Contents Field Corn (FC)

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Corn Diagnostic Guide

The diagnostic guide has been developed to help identify causes abnormal corn. A wide range of corn problems and symptoms encountered throughout the season are included. For each symptom, concise descriptions of the possible causes are listed. Because different problems are associated with different growth stages this guide is divided into the following **four sections**:
1) Before emergence; 2) Emergence to Knee-high; 3) Knee-high to Tasseling; 4) Tasseling to Maturity

Realize that this information is intended as a field identification guide to provide a fast and tentative diagnosis of corn production problems. Many of the causes of problems listed here can be positively identified only through extensive sampling and testing, often only in a laboratory. Therefore, use this diagnostic guide as a preliminary source for problem identification and consult other, more complete sources for positive identification before making any management decisions.

Before Emergence

General appearance	Specific symptoms	Possible causes
Skips in rows plants fail to emerge	No seed planted	◤Planter malfunction ◤Empty planter box ◤Irregular seeding depth
	Seed not sprouted	◤Seed not viable ◤Anhydrous or aqua ammonia injury ◤Excessive fertilizer *(nitrogen and/or potash)* placed too close to seed ◤Soil too dry ◤Toxicity of seed from applied pesticides
	Seed swollen but not sprouted	◤Seed not viable ◤Soil too cold—50º F (10°C) or lower ◤Soil too wet
	Rotted seed or seedlings	◤Fungal seed rots or blights–for description ◤Anhydrous or aqua ammonia injury
	Sprouts twisted or leaves expanded underground	◤Soil crusted ◤Compacted soils ◤Damage from rotary hoe ◤Cloddy soil—allowing light to reach seedling prematurely ◤Seeds planted too deep in cold, wet soil ◤Chloroacetamide Herbicide injury—alachor (Lasso), metolachor (Dual), dimethenamid (Frontier), acetochlor (Harness/Surpass) or premixes ◤Excessive soil insecticide dosage ◤Anhydrous or aqua ammonia injury
Seed eaten, dug up or sprout cut off	Seed hollowed out	◤Seedcorn maggot ◤Wireworms—sect. ◤Seedcorn beetles–
	Unemerged seedlings dug up and entire plant eaten	◤Mice, groundhogs, ground squirrels, gophers, skunks, rats

Emergence to Knee-high

General appearance	Specific symptoms	Possible causes
Scattered problem spots of dead or poorly growing plants	Uneven growth of corn	◤Drainage problems ◤Soil compaction ◤Variation in planting depth, soil moisture, etc. ◤Poor growing conditions (cold, wet, dry, etc.) ◤Seed bed not uniform (cloddy) ◤Anhydrous or aqua ammonia injury ◤ALS-inhibitor herbicide injury—carryover of previous soybean herbicide or injury from soil applied corn herbicide
	Plants stunted, wilted and/or discolored	◤Nematodes—microscopic, wormlike organisms, several species of which live in the soil and are parasitic on corn roots ◤Damping-off and seedling blight pathogens
	Roots on newly formed crown are discolored and decayed. Limited lateral root development	◤Nematodes ◤Seedling blight pathogens
	Plants cut off above or below ground	◤Cutworms—
	Sudden death of 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 normally ◤Lightning—both corn and weeds killed, usually in a circular area with clearly defined margins; affected area does not increase in size
Wilting	Upper leaves roll and appear dull or sometimes purple; stunting of plants plants may die	◤Drought conditions ◤Black cutworms—may chew a hole in the stalk below soil surface, which results in the plant wilting and dying ◤White grubs—chew off roots, no tunneling ◤Wireworms—may chew off or bore into roots ◤Corn root aphids—suck the juices from roots; always attended by brown ants ◤Mechanical pruning of roots by cultivator ◤Root and crown rot caused by pathogens
	Whorl leaves dead	◤Wireworms ◤Cutworms ◤Stalk borer ◤Hop vine borer ◤Bacterial stalk rotlk rot
	Crown roots not developing	◤Dry surface soil, shallow planting, wind

Emergence to Knee-high

General appearance	Specific symptoms	Possible causes
Plants discolored	Leaves appear sandblasted; leaves pale green or whitish in color	◤Wind damage—blowing sand and soil ◤Spider mites—feed primarily on underside of leaves; produce fine webbing across leaf surfaces; most destructive during hot, dry weather
	Lower leaves with speckles or spots of dead tissue, new growth undamaged	◤Herbicide injury—postemergence contact herbicides, either photosynthetic inhibitors or membrane disrupters
	General yellowing of upper leaves	◤Magnesium deficiency
	General yellowing of lower leaves	◤Excessive moisture
	Yellowing in the whorl, may present as yellow/translucent regions on these leaves after they emerge	◤Herbicide injury—from postemergence ALS-inhibitor herbicide or low dose of ACCase-inhibitor
	Purpling or reddening of leaves from tip backward; affects lower leaves initially, leaf tips may later turn dark brown and die	◤Phosphorus deficiency—severe ◤Compacted soil ◤Cold weather ◤White grubs ◤Dinitroaniline herbicide injury—check for clibbed root tips
	Leaves of seedlings bleached white	◤Herbicide injury—Command carryover, Balance injury, low dose of Roundup Ultra
	Irregular light and dark mottling or mosaic at base of whorl leaves	◤Maize dwarf mosaic or Maize chlorotic dwarf virus
	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 sunny mornings ◤Frost
	Light streaking of leaves which develops into a broadband of bleached tissue on each of the midribs; leaf midribs and margins remain green; sometimes stalks and leaf edges appear to be tinted red or brown	◤Zinc deficiency
	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 deficiency ◤Maize white line mosaic virus–if white lines are not continuous
	Distinct bleached bands across leaf blades; leaf tips may die back; leaf tissue may collapse at discolored bands, resulting in the leaf folding downward at this point	◤Air pollution injury

Emergence to Knee-high

General appearance	Specific symptoms	Possible causes
Plants discolored and stunted	Leaves yellow; plants spindly and stunted	◤Nitrogen deficiency ◤Sulfur deficiency—more pronounced on younger leaves than nitrogen deficiency
	Purple or red discoloration of leaves, especially leaf margins; stunting; stubby, malformed roots sometimes confused with injury by nematodes	◤Dinitroaniline herbicide injury—trifluralin(Treflan), pendimethalin (Prowl) Usually results from excessive rates, carryover from the previous year's application for soybeans or sunflower production or if pendimethalin applied to shallow planted corn; causes stubby roots with tips swelling and restricted secondary root development. ◤Phosphorus deficiency—mild
Plants discolored, malformed and/or stunted	Excessive tillering; stunting	◤Crazy top—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 ◤Herbicide injury—Chloroacetamide herbicide (Lasso, Dual, Frontier, Surpass, Harness); Thiocarbamate herbicides (Eradicane)
	Leaves yellow and not fully expanded; roots sheared off or dried up	◤Overapplication of anhydrous or aqua ammonia
Plants stunted and/or malformed	Leaves fail to unfurl properly, often leafing out underground; plants may be bent, lying flat on the soil surface	◤Excessive Chloroacetamide herbicide rates—(Lasso, Dual, Frontier, Surpass, Harness)
	Leaves stunted—twisted, and may appear knotted	◤Thiocarbamate herbicide injury—(Eradicane)
	Shoots and roots stunted and/or onion-leafing (leaves remain wrapped in a tall spike)	◤Growth regulator herbicide (2,4-D, Banvel, Clarity) applied pre-emergence on coarse textured soil or to shallow planted corn, roots may also be short and thick
	Plants bent or twisted	◤Growth regulator herbicide (2,4-D, Banvel, Clarity) applied post-emergence
	Plants bent or twisted; stunted; irregular rows of holes in unfolded leaves	◤Stalk borer ◤Billbugs
Lesions on leaves	Oval, circular or rectangular lesions on leaves	◤Northern corn leaf spot—
	Long lesions (1-8 in.) that taper at ends	◤Northern corn leaf blight—
	Long, irregular yellow to brown streaks in leaves	◤Stewart's bacterial leaf blight—
	Tan to spindel-shaped lesions with parallel sides and buff to brown borders	◤Southern corn leaf blight—

Emergence to Knee-high

General appearance	Specific symptoms	Possible causes
Lesions on leaves	Oblong, oval, tan-colored spots with considerable yellowing of leaves	zYellow leaf blight—
	Brown, oval lesions; yellow to reddish-brown	◤Anthracnose leaf blight—
	Very small, yellow to brown spots in bands near leaf base	◤Physoderma brown spot—
	Small (1-4 mm), translucent, circular to oval lesions	◤Eyespot—
	Brown opaque, rectangular lesions (½-2 in.) between veins; lesions do not taper	◤Gray leaf spot
	White dried areas between leaf veins	◤Air pollution injury
	Dull, gray-green, water-soaked lesions that develop into white dry areas on leaf surfaces; oldest leaves may show the injury symptoms at their bases, next oldest leaves across their middles, and the youngest leaves at their tips; leaf margins most severely injured; midribs remain undamaged; NOTE: sweet corn is much more susceptible than field corn	◤Air pollution injury
	Yellow mottling along leaf margins and tips; small, irregular yellow spots develop between veins and may form continuous yellow bands	◤Air pollution injury
Plant tissue removed	Whole plant cut off at ground level	◤Back cutworm—
	`Leaves entirely eaten off or large chunks of leaf tissue removed	◤Armyworms— ◤Grasshoppers—
	Ragged holes in leaves	◤Hail damage ◤Slugs— ◤European corn borers— ◤Black cutworms—early larval instar damage
	Shredding, tearing of leaves	◤Wind damage ◤Hail damage
	Rows of circular to elliptical holes across leaves	◤Billbugs— ◤European corn borers— ◤Stalk borers—
	Irregular brown lines or 'tracks' scratched from the top layer of leaf tissue; heavily infested leaves may appear gray in color, shrivel and die	◤Corn flea beetles—

Emergence to Knee-high

General appearance	Specific symptoms	Possible causes
Plant tissue removed	"Window effect" of leaves—interior of leaves (area between upper and lower surface) eaten out, leaving a transparent 'mine' with bits of dark fecal material scattered throughout	◤Corn blotch leaf miners—
	Yellowed and weakened area on leaf midrib from tunneling feeding damage; often frass (sawdust-like excrement) evident around the feeding wound; the midrib will commonly break at this point, causing the leaf blade to fold down from the damaged area	◤European corn borers—

Knee-high to Tasseling

General appearance	Specific symptoms	Possible causes
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
	Dieback of leaves, wilting, then drying up of leaf tissue, beginning at leaf tips	◤Molybdenum deficiency—younger leaves may twist ◤Air pollution injury
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 ◤Drought conditions—produce nitrogen deficiency ◤Ponded conditions—standing water can produce nitrogen deficiency
	Yellowing of leaf margins, beginning at tips; affected tissue later turns brown and dies	◤Potassium deficiency
	Purpling or reddening of leaves from tip backward; affects lower leaves initially; leaf tips may later turn dark brown and die	◤Phosphorus Deficiency
	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 ◤Magnesium deficiency—yellow to white striping usually developing on lower leaves; red-purple discoloration along edges and tip; stunting may occur

Knee-high to Tasseling

General appearance	Specific symptoms	Possible causes
Plants discolored	Yellow to white interveinal striping on leaves	◤Boron deficiency—initially white, irregularly shaped spots develop between veins which may coalesce to form white stripes that appear waxy and raised from leaf surface; plants may be stunted
	Pale green to white stripes between leaf veins, 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 turn brown and fall out	◤Magnesium deficiency
Plants discolored and malformed	Plants show stunting and/or a mottle or fine chlorotic stripes in whorl leaves	◤Maize dwarf mosaic or Maize dwarf chlorotic
	Stunting, tillering; twisting and rolling of leaves;	◤Crazy top—fungal disease
Plants malformed	Plants "rat-tailed"—leaf edges of top leaf fused so leaves cannot emerge ALS-inhibitor herbicide to seedling corn	◤Growth regulator herbicide (2,4-D, Banvel, Clarity) applied post-emergence with an ◤Mechanical injury
	Leaves tightly rolled and erect	◤Growth regulator herbicide (2,4-D, Banvel, Clarity) applied at high rates or excessive spray in the whorl after 8 inches tall ◤Drought stress
	Plants lodge or grow up in a curved 'sledrunner' or 'gooseneck' shape	◤Corn rootworm larvae feeding damage—damaged root systems result in entire plant becoming lodged; stalk breakage (lodging) does not result from rootwom damage ◤Nematode feeding damage—microscopic worm-like organism, several species which live in the soil and are parasitic on corn roots ◤Previous herbicide injury that had pruned root system—dinitroaniline or growth regulators ◤Mechanical injury ◤Hot, dry weather and winds—preventing normal brace root development
	Brown, soft rot of a lower internode; stalks twist and fall	◤Pythium stalk rot or bacterial stalk rot ◤European corn borers—stalks weakened by borer feeding damage ◤Stalk borer
	Fused braced roots	◤Growth regulator herbicide (2,4-D, Banvel, Clarity) applied after 8 inches tall
	Soft, glistening white galls that soon become black and dusty; appears on stalks, leaves, ear or tassel	◤Common smut—

Knee-high to Tasseling

General appearance	Specific symptoms	Possible causes
Plant tissue removed	Ragged holes in the leaves, shredding of plants	◤Hail damage
	Shredding, tearing of leaves	◤Wind damage
	Green upper layer of tissue stripped from leaves	◤Western corn rootworm beetles—
	Window effect on leaves—interior of leaves (area between upper and lower leaf surfaces) eaten out, leaving a transparent 'mine' with bits of dark fecal material scattered throughout	◤Corn blotch leafminers—
Plants tissue removed *(continued)*	Leaves entirely eaten off or large chunks of leaf tissue removed	◤Armyworms— ◤Grasshoppers— ◤Fall armyworm— ◤Livestock
	Holes bored into stalks and area within stalk hollowed out by feeding damage	◤European corn borers—late instar damage ◤Stalk borers
Lesions on plants	Oval, circular or rectangular lesions on leaves	◤Northern corn leaf spot—
	Long lesions (1-8 in.) that taper at ends	◤Northern corn leaf blight—
	Brown opaque, rectangular lesions (½-2 in.) between veins; lesions do not taper	◤Gray leaf spot
	Tan, oval to circular lesions	◤Holcus bacterial spot ◤Fungal leaf spots ◤Paraquat herbicide injury
	Irregularly or wavy-margined, pale green to yellow or pale brown streaks; in Corn Belt usually after tasseling	◤Stewart's bacterial leaf blight
	Tan leaf lesions with parallel sides or spindle shaped with buff to brown borders; in Corn Belt usually after tasseling	◤Southern corn leaf blight
	Long, elliptical gray-green or tan lesions developing first on lower leaves; in Corn Belt usually after tasseling	◤Northern corn leaf blight
	Very small, yellow to brown spots in bands near leaf base	◤Physoderma brown spot
	Yellow mottling along leaf margins and tips; small irregular, yellow spots develop between veins and may form continuous yellow bands	◤Air pollution injury
	Interveinal tan to yellow streaks on leaves	◤Air pollution injury
	White dried areas between leaf veins; severe injury may cause tip dieback	◤Air pollution injury

Lesions on plants	Dull, gray-green, water-soaked lesions that develop into white dry areas on leaf surfaces; oldest leaves may show the injury symptoms at their bases, next oldest leaves across their middles, and the youngest leaves at their tips; leaf margins most severely injured; midribs remain undamaged; *NOTE: sweet corn is much more susceptible than field corn*	◤Air pollution injury
Lesions on plants (continued)	Brown, oval lesions with yellow to reddish-brown borders	◤Anthracnose leaf blight—
	Irregular to elliptical, brown, water-soaked leaf spots	◤Bacterial leaf spot and stripe
	Small, circular tan spots with brown to purple margins	◤Eyespot—
	Circular to oval, brown to black pustules on leaves	◤Common corn rust

Tasseling to Maturity

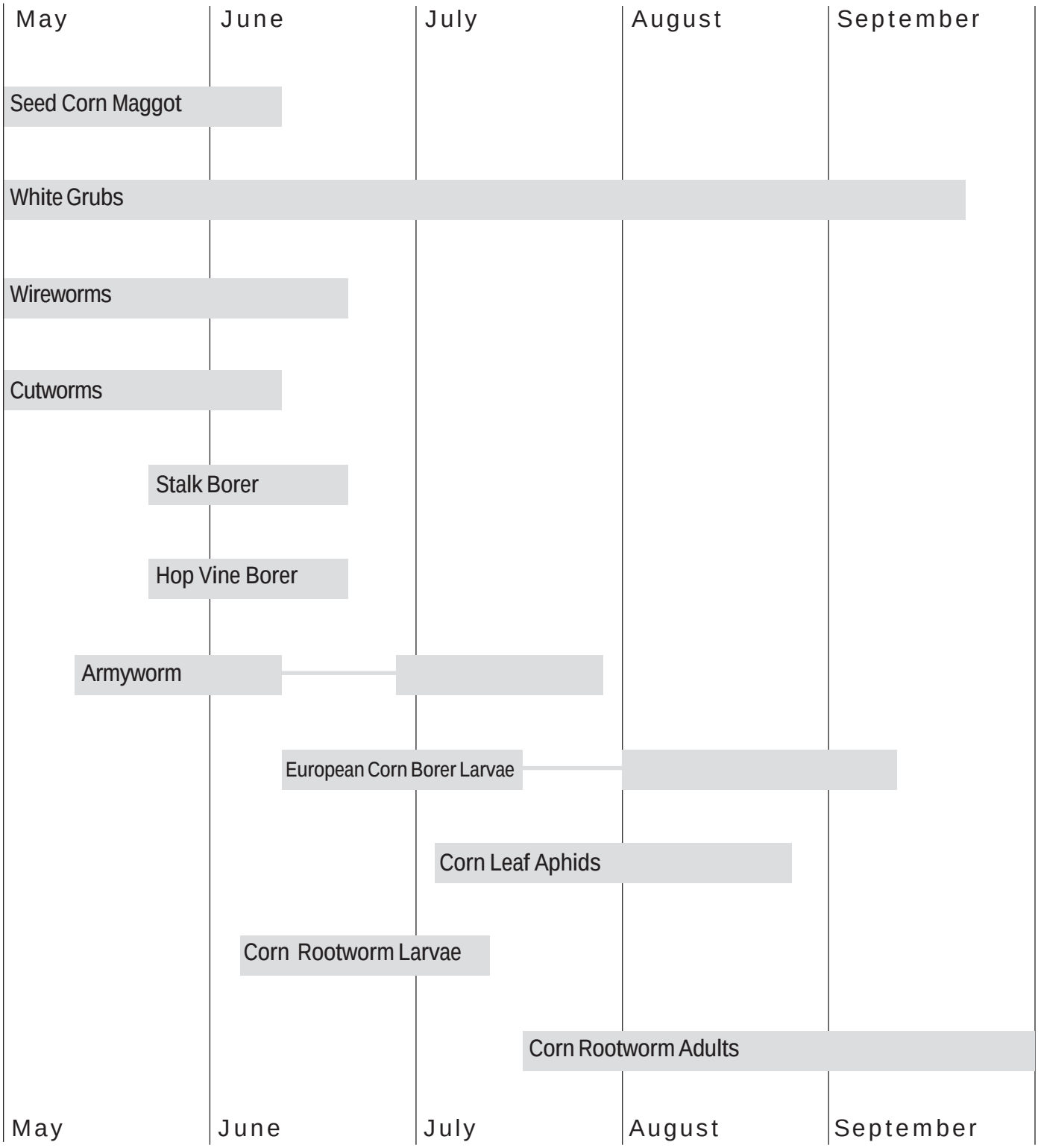
General appearance	Specific symptoms	Possible causes
Silking impaired	Delayed silking or failure to silk	◤Stress on plants earlier in the season ◤Plant population too high ◤Nutrient deficiency ◤Corn leaf aphids—typically found in large numbers feeding within the whorl
	Silks clipped off	◤Corn rootworm beetles—two species attack corn: northern and western and ◤Grasshoppers
Tassels malformed	Tassels fail to emerge	◤Boron deficiency
	Tassels, upper stalk and foliage bleached; premature drying	◤Anthracnose
	Tassels develop as a mass of leaves	◤Crazy top
Ears replaced by leaves	Leafy condition at ear node	◤Crazy top
Plants discolored	Yellowing of leaf margins, beginning at tips; affected tissue later turns brown and dies	◤Potassium deficiency
	Irregular, purple-brown spots or blotches on sheaths	◤Purple sheath spot
Stalks malformed and/or broken	Lower stalk internodes easily compressed; stalks may lodge (break over); pith tissue destroyed	◤Diplodia stalk rot ◤Charcoal stalk rot ◤Gibberella stalk rot ◤Fusarium stalk rot

General appearance	Specific symptoms	Possible causes
Stalks malformed and/or broken *(cont'd.)*	Lower internodes easily compressed; black linear streaks on stalk surface	◤Anthracnose stalk rot
	Plants lodge, stalk may break	◤European corn borer ◤Potassium deficiency—yellowing of leaf margins, beginning at the tips; affected tissue later turns brown and dies
Premature death of all or some parts of plants	Sudden death of entire plant	◤Stalk rot complex ◤Lightning—all plant material in an approximately circular area suddenly killed; plants along margins of affected area may be severely to slightly injured; severely injured plants may die later ◤Frost—before plants reach maturity—eaves first appear water-soaked, then gray; plants in low areas of fields most susceptible
	Extensive areas of leaf tissue die prematurely resulting in leaf drying	◤Air pollution injury ◤Stewart's Bacterial leaf blight ◤Northern corn leaf blight ◤Anthracnose leaf blight
	Top kill—premature death of all or portion of plants above ears	◤Anthracnose
Leaf tissue removed	Ragged holes in the leaves	◤Hail damage
	Shredding, tearing of leaves	◤Wind damage
	Small, irregular holes in leaves	◤European corn borer—second brood larval feeding
	Large, irregular holes in leaves	◤Grasshoppers ◤Fall armyworms
Plants discolored or stunted	Slight to severe stunting; yellowing and sometimes reddening of foliage	◤Maize dwarf mosaic/Maize chlorotic dwarf
Lesions on leaves	Tan leaf lesions with parallel sides or spindle-shaped and buff to brown borders	◤Southern corn leaf blight
	Long, elliptical, gray-green or tan lesions	◤Northern corn leaf blight
	Small brown to red-brown spots to irregular blotches in bands	◤Physoderma brown spot
	Small (1/16 to 3/8 inch) circular to oval lesions	◤Eyespot
	Elongate, irregular brown water-soaked leaf stripes or spots on lower leaves	◤Bacterial leaf spots and stripe

Tasseling to Maturity

General appearance	Specific symptoms	Possible causes
Lesions on leaves *(cont'd.)*	Oval, circular or rectangular lesions on leaves	◤Northern corn leaf spot
	White, dried areas between leaf veins	◤Air pollution injury—severe injury may cause premature maturity
	Circular to oval lesions, brown centers with yellow to orange borders	◤Anthracnose leaf blight
	Numerous brown to black pustules on any above ground part, especially the leaves; leaves dry out	◤Common corn rust
Damaged or malformed ears	Dark 'bruises' on husks	◤Hail damage—all plant material in an area affected; often more severe on one side of plant
	Pinched ears	◤ALS-inhibitor herbicide (Accent, Beacon, etc.) applied broadcast "over-the-top" after reaching the V6 stage
	Ears with missing kernels	◤Growth regulator herbicide (2,4-D, Banvel, Clarity) applied at tasseling
	Large chunks removed from husks and ears;	◤Grasshoppers ◤Birds—ears often upright, husks shredded ◤Rodents, raccoons, squirrels or other animals; stalks often pulled over, husks shredded or pushed back
Brown mold at base of ear	White to pink mold starting at ear tip; husk rotted	◤Gibberella ear rot
	White to pink mold on individual kernels	◤Fusarium ear rot ◤Diplodia are rot

Generalized Calendar for Corn Insect Pests of Wisconsin



Plant Physiology

Critical Stages in the Life of a Corn Plant

Heather Darby and Joe Lauer

Nature greatly influences corn growth and yield. However, the corn producer can manipulate the environment with managerial operations including hybrid selection, soil tillage, crop rotation, soil fertilization, irrigation, and pest control. A producer who understands growth and development of corn will understand the importance of timeliness when using production practices for higher yields and profit.

Our objective with this article is to aid those in corn production in understanding how a corn plant develops by explaining corn growth and development of stages critical for determining yield and identifying practices needed for optimum growth and production. A producer who understands the corn plant can use production practices more efficiently and timely to obtain higher yields and profits.

Identifying Stages of Development

The staging system most commonly used is the Iowa System. It divides plant development into vegetative (V) and reproductive (R) stages.

Vegetative Stages	Reproductive Stages
VE Emergenece	R1 Silking
V1 First leaf	R2 Blister
V2 Second leaf	R3 Milk
V3 Third leaf	R4 Dough
*	R5 Dent
*	R6 Physiological maturity
*	
Vnth	
VT tasseling	

Subdivisions of the V stages are designated numerically as V1, V2, V3, through Vn, where n represents the last stage before Vt (tasseling). The six subdivisions of the reproductive stages are designated numerically.

Each leaf stage is defined according to the uppermost leaf whose collar is visible. Beginning at about V6, increasing stalk and nodal root growth combine to tear the small lowest leaves from the plant. To determine the leaf stage after lower leaf loss, split the lower stalk lengthwise and inspect for internode elongation. The first node above the first elongated stalk internode generally is the fifth leaf node. The internode usually is about one centimeter in length. This fifth leaf node may be used as a replacement reference point for counting to the top leaf collar. In a corn field all plants will not be in the same stage at the same time. Each specific V or R stage is defined only when 50% or more of the plants in the field are in or beyond that stage.

Although each stage of development is critical for proper corn production we will focus on VE, V6, V12, V18, R1, and R6. Yield components and the number of Growing Degree Units required at each growth stage are described below.

Stage	GDU	Potential Yield	Actual Yield
VE	125	ears/area	
V6	470	kernels rows/ear	“factory”
V12	815		kernel rows/ear
V18	1160	kernels/row	
R1	1250	kernel weight	kernel number
			ears/area
R6	2350		kernel weight

Stage VE **Determination of potential ear density**

- Approximately 7-10 days after planting (125 GDU)

Photo 1

Photo 2

Aboveground

- Coleoptile tip emerges above soil surface *(Photo 1)*
- Elongation of coleoptile ceases
- 1st true leaves rupture from the coleoptile tip *(Photo 2)*

Belowground

- Mesocotyl and coleoptile elongation
- Elongation of mesocotyl ceases when coleoptile emerges above soil surface
- Growing point is below the soil surface
- Completed growth of seminal root system (radicle + seminal roots)
  Seminal root system supplies water and nutrients to developing seedling
- Nodal roots are initiated
  Nodal roots are secondary roots that arise from belowground nodes.

Troubleshooting

- Watch forseed attacking insects: (see chart on page 9)
- Germination and emergence delayed when:
  Inadequate moisture
  Cool soil temperatures (<50°F)
- Planting depth around 1.5-2.0"
  1st leaves will emerge belowground if seed planted to deep, or soil is cloddy or crusted
- Herbicide injury: coleoptiles will be corkscrew shaped, and have swollen mesocotyls
- Frost will not affect yield (<28 F)
- Hail will not affect yield (max)
- Severe yield losses from flooding (>48 h)

Management Guide

- Banding small amounts of starter fertilizer to the side and slightly below the seed can improve early vigor, especially when soils are cool.
- If conservation tillage is implemented add 30-60 GDU to VE
- If planting date is <April 25 add 10-25 GDU to VE
- If planting date is >May 15 subtract 50-70 GDU to VE
- Seeding depth: add 15 GDU for each inch below 2 inches to VE
- Seed-bed condition: soil crusting or massive clods add 30 GDU to VE
- Seed-zone soil moisture: below optimum, add 30 GDU to VE

Stage V6 **Potential plant parts ("factory") developed**

- 24-30 days after emergence (475 GDU)

Photo 3

Photo 4

Aboveground

- All plant parts are present
- Growing point and tassel (differentiated in V5) are above the soil surface *(Photo 3)*
- Stalk is beginning a period of rapid elongation
- Determination of kernel rows per ear begins
  Strongly influenced by hybrid genetics
- Tillers (suckers) begin to emerge at this time
- Degeneration and loss of lower leaves
- New leaf emerging (V-stage) about every 3 days

Belowground

- Nodal root system is established (approx. 18" deep X 15" wide) *(Photo 4)*
  This is now the main functional root system of the plant

Troubleshooting:

- Lodged plants
  Rootworm eggs will soon hatch and larvae begin feeding on root systems
- Foliar defoliation from hail ,wind, and leaf feeding corn borers
  May decrease row number
- 100% yield loss to frost caused from plant death
- 53% yield loss to hail when completely defoliated
- Severe yield loss to flooding

Management Guide

- Time to apply nitrogen (up to V8) before rapid uptake period in corn
  Precise fertilizer placement is less critical

Stage V12 **Potential kernel rows determined**

- 42-46 days after emergence (815 GDU)

Aboveground

- Number of kernel rows is set
- Number of ovules (potential kernels) on each ear and size of ear is being determined
  Strongly affected by environmental stresses
- New V-stage approximately every 2 days

Belowground

- Brace root formation begins stabilizing the upper part of the plant.

Troubleshooting

- Moisture Deficiencies will reduce potential number of kernels and ear size
  Plant is utilizing 0.25 inches per day.
  Water use rates for corn shown below.

Water Use Rate (inches/day)	Growth Stage
0.25	12 leaf
0.28	early tassel
0.30	silking
0.26	blister kernel
0.24	milk
0.20	dent
0.18	full dent

- Nutrient Deficiencies, will reduce potential number of kernels and ear size
  Large amounts of nitrogen, phosphorous, and potassium are being utilized at this stage
- 100% yield loss to frost caused from plant death
- 81% yield loss to hail when completely defoliated
- 3%/day yield loss to drought or heat (leaf rolling by mid-morning)
- Flooding (<48 h) will not affect yield

Management Guide

- Potential kernel number and ear size is also related to the length of time available for their determination. Early hybrids- progress faster through growth stages and usually have smaller ears than late hybrids.

Stage V18 **Potential kernels per row determined**

- 56 days after emergence (1160 GDU)

Photo 5

Aboveground

- Ear development is rapid
- The upper ear shoot is developing faster than other shoots on the stalk

Belowground

- Brace roots are now growing from nodes above the soil surface. They will scavenge the upper soil layers for water and nutrients during reproductive stages. *(Photo 5)*

Troubleshooting

- Moisture deficiency will cause lag between pollen shed and beginning silk ("nick")
  Largest yield reductions will result from this stress
  Plant using 0.30 inches per day

- Lodging will cause 12-31% yield reduction
- 100% yield loss to frost (<28 F) caused from plant death
- 100% yield loss to hail (max) when completely defoliated
- 4% yield loss per day due to drought or heat when leaf rolling by mid-morning
- Flooding (<48 h) will not affect yield

Management Guide

- Nitrogen applied through irrigation water, should be applied by V18

Stage R1 **Actual kernel number and potential kernel size determined**

Photo 6

Photo 7

- 69-75 days after emergence (1250 GDU)

Aboveground

- Begins when any silks are visible outside the husks *(Photo 6)*
- Pollen shed begins and lasts 5-8 days per individual plant *(Photo 7)*
- Silk emergence takes 5 days
  Silks elongate from base of ear to tip of ear
  Silks elongate until pollinated
- Silks outside husks turn brown
- The plant has now reached its maximum height
- First 7-10 days after fertilization cell division occurs within kernel
- Remaining R stages, endosperm cells fill with starch

Belowground

- The plant must have a healthy root system because proper uptake of moisture and nutrients
are critical at this time

Troubleshooting

- Hot and Dry weather results in poor pollination and seed set
  Dehydrates silks (delay silking) and hastens pollen shed
  Causes plants to miss window for pollination
  Decreases yield 7% per day (leaf rolling by mid-morning)
- Moisture deficiencies at this time will reduce yields 7% per day
- Rootworm beetle clips silks which prevents pollination if less than a ½" of silk is showing
- 100% yield loss to frost (<28 F) caused from plant death
- 100% yield loss to hail when completely defoliated
- Flooding (<48h) will not affect yield at this stage

Management guide

- Rootworm beetle control should be implemented if 4-5 beetles are observed feeding near ear tip.
- Stresses that reduce pollination result in a "nubbin" (an ear with a barren tip)

Stage R6 **Actual kernel weight determined**

- 130 days after emergence or 50-60 days after silking (2350 GDU)

Photo 8

Aboveground

- Physiological maturity is reached when all kernels on the ear have attained their dry matter maximum accumulation
- The hard starch layer has advanced completely to the cob
  Goes from top of kernel to base of cob
- A black abscission layer has formed (Photo 8)
  This indicates that moisture and nutrient transport from the plant has ceased
- Kernels are at 30-35% moisture and have attained 100% of dry weight (Photo 9)

Photo 9

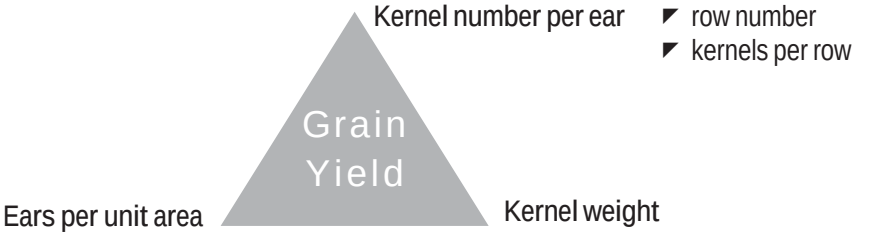
Management Guide

- Grain is not ready for safe storage
  Needs to be at 13-15% moisture for long-term storage
  May be advantageous to let crop partially dry in the field
- Silage harvest would be slightly earlier than R6 as milkline moves down towards kernel tip
- Frost has no effect on yield at this point. However, lodging from disease, insect damage or can result in physical loss of yield.

Conclusion

For most of Wisconsin hybrids (~100 day), each plant typically develops 20-21 leaves, silks about 65 days after emergence, and matures about 120 days after emergence. All normal plants follow this same general pattern of development, but specific time intervals between stages and total leaf numbers developed may vary between different hybrids, seasons, planting dates and locations. The rate of plant development for any hybrid is directly related to temperature, so the length of time between the different stages will vary as the temperature varies. Environmental stress may lengthen or shorten the time between vegetative and reproductive stages.

The length of time required for the yield components of ear density, kernel number, kernel weight varies between hybrids and environmental conditions.



- row number
- kernels per row

Ears per unit area, kernal number per ear and kernal weight all contribute to yield. These yield components of corn are determined early in the life cycl;e of the corn plant. It is true that yield is the end product but the plant must go through a number of stages to produce yield. Understanding this process won't necessarily put "money in your pocket", but by knowing when yield components are determined helps to interpret management and environmental factors influencing yield.

Weed Control Ratings of Corn Herbicides

Herbicides[abd]

Preplant–incorporated

Acetanilides + atrazine premixes [d]	VS
Acetochlor	VS
Alachlor	VS
Dual II	VS
Frontier	VS
Atrazine	N
Broadstrike + Dual	S/M
DoublePlay	VS
Eradicane	VS
Pursuit [e]	VS

Preemergence

Acetanilides + atrazine premixes [d]	VS
Acetochlor	VS
Alachlor	VS
Dual II	VS
Frontier	VS
Atrazine	N
Bladex	S
Broadstrike + Dual	S/M
Dicamba	S
Extrazine II	S
Hornet	S/M
Marksman	S
Prowl	S
Pursuit [e]	VS
Pursuit Plus[e]	S

Postemergence

Accent	S
Atrazine & oil	VS
Basagran	VS
Basis	S/M
Basis Gold	S/M

Postemergence (cont'd)

Beacon	S
Bladex	M
Buctril	S
Buctril+atrazine	S
Dicamba	S/M
Exceed	S
Hornet	S
Laddok S-12	VS
Liberty [f]	VS
Lightning [e]	S
Marksman	S/M
Permit	VS
Resolve [e]	S
Resource	S
Scorpion III	S
Stinger	VS
Tough	VS
2,4-D	M

[a] These herbicides have been rated for expected weed control, but actual results may vary depending upon rates applied, soil types, weather conditions, and crop management.

[b] Crop injury: M=moderate; S=slight; VS=very slight; N=none.

[d] Acetanilide + atrazine premixes include Bicep Lite II, Bullet, Guardsman, Harness Xtra, Lariat, and Surpass 100.

[e] Lightning, Pursuit, Pursuit Plus, and Resolve can only be used with IR or IT corn hybrids.

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Scouting Corn: A guide to efficient pest scouting

J. Doll, C. Grau, B. Jensen, J. Wedberg, J. Meyer

Introduction

Field monitoring, or scouting, is the backbone of all pest management programs. Before appropriate pest control decisions can be made, a detailed assessment of pest populations must be obtained. Efficient pest scouting requires a thorough knowledge of pest and crop biology, pest identification and habits, correct sampling methods, and economic thresholds (when available). The goal of scouting is to give a complete, accurate and unbiased assessment of pest populations. The field scout is the link between the consultant and grower. Scouting report forms must be comprehensive enough so control decisions can be made directly from the report form. These forms not only serve as a record of current pest populations but should be saved by the growers or consultant as part of the field history records.

Scouting Frequency

The frequency with which visits must be made depends on the type of crop grown and pest(s) present or expected. Field visits must be scheduled such that increases in pest populations are detected as soon as economic thresholds are reached.Field corn should be monitored at weekly intervals until pollination is completed, at which time scouting frequency can be relaxed to approximately once every ten days. At this time there is little danger of pest levels exceeding the economic threshold level between visits. The field scouts, however, should always have flexible schedules to allow revisiting problem fields.

Scouting Patterns

Before a scout enters a field an appropriate route must be planned. For efficiency sake, an M-shaped walking pattern is best used on square or rectangular shaped fields. In irregularly shaped fields scouts must keep in mind that they must cover a representative area of the field. Consult Figure 1 for suggested field patterns. You cannot scout one edge of the field and expect pest populations to be the same in other areas. Do not sample the edge of a field unless it is specifically recommended (i.e. stalk borer or weed scouting). Often pest populations found on the field edge do not indicate what is present in the rest of the field. The exception, of course, is contour strips, where the whole strip can be considered "edge." When scouting contour strips, walk the middle of the contour and zig-zag back and forth. Each individual strip must be scouted separately because the types of pest found as well as degree of infestation may vary from strip to strip.

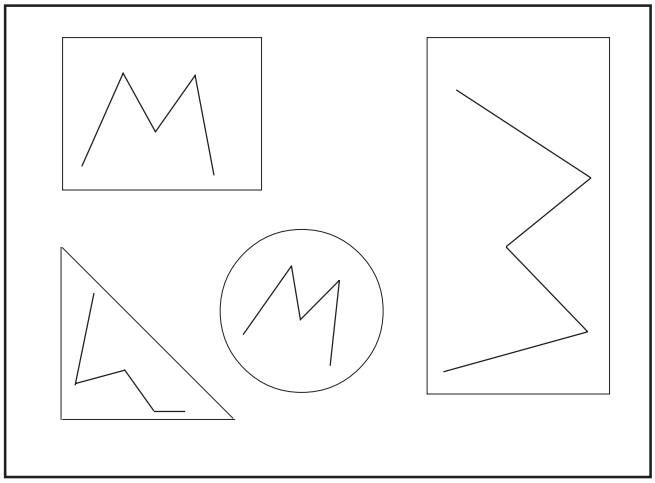

Figure 1: Suggested field patterns

The number of times a scout must stop to make specific counts will vary according to the type of pests found and will be discussed later in this bulletin.
For large fields (greater than fifty acres), the scout's accuracy diminishes to the point where a field of this size or larger should be split into two separate fields. Separate fields according to geography, previous cropping history or soil type.

Field History Forms

Before the scouting season begins, growers should complete a Field History Form (Appendix A). It should contain such information as field location, cropping history, crop yields, pesticide use, fertilizer and lime applications, soil type, soil test records, major pest problems, and anything else that could make scouting more effective.

Scouting Report Forms

Whenever a field is scouted, a field report form (Appendices B or C) should be filled out and a copy left with the grower. Even if damaging levels of pests are not found, farmers are still interested in general crop health and growth stage. These forms should be filled out in triplicate with copies given to the grower, scout supervisor, and a copy should stay with the scout. As scouts prepare to walk individual fields, they should familiarize themselves with past reports so problem areas can be closely monitored.

Equipment

When monitoring corn a scout should carry the following equipment:

- scout report forms and clipboard pencil(s)
- pocket knife (for splitting stalks and cutworm scouting)
- magnifying glass or hand lens for accurate pest identification
- bags, plastic vials and labels (for collecting plant and insect specimens for future identification)
- mechanical hand counter
- measuring tape

In addition the scout should have available in their vehicle:

- reference materials (in case problems are encountered in the field)
- spade (for digging entire plant for pest identification)
- cooler with ice (to keep unknown weed, insect and disease samples fresh until accurate identification can be obtained

Stand Counts

Stand counts should be made the second week after emergence. Count the number of plants in 20 linear feet of row from five randomly selected areas of a field. Measure the distance between rows in several locations within the field. Multiply the total number of plants counted in the 100 feet of row by the appropriate conversion factor (Table 1) to determine plant population.

Row Width	Conversion Factor
30 inches	174
36 inches	145
38 inches	138
40 inches	131

For example, if you have counted a total of 145 plants and the row width was 30 inches, multiply 145 (plants) x 174 (conversion factor) = 25,230 plants per acre.

Table 1: Conversion factors to determine corn populations

Weed Scouting Procedure

The first weed survey should occur shortly after corn emergence and continue at weekly intervals until control options are no longer available. Scouts should record the relative weed abundance and growth stages at ten randomly selected sites. When moving between sites always look for pockets of problem weed infestations. Mark their location on a weed map (Appendix D) so growers can spot treat these areas if necessary. Continue adding to this weed map as the season progresses. This map should be as accurate as possible and include field boundaries and other points of reference (i.e. waterways, access roads and buildings).

Scouts can group individual weed populations into these four categories:

Scattered-Weeds present but very few plants within the field. Enough plants to produce seed but not likely to cause economic loss in the current year.

Slight-Weeds scattered throughout the field, an average of no more than 1 plant per 3 feet of row, or scattered spots of moderate infestations. Economic loss unlikely but possible in certain areas.

Moderate-Fairly uniform concentration of weeds across the field. Average concentrations of no more than 1 plant per foot of row or scattered spots of severe infestations. Economic loss likely unless control measures taken.

Severe-More than 1 plant per foot of row for broadleaf weeds and 3 plants per foot of row for grasses, or large areas of heavy infestations. Economic loss certain unless weeds controlled.

We do not have exact threshold numbers on a species by species basis at this time. Common sense and intuition should be the guides to determine the course of action in a given field.

Perennial broadleaves like Canada thistle, hemp dogbane, bindweeds, and Jerusalem artichoke usually occur in scattered patches. Yield loss in these areas can be very serious. The decision of what action is appropriate will be based on the percentage of the field infested, weed and crop growth stage, and distribution pattern of the patches.

In addition to yield losses, certain weeds can interfere greatly with harvest. Bindweeds and giant ragweed are examples of weeds that should be controlled regardless of their impact on corn yield as they can greatly reduce harvest efficiency and increase machinery repair costs.

A comprehensive weed survey/map should be completed by the end of the scouting season. Growers can then develop a preventative weed control program, if necessary, based on weeds most likely to be present next season.

Corn Disease Scouting

Corn should be monitored for evidence of disease during each field visit. If seedling blights are present during the early season scouting, determine percent of plants infected by looking at 20 plants in each of five randomly selected areas within a field.

For leaf diseases, general remarks should be noted as to crop stage, percent of plants affected, percent of foliage infected, whether the disease is above or below the ear, and the location of the infestation within the field. Stalk rots evaluation should be treated differently. Use either the “squeeze test” (squeezing the lower internodes between thumb and forefinger, if tissue collapses then stalk rots are likely to be present) or the “push test” (pushing the plant 6-8 inches off vertical center, if it breaks between the ear and lowest node then stalk rots are likely present) to determine if plants are infected. Conduct either test on 20 plants in each of five randomly selected areas of a field. Report to grower which of the stalk rots are likely the cause and an average percent infestation. Stalk rot tests should begin about four weeks after tasseling. If a fall scouting is conducted, examine for ear rot infestation. Strip back husks from 10 consecutive plants. Record percent infested and color(s) of mold. Repeat 10 times in a 25 acre field, including representative areas.

Sampling For Corn Nematodes

A nematode assay can be valuable to: 1) confirm a suspected nematode problem or 2) eliminate nematodes as one of several possible causes of poor plant growth.

The best results are obtained when soil and root samples are taken 6 to 10 weeks after planting. Nematode populations at this time appear to correlate best with grain yield. However, late summer or fall samples can also be useful in predicting next year's problems.

Nematode damage to corn often appears in circular or oval pockets in the field. Rarely does an entire field show symptoms. Sample the suspected areas.

There are several ways to take a soil sample for nematode analysis. The following is a general guide.

1. Use a soil probe, narrow-blade trowel or a shovel. Take samples close to plants and to a depth of 8 to 10 inches. Discard the upper 2 inches of soil, especially if it is dry. Be sure to include plant roots.
2. One sample is adequate per 10 acre field or suspected area within the field. Sample soil and roots from 10 plants and mix into one composite sample - 2 pints of soil is adequate. Sample from plants in the margins of suspected areas and not from their centers.
3. Place samples in sturdy plastic bags. Fasten the open end securely and accurately label samples. Keep the samples from becoming overheated. Mail samples early in the week to avoid delays in transit.

Corn Insect Scouting

Scouting methods for insects vary according to species present. The following are scouting guidelines for the major insect pests of Wisconsin field corn.

Seed Corn Maggot and Seed Corn Beetles

Scheduled scouting for seed corn maggots and seed corn beetle damage is unnecessary. However, if you find wilted, yellowed or stunted plants during seedling stand counts, or during cutworm or other soil insect scouting activities, check for damage from these insects. If numbers justify it, check 50 plants in 5 randomly selected areas of the field (250 plants) to determine percent damaged plants. Dig up and examine damaged seedlings and search for seeds in areas that have no plants to determine if skips are insect or planter related. Unlike the spotty nature of wireworm damage, damage from these insects will usually cover most of the field.

Wireworms

Like seed corn maggot and seed corn beetles, scheduled scouting for wireworms is not suggested. However, symptoms of their activity may be observed during seedling stand counts or cutworm scouting. If wireworm damage is suspected, check 50 plants in 5 areas of the field to determine average percent of plants damaged. Dig up several damaged plants along with a 4-6 inch core of surrounding soil. Check for wireworms in the soil surrounding the roots, the underground portion of the stem, and in the remains of the seeds (if still present). Search for seeds in areas where plants are missing.

White Grubs

Routine scouting is not suggested. However, damage may be observed during seedling stand counts or cutworm surveys. If signs of white grub damage are found, make counts on 25 plants in 5 areas of the field to determine percentage of damaged plants. Dig up suspect plants and examine the roots for signs of pruning; search for grubs in the soil immediately surrounding the root zone. Record the percent of damaged plants and number of grubs found.

Stalk Borer and Hop-Vine Borer

Start scouting for plant damage at emergence and until approximately mid-June. Examine 5 sets of 50 consecutive plants for signs of damage and record the percent of plants damaged by each species. Infestations will typically be found in the first 4-6 rows around field margins, grassy waterways, and alfalfa/grass strips. However, damage can be found field-wide if grassy weeds were present the previous year. If the infestation is localized, make detailed maps of infested areas so spot treatments can be made.

Cutworms

As corn plants emerge, check 5 groups of 50 plants. Cutworm infestations are already started by the time corn is planted. Low, wet fields or low, wet areas within fields have a greater probability of attack from black cutworms. Reduced tillage, weed growth prior to tillage, and late planting are also suspected of contributing to cutworm problems. Some Wisconsin farmers have experienced severe cutworm damage in first year corn following spring plowed sod or alfalfa/grass sod.

Check for cutworms on and below the soil surface adjacent to damaged plants. Occasionally cutworms will be found under crop residue, soil clods, or in soil cracks. Count and record the number of damaged plants (leaf feeding, cut, or wilting), the number and size of cutworms and crop stage.

Corn Leaf Aphid

Examine 10 sets of 5 consecutive plants for corn leaf aphids during the late whorl to early tassel emergence stages. The aphids initially will be found in the whorl of younger plants and later on the tassel. Start scouting for aphids just prior to or during the tassel emergence period. You will, of course, have to pull the whorl leaves, unroll them, and search for aphids.

Because parasites, predators, and diseases will often keep aphids under control, it is important to note and record their presence. Look for lady beetles and lady beetle larvae, lacewing larvae (aphid lions) and syrphid fly maggots. The aphid colonies may have brown or golden aphids; these are diseased or parasitized.

Corn Rootworms

Make three counts of both species of beetles at 7-10 day intervals between mid-July and Sept. 1. Count the total number of western and northern rootworm beetles on 50 plants (10 sets of 5 plants) each time. Do not select adjacent plants at each location;

approach plants with caution because the beetles are easily disturbed. Leave a space of about 3-4 plants between each sampled plant.

Count the beetles on the entire plant, including the ear tip, the tassel, the leaf surfaces and behind leaf axils. When approaching a plant, grasp the ear tip firmly with one hand while you use the other to search for beetles on the rest of the plant. When you are ready to examine the silks and ear tip for beetles, open your hand carefully so none of the beetles escape unnoticed. Expose the ear tip as some beetles may be feeding on developing kernels.

The purpose of this scouting is twofold. First, accurate counts are necessary to determine if the silks need insecticide protection against beetle feeding. Because of this, one of the counts must be made at the onset of silking. The second purpose is to determine the potential for rootworm larval damage to corn planted the following year in the field.

European Corn Borer

First Generation. Scouting activity for first generation European corn borer must begin at 700 borer degree days (base 50 degrees Fahrenheit). In southern Wisconsin, this can occur as early as the first week of June .

Examine 10 random sets of 10-20 consecutive plants each. Record the number of plants that show signs of whorl feeding. Dissect one infested plant per set and record the number of larvae found on the leaves or in the whorl. The usual range is 1-5 larvae per plant. More mature larvae (3/8 inch or larger) will be found within the stalk and are no longer susceptible to chemical insecticide treatments. These mature larvae should not be included in the larval counts.

Larvae are susceptible to chemical control for only 7-10 days after eggs hatch depending on temperatures. It is important that scouting visits are timely to make sure that larvae are not feeding within the stalk.

Second Generation Scouting. Egg scouting is necessary after tassels emerge; leaf-feeding is no longer a valid indicator once tassels emerge. Begin to look for second generation borer eggs at 1250 borer degree days (mid to late-July in southern Wisconsin). Examine 10 random sets of 5 consecutive plants each. Egg masses are usually laid on the undersides of leaves. Examine the undersides of all leaves for unhatched masses or the remains of hatched masses. Record the number of egg masses found. When an egg mass is found, record the egg's stage of development according to the following categories:

- White (W) - eggs are newly laid
- Cream (C) - intermediate
- Black head (B) - will hatch in a few hours
- Hatched (H) - remains of an egg mass

Special Problems

When monitoring corn there will be situations when scouts encounter crop injury from unknown causes. When this occurs, it is very important that scouts collect suitable plant samples and gather enough background information to make proper identification possible. Collect a variety of plant samples (including roots) to show a variety of symptoms. Include healthy plants from the same field so comparisons can be made. All samples should be stored in a cooler until the scout has access to a refrigerator. Label each sample with the grower's name, field number and gather as much field history data as possible. Information such as variety, planting date, environmental conditions, pesticide use information (for the field in question as well as surrounding fields), soil type, distribution of symptoms in the field, cropping history, and soil test results are invaluable for making proper diagnosis. Scouts should also carry plastic vials with them in case unknown insects are found. Store the insect samples in a cooler until identification can be made.

References

Whether you are scouting your own fields or someone else's, you are sure to have many questions. Your local county extension agent can serve as an excellent source of information.
The following is a list of suggested reading materials that are available from your local county extension office or from:

Cooperative Extension Publications
45 N. Charter Street, Madison WI 53715
Phone (608) 262-3346 or (877) 947-7827

- Weeds of the North Central States, North Central Regional Publication (NCR) # 281
- Annual Broadleaf Weed Seedling Identification, NCR # 89
- Herbicide Mode of Action and Injry Symptoms, NCR #377
- A3595, A Simple Method for Predicting Future Weed Problems
- A3615, Avoiding Herbicide Resistance in Weeds
- A2296, Field Crop Herbicide Manual
- Wild Proso Millet Control in Field Crops, NCR # 265
- Controlling Canada Thistle in Field Crops, NCR # 218
- Yellow nutsedge Control in Field Crops, NCR # 220
- Quackgrass Control in Field Crops, NCR # 219
- A 1684, Corn Pest Management in Wisconsin
- A 2994, Nematodes and the Damage They Can Cause
- A 3175, Eyespot of Corn
- A 7800603, Corn Diseases I
- A 7800604, Corn Diseases II
- A 2046, Corn Insects Above Ground
- A 2047, Corn Insects Below Ground
- A 3328, Corn Rootworms
- A3631, Corn Rootworm Pest ID card
- A 1220, The European Corn Borer
- A 3327, The Armyworm
- A 3354, Stalk-Boring Insect Pests of Corn
- Special Report No. 48, How a Corn Plant Develops.

Newsletters

For updates on crop and pest related topics, the following newsletters are suggested. Each is published on a weekly schedule during the growing season.

Wisconsin Crop Manager
Department of Agronomy
1575 Linden Drive
Madison, WI 53706-1597

Wisconsin Cooperative Pest Survey Bulletin
Bureau of Plant Industry
P.O. Bow 8911
Madison, WI 53708-8911

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A3547 Scouting Corn: A Guide for Wisconsin corn production

Appendix A: Field History (example)

Grower Information

Grower

Address

Town

Zip

County

Business Phone

Home Phone

Field Location

Township

Section

Field Number

Acres

Field Specifics

Slope (degree and direction)

Drainage

Soil Type(s)

Irrigated or Dryland?

Percent Organic Matter

Field Map

Crop Information

	Variety	Planting Date	Planting Rage	Final Population	Harvest Date(s)	Yield
1st crop						
2nd crop						
3rd crop						
Other comments						

Nutrients

Manure	Date	Load Size	# of Loads	Incorporated?	Type of manure	Temperature

Lime T/A	Date	T/A	Cost	Source of Purchase

Fertilizer	Date	Analysis	Cost	Rate	Source of Purchase
Broadcast Fertilizer					
Starter Fertilizer					
Side Dress Fertilizer					
Other Fertilizer					

Herbicide*

Materials Used

Date(s)

Rate

Application Method

Weather /Rain / Temperature

Weed Problems

Insecticide

Materials Used

Date(s)

Rate

Application Method

Weather /Rain / Temperature

Insect Problems

Equipment

Tillage	Date	Equipment Size	Time Spent
Primary			
Secondary			
Planting			
Cultivation			
Harvesting (type)			
Other			

Soil Tests

Routine	OM	pH	N	P	K	S
Micro's						
Nitrate Test						
Tissue Test	N	P	K	S	B	Zn
Major Soil Type						

Miscellaneous

Fungicides

- Seed Treatment
- Foliar Treatment

Crop Insurance

Crop Scouting

- Dates

Appendix B: Sweet Corn Pest Management (early season)

General Info.

Farmer's name :	Date :	Time : am pm	County :	Field No./ Location :
Crop stage :	Weed height :	Corn borer degree days (Base 50 ^{0}) :		Scout's name :

Weeds

Herbicide program: PPI Pre Post Date applied:	Date of 1st rainfall of 1/2 or more after herbicide application :

Plant population

Count plants in 20 ft. at 5 locations. Circle row width. A = row width factors: 30"=174, 36"=145, 38"=138, 40"=131

	1	2	3	4	5	T	
No. of plants							x A = _____ plants per acre

Field Map

Notes

(diseases, abnormal plants, other insects of importance, etc.)

Cutworms

Sample 50 consecutive plants/set, count worms around all cut plants/set, record predominate instar present.

	1	2	3	4	5	T	
Damaged plants/set							÷ 2.5 = _____% damage
Number of insects							÷ 2.5 = _____% damage
Predominant instar							Instar range _____

European Corn Borer

1st generation : Sample 10 consecutive plants/set. In each set, count the number of insects on 2 infested plants per set. Instar range I-V.

	1	2	3	4	5	6	7	8	9	10	T	
Damaged plants/set												_____% of plants with whorl feeding
Number of insects												T/20 = _____ ave. # of larvae / plant
Predominant instar												Instar range _____
Extended leaf height (10 plants) _____ inches												

Corn Leaf Aphid

Each set consists of 5 consecutive plants. Note beneficial insects.

	1	2	3	4	5	6	7	8	9	10	T	
None-few present (< 50 aphids/plant)												x 2.0 = _____% low
Moderate-high (> 50 aphids/plant)												x 2.0 = _____% mod-high
Tassel covered												x 2.0 = _____% tassel covered

Appendix C: Sweet Corn Pest Management (late season)

General Info.

Farmer's name :	Date :	Time : am pm	County :	Field No./ Location :
Crop stage :	Corn borer degree days (Base 50 ^{0}) :		Scout's name :	

European Corn Borer

2nd generation : Examine 5 consecutive plants/set for egg masses.

	1	2	3	4	5	6	7	8	9	10	T
White stage											
Cream stage											
Black head stage											
Hatched											
Total divided by 50 = Average egg masses per plant											

Corn Rootwom Beetles

Examine 5 plants/set. Do not chose adjacent plants.

	1	2	3	4	5	6	7	8	9	10	T
Northern corn rootworm											
Western corn rootworm											
Total divided by 50 = Average beetles per plant											

Trap Results

Pheromone Traps:

Location(s):

Date / # caught :

Blacklight Traps:

Fall Armyworm

European Corn Borer

Corn Earworm

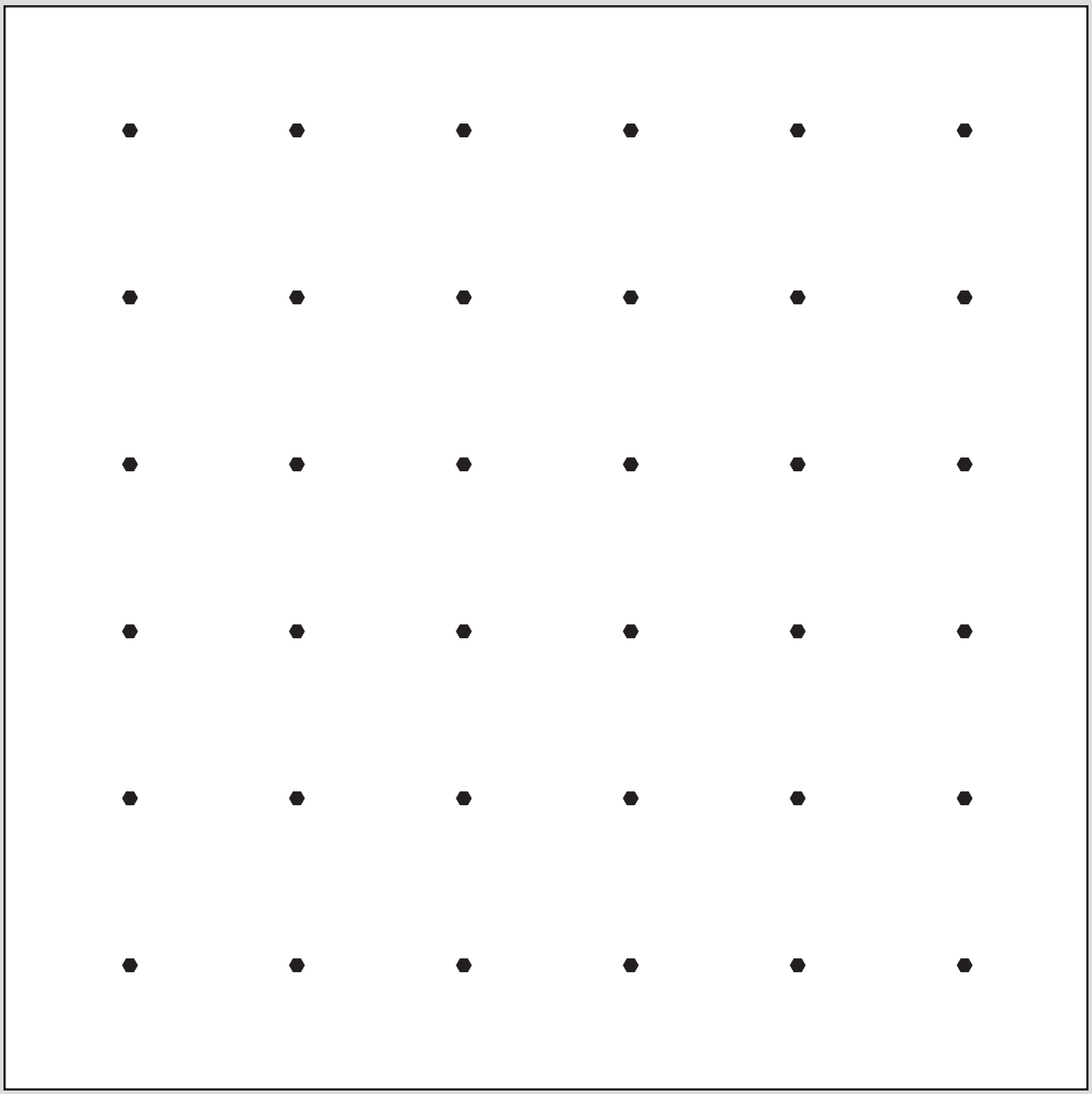
Field Map

Field Notes

Appendix D: Weed Map

General Info.

Farmer's name :			Date :	Crop :
Field No./ :	Section :	County :		



Date of Application _____ / _____ / _____
Month Day Year

Restricted-Use Pesticide ☐

PESTICIDE APPLICATION RECORD

This form meets ALL federal and Wisconsin pesticide application recordkeeping requirements.

Applicator

Name _____ Business Phone (____) _____

Certification No. _____ (Exp. Date___ /___ /___) License No. _____

Address _____
Route or Street

_____ _____ _____
City State Zip

Client

Name _____ Business Phone (____) _____

Address _____
Route or Street

_____ _____ _____
City State Zip

Treated Site

Location _____

Specific Crop/Commodity/Structure/Livestock/Other _____

Size/Number _____ Target Pest(s) _____

Pesticide Product(s) Used

Trade Name _____ Manufacturer (optional) _____
EPA Reg. No. _____ Active Ingredient (optional) _____

Trade Name _____ Manufacturer (optional) _____
EPA Reg. No. _____ Active Ingredient (optional) _____

Trade Name _____ Manufacturer (optional) _____
EPA Reg. No. _____ Active Ingredient (optional) _____

Application Information

Time ____ : ____ AM/PM to ____ : ____ AM/PM Mixing/Loading Location _____

Application Rate(s) _____

Total Amount of Each Product Used _____

If you apply a soil fumigant that contains metam sodium, record the following additional information:

Soil Temperature at Depth of 5 to 6 Inches (if you used knife rig injection or chemigation) _____

Time of 1st Inspection ____ : ____ AM/PM Results/Action Taken _____

Time of 2nd Inspection ____ : ____ AM/PM Results/Action Taken _____

Comments (optional): Put additional comments (weather, site conditions, pest population, etc.) on back.

How to Use the Pesticide Application Record Form

Fill out the relevant sections of this form on the day that you apply any pesticide. Keep the form on file for at least 2 years (3 years if you apply an atrazine-containing product) to comply with all current federal and Wisconsin recordkeeping requirements.

Restricted-Use Pesticide. Put an 'X' in the box in the upper right hand corner of the form if you applied a restricted-use pesticide. This will make it easier to retrieve records of such applications for the USDA if you are requested to do so.

Applicator. To save time, fill out the applicator information before you make photocopies of the form. Write 'NA' (for 'not applicable') on the appropriate line(s) if you are not certified and/or licensed.

Client. Fill out this part of the form if you are a commercial applicator or if you are a private applicator making an application on another person's land, even if only for exchange of services.

Treated Site.

Location. Provide enough information that would allow someone to find the way to the location of the application. For example, if you use a field-numbering system, enter the field number on the form but also have a copy of the farm plan on file where you keep your pesticide records; that way, a person could look at the farm plan and determine how to get to the field in question.

Specific Crop/Commodity/Structure/Livestock/Other. This is the site to which you applied the pesticide. Be specific enough to accurately describe what was treated. For example, 'field corn' vs. 'sweet corn' vs. 'field corn seed' vs. 'stored corn.' Likewise, if you treat a storage structure, such as a grain bin or potato warehouse, be sure to mention whether or not it was empty at the time of treatment. Other examples of sites include dairy cows, chickens, fence rows, barns, and private ponds.

Size/Number. Generally speaking, use whatever units of measurement are mentioned on the label. Examples include acres, feet of row, cubic feet, and number of livestock.

Target Pest(s). Be as specific as you can be; this will help you determine how effective the application was. For commercial applicators, it is especially important that your client know which pests the treatment was intended to control.

Pesticide(s) Used. You can get the requested information from the product label. If you tank mix 2 or more pesticide products, record each product separately. If you use a restricted-use pesticide, even in a tank mix with nonrestricted-use pesticides, put an 'X' in the box in the upper right-hand corner of the form.

Active Ingredient(s) *optional*. Record the common name of the active ingredient that appears in the ingredients statement. (Do not record the complex chemical name that may also appear in parentheses after the common name.) If a product contains more than 1 active ingredient (as is the case with all prepackaged tank mixes), record the common name of each active ingredient.

Application Information. The application rate is just your calibrated rate (pints or pounds of product per acre, percent solution, etc.) Also record the spray volume applied per acre (or the spray volume used to treat a barn, fence row, etc.) If you apply a tank mix, be sure to record the application rate and the total amount of product used for each product in the mix. The mixing/loading location is where you loaded the pesticide into the application equipment or nurse tank. To record this location, use the same guidelines described above for the location of the treated site; you can write 'site of application' if that was the mixing/loading location as well.

Comments. Although not required by law, additional comments can help you evaluate the effectiveness of the pesticide application. Examples include weather conditions, application equipment, adjuvants, and timing of application
(e.g., preplant incorporated or postemergence). Because you will use a separate, photocopied recordkeeping form for each application, you can record optional comments on the blank back of the photocopied form.

Field Corn Insects

Armyworm

Black Cutworm

Corn Leaf Aphid

Corn Rootworm
Larvae

Corn Rootworm Adult
(Northern)

Corn Rootworm Adult
(Western)

European Corn Borer
Eggs/Larvae/Adult

Hop Vine Borer

Potato Stem Borer

Seed Corn Beetles
Striated/Smooth

Seed Corn Maggot
All Stages

Stalk Borer

White Grub

Wireworm

Armyworm

Scientific Name: *Pseudaletia unipunctata*
Order: Lepidoptera
Family: Noctuidae

General Information

Biological Description:

The armyworm can be a serious pest on field corn. Outbreaks are more severe following cold, wet, spring weather. The sand colored moths have a wing span of 1.5" with definitive white dots in the center of each forewing and dark markings on the hind wings. The brownish green larvae are hairless, have alternate dark and light stripes down their backs and are about 2" long when fully grown. The head is pale brown with dark markings. Pupae are dark brown and approximately 3/4 inch in length. They are sharply tapered at the tail end with a much more rounded head end. The greenish white eggs are laid in rows or clusters on leaves. Moths often seem to congregate in certain locations. Armyworms often are confused with the variegated cutworm and other related species.

Economic Importance:

Damage is sporadic and dependent on heavy flights of southern moths reaching Wisconsin. Armyworms may be a problem in corn no-tilled into alfalfa or grass sod or in fields with heavy weed pressure.

Life Cycle:

Armyworms do not overwinter in Wisconsin. The moths usually migrate to Wisconsin. Once they arrive, they immediately mate. Eggs are laid in the evening and at night and eggs are laid in rows or clumps of many eggs. Grasses and small grains are the preferred host and blades are often folded and sealed to protect the eggs. One week to 10 days after the eggs are laid, the larvae emerge and begin to feed. After feeding for 3-4 weeks, the full-grown larvae pupate for an additional 2 weeks and emerge as adults. There are 2-3 generations per season, with each generation lasting 5-6 weeks. The first generation is usually small and does little damage; however the success of this generation produces later, more injurious, generations of armyworms. The second larval generation, which appears in July, is the largest and most damaging generation to Wisconsin crops. The fall generation is typically not injurious and is often heavily parasitized by beneficial insects, fungi and viruses.

Host Range:

Armyworms attack all grasses, particularly wheat, oats, corn barley and rye and some legumes; but when under stress armyworms will attack neighboring vegetable crops and seedling alfalfa. Additionally, the presence of grass weeds in fields will attract moths for egg laying.

Damage/Symptoms:

Larvae tend to feed at night or on cloudy days and hide in the soil or under foliage during the day. Infestations may occur throughout a corn field in July if grassy weeds such as foxtail, quackgrass, goosegrass, and nutsedge are present for oviposition in the field. In this case, plants in scattered areas of the field will have ragged leaves from larval feeding. The other type of infestation results when armyworms migrate from pastures, oats, or grassy pea or alfalfa fields, to destroy the outside rows of corn. Damage is usually highest along the field edge or in grassy spots.

Scouting Procedure and ET:

Timely detection is critical if post emergent insecticidal treatment is to be effective. If you find signs of armyworm feeding, check 5 sets of 20 plants at random. Record the number of damaged plants and the number of worms per plant. Repeat in several locations within the field since infestations may be restricted to certain areas. Treatment is suggested if worms are ¾ inch long or less, and two or more worms per plant can be found on 25% of the stand; or if one worm per plant can be found on 75% of the stand. Spot treat when possible. When armyworms migrate from adjoining areas, treat only border rows.

Integrated Control

Non-Chemical Control:

Natural Control: A number of braconid wasps and tachinid flies help keep armyworm numbers down, as do birds, toads, skunks and some domestic fowl.

Cultural Control: Since female moths prefer to lay eggs in grassy areas, keeping grassy weeds controlled will lessen the possibility of problems. Avoid planting susceptible crops in low wet areas or in rotations following sod. If this is unavoidable, be sure to plow in the fall of the previous season to decrease early spring egg-laying sites. Killing grass with a herbicide or tillage may drive armyworms to the susceptiblecrops.

Biological Control: Several natural enemies exist which may

keep armyworm populations low. The red-tailed tachinid fly (Winthemia quadripustulata) is one such biocontrol agent. It lays its eggs on the armyworm's back and the tachinid larvae bore into larval armyworms to feed. In addition, several ground beetles and parasitic hymenoptera prey upon the armyworm. There is also and egg parasite (Telenomus minimus) that is effective in preventing egg hatch and subsequent larval feeding damage.

Chemical Control:

For current Wisconsin recommendations, consult University of Wisconsin-Extension Bulletin #A3646, Pest Management in Wisconsin Field Crops which is available from your local county extension office or from:

Cooperative Extension Publications
45 N. Charter Street, Madison WI 53715
Phone (608) 262-3346 or (877) 947-7827

In other states, contact your local county extension office for similar recommendations.

Insecticide Resistance: None.

References:

R. H. Davidson and W. F. Lyon (1987) Insect Pests 8th Ed. of Farm, Garden, and Home. John Wiley & Sons, New York 640 pp.

C. L. Metcalf and R L. Metcalf (1993) Destructive and Useful Insects, Their Habits and Control 5th Ed. McGraw Hill Book Co., New York.

Black Cutworm

Scientific Name: *Agrotis ipsilon*

Order: Lepidoptera

Family: Noctuidae

General Information

Biological Description:

Black cutworm larvae generally feed at, or below the ground surface at night. It is an active feeder on young foliage or stem tissue and will cut off many young seedlings in an evening. The large, greasy, dark gray larvae will curl up into a tight c shape if disturbed. Mature, larvae, are 1.5" long and have a grainy texture. Adult cutworms are gray moths which have a series of distinctive dark markings on their forewings and lighter colored hind wings. The black cutworm larvae are easily confused with other cutworms, but generally damage crops earlier in the season than other species. This cutworm is particularly problematic to the home gardener.

Economic Importance:

Damage is not common on field corn but heavy infestation can occur. Early season scouting is recommended. Consult county and state newsletters for moth flight records.

Life Cycle:

Moths that appear in late May have migrated into Wisconsin from other states. Overwintering black cutworms in Wisconsin are rarely abundant enough to cause significant damage. Female moths lay hundreds of eggs either singly or in clusters. Oviposition is typically concentrated on low-growing vegetation such as chickweed, curly dock, mustards or plant residue from the previous year's crop. Corn planted after soybeans is often a preferred oviposition site. As a result, heavy spring weed growth, newly broken sod, previous crop and plant debris all increase the risk of black cutworm infestations. Late-planted cornfields are most heavily damaged during an outbreak of black cutworms. Generally, black cutworm moths will not lay eggs in fields that have already been planted. Young larvae (less than one-half inch in length) feed above ground. Larger larvae feed at, or just below the soil surface, although in fields with very dry soil conditions the larvae may be found 2-3 inches deep. Cutting stage larvae may take as long as 34 days to pupate at temperatures of 60°F, while only 12 days may be required at temperatures of 75°F. There are three generations per year. It is the first generation which is active during May and June that causes the most damage.

Host Range:

Black cutworm larvae attack a wide variety of vegetable and field crops, especially in the seedling stage.

Environmental Factors:

Excessive rainfall may disrupt egg-laying. Flooding may force larvae to the soil surface during the day where they are attacked by parasites or predators.

Damage/Symptoms:

Newly hatched larvae are unable to chew entirely through the leaf surface resulting in a "window pane" appearance on the leaves. As the larvae grow, their feeding damage appears as small pinholes in the leaves and often complete defoliation of the leaves is possible. Once the larvae reach the "cutting" stage, they are 1/2 inch long and cut the stem at, or just below the soil surface. This type of injury is common during extended periods of dry weather. In later crop stages (V3-V4) large larvae may not be able to cut plants. Instead, larvae will burrow into the corn plant, below ground level, and result in symptoms often described as "wilted whorl" or "dead heart". In these situations the newly emerging whorl leaves wilt. Older leaves may remain green for a period of time.

Scouting Procedure and ET:

Timely detection is critical if post emergence insecticidal treatment is to be effective and economical. Concerns over damage are greatest during the first ten days to two weeks after corn emergence. Examine a minimum of 250 plants (50 plants in each of 5 locations) in a field. When damaged plants are found, dig around the base of the plant for live cutworms. Collect at least 10 larvae and determine their age by using the head capsule gauge found in the bulletin titled "Field Crop Insect Stages" which can be found later in this chapter.

Consider treating when approximately 5% of the plants show damage AND cutworm larvae are sixth instar or smaller. For help in determining the damage potential of various cutworm instars, consult the table at the bottom of page.

Integrated Control:

Non-Chemical Control:

Natural Control: A number of braconid parasites and predaceous ground beetles help keep cutworm numbers down. Cutworms are most problematic in low, wet, grassy areas. Cutworms serve as prey to birds.

Cultural Control: Since female moths prefer to lay eggs in weedy situations, keeping weeds controlled will lessen the possibility of damage. Avoid planting susceptible crops in low wet areas or in rotations following sod.

Biological Control: Several species of tachinids, braconids and ichneumonids help reduce populations.

Chemical Control:

For current Wisconsin recommendations, consult University of Wisconsin-Extension Bulletin #A3646, Pest Management in Wisconsin Field Crops which is available from your local county extension office or from:

Cooperative Extension Publications
45 N. Charter Street, Madison WI 53715
Phone (608) 262-3346 or (877) 947-7827

In other states, contact your local county extension office for similar recommendations.

Insecticide Resistance: None.

References:

R. H. Davidson and W. F. Lyon (1987) Insect Pests 8th Ed. of Farm, Garden, and Home. John Wiley & Sons, New York 640 pp.

Guide to Black Cutworm Development and Damage to Corn

		Potential number of plants that may be cut		
Larval Instar	Approximate days left to feed	1 leaf	2 leaf	4 leaf
4	25	4	3	1
5	21	4	3	1
6	14	4	3	1
7	5	1	1	1

Corn Leaf Aphid

Scientific Name:
Rhopalosiphum maidis

Order: Homoptera

Family: Aphididae

General Information

Biological Description:

The corn leaf aphid is a small, bluish-green to gray, soft-bodied insect about the size of a pinhead. They may be winged or wingless. One unique characteristic of aphids is the ability of the adult females to give birth to live young as opposed to laying eggs like other insects. Both the immature nymphs and adults appear similar and it is often difficult to distinguish between the two.

Economic Importance:

The corn leaf aphid may occasionally be a problem in field corn grown in the Midwest.

Life Cycle:

Corn leaf aphids appear in the upper Midwest in mid-summer as winged forms migrate from the south. There may be as many as nine generations per year. Winged and wingless adults as well as nymphs may be found on the same plant at the same time. As the aphids grow, they shed their skins. In heavy infestations, plants may take on a grayish cast as these skins begin to accumulate. Because the aphid's diet is high in sugars, the honey dew excreted by the aphid as waste serves as an excellent medium for the growth of molds. These molds may give the plant a black appearance.

Host Range:

The corn leaf aphid may be found on all varieties of corn as well as many other wild and cultivated plants in the grass family.

Environmental Factors:

Heavy rain can rapidly decrease aphid populations as well as produce ideal conditions for the rapid spread of several fungal diseases.

Damage/Symptoms:

Like other aphids, the corn leaf aphid possesses fine, needle-like, piercing mouthparts, which are inserted between plant cells and into the vascular tissue. Typically, this causes little direct morphological damage. Under heavy infestations, leaves may curl, wilt and become chlorotic. Plants may become sticky with honeydew or blackened with sooty mold, a fungus which grows saprophytically on the honey dew. Occasionally, heavily infested plants may be barren if aphid feeding on the tassel or silk interferes with pollination. Corn leaf aphids may be vectors for some corn diseases.

Scouting Procedure and ET:

Corn leaf aphids can be found in the curl of the leaves, deep within the whorl, the upper part of the corn stalk, and the unemerged tassel and emerged tassel. Examine 10 sets of five consecutive plants (50 plants) for corn leaf aphids during the late whorl to early tassel emergence stages. You will, of course, have to pull the whorl leaves, unroll them, and search for the aphids. Make note of any natural predators and numbers present. If 50% of the plants have 50 or more aphid, make a single insecticide application when plants are in the late whorl to early tassel stage of development.

Integrated Control:

Non-Chemical Control:

Natural Control: Several parasites, predators, and pathogens are effective in keeping aphid populations below economically damaging levels. When scouting, look for lady beetle adults and larvae, lacewing larvae and syrphid fly maggots. Aphid colonies with brown or golden aphids are diseased or parasitized.

Cultural Control: Damage by the aphids may be avoided by planting early in the season. Proper tillage and fertilization which hastens plant growth is also recommended.

Biological Control: None.

Chemical Control:

For current Wisconsin recommendations, consult University of Wisconsin-Extension Bulletin #A3646, Pest Management in Wisconsin Field Crops which is available from your local county extension office or from:

Cooperative Extension Publications
45 N. Charter Street, Madison WI 53715
Phone (608) 262-3346 or (877) 947-7827

In other states, contact your local county extension office for similar recommendations.

Insecticide Resistance: None.

References:

C. L. Metcalf and R. L. Metcalf (1993) Destructive and Useful Insects, their Habits and Control 5th Ed. McGraw Hill Book Co., New York.

Corn Rootworm

Scientific Name:	*Diabrotica barberi,*
	Diabrotica virgifera virgifera
Order:	Coleoptera
Common Names:	Northern Corn Rootworm,
	Western Corn Rootworm

General Information

Biological Description:

Fully grown larvae of northern and western corn root worms are approximately 1/2 inch long and the diameter of a medium pencil lead. Their heads are brown to black and there is a dark plate on the dorsal side of the last abdominal segment. Northern corn rootworm beetles are approximately 1/4 inch long and pale yellow to tan in color when they first emerge from the soil. As adults mature, they become light green. The western corn rootworm adult is also 1/4 inch long but is characterized by the alternating yellow and black stripes along the back of the female. The male is also yellow and black but the wing covers are more uniformly black and lacks the striping present on females.

Economic Importance:

Northern and western corn rootworms are two of the most destructive insect pests of corn in the southern two-thirds of Wisconsin. Damage results from both root feeding by the larvae and silk clipping by the adults. In addition, the western corn rootworm also feeds on the leaves, however, leaf feeding is not an economic concern.

Life Cycle:

Both species of corn rootworm beetles overwinter as eggs in the upper soil layers. In the spring. Eggs complete development and larvae emerge and begin invading corn roots. The first instar larvae begin feeding on the smaller branching corn roots. Later, the rootworms migrate toward roots at the base of the plant. Larvae may be present throughout the summer but commonly, larval damage peaks in mid-July. After three weeks, three larval instars have been completed and the larvae enter the pupal stage. Pupae are white and resemble the beetle. Typically they are found near the plant base but pupae have been recovered over 2 feet away. After a day or two the adult beetles emerge. Adult corn rootworm beetles are pollen feeders and are often found on ornamental flowers as well as vegetables. A three year study at the UW Arlington Research Station revealed that adults typically appear between July 16-24. The western corn rootworm adults appear slightly before those of the northern corn rootworm and the western corn rootworm male beetles begin to emerge before the females. Females begin laying eggs approximately two weeks after mating. In Wisconsin, this starts in early to mid-August and continues well into September. While the reproductive potential of each female beetle is 1000 eggs, 300-500 eggs are more common. The eggs enter diapause, a resting state in which they will overwinter. Development and maturation occurs in the spring. There is one generation per year.

Host Range:

Sweet corn, field corn and some prairie grasses.

Environmental Factors:

Soil moisture influences both the number of eggs laid as well as the location of oviposition. Corn rootworm beetles lay more eggs in moist soil than dry soil. The higher the soil moisture, the closer to the surface the eggs are laid. Low soil temperatures in the winter as a result of little snow cover may contribute to high egg mortality of the western corn rootworm.

Damage/Symptoms:

Rootworms cause damage by tunneling in corn roots. Evidence of corn rootworm activity consists of brown, elongated scars on the root surface, tunnels within the roots and varying degrees of root pruning. Lodging of plants caused by root pruning is common after storms containing heavy rains and high winds. Slight to moderate lodging can result in reduced ear weight and a goose-necked appearance in the plants. Adult corn rootworm beetles also feed on green corn silks, thereby reducing pollination. This often results in poor ear fill. The western corn rootworm also feeds upon corn leaves. Late planted corn is more susceptible to adult leaf feeding injury (western) and silk pruning by both species because beetles are attracted to fresh pollen and silk. These late-planted fields will attract beetles from surrounding, more advanced fields.

Scouting Procedure and ET:

Because corn rootworm beetles can reduce yield by silk pruning, it is important to scout corn fields during pollination. Growers should begin checking for adults beetles before 70% of the plants are in the process of silking. Count the number of beetles on 10 random plants in five separate areas for a total of 50 plants. Record the number of beetles per plant and the number of plants with silks clipped to 1/4 inch or

less. In addition, record the number of plants that haven't begun to silk, the number with fresh silk and the number with brown silk.

In addition to determining the potential for corn rootworm damage in the current year, scouting will also provide insight into the potential for damage if corn is planted the following year. For continuous corn (corn after corn), scout corn acreage three times at 7-10 day intervals from early August through early September. Count the number of western and northern corn rootworm beetles on 50 plants each time you sample. Examine 5 plants at each of ten areas in the field. Count the beetles on the entire plant. First, grasp the ear tip tightly enclosing the silks in the palm of your hand and count all other areas of the plant first. Pull leaves away from the stalk to examine leaf axils and expose hiding beetles. The silks often have the most beetles on the plant, so a tight hold on the ear tip keeps beetles from dropping out. Open your hand slowly and count the beetles that come out of the silks as you strip the husk away from the ear tip. By determining the level of adult infestation this year, you may be able to determine whether preventative corn rootworm insecticide treatments will be necessary the following year. The grower will need to use a soil insecticide, or rotate to a crop other than corn, if you find an average of 0.75 beetles per plant during any of the three field samplings.

In limited areas of south/southeastern Wisconsin, western corn rootworm females may lay enough eggs in soybeans to cause significant economic damage to first year corn planted after soybean. To avoid unnecessary insecticide applications in first year corn, it would be advisable to monitor western corn rootworm populations where there is a potential for damage. The Pherocon AM unbaited yellow sticky trap is the most reliable method to monitor western corn rootworm populations in soybean and to predict damage potential in first year corn. These traps are a visual attractant. No lure is needed.

Evenly distribute 12 traps/soybean field beginning in early August. Traps should be placed a minimum of 100 feet from the field edge and 100 paces between traps. Place traps on a stake above the soybean canopy. Count beetles and replace traps (if needed) on a weekly schedule. Trapping can conclude the first full week in September when egg laying is complete. A management technique (crop rotation or insecticide) should be used if an average of 5-10 western corn rootworm beetles are caught/trap/day. For example, if you counted a total of 1680 WCR beetles in twelve traps over a 28 day period this would equal an average of 5 beetles/trap/day {1680 divided by 12(#traps/field) divided by 28 (# days you trapped) = 5}.

Research conducted by entomologists at the University of Illinois, suggest an average of 5 beetles/trap/day would likely result in a corn root rating of 0.25 on the Iowa State node-injury scale. An average of 10 beetles/trap/day would result in a root rating of 1.00. Root feeding damage by corn rootworms can be difficult to interpret into yield loss. A corn root rating less than 0.25 is not expected to suffer yield loss greater than the cost of an insecticide application. A corn root rating greater than 1.00 would be expected to suffer significant economic loss. Roots that rate between 0.25 and 1.00 are considered to be in a gray area and economic loss could be dependent on other crop growth factors (weather, size of root mass, fertility, etc.).

Integrated Control

Non-Chemical Control:

Natural Control: While adult and larval corn rootworms are essentially free of parasites, ground beetles and predacious mites may control rootworm populations by feeding on eggs, larvae and pupae.

Cultural Control: Crop rotation has been an excellent method of controlling corn rootworm damage. However, since 2002, western corn rootworm damage to corn after soybeans has been documented in areas of southern and southeastern Wisconsin. This damage is the result of female western corn rootworm laying eggs in soybean fields and has limited the effectiveness of crop rotation within this region. However, it must be noted that the majority of Wisconsin can effectively use crop rotation to control western corn rootworm damage.

The northern corn rootworm has a different method of circumventing crop rotation. Extended egg diapause, although not been observed in Wisconsin, has been documented in Minnesota, Iowa and South Dakota. Typically, rootworm eggs must go through one winter chill period before hatching. Northern corn rootworm eggs with the extended diapause trait must go through two winter chill periods before hatching. Thereby limiting the effectiveness of a corn/soybean rotation in these regions of the corn belt.

Biological Control: None.

Chemical Control:

Commercial: For current Wisconsin recommendations, consult University of Wisconsin-Extension Bulletin #A3646, Pest Management in Wisconsin Field Crops which is available from your local county extension office or from:

Cooperative Extension Publications
45 N. Charter Street, Madison WI 53715
Phone (608) 262-3346 or (877) 947-7827

In other states, contact your local county extension office for similar recommendations.

Insecticide Resistance: Resistance has developed to carbaryl and methyl parathion in areas of Nebraska where there has been a history of adult control.

European Corn Borer

Scientific Name: *Ostrinia nubilalis*

Order: Lepidoptera

Family: Pyralidae

General Information

Biological Description:

Eggs are white, overlap like fish scales, and are deposited on the lower leaf surface of corn leaves and near the midvein. If ears are present, moths will also lay eggs on the flag leaves at the tip of the ear. There can be as many as 30-40 eggs in each mass. As they develop, the eggs change to a creamy color. Just before hatching, the black heads of the larvae become visible inside each egg. This is referred to as the black-head stage and each egg reaching this stage usually hatches within 24 hours. Full grown larvae are ¾ -1 inch in length and grey to cream-colored with numerous dark spots covering the body. The pupae are brown, 3/4 inch long and cigar shaped with segmentation evident on one-half of the body. The adults are nocturnal, straw-colored moths with a 1 inch wing span. Males are slightly smaller and distinctly darker than females.

Economic Importance:

Economic importance of the European corn borer varies from generation to generation and from year to year. Routine field scouting is suggested.

Life Cycle:

The European corn borer overwinters as mature 5th instar larvae in corn stalks and stems of weedy hosts. Spring development begins when temperatures exceed 50 degrees F. Pupation occurs in May with the first moths emerging in early June in southcentral Wisconsin. Peak emergence occurs in mid June at 600 degree days (base 50). This generation usually infests corn and females will seek out the tallest field for egg laying., Adult moths are nocturnal and spend most of their daylight hours in sheltered areas along field edges. Female moths lay eggs in the evening. The eggs hatch in 3-7 days depending on the temperatures and young larvae feed on leaves and in the midrib of the leaves for 5-7 days (125 DD_{50}) before boring into stalks. Boring usually begins with the third instar. The larvae pass through five instars and complete their feeding and development while boring inside stems. The earliest larvae to mature embark upon a 12 day pupal period within the stalk after which time the adult moths emerge. This begins the second generation. Second generation moths peak in mid August when approximately 1700 DD_{50} have been reached. Newly hatched second generation larvae tend to migrate to leaf sheaths and beneath ear husks. Larvae enter the silk channel at the tip of the ear, tunnel up the shank and into the ear, or bore directly through the husks and into the ear. All mature 2nd generation larvae enter diapause in late September and October and overwinter. In seasons with unusually warm spring and summer temperatures, some of the second generation larvae will pupate, emerge as moths and lay eggs for a late-season, third generation of larvae. These larvae do not have a chance to become fully grown before cold weather arrives and ultimately will perish.

European Corn Borer Development (DD base 50)

First Generation	Accumulated DD
First moth	375
First eggs	450
Peak moth flight	600
Larvae present	800-1000
2nd generation adults	1550-2100

Host Range:

Corn borers attack over 200 different kinds of plants and may cause serious damage to field and sweet corn, peppers, potatoes and snap beans.

Environmental Factors:

Cool weather or drought may delay spring insect development due to the desiccation of eggs and young larvae. Conversely, warm weather and moisture may accelerate insect development. Excessive heat and drought in spring may cause increased mortality of all stages. The number of eggs laid is affected by the availability of drinking water of which, dew is considered an important source. Heavy rainfall will decrease moth activity and drown newly-hatched larvae in whorls and leaf axils, or even wash them from the plant.

Damage/Symptoms:

Damage to corn is caused by early larval stages chewing on the leaves and later larval stages tunneling into the stalks, ears and ear shanks. Early leaf feeding appears as pinholes, called “shotholes”, as leaves emerge from the whorls. Third instar larvae begin to burrow into the midrib of the leaf, eventually working their way to the stalk. Severe feeding damage will result in broken stalks and tassels, poor ear development and dropped ears in dent corn.

Scouting Procedure/ET:

Black light traps can be used to monitor adult corn borer activity. Moth catches provide data on the time of appearance and potential severity of the subsequent larval infestation.

First Generation Scouting: Once corn reaches 18 inches extended leaf height, examine 10 consecutive plants in 10 areas of the field for leaf feeding. Pull the whorl leaves from two infested plants in each area and unroll the leaves to look for borers Calculate the percentage of plants with recent leaf feeding and average number of European corn borer larvae/ infested plant and consult the management worksheet for first generation corn borer.

Second Generation: Second generation European corn borer egg laying occurs over a long period of time and infestations can go unnoticed until ears begin to drop and stalks begin to break in the fall. Due to the extended egg-laying period, one sampling of a field is not sufficient. Scout fields weekly looking for white egg masses on the undersides of leaves near the midrib. Most of the eggs will be laid on leaves near the ear and above. Use the management worksheet for second generation corn borers to determine whether treatment will be worthwhile. If possible, treat when tiny black dots are apparent on most of the egg masses. At this "black-head" stage, the eggs are almost ready to hatch.

Integrated Control

Non-Chemical Control:

Natural Control: Weather conditions greatly influence European corn borer survival, particularly during the egg stage and while young larvae are feeding on the leaves.

1st Generation European Corn Borer Management Worksheet

☐ % of 100 plants infested x ☐ average # of borers/plant[A] = ☐ average borers/plant

☐ average borers/plant x 5% yield loss per borer = ☐ % yield loss

☐ % yield loss x ☐ expected yield (bu/A) = ☐ bu/A loss

☐ bu/A loss x ☐ $ expected selling price/bu = ☐ $ loss/A

☐ $ loss/A x ☐ % control[B] = ☐ $ preventable loss/A

☐ $ preventable loss/A - ☐ $ cost of control/A = ☐ $ gain (+) or loss (-) per acre if treatment is applied

[A] Determined by checking whorls from 20 plants.

[B] Assume 80% control for most products: assume 50% control for Asana, Furadan and Lorsban sprays.

2nd Generation European Corn Borer Management Worksheet

☐ # of egg masses /plant[A] x 2 borers/egg mass[B] = ☐ borers/plant

☐ borers/plant x 4% yield loss per borer[C] = ☐ % yield loss

☐ % yield loss x ☐ expected yield (bu/A) = ☐ bu/A loss

☐ bu/A loss x ☐ $ expected selling price/bu = ☐ $ loss/A

☐ $ loss/A x 75 % control = ☐ $ preventable loss/A

☐ $ preventable loss/A - ☐ $ cost of control/A = ☐ $ gain (+) or loss (-) per acre if treatment is applied

[A] Use cumulative counts, taken seven days apart.

[B] Assumes survival rate of two borers per egg mass.

[C] Use 3% loss/borer if infestation occurs after silks are brown. The potential economic benefits of treatment decline rapidly if infestations occur after corn reaches the blister stage.

Heavy rains wash the egg masses and young larvae off the plants and thus can greatly reduce borer numbers. In addition, very hot, dry weather causes desiccation of the eggs and young larvae. These climatic variables will kill 22-68% of the freshly hatched larvae. Predators, parasites and disease also take their toll on European corn borer populations, however there is no way to predict the impact of these factors.

Cultural Control: Plowing under crop stubble and shredding stalks on a community-wide scale in the fall to destroy overwintering larvae may reduce borer populations. However, moldboard plowing of fields is often unacceptable because of the potential for soil erosion and incompatibility with conservation plans. This, plus the fact that moths can fly several miles, and the wide host range of the European corn borer, limit the value of plowing under or shredding corn stubble.

Biological Control: Predators, parasites and disease also take their toll on European corn borer populations, however there is no way to predict the impact of these factors making them a less practical alternative.

Chemical Control:

For current Wisconsin recommendations, consult University of Wisconsin-Extension Bulletin #A3646, Pest Management in Wisconsin Field Crops which is available from your local county extension office or from:

Cooperative Extension Publications
45 N. Charter Street, Madison WI 53715
Phone (608) 262-3346 or (877) 947-7827

In other states, contact your local county extension office for similar recommendations.

Insecticide Resistance: None.

References:

R. H. Davidson and W. F. Lyon (1979) Insect Pests 7th Ed. of Farm, Garden, and Home. John Wiley & Sons, New York 596 pp.

K. F. Harris and K. Maramorosch, Eds. (1980) Vectors of Plant Pathogens. Academic Press, New York 467 pp.

C. L. Metcalf and R. L. Metcalf (1993) Destructive and Useful Insects, their Habits and Control 5th Ed. McGraw Hill Book Co., New York.

Hop Vine Borer & Potato Stem Borer

Scientific Names: *Hydraecia immanis*, *Hydraecia micacea*

Order: Lepidoptera

Family: Noctuidae

General Information

Biological Description:

Hop vine borer larvae are white with violet transverse bands. The head is orange to reddish-brown. Just prior to pupation, the violet bands disappear. By comparison, the larvae of the potato stem borer are white with reddish dorsal bands. The potato stem borer is a European relative of the hop vine borer and is almost identical in appearance but has a much wider host range. The distinctive coloration of the hop vine borer and potato stem borer will distinguish them from cutworms. Adult moths of both the hop vine borer and potato stem borer are non-descript brown to tan moths.

Economic Importance:

The hop vine borer is a native, stem-feeding caterpillar that has caused localized damage to corn in portions of Wisconsin, Iowa, Illinois and Minnesota.

Life Cycle:

These insects overwinter as eggs which were laid on grass stems the previous August. Larvae hatch from the eggs in May and begin feeding on grass stems and rhizomes. In late May, second or third instar larvae move from grassy weeds into adjacent corn to complete development. Larvae complete development after tunnelling in the below-ground portions of the stem in late June to mid July. Larvae pupate in the soil within a few inches of the last host plant. The pupal stage lasts 4-6 weeks and adults are present from late July until early September. There is only one generation per year.

Host Range:

The potato stem borer feeds primarily on potato, eggplant

and other solanaceous weeds while the hop vine borer prefers corn, hops, and various grasses.

Environmental Factors:

Reduced tillage and poor grassy weed control favors both the hop vine and potato stem borers.

Damage/Symptoms:

Damage is usually confined to the outer four to six rows of corn fields as the larvae migrate into corn from adjacent grassy areas. However, if corn follows sod or grassy weeds, outbreaks may be found throughout the field. The first indication of a hop vine borer or potato stem borer infestation is wilted corn plants. Unlike the common stalk borer which tunnels mainly in the corn stalk above ground, the hop vine and potato stem borers usually feed on the stem below ground.

Scouting Procedure and ET:

To check for suspected hop vine and potato stem borers, remove damaged corn seedlings along with a 3-4 inch cube of soil. Look for entry holes in the stalk just below the soil surface, split the stalk, and sift through the soil. You may have to dig and examine several plants before finding any larvae.

Integrated Control:

Non-Chemical Control:

Natural Control: The skunk is the only known natural enemy of hop vine borer and potato stem borer. However, skunks often cause additional damage to corn plants by digging the plants in search of the borers.

Cultural Control: Adequate management of grassy weeds is the primary means of successfully controlling both of these borers.

Biological Control: None.

Chemical Control:

Commercial: For current Wisconsin recommendations, consult University of Wisconsin-Extension Bulletin #A3646, Pest Management in Wisconsin Field Crops which is available from your local county extension office or from:

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45 N. Charter Street, Madison WI 53715

Phone (608) 262-3346 or (877) 947-7827

In other states, contact your local county extension office for similar recommendations

Insecticide Resistance: None.

References:

C. L. Metcalf and R. L. Metcalf (1993) Destructive and Useful Insects, their Habits and Control 5th Ed. McGraw Hill Book Co., New York.

Seedcorn Beetle

Scientific Name:
Stenolophus lecontei (striped seedcorn beetlle), *Clivina impressifrons (slender seedcorn beetle)*

Order: Coleoptera

General Information

Biological Description:

Striped and/or slender seed corn beetles can be common in corn fields. The striped seed corn beetle is dark brown with a brown to tan longitudinal stripe on each wing cover. The slender seed corn beetle is uniformly chestnut brown.

Life Cycle:

Many aspects of their life cycle are not known but it is believed they overwinter as adults or perhaps as pupae. Adults appear during the first warm days of April. Larvae live in the soil and are believed to be predacious on other insect forms.

Damage/Symptoms:

Planting to early seedling emergence is the critical period for the seed corn beetle. Only the adults attack the germinating seed and, in fields with poor germination, seed corn beetles can often be found feeding inside the seed. Light damage to the endosperm may not be significant but, if the germ is damaged, the entire plant may be lost. They can also damage the emerging sprout. As with the seed corn maggot, damage is worse during years with delayed seedling emergence.

Scouting Procedure :

Scheduled scouting for seed corn beetles is unnecessary. However, if you find wilted, yellowed or stunted plants during sweet corn seedling stand counts, or during cutworm or other soil insect scouting activities, check for seed corn beetles. If numbers justify it, check 50 plants in 5 areas of the field (250 plants). Dig up and examine damaged seedlings and search for seeds in areas that have no plants. Unlike the spotty nature or wireworm damage seedcorn beetle damage will usually cover most of the field.

Seed Corn Maggot

Scientific Name: *Hylemya platura* (Meigen)

Order: Diptera

Family: Anthomyiidae

General Information

Biological Description:

The yellowish-white larvae are typical looking fly maggots, 1/5 inch long when fully grown, cream colored, legless and wedge-shaped with the head end sharply pointed. Pupae are brown, 1/5 inch long, cylindrical in shape, and rounded on both ends. Adults resemble miniature houseflies; they are dark grey, 1/5 inch long and their wings are held overlapped over their bodies while at rest. Flies are smaller than cabbage and onion maggots, with whom they are easily confused. Eggs are about 1/32 of an inch in length, oval, and white.

Economic Importance:

Although seedcorn maggot is a threat to corn, damage is not as severe as that found on soybeans and other vegetables such as peas and succulent beans.

Life Cycle:

The seedcorn maggot overwinters as pupae in the soil. Peak adult emergence from overwintering pupae occurs anytime from early to mid May when degree day accumulations have reached 200 DD_{39} Newly emerged adults may be seen flying in large numbers over recently-tilled fields. Adults mate within 2-3 days of emergence and females lay eggs in soils containing high organic matter or near seeds and seedlings of a wide variety of plants. Egg hatch occurs in 2-4 days. Larval feeding, development and pupation all occur below ground and the subsequent generation of adults appears 3-4 weeks later. This sequence of events is repeated and 3-5 generations of seedcorn maggots may occur during a season.

Host Range:

Seeds and seedlings of corn, soybean most vegetable crops including beets, cabbage, cucumbers, peas, radishes, squash, turnips, and kidney, lima and snap beans.

Environmental Factors:

Cool, wet weather favors this insect while hot, dry weather is detrimental to its survival. Therefore, the seed corn maggot is more likely to be a problem during the spring and early summer than later in the season. Cool, wet springs and doughty conditions may delay seed germination and lead to increased damaged by the seed corn maggot. The application of livestock manure and incorporation of vegetation prior to egg laying makes fields more attractive to the female flies. Tillage of live plant material is more attractive than tillage of dead plant residue. The decomposition of the green vegetation may produce compounds that attract the flies.

Damage/Symptoms:

All parts of sprouting corn seeds are attacked by the maggot larvae, resulting in weakened, stunted plants and poor germination rates. Plants which survive maggot damage to the seed often have holes in the first pair of true leaves. Extensive feeding on seed endosperm can reduce plant vigor and lead to small “nubbin” ears. Larvae feeding on the seed germ will destroy the seed and prevent seedling emergence. Unlike the spotty nature of wireworn damage, seedcorn maggot damage will usually cover most of the field.

Scouting Procedure and ET:

Seedcorn maggot damage cannot be detected until it is too late to take control actions. Therefore, economic thresholds for this insect are not useful and insecticides are applied at planting as a protective measure. However, if you notice skips in the row, wilted, yellowed or stunted plants, or seedlings with pinholes in the leaves check for seedcorn maggots. If numbers justify it, check 50 plants in 5 separate field areas to both verify and quantify seedcorn maggot injury. Forecasting the appearance of generations may be accomplished by accumulating degree days beginning when the ground thaws in spring. Degree days are calculated each day using the formula ((maximum temperature + minimum temperature)/2) 39. A running total of degree days is kept and peak emergence of the first three generations will occur when totals of 200, 600 and 1000 day degrees, respectively, have been reached.

Integrated Control

Non-Chemical Control:

Natural Control: Naturally occurring fungal diseases occasionally will reduce seedcorn maggot numbers significantly, particularly when flies are abundant and relative humidity is high. During a fungal epidemic, dead or diseased flies can be seen clinging to the highest parts of plants along field edges. Predaceous ground beetles, which eat seedcorn maggot eggs, larvae and pupae can also be important in reducing maggot numbers. Because these soil inhabiting beetles are susceptible to insecticides, broadcast soil insecticide treatments should be avoided whenever possible.

Cultural Control: Since the seedcorn maggot is attracted to decaying organic matter, fields where animal or green manure has recently been applied should not be planted.

Plant seeds as shallow as feasible to speed germination. Any procedure which promotes fast germination and seedling growth will reduce chances of maggot infestation. In addition, home gardeners may soak seeds in water for about 2 hours prior to planting to promote fast germination and seedling growth. It is also possible to avoid seedcorn maggot damage by planting during fly free periods that occur between generations of flies (see Scouting/ET).

Biological Control: None.

Chemical Control:

Commercial: For current Wisconsin recommendations, consult University of Wisconsin-Extension Bulletin #A3646, Pest Management in Wisconsin Field Crops which is available from your local county extension office or from:

Cooperative Extension Publications

45 N. Charter Street, Madison WI 53715

Phone (608) 262-3346 or (877) 947-7827

In other states, contact your local county extension office for similar recommendations.

Insecticide Resistance: None.

References:

R. H. Davidson and W. F. Lyon (1979) Insect Pests 7th Ed. of Farm, Garden, and Home. John Wiley & Sons, New York 596 pp.

C. L. Metcalf and R. L. Metcalf (1993) Destructive and Useful Insects, their Habits and Control 5th Ed. McGraw Hill Book Co., New York 1087 pp.

S. M. Sanborn, J. A. Wyman and R. K. Chapman. "Threshold Temperature and Heat Unit Summations for Seedcorn Maggot Development Under Controlled Conditions." Annals of Entomology. Vol. 75, No. 1 103-106.

Stalk Borer

Scientific Name: *Papaipema nebris*

Order: Lepidoptera

Family: Noctuidae

General Information

Biological Description:

The larvae are purplish brown with longitudinal, off-white stripes running the length of their body. There is a purplish saddle band located behind a yellow head. They range from 1/2 to 1 1/2 inches long and are extremely active when disturbed. Adult moths have dark grey-brown forewings with numerous small, white spots. The wingspan is approximately 1 1/4 inches.

Economic Importance:

Damage to corn by the common stalk borer and other borers besides the European corn borer tends to be localized and less common. In recent years however, this insect has become relatively common in some parts of the state.

Life Cycle:

Adult female stalk borers lay up to 2,000 eggs in late August and September in grassy weeds (especially quackgrass and wire-stemrd muhly), ragweed, pigweed, curlydock, burdock. The eggs overwinter and hatch in early spring (mid-April to early May). As the larvae grow, the grass stems become too small and by late May to early June larvae begin to migrate from the grassy field borders into the border rows of adjacent crops. Larvae are fully grown in early August and may bore into many stems before pupating in the soil. Adults emerge 2 6 weeks later (late August) and seek grassy areas in which to oviposit. There is one generation/year.

Host Range:

The host range of the common stalk borer is comprised of over 170 species. This insect attacks virtually any plant large enough for it to bore into, including all beans, corn, and potatoes.

Damage/Symptoms:

There are basically two types of damage caused by the common stalk borer in corn. In the first, the larva enters the corn plant near the base of the plant and tunnels within the stem. Stem tunneling in seedling plants causes unfurled leaves to wilt and flag. Seedling plants may be killed by this tunneling activity, and the larva will move to another plant if the food supply is exhausted. In the second case, the stalk borer larva enters the whorl and feeds there before tunneling downward. This results in numerous larval droppings (frass)

and a series of irregular holes in the unfurled leaves.

Scouting Procedure/ET:

Record % of plants infested. Draw accurate field maps if damage is concentrated in specific areas (e.g. field edges, grassy waterways, fence rows or where grassy weeds were growing the previous growing season) so spot applications can be made if necessary.

Integrated Control

Non-Chemical Control:

Natural Control: Populations seem to build and decline in 4-6 year cycles but the reasons for this are not understood. Natural enemies of the common stalk borer include a tachinid fly (*Gynmochaeta ruficornis*), an ichneumonid wasp (*Lissonota brunner*) and two brachonid wasps (*Meteorus leviventris* and *Apanteles papaipemae*).

Cultural Control: Cultural control is by far the most important control for this pest. Poor weed control during the previous year provides numerous oviposition sites and can result in extensive patches of crop damage the following year. Keep fall weeds, especially grasses, controlled to prevent egg laying. Mowing fence rows in mid August as eggs are laid may also help to reduce next season's populations.

Biological Control: There are no commercially available biological control agents which are cost effective to use to reduce stalk borer populations.

Chemical Control:

For current Wisconsin recommendations, consult University of Wisconsin-Extension Bulletin #A3646, Pest Management in Wisconsin Field Crops which is available from your local county extension office or from:

Cooperative Extension Publications
45 N. Charter Street, Madison WI 53715
Phone (608) 262-3346 or (877) 947-7827

In other states, contact your local county extension office for similar recommendations

Insecticide Resistance: None.

References:

J.L. Wedberg & B.L. Giebink. (1986) UWEXnote 5 - Stalk-Boring Insect Pests of Corn. University of Wisconsin Agricultural Bulletin Office. Madison, WI 4 pp.

R. H. Davidson and W. F. Lyon (1979) Insect Pests of Farm, Garden, and Home. 7th Ed. John Wiley & Sons, New York 596 pp.

C. L. Metcalf and R. L. Metcalf (1993) Destructive and Useful Insects, their Habits and Control 5th Ed. McGraw Hill Book Co., New York.

White Grub

Scientific Name:
Phyllophaga spp.

Order: Coleoptera

Family: Scarabidae

General Information

Biological Description:

Grubs are white-bodied, 1/2 1 1/2 inches, sluggish, C-shaped larvae with brown heads and six prominent brown legs. The hind part of body is smooth with body contents showing through skin. True white grubs are distinguished from similar larvae by 2 rows of minute hairs on the underside of the last segment. Adults are the common brown to black May or June beetles seen in the spring. There are several species of white grub in Wisconsin; they typically have 3-year lifecycles. Adult activity is primarily nocturnal.

Economic Importance:

White grubs are typically only a problem in corn following sod or when weeds are not controlled. However, damage to corn following soybeans has been reported periodically.

Life Cycle:

Most species have a three year life cycle in Wisconsin. Adults emerge and mate in late May to early June. Females search out grassy areas, burrow into the soil and deposit eggs. Eggs hatch in 2-3 weeks and grubs begin feeding on roots and underground plant parts. With the onset of cold weather, the grubs move beneath the frost line in the soil to overwinter. In May, to early June the grubs migrate back to the upper soil horizons. It is during the second year that the most damage is done as larvae increase in size before they return to the subsoil layers to overwinter. In the third spring, the grubs return to the surface, feed for a short time and pupate. In late summer, adults emerge from the pupae but remain underground until the following spring. Historically, Peak adult flights occur in Wisconsin every three years.

Host Range:

Many species of crops are attacked. All vegetables, strawberries, roses, nursery stock, and most grass and grain crops are susceptible to grub damage.

Environmental Factors:

White grub injury is typically a problem in areas which were previously planted to sod.

Damage/Symptoms:

Damage is usually patchy, rather than randomly distributed throughout the field. They do not damage planted corn seed but rather prune and destroy corn roots and will burrow into corn stalks below ground. Small areas of infested fields may be totally destroyed. Plants may be wilted, stunted and under heavy infestations, can easily be lifted from the ground. Damage is most severe in years following peak adult flights and is most pronounced in corn following sod or fields with grassy weeds.

Scouting Procedure/ET:

Routing scouting is not suggested. However, damage may be observed during seedling stand counts or cutworm surveys. If signs of white grub damage are found, count the number of grubs on 25 plants in five areas of the field. Dig plants suspected of being infested and examine the roots for signs of pruning. Search for grubs in the soil immediately surrounding the root zone. Record the number of damaged plants and number of grubs found.

Integrated Control:

Non-Chemical Control:

Natural Control: A parasitic fly *Pyrogota* spp. parasitizes the grubs and may reduce populations. Birds are effective predators in freshly plowed fields.

Cultural Control: The first year after sod or grassy, weedy alfalfa will be the most damaging. Keeping grass weeds down in spring will prevent egg laying.

Biological Control: Commercial preparations of milky spore disease are rarely effective.

Chemical Control:

For current Wisconsin recommendations, consult University of Wisconsin-Extension Bulletin #A3646, Pest Management in Wisconsin Field Crops which is available from your local county extension office or from:

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45 N. Charter Street, Madison WI 53715
Phone (608) 262-3346 or (877) 947-7827

In other states, contact your local county extension office for similar recommendations

Insecticide Resistance: None.

References:

R.H. Davidson and W.F. Lyon (1979) Insect Pests 7th Ed. of Farm, Garden, and Home. John Wiley & Sons, New York. 596 pp.

C.L. Metcalf & R.L. Metcalf (1993) Destructive and Useful Insects, Their Habits and Control. 5th Ed. McGraw Hill Book Co., New York.

Wireworm

Scientific Name: Many species and genera

Order: Coleoptera

Family: Elateridae

General Information

Biological Description:

The larvae of click beetles or wireworms are the damaging stage of this insect. Larvae are thin, yellow to reddish brown, shiny, jointed, worm-like larvae, 1/4 to 1 1/2 inch in length by 1/8 inch in diameter. They are distinguished by the ornamentation on the last segment. Adults are hard shelled, brown or black “streamlined” beetles which flip into the air with an audible click if they are placed on their back.

Life Cycle

Wireworms have an extended life cycle, taking from 1-6 years depending on species. In Wisconsin, wireworms overwinter as either adults or larvae. Larvae live in the upper six inches of soil and feed on seeds and roots. They migrate only short distances. They are sensitive to moisture and may burrow deeply into the soil in dry conditions. Adults become active in the spring as they fly about searching for a site on which to lay eggs. Adult females may live 10-12 months, spending most of this time in the soil where they may lay up to 100 eggs. Eggs are laid in soil in grassy areas. This includes pastures, alfalfa, sod, and grassy weed infestations in row crops. Egg hatch occurs in several days to weeks. Tiny larvae immediately begin to feed on the roots of grasses , weeds and other crops. Because of the extended life cycle, larvae of some species will feed for two to three years before pupating. Adults that emerge from these pupae remain in the pupal chambers until the following spring.

Environmental Conditions

Wireworms tend to be most damaging 1-4 years after plowing up sod or in poorly drained lowlands, but they are not exclusive to those areas.

Host Range

Wireworms feed primarily on grasses, including corn and small grains as well as nearly all wild and cultivated grasses. Favored row crops include beans, beets, cabbage, carrot, lettuce, onions, peas, potato, radish, turnips, sweet potatoes, cucumber, and tomato. Asters, phlox, gladioli, and dahlias are some of the more commonly infested herbaceous ornamentals.

Damage/Symptoms

Damage is most likely to occur when infested pastures or

alfalfa sod are plowed under and planted to row crops. Because of the long life cycle of wireworms, damage is possible two to three years after the field is taken out of sod. A second year of corn after sod may have more damage than the first year, perhaps because there are fewer grass roots to feed on. Damage to the ungerminated seed occurs when wireworms hollow out the seed, thus preventing germination. Later, they feed on below ground portions of the stem. They drill a hole into the stem and occasionally drill completely through it. Stems of small seedlings may be hollowed out up to the soil surface. By midsummer, soil temperatures have increased and soil moisture is reduced. At this time, wireworms and their damage often disappear when in fact the wireworms have merely migrated deeper into the soil. Early indications of wireworm damage to corn is the lack of germination which results from the destruction of the seed. Only a few plants may remain in a heavily infested area. The first few leaves of emerging seedlings will often show a pattern of holes which is caused by wireworms feeding through the leaves before they unfurl. Stem feeding caused plants to wilt and die, further adding to the "spotty" appearance of the field. On larger plants, only the center leaves may wilt. If these plant do not die, they are usually stunted and distorted, and will not produce a normal ear.

Scouting Procedure/ET

Scheduled scouting is not suggested. However, symptoms of wireworm activity may be observed during seedling stand counts or cutworm scouting. No thresholds have been developed. If wireworm damage is suspected, dig up several ungerminated seeds or damaged plants along with a 4-6 inch core of surrounding soil and check for wireworms in and around the roots, or in the underground portion of the stems.

Integrated Control

Non-Chemical Control

Natural Control: Several natural enemies have been described but they are not effective in reducing populations.

Cultural Control: Crop rotations which avoid susceptible crops and clean cultivation may reduce wireworm numbers. Some species thrive in poorly drained soil and can be reduced by adequate drainage. Clean summer fallowing of infested fields has been effective in some areas. Certain soil types (e.g. silt loams) are particularly susceptible.

Chemical Control:

Commercial: For current Wisconsin recommendations, consult University of Wisconsin-Extension Bulletin #A3646, Pest Management in Wisconsin Field Crops which is available from your local county extension office or from:

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In other states, contact your local county extension office for similar recommendations.

Insecticide Resistance: None.

References:

R. H. Davidson and W. F. Lyon (1979) Insect Pests of Farm, Garden, and Home. 7th Ed. John Wiley & Sons, New York 596 pp.

C. L. Metcalf and R. L. Metcalf (1993) Destructive and Useful Insects, their Habits and Control 5th Ed. McGraw Hill Book Co., New York.

Field Crop Insect Stages

Insect management decisions should be based on the potential for economic damage. In order to determine damage potential, the size and number of larvae and the number of remaining insect stages must be known. Certain insects can very quickly become major pests on field crops because as insects grow, they eat more each day.

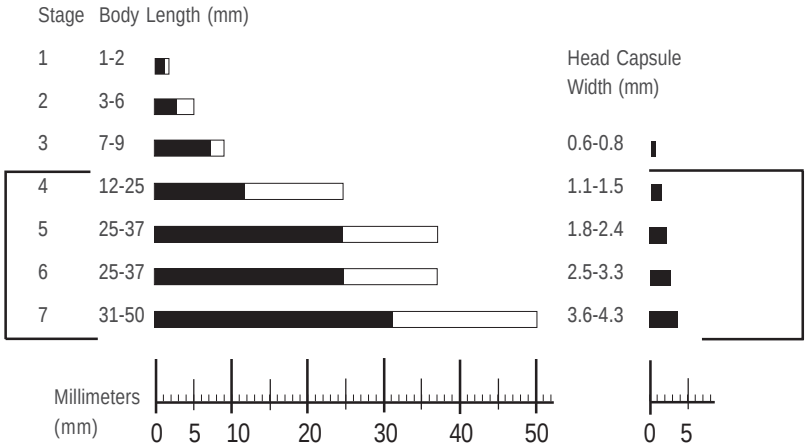
Although small larvae are usually not damaging, larvae can become devastating in a few days as they near maturity. Sixth-stage green cloverworm larvae, for example, may consume 75% of their larval food during the last six days of the 23-day larval life. Damage, however, will quickly subside after the insects have pupated.

As larvae grow, they molt, or shed their skins. The stage between molts is called the **instar**. Most field crop insects have 3 to 7 larval stages. For example, the European corn borer has 5 larval stages, the black cutworm has 7, and the western corn rootworm 3.

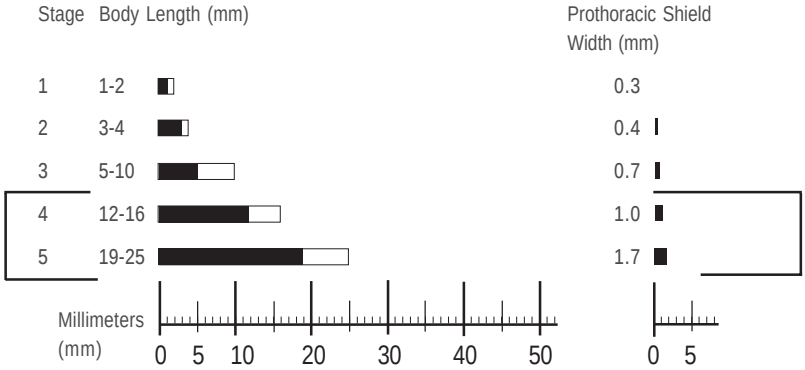
During a stage the larva's body grows but its head does not increase in size. Only between stages does the size of the head increase. Identification of larval stages can be partially determined by the length of the larva. The most accurate method, however, is measuring the width of the head capsule. An exception is the European corn borer, where measuring the width of the prothoracic shield is more accurate than measuring the width of the head capsule.

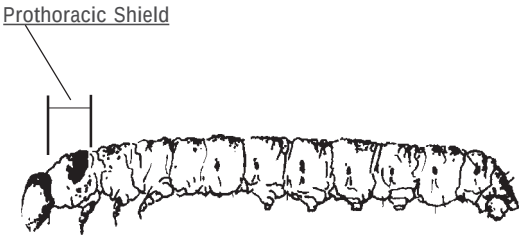
Head capsule (or prothoracic shield) measurements and approximate body lengths corresponding to larval stages are given for 7 common crop insects. Approximate lengths are illustrated. For body length measurements, the unshaded portion is the range corresponding to the particular larval stage. For example, for the fourth stage of black cutworm, the dark portion of the line is equal to 12 mm. The unshaded portion is the 12 to 25 mm range in body length for the fourth larval stage. The stages within the brackets are considered to be the most destructive.

Black cutworm—*Argrotis ipsilon (Hufnagel)*



European corn borer—*Ostrinia nubilalis (Hübner)*

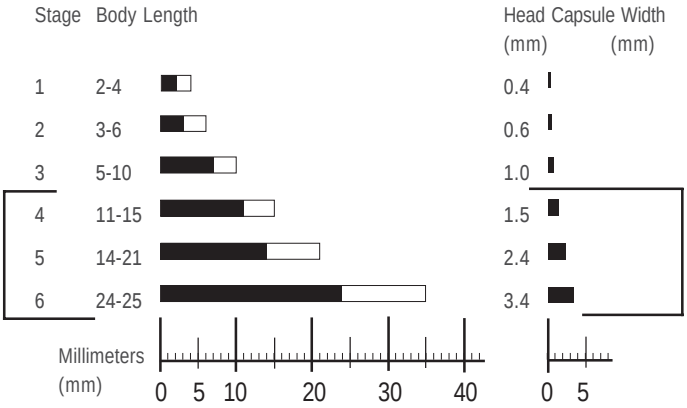




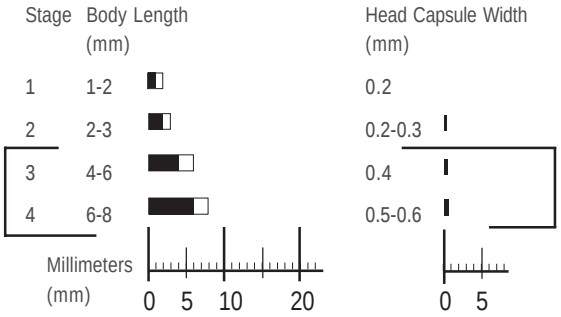
All information in this Field Crop Insect Stages sheet, taken from Iowa State University of Science and Technology, Cooperative Extension Service, publication prepared by Jerry DeWitt, integrated pest management coordinator, and Harold Stockdale, extension entomologist at the Cooperative Extension Service, Iowa State University.

Field Crop Insect Stages

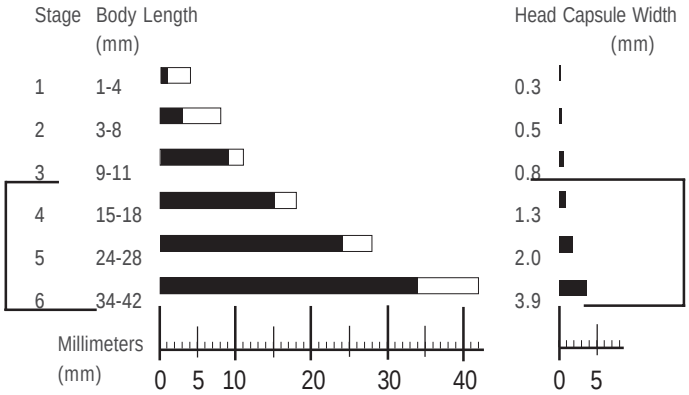
Armyworm—*Pseudaletia unipuncta (Haworth)*



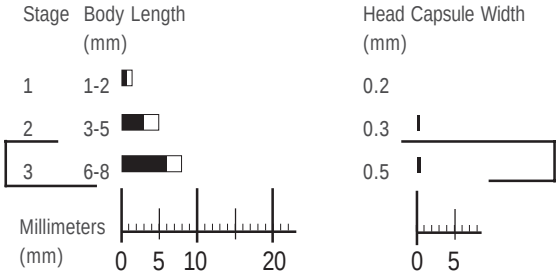
Alfalfa weevil—*Hypera postica (Gyllenhal)*



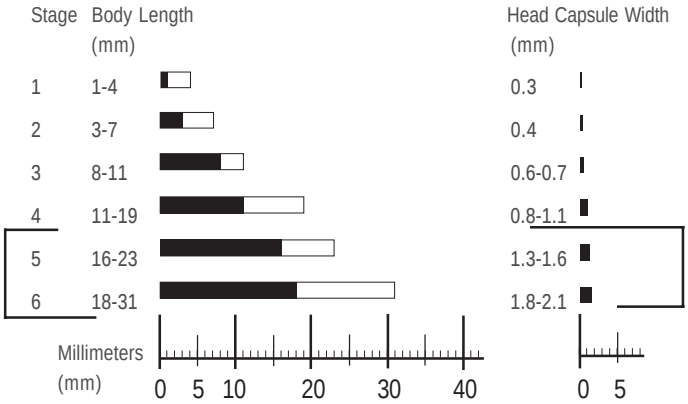
Corn earworm—*Heliothis zea (Boddie)*



Western corn rootworm—*Diabrotica virgifera LeConte*



Green cloverworm—*Plathypena scabra (Fabricius)*



A Key to the Types of "Worms" Found in Corn & Alfalfa Fields

1. Worms without legs	1/8" to 1/2" long, often spindle-like or peg-shaped Maggots (fly larvae)
1[1]. Worms with 6 or more legs	2

2. Worms with only 6 legs	Beetle larvae *Coleoptera*
2[1]. Worms with more than 6 legs	3 *(see figure 1)*

figure 1

3. Worms with 6 pointed legs on front of body and 10 to 14 blunt legs on middle and rear of body	4
3[1]. Worms with 15 or more pairs of legs, legs all of same size and shape, two pair of legs per segment	Millipeds—*(see figure 2)* feed on organic matter

figure 2

4. Worms with 6 pointed legs on front, 10 or less blunt prolegs on middle and rear of body, each proleg has group of small hooks at tip	True Caterpillars—*Go on to next page*
4[1]. Worms with 6 pointed legs, plus 14 blunt prolegs, no hooks on ends of proleg, only one pair of eyes on head	Sawflies—*(see figure 3)* feed on weeds

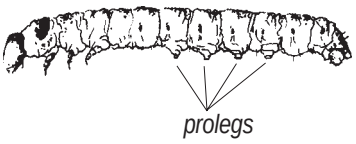


figure 3

Wisconsin Field Pest Caterpillar Key

This key has been put together to help in the identification of the more common general pest caterpillars in Wisconsin. It will by no means identify everything in the field, but should work for 80% of the worms found. Such things as when, what crop and where on the plant the insect is found are important aids in identification and are included whenever practical in this key. Read through the total description of each insect before making your decision on which direction to go. Most characteristics can be observed with a 10X hand lens. Looking at the skin texture will require good light and a 15-20X lens. Worms over 1" in length will be easier to work with. Whenever possible, a series of specimens should be used for ID purposes.

A. Two pair of ventral prolegs on abdomen	B *(see figure 1)*
A[1]. Four pair of ventral prolegs present on abdomen	C *(see figure 4)*

figure 1

B. General color green, body thick with thin white line on side. Most often found in cole crops and potatoes. Does not appear until late July.	Cabbage Loper *Trichoplusia ni*
B[1]. General color light tan to pink, head with distinct white, brown or pink stripe. Usually associated with clover or alfalfa	Forage Loper *Caenurynia erechtea*

figure 3

C. Caterpillar with very distinct, sharply defined stripes along back or sides	D
C[1]. Caterpillar without distinct, prominent stripes. May have indistinct bands or markings	J

D. Skin covered with densely packed microspines *(see figure 5)*. Larvae variable in color. Dark brown to green or yellow with lengthwise light and dark stripes. Found in corn silks, ears and tomatoe fruit. Not found in Wisconsin until July or later.	Corn Earworm *Helicopvera zea*
D[1]. Skin not as above, but may have pebbly texture	E

figure 5

E. Purple ringed area around middle of body. Body whitish with dark brown lateral stripes. Larvae most often boring into stem of corn, potatos, peppers, tomatoes during June and July.	Common Stalk Borer *Papipama nebris*
E[1]. No purple saddle around middle of larvae	F

F. Prominent light colored, inverted Y on head. Body tan, green or black. Back somewhat lighter colored, dark side stripes running length of body. Prothoracic shield usually with 3 pale yellow lines. Four spots (pinacula) arranged as points of square on back of next-to-last abdominal segment. Spiracles with lighter center. Found only in late summer in corn ears or rarely in grain fields.	Fall Armyworm *Spodoptera frugiperda*
F[1]. Body with various markings. Larvae not as above. Found throughout growing season, rarely found in corn ears.	G
G. Several thin, prominent bright yellow side stripes. Large black spot above first abdominal spiracle and double row of black triangular markings on most of back. Spiracle, gray center with dark rim (general feeder). Found on vegetables from mid June on.	Yellow-Striped Armyworm *Spodoptera ornithogalli*
G[1]. NO yellow stripes or black spot on first abdominal segment. Spiracle totally black or with white center. If black markings present on back, never present on more than 1/2 of larvae.	H
H. Spiracle white or yellowish center, prominent black chevron wedge shaped markings on last 2 abdominal segments. Pale pink or orange side stripe present. Large larvae found in Spring on alfalfa—Fall. General feeder. Often in mixed infestation of true Armyworm.	Spotted Cutworm *Amathes C-nigrum*
H[1]. Spiracle black. If markings on back, they are all defined and not as above.	I
I. No distinct lines on back. A row of 4-7 pale yellow spots along center of back. In dark colored forms, a black W-shaped spot found on last abdominal segment. Larvae black to pale brownish gray. Jaws with sharp teeth. General feeder. A climbing cutworm on tree fruits in Spring, strawberries, potato, general vegetables.	Variegated Cutworm *Paridroma saucia*
I[1]. Back of caterpillar with numerous lines running lengthwise. No light spots on back. Jaws without teeth. Light to pink side stripe present. Most common on corn and various small grains. From mid June and July. Often associated with weedy grasses.	True Armyworm *Pseudaletia unipunta*

J. Caterpillar with some striping on body—may be inconspicuous.	K
J[1]. Caterpillar with no stripes (may have small spots). All whitish or gray.	N
K. Caterpillar with several indistinct stripes on BACK.	L
K[1]. Caterpillar with no stripe or only one broad (or narrow) inconspicuous stripe on BACK.	M
L. Skin bearing coarse granular *(see figure 4)*. Caterpillar dingy brownish tan. Faint V-shaped markings on back. Spiracles black. Found on alfalfa, corn and vegetables.	Dingy Cutworm *Feltia ducens, F. subgothica*
L[1]. Skin smooth. Caterpillar dull gray with prominent dark gray side stripe above spiracles. Sides darker than back. Spiracles dark brown. On tree fruits, onion, potato, corn. Can climb.	Dark Sided Cutworm *Euxoa messoria*
M. Skin granules appear greasy under hand lens *(see figure 6)*. Body is light gray to black. Narrow indistinct striped down middle of back. No distinct spots. Spiracles and tubercles black. Most common cutworm in Wisconsin. Seen in corn, turf and vegetables.	Black Cutworm *Argrotis ipsilon*
M[1]. Caterpillar with skin granules, 4-6 sided *(see figure 7)*. Body pale gray with broad, tanish stripe on back. Spiracles black. Occasional pest of corn, strawberries, general vegetables.	Clay-Backed Cutworm *Argrotis gladiaria*
N. Caterpillar with head and neck shield bright reddish brown. Body greasy white and very plump. No conspicuous markings or stripes on body. Spiracles brown, mandible with four distinct, blunt outer teeth and three inner teeth.	Glassy Cutworm *Crymodes devastator*
N[1]. Not as above. Head pale brown to black. Dull. Body normal size. Some spots or indistinct markings.	O
O. Head pale brown. Body semi-translucent with several white side stripes. Spiracles black. Larva limited to sandy soils. Most often feeding at or below ground level.	Sand Hill Cutworm *Euxoa detersa*
O[1]. Head dark brown to black. Body grayish to yellowish white. Distinct hair bearing spots on body. Spiracles light brown with yellow rim. Most often found boring into stem on fruit of the plant. Primarily on corn, tomato, pepper, potato.	European Corn Borer *Ostrina nubalis*

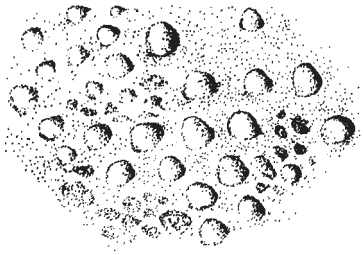


figure 4

figure 6

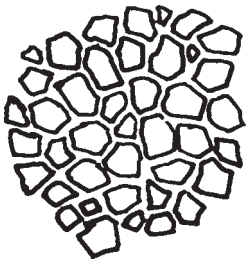


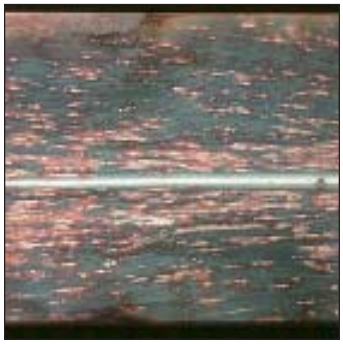
figure 7

Field Corn Diseases

Anthracnose

Anthracnose

Northern Corn Leaf Blight


Northern Corn Leaf Spot

Goss Bacterial Wilt

Stalk Rot
Larvae

Stalk Rot
Lodging

Corn Ear Rot

Seedling Blight

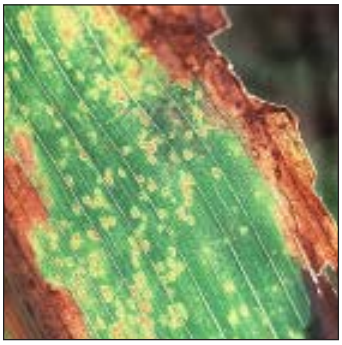
Seedling Rot

Nematodes
Root Damage

Nematodes
Stunting

Gray Leaf Spot

Rust


Eye Spot
Blacklighted

Yellow Leaf Blight

Corn Disease Management

Dr. Craig Grau
Department of Plant Pathology
University of Wisconsin–Madison

Diseases of corn, like those of other crops, vary in severity from year to year and from one locality or field to another, depending on environmental conditions, the resistance of the corn hybrid grown, and the disease-causing organisms that are present. It is important for growers to distinguish when poor crop development is due to diseases and when nutrient deficiencies, herbicide injury, insect injury, or weather conditions are the problem.

General Approaches to Disease Control

Corn diseases can be prevented or controlled by planting resistant or tolerant corn hybrids, crop rotation, tillage practices, balanced fertility and applying pesticides. Although a single control procedure can be effective, a sound disease control program is an integration of all these crop management factors. An integrated approach can greatly reduce the potential risk of disease. Disease potential has increased because of the trend to shorten crop rotation and reduce or eliminate tillage operations.

Resistant Hybrids

Selecting corn hybrids that have resistance or tolerance to major corn diseases can be an effective and economical method to disease control. Your seed dealer is a good source of information on specific hybrid reaction to disease. Terms describing hybrid reaction to disease are somewhat confusing. "Disease-resistant hybrids should be regarded only as a general term that suggests resistance to specific diseases —it cannot be an all-inclusive statement, since no hybrid is resistant to attack by all diseases known to affect the crop.

Many hybrids have good resistance or tolerance to most of the major diseases likely to occur in Wisconsin. Such diseases include rust, northern leaf spot, smut, stalk rot, Gilbberella ear rot, Goss's wilt, northern corn leaf blight (NCLB), southern corn leaf blight (SCLB), yellow leaf blight (YLB), and eyespot. If you have had a history of problems with one or more of these diseases, ask your seed dealer about hybrid reactions to these specific diseases.

Also, "resistance" does not mean "immunity"—complete freedom from infection or disease development. A resistant hybrid will withstand damage, but may show some disease development when conditions favor the disease. Some hybrids can also tolerate infection to certain diseases, that is, show considerable disease development, yet not suffer much yield reduction. In other words, there is a gradation among hybrids ranging from susceptible, to tolerant, to resistant, to highly resistant to disease. Changes in cultural practices, new forms (races) of known corn pathogens, and new corn pathogens can result in more disease in corn hybrids that were thought resistant. Learn to identify the major diseases of corn and evaluate disease reactions of the hybrids you grow. Disease reactions of various hybrids can differ with each year or locality because of different local weather conditions, tillage operations, soil type and soil fertility.

Crop Rotation and Tillage Practices

Crop rotation and clean tillage are effective disease control procedures. In many cases, the fungi that cause corn diseases must overwinter on or in stalks, leaves, and roots. Once this corn debris is thoroughly decayed, corn pathogens perish or are greatly reduced in population. Therefore, crop rotation and tillage programs that permit residue decay before the next corn crop is grown in a given field will help reduce diseases such as ear rots, stalk rots, root rots, seedling blights, and leaf diseases.

We support the concept of no-till or minimum tillage for crop production for its soil conserving potential. However, growers using no-till or minimum tillage should be more alert for an increase in crop pest problems and be aware that the potential is greater with reduced tillage than with conventional tillage systems. The risk of increased corn disease problems is high when reduced tillage is associated with continuous corn, planting of susceptible hybrids, and climatic conditions favorable for disease development. Continuous corn in conjunction with reduced tillage techniques increases the risk of disease. The need for disease-resistant hybrids increases under such practices. If you are considering continuous reduced tillage or no-till corn production, we suggest the following steps to minimize corn diseases:

1. Select corn hybrids with resistance or tolerance to major leaf diseases.
2. Select hybrids reported to have good stalk strength.
3. Monitor fields periodically during the growing season for disease development.
4. Consider crop rotation or plowing every few years to help curb the build-up of corn pathogens that could be increasing due to monoculture corn.
5. Seedsmen should not grow inbreds susceptible to leaf disease, or if grown, be prepared to manage leaf diseases with fungicides under reduced tillage systems.

Leaf Diseases

Leaf diseases vary in prevalence and severity from year to year and from one locality to another, depending largely on environmental conditions. Humid weather, along with heavy dew, favors the spread and development of leaf diseases caused by fungi. Leaf diseases can be found on corn grown in poor and rich soils, and soil fertility does not seem to affect these diseases as much as weather conditions, the genetic make-up of a hybrid, and tillage practices used by the grower. Corn leaf disease can be expected when minimum or no-tillage is employed. Growers using overhead irrigation should be more watchful for leaf disease development. Leaf diseases are commonly observed in fields located in valleys between ridges and lowland areas along streams and rivers. These field locations can have prolonged periods of high relative humidity and low or moderate temperatures that favor most leaf diseases of corn. If it is necessary for you to plant blight-susceptible hybrids, restrict their use to upland fields with good air drainage, where corn debris from the previous crop has been thoroughly covered by flowing, or where corn does not follow corn in the rotation.

Leaf Disease Control in Seed Production Fields with Fungicides

The increase in leaf diseases in recent years has necessitated control by use of protectant fungicides for seed producers. Northern leaf spot (NLS), rust, yellow leaf blight (YLB), northern corn leaf blight (NCLB) and eyespot severity can be effectively reduced by foliar fungicide applications. It is rarely economical for commercial corn producers to use fungicides for leaf disease control. However, this is not the case for seed corn producers, because inbreds can be very susceptible to leaf diseases. Early detection is the key for fungicides to be effective. Should any leaf disease threaten during the period between tasseling and dent (about 35 days), treatment may be economical. It usually is not practical to apply chemicals at earlier or late stages. Early detection is critical; fields of susceptible lines should be monitored on a weekly basis. Chocolate spot, a bacterial disease of occasional severity (where K levels are low), does not respond to fungicide treatment. Severe rust infection developed in certain hybrids and inbreds in recent years. Many inbreds are susceptible to NLS; subsequently, this disease is severe in many seed fields.

If possible, obtain a positive diagnosis of the disorder and consider the factors discussed below before initiating a spray program.

1. The susceptibility of the inbred to the disease or diseases which threaten.
2. The anticipated time of disease developments and severity. Several leaf disease development may occur at any time. Consequently, wet weather or continued heavy dews signal possible blight problems on fields already showing modest leaf spotting. If the blight has already invaded much of the leaf surface above the ear, the treatment benefits will be minimal.
3. Treatments cost versus expected benefit. Each treatment costs about $15 to $20 per acre for the chemical, wetting agent, and application, and at least two applications are needed and three or four may be required.
4. Availability of competent commercial applicators and equipment.

Disease Profiles

Anthracnose

Causal Organism

Anthracnose of corn is caused by the fungus *Colletotrichum graminicola.* This fungal pathogen infects corn, sorghum, wheat, barley oat, rye, and a large number of grasses. However, strains of *C. graminicola* that infect only one specific crop appear to be commonplace. *Colletotrichum graminicola* is a different species from other *Colletotrichum* species that cause anthracnose of other crops, such as alfalfa and soybean

Symptoms

Symptoms of anthracnose can appear on leaves, stalks, husks, earshanks, and kernels. Symptoms may appear at various stages of crop development and are influenced by hybrid or inbred susceptibility and the occurrence and duration of warm and humid weather conditions

The leaf disease phase starts as small, oval to elongate water-soaked spots that appear on leaves at any growth stage. Leaf lesions are semi-transparent and may originate on any part of the leaf blade. Spots may enlarge up to 1/4 to 1/2 inch long and become tan at the center with red to yellow-orange borders. Leaf symptoms progress from lower to upper leaves during the growing season and infected leaves wither and die late in the season.

Stalk symptoms may show as a top die-back four to six weeks after silking while lower portions of the plant will remain green. The upper two to three leaves may burn yellow or red and, in time, die and drop off. In some cases, the entire plant may die prematurely and later lodge, although this phase of anthracnose is often expressed later than top die-back.

Anthracnose develops more commonly on the lower sections of the stalk. External stalk symptoms appear after tasseling as narrow, vertical or oval, water-soaked lesions on the rind. Lesions progress from tan to black in color as stalks begin to mature. Lesions are typically shiny black linear streaks or blotches that appear on the lower portion of stalks. Internally, stalk tissues are decayed a dark brown to black color that is most prominent at nodes and progress each direction into the internodes. Stalk strength is reduced because of internal decay. However, pith tissues are not as disintegrated by C. graminicola in comparison to Gibberella and other stalk rotting fungi. Lodging due to the stalk rot phase of anthracnose is normally higher on the stalk when compared with other stalk rot diseases like *Gibberella* and Fusarium stalk rot.

Disease Cycle and Epidemiology

Stalk rot due to anthracnose has increased in prevalence and severity in Wisconsin corn fields. Anthracnose is no longer considered to be a minor disease in Wisconsin, and farmers and agricultural consultants should be familiar with symptoms and control strategies.

The anthracnose fungus survives in corn leaves and stalks that were diseased in previous years. The pathogen continues to colonize corn debris in the spring and summer. Spores produced on the infested debris are disseminated to corn plants by wind and rain. Spores are produced and germinate most readily during warm and humid weather conditions of leaves and/or stalks. Anthracnose is favored by warm temperatures (70-80°F) and extended periods of cloudy weather and high relative humidity. Frequent rainfall is important for dispersal of the anthracnose fungus. Foliage and stalk wetness are important for infection. Older tissues are more susceptible than younger tissues.

Infection of leaves can occur throughout the seasons, but stalk tissues after tasseling. Stalk rot followed by lodging is the most damaging aspect of ant anthracnose

Control

Cultural practices such as crop rotation and residue management are important control strategies. The removal, soil incorporation or destruction of infested corn debris will reduce the potential for anthracnose. Tillage systems that leave considerable amounts of anthracnose infected debris on the soil surface may lead to greater severity of anthracnose. Crop rotation to a non-host crop is an alternative management decision.

Corn hybrids differ in susceptibility to anthracnose. Resistance to the leaf blight phase is not always correlated with resistance to the stalk rot phase. Also, resistance or tolerance to other stalk rot diseases is not correlated with resistance to anthracnose. Selection of resistant hybrids may be more critical for fields where reduced tillage is used because of the greater potential for anthracnose. However, the anthracnose fungus reproduces abundantly and is readily disseminated by wind and rain; thus, anthracnose may develop readily in fields where corn debris from the previous year has been deeply incorporated into the soil.

Northern Corn Leaf Blight

Northern corn leaf blight was a serious leaf disease of corn in the 1950's and 60's. Corn hybrids at that time had little resistance and yields were greatly reduced by this foliar disease. Two forms of resistance were identified (race-specific and field resistance or tolerance) and incorporated into many corn hybrids which resulted in a reduced prevalence and severity of the disease. However, new races of the northern leaf blight fungus have been identified in Illinois, Indiana, Iowa and in Wisconsin. The increased severity observed in 1981 is possibly due to the timely arrival of inoculum, favorable weather conditions, hybrids with less than adequate field resistance (tolerance) and new races that can attack hybrids formerly resistant.

Causal Organism

Helminthosporium turcicum is the fungus responsible for northern corn leaf blight. Three races of the fungus exist, with their virulence depending on presence or absence of specific resistance genes.

Symptoms:Northern corn leaf blight lesions, caused by the fungus Helminthosporium turcicum, appear first on the lower leaves of the plant. Spots of either grayish-green or tan in necrotic tissue color are 1 - 7 inches in length and canoe-shaped and approximately 1/2 to 1 1/2 inches in width. The form of resistance, if present, will condition lesion size. Little death of leaf tissues occurs and sporulation of the pathogen is minimal. Under suitable conditions the disease progresses to the upper leaves. Severe infection causes death of foliar tissue that resembles frost of drought with its gray appearance. With the aid of a hand lens, spores can bee seen on the necrotic leaf tissue. Ears are not infected, but husks may display lesions. In cases influenced by what is known as HT1 gene condition the lesion takes the form of a long chlorotic linear streak-sometimes the entire length of the leaf.

Disease Cycle and Epidemiology

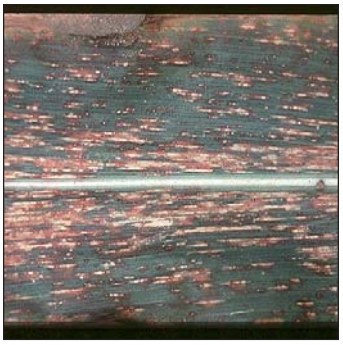
The fungus overwinters on infested debris of leaves, husks, and other plant parts. It may not survive where winter conditions are especially severe, but conidia (spores) can be wind-borne and transported from corn growing regions south of Wisconsin. Secondary infection occurs from spores produced on the lesions. Spores are spread by wind and rain within a field and from field to field.

Incidence of northern corn leaf blight is found in most humid areas wherever maize is grown. Temperatures from about 65 to 80°F with heavy dews or high relative humidity are optimal for disease development. Northern leaf blight may be more severe in low lying fields along waterways or fields located in deep valleys. Dry weather will retard the advance of the disease. Loss of grain yield up to 50% can occur if the disease becomes established early before silking. Yield losses will be minimal if disease infection is moderate or occurs six weeks after silking.

Control

Two types of resistance are available; single gene resistance (race-specific) and multigenic resistance (field resistance). Inbred lines may greatly differ in resistance or susceptibility. Chemical control may be economical for hybrid seed corn production when the female inbred is particularly susceptible. Currently, the northern leaf blight fungus is believed not to survive in Wisconsin during the winter months. Thus crop rotation or management of corn debris has little effect on northern leaf blight development. Selection of resistant hybrids is the best control for commercial production.

Northern Leaf Spot



Causal Organism

Helminthosporium carbonum is the fungus responsible for this disease.

Symptoms

This disease is also known as Helminthosporium Leaf Spot. Symptoms on leaves consist of narrow linear lesions 1/16 to 1/8 inch wide and up to 1 inch long, usually consisting of a row of circular lesions, giving a bead-like appearance. The fungus also affects sheaths, husks and ears. The ear can develop a black rot.

Epidemiology

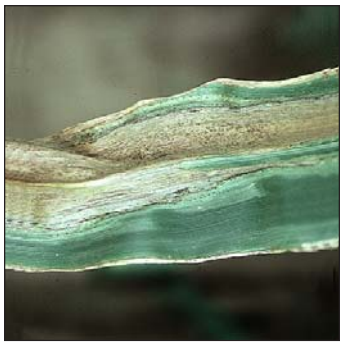
Its disease cycle is similar to that for the previously discussed diseases; the fungus overwinters in debris or on the ear. Secondary infection occurs with moderate temperatures and high relative humidity. Spore production is abundant in damp

weather. At present the severity of the disease has not reached economic proportions. With an increase of conservation tillage, the situation may become problematic. The disease has been a problem in seed production with highly susceptible inbreds.

Control

Clean plowing and crop rotation will help control the disease. Resistant hybrids exist, but are not well documented and advertised. Chemical control will only be economical for seed producers.

Goss' Bacterial Wilt and Blight



Causal Organism

Corynebacterium nebraskense is the causal bacterium.

Symptoms

As the common name of the disease indicates, the symptoms of Goss' wilt are expressed both as a wilt and a leaf blight. Lesions may occur on seedlings or older plants. Initial leaf symptoms consist of dark green to silver lesions with dark, water-soaked spots that resemble freckles and run parallel to leaf veins. The water-soaked spots develop into streaks with a greasy appearance. Yellow, grayish-green or purple streaks with irregular margins may also develop. With enlargement of the streaks, bacteria may actually exude from the diseased tissue. The exudate will be sticky when wet, will take on a crystalline appearance when dry, and will glisten in the light. As the streaks coalesce, lesions form and cover much of the leaf surface giving the foliage a scorched appearance. Systemically infected plants wilt and symptoms resemble those of drought stress. The vascular bundles will be discolored (yellow-brown to orange) and an orange bacterial exudate is extruded from the vascular elements when exposed in cross section. Stalks become weakened and discolored internally with a slimy yellow appearance.

Epidemiology

Goss' bacterial wilt and blight is a leaf and stalk disease of corn, which was initially reported in Nebraska. Goss' wilt was suspected in Wisconsin in 1980 and was confirmed in southern Wisconsin in 1981. Goss' wilt may reduce yield up to 50% and stalk rot phase may result in lodged stalks. Thus, the disease is considered potentially serious in Wisconsin and fields should be scouted for its presence.

The pathogen overwinters in infested debris on or near the soil surface. The bacterium is seed-borne, but the importance of infected seed is not well documented. Seed-borne inoculum is a means of introducing the bacterium into new areas or fields. Primary infection comes from bacteria that survive in infested corn debris from the previous crop. Wounds are necessary for the bacteria to penetrate the plant tissue. Wind blown sand, hail, pelting rain, and wind can cause abrasions that allow the bacteria to enter and become established within the tissue. Bacteria are spread from plant to plant by wind, driven rain or irrigation water. In addition, the Goss' wilt bacterium may by spread by farm implements that come in contact with diseased plants, especially if plants are wet. Insects are not believed to play a role in disease development. Spread of this bacterium is not completely understood, but it apparently is spread from one geographic area to another through infected seed. Field to field spread probably occurs through movement of infested debris on tillage or harvest equipment.

Control

The burial of corn debris by deep plowing reduces the primary source of Goss' wilt bacterium. Thus, tillage practices that leave corn debris on the soil surface may lead to greater disease severity once the pathogen is introduced. Crop rotation will also aid in control. However, grass weeds such as foxtail, barnyard grass and shattercane are also hosts and are commonly present in the vicinity of most corn fields. Corn hybrids differ in susceptibility to Goss' wilt. Resistant or less susceptible hybrids should be considered for control of Goss' wilt when it occurs. Consult with your local seed dealer for information on hybrid susceptibility to Goss' wilt.

Gilbberella & Fusarium Stalk Rot

Stalk rot causes substantial losses each year through early plant kill and/or pre-harvest stalk-lodging. It causes premature death of some plants, fermenting or rotting stalks, and discolored pith that weakens the stalk. Stalk rot is caused by a complex of fungal organisms that are particularly damaging to plants subjected to stress during the growing season. High soil moisture in the month of August appears to favor root infection of Pythium spp. This fungal infection leads to early plant death and subsequent stalk rot. Small ears and lodging are often the result of the early plant kill phase of the stalk rot disease.

Complete control is difficult for stalk rot, but you can take several steps to reduce the problem; (1) select hybrids that stand the best under your system of farming; (2) maintain a high level of potassium in accordance with soil test recommendations; (3) control leaf diseases, for they cause premature leaf death which leads to greater susceptibility to stalk rot; (4) grow full season corn hybrids where possible, as early maturing hybrids generally suffer more from stalk rot; (5) harvest as early as practical to prevent greater losses from stalk-lodging; (6) consider other methods of keeping the plant free from stress during the growing season, such as controlling leaf feeding insects and borers, and irritating during drought conditions where possible. Also, avoid unprofitably high plant populations and excessive applications of nitrogen, as both of these stresses increase stalk rot severity.

The nitrogen stabilizer nitropyrin (N-SERVE) reduces incidence and severity of stalk rot in some tests. If you are considering using N-SERVE, the potential for reduced stalk rot and, subsequently, less stalk-lodging may be another benefit, along with reduced loss of nitrogen through leaching action in the soil.

Ear Rot

Corn is susceptible to several ear-rotting fungi that reduce yield, quality, and feeding value of the grain. Many of these fungi are capable of producing mycotoxins that affect animal health. Gilbberella and Fusarium ear rot are the most common ear rot diseases in Wisconsin. The prevalence and severity of ear rot is associated with: (1) above normal rainfall in July through October; (2) insect feeding on ears; (3) severity of leaf diseases; and (4) hail injury to ear.

The following suggestions may help control corn ear rots:

1. Corn hybrids differ in susceptibility. Ears that are well covered by husks and those that mature in a reclining position have less rot that ears with open husks or those that mature upright. Hybrids that are susceptible to leaf diseases may have more ear rot. Full-season hybrids have fewer ear rot problems compared to early maturing hybrids.
2. Control corn earworms and corn borers where practical.
3. Harvest early.

Consider the following strategies when ear rots are prevalent:

1. Harvest early; the chance of mycotoxin production is less early in the harvest season.
2. Harvest as shelled corn or silage. The fungi associated with ear rots will cease activity in corn lower than 20% moisture content and will not survive activities of fermentation in the silo. Problems will continue if stored as cribbed ear corn.

Many fungi that cause ear rots also produce mycotoxins in the grain that are harmful if fed to livestock. The fungus that causes Gilbberella ear rot produces mycotoxins that cause reproductive problems in swine. It also produces a mycotoxin called a refusal factor. If the refusal factor is present, swine will not eat the grain.

Seed Rot & Seedling Blights

Fungicide seed protectants generally control or minimize seed rot and seedling blights of corn. However, seed rot and seedling blight can be expected if corn is planted in wet and cool soils. Hybrids that have good seedling visor are generally less susceptible to seed rot and seedling blights. Reduced stands and stunted and/or dying seedlings are the main symptoms to watch for. Often infected seedlings may develop into a mature plant, but the same disease organism can cause root rot and stalk rot later in the life of a plant. Because injury from herbicides, insecticides, starter fertilizer, and soil insects can cause similar symptoms and results, accurate diagnosis of the problem is important.

Corn Nematodes

Nematodes are microscopic roundworms that reside in many environments including soil. Soil inhabiting nematodes may be parasitic on man, animals, plants or non-parasitic (free-living) and feed on organic matter or soil microorganisms. Plant parasitic nematodes obtain nutrients by feeding of living plant tissues, usually roots. Species of plant parasitic nematodes can feed on a wide range of plants or can be very host specific. Plant-parasitic nematodes obtain nutrients by feeding off living plant tissues, usually roots. Species of plant parasitic nematodes can feed on a wide range of plants or can be very host specific. Plant-parasitic nematodes lower plant productivity by extracting nutrients from the plant, disrupting nutrient and water uptake by roots, root structure is disrupted by the physical presence of the nematodes, and nematode feeding provides wounds for other disease organisms to enter roots and cause decay.

Nematodes reproduce by eggs. The eggs hatch and three larval stages are present before developing into mature adults. The life cycle, from egg to egg may be completed in 3 to 4 weeks depending on environmental conditions, susceptibility of the hose and nematode species.

Nematodes Associated with Corn

The lesion (*Pratylenchus*), needle (*Longidorus*), stunt (Tylenchoryhncus), stubby root (Trichodorus), Lance (Hoplolaimus), and dagger (Xiphinema) nematodes have been found to be associated with corn in Wisconsin. Every cornfield in Wisconsin may be infested with one or more of these types of nematodes, but not all fields have populations that may reduce yield.

Soil and root assays have revealed nematode populations capable of reducing corn yields 5-35 bushels/acre in Wisconsin. There seems to be some relationship with soil types. More economic problems with nematodes have been observed on sandy compared to clay soils. Crop rotation does not appear to have much effect on soil populations of the lesion, stunt, lance, and dagger nematodes because they infect many other crops besides corn.

There are indications that higher nematode populations build-up in reduced tillage fields compared to fields tilled with a moldboard plow. Moldboard flowing brings roots to the surface, exposing them to the elements and also diluting the nematode populations throughout the soil profile.

Symptoms of Nematode Injury

Because of the nonspecific nature of above-ground symptoms, plant damage by nematodes is often blamed on weather, local soil conditions, nutritional deficiencies, injury by agricultural chemicals, insects or other disease causing organisms. In addition, plant symptoms associated with low-level yield losses are often not visible unless concentrated in one part of the field. In such cases, the only visible symptom is the lower-than-expected yield of the field. Nematodes do not kill plants except in very unusual circumstances. Above

ground symptoms are usually due to nematode injury to the roots.

Early Season Above-Ground Symptoms

1. Look for irregular areas of stunted corn. Patches may involve a few square yards up to several acres.
2. Nutrient deficiency symptoms such as phosphorus (purple leaves) manganese or zinc (leaf strippings) may be the result of nematode feeding.
3. Height variation can be seen when plants are waist high to tasseling. Nematode damaged areas may tassel a few days later than healthy plants.

Late Season Above-Ground Symptoms

1. Later in the season, nitrogen and potassium deficiency symptoms may appear.
2. Curling of the leaves, associated with drought stress, often will occur during hot afternoons and is one of the most common nematode symptoms on lighter soils.
3. Other above-ground symptoms to look for include small ears with poor grain fill and low yields over the entire field or in the localized areas in the field.
4. Stall lodging or stalk rot may be associated with nematode damage.
5. In general, nematode feeding may enhance the effects of medium to low soil fertility, low soil moisture, soil compaction, and other non-living causes of poor plant growth. Plants can tolerate nematode feeding if the conditions are optional for plant growth.

Root Symptoms

Normally, the root mass of a corn plant is fan or broom shaped in cross section, with many fibrous secondary roots off the main roots.

Root injury caused by nematodes:

1. Stubbing of roots, numerous short and stubby roots, often arranged in clusters. Root injury by dinitroanaline herbicides can cause a similar symptom.
2. Few fine feeder roots. Fine feeders are necrotic.
3. Smooth sections of main roots, few feeder roots, possible root lesions and rotted sections of roots.

Root damage by corn rootworms may also be involved from June until the crop matures. Damage by rootworm larvae is identified as grooves or tunnels, either on the surface or within the root. Nematodes never leave visible feeding areas that give the appearance the tissues have been consumed.
Nematode damage often is related to the growing conditions of the plant. A corn plant that is stressed by poor fertility or lack of moisture cannot withstand an additional stress of nematode feeding. Plants growing with adequate moisture and fertilizer are more likely to compensate for nematode feeding by producing new roots. However, when the nematode population is too high, even vigorously-growing plants will eventually show symptoms of unthriftiness.

Sampling for Corn Nematodes

A nematode assay can be used in two ways: 1) to confirm a suspected nematodes problem or 2) to eliminate nematodes as one of several possible causes of poor plant growth.
The best results are obtained when soil and root samples are taken 6 to 10 weeks after planting. Nematode populations at this time appear to correlate best with grain yield. However, late summer or fall samples can also be useful in predicting next year's problems.
Nematode damage to corn often appears in circular or oval pockets in the field. Rarely does an entire field show symptoms. Sample the suspected areas.
There are several ways to take a soil sample for nematode analysis. The following is a general guide.
1. Use a soil probe or narrow-bladed trowel or shovel. Take samples close to plants and to a depth of 8 to 10 inches. Discard the upper 2 inches of soil, especially if it is dry. Be sure to include plant roots.
2. One sample is adequate per 10 acre field or suspected area within the field. Sample soil and roots from 10 plants and mix into one composite sample-2 pints of soil is adequate. Sample from plants in the margins of suspected areas and not from their centers.
3. Place samples in sturdy plastic bags and fasten the open end securely and accurately label samples. Keep the samples from becoming overheated. Mail samples early in the week to avoid delays in transit.

Interpreting Results of Nematode Soil Analysis

Laboratories will report the number of nematodes per pint of soil (500 cc), per 100 cc of soil, or nematodes per gram of dry root. Each laboratory has its own damage thresholds for individual nematode species. However, each laboratory will give an assessment regarding the possibility of economic damage .
Corn growers can utilize reports on soil and root test and field strip tests using effective nematicides compared to no treatment to determine if nematodes are reducing corn yields on their farms. If rootworms are present in a field, a strip test should include an effective insecticide/nematicide compared to a product that gives only rootworm control, but not nematode control.
Factors that influence economic thresholds for plant-parasitic nematodes are time of year or stage of crop development when the sample was taken and soil type.

Corn Nematode Control

If economic populations of nematodes are detected, corn growers can employ these control recommendations.
1. Chemical control: Several insecticides/nematicides are registered for nematode control on corn. Mocap 20G, and Counter 15G are registered for nematode control on corn.

Follow the label for rate and method of application. Many corn rootworm insecticides are effective against rootworms but not nematodes.

2. Maintain high soil fertility. Nutrient deficient plants are more susceptible to nematode injury.

3. Crop rotation may be of value, but little is Known about the susceptibility of other crops.

4. Practice good weed control. Many weeds are good hosts for corn nematodes and will help maintain or even increase nematode populations.

Gray Leaf Spot

Causal Organism

Cercospora zeae-maydis and *Cercospora* sorghi var. *maydis* are two closely related fungi that can cause gray leaf spot. *C. zeae-maydis* is the more common cause of the disease in the USA.

Symptoms:

In contrast to most leaf spots that have circular or ellipsoidal lesions, lesions of gray leaf spot tend to be long (3/16 to 2 inches) and rectangular, and are typically restricted by veins of the leaf. Lesions are pale brown, gray or tan, and are opaque. When the disease is severe, individual lesions may merge, the entire leaf may die and total defoliation of the plant is possible. Weakening of plants due to gray leaf spot may result in lodging.

Epidemiology:

The disease cycle of gray leaf spot is similar to those of other corn leaf spot diseases. The fungus overwinters in corn debris and thus the disease tends to be most prevalent where continuous corn is produced and no-till practices are used. The causal fungus tends to be favored by higher temperatures and thus gray leaf spot is more common in the southern USA. However, reports of the disease have recently increased in the upper mid-west, perhaps due to the increased use of no-till practices.

Control:

Clean plowing and crop rotation will help control this disease. Resistant hybrids are available and should be used when available and the potential for the disease is high. Chemical control is also possible, although likely only to be economical for seed corn production.