NORTH CAROLINA

Soybean Scouting and Field Guide

SOYBEAN

NORTH CAROLINA SOYBEAN PRODUCERS ASSOCIATION, INC.

OUR SOY CHECKOFF℠

NC STATE

The mission of the North Carolina Soybean Producers Association (NCSPA) is to maximize the profitability of N.C.'s soybean farmers in an economically and environmentally sound manner. The volunteer farmer-leaders who serve on the NCSPA board of directors invest your checkoff dollars in research to improve soybean production practices to make your farm more profitable and ensure the sustainability of N.C. soybean production.

This guide outlines scouting practices, common pests and other issues in N.C. soybeans. Use this information to help identify and treat problems in the field. This guide is not meant to replace the expertise of an agronomist or crop consultant and should be used only as a reference.

Contributions and technical editing for this guide were provided by:

Katherine Drake Stowe, Ph.D., *North Carolina Soybean Producers Association Research Coordinator*

Carl Crozier, Ph.D., *North Carolina State University Extension Soil Science Specialist*

Jim Dunphy, Ph.D., *North Carolina State University Extension Soybean Specialist*

Wesley Everman, Ph.D., *North Carolina State University Extension Weed Specialist*

Dominic Reisig, Ph.D., *North Carolina State University Extension Entomology Specialist*

Lindsey Thiessen, Ph.D., *North Carolina State University Extension Plant Pathologist*

BOARD OF DIRECTORS:

President
Jeff Peed, Aurora

Vice President
John Fleming, Scotland Neck

Secretary
Jeff Tyson, Nashville

Treasurer
Bernard Lennon, Evergreen

USB Director
Jacob Parker, Columbia

ASA Director
Wyatt Whitford, Ernul

Justin Allen, Pantego
Kenneth Bartlett, LaGrange
Mart Benson, Pantego
Isaac Boerema, Pantego
Jessica Burgess, Eure
Ryan Cahoon, Fairfield
Elbert Dixon, Maury
Sydney Dunn, Edenton
Curtis Furr, Albemarle
David Heath, Dover
Gary Hendrix, Raeford
Lance Herndon, Parkton
Chris Hester, Bladenboro
Bob Hyman, Oak City
Bryant Jennings, Camden
Wesley Johnson, Dobson
Ryan Kennedy, Hope Mills
Greg Manning, Nashville
Dan McDuffie, Waccamaw
Michael McPherson, Mebane
Ben Moses, Conway
Christopher Naylor, Clinton
Cody Paul, Bayboro
Shane Revelle, Murfreesboro
Craig Seaman, Manson
Christopher Seymour, Kinston
Philip Sloop, Mt. Ulla
Jason Starnes, Salisbury
Reggie Strickland, Mt. Olive
Logan Watson, Monroe
Simmy Williams, Shiloh

NORTH CAROLINA SOYBEAN PRODUCERS ASSOCIATION
211 E Six Forks Rd
Suite 102
Raleigh, NC 27609
www.ncsoy.org

TABLE OF CONTENTS

INTRODUCTION TO SCOUTING

The genetic potential of the soybean variety grown and how those plants interact with the environment both have a large influence on soybean growth, development and ultimately yield. Growers must understand how soybeans respond to production practices and how to properly manage pests to increase yields and reduce costs.

Scouting is the best way to know which pests and problems are in your field and if they threaten yields and profits. The use of proper scouting procedures and knowledge of economic thresholds ensures farmers use pesticides properly to obtain the maximum return on investment.

HOW TO SCOUT:

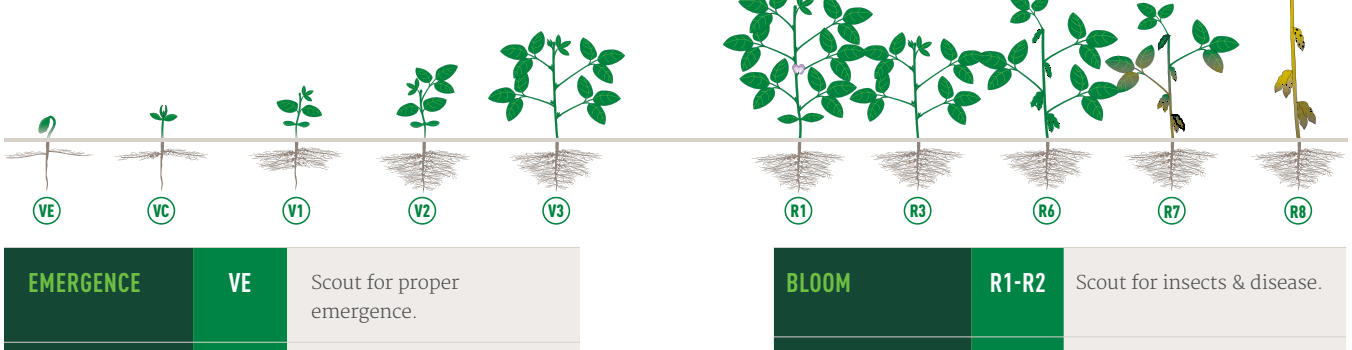
- Start at a different point each week. Walk a random pattern. Don't consciously pick out good or bad spots.
- Many pest problems begin at field edges. Walk to within 30 feet of every border. If a problem is found, try to find out whether it is isolated or widespread.
- As samples are taken, look at plants around the sample site. Scan the field while walking from one site to the next.
- If you find insects or weeds you don't recognize, consult your county extension personnel or another expert.

3 KEYS TO INTEGRATED PEST MANAGEMENT

1. Scout regularly and systematically.
2. Treat only when a pest population reaches a profit-threatening economic threshold.
3. When control is needed, apply the labeled rate with properly calibrated equipment.

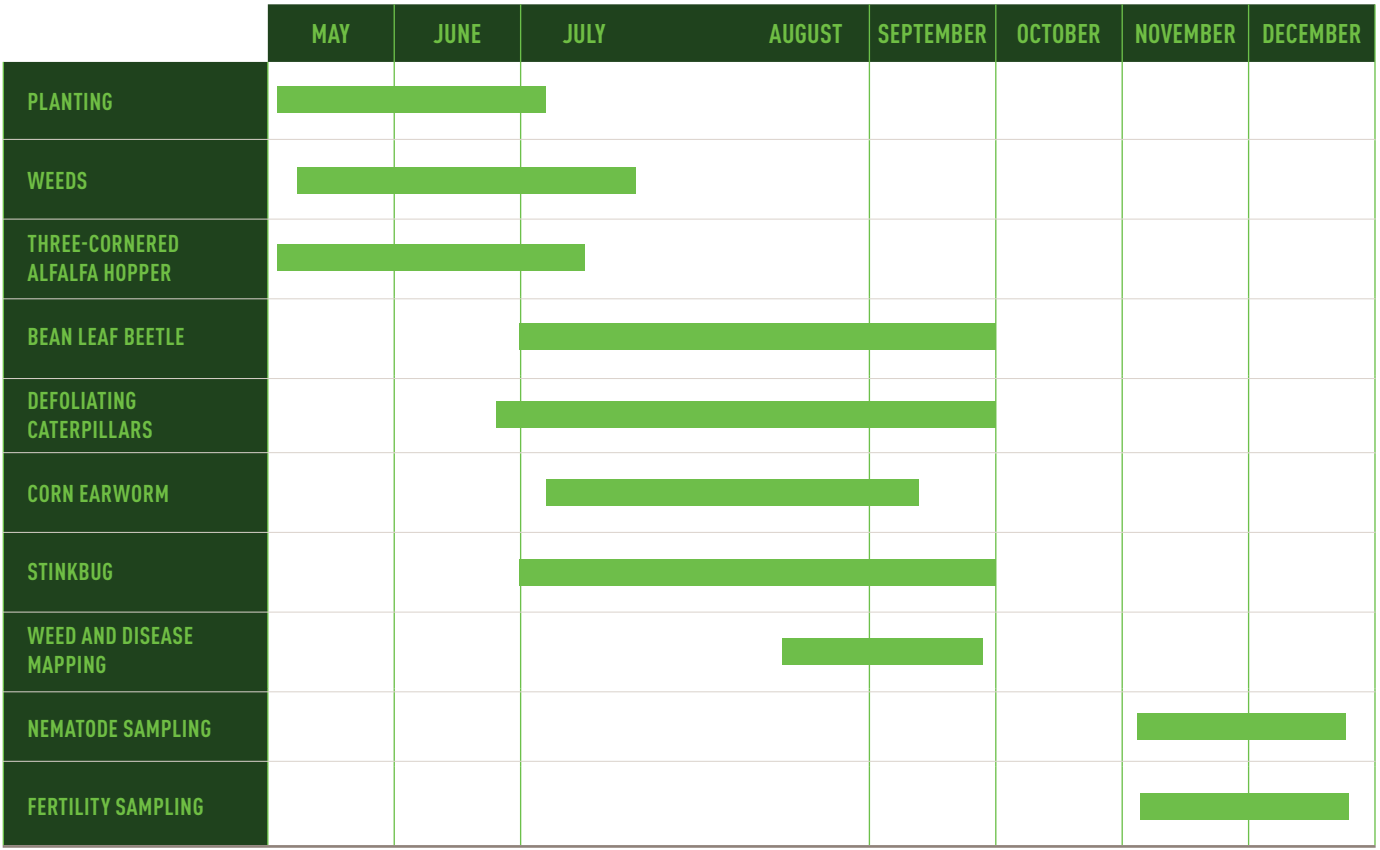
LOOK FOR PATTERNS

- Problems in high or low spots may be related to soil conditions
- Problems on only one side of the field may be related to spray drift or an invasion from a field border
- Problems in isolated plants may indicate root or stem rot
- Problem areas with sharply defined edges may indicate nematode injury



EMERGENCE	VE	Scout for proper emergence.
COTYLEDONS EXPAND	VC	Check final stand & uniformity. If poor stand, replanting may be needed.
FIRST TRIFOLIATE	V1	Scout for early-season weeds, insects and diseases.
SECOND TRIFOLIATE	V2	If needed, apply postemergence herbicides, check for nodulation.
N-TH TRIFOLIATE	V (N)	Continue scouting for weeds, insects and diseases; apply postemergence herbicides and pesticides as needed.
BLOOM	R1-R2	Scout for insects & disease.
POD DEVELOPMENT	R3-R4	Scout for insects and diseases. Late-season disease or insect damage from pod feeders can lower yields.
SEED DEVELOPMENT	R5-R6	Continue scouting for late-season insects and disease.
MATURITY	R7-R8	If stalks are still green, harvest slowly & make sure the harvesting equipment is sharp & in excellent operating condition.

*Adapted from Soybean Growth and Development chart, a collaboration by Kansas Soybean Commission, Kansas State University, and the United Soybean Board.



*Adapted from Integrated Pest Management Soybean Scouting Manual, NCSU.

Planting dates in N.C. are largely dependent on the harvest of the previous crop in the rotation, thus practical planting dates vary greatly from farm to farm. Soybeans are planted from May 1 to July 20, with most of the planting occurring from May 20 to June 30. Maturity group choice is largely dependent on planting date. In addition, planting date should be based on seedbed conditions and the weather forecast. Planting after July 1 reduces growth, branching, nitrogen fixation and yield. May-planted soybeans typically out-yield July-planted soybeans by more than 20% in N.C.

MATURITY GROUP	OPTIMUM PLANTING DATES
IV	May 5-May 25
V	May 5-June 5
VI	May 5-June 10
VII	May 5-June 15

Soybeans have a unique ability to compensate for low stands and produce similar yields across a wide range of plant populations. Aim for a final stand between 85,000 to 125,000 plants per acre. Actual seeding rates should be increased to compensate for germination, soil temperature and seedbed conditions, and are typically 120,000 to 180,000 seeds per acre. Late-planted soybeans should be planted at a higher density than early-planted soybeans.

		MAY PLANTING		JULY PLANTING	
Row Spacing (in.)	Row Feet/ Acre	Seeds/ Row Ft.	Plants/ Row Ft.	Seeds/ Row Ft.	Plants/ Row Ft.
36	14,520	7.8	7	13.3	12
30	17,424	7.1	6.4	11.2	10.1
20	26,146	5.4	4.9	7.7	6.9
15	34,484	4.3	3.9	5.9	5.3
7	74,674	2.2	2	2.8	2.5

Replant decisions should be based on accurate stand counts from 10 randomly selected areas of the field, replanting date, maturity group and true cost of replanting. In general, stands greater than 70,000 healthy, uniformly spaced plants one month after planting are worth keeping.

SYMPTOM	POSSIBLE CAUSES
SEEDLING SYMPTOMS:	
Seedlings don't emerge	Low seed quality, root rots, certain chemicals, crusting, deep planting depth
Seedling death	Root and stem rots, chemicals (such as metribuzin, linuron and atrazine) that inhibit photosynthesis
LEAF SYMPTOMS:	
Misshapen leaves	Chemical, virus infection or thrips
Leaves yellow from edges	Potassium deficiency
Leaves yellow, veins green	Manganese deficiency
Bronze leaves	Virus, thrips or Cercospora leaf blight
Holes in leaves	Foliage-feeding insects or hail damage
Spotted leaves (or stems)	Diseases or tiny insects, such as thrips
Leaf yellowing spreads quickly from top; poor nodulation	Symptoms of bacterial chlorosis look like a combination of manganese and potassium deficiencies (very distinctive condition but not common in N.C.), or may be caused by cyst nematodes or nodule fly
Light-colored leaves or yellowish plants	Nitrogen and sulfur deficiencies (N deficiencies may be caused by a number of problems, including Columbia lance and cyst nematode)

SYMPTOM	POSSIBLE CAUSES
WHOLE PLANT SYMPTOMS:	
Twisted plants	Chemical damage (frequently from phenoxy herbicide)
Broken plants	Stem-feeding insects
Poor growth	Poor growing conditions, nematodes, drainage problems, dry weather or insects
Stunted plants	Viruses, nematodes or chemical damage
POD SYMPTOMS:	
Absence of pods or seeds	Poor growing conditions earlier in season, pod-feeding insects, some viruses, translocated chemicals
ROOT SYMPTOMS:	
Stunted plants	Soil compaction or hardpan, root rots, nematodes, insects or chemical damage
Cysts on small roots	Usually caused by soybean cyst nematode
Galls on roots	Usually caused by root-knot nematode
Limited nodulation	Lack of rhizobia, low pH, molybdenum deficiency, insect injury, nematodes, inadequate fertility

*Adapted from Integrated Pest Management Soybean Scouting Manual, NCSU.

WEED CONTROL

The key to weed management is the correct identification and treatment of weeds while they are small, combined with a diversified plan for control. A good weed-management plan involves field scouting to determine the size and species present. By understanding what is present in a field, treatment decisions can be made to protect crops from weed competition and prevent selection of herbicide-resistant weeds. If weeds can be effectively managed until the middles are lapped between rows, soybeans can typically compete well with weeds that emerge later in the season. Scouting should also occur after a herbicide application to effectively identify escapes and possible resistant individuals.

A successful weed-control program should include both pre- and post-emergence herbicides with overlapping residuals, rotation of crop sequences and rotation of herbicides with different modes of action.

COMMON COCKLEBUR

CLASSIFICATION:

Asteraceae (sunflower) family. Summer annual.

DESCRIPTION:

Height: Up to seven feet tall.

Leaves: Thick, waxy, ovate cotyledons. The first true leaves are opposite while later leaves are alternate. Leaves feel like sandpaper, are triangular in shape, have serrated edges and have three prominent veins arising from the same point.

Stems: Erect and branched, with dark spots and short, stiff hairs.

Flowers: Inconspicuous, green flowers occur in clusters in leaf axils and at the ends of stems. Fruit is encased in an egg-shaped, brown bristly burr with two chambers.

MANAGEMENT CONSIDERATIONS:

Common cocklebur is very competitive and germinates from deep in the soil. Control with an ALS, PPO or PSII-inhibiting herbicide, pre-emergence is ideal. Glyphosate and glufosinate are effective post-emergence options in soybeans.

Photo credit: John D. Byrd, Mississippi State University, Bugwood.org

Photo credit: David J. Moorhead, University of Georgia, Bugwood.org

HORSEWEED *(marestail)*

CLASSIFICATION:

Asteraceae (sunflower) family. Emerges from March through November, so considered both a winter and summer annual.

DESCRIPTION:

Height: One to nine feet tall.

Leaves: Alternate and crowded along the stem with simple blades.

Stems: Erect, simple, with stiff hairs. Branched above the inflorescence.

Flowers: Small white, pink or yellow disc flowers.

MANAGEMENT CONSIDERATIONS:

Horseweed can germinate nine months out of the year and be a challenge to control. Once it begins flowering, it becomes very difficult to control with post-emergence herbicides, so treat when the weed is small, typically with an effective burndown program. Deep tillage can help combat horseweed.

Photo credit: www.mississippi-crops.com

MORNING GLORY SPECIES

CLASSIFICATION:

Convolvulacea (morning glory) family. Annual.

DESCRIPTION:

Height: Vine up to six feet long.

Leaves: Butterfly-shaped cotyledons. Alternate ivy- or heart-shaped leaves up to four inches long/wide. Depending on the species, leaves may have few hairs or be densely pubescent.

Stems: Climbing, hairy vines.

Flowers: Multicolored, funnel-shaped flowers with colors including red, blue, purple, white and variegated.

MANAGEMENT CONSIDERATIONS:

The vining/climbing nature makes this a difficult weed to control. Control with glyphosate, glufosinate, ALS inhibitors or PPO inhibitors is ideal when plants are four leaves or smaller and have not developed runners. Once runners develop, control is greatest with cloransulam (FirstRate) or flumiclorac (Resource).

Photo credit: John D. Byrd, Mississippi State University, Bugwood.org

PALMER AMARANTH

CLASSIFICATION:

Amaranthaceae (pigweed) family. Annual.

DESCRIPTION:

Height: Up to eight feet tall.

Leaves: Alternate, ovate-shaped, hairless leaves with long petioles, prominent veins and a white V-shaped watermark.

Stems: Erect, branched and hairless. May be tinged red.

Flowers: Arranged in thick spikes. Male and female flowers are produced on separate plants. Male flowers have soft, thin, triangular bracts that shed pollen. Female flowers have bristly, stiff, sharp bracts.

MANAGEMENT CONSIDERATIONS:

This is the biggest weed problem in N.C. as it has developed resistance to glyphosate as well as both ALS and PPO-inhibiting herbicides. Combat with multiple modes of action and supplement herbicide control with hand weeding, if needed. A single plant can produce a million seeds so take all measures to prevent these weeds from going to seed.

Photo credit: Bruce Ackley, The Ohio State University, Bugwood.org

Photo credit: Take Action On Weeds

COMMON RAGWEED

CLASSIFICATION:

Asteraceae (sunflower) family. Annual.

DESCRIPTION:

Height: Up to three feet tall.

Leaves: Thick, oblong cotyledons. Lacey, finely divided and slightly hairy leaves up to four inches long. Lower leaves are alternate while upper leaves are opposite.

Stems: Erect, branched and hairy.

Flowers: Greenish-yellow flowers about 1/8-inch long. Male flowers are produced in racemes at the end of stems and female flowers are produced in the upper leaf axils.

MANAGEMENT CONSIDERATIONS:

Ragweed is very competitive. Resistance to glyphosate as well as the ALS and PPO inhibitors has been documented in N.C. Residual herbicides are critical for early-season control of common ragweed. PPO inhibitors, ALS inhibitors and PSII inhibitors, such as metribuzin and linuron, should be considered where infestations occur. Combat with effective pre-emergence herbicides followed with effective post-emergence herbicides.

Photo credit: Ohio State Weed Lab, The Ohio State University, Bugwood.org

Photo credit: Take Action On Weeds

SICKLEPOD

CLASSIFICATION:

Fabaceae (bean/pea) family. Annual.

DESCRIPTION:

Height: One to six feet tall.

Leaves: Rounded cotyledons with three to five distinct veins. Alternate leaves with four to six egg-shaped leaflets.

Stems: Erect, branched and hairless.

Flowers: Distinctive yellow petals that arise from the leaf axils. Seeds are housed in long, sickle-shaped hairless pods.

MANAGEMENT CONSIDERATIONS:

The critical time to control sicklepod is the first four weeks after planting. Seeds can be an issue when harvesting so manage escapes before plants go to seed.

Photo credit: James H. Miller & Ted Bodner, Southern Weed Science Society, Bugwood.org

Photo credit: Rebekah D. Wallace, University of Georgia, Bugwood.org

BROADLEAF SIGNALGRASS

CLASSIFICATION:

Poaceae (grass) family. Semi-prostrate summer annual.

DESCRIPTION:

Height: Up to three feet tall.

Leaves: Seedlings have hairless blades that may be maroon-tinged with hairy, maroon-tinged sheaths. True leaves are short, wide, hairless blades that are rolled in the bud. Margins, collar, ligule and sheaths are hairy.

Flowers: Slender, 12-inch-long seedhead with two to six smaller branches. Spikelets are somewhat flattened.

MANAGEMENT CONSIDERATIONS:

Emerges from April through July, making it difficult to manage. Control with both a pre-emergence and post-emergence application.

Photo credit: www.mississippi-crops.com

ITALIAN RYEGRASS

CLASSIFICATION:

Poaceae (grass) family. Annual.

DESCRIPTION:

Height: One to three feet tall.

Leaves: Seedlings have shiny leaves. True leaves are flat, glossy, hairless blades that range from two to 10 inches long. Leaves are rolled in the bud and ligules are membranous. Auricles are usually well-developed but sometimes lacking.

Flowers: Small, stalkless spikelets alternate along the three- to 12-inch-long main flowering stem. Needlelike awns, or bristles, are on the individual flowers.

MANAGEMENT CONSIDERATIONS:

The best time to control ryegrass is in the fall with tillage or herbicides. If plants emerge in the spring, treat when plants are small as larger plants become difficult to control because of profuse vegetative growth and a dense root system.

Photo credit: www.mississippi-crops.com

Photo credit: Take Action On Weeds

TEXAS MILLET
(Texas panicum)

CLASSIFICATION:

Poaceae (grass) family. Spreading summer annual.

DESCRIPTION:

Height: May be erect and reach up to two feet tall or grow close to the ground.

Leaves: Seedlings have soft hairs that cover sheaths and blades, and the first leaves are relatively broad for a grass. True leaves are pale or yellowish-green, velvety, hairy leaves that extend to leaf sheaths and nodes. Auricles are absent and ligule is membranous with a fringe of hairs.

Flowers: Simple, narrow-spike seedhead up to 10 inches long. Each spike has two rows of spikelets.

MANAGEMENT CONSIDERATIONS:

Texas millet germinates late in the season. Residual herbicides applied with post-emergence applications will provide the greatest control.

Photo credit: www.mississippi-crops.com

Photo credit: Rebekah D. Wallace, University of Georgia, Bugwood.org

YELLOW NUTSEDGE

CLASSIFICATION:

Cyperaceae (sedge) family. Perennial.

DESCRIPTION:

Height: Up to two feet tall.

Leaves: Shiny, green and hairless with a noticeable ridge along the mid-vein. Leaves occur in groups of three from the base of the plant.

Stem: Three-sided, erect and unbranched.

Flowers: Yellow or brown spikelets that occur at the ends of the stem in a cluster.

MANAGEMENT CONSIDERATIONS:

Nutsedge is hard to control because it emerges from tubers throughout the growing season. Tillage will only temporarily disrupt the tubers. Glyphosate provides only marginal control. Basagran is an effective option for control.

Photo credit: Jeff Stachler, The Ohio State University, Bugwood.org

Photo credit: Ohio State Weed Lab, The Ohio State University, Bugwood.org

DISEASE MANAGEMENT

There are several diseases that can cause significant yield loss to soybeans in N.C. Each time a field is scouted for weeds or insects, it should also be scouted for disease. Stunted or discolored plants are indicators that a plant may be infected with a fungus, virus or nematodes (bacteria typically don't cause diseases of economic importance in N.C.).

Identifying diseases caused by viruses, fungi or nematodes is essential. Without treatment, these organisms may persist in the soil and infect future soybean (or other) crops. Understanding disease development in the current season is the best way to plan prevention for future years.

Most fungal diseases can be managed with crop rotation, tillage, resistant varieties and foliar fungicides. Foliar fungicides should only be used when susceptible varieties are being grown and weather conditions are conducive to disease development (humid or wet weather). The return on investment of a fungicide application depends on the potential yield of the crop, price of grain and cost of the treatment.

Nematodes are probably the most serious disease problem in N.C. soybeans. The best way to detect nematodes is through soil assay following harvest. Nematode damage can be detected by routine scouting. Look for areas in the field where plants are stunted or off-color. Six species of nematodes are of economic importance to N.C., yet only two are easily identifiable in the field – soybean cyst nematode and root-knot nematode. The others – sting, Columbia lance, lesion and reniform – all must be identified through a soil test.

Photo credit: United Soybean Board

ROOT-KNOT NEMATODES *(RKN)*

DESCRIPTION:

There are three species of RKNs in N.C. – southern, peanut and northern. All cause galls (abnormal enlargements) of the roots. The size and shape of the gall varies with which RKN species are present as well as the soybean variety. Typically, a soil test is needed to distinguish one species from another. If large numbers of RKN are present following a corn crop, often the southern or peanut RKN is present. If high numbers follow a peanut crop, often it is the peanut or northern RKN that is prevalent.

DAMAGE:

Areas of depressed growth with nonuniform stunting of plants appear. Severely infected plants may be chlorotic.

SCOUTING TIPS:

Damage will typically appear first in low-yielding areas.

Photo credit: Edward Sikora, Auburn University, Bugwood.org

SOYBEAN CYST NEMATODE *(SCN)*

DESCRIPTION:

SCN develop very small (less than 1 mm) white to yellow cysts on the root system. These cysts are much smaller than Bradyrhizobium root nodules.

DAMAGE:

Irregular patches of stunted and/or yellow soybeans and an up-and-down growth pattern will appear. Buildup of SCN in a field will result in a slow decline in yield over several years.

SCOUTING TIPS:

Damage tends to be greater in early-planted beans. SCN may first appear in high-pH spots or lower-yielding areas.

Photo credit: Paul Bachi, University of Kentucky Research and Education Center, Bugwood.org

Foliar disease can affect crop production in many different ways, including reduction in photosynthesis, early senescence and yield reduction.

ASIATIC SOYBEAN RUST

DESCRIPTION:

Superficial, angular, tan to reddish-brown lesions can develop on the underside of leaves. Lesions contain rust pustules, which are raised on the surface.

ENVIRONMENT:

Spores infect at temperatures of 45 to 83 degrees. Leaves must be wet for infection to occur.

SCOUTING TIPS:

Soybean rust has not been a big problem in N.C., but it has the potential to be damaging. Keep an eye on the national movement of the pathogen and consult with your crop adviser or extension agent to determine when to start scouting.

Photo credit: Reid Frederick, USDA Agricultural Research Service, Bugwood.org

CERCOSPORA LEAF BLIGHT

DESCRIPTION:

Light purple discoloration develops on the upper surface of leaves in the uppermost canopy. As disease progresses, affected leaves will have a dark purple, leathery appearance.

ENVIRONMENT:

Warm, wet weather.

SCOUTING TIPS:

Check plants in wet spots or where moisture collects from extended dew periods.

Photo credit: Daren Mueller, Iowa State University, Bugwood.org

FROGEYE LEAF SPOT

DESCRIPTION:

Lesions on leaves appear as small, round, brown-to-gray spots with a distinct reddish-brown border.

ENVIRONMENT:

Warm, humid weather. Disease is likely to develop after frequent rains.

SCOUTING TIPS:

Check plants in wet spots or where moisture collects from extended dew periods and fields where soybeans were planted back-to-back.

Photo credit: Daren Mueller, Iowa State University, Bugwood.org

SEPTORIA BROWN SPOT

DESCRIPTION:

Small, reddish-brown, angular spots develop first on lower leaves and then move up the plant. Adjacent lesions can grow together to form larger patches. Infected leaves quickly turn yellow and drop.

ENVIRONMENT:

Warm, wet weather.

SCOUTING TIPS:

Check leaves in the lower canopy first as that is where the disease starts to develop.

Photo credit: Daren Mueller, Iowa State University, Bugwood.org

BEAN POD MOTTLE VIRUS *(BPMV)*

DESCRIPTION:

Leaves are mottled and distorted, seed is mottled, and stunting of the plant occurs. The virus is most evident on new or expanding leaves.

ENVIRONMENT:

Cool temperatures enhance development of leaf symptoms while high temperatures limit symptoms. It is transmitted by the bean leaf beetle and other leaf-feeding beetles.

SCOUTING TIPS:

Check fields surrounded by weedy borders first as the virus overwinters in wild legume weed species.

Photo credit: Martin Draper, USDA-NIFA, Bugwood.org

SOYBEAN MOSAIC VIRUS *(SMV)*

DESCRIPTION:

Leaf surfaces appear with raised or puckering areas, stunting of the plant and mottling of the seed occurs.

ENVIRONMENT:

Cool temperatures enhance development of leaf symptoms while high temperatures limit symptoms. It is transmitted by aphids and infected seed.

SCOUTING TIPS:

This is the most common virus in N.C. Scout after periods of cool weather in late summer or early fall as this is when the virus is most likely to appear. SMV can be transmitted through seed so check seed for mottling before planting.

Photo credit: Daren Mueller, Iowa State University, Bugwood.org

TOBACCO RINGSPOT VIRUS *(TRSV)*

DESCRIPTION:

Leaves appear distorted, stunting of the plant occurs, and the terminal branch will be brown and curled. Terminal buds may be brown, curved downward and dry. Pod formation may be affected.

ENVIRONMENT:

TRSV can occur all season long. Seed transmission is most common, but TRSV may also be transmitted by thrips and grasshoppers.

SCOUTING TIPS:

TRSV is generally more severe near pastures or at the edges of fields as they harbor weeds infected with the virus.

Photo credit: Steve Koenning, North Carolina State University

Stem and root diseases can result in dead or dying plants in mid-to-late summer, leading to reduction in yield. Development of stem and root diseases may be a symptom of other problems, such as inadequate fertility, soil compaction, poor drainage or nematode infestation.

CHARCOAL ROT

DESCRIPTION:

Infected plants grow slowly and have smaller leaves. Leaves of older plants turn yellow and wilt, but do not fall off. Gray or silvery discoloration of tissue with tiny black specks that look like pulverized charcoal are visible under the bark of the upper tap root and lower stem.

ENVIRONMENT:

Hot, dry weather.

SCOUTING TIPS:

Most common when soil pH or fertility are low or plants are under drought stress. Also more prevalent in fields with a hardpan.

Photo credit: Katherine Drake Stowe, North Carolina Soybean Producers Association

PHYTOPHTHORA ROOT AND STEM ROT

DESCRIPTION:

Plants will be wilting or dying and have root rot. Stems may be dark brown and the discoloration can extend from the base of the plant to a foot above the soil line. When the stalk is cut, brown to black discoloration of vascular tissue and disking of the pith is visible.

ENVIRONMENT:

Most likely to be a concern in heavy, poorly drained soils or low-lying areas of the field.

SCOUTING TIPS:

Look for symptoms to appear where soils have been waterlogged for extended periods of time.

Photo credit: Daren Mueller, Iowa State University, Bugwood.org

PYTHIUM ROOT ROT

DESCRIPTION:

Plants will have symptoms very similar to Phytophthora rot, including root rot, wilting and death of plants. In young seedlings, damping off is very common. Roots often appear withered. Seeds can also be infected, and they appear rotted and soil will stick to them.

ENVIRONMENT:

Saturated environments, such as low-lying areas.

SCOUTING TIPS:

Look for symptoms to appear where soils have been waterlogged for extended periods of time. Pythium-like symptoms are often confused with Phytophthora in older plants.

Photo credit: Daren Mueller, Iowa State University, Bugwood.org

SOUTHERN BLIGHT

DESCRIPTION:

Plants will suddenly wilt and die. Leaves remain attached to the dead stem, and a dense, white mat of fungal seed-like tissue appears on the stem and soil at the base of the plant.

ENVIRONMENT:

Hot, humid weather.

SCOUTING TIPS:

Most common in sandy soils but present in almost all N.C. fields. Economic losses are rare in N.C.

Photo credit: North Carolina State University, Bugwood.org

STEM CANKER

DESCRIPTION:

The base of lower leaf nodes develop brown, slightly sunken lesions on one side of the stem. As the disease progresses, lesions expand along and around the stem, killing the plant. Leaves may turn yellow and brown between veins but remain attached after death.

ENVIRONMENT:

Prolonged wet weather early in the season, followed by dry conditions.

SCOUTING TIPS:

More likely to be problematic in no-till fields.

Photo credit: Daren Mueller, Iowa State University, Bugwood.org

There are some diseases that can infect seeds under the right conditions (delayed harvest or humid conditions during seed development). They cause seed discoloration and may completely colonize the seed. Avoid planting infected seed if possible.

DOWNY MILDEW

Seeds may have a dull white, crusty coating and spores may be visible. Pods can be infected without obvious external symptoms.

PHOMOPSIS

This is N.C.'s most common seedborne disease. Infected seeds may appear shriveled, cracked and white or chalky, though they also may appear normal. This seed may not germinate or may produce seedlings with reduced vigor.

PURPLE SEED STAIN

Seeds may have pink or purple spots that extend from the seed hilum. This does not affect yield, but value may be lowered by dockage at the elevator.

Downy Mildew
Photo credit: United Soybean Board

Phomopsis
Photo credit: Daren Mueller, Iowa State University, Bugwood.org

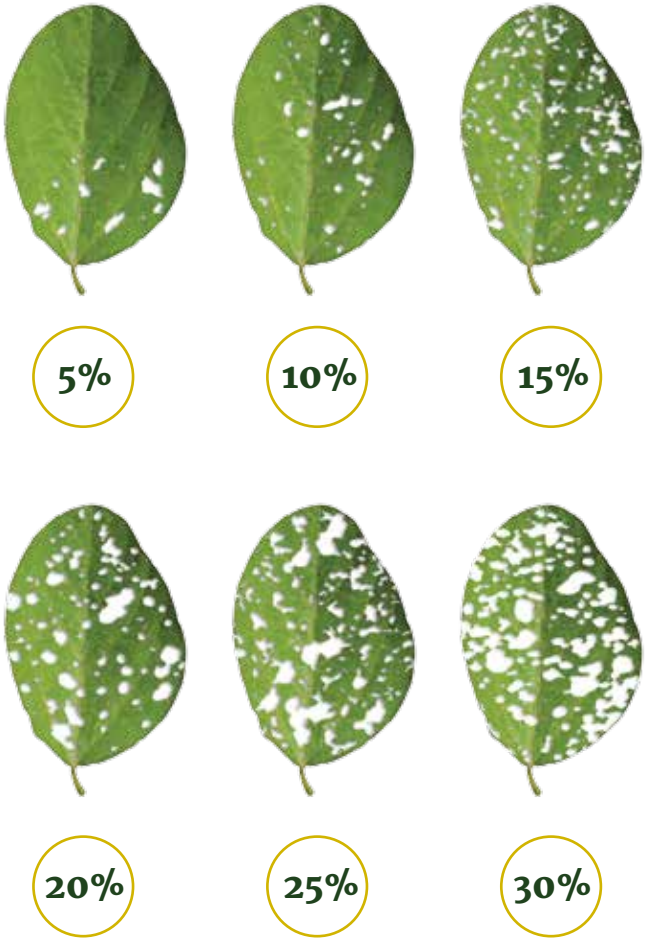
Purple Seed Stain
Photo credit: Paul Bachi, University of Kentucky Research and Education Center, Bugwood.org

INSECT MANAGEMENT

A number of insects are found in N.C. soybean fields. Most are beneficial or harmless, and only a few reduce yields enough to lower profits. Pest insect populations can vary greatly from year to year or even field to field; therefore, farmers must scout for insects regularly throughout the growing season.

The decision to use insecticides should be made on an as-needed basis. Unnecessary treatment is expensive, can have negative consequences and increases the likelihood for pests to develop resistance. Poorly-timed treatments may also lead to future insect problems later in the season.

Some insects will attack seedlings, but most do not start harming leaves and pods until late July. Insects that occur very early seldom pose any threat. Don't treat for leaf-feeding insects unless more than 30% of the foliage is lost before blooming begins or more than 15% is lost from two weeks before blooming through pod fill. Threshold calculators for other insects can be found on the North Carolina State University soybean portal at *https://soybeans.ces.ncsu.edu/thresholds/*.



Foliage-eating insects are present in almost all soybean fields throughout the season. Most fields rarely suffer yield loss though, because the amount of leaf loss remains at low to moderate levels and soybean plants have the unique ability to compensate for foliage loss.

BEAN LEAF BEETLE

DESCRIPTION:

Yellow to red beetles with a distinct black triangle-shaped mark behind the head at the base of the forewings and usually four distinct black spots on their back.

DAMAGE:

They feed on leaves, leaving small, rounded holes inside the leaf margins. Damage is often more visually alarming than serious as holes expand with leaf growth. Beetles can also feed on outer pod walls late in the season, causing the seed to rot and shrivel.

SCOUTING TIPS:

Bean leaf beetles attack the plant throughout the season but are most severe in late July and early September in late-maturing beans.

Photo credit: Adam Sisson, Iowa State University, Bugwood.org

ARMYWORM COMPLEX

DESCRIPTION:

Armyworms are smooth caterpillars with four pairs of prolegs on the abdomen plus a pair of prolegs at the back.

Beet Armyworm: Olive-green to black caterpillar with a stripe down each side and a black dot behind the head just above the second pair of legs.

Yellowstriped Armyworm: Pale-gray to black caterpillar with a yellowish stripe running down each side, a black triangular spot above the stripe on nearly every segment of the body, and a distinct cream-colored upside-down "Y" separates the eyes on either side of the head.

Fall Armyworm: Olive-green to dark-brown caterpillar with a dark band above a stripe running down each side, four black spots arranged in a square pattern near the rear and a dark brown head with a cream-colored upside-down "Y" separating the eyes on either side of the head.

DAMAGE:

Beet and fall armyworm primarily affect late-planted seedling soybeans. Severely damaged plants are very ragged in appearance. Yellowstriped armyworms can be found throughout the season but generally are only injurious to young seedlings.

SCOUTING TIPS:

Beet armyworms often feed on pigweed plants in and around soybean fields, so noticing defoliation of pigweed can alert growers the worms may be moving into the field. Treat only if defoliation is greater than 30% before first bloom.

Beet Armyworm
Photo credit: John Capinera, University of Florida, Bugwood.org

Yellowstriped Armyworm
Photo credit: Alton N. Sparks Jr., University of Georgia, Bugwood.org

Fall Armyworm
Photo credit: Alton N. Sparks Jr., University of Georgia, Bugwood.org

GREEN CLOVERWORM

DESCRIPTION:

Slender, greenish caterpillars with faint white stripes along the body that have the same thickness from head to rear. They have three pairs of thoracic legs in the front, three pairs of prolegs near the midsection and a pair of prolegs at the rear. They often wriggle violently when disturbed.

DAMAGE:

They feed on leaves between veins, leaving irregular holes and prove damaging only under very high populations. They are present through most of the growing season but seldom cause economic damage.

SCOUTING TIPS:

Rarely an economic pest; most often concentrated in the upper canopy.

Photo credit: Daren Mueller, Iowa State University, Bugwood.org

SOYBEAN LOOPER

DESCRIPTION:

Light green caterpillars with thin, light lines running the length of the body. The body is largest at the rear and tapering to the head. They have two pairs of prolegs on the abdomen plus one pair near the back and form the characteristic hump or "loop" when crawling.

DAMAGE:

They feed on leaves, leaving large holes, and heavy populations can strip entire fields of leaves.

SCOUTING TIPS:

Economic infestations rarely occur before late August or early September. Loopers are usually found in fields previously sprayed with broad spectrum insecticides, which can kill off natural enemies.

Photo credit: Dominic Reisig, North Carolina State University

Pod feeders are the most dangerous insect pests as they directly attack soybean yield. Insecticide treatments should primarily target these insects. Scouting for these insects is essential as not all fields are subject to attack by pod feeders. Variety, row width and planting date all influence which insect pests are present.

CORN EARWORM

DESCRIPTION:

Green, brown, yellow or black caterpillars with light and dark stripes running the length of the body and prominent pale brown or orange heads (never dark brown). They have four pairs of prolegs on the abdomen plus one pair at the back. When disturbed, they curl into a tight circle but do NOT crawl with a looping motion.

DAMAGE:

This is one of the most serious insect pests of soybeans in N.C. Feeding typically occurs first on foliage, later on pods and can cause severe defoliation and/or pod damage.

SCOUTING TIPS:

Field infestation normally occurs in late July and August. Late-planted and drought-stressed fields are most likely to see severe damage. Use the online threshold calculator to determine when to treat: *https://www.ces.ncsu.edu/wp-content/uploads/2013/02/CEW-calculator-v0.005.html*.

Photo credit: Dominic Reisig, North Carolina State University

STINK BUG COMPLEX

DESCRIPTION:

Stink bugs are shield-shaped and often emit a foul-smelling substance when threatened.

Green Stink Bug: Green bug that produces a distinct buzz when flying. On the underside, it has a pointed spine between the last two legs.

Brown Stink Bug: Dull brown and somewhat smaller than green stink bugs.

Brown Marmorated Stink Bug: Brown-colored bug with white angular spots on the outside edges of its rear.

DAMAGE:

Stink bugs will suck juices from immature soybean seeds, resulting in yield losses in the form of seed shriveling or abortion, pod shriveling, or decreases in seed quality.

SCOUTING TIPS:

Stink bugs are most attracted to fields with developing pods. Brown marmorated stink bugs may be found in large numbers near field edges, especially next to wooded areas or late-planted corn fields.

Green Stink Bug
Photo credit: Dominic Reisig, North Carolina State University

Brown Stink Bug
Photo credit: Dominic Reisig, North Carolina State University

Brown Marmorated Stink Bug
Photo credit: Dominic Reisig, North Carolina State University

Stem-feeding insects regularly occur in soybeans but infrequently cause economic damage, with the exception of lesser cornstalk borer which can be a serious pest following burned wheat and/or in sandy soil.

DECTES STEM BORER

DESCRIPTION:

Charcoal-gray beetles with very long antennae. Larvae are cream-colored grubs.

DAMAGE:

It is the larvae that cause damage to plants by tunneling through soybean stems and cutting off the plant at the base. This may result in lodging of mature plants.

SCOUTING TIPS:

The most serious lodging damage is seen in early-maturing and non-rotated soybeans.

Photo credit: Dominic Reisig, North Carolina State University

KUDZU BUG

DESCRIPTION:

Olive green to dark brown, small, shiny bugs that are strong fliers. When handled, they produce a secretion that can stain hands and cause irritation.

DAMAGE:

Stem feeding by kudzu bugs can lead to stem lesions and, in severe cases, dark sooty mold may cover the plant. Occasionally, external injury of the pods is visible, but this does not harm seed. Yield losses take the form of reductions in seed number and seed weight. Seed quality remains unaffected.

SCOUTING TIPS:

Migration from overwintering sites begins in March and April, and a second migration occurs in July and August. The edges of fields are colonized first before the bugs move to the interior sections. Wait until nymphs are present before spraying to avoid multiple sprays.

Photo credit: Dominic Reisig, North Carolina State University

LESSER CORNSTALK BORER

DESCRIPTION:

Dark yellow-green or bluish caterpillars with reddish-brown cross bands. Larvae wiggle violently when disturbed and can crawl backwards. They are found next to the plant at the soil surface in silk or soil tubes or under the stem near the soil surface.

DAMAGE:

These caterpillars can tunnel soybean plants at the ground level, causing plants to be severely stunted, lodge or even die.

SCOUTING TIPS:

This can be a serious pest of soybeans, especially in fields with burned wheat stubble or late-planted beans on dry, sandy soils.

Photo credit: Dominic Reisig, North Carolina State University

THREE-CORNERED ALFALFA HOPPER

DESCRIPTION:

Shiny, green, wedge-shaped insects that have a blunted front end and pointed rear. Young insects appear similar to adults but have no wings.

DAMAGE:

These insects feed on young soybean stems near the soil with damage largely occurring on plants less than 12 inches in height. The punctures in the stem caused by this bug may result in lodging issues later in the year, but lodging rarely reduces yield. They may also feed on leaf petioles and upper stems, leaving dark scars, but should not affect yields.

SCOUTING TIPS:

This insect overwinters in weedy plants and migrates to soybeans in May or June. Fields with weedy borders are more likely to see an infestation.

Photo credit: Gerald J. Lenhard, Louisiana State University, Bugwood.org

Many beneficial insects occur in soybean fields, and some of the most common ones are described below. These helpful insects are best preserved by avoiding unnecessary insecticide applications and insecticidal seed treatments.

ASSASSIN BUG

DESCRIPTION:

There are a number of different assassin bugs that occur in soybean fields. Many species have orange and gray, green or black patterns. Adults have a long, thin body with wings that cover the abdomen and a long, thin beak for feeding on insects. Rarely, these insects may use their beak to bite humans, which can be painful.

PREY:

Adults and immatures use their front legs to capture and feed on caterpillars and aphids.

Photo credit: Louis Tedders, USDA Agricultural Research Service, Bugwood.org

GREEN LACEWING

DESCRIPTION:

Adults are green, thin, cigar-shaped insects with very long antennae and clear wings that have net-like veins. Larvae are grayish-brown and have large jaws that snap shut sideways. They can give a pinch that is detectable on human skin. Single eggs are laid on silken stalks attached to leaves.

PREY:

Larvae feed on many arthropods in soybeans, including mites, thrips, whiteflies, aphids and small caterpillars. They will also eat insect eggs.

Photo credit: Russ Ottens, University of Georgia, Bugwood.org

SPINED SOLDIER BUG

DESCRIPTION:

This stink bug closely resembles the brown stink bug, but it has a very thick beak on the bottom side of the body (this structure is much thinner on the brown stink bug). The beak is more than twice the thickness of the antennae. Immatures have orange and black coloring and a thick beak.

PREY:

The thick beak allows these stink bugs to feed on insects rather than plants. They commonly feed on caterpillars.

Photo credit: Clemson University – USDA Cooperative Extension Slide Series, Bugwood.org

CATEGORY	NUTRIENTS	COMMENTS
MACRO	Nitrogen (N) Phosphorus (P) Potassium (K) Calcium (Ca) Magnesium (Mg) Sulfur (S)	These are the most important soil-supplied nutrients due to the quantity required by crops and frequent application needed.
MICRO	Boron (B) Chlorine (Cl) Copper (Cu) Iron (Fe) Manganese (Mn) Molybdenum (Mo) Nickel (Ni) Zinc (Zn)	These nutrients are required in small amounts, but deficiencies can reduce yield since they are essential for specific functions.

Soybeans remove a large amount of nutrients from the soil compared with other crops. While these quantities are high, this should not be interpreted as the amount of fertilizer to be added. Nutrient applications should vary according to soil type, residual nutrient status and soil pH. Maintaining optimum soil pH is essential for healthy root development and to maintain availability of plant nutrients. Soil testing is essential for determining the appropriate fertility program before planting.

ESTIMATED NUTRIENT-REMOVAL RATE (LBS.) IN SOYBEANS*			
Nutrient	30 bu./A.	50 bu./A.	70 bu./A.
N	113	188	263
Phosphorus (P_2O_5)	25	41	57
Potassium (K_2O)	44	74	104
S	7	11	15
Mg	6	10	14
Ca	11	19	27

*Additional nutrients are taken up by the crop but recycled in the residue. For complete crop uptake values, see Soil Facts: Nutrient Removal by Crops in North Carolina. *http://content.ces.ncsu.edu/nutrient-removal-by-crops-in-north-carolina.*

NITROGEN (N) DEFICIENCY

DESCRIPTION:

Plants become pale green, and older leaves may turn yellow or even brown in very extreme cases. Symptoms will start in lower leaves and move up the plant over time. These symptoms may also be an indication of a condition that inhibits N fixation, such as waterlogging, lack of inoculum or a molybdenum (Mo) deficiency. Mo is essential for symbiotic nitrogen fixation. Check the inside of nodules on the roots. If they have a pink color, they are active, but green, brown or white indicate no fixation is occurring. If the number or quality of nodules is not sufficient, supplemental N can be applied.

SCOUTING TIPS:

Low or no N fixation is most commonly a problem in fields without a recent history of soybean production, as there are fewer *Bradyrhizobium* or when there is insufficient photosynthate production to feed the roots and nodules. Mo deficiency occurs in very acidic soils.

Photo credit: Chad Lee, University of Kentucky

PHOSPHORUS (P) DEFICIENCY

DESCRIPTION:

Plants are spindly and have small leaflets and slowed growth. Leaves may appear dark green or bluish-purple in extreme cases. P deficiency can delay blooming and maturity.

SCOUTING TIPS:

P deficiency most often occurs in cool, wet soils because of a decrease in P uptake. It may also be a problem if root function and growth are limited (from compacted or wet soils, or disease/pest damage) or early in the season during periods of rapid vegetative growth if the shoots experience better growing conditions than the roots.

POTASSIUM (K) DEFICIENCY

DESCRIPTION:

Lower, older leaves will show symptoms of yellowing and chlorosis of the leaf margins and in between veins first. In extreme cases, symptoms may move up the plant to newer leaves.

SCOUTING TIPS:

Like P deficiency, K deficiency also most often occurs in cool, wet soils. It may also be a problem if root function and growth are limited (from compacted or wet soils, or disease/pest damage) during periods of rapid vegetative growth.

Phosphorus (P) Deficiency
Photo credit: Bobby Golden, Mississippi State University

Potassium (K) Deficiency
Photo credit: Bobby Golden, Mississippi State University

References

AgWeb. Online Weed Identification Guide. *www.agweb.com/crops/online-field-guide-weeds.*

Crozier, C.R. Nutrient deficiency image collection. *http://deficiencies.soil.ncsu.edu.*

Mueller, D. and A. Sisson. Soybean Field Guide. CSI-0010. ISU. Ames, IA.

North Carolina Cooperative Extension Service. Integrated Pest Management Soybean Scouting Manual. NCSU. Revised AG-385. Raleigh, NC.

Osmond, D.L and J. Kang. 2008. Soil Facts: Nutrient Removal by Crops in North Carolina.

Schaefer, K., D. Mueller, A. Sisson, B. Hartzler, M. Anderson, and C. McGrath. Weed Identification Field Guide. IPM-0003. ISU. Ames, IA.

NC STATE

Technical editing for this guide was led by researchers from North Carolina State University and personnel from the North Carolina Soybean Producers Association. The United Soybean Board/soy checkoff neither recommends nor discourages the implementation of any advice contained herein, and is not liable for the use or misuse of the information provided.