 days) stalk brittleness.
	Plants bent or twisted; stunted; irregular rows of holes in unfolded leaves.	Stalk borer. [35] Billbug. [34]
G. Lesions on leaves	Small spots of dead tissue on leaves, tan or paper-bag colored.	Gramaxone Extra or Starfire (paraquat) herbicide damage occurs only where the chemical contacts the plant tissue. [36]
	Circular to oval cinnamon-brown or reddish pustules.	On both sides: Common rust. [37] On one side: Southern rust. [38]
H. Plant tissue removed	Whole plant cut off at ground level.	Cutworm. [39]
	Leaves entirely eaten off or large chunks of leaf tissue removed.	Armyworms. Grasshoppers. Deer, rabbits.
	Ragged holes in the leaves, not in regular rows.	European corn borers. [40] Corn earworms. Cutworms – early larval instar damage. Fall armyworms. Yellow striped armyworms Grasshoppers.
	Shredding, tearing of leaves.	Wind damage. Hail damage.
	Rows of circular to elliptical holes across leaves.	Billbugs. Black cutworm. Stalk borers. Corn earworms.
	Long narrow strips of continuous feeding, transparent window pane effect on surface of one side	Cereal leaf beetle. [41] Flea beetle.
	Small, oval transparent windowpane effect.	Corn earworm, (early instar). European corn borer, (early instar).

III. Knee-High To Tasseling

General Appearance	Specific Symptoms	Possible Cause(s)
A. Severe wilting and/or death of plants	Sudden death of plants.	Lightning – all plant material in an approximately circular area suddenly killed; plants along margin of affected area may be severely to slightly injured; severely injured plants may die later.
	Dead leaves or plants, usually at row ends.	Ammonia burn. Post-directed herbicide injury: Gramoxone Extra, Evik, Lorox. [42]
B. Plants discolored	Yellowing of plants, beginning with lower leaves.	Nitrogen deficiency: V-shaped yellowing of leaves, beginning at midrib and widening toward leaf tips; leaf tips die ("firing") while leaf margins remain green. Excessive rain, causing nitrogen leaching. Drought conditions – produce nitrogen deficiency. Water logging-standing water can produce nitrogen deficiency and low soil oxygen conditions.
	Yellowing of leaf margins beginning at tips; affected tissue later turns brown and dies.	Potassium deficiency.
	Yellowing, generally followed by leaf burn or death.	Post-directed herbicide injury - Gramoxone Extra, Evik, Lorox.
	Leaf yellowing, beginning with newest emerging leaves, may be associated with plant stunting. May experience rotting of growing point.	Accent, Basic Gold, Beacon, Exceed herbicide injury applied to corn with in-furrow at-plant insecticide treatment (most commonly associated with organophosphate insecticide). Can also be observed under cool, wet growing conditions.
	Purpling or reddening of leaves from tip backward; affects lower leaves initially; leaf tips may later turn dark brown and die.	Phosphorus deficiency.
	General yellowing.	Nitrogen deficiency. Sulfur deficiency. [20] Conduct leaf analysis – N/S ratio should be lower than 15:1.
	Yellow to white interveinal striping on leaves.	Genetic stripe: stripes have smooth margins; may appear on scattered plants throughout the field and, sometimes, only one side of a plant. Sulfur deficiency: yellow interveinal striping. Magnesium deficiency: yellow to white striping usually developing on lower leaves; red-purple discoloration along edges and tips; stunting may occur.

General Appearance	Specific Symptoms	Possible Cause(s)
B. Plants discolored *(continued)*	Top leaves completely white.	Heat. Irrigating with cold water on very hot day.
	Leaves and/or shucks turn whitish, fine stippling.	Spider mites feed primarily on underside of leaves; produce fine webbing across leaf surfaces; most destructive during hot, dry weather.
	Pale green to white stripes interveinal, usually on upper leaves.	Iron deficiency.
	Upper leaves show pale green to yellow interveinal discoloration; lower leaves appear olive green and somewhat streaked; severe damage appears as elongated white streaks, the center of which turns brown and falls out.	Manganese deficiency: generally found in soils with high water tables, i.e., flatwood soils and high soil pH.
C. Plants discolored and malformed	Plants show stunting and/or a mottle or fine chlorotic stripes in leaves. Leaves can be reddish.	Maize dwarf mosaic or Maize dwarf chlorotic virus vectored by insects. Frequently associated with control of johnsongrass and movement of insects from grass to corn.
	Stunting, tillering; twisting and rolling of leaves.	Crazy top. [24]
D. Plants malformed	Upper leaves tightly rolled, enclosing upper leaves and tassel; plant elbowing or lodging.	2,4-D herbicide injury – also may result in upcurling or fusing of brace roots and brittleness of lower nodes. [30, 31] Mechanical injury.
	Plants lodge or grow in a curved "sled runner" or "gooseneck" shape.	Corn rootworm larvae feeding damage – damaged root systems result in entire plant becoming lodged; lodging due to stalk breakage, not from rootworm damage. [43] Herbicide injury: Banvel, 2,4-D. Mechanical injury. Hot, dry weather and winds: preventing normal brace root development. Soil compaction.
E. Plant tissue removed	Ragged holes in leaves accompanied with small window pane feeding	Corn earworm. Fall armyworm. European corn borer.
	Shredding, tearing of leaves and plants, some ragged holes.	Wind damage. Hail damage. [61, 70]

General Appearance	Specific Symptoms	Possible Cause(s)
E. Plant tissue removed *(continued)*	Leaf tissue skeletonized or lacy in appearance.	Japanese beetles.
	Leaves entirely eaten off or large chunks of leaf tissue removed.	Armyworms. [68] Grasshoppers. Fall armyworms. [62] Corn earworms. [44] Wildlife.
	Holes bored into stalks and area within stalk hollowed out by feeding damage. Frass sometimes evident.	European corn borers – late instar damage. Other stalk borers. [45]
	Elliptical holes across leaves.	Grasshoppers.
F. Lesions on plants	Oval, circular, or rectangular lesions, tan to brown in color.	Fungal leaf spots.

IV. Tasseling to Maturity

General Appearance	Specific Symptoms	Possible Cause(s)
A. Silking impaired	Delayed silking or failure to silk.	Heat, drought stress. Nutrient deficiency: low phosphorus or nitrogen. Corn leaf aphids – typically found in larger numbers feeding within the whorl.
	Silks clipped off.	Western corn rootworm adults. Cucumber beetles. Japanese beetles. [46] Grasshoppers. Corn earworm.
	Silks fail to emerge.	Silk balling; associated with sudden cool temperatures. Some hybrids more prone than others. [47]
B. Tassels malformed	Tassels and upper stalk and foliage bleached – premature drying.	Anthracnose.
	Tassels develops a mass of leaves.	Crazy top. [24]
	Tassel forms miniature ear.	Genetic/environmental condition. Injury during reproductive development. [48]

General Appearance	Specific Symptoms	Possible Cause(s)
C. Plants discolored	Tassels broken off from tunneling.	European corn borer. [49]
	Yellowing of leaf margins beginning at tips; affected tissue later turns brown and dies.	Potassium deficiency.
	Reddish or purple leaves and stalk.	Barren plant. [50]
	Irregular, purple brown spots or blotches on sheaths.	Purple sheath spot – harmless discoloration on side of leaf sheaths where fungus or bacteria grow.
D. Stalks malformed and/or broken	Lower stalk internodes and brace roots easily compressed; stalks may lodge.	Fungal stalk rots. [51]
	Twisting and bending at corn stalks above the ear shoot; ear may be malformed.	Mechanical injury. Hybrid characteristic.
	Brown, soft rot of lower internode; stalks twist and fall.	Pythium stalk rot or bacterial stalk rot. European corn borers, other stalk borers; entry holes evident.
	Plants lodge, stalk may break.	European corn borer. Southwestern corn borer. Wind. Potassium deficiency.
E. Premature death of all or some parts of plant.	Sudden death of entire plant. All plant material in an approximately circular area suddenly killed; plant along margins of affected area may be severely to slightly injured; severely injured plants may die later.	Stalk rot complex resulting when the plants are under severe drought and growers apply high rates of nitrogen near tasseling. Lightning. Frost: before plants reach maturity, leaves first appear water-soaked, then gray; plants in low areas of field most susceptible. Severe corn borer damage. Accidental herbicide application (drift) of glyphosate (Roundup). Definite drift pattern should be evident. Plants will turn yellowish-white and die.
	Extensive areas of leaf tissue die prematurely, resulting in leaf drying.	Anthracnose leaf blight. [55]
	Top kill – premature death of all or portion of plants above ears.	Anthracnose. [55] Stalk rots. [69, 71]
F. Leaf tissue removed.	Ragged holes in the leaves.	Hail damage.

General Appearance	Specific Symptoms	Possible Cause(s)
F. Leaf tissue removed. ***(continued)***	Shredding, tearing of leaves.	Wind damage, hail damage..
	Small, irregular holes in leaves.	European corn borer (first and second instar). Corn earworm.
	Large, irregular holes in leaves.	Grasshoppers. Fall armyworms, corn earworm, other armyworms.
G. Plants discolored or stunted	Slight to severe stunting; yellowing and/or sometimes reddening of foliage.	Maize dwarf mosaic or maize chlorotic dwarf viruses. [54, 74]
H. Lesions on plants	Tan, oval to rectangular lesions, tan to brown in color.	Fungal leaf spots or blights.
	Lesions are elongated running between the veins, with parallel margins, and usually with buff to brown borders. Usually 2-6 mm wide by 3-22 mm long.	Southern leaf blight. [56, 57]
	Lesions are long, elliptical, grayish-green or tan, margins irregular, can range from 2.5 to 15 cm in length.	Northern leaf blight. [58]
	Lesions are usually oval to circular, with concentric zones ranging from 1.0-2.5 cm.	Helminthosporium leaf spot (Northern).
	Small, oval becoming elongate, with water-soaked spots, occurring on any part of the leaf. The spots may increase in size up to 15mm long becoming tan with red, reddish-brown, or yellow-orange borders.	Anthracnose.
	Lesions on mature leaves are pale brown or gray to tan, ranging from 0.5 to 5.0 cm, narrow and rectangular, restricted by veins, lesions coalesce giving appearance of a large lesions.	Gray leaf spot.
	Lesions are water-soaked on leaves as they emerge from whorl, becoming brown to gray or white. Lesions do not elongate. Common in fields irrigated from pond.	Bacterial leaf blight.

General Appearance	Specific Symptoms	Possible Cause(s)
H. Lesions on plants ***(continued)***	Lesions occur on the upper and lower portions of the leaf surfaces. Most common when weather is below 65ºF for extended periods. Lesions are circular can become elongate, golden brown to cinnamon brown becoming brownish-black.	Common rust. [37]
	Lesions occur primarily on the upper portion of the leaves. Occurs when temperatures are above 65º F. Lesions are usually light cinnamon brown, becoming chocolate brown to black, circular to oval, 0.2-2.0 mm long and densely scattered on upper leaf surface.	Southern Rust. [38]
	Elongate, irregular brown water-soaked leaf stripes or spots on lower leaves.	Bacterial leaf spots.
	White, dried areas between leaf veins.	Air pollution injury (ozone); severe injury may cause premature maturity.
I. Damage to ears	Dark "bruises" on husks.	Hail damage: all plant material in an area affected; damage often more severe on one side of plant.
	Large chunks removed from husk and ears; kernels eaten off.	Grasshoppers. Birds: ears often upright; husks shredded. Rodents, raccoons, squirrels or other animals: stalks often pulled over, husks shredded or pushed back.
	Tunneling or chewing feeding damage on kernels.	Corn earworm (usually feed near the ear tip). [59, 63] European corn borer (bores into kernels and cobs.) [49] Fall armyworms (usually bores in from the side).
	Small shot holes in kernels; often associated with "sawdust". Tunneling between kernel rows. Webbing may be present.	Maize weevil [60] angoumois grain moth (larvae stage)
	Chewing on ear tip kernels.	Birds, wild animals, corn earworm, fall armyworm. Corn sap beetles (small brown or black beetles)
	Individual kernels brown, soft	Stink bugs.

General Appearance	Specific Symptoms	Possible Cause(s)
I. Damage to ears ***(continued)***	Ears drop to ground.	European corn borers – feeding damage to ear shanks. Hybrid susceptible to ear drop. Wildlife damage.
J. Ears or kernels malformed	Ears not filled, partially filled, smaller than normal ("nubbins") or barren stalks.	Maize dwarf mosaic or maize chlorotic dwarf viruses. High temperatures and lack of moisture. Drought. Plant population too high. Low fertility such as nitrogen or potassium. Corn leaf aphids which caused delay or failure of silking. 2,4-D herbicide injury applied during tasseling or pollen shed stage.
	Ear not filled or partially filled.	Moisture and heat stress (collapse of silk at pollination) Timing of silking not synchronized with pollen shed. Silks clipped back by insects causing poor pollination. Silkballing – failure of silk to emerge from ear due to environment – genetic effect. [67]
	Soft, glistening galls on the ear, later black and powdery.	Common smut. [64]
	Ears twisted with irregular kernel rows and imperfectly developed ear tips.	Phosphorus deficiency. [65]
	Ears partially filled, ear tip curved	Boron deficiency.
	Ears partially filled and C shape or pinched.	Stink bugs. [66]
	Irregular breaks in seedcoats; kernels resemble partially expanded popcorn kernels.	Popped kernels – most common form in inbreds.
	Horizontal cut or split in seedcoats.	Silk-cut, most common in inbreds.
	Red streaking of seedcoats, most common at ear tips.	Kernel red streak.
K. Ears rot or are moldy.	Kernels become salmon pink to reddish brown, as disease progresses a powdery or cottony-pink mold growth develops.	Fusarium kernel ear rot.

General Appearance	Specific Symptoms	Possible Cause(s)
K. Ears rot or are moldy. ***(continued)***	Reddish colored mold develops especially near the ear tip, bluish-black fruiting structures often observed on husks and ear shanks.	Gibberella rot.
	Powdery, green or blue-green mold observed between kernels, in areas damaged by insects.	Penicillium rot.
	Kernel contain mold which are black, greenish-yellow or with tan growth on and between kernels.	Aspergillus rot.
	Not observed until ears are harvested. Kernels are then observed having a gray mycelium and a stippling of small, round, black spores occurs.	Nigrospora ear rot.
	Ears are bleached or straw colored, entire ear can turn grayish-brown, sunken, becomes lightweight and completely rotten.	Diplodia ear rot.

Herbicide Injury Guide

Herbicide (U.S. Trade Name)	Symptoms	Remarks
Triazines (Several atrazine products): cyanazine (Bladex) ametryn (Evik)	Gradual interveinal chlorosis. Leaves may die back from tips and turn light brown. Height of plants may be highly variable. Where severe, entire plants may be killed. Ametryn applied within 3 weeks of tasseling may affect pollination.	Injury may occur on sandy soils low in organic matter or due to excessive rates. Cool, wet weather, or other factors adversely affecting plant metabolism.
Acetanilides: Alachlor (Lasso), metolachlor (Dual), propachlor (Ramrod, Bexton) dimethanit (Frontier), acetochlor (Surpass, Harness)	Injured seedlings and older plants may have stunted or malformed shoots that fail to unfurl. Plants may tend to leaf out underground; may have some "laddering."	Cool, wet weather prior to emergence is usually associated with injury, but majority of plants will outgrow damage.
Thiocarbamates: Butylate, (Sutan), EPTC (Eptam, Eradicane),	Extreme stunting, twisting, bending, and mal-formation of plants. Expanding leaves may rupture and shred. Ear mal-formation may occur.	A "safening agent" added to formula-tions reduces injury to maize. Hybrids differ in sensitivity.
2,4-D (Several products)	Pre-emergence applications may produce severe stunting and malformation of roots and shoots. Postemergence directed sprays may cause fasciation and upcurl-ing of the brace roots. Applied "over-the-top," especially on hot day, 2,4-D may cause stalks to be brittle and break. Occa-sionally, new leaf will fail to unfurl (onion-leaf). Applied near tasseling or at silking time, 2,4-D may interfere with seed set.	Do not apply 2,4-D with atrazine and oil. Temperature and humidity at or near time of application, growth stage of maize, genetic susceptibility method of application, and rates all influence amount of postemergence injury. To avoid breakage, avoid cultivating while plants are brittle.
Benzoic acid Dicamba (Banvel)	Misapplication may cause onion leafing, proliferation of inhibited roots, abnormal brace root formation, or fasciation. Lodging may occur from postemergence applications. Resembles 2,4-D injury symptoms.	Dicamba combinations applied pre-emergence may cause injury, especially when unfavorable environmental conditions exist during seedling emergence.
Phenylureas Linuron (Lorox)	Injury is similar to that caused by triazine herbicides. Yellowing occurs first at leaf tips and margins followed by browning. Entire leaves may turn yellow and die.	This compound is taken up by the roots and translocated to the foliage. Can also affect leaves if applied postemergence.

Herbicide (U.S. Trade Name)	Symptoms	Remarks
Bipyridilium Paraquat, (Gramoxone Extra, Starfire)	Leaf tissue turns brown and dies in flecks or spots where contacted by spray droplets; may superficially resemble bacterial or fungal leaf blight.	A nonselective contact herbicide with no significant soil activity.
Dinitroanilines Pendimethalin (Prowl), trifluralin (Treflan),	Reduced stand, stunting, or uneven plant height, purpling of leaves with roots somewhat pruned and "clubby" at ends. Injury from pendimethalin may result from direct preplant application.	Incorporation of pendimethalin increases risk of injury. May be confused with injury from nematodes. Major damage is from carryover residue; chemicals differ in their persistence.
Sulforylueas Nicosulfuran (Accent), Primisulfuran (Beacon), Primisulfuran + Prosulfuron (Exceed), Nicosulfuron + Rimsulforon + Atrazine (Basis Gold)	Overall stunting with youngest leaves appearing yellow, may see ear malformation	Associated with applications made to corn treated with an at-plant, in-furrow application of insecticide (most often seen with Counter). Also cool, wet conditions.
Imidazolinones (Scepter) Imazethapyr (Pursuit) Imazapic (Cadre) Imazethapyr + Imazapyr (Lightning)	Overall stunting during early growth, roots club-rooted. Leaves may be purplish or lime-yellow color.	Associated with carryover from previous crops and is generally more severe in lower pH areas (<6.0). May be a misap-plication of Pursuit or Lightning to a non-IR or IT corn hybrid.

Guide to Nutrient Deficiency Symptoms of Corn

I. Stunted plant . . . . . common to all deficiencies

II. Loss of green color . . . . . common to all deficiencies

A. **Color changes in lower leaves:** **Element Deficient**

1. Yellow discoloration from tip backward in form of a **V** . . . . . Nitrogen
2. Brown discoloration and scorching along outer margin from tip to base . . . . . Potassium
3. Yellow discoloration between veins, finally edges become reddish-purple . . . . . Magnesium
4. Purpling and browning from tip backward, in waves . . . . . Phosphorus

B. **Color changes in upper leaves**

1. Emerging leaves show yellow to white bleached bands in lower part of leaf . . . . . Zinc
2. Young leaves show interveinal chlorosis along entire length of leaf . . . . . Iron
3. Young leaves uniformly pale yellow, older leaves dying at the tips . . . . . Copper
4. White, irregular spots between veins . . . . . Boron
5. Young leaves show pale green to yellow discoloration between veins . . . . . Manganese
6. Young leaves wilt and die along the margins . . . . . molybdenum
7. Upper leaves usually paler than lower leaves but can be uniform. Often develops stripping between the veins. . . . . Sulfur

Growth Stage Management Guide:

BEFORE EMERGENCE — Slow germination and plant growth in cool soils may be improved by banding fertilizer near the row. Applications of starter fertilizer can and should be made at planting. Caution should be taken to avoid salt injury from banding too close or placing fertilizer in the row. At-plant insecticide applications help minimize the danger from early insect infestations.

TWO LEAF STAGE — The growing point is below soil surface, a light frost or hail may destroy leaves with minimal yield reduction. Check for early insect infestations such as chinch bugs, worms, billbugs, etc. Early weed control is essential to top production. Apply pesticides timely and at the correct rate.

EARLY WHORL — Plant growth less than 15 inches tall. Cultivation too close to the plant or too deep from this stage on will destroy some of the permanent root system. Moisture stress will limit root development. Over the top herbicide applications should be limited. Shield sprayers or direct spray applications improve weed control. Several days of flooding or waterlogged conditions is detrimental to growth and may result in severe plant loss. Fertilizer applications becoming critical to yield potential.

MID WHORL — This is a period of rapid leaf formation and the beginning of rapid stalk elongation. The tassel and ear shoots are developing. Nutrient uptake is rapid and deficiencies from this stage on can seriously reduce growth and yield. This is a period of high nitrogen demand and side dressing should be applied (15"-24"). The growing point should be above the soil surface. Flooding after this stage is not as detrimental as earlier stage. Plants broken over at this stage or later will not recover.

LATE WHORL — Leaf enlargement is complete. Brace roots are developing. The potential numbers of kernels on the top ear is determined by this time. The stalk is rapidly growing and the tassel is almost full size. Moisture or nutrient deficiencies at this stage will seriously reduce yield. Early hybrids will go through this stage in less time than mid or full season hybrids. Irrigation is critical if moisture is limited.

TASSELING — Final stalk growth occurs. Moisture stress at this stage will delay silking more than tassel emergence and pollen shedding. Moisture demand approaching ⅓ inch of water per day. Irrigation is critical.

EARLY SILK — Tassel fully emerged, stalk development complete. The ear shank and husks are growing rapidly. Ovules are enlarging. The silk from each ovule is near the tip of the ear and just emerging. The number of ovules that will be fertilized and develop into kernels is being determined at this stage. Moisture stress or nutrient deficiencies may result in poor pollination and seed set. Leaf analysis at this stage is high correlated with final grain yield and yield response to fertilizer applications. Most soils in Georgia at field saturation have only 3 to 4 days of moisture holding capacity at peak demand for corn. Maintain irrigation.

BLISTER STAGE — This stage occurs 10 to 14 days after silking. The cob, husk and shank are fully developed. Kernels are white in color and resemble a blister. Starch has begun to accumulate and the kernels are rapidly increasing in size. The plants continue to take up soil nitrogen and phosphorus, but much of these nutrients are being supplied from other plant parts. Water availability is crucial for proper grain fill. Unfavorable conditions will result in unfilled kernels particularly at the tip.

MILK STAGE — Generally occurs at 18 to 22 days after silking. Kernels beginning to turn solid color (yellow or white) and the inner fluid is a milky white. The embryo is beginning to form.

SOFT DOUGH — Starch is accumulating. Inner fluid beginning to turn into a paste or dough-like matter. Kernel is about 70 percent moisture. Time occurrence is approximately 24 to 28 days after silking. Unfavorable conditions or deficiencies such as potassium will result in unfilled kernels and "chaffy" ears.

HARD DOUGH OR "DENT STAGE" — Rapid embryo growth. Kernels denting. Generally 35 to 45 days after silking. Milk line (boundary between hard starch and soft starch) visible and a good indicator to signal silage harvest. The dent is a result of starch that is drying at the top of the kernel.

PHYSIOLOGICAL MATURITY — Dry matter accumulation has ceased. Moisture loss will begin. The husks and some leaves are usually no longer green. Most kernels are dented and "black layer" formation is complete. Irrigation should cease. Moisture is between 30-35 percent. Kernels attained maximum dry weight. Generally occurs 55 to 65 days after silking.

Corn Insects, Description and Symptom(s) of Damage

Insect	Description of insect	Symptom(s) of Damage
Armyworm	The full grown larva is about 1½ inches long with two orange stripes on each side of the bode and thin, white stripes elsewhere; younger larvae are mostly green with stripes	Large chunks of leaf tissue removed, or leaves eaten off. Likely found in corn no-tilled into a grass crop like rye or wheat, or field with a grassy weed problem.
Billbugs	Gray to brown or nearly black in color with a prominent snout; $^1/_5$ to ¾ inch long; play "possum" when disturbed.	Plants bent or twisted, suckers may be apparent; rows of elliptical holes in leaves. Often found with yellow nutsedge problem
Black cutworm	The larvae vary from ¼ inch long when newly hatched to 2 inches when full grown; light gray to black in color; under magnification, convex, rounded, coarse granules apparent on skin.	Small holes in a row across leaves (early instar larvae). Plants missing or dead, plants cut off above or below ground level. Whorl leaves wilted or dead; cutworms have drilled into stalk below ground. Often seen in late-planted corn, or fields in which early season weeds were prevalent; fields in conservation tillage
Cereal leaf beetle	The adult is $^3/_{16}$ inch long, with metallic bluish-black head and wing covers; legs and "neck" are orange. Larva is yellow to yellowish-brown, slug-like, but color obscured by dark fecal matter carried on their back.	Longitudinal slits chewed out from between leaf veins, usually at field edge.
Chinch bug	Adult chinch bugs are about $^1/_5$ inch long, black with white wing covers crossed by a black zigzag line; nymphs have reddish (young) to black (older) bodies with no wings.	Plants wilted, stunted; chinch bugs found in large numbers at base of stalks, behind leaf sheaths. Most prevalent in hot, dry conditions.
Common stalk borer	Prominent longitudinal white stripes at the head end and posterior end of body interrupted by a dark purple area near "shoulders;" head yellowish.	Plants bent or twisted, suckers apparent; irregular holes in leaves; insect frass (excrement) obvious.
Corn root aphid	About $^1/_{16}$ inch long or less, almost spherical, bluish-green to gray-green in color; located on roots; always accom-panied by cornfield ants.	Plants wilted, stunted; numerous ants obvious
Corn rootworms	Full grown larva is yellowish-white, about ⅜ inch long, and has a brown head capsule and brown tail plate.	Brownish tunnels in roots, root chewing or pruning evident. Generally, more prevalent with corn planted after corn.
Flea beetles	The corn flea beetle is about the size of a pin-head ($^1/_{16}$) and is black; strong jumper.	Irregular brown lines or "tracks" scratched from the top layer of leaf tissue; severely damaged plants turn silvery, may wilt and die.

Insect	Description of insect	Symptom(s) of Damage
Grasshoppers	Differential grasshopper is about 1½ inches long, yellowish-green, with "sergeant's stripes" on jumping hind legs.	Large chunks of leaf tissue removed, usually next to field edge or grass waterway.
Seedcorn maggot	Pale, yellowish-white maggot; legless, cylindrical, tapered toward one end (head) like a carrot; about ¼ inch long.	Plants missing because seeds are eaten, hollowed out.
Stink bugs	The brown stink bug is shield-shaped, about ½ inch long, and has needle-like mouthparts.	Plants bent or twisted, suckers may be apparent; plants stunted; necrotic area at or near growing point. Generally, occurs with a cover crop or a small grain crop planted the previous fall.
Thrips	Only about $^{1}/_{16}$ inch long, very slender, tan in color; adults with two pairs of feathery wings.	Leaves look sand-blasted. Whitish in color with yellow streaking.
White grubs	The grub larva is about ¾ inch long when full grown, has a **C**-shaped white body, brown head, and three pairs of long legs; tip of the abdomen is usually dark because body contents show through the skin.	Plants wilted, stunted; purpling of leaves obvious; roots and root hairs chewed off.
Wireworms	After hatching, the larvae change from small, soft, and white to hard-shelled, yellowish-brown to reddish-brown, wire-like worms with very short legs.	Plants missing because seeds are eaten, hollowed out. Whorl leaves wilted or dead; wireworms have drilled into stalk below ground. Often seen in fields rotated to peanuts.

Photographs

Figure 1. Low pH problem.

Figure 2. Nematode damage.

Figure 3. Lasso herbicide damage.

Figure 4. Dual herbicide damage.

Figure 5. Prowl herbicide damage.

Figure 6. Cutworm damage.

Figure 7. Frost burn.

Figure 8. Nitrogen burn.

Figure 9. Leaf curl from drought.

Figure 10. Chinch bugs,

Figure 11. Sugarcane beetle damage.

Figure 12. Tunneling injury from insects.

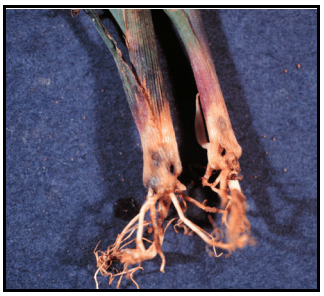

Figure 13. Wireworm feeding.

Figure 14. Thrips damage.

Figure 15. Reddening of leaf tips due to temporary phosphorus deficiency.

Figure 16. Glyphosate herbicide injury.

Figure 17. Early symptom of zinc deficiency.

Figure 18. Later stage of zinc deficiency.

Figure 19. Cold banding.

Figure 20. Sulfur deficiency on right; sulfur added on left.

Figure 21. Uneven application of starter fertilizer.

Figure 22. Command injury.

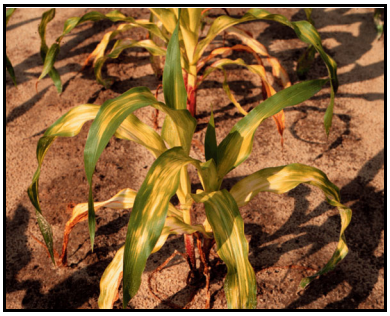

Figure 23. Zorial damage.

Figure 24. Crazy top.

Figure 25. Calcium deficient corn.

Figure 26. Incorporated Dual corn.

Figure 27. Anhydrous damage.

Figure 28. Stink bug damage

Figure 29. Buggy whip stink bug damage.

Figure 30. 2,4-D damage.

Figure 31. 2,4-D damage.

Figure 32. 2,4-D + Banvel damage.

Figure 33. Stink bug damage, tillering.

Figure 34. Billbug damage.

Figure 36. Paraquat damage.

Figure 35. Common stalk borer damage.

Figure 37. Common rust.

Figure 38. Southern rust.

Figure 39. Cut worm larva and cut plant.

Figure 40. Lepidopteran feeding.

Figure 41. Cereal leaf beetle.

Figure 42. Paraquat burn.

Figure 43. Western corn rootworm.

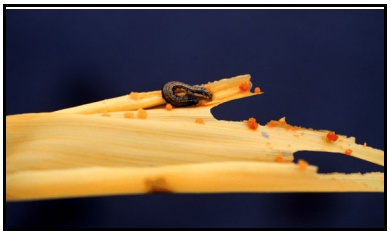

Figure 44. Corn earworm.

Figure 45. Southern cornstalk borer.

Figure 46. Japanese beetles.

Figure 47. Silk balling.

Figure 48. Ear in tassel.

Figure 49. European corn borer damage.

Figure 50. Barren corn stalk. Note sugar accumulation.

Figure 51. Root rot.

Figure 52. Frozen coleoptile.

Figure 53. Lesser corn stalk borer.

Figure 54. Maize dwarf mosaic virus.

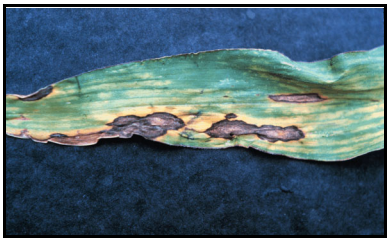

Figure 55. Anthracnose.

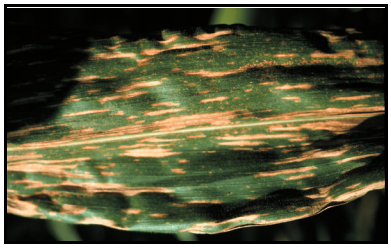

Figure 56. Southern leaf blight.

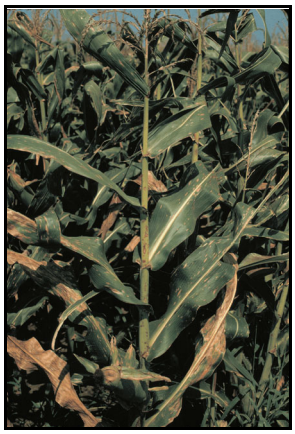

Figure 57. Southern leaf blight

Figure 58. Northern leaf blight.

Figure 59. Corn earworm.

Figure 60. Adult weevil emerging from kernel.

Figure 61. Hail damage.

Figure 62. Corn earworm and/ or fall armyworm damage.

Figure 63. Earworm hole in shuck.

Figure 64. Smut.

Figure 65. Ear of corn showing signs of phosphorus deficiency.

Figure 66. Stink bug damage.

Figure 67. Silk balling.

Figure 68.

Figure 69. Stalk rot.

Figure 70. Hail damage.

Figure 71. Corn stalk rots.

Figure 72. Dinitroaniline herbicide injury.

Figure 73. Frozen seed and radicle.

Figure 74. Maize dwarf mosaic or maize chlorotic dwarf virus.

Learning for Life

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