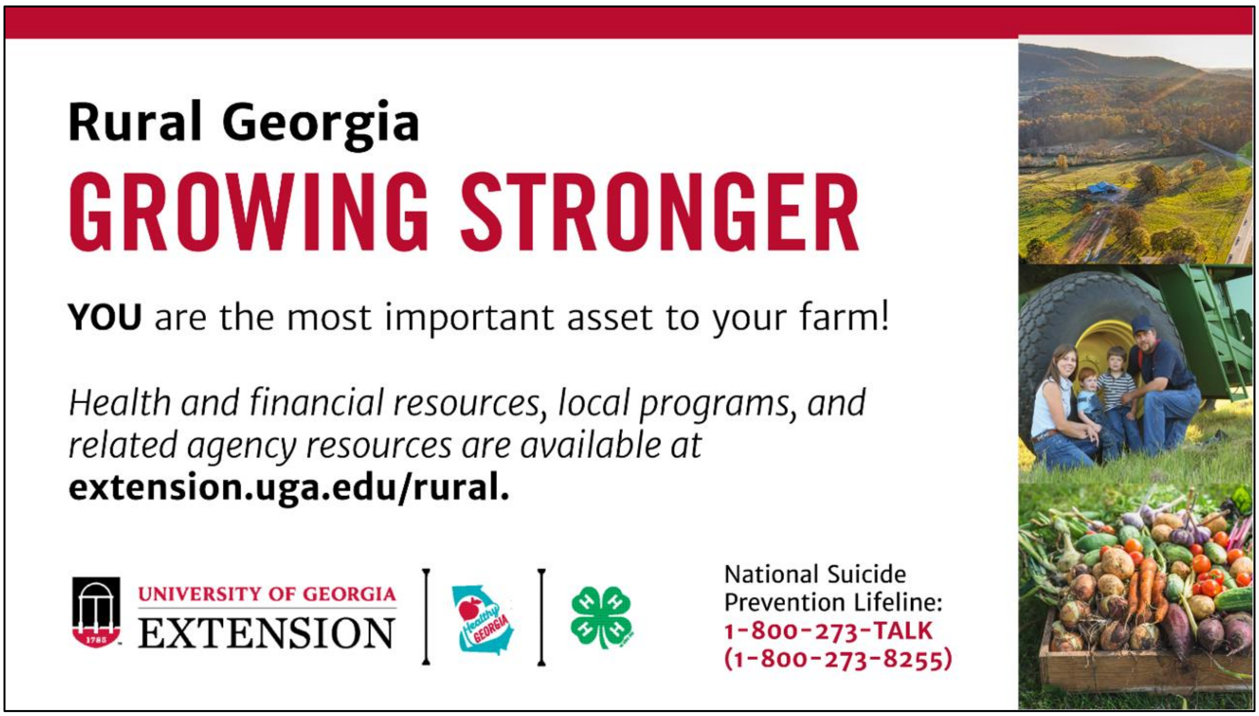
Georgia Soybean Production Guide

2023

UNIVERSITY OF GEORGIA
EXTENSION



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Soybean Production in Georgia

Richard Roth and Rome Ethredge

In the last 10 years, Georgia soybean planted acres peaked at 325,000 2015 but dropped as low as 100,000 acres in 2019 and 2020 (Table 1). Much of this rise and decline in soybean acres has followed prices. As soybean prices climbed above $10/bu soybean acreage increased; however, as prices declined below $10/bu acreage declined as well. Many Georgia peanut growers are not willing to accept the risk of additional disease pressure if soybean prices are below approximately $10 - $11/bu. While soybeans are not a major crop for Georgia, they are important to regions where cotton and peanut are not traditionally grown, such as north Georgia.

Table 1. Planted and harvested acres, state average yield, and price received for soybean grown in Georgia over the last 10 years.

Year	Planted Acres	Harvested Acres	Yield (bu/a)	Price ($/bu)
2022	165,000	160,000	41	15.50
2021	140,000	135,000	46	13.90
2020	100,000	95,000	41	13.00
2019	100,000	86,000	29	8.95
2018	145,000	130,000	39	7.90
2017	155,000	150,000	42	9.62
2016	260,000	240,000	30	10.1
2015	325,000	310,000	43	9.25
2014	300,000	290,000	40	10.50
2013	235,000	230,000	40	13.30

The majority of Georgia soybean production is yellow soybean used for animal feed and cooking oil. Across Georgia there are four production systems that growers can adopted, allowing soybeans to fit into almost any farm operation. The four soybean production systems in Georgia include the Early Soybean Production System, Full Season Soybean Production System, Double Crop Soybean Production System, and Ultra-Late Soybean Production System. Agronomic practices between and within systems vary by region in the state. Many soybean producers in South Georgia plant on 30 – 36-inch rows, while many producers in North Georgia will drill soybeans in 7.5-inch rows. Tillage systems vary from conventional and strip-till in South Georgia to no-till in the mountain region of North Georgia. Currently, the majority of Georgia soybean acreage is non-irrigated with only approximately 15% irrigated with overhead center-pivot or lateral sprinkler systems, mainly in South Georgia.

While Georgia soybean yields have traditionally lagged those of more traditional soybean producing states there is great potential for exceptional soybean yields in Georgia. Georgia achieved its highest state average yield ever (46 bu/a) in 2021. In addition, the current world record soybean yield was produced in Georgia. While you may not be trying for world records, please carefully read this guide and use it to achieve maximum yields for your operation.

Steps to High Yield and High-Quality Soybean in Georgia

Richard Roth

1) Rotate land so soybeans and other legumes are planted no more than once every two years. If a field has nematodes, plant a resistant variety. Avoid deep sands or eroded clay soils.
2) Lime and fertilize according to soil test results. Apply an appropriate inoculant if soybeans have not been grown on land in the last three years.
3) For Coastal Plain soils, use deep tillage (12-14 inches) to get deep soybean rooting. For conservation tillage, use strip tillage and/or traffic control to reduce soil compaction.
4) Use good cultural practices.
   a. Plant full season beans between April 10 and June 10.
   b. Plant tall growing and/or late maturing varieties if planting after June 10.
   c. Plant in rows 10-36 inches wide.
   d. Plant about 145,000 seed per acre (~ 10 seed/foot for 36" spacing).
   e. Plant seed 1-1.25 inches deep in moist soil.
   f. Plant when soil temperature is between 70-90^{o} F at 2 inch depth.
5) Plant recommended varieties for your location and planting situation. Plant varieties of different maturities to spread drought risk. Contact your local county extension agent and UGA Variety Site https://swvt.uga.edu/
6) If possible, Irrigate to eliminate stress from soil moisture deficits. Refer to the Irrigation Section for details.
   a. If irrigating, apply water
      i. During vegetative growth, leaf wilt occurs by mid-day.
      ii. During reproductive growth to eliminate soil moisture stress and prevent wilting.
   b. Refer to the Irrigation Section for details.
7) Control Weeds.
   a. In reduced tillage systems, try to obtain a weed-free seedbed at planting.
   b. Use preemergence herbicides at planting.
   c. Apply postemergence herbicides when weeds are 2-4 inches tall.
   d. Be on the lookout for glyphosate and ALS-resistant Palmer amaranth.
   e. Refer to the weed control section for more specific weed control information.
8) Control insects.
   a. Scout fields weekly to monitor insect populations.
   b. If in the Georgia Coastal Plain, apply preventative velvetbean caterpillar control treatment (Dimilin + Boron) at or after full flower (R2).
   c. Treat for stinkbugs, and other pod/foliage feeding insects as needed.
   d. Refer to the insect control section for more specific insect control information.
9) Control Asian Soybean rust and other foliage diseases.
   a. Scout fields bi-weekly prior to first-bloom and weekly at first-bloom and beyond to monitor for leaf diseases (Asian soybean rust, frogeye leaf spot, etc.).
   b. Pre-bloom, apply foliar fungicide if Asian soybean rust is found in your fields or close by.

c. Post-bloom, apply foliar fungicide if Asian soybean rust is found in your region or local area. Specific choice of a fungicide will be determined in part by confirmed proximity of disease to a specific field.
d. Refer to the disease control section for more specific disease control information.

10) Harvest soon after maturity to reduce seed shatter and maintain good seed quality.
    a. Adjust combine to match crop and field situation.
    b. Begin harvest soon after soybean seed have dried to 13% moisture or less.

Soybean Growth and Development

Richard Roth

Proper knowledge and identification of soybean growth stages is essential to ensure accurate management decisions. Soybean development is divided into vegetative (V) and reproductive (R) stages. These distinctions are important as several management practices will have little effect if performed outside of their prescribed developmental stage. Soybean is noted as progressing to the next growth stage when at least 50% of the plants in a field are at the later growth stage.

Soybean seeds absorb approximately 50% of their weight in water prior to germination. Soybean emergence then occurs as hypocotyl elongation brings the cotyledons out of the soil.

Growth Stages

After emergence, the unifoliate leaves unroll above the cotyledons followed by the trifoliate leaves as the plant grows. Vegetative growth stages, designated by the letter V, will progress in order from VE to Vn where n indicates the number of nodes with a fully developed trifoliate with at least one unrolled leaflet. Reproductive growth stages, designated by the letter R, begin when the first flower is present at any location on the plant. Reproductive growth stages are defined by the plant reaching determined seed development stages. Table 2 provides the designations and a brief description of all soybean growth stages.

Development

Soybean development is controlled by the determinate or indeterminate growth habit of the variety. Determinate soybean varieties typically range from maturity group (MG) V to MG X; however, some late MG IV varieties are also determinate. Indeterminate varieties typically range from MG 000 to MG IV; however, some early MG V varieties are also indeterminate. The primary difference between determinate and indeterminate soybean varieties is the termination of vegetative growth and production of nodes on the main stem. In Determinate varieties vegetative growth and node production ceases shortly after flowering begins; however, node production on branches will continue until seed fill (R5). Conversely, indeterminate varieties will continue vegetative growth and node production on the main stem until seed fill begins.

Georgia soybean producers can select one of four soybean production systems depending on their specific capabilities and goals. Please read the chapters for individual soybean production systems for agronomic practices and considerations specific to that production system.

Table 2. Soybean growth stages with descriptions.

Designation	Growth Stage	Description
VE	Emergence	Cotyledons and growing point above soil surface Unifoliate leaves emerging but still rolled
VC	Cotyledons Expanded	Cotyledons and unifoliate leaves expanded and unrolled
V1	1st Trifoliate	First trifoliate developed AND Leaflet margins no longer touching
Vn	nth Trifoliate	Last trifoliate prior to flowering developed AND Leaflet margins no longer touching
R1	Beginning Bloom	One open flower at any location on the plant
R2	Full Bloom	One open flower at one of the two uppermost nodes on the main stem with a fully developed trifoliate
R3	Beginning Pod	One pod approx. $^{3}/_{16}$ inch long at one of four uppermost nodes on main stem with fully developed trifoliate
R4	Full Pod	One pod approx. ¾ inch long at one of four uppermost nodes on the main stem with a fully developed trifoliate
R5	Beginning Seed	Seeds in pods at any of four uppermost nodes with fully developed trifoliate is $^{1}/_{8}$ inch long
R6	Full Seed	One pod at one of four uppermost nodes on main stem with fully developed trifoliate contains green seed that completely fills seed cavity.
R7	Beginning Maturity	One normal pod on main stem has reached mature pod color; usually brown or tan.
R8	Full maturity	95% of pods reached mature color and drying down for harvest.

Agronomic Practices for Soybean

Richard Roth

The following agronomic practices should be considered regardless of which soybean production system you choose. Consider this information plus the information in the chapter about your specific production system as you plan for the coming year.

Field Selection and Rotation

When considering fields for soybean production, make sure to account for factors such as yield potential, crop rotation, and soil type. The selected field should have been planted to something other than soybean the previous year. It is preferable that the preceding crop be either cotton or corn as following another legume, such as peanut, can increase the risks of disease incidence. Current UGA data recommends avoiding fields where the soil is deep sand or eroded clay as yield potential is severely limited.

Land Preparation

Land preparation, whether in conservation or conventional tillage systems, should provide deep rooting channels and a moist seed bed at planting. Soybeans grown on sand-textured Coastal Plain soils respond positively to in-row subsoiling to a depth of 12 to 14 inches. However, deep turning or chisel plowing are acceptable alternatives so long as the soil is not re-compacted by roto-tiling, disking, or other seed-bed preparation operations. To date, soybeans grown on fine-textured and red soils of the Upper Coastal Plain, Piedmont, and Limestone Valley have not expressed positive responses to in-row subsoiling. Often, these soils can be prepared by deep disking and turning, or chisel plowing.

Row Spacing

Generally, narrow-row production systems produce top soybean yields. Row widths of 20 to 30 inches are generally considered optimum for soybean production. However, most soybean varieties will give near top yield with row space ranging 30 to 36 inches, if planting occurs at the proper time. In general, benefits of narrow rows increase as planting date moves later in the year.

Georgia research has demonstrated a yield benefit of 0.7% for every inch the row is narrowed, relative to 36-inch rows. Therefore, decreasing row width from 36 to 20 inches could increase soybean yield up to 11%. However, changing row width requires significant investments in new equipment and changes to existing operations. Note the absence of in-row subsoiling and proper maturity group and planting date decisions may negate any potential benefits of narrow rows.

One way to modify row spacing, without making significant investments in new implements, is to plant in a twin-row configuration. Many peanut growers have twin-row peanut planters which require minimal adjustment to plant soybean. Mid-South research demonstrates twin-row planting has the potential to increase soybean yield up to 11% compared to single-row planting. Georgia research in 2009 and 2010 showed an average soybean yield increase of 3.5% with twin-row planting compared to 36-inch single-row planting. The results from Georgia are far less than the 11% yield increase observed in other regions and is attributed more to planting date and variety architecture as positive yield effects were observed more in later planting dates and "columnar" varieties. The advantages of twin-row planting in Georgia are not thought to equal the advantages of conventional row spacing alterations.

Planting

Set planters to place seeds 1.0 – 1.25-inches deep in moist soil. If surface soil moisture is limited, set planters to push aside dry soil and plant in a shallow seed furrow. If seed must be placed deeper than 1.25-inches to reach moisture delay planting until moisture returns. In sandy soils, irrigating directly after planting risks causing surface crusts which can negatively affect emergence. Adjust closing wheels to firm the soil around seed but not so firm as to induce soil crusting. If soil crusts form, rotary hoe within one to three days to ensure adequate stands.

Research has indicated that the optimum soil temperature for soybean emergence is 82^{o} to 85^{o}F; however, there is a wide range of soil temperatures at which soybeans will emerge. Soybeans can be planted in soils as cold as 42^{o}F and as warm as 95^{o}F. When planting in cold soils, between 42^{o} and 59^{o}F, emergence may take as long as 14 days after planting. As soils warm above 59^{o}F soybean emergence can be as fast as 4 days after planting, depending on soil moisture status. When peak daily soil temperatures at the 2-inch depth exceed 100^{o}F planting should be delayed until peak daily temperatures decrease. Soil surface temperatures can be reduced by utilizing conservation tillage methods that increase soil surface coverage.

NOTE: Please read the chapters specific to your soybean production system for details regarding planting date, seeding rate, and plant populations.

Conservation Tillage in Soybean Production

Richard Roth

Conservation tillage can provide distinct advantages to soybean production systems but may require increased management to get sufficient crop stands and weed control. The following describes principles specific to Georgia soybean production in conservation tillage systems.

Cover Crops

Winter cover crops are often used in conservation tillage systems to prevent topsoil erosion, conserve soil moisture, modify soil temperature, suppress winter weeds, and potentially add N. Grass cover crops like cereal rye, oats, wheat, etc. should be used before soybeans. Grass cover crops are easily established and reduce risks of planting a legume cash crop after legume cover crops. Cover crops should be terminated around 14 days before soybean planting. Termination can be accomplished using herbicides, tillage, roller crimping, or mowing. Early termination can lead to improved soybean stands by reducing competition for water, nutrients, and light.

Seeding Rates and Row Spacings

Good soybean stands are more difficult to obtain with conservation tillage than conventional tillage due to interference of seed to soil contact by plant residues. Soybean seeding rates should be increased 10 to 15 percent in conservation tillage soybean systems to help offset this issue. There is no need to adjust seeding depth in conservation tillage systems. However, conservation tillage planter setup must be checked to ensure the planter does not create a furrow.

Soybeans do not normally accumulate as much vegetative growth in conservation tillage systems compared to conventional tillage. Consequently, narrow rows may be more beneficial in conservation tillage systems, especially when planting later in the year. Narrowing row spacing from 36-inches to 20- or 30-inches will aid canopy closure even with reduced vegetative growth.

Rows can be further narrowed by drill seeding soybean. Soil compaction may be an issue in drill seeded systems as subsoiler shanks will not cover each seed row. This can be corrected by chisel plowing in the fall but care must be taken not to reconsolidate the soil prior to planting in the spring. Conservation tillage seed drills should have double disk openers with depth control bands to ensure uniform seeding depth. Often, especially in no-till systems, extra weight on the seed drill is necessary to achieve adequate soil penetration and even seeding depth.

Soybean Stand Issues

There are ways to lessen the risk of poor soybean stands associated with conservation tillage systems. One method is to outfit planters and seed drills with smooth instead of fluted coulters. Another method is to use row cleaners attached to the planter or seed drill. Row cleaners should be adjusted so they barely scratch the soil surface when planting. Setting row cleaners too deep can cause plant residues to become entangled, prevent proper operation, and cause delays in planting as time is spent cleaning the plant residues off.

Early Soybean Production Systems in Georgia

Richard Roth

Early soybean production systems (ESPS) utilize MG V or earlier indeterminate varieties to facilitate earlier planting and harvest of soybeans. This system has gained popularity in Georgia over the last several years and is most adopted in the Middle/Upper Coastal Plains and Limestone Valley regions. ESPS has shown potential for high yields in Georgia, but management decisions about row spacing, planting, and harvesting must be considered to achieved high quality yield.

Row Spacing

Current research indicates that ESPS perform better with narrower row widths. Soybeans in ESPS can be planted in rows as narrow as 7.5-inches with a grain drill or up to 30-inches with traditional planters. High yields in the ESPS have also been achieved utilizing 36-inch row spacing.

Planting Date

Soybeans in ESPS should be planted as early as possible after the historic last frost for your region. This is as early as March 15th in the lower coastal plain or as late as May 31st in Northeast Georgia. The optimal planting window for the majority of Georgia is April 1st to April 30th.

Seeding Rate and Population

As soybeans in ESPS are planted into cooler soils the recommended seeding rates are greater than for full-season production systems. ESPS seeding rates should be around 120,000 to 140,000 seeds/acre to achieve maximum yields. This should result in final plant populations between 100,000 and 120,000 plants/acre accounting for varietal germination rates and any effect of cold soils on germination. Research in the mid-south shows final plant stands as low as 75,000 plants/acre do not yield significantly different from higher populations if stands are uniform and do not contain large gaps.

Harvest Timing

Harvest timing is the most critical management decision to obtain quality grain in the ESPS. Soybeans grown in ESPS typically reach maturity and begin drying down in late-August to mid-September. This can coincide with seasonal rains and hurricanes leaving mature soybeans sitting in the field waiting on a combine. Timely desiccation can alleviate this problem and improve seed quality. Desiccation options include Paraquat, Saflufenacil, and Sodium Chlorate. Read product labels and know application and preharvest interval restrictions before using any desiccant.

Full Season Soybean Production System

Richard Roth

Full season soybean production systems (FSSPS) are the most utilized soybean production system in Georgia. Traditionally, MG V through MG VIII determinate varieties are grown in this system. The FSSPS alleviates many harvest and seed quality concerns associated with ESPS by maturing in October and early November. However, this production system can overlap with planting and harvest of other crops grown in Georgia such as cotton and peanut.

Row Spacing

As with other soybean production systems in Georgia, FSSPS can benefit from narrow row spacing. Row widths of 20 – 30 inches are optimum for FSSPS while 7.5-inch rows are not advised as with ESPS. Row widths of 36 – 38 inches can produce near top yield given proper management.

Planting Date

Care must be taken to not plant full-season determinate soybean varieties too early. Planting too early can result in premature flowering causing plant stunting, reduced seed quality, and lower yields. Research in Georgia shows the optimum planting date ranges from May 10th to June 10th. Soybeans may be planted as early as April 25th so long as soil temps are above 70^{o} F and tall-growing MG V or MG VI varieties are selected.

Seeding Rate and Population

FSSPS seeding rates should be between 100,000 and 120,000 seeds/acre to achieve a final plant population of 85,000 to 100,000 plants/acre. Final plant stands as low as 60,000 plants/acre can produce reasonable yields if plants are evenly distributed without large gaps. If planting late in the planting window or into dry or trashy seedbeds consider increasing seeding rate 10 to 20%.

Harvest Timing

Since full-season soybean varieties mature after the traditional rainy and hurricane prone portions of August and September concerns with seed quality are reduced and use of a desiccant is not recommended. However, if you wish to use a desiccant to speed up harvest prior to harvest another crop take careful note of growth stage restrictions. Current data suggests determinate varieties cannot be desiccated as early as indeterminate varieties, as yield loss may occur. Consult your county agent to determine optimum desiccation timing in FSSPS.

Double Crop Soybean Production System

Richard Roth

As with most southern states, Georgia growers can plant soybeans after harvesting a small grain crop. Typically, the small grain crop is wheat but may also be rye, oats, or triticale. This production system offers unique challenges as planting date is controlled by small grain harvest and straw must be managed properly to achieve maximum yield. Current UGA data recommends planting determinate, MG VI or MG VII varieties when planting in late May through June.

Row Spacing

Narrow rows become more beneficial as soybean planting moves later in the year. Optimum row spacing is 20 to 30-inches. If using wider rows, growers should select a tall growing bushy variety.

Planting Date

Planting date depends on small grain harvest and should occur as soon as possible following small grain harvest. Timely double crop soybean planting can be achieved by planting directly into small grain straw with a no-till planter. Small grain straw can help reduce surface soil temperatures and conserve soil moisture which may be added benefits of planting soybeans directly into it. However, the greatest benefit is the ability to plant soybeans as soon as possible after small grain harvest. Regardless of straw management practices planting should not exceed July 1^{st}.

Seeding Rate and Population

Because double crop soybeans are often planted into hot soils (> 90^{o} F) and standing residues seeding rates should be 120,000 to 140,000 seeds/acre to alleviate potential issues of poor germination or poor seed to soil contact. Final plant stands should be 100,000 to 120,000 plants/acre but populations as low as 75,000 to 80,000 plants/acre can produce sufficient yields.

Harvest Timing

As with FSSPS, concerns about grain quality at harvest are abated by later maturation and harvest of soybeans planted in double crop soybean production systems. Desiccation is not generally recommended in this system but can be utilized especially if weed pressure (e.g. morning glory) is heavy enough to slow down harvest. If you choose to desiccate in this system, please contact your county agent to discuss proper application timing.

Ultra-Late Soybean Production System

Richard Roth and Rome Ethredge

South Georgia growers can take advantage of a unique production system where soybeans are planted in late July to early August following corn harvest. Adoption ultra-late soybean production systems (ULSPS) has been driven by the ability to control late season weed pressure while producing a marketable crop. The ULSPS is most widely adopted when soybean prices are above $12/bushel. Current maturity group recommendations are to plant fast growing MG VI or MG VII varieties. ULSPS variety trial results from Camilla can be found at https://swvt.uga.edu/.

Row Spacing

The ULSPS is highly responsive to row spacing. Current UGA recommendations are to drill seed in 7.5-inch rows. The primary benefit of 7.5-inch rows is the ability to reach canopy closure and shade the soil surface in a production system where soybeans will not get very tall. Drill seeding in 7.5-inch rows allows for easier no-till planting into corn residue as most grain drills are setup for no-till applications. Row spacings up to 30 inches have been used with some success.

Planting Date

As with double crop soybean production systems, planting date in ULSPS depends on harvest timing of the preceding crop. Current UGA recommendations are to avoid planting soybeans after the first week of August. No-till planting into corn residue allows for timely soybean planting. Furthermore, land preparation operations may accelerate evaporation of valuable soil moisture.

Seeding Rate and Population

Greatest yield potential in ULSPS result from seeding rates of at least 175,000 seed/acre and current UGA research shows additional yield benefits from rates exceeding 200,000 seed/acre. Final plant stands in ULSPS should be at least 150,000 plants/acre to achieve maximum yield.

Irrigation Capabilities

Irrigation is required for ULSPS to be successful and may be needed for both germination and growth when planting this late in the year. Ensure ULSPS do not become drought stressed or significant yield loss will occur.

Fertility

Growers who successfully adopt ULSPS generally apply N fertilizer at or close to planting. This Nitrogen boosts early-season vegetative growth which raises the first node off the ground so all pods can be harvested. Increased plant height and yield can be achieved with 30 to 50 units of N.

Variety Selection

Richard Roth

Variety selection is the most important decision growers make that influences yield. This is closely followed by maturity group and planting date which are discussed in the individual production system chapters.

Variety Selection Process

Growers should seek varieties that possess high yield potential and yield consistency. Many different varieties are grown in Georgia with new varieties constantly being released. However, not all varieties are created equally. The following information can help when selecting varieties.

Planting Date and Maturity Group

The chosen soybean production system determines your optimum planting date and maturity group. This information allows variety choices to be narrowed to one or two maturity groups.

Yield Potential and Yield Stability

When making variety selections most growers look at maximum yield potential but it is just as valuable to account for yield stability across years. The University of Georgia Statewide Variety Testing Program is a good way to see how varieties perform in your area and across the state. When consulting SWVT data, look at the two or three-year average compared to the single year yield to help determine the yield stability of that variety. Detailed notes from previous growing seasons are the best tool to help make variety selections.

Weed Control

Soybean variety herbicide traits (or lack thereof) can help significantly narrow variety decisions dependent on the chosen herbicide program. Knowing field history and specific weed pressure helps determine between RoundUp Ready, Liberty Link, or some other specific herbicide trait. There are also several herbicide choices if utilizing non-GMO soybean varieties.

Irrigation

Whether or not soybeans will be irrigated can also help with variety selections. Some varieties are more prone to lodging than others which is especially problematic in irrigated environments where soybeans can accumulate vast vegetative growth. If irrigating, select a variety with good lodging ratings to reduce your risks. Irrigated environments provide the best opportunity for high yields so varieties with high yield potential should be selected.

Nematodes

Nematodes can drastically reduce soybean yields, and the occurrence of these pests can affect variety selection. If a grower is aware of nematode species and pressure in a field, planting a variety resistant to those nematodes will almost certainly increase yield.

Farmer Saved Soybeans

A few words of caution when considering the use of farmer saved soybeans:

1. Be aware of stewardship or technology agreements for soybean varieties. Some agreements specifically forbid farmer saved seed and can result in legal action. Talk to your seed supplier to find out if a variety is protected.
2. Remember, the eye cannot detect seed viability; therefore, germination tests are essential. Germination should be 80% or above. Plump seed with high germination, good color, and no visible damage will generally produce acceptable stands.

Buying certified seed is an excellent way to ensure that seed is true to variety, of high quality, and of good germination.

Fertilization and Liming of Soybean in Georgia

Glen Harris

Soybeans remove relatively large amounts of nutrients from the soil. The approximate nutrient content of a 40 bushel per acre soybean crop are shown in Table 3.

Table 3. Approximate Nutrient Utilization of 40 bu/a soybean[1]

Plant Part	Plant Nutrients Absorbed				
	N[2]	P_2O_5	K_2O	Mg	S
	lb/a				
Total Uptake	224	38	144	16	14
Seed Only	160	32	56	17	11

[1] Amounts may vary with variety, soil type, and fertilization
[2] All N fixed from the atmosphere

As seen above, soybeans utilize relatively large amounts of nutrients but these quantities should not be interpreted as the amount of fertilizer required. Nutrient additions vary according to soil type, residual nutrient status, soil pH, and past crop management. Thus, fertilizer needs should be based on soil test results.

Soil Testing and Recommendations

Soil tests are valuable for predicting fertilizer needs and monitoring soil nutrient status. Soil tests are a helpful diagnostic tool requiring common sense and experience to interpret and use in managing your fertilizer programs.

Method of Sampling

Sampling protocols are the weakest link when soil testing. Samples must accurately represent field conditions, or the results will be meaningless. Ensure soil samples are taken to plow depth.

Interpreting Soil Tests

Soil pH

Low soil pH can limit soybean yields. Liming soils for a pH between 6.0 and 6.5 is desirable for producing optimum soybean yields.

Liming acidic soil improves yield potential by reducing toxic quantities of aluminum and manganese, favoring nodule-forming bacteria growth, increasing molybdenum and phosphorus availability, supplying calcium and/or magnesium, and improving soil physical conditions.

Limestone additions should always be based on soil test results. Adding limestone without a soil test may increase pH above 6.5 causing micronutrient deficiencies. Somewhat poorly drained soils are particularly susceptible to Mn deficiencies as soil pH increases above 6.3.

When needed, limestone is most effective when applied at least three months prior to planting soybeans. Since limestone is fairly insoluble and will not leach downward, it should be thoroughly incorporated throughout the plow-layer. Surface applications will have little effect on soil acidity beyond the surface two or three inches.

Fertilization

Profitable responses to fertilizer are more likely on low fertility soils than high fertility soils. This does not rule out profitable responses from high fertility soils if factors other than fertility are optimum. Likewise, profitable responses on low fertility soils are not assured when factors such as adverse climate, poor management, or pest problems are present.

An example of soil test recommendations for phosphate and potash fertilizer for full season and double-crop situations is given in table 4. Pulling soil samples between the small grain and soybean double crop may be helpful in confirming fertility is sufficient in this system.

Table 4. Fertilizer Recommendations for Soybeans.

	Full Season		**Small Grain – Soybean**	
Soil Test Level	**P_2O_5**	**K_2O**	**P_2O_5**	**K_2O**
	lb/a			
Low	70	100	150	180
Medium	40	80	80	120
High	0	60	40	60
Very High	0	0	0	0

Nitrogen

Soybeans are a leguminous crop so nitrogen-fixing bacteria contained in nodules on roots can supply nitrogen to the plant. These bacteria convert atmospheric nitrogen to plant usable forms. Total nitrogen needs can be supplied through symbiotic nitrogen-fixation. **If soybeans have not been successfully grown in a field for three years, an inoculant containing nitrogen-fixing bacteria should be applied at planting.** Some helpful hints concerning soybean inoculation are:

- Purchase a proven soybean inoculant from a reputable dealer.
- Check the expiration date to assure viability at planting.
- Store inoculant in a cool, dry place prior to planting.
- Do not buy inoculant that is prepackaged with fungicide treatments.
- Do not mix inoculant and fungicide treatments far in advance of planting.
- Apply inoculant at rates and in the manner according to manufacturer recommendations.

Many producers use small amounts of N fertilizer for soybeans. While this practice generally provides no yield advantage, an early season growth response may be observed. In some cases, this could permit more efficient use of early season directed herbicide applications. More than 20 pounds of N per acre can seriously inhibit the symbiotic nitrogen-fixation process.

Phosphate and Potash

Phosphate and potash recommendations for soybeans are based on soil test levels as shown in table 4. Fertilization without a soil test is an unsound agronomic practice.

Soybeans are best produced on soils with good residual fertility. On most Georgia farms, it is desirable to maintain soil P index at a “High” test level and soil K index at a “Medium” or “High” test level. **Use soil test recommendations to determine P and K rates to apply to each field.**

In double-cropping systems, soybean P and K requirements can be applied to the preceding crop. On deep sands (depth to clay layer >18-20 inches), K applications should be split, with half applied in the fall, and half applied prior to planting in the spring. The quantities recommended for a small grain and soybean systems are given in table 4.

Secondary Nutrients (Calcium and Magnesium)

For most situations, adequate levels of calcium and magnesium can be maintained by using dolomitic limestone. In situations where soil pH is above 6.0 and soil Mg tests low, it is advisable to use a magnesium fertilizer rather than additional limestone.

Micronutrients

Direct application of micronutrients to soils is seldom required for soybeans in Georgia, but should be applied when soil test results indicate levels are low. When Mn levels are low and pH is above 6.0, apply 10 lbs Mn/A as manganese sulfate or manganese oxide. Liming to pH levels greater than 6.5 can induce deficiencies of manganese, zinc and copper on some soils. The most frequent occurrence of such deficiencies has been in the Ocilla, Pelham, Leefield, and similar soils in the Flatwoods area. Under high pH conditions, foliar applications of micronutrients during the growing season are more effective than soil applications. Soil applied micronutrients are rapidly converted to unavailable forms in soils with high pH. Foliar boron (1/4 to 2 lb/A) at soybean bloom often gives slight yield increases, especially on sandy soils. Adding boron to insecticide sprays (where compatible) at the R3 growth stage can improve the economics of this treatment.

It is recommended to apply 2 oz/A Dimilin plus 1/4 to 2 lb/A boron at early podding (R2-R3) to (1) increase soybean yields, (2) control velvetbean caterpillar, (3) suppress soybean looper, (4) increase insecticide effectiveness and (5) increase potential profitability of soybeans.

Poultry Litter

Poultry litter contains significant amounts of plant nutrients and is a valuable source of fertilizer for crop production. The nutrient content of poultry litter varies depending on moisture content, type of bird, feed rations, and handling / storage methods. The average N-P-K analysis of chicken litter reported by the University of Georgia Agricultural Services Laboratory is 3-2- 2. Therefore, on average, a 1 ton/A application of chicken litter will supply 60 lbs of N, 40 lbs of P_2O5 and 40 lbs of K_2O.

NOTE: These are average values. Having litter tested for nutrient content by a reputable laboratory before calculating application rates is highly recommended.

Besides N, P, and K, poultry litter contains significant amounts of calcium and magnesium (around 30 lbs of Ca and 5 lbs of Mg per ton of litter). This will not only supply these secondary elements for crop uptake, but may also maintain or even increase pH of the soil. Maintaining adequate soil levels of micronutrients such as Zn Mn, B, and Cu is another potential benefit of using poultry litter, since small quantities of these nutrients are contained in litter. An additional benefit of applying poultry litter to soil is a potential increase in soil organic matter. This could result in improved soil physical properties, such as tilth and water holding capacity.

The basic strategy for using poultry litter as fertilizer is to: 1) soil test, 2) test the litter for nutrients, then 3) match the nutrient requirements of the crop with nutrients in a corresponding amount of litter.

Nitrogen recommendations are normally based on the nitrogen requirement of the crop to be grown. Nitrogen is not recommended for soybeans because soybeans are a legume, and nitrogen needs are met through fixation of atmospheric nitrogen by symbiotic bacteria. However, nitrogen still needs to be considered since excessive amounts can cause pollution of surface water and groundwater with nitrates. In addition, excessive N in litter applications can cause lodging. Planting shorter stemmed soybean varieties may reduce the risk of lodging in this situation. Another consideration is that not all nitrogen in the applied litter will be available for uptake by the soybeans. The soybean plant will have to rely on symbiotic fixation to fulfill the total nitrogen demand. Therefore, inoculating soybeans with nitrogen-fixing bacteria is still recommended if soybeans haven't been grown successfully within three years.

SOYBEAN IRRIGATION MANAGEMENT

Wesley Porter, David Hall, and Jason Mallard

Irrigation requires a relatively high investment in equipment, fuel, maintenance, and labor, but offers a significant potential for stabilizing and increasing crop yield and proportionally net farm income. Typically, soybeans are one of the last crops that are chosen for irrigation when compared to the other major row crops produced in Georgia. However, as with all crops, the frequency and timing of water application have a major impact on yields and operating costs. To schedule irrigation for the most efficient use of water and to optimize production, it is necessary to frequently determine soil moisture conditions throughout the root zone of the crop being grown. Several methods for monitoring soil moisture have been developed and employed with varying degrees of success. In comparison to investment in irrigation equipment, scheduling methods are relatively inexpensive. When properly utilized and coupled with grower experience, a scheduling method can improve the grower's chances of successful and profitable production. Irrigation is expensive and requires proper management to be economically feasible. This can usually be accomplished when soybean market prices are good and irrigation for soybeans can be targeted for "critical periods" in July, August and September.

Corn, cotton, and peanuts are our most popularly irrigated row crops; however, we do see soybeans rotate into irrigation. Dryland soybean yields in Georgia range from about 5 to 50 bushels per acre depending on year and rainfall distribution. Extended drought during the "critical fruiting period" is the major reason for yield variation. Timely rainfall and/or irrigation events can stabilize soybean yields at 45 to 50 bushels per acre OR MORE and improve average yields by at least 20 bushels per acre. Thus, when commodity prices are high and more soybeans are rotated into irrigated production it is critical that producers have the necessary information to properly irrigate them throughout the season.

Whether irrigating low- or high-priced soybeans, there should be an increase in yield. When prices are good like they have been recently, the increase in soybean yield exponentially increases profits. Regardless of the harvested price of soybeans, irrigation management always remains important.

The utilization of any irrigation scheduling method is typically better than no plan or method at all. A good plan pays dividends in terms of yield, water-use efficiency (WUE) and net returns. In soybean, improper irrigation timing causes yield loss while irrigating too much wastes energy, water, and money. It is important to note that studies have shown that a lack of irrigation and rainfall during peak consumptive periods can deplete deep soil moisture especially in sandy soils, which is very difficult to replace via irrigation only. Thus, caution is advised during high water requiring periods.

The most simple and practical way of scheduling soybean irrigation is to use a moisture balance or checkbook method. This method helps a grower keep up with an estimated amount of available water in the field as the crop grows. The objective is to maintain a record of incoming and outgoing water so that an adequate balanced amount is maintained for crop growth. Growers require certain basic information to use a checkbook method. This information typically includes the soil type of the field and/or soil infiltration rate and water holding capacity, expected daily water use of soybean, and a rain gauge or access to nearby rainfall information. An example of a checkbook method calculation is presented in Figure 1. The UGA Soybean Checkbook was developed from a historical average of evapotranspiration between the years of 2001-2016. The crop coefficient has been refined from the development of an irrigation scheduling application by using soil moisture sensors, soil moisture information, and soybean yields. The checkbook method is very conservative and most often errors on the side of over irrigating rather than under irrigating. However, caution is advised when utilizing a checkbook method alone as it was developed from a historical average and may not adequately address water requirements during extreme (either extended cloudy weather or higher temperatures) years. This means that in years that are hotter than average the checkbook method would tend to under-irrigate and during years that have more cloudy days and cooler temps it would tend to over-irrigate.

Irrigation recommendations for soybeans in the past have been based on properly utilizing irrigation to produce a moderate yield of 45 to 50 bushels while maintaining profitability at much lower market prices. To meet those criteria, the following recommendations were created and have been used for many years (Table 5).

Table 5. The following water balance method is suggested for 45 to 50 bushel soybean yields:

Growth Stage	Trigger	Amount
Stand Establishment	Irrigate prior to planting	1 - 1.5”
Prior to 1st Bloom (VE – R1)	Wilting by late afternoon	1 – 1.5”
1st Bloom – Beginning Pod Elongation (R1 – R4)	Wilting by mid-day	1.0 –1.5”
Beginning Seed – Full Seed (R5 – R6)	Keep from wilting	1.0 –1.5”
Full Seed – Maturity (R6 – R7)	Wilting by late afternoon	1.0”

This scheduling method can consistently increase yield. However, current soybean prices and higher yield potential of modern varieties create a situation where producers may be able to manage irrigation more adequately to further increase yield. Thus, it is advised that a producer new to irrigating soybean start at a minimum with the UGA Checkbook method as a guide.

It should be noted that one issue with traditional recommendations is that scheduling has been based on wilting of the soybean crop. However, once the soybean plant wilts, yield potential will be lost, and the degree of loss is related to crop stage during which stress occurs. Specifically, when wilting occurs during reproductive growth the chance for lost yield potential is greater than if it occurs during vegetative growth. Therefore, this system can be modified by irrigating to prevent wilting from first Bloom (R1) until full seed (R6) instead of just between R5 and R6.

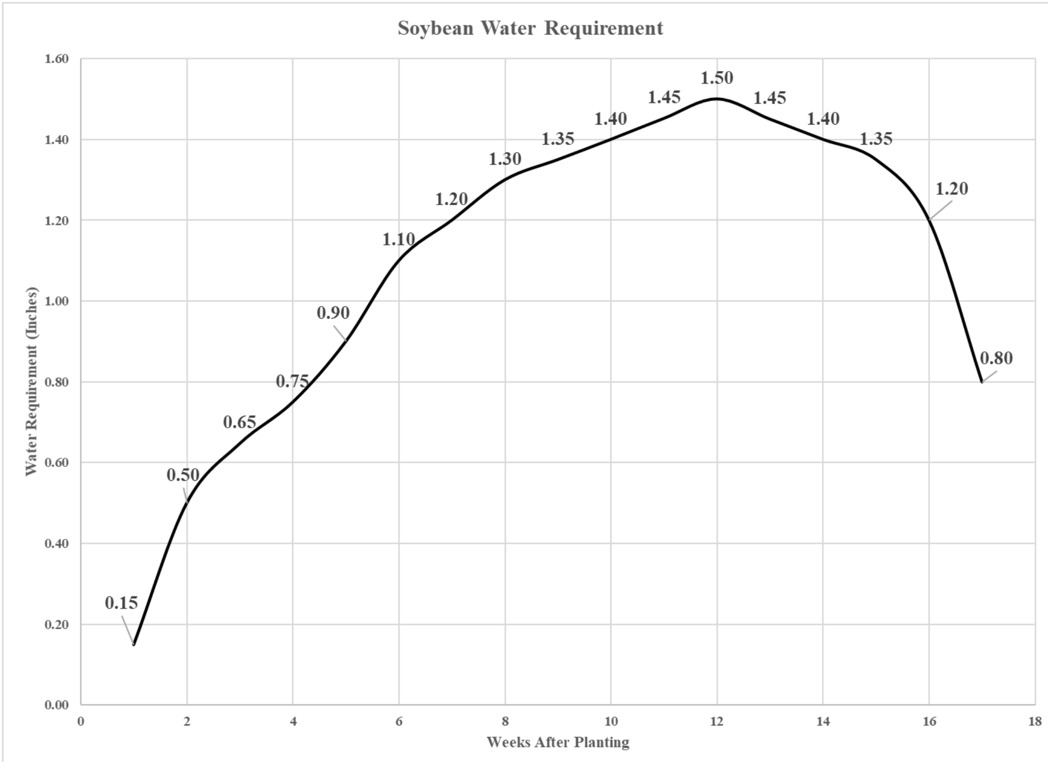

Figure 1. The weekly water requirement for soybeans.

Table 6. Weekly water requirement for soybeans.

Physiological Stage	Weeks After Planting	Average Weekly Water Requirement (Inches)	Average Daily Water Requirement (Inches)
Stand Establishment	1	0.15	0.02
Stand Establishment–VE	2	0.50	0.08
VE – VC	3	0.65	0.09
VC – V2	4	0.75	0.11
V2 – V4	5	0.90	0.13
V4 – V5	6	1.10	0.15
R1 – R2	7	1.20	0.17
R2 – R3	8	1.30	0.18
R3 – R4	9	1.35	0.19
R4 – R5	10	1.40	0.20
R4 – R5	11	1.45	0.21
R5 – R6	12	1.50	0.22
R5 – R6	13	1.45	0.21
R5 – R6	14	1.40	0.20
R6 – R7	15	1.35	0.19
R7 – R8	16	1.20	0.17
R8 – Maturity	17	0.80	0.12

It is important to keep in mind planting date and the maturity group being grown. For example, if an MG VII or MG VIII is planted in early May and you follow the weekly water applications, near the end of the growing season you will run out of weeks according to our chart. The weekly rates are important but keeping in mind the growth stage may prove more beneficial. Contact your local Extension office if you need assistance distinguishing soybean growth stages.

Temperatures during early reproductive growth play a large role in Georgia soybean yield potential. High temperatures during early reproductive growth (R1 through R3) can significantly reduce flower and pod retention and potentially reduce yield. There are two ways proper irrigation could help alleviate these effects. First, proper irrigation prior to bloom can help ensure canopy closure, so shading can create a cooler microclimate during reproductive growth. Secondly, proper irrigation ensures adequate soil moisture during initiation of reproductive growth so the crop can withstand more heat and retain pods and blooms.

Irrigation Scheduling Methods

Scheduling irrigation for maximum water use efficiency and yield requires frequent determination of soil moisture conditions in the root zone of the crop being grown. Several methods for this have been developed and used with varying degrees of success. In comparison to investment in irrigation equipment, these instruments are relatively inexpensive. Talk to your County Extension Agent for information on particular sensor technology and potential costs.

Keeping a Record of Rainfall/Irrigation

Regardless of method used to irrigate, full benefits of irrigation can be obtained by keeping accurate records of irrigation and rainfall events. Maintaining good records allows producers to predict irrigation events more accurately because they know exactly how much water has been applied to the crop during which stages. This method can be combined with any irrigation scheduling method from the simple Checkbook to the advanced soil moisture sensor systems.

Water Balance Methods

The most common method used that does not require frequent field activity is the water balance method. The principle of the water balance method is to obtain a balance of incoming and outgoing soil water so adequate soil water is maintained for the plant. Inputs include incoming water in any form, whether rainfall or irrigation. It is suggested that irrigation and rainfall efficiency be accounted for to provide more accurate estimations of soil moisture. Outputs include evapotranspiration, runoff, and deep percolation. Water removal is more commonly referred to as evapotranspiration (ET). Evapotranspiration is usually expressed in inches per day. It consists of water removal by the plant and water loss directly by the soil. Two variations of the water balance method are used. One utilizes crop water use curves; the other uses pan evaporation data. To use either variation you must know your soil type and the available water holding capacity of the soil. This information can be obtained from your local Natural Resource Conservation Service, County Agent, or online through the NRCS Web Soil Survey. It should be noted that the Checkbook is a simplified version of this method. The Checkbook does not account for soil type if it is used standalone, but it can be used in combination with a water balance method as is being described here. Next you should determine the soil zone you are trying to manage. This zone will vary according to the effective rooting depth of the soybeans. Usually 24 inches or less (2 feet) is the most that can be managed with irrigation. Determine the total water you have available to manage in this zone. It is desirable to try to maintain water content above 50% of the available water holding capacity. As water is removed daily (by either crop use or evaporation) these amounts are subtracted from the water available. When the moisture available approaches a zero balance, it is time to irrigate. The amount to add depends on the soil type but will usually be the same as the 50 percent value calculated earlier plus an added amount to account for application efficiencies less than 100%. (Typical application efficiencies for sprinkler irrigation equipment vary from 75 percent to 90 percent.)

Soil Water Balance Irrigation Example

Step 1. Soil type is Tifton loamy sand. In Table 7, average available water holding capacity is 1.0 in/ft. Assuming a 2 ft rooting depth, total available water is 2.0 inches (2 ft x 1.0 in/ft)

Step 2. If soybeans are in 10th week after planting then daily water use is 0.2 inches/day (Table 6)

Step 3. Determine replacement water amount by setting the lower allowable limit of available water in the profile. For this example, a typical value of 50% allowable depletion is used (i.e. only 50% of water in the root zone is allowed to be deplete). Therefore, 1.0 inch of water will be required to replace the water used (2.0 inches x 0.50).

Step 4. Determine the amount of irrigation to apply by dividing the replacement amount by an irrigation efficiency from Table 8. (There are always losses between water pumped and water reaching the crop, such as evaporation, drift, etc.). In this example, assume a fairly new center pivot with 88% efficiency. Thus, amount to apply = 1.0 inch/0.88 = 1.14 inches

Step 5. Determine irrigation frequency by dividing the replacement water amount by water use per day. For example, frequency = 1.0 / 0.2 = 5 days.

Step 6. In this example, it would be necessary to apply 1.14 inches every 5 days to maintain 50% available water in Tifton loamy sand soil for soybeans during the 10th week after planting. Any rainfall received would be subtracted from the amount to apply.

Please note that irrigation applications over 0.75 inches typically result in runoff in most Georgia soil types. This is due to infiltration rates of Georgia soils. It is important to consider this when monitoring rainfall events (especially high intensity rainfall events). This means any additional water over 0.75 inches will be lost, so no single application should exceed this amount. High intensity rainfall events often become runoff too, and producers should carefully manage for rainfall. It is more beneficial for the crop if the required 1.14 inches were split into two applications of 0.57 inches every 2.5 days. If you have a pivot so large that it cannot make a round through the field in the calculated split time it is recommended that you apply the minimum amount required for the pivot to travel around the field as quickly as possible, and repeat this step as often as needed to reach required irrigation amounts. In most cases more frequent irrigation applications with lower rates are recommended. However, the rates still need to be high enough so that they can reach and infiltrate into the soil.

Irrigation intervals for most of the season will be 3 to 4 days for coarse textured sand, 4 to 6 days for more productive loamy sand and sandy loam, and 5 to 8 days for fine textured sandy loam or clay soils. A 4 to 6 day interval will fit a majority of the situations.

Table 7. Available Water Holding Capacity and Infiltration Rate of Coastal Plain Soils in Georgia.

Soil Series	Description	Infiltration Rate (Inches/Hr) for Bare Soil*	Available Water Holding Capacity (inches/Ft)
Faceville	Sandy Loam, 6-12" Moderate intake, but rapid in first zone	1.0	1.3
Greenville			1.4
Marlboro			1.2-1.5
Cahaba	Loamy Sand, 6-12" Loamy subsoil, rapid in first zone, moderate in second	1.2	1.0-1.5
Orangeburg			1.0-1.3
Red Bay			1.2-1.4
Americus	Loamy Sand, 40-60" Rapid permeability	2.0	1.0
Lakeland			0.8
Troup			0.9-1.2
Norfolk	Loamy sand, 12-18" Rapid permeability	1.3	1.0-1.5
Ochlocknee			1.4-1.8
Dothan	Loamy sand and sandy loam, 6-12" Moderate intake	1.0	1.0-1.3
Tifton			0.8-1.0
Fuquay	Loamy sand, 24-26" Rapid permeability in first zone, moderate in second	1.5	0.6-0.8
Lucy			1.0
Stilson			0.9
Wagram			0.6-0.8

*Increase soil infiltration rate in field where conservation tillage methods are used.

Table 8. Examples of Application Efficiency Values for Various Irrigation Systems.

Irrigation System Type	**Application Efficiency (%)**	
	Attainable	**Expected**
Center Pivot w/ Impact Sprinklers	85	75-85
Center Pivot w/ Spray-type Sprinklers	95	75-95
Lateral Move w/ Spray-type Sprinklers	95	75-95
Subsurface Drip	95	70-95
Micro-Spray	95	70-95
Trickle	95	75-95
Subsurface Drip	95	70-95
Moving Big Gun	75	60-75

Advanced Irrigation Scheduling

The soil water balance or Checkbook method of scheduling described above is a relatively straight-forward means of determining WHEN and an estimated amount of HOW MUCH to irrigate. This method helps a grower keep up with an estimated amount of available water in the field as the crop grows. However, this is a pretty basic method and as was earlier stated in this chapter is not applicable to all years. Thus, more advanced producers should consider utilizing more advanced irrigation scheduling methods such as soil water balance models or soil moisture sensors. More advanced methods include software such as the SmartIrrigation Soybean App (www.smartirrigationapps.org). The benefit of an interactive App is that it utilizes real time weather data to make daily decisions on irrigation requirements based on a few parameters input by the producer with little to no cost. Soil moisture sensors provide near real-time readings of either soil moisture content or soil water tension in the root zone and can identify when water is needed to replenish the root zone. Soil moisture sensors coupled with a sound irrigation strategy will typically provide the highest yield level when compared to other methods because they are providing current readings and current crop water status, while other methods may just be estimates. When utilizing soil moisture sensors, it is important to select locations for the sensors in soil types and conditions representative of most of the field, avoiding extreme areas of the field. It is also recommended to adjust the number of sensors based on the size of the field and field conditions. Research results show that the checkbook method, although conservative, is not necessarily the most economically feasible method. Especially during years with higher levels of rainfall the checkbook method tends to over-irrigate and reduce yields if not properly managed.

Soybeans are legumes so fertigation is not usually considered, but chemigation can be a very useful tool in growing soybeans. If your system has the capacity to apply 0.1 inches or less of water per application, chemigation can save a costly trip across the field when it comes time for boron, dimilin and other possible insecticide. UGA Extension highly recommends that a producer ensures the system to be used is applying water uniformly. All center pivots need to be applying water as even and efficiently as possible but with Chemigation, it is vital. A uniformity test can be completed with a quick catch can test or contact your local County Agent for a possible Mobile Irrigation Lab to be conducted on the system.

As stated earlier, growers with high yield goals should consider implementing a robust irrigation management plan. However, the grower must evaluate if the implementation of this plan is feasible for their operation. Based on the level of interest the grower should decide if they want to implement a simple plan that they can manage themselves or if they want to go more advanced and either hire a full-time employee for irrigation management or hire a consultant to provide recommended irrigation amounts. This decision will be related to farm size, crop produced, and grower investment. Irrigation scheduling does take time, and growers are cautioned against implementing a plan without being properly prepared.

Soybean Weed Control

Eric Prostko

Weed management is one of the most critical management factors for soybean production. Uncontrolled weeds can reduce yield through competition for light, nutrients, and moisture, and severely reduce harvest efficiency. Before implementing a weed management plan for soybeans, several factors should be considered including weed species, rotational crops, and cost/A.

Soybean Weed Management Strategies

The most effective weed management programs in soybeans use a combination of cultural, mechanical, and chemical control strategies. Cultural practices include factors like planting date, planting rate, and row spacing. Cultural practices improve weed control by enhancing the competitive ability of soybeans. Mechanical practices, such as cultivation, are a non-chemical method for controlling weeds between rows. Many herbicides are labeled for use in soybeans and can be applied preplant incorporated, preemergence, postemergence, and post-directed. A complete update on herbicides recommended in Georgia can be found in the latest edition of the Georgia Pest Control Handbook – Special Bulletin 28. Because so many herbicides are labeled for use in soybeans, just about any weed problem that arises can be controlled. It is just a matter of how much money can be economically justified for weed control in soybeans.

Row Spacing Effects on Weed Control and Soybean Yield

A review of soybean row spacing trials shows narrow row spacing (i.e. < 30”) provides significant reductions in late-season weed density in the majority of experiments across the U.S. Additionally, research in Georgia shows narrow row spacing can increase soybean yield (Table 9).

Table 9. Soybean yield change from reducing row spacing in Georgia.

Year	Location	Row Spacing Comparison	Yield Increase with Narrower Row (%)
1979	Athens	38” to 19”	11
1981	Tifton	36” to 18”	4
1982	Plains	36” to 20”	17
1989	Plains	30” to 20”	8
		30” to 10”	11
		20” to 10”	3
2007/2008	Camilla	36” to 24”	8
2015	Midville	22” to 15”	19
		22” to 7.5”	30
Average			**12**

Georgia's Soybean Weed Problems

Table 10 lists Georgia's most common and troublesome weeds of soybean.

Table 10. Common and Troublesome Weeds of Georgia Soybeans.

Rank	Common	Troublesome
1	Palmer amaranth	Glyphosate + ALS-resistant Palmer amaranth
2	Texas millet (panicum)	Glyphosate-resistant Palmer amaranth
3	Smallflower Morningglory	Benghal dayflower (tropical spiderwort)
4	*Ipomoea M*orningglory Species	Palmer amaranth
5	Florida Pusley	*Ipomoea* morningglory species
6	Crabgrass Species	Florida pusley
7	Florida Beggarweed	nutsedge species
8	Nutsedge Species	spreading/Asiatic dayflower
9	Sicklepod	smallflower morningglory
10	Bristly Starbur	Texas millet

Weed Competition in Soybeans

If a weed management program in soybeans is going to be successful and economical, a thorough understanding of the competitive effects of weeds is important. Regarding this area, two things must be considered: 1) When do the weeds need to be controlled to prevent significant yield losses? and 2) How much yield loss are they causing? Research shows that weeds emerging just prior to or at the same time as the soybeans cause greater yield losses than later emerging weeds. Consequently, effective weed control during the initial 2 to 4 weeks after soybean emergence usually prevents yield losses due to weed competition. However, later emerging weeds can have a negative influence on seed quality and harvest efficiency. Other research has shown that soybean plants can tolerate a certain level of weed pressure and that control strategies should only be implemented when the potential yield losses caused by the weeds exceeds the cost of control (*i.e. economic threshold concept*). Table 11 illustrates the influence of various weed species on soybean yield: However, recent concerns about herbicide-resistant weeds have caused many growers to re-consider a ***zero-tolerance*** policy for weeds with the goal of reducing seed-rain back into their fields.

Table 11. Number of Weeds/100 Row Feet that Cause Yield Reductions in Soybeans.

Weed	Soybean Yield Loss (%)					
	1	2	4	6	8	10
Cocklebur or giant ragweed	1	2	4	6	8	10
pigweed or lambsquarters	2	4	6	10	15	20
morningglory or velvetleaf	8	16	24	32	40	50
smartweed or jimsonweed	2	4	6	10	15	20

Source: Pike, D. R. 1999. Economic Thresholds for Weeds. University of Illinois, Cooperative Extension.

Metribuzin in Soybeans

Metribuzin is an older herbicide that at one time was very popular in soybeans. Back in 1990, nearly 20% of the soybean acres in the U.S. were treated with metribuzin. Many seasoned soybean growers likely remember when metribuzin was sold under the trade names of Sencor or Lexone. Over the past few years, UGA weed scientists have encouraged the use of metribuzin in Georgia for various reasons (i.e. can be applied PPI or PRE, a non-PPO herbicide, good on ALS-resistant pigweed, residual control of sicklepod). However, the use of metribuzin is not without complications. Growers must be aware of many factors before considering the use of metribuzin. These include soil pH, soil organic matter (%), soil texture, application rate, planting depth, and variety. Generally, metribuzin injury is more likely to occur when higher rates are used on sensitive varieties that are shallowly planted in lighter soils.

Examples of commercial herbicides containing metribuzin are: Authority MTZ (Spartan + metribuzin); Boundary (Dual Magnum + metribuzin); Canopy (Classic + metribuzin); Fierce MTZ (Valor + Zidua + metribuzin); Intimidator (Dual Magnum + Reflex + metribuzin); Mauler (metribuzin); Metri (metribuzin); TriCor (metribuzin), and Trivence (Valor + Classic + metribuzin).

Roundup Ready (RR) Soybeans

It has been estimated that 95% of the soybeans planted in the U.S. during 2022 were herbicide-resistant varieties. Since 1996, producers rapidly adopted the Roundup Ready (glyphosate) soybean system because of its ease of use. In the early days of this system, it was very common for growers to apply 1 or 2 applications of glyphosate and to not use any other herbicides or weed control strategies. Consequently, glyphosate-resistant weeds have become a serious problem. It is now recommended that every acre of Roundup Ready soybeans (and any other type of soybean) in Georgia should receive at least 1 application of a residual herbicide. In most cases, 2 residual herbicides may be required for optimum weed control, especially when heavy populations of Palmer amaranth exist. Additional information about the control of herbicide-resistant weeds in soybeans is discussed later in the chapter.

Tank-Mixes with Glyphosate for Improved Morningglory Control in RR Soybeans

One of the more common weeds that glyphosate has not provided consistent control of is morningglory. Single applications have rarely been adequate to control this weed complex. Split applications of glyphosate provide better morningglory control than single applications but many producers are reluctant to pay the additional application and herbicide costs. Tank-mixes with other broadleaf herbicides (Table 12) can help improve the control of morningglory at a reduced cost compared to split applications. In most cases, the addition of these herbicides has only resulted in a 5 to 10% increase in morningglory control. Morningglory control with glyphosate can also be greatly improved by making a timely application before the weed exceeds 2" in height.

Growers who continue to struggle with annual morningglory control in RR soybean systems may want to consider growing Liberty-Link (LL) soybeans. The active ingredient in Liberty, glufosinate, is generally known to be more effective on morningglories than glyphosate. The LL soybean weed control system is discussed later in this section.

Table 12. Potential tank-mixes with glyphosate to improve morningglory control in RR soybeans.

Herbicide	Rate/A
Classic 25DF	0.25 - 0.33 ozs
FirstRate 84WDG	0.15 - 0.30 ozs
Resource 0.86EC	4 ozs

Glyphosate/Boron/Dimilin Tank-Mixes

A common soybean production practice in Georgia is to apply a combination of Dimilin (diflubenzuron) + boron at the R2 to R3 stage of growth. Numerous inquiries have been made about the potential for adding glyphosate to this treatment. Research conducted in Georgia and South Carolina indicates that the 3-way combination of glyphosate + Dimilin + boron can be used in soybeans without concern for compatibility problems or excessive soybean injury.

However, it has been demonstrated in numerous studies that the best time to apply glyphosate is between the V2 and V3 stages for soybeans grown in 30" rows and between the VC and V4 stages for soybeans grown in 7.5" rows. Thus, single applications of glyphosate made at the R2 to R3 stage of growth are too late to provide the best level of weed control and optimal yields. The 3-way combination of glyphosate + Dimilin + boron would be much more effective when used following an earlier application of glyphosate applied at the appropriate time. If the 3-way combination is used, the rate of boron should not exceed 0.25 lb ai/A.

Glyphosate/Manganese Tank-Mixes

Growers with soybeans that are exhibiting foliar manganese (Mn) deficiency symptoms should be cautious when considering tank-mixing Mn fertilizers with glyphosate. Research has shown that certain formulations of Mn, particularly Mn-EAA, Mn-LS, and $MnSO_4$, applied in combination with glyphosate, can significantly reduce weed control. Consequently, split-applications would be preferred if these formulations of Mn are used. Mn-EDTA (chelated) formulations of Mn have not reduced weed control when applied in combination with glyphosate. $MnSO_4$ has not reduced the weed control performance of other herbicides such as Basagran, Ultra Blazer, Classic, or Pursuit.

Nutsedge Management in RR Soybeans

Potential nutsedge control strategies in the RR soybean production system include:

1. Two postemergence glyphosate applications (14 days apart). This will be more effective on purple nutsedge than yellow nutsedge.
2. Classic tank-mixed with glyphosate. This treatment will control yellow and suppress purple.
3. Pursuit tank-mixed with glyphosate. This will be more effective on purple than yellow. A pre-mixed combination of Pursuit + glyphosate is sold under trade names of Extreme or Tackle.

Soil-applied herbicides that have fair to good activity on yellow nutsedge include the following: Canopy/Cloak, Dual Magnum, Envive, Prefix, Pursuit, Reflex, Scepter, and Warrant.

Liberty-Link® (LL) Soybean System

Liberty-Link® soybean varieties were introduced into the market in 2009. These varieties are resistant to postemergence applications of Liberty (glufosinate). Generally, Liberty is very effective on numerous broadleaf weeds, particularly morningglory species. With proper management, the Liberty-Link system can also be used to help control glyphosate and ALS-resistant Palmer amaranth. Before using the Liberty-Link soybean system, consider the following:

1. Liberty is not necessarily a direct replacement for Roundup (glyphosate). There are many differences in weed susceptibility to these herbicides.
2. It is strongly recommended that a residual herbicide be used with the Liberty-Link system! The use of residual herbicides in the Liberty-Link system will improve the control of herbicide-resistant weeds and help delay the development of resistance to Liberty.
3. Liberty must be applied in a minimum of 15 GPA.
4. Liberty should be applied using nozzle and pressure combinations that generate medium to coarse spray droplets (VMD_{50} = ~236-403 microns). Refer to spray nozzle tip manufacturer guidelines for more information about droplet size.
5. Liberty is most effective when applied between the hours of 9:00 am and 6:00 pm.
6. Liberty tank-mixes with grass herbicides (Assure, Fusilade, Poast, and Select) may result in reduced grass weed control.
7. Liberty will not consistently and effectively control Palmer amaranth that exceeds 3" in height.
8. Refer to the latest UGA Soybean Variety Tests for more information about the agronomic performance of Liberty-Link soybeans. These results can be accessed from the following web-site: https://swvt.uga.edu/
9. Some Liberty-Link soybean varieties have exhibited poor tolerance to metribuzin herbicides. Refer to the most current list of metribuzin-tolerant soybean varieties in the 2022 Edition of the Georgia Pest Control Handbook – Special Bulletin 28. Herbicides that contain metribuzin include the following: Authority MTZ, Boundary, Canopy, Fierce MTZ, Intimidator, Mauler, Tricor, and Trivence.
10. Liberty can also be applied POST on Enlist™ E3, XtendFlex®, and LL-GT27 soybean varieties.

Enlist™ Soybean Production Systems (2,4-D Choline Tolerant Soybeans)

Corteva™ Agriscience (formerly DowAgroSciences) has developed soybeans that are tolerant to glyphosate, 2,4-D choline, and glufosinate (Liberty). Collectively, the trait and herbicides are marketed as the Enlist™ Weed Control System. Deregulation of the Enlist™ soybean trait occurred in September of 2014. Enlist Duo® herbicide (glyphosate + 2,4-D choline) was registered in October 2014. Enlist One® (2,4-D choline) was registered in September 2017. China approved the import of Enlist™ soybeans in January 2019. Enlist Duo® and Enlist One® have numerous requirements for application including but not limited to the following:

1. Only for use on Enlist E3™ soybean varieties.
2. Apply POST in soybeans no later than the R1 or full flowering stage. A total of 2 POST applications can be made (12 days apart)
3. Only used approved tank-mixes and nozzles.
4. Clean sprayer before using Enlist™ herbicides to avoid contamination from a previous application.
5. Apply Enlist™ herbicides when wind speed is between 3 MPH and 10 MPH. Do not apply if wind speeds are greater than 15 MPH.

6. Do not spray Enlist™ herbicides during a temperature inversion.
7. Must maintain a 30' foot downwind buffer from any area except a) roads, paved, or gravel surfaces; b) planted agricultural fields except those listed as susceptible; c) agricultural fields that have been prepared for planting; and d) areas covered by the footprint of a building, shade house, greenhouse, silo, feed crib, or other man-made structures with walls and/or a roof.
8. Do not spray if wind is blowing towards susceptible crops including tomatoes (EPA crop group 8), cucurbits (EPA crop group 9), grapes, and non-tolerant cotton.
9. Use a minimum of 10 GPA (15 GPA is preferred).
10. Apply either 4.75 pts/A of Enlist Duo® or 2 pts/A of Enlist One®. Enlist Duo is not labeled for use in the following counties: Baker, Berrien, Brooks, Burke, Calhoun, Early, Irwin, Lee, Miller, Screven, and Worth.
11. Follow Corteva™ labeled/recommended sprayer cleanout procedures (including triple-rinsing).
12. The certified applicator applying this product on soybeans must attend UGA's Using Pesticides Wisely (UPW) training.

For more information on application requirements, tank-mixes, nozzle types, etc. for the Enlist™ Weed Control System, please refer to the following web-site: https://www.enlist.com/en.html

NOTE: It is illegal to apply older formulations of 2,4-D amine or ester (i.e. Weedar 64 or Weedone, etc.) to 2,4-D-tolerant soybeans. It is also very important to note that Enlist™ soybean variety performance data for the Southeast is very limited at this time.

Xtend™ Soybean Production Systems (Dicamba-Tolerant Soybeans)

Soybean varieties that are tolerant to both glyphosate and dicamba have been developed. Collectively, the trait and herbicides are marketed as the Roundup Ready® Xtend® Crop System. Currently, 3 low-volatile formulations of dicamba are labeled for use in this system including Xtendimax® with Vapor Grip®, Engenia™, and Tavium® Plus Vapor Grip®. Tavium is a pre-mixture of dicamba + s-metolachlor. It is illegal to apply non-labeled formulations of dicamba (i.e. Banvel, Clarity, Rifle, Sterling Blue, etc.) on dicamba-tolerant soybeans!

Xtendimax®, Engenia®, and Tavium®, are restricted use pesticides and their labels have numerous requirements for application including but not limited to the following:

1. Can only be used on Roundup Ready 2 Xtend® or XtendFlex® soybean varieties.
2. Can only be purchased and applied by certified pesticide applicators.
3. Can be applied preemergence and/or postemergence (R1) but no later than June 30. Only 2 POST applications of Xtendimax or Engenia can be made in soybeans (7 days apart). Only 1 POST application of Tavium is permitted.
4. Can only be tank-mixed with products that have been tested and found not to adversely influence off-site movement potential. Check the following web-sites for a current list of approved tank-mixes and all other requirements:
    a. Xtendimax:www.XtendiMaxApplicationRequirements.com
    b. Engenia:https://www.engeniaherbicide.com/
    c. Tavium:https://www.syngenta-us.com/herbicides/tavium-application-stewardship

5. Cannot be tank-mixed with AMS or UAN.
6. Can only be applied using specific nozzles. Refer to above web-sites for current list of approved nozzles.
7. Must be applied in minimum of 15 GPA.
8. Application speeds cannot exceed 15 MPH.
9. Maximum boom height of 24”.
10. Cannot be applied when wind speeds are < 3 MPH or > 10 MPH.
11. Can only be applied between 1 hour after sunrise to 2 hours before sunset.
12. Must include an approved drift reduction adjuvant (DRA) and a volatility reducing agent (VRA) with Xtendimax and Tavium. An approved DRA + pH buffering adjuvant (PHBA) is required with Engenia.
13. Must maintain a 240’ downwind buffer for all applications. In counties with endangered dicot species, must maintain a 310’ downwind buffer + a 57’ omni-directional buffer around other sides of a field. More information about endangered species in Georgia counties can be obtained at the following web-sites:
14. Bulletins Live! Two: https://www.epa.gov/endangered-species/bulletins-live-two-view-bulletins
15. Cannot be applied when wind is blowing toward sensitive crops/residential areas including but not limited to non-dicamba tolerant cotton/soybean, tobacco, peanut, tomatoes and other fruiting vegetables (EPA Crop Group 8), cucurbits (EPA Crop Group 9), ornamentals, fruit trees, and grapes.
16. Specific application records must be generated with 72 hours of application and kept for a minimum of 2 years. Refer to product labels.
17. All growers/applicators who intend to apply Xtendimax®, Engenia®, and Tavium® in soybeans in 2023 must have attended UGA’s “Using Pesticides Wisely” training program.

XtendFlex® Soybean Systems

In September 2020, full approval was granted for XtendFlex® soybean varieties in the U.S. XtendFlex® soybean varieties are tolerant of glyphosate, dicamba, and glufosinate. Dicamba and glufosinate should not be tank-mixed. Xtend® varieties are *NOT* tolerant of glufosinate. The tank-mixture of glyphosate + glufosinate has been shown to be antagonistic (*i.e. reduced control*) on certain weeds in some research and has not been adequately evaluated for XtendFlex® soybeans in Georgia at this time.

Sicklepod Control

Historically, sicklepod has been one of the most troublesome weeds in Georgia soybeans. Although considered less competitive than many other weeds, sicklepod populations can quickly reach levels that could significantly reduce yield. Fortunately, several control strategies for this weed are available.

In conventional soybeans, the best method to control sicklepod is to use a systems approach that includes a preplant incorporated or preemergence application of Tricor (metribuzin), Canopy/Cloak (metribuzin + chlorimuron), or Boundary (metribuzin + *S*-metolachlor) followed by a postemergence application of Classic. Caution is advised when using metribuzin products because several restrictions on soil type, organic matter, pH, and variety exist. Refer to the specific herbicide label for these restrictions. Python (flumetsulam) can be substituted for metribuzin products in those situations where metribuzin use is prohibited or not preferred.

Sicklepod is susceptible to glyphosate and glufosinate (Liberty) thus can be managed using either the RR or LL production systems. However, 2 applications of glyphosate or glufosinate may be required to provide season-long control.

Tropical Spiderwort (Benghal Dayflower) Control in Soybean

Tropical spiderwort, also known as hairy wandering jew or Bengal dayflower, has become an increasing problem in many soybean fields. Planting in narrower rows and increasing plant populations will improve control of tropical spiderwort through competition. Tropical spiderwort control can also be improved using tillage (i.e. moldboard plow).

The most effective herbicide control strategies for tropical spiderwort include using a combination of preemergence (PRE) and postemergence (POST) herbicides. One of the best soil-applied herbicides for tropical spiderwort control is Dual Magnum (*S*-metolachlor). Generic formulations of metolachlor are available (Me-Too-Lachlor, Stalwart, and Parallel PCS) but these have not provided the same length residual control of tropical spiderwort as Dual Magnum in UGA trials. Outlook (dimethenamid-*P*), Warrant (micro-encapsulated acetochlor), and Zidua (pyroxasulfone) also provide effective residual control of tropical spiderwort. POST herbicides with fair to good activity on tropical spiderwort include Basagran, Classic, FirstRate, and Pursuit.

Gramoxone/Firestorm/Parazone or Aim can be used post-directed or in a hooded sprayer. When using Gramoxone/Firestorm/Parazone post-directed, the soybeans must be at least 8" in height and the herbicide should not be sprayed higher than 3" on the soybean plant.

In RR soybean systems, glyphosate can provide fair to good control of tropical spiderwort if applied to plants 3" tall or less and under ideal growing conditions. More effective control can be obtained by applying either Sequence or Extreme/Tackle. Sequence is a pre-mix of glyphosate + Dual Magnum. Extreme/Tackle is a pre-mix of glyphosate + Pursuit. Classic or FirstRate can also be tank-mixed with glyphosate to improve control of tropical spiderwort.

Herbicide-Resistant (HR) Weeds

HR-weed species can become a serious problem in fields when a single herbicide or herbicides with similar modes of action are used repeatedly. This phenomenon has been documented in Georgia with Palmer amaranth (pigweed) and other weed species (Table 13). Populations of Palmer amaranth have been found in Georgia that are resistant to atrazine, glyphosate, and/or ALS-inhibiting herbicides. Check with your local County Extension Agent for updated information about the distribution of HR-weeds in your area.

Table 13. Confirmed Herbicide-Resistant Weeds in Georgia.

Weed	Year	Herbicide(s)	Site of Action
goosegrass	1992	Treflan	Microtubule inhibitor
prickly sida	1993	Scepter	ALS inhibitor
Italian ryegrass	1995	Hoelon, Poast	ACCase inhibitor
Palmer amaranth	2000	Cadre, Pursuit	ALS inhibitor
Palmer amaranth	2005	glyphosate	EPSP synthase inhibitor
Palmer amaranth	2008	Staple + glyphosate	ALS + EPSP
large crabgrass	2008	Poast	ACCase inhibitor
Palmer amaranth	2008	atrazine	PS II inhibitor
Italian ryegrass	2009	Hoelon + Osprey	ACCase + ALS
Palmer amaranth	2010	Atrazine + glyphosate + Staple + Cadre	PS II + EPSP + ALS
spotted spurge	2014	Manor, Blade	ALS
annual sedge	2016	Sandea, Plateau, Certainty, Monument	ALS inhibitor
yellow nutsedge	2018	Cadre	ALS inhibitor
Palmer amaranth	2022	Valor, Reflex, Cobra, Ultra Blazer	PPO inhibitor

PPO-resistance is on the rise (14 species worldwide; 6 species in US). PPO-resistance has recently been officially confirmed in at least 1 population of Palmer amaranth in Georgia. Popular PPO herbicides include Aim (carfentrazone), Cobra (lactofen), Reflex (fomesafen), Spartan (sulfentrazone), Ultra Blazer (acifluorfen), and Valor (flumioxazin). Avoid repeated applications of PPO herbicides in the same year and hand-remove any weed escapes before seed production!

Auxin-resistance has occurred in 42 species worldwide including 10 in the U.S. Thus, wisely stewarding new Xtend™ (dicamba) and Enlist™ (2,4-D choline) weed control systems is critical.

Liberty (glufosinate) resistance has only occurred in 6 species worldwide (3 species in US).

Finally, HR-weeds can only be successfully managed using diversified systems that utilize a combination of strategies like cover crops, crop rotation, row patterns, mechanical cultivation, herbicides with different modes of action, timely POST herbicide applications, and hand-weeding.

Rotational Crop Concerns

Advances in herbicide chemistry have led to development of some exceptional families like the sulfonlyureas (Classic, Pinnacle), imidazolinones (Pursuit, Scepter), sulfonanilides (Python, FirstRate), and others. Many of these are used in soybeans. However, some of these may injure rotational crops if appropriate replanting intervals are not observed. Cropping system diversity in Georgia necessitates that producers consider potential effects that herbicides could have on rotational crop the following year. This information is available on nearly all herbicide labels.

Herbicide Recommendations

A general summary of potential herbicide programs for the various soybean weed control systems is provided in Table 14. For a more complete listing of herbicides and their use patterns in soybeans, please refer to the latest edition Georgia Pest Control Handbook – Commercial Edition (UGA Special Bulletin #28). This publication is available from your local county extension office or the following web-site: https://ipm.uga.edu/georgia-pest-management-handbook/

Table 14. Herbicide Programs for Soybeans.

Soybean Variety/System	Program	Preemergence[1]	Postemergence (~20-30 DAP)
Roundup Ready® (glyphosate)	1	***One*** of the following: Authority MTZ; Canopy/Cloak; TriCor/Metribuzin	glyphosate + Reflex; or glyphosate + (Prefix or Warrant Ultra); or Flexstar GT
	2	***One*** of the following: Boundary; Prowl; Anthem Maxx; Dual Magnum; Warrant; Zidua; Outlook; Tendovo; Treflan (PPI)	glyphosate + Reflex; or Flexstar GT
	3	***One*** of the following: Authority XL; Envive; Fierce; Fierce MTZ; Surveil; Trivence; Valor	glyphosate + (Dual Magnum or Warrant or Zidua or Anthem Maxx); or Sequence
Liberty Link® (glufosinate)	1	***One*** of the following: Treflan (PPI) or Prowl; Anthem Maxx; Boundary; Dual Magnum; Tendovo; Tricor/Metribuzin; Warrant; Zidua; Outlook	Liberty + Reflex
	2	***One*** of the following: Authority MTZ; Envive; Fierce; Fierce MTZ; Surveil; Tricor/Metribuzin; Trivence; Valor	Liberty + (Dual Magnum or Warrant or Zidua)
Xtend® (glyphosate, dicamba)[2]	1	***One*** of the following: Authority MTZ; Boundary; Canopy/Cloak; Envive; Fierce; Fierce MTZ; Surveil; Tricor/Metribuzin; Tendovo; Trivence; Valor	1) labeled glyphosate + Xtendimax (VG) + (Dual Magnum or Warrant) or 2) labeled glyphosate + Engenia + (Dual Magnum or Warrant or Zidua or Outlook) or 3) labeled glyphosate + Tavium (VG) **Use DRA, VRA/PHBA with dicamba as required.**
XtendFlex® (glyphosate, glufosinate, dicamba)	1	***One*** of the following: Authority MTZ; Boundary; Canopy/Cloak; Envive; Fierce; Fierce MTZ; Surveil; Tricor/Metribuzin; Tendovo; Trivence; Valor	1) labeled glyphosate + Xtendimax (VG) + (Dual Magnum or Warrant) or 2) labeled glyphosate + Engenia + (Dual Magnum or Warrant or Zidua or Outlook) or 3) labeled glyphosate + Tavium (VG) or 4) Liberty + Reflex or Dual Magnum or Warrant or Zidua ****Liberty and dicamba should not be tank-mixed. Use DRA, VRA/PHBA with dicamba as required.**
Enlist E3™ (2,4-D choline, glyphosate, glufosinate)	1	***One*** of the following: Authority MTZ; Boundary; Canopy/Cloak; Envive; Fierce; Fierce MTZ; Surveil; Tricor/Metribuzin; Tendovo; Trivence; Valor	1) Enlist One + Liberty + (Dual Magnum or Warrant or Anthem Maxx or Zidua) or ***2)*** **Enlist Duo*** + (Anthem Maxx or Warrant or Zidua) ***Not labeled for use in Baker, Berrien, Brooks, Burke, Calhoun, Early, Irwin, Lee, Miller, Screven, and Worth counties.**
Conventional	1	Treflan (PPI) or Prowl + ***One*** of the following: Authority MTZ; Canopy/Cloak; TriCor/Metribuzin	Reflex; or Prefix; or Warrant Ultra *(tank-mix with Classic or FirstRate if annual MG and/or sicklepod are problems)*
	2	***One*** of the following: Boundary; Prowl; Anthem Maxx; Dual Magnum; Warrant; Zidua; Outlook; Tendovo; Treflan (PPI)	Reflex *(tank-mix with Classic or FirstRate if annual MG and/or sicklpod are problems)*

[1]Before using any metribuzin product in soybeans, check variety tolerance, soil pH, organic matter, and soil texture. [2]Xtend® soybeans are NOT tolerant of glufosinate (Liberty). Authority (sulfentrazone) products have an 18 month cotton rotation restriction. Updated: January 18, 2023 (replaces all previous versions).

Soybean Insect Management in Georgia

Phillip Roberts

Several insect pests are capable of severely damaging soybeans. However, can withstand considerable insect damage at certain times without economic yield loss. In Georgia, it is possible to produce a crop of soybeans without using any insecticides. In some years, however, several insecticide applications may be necessary to protect the crop. Because of this situation, soybeans are ideally suited to an insect pest management program. This program consists of two phases:

1. Understanding risk of pest outbreaks and planning to prevent damage.
2. Periodic monitoring or scouting and the use of thresholds.

Risk of Early-Season Insect Problems

Before Planting

Check for soil insects such as wireworms, white grubs, and white fringed beetle larvae in each field. Inspect soil closely when preparing land for presence of these insects. In reduced tillage systems, cover crops or winter annual weeds should be controlled at least three weeks before planting. In conventional tillage fields, let fields remain fallow as long as possible before planting. These practices reduce risk of cutworms, lesser cornstalk borer, and other seedling pests, which may have established on weeds or the previous crop, infesting soybean seedlings.

At-Planting

Anticipate seedling-insect problems in the following situations and plan at-planting and/or an early post emergence insecticide application and intensified scouting accordingly.

1. When late-planting for any reason, lesser cornstalk borer populations may increase as the season progresses.
2. When planting on light soils following periods of drought, lesser cornstalk borer damage is more likely under these conditions.
3. When planting behind burned wheat stubble, lesser cornstalk borer infestations are more likely to develop.
4. When planting in double-crop or minimum-till situations with previous-crop residue on the soil surface, cutworms or other soil insects may have built up in the preceding crop.

Scouting: Check Crop Regularly to Prevent Insect Damage

Soybeans should be scouted at least once a week, twice a week under certain conditions, from seedling emergence until the leaves begin to turn yellow and fall from the plants. Management decisions should be made independently for each field based on the pest(s) situation. Accurate monitoring of fields will allow growers to make timely applications of the correct insecticide(s) and rate to prevent damage from reaching economic levels.

Several species of predatory and parasitic beneficial insects are present in Georgia soybeans. These natural controls or beneficial insects are our most economical pest management tools and conservation of beneficial populations should be considered especially during early season. Big-eyed bugs, minute pirate bugs, fire ants, and Cotesia wasps are four important beneficial insects.

The presence of these natural controls may delay the need to treat for some insect pests. The use of natural controls should be maximized in attempts to reduce production costs.

Action or economic thresholds have been established for major soybean insect pests and are defined as the pest density at which action must be taken to prevent economic damage. The decision to apply an insecticide should be based on scouting and the use of thresholds. Thresholds for major soybean insects found in table 16 below should serve as a guide for decision making. Unnecessary application can be more costly than just the insecticide due to destruction of beneficial insects. In the absence of beneficial insects, the risk of economic infestations for many insect pests increases. Application of insecticides on an as-needed basis preserves beneficial insects and reduces the chance of secondary pest outbreaks.

Seedling Pests

Soybean fields should be scouted for seedling pests until the plants are about 12 inches tall; stems become woody and severe damage from seedling pests becomes less likely at this time. Look for insects on the plant (threecornered alfalfa hopper) or in the soil around the plants (lesser cornstalk borer, cutworms, sugarcane beetle). Evaluate stand loss (percent dead or dying plants) and determine if future stand loss is probable (insects easily found and actively damaging plants).

Foliage Feeders

Throughout the season, determine what insects are feeding on the foliage and how much defoliation they are causing. On small beans, it is possible to brush the insects off the plants into the row middle where they can be counted. On larger beans, it is better to use a shake cloth or sweep net. Place the shake cloth on the ground in the row middle ahead of you under undisturbed plants because some insects fly or fall off plants quickly when disturbed. Quickly shake or beat the plants from 3 feet of row on each side of the cloth so that insects are dislodged onto the cloth where they can be identified and counted. With a sweep net, take a 25 sweep sample across a single row to capture insects into the net. After passing the net through the foliage take a step forward, then pass the net back across the foliage. Then identify and count the insects present in the net. At each sample point, estimate the percent of the foliage loss so that an average defoliation value can be calculated for the field.

Pod Feeders

After full bloom (when pods are being set), look closely for stink bugs and any pod feeding caterpillars (corn earworm and fall armyworm) that are dislodged on the shake cloth or in the 25-sweep sample.

When to Treat

Important: Reserve materials which are highly disruptive to beneficial insects for late season use. Conservation of beneficial insects and spiders, especially during early and mid-season, suppress some pest species.

Soil Insects

Wireworms, white grubs, and whitefringed beetle larvae. Treat fields with a history of infestation or if insects are found during land preparation at an average of one per square yard.

Seedling Pests

Use preventive methods if damage is expected due to planting situation and/or treat if stand is being threatened. From seedling emergence until plants are 12-inches tall treat for:

- **Lesser cornstalk borer:** treat when 10% of seedlings are infested with larvae.
- **Cutworms:** treat when 10% of stand is lost and larvae are still present.
- **Sugarcane beetle:** treat when 10% of plants (regardless of size) are damaged or dead and beetles are still present.
- **Threecornered alfalfa hopper:** treat when 10% of plants are infested with nymphs and/or adults.

It is uncommon for the above pests (with the exception of sugarcane beetle) to damage soybeans larger than 12-inches.

Foliage Feeders

Foliage feeders should be controlled based on defoliation and plant growth stage;

- Prior to bloom: treat when the defoliation level reaches 30%.
- After bloom: treat when the defoliation level reaches 15%.

Fields should be scouted twice per week when insect pest populations and percent defoliation are within 50 percent of the treatment threshold, and the decision to treat is being delayed to derive maximum benefits from natural control factors.

Foliage feeders commonly encountered include velvetbean caterpillar, soybean looper, green cloverworm, grasshoppers, fall and beet armyworms, and occasionally blister beetles, Japanese beetle, and others. The green cloverworm rarely requires control on soybeans in Georgia. It is very common on soybeans but generally does not occur in sufficient numbers to cause economic defoliation losses. Green cloverworms infest soybeans early at low levels and serve as a host for numerous insect parasites and predators, spiders, and diseases. These beneficial insects in turn are of great value in suppressing subsequent infestations of insect pests.

Pod Feeders

Stink Bugs

Stink bugs are the most common pod feeding insect pest of soybean in Georgia. Occasionally, corn earworm and fall armyworm may also feed on developing pods. Pod feeders should be controlled based on number of pod feeding insects present and plant growth stage:

- Bloom to mid pod fill: 0.33 stink bugs per row foot or 3/25 sweeps
- Mid pod fill to maturity: 1 stink bug per row foot or 9/25 sweeps

NOTE: Soybean grown for seed production, 1 stink bug per 6 row feet will justify control.

Kudzu Bugs

Kudzu bugs can be scouted using a 15-inch diameter sweep net. Although kudzu bug populations have been low in recent years (due to the naturally occurring fungus Beauvaria bassiana (kudzu bug cadavers covered with white fungal growth) and the egg parasitoid Paratelenomus saccharalis), infestations in soybeans can be extremely high. Kudzu bug infestations tend to be higher in early planted soybeans. Current recommendations include interrupting the development of each generation of kudzu bug by applying an insecticide to target the immature stage of the insect. Insecticide should be applied when sweep–net sampling catches one immature insect per sweep. Samples should be taken from all areas of the field, including edges and the middle, taking care not to bias sampling along border rows where populations build initially. As an alternative to sweep-net sampling, visual inspections of insect density lower in the canopy will suffice. If immature kudzu bugs are easily and repeatedly found on leaf petioles and/or main stems, treatment is likely warranted.

Trap Cropping

Trap cropping has proven to be a cost-effective in managing insects in soybeans. Soybean producers have found that managing stink bugs using trap crops can often reduce insecticide applications and preserve yields. Soybean field borders (trap) are planted using a soybean variety at least 2 maturity groups earlier than the rest of the field. Early maturity group soybeans planted around late MG VII or MG VIII soybeans have been proven to be most effective in trapping stink bugs from the whole field. Treating only the trap area for stink bug controls the pest without disrupting beneficial insect populations in the rest of the field. When using a trap crop, be sure to scout the remainder of the field and treat as needed. Field evaluations indicate that trap cropping can be extremely effective in controlling stink bugs without flaring soybean looper or velvetbean caterpillar populations. The trap may require two or more insecticide treatments.

Preventive Insect Control and Damage

Historical insect data indicate that the probability for treating late season foliage feeding caterpillars in soybeans is extremely high in the Coastal Plain Region of Georgia. Populations of 50 velvetbean caterpillar and soybean looper migrate into Georgia during August and September. For this reason, growers often apply protective treatments using the insect growth regulator Dimilin in combination with boron at the R2-R3 stage.

A two-ounce application of Dimilin at the R2-R3 stage controls velvetbean caterpillar (VBC) and green cloverworm (GCW) with minimal disruption to beneficial insects. In most cases, fields treated with Dimilin at the R2-R3 stage do not require an additional insect icide treatment for VBC or GCW for the remainder of the growing season. Dimilin will not control soybean looper and soybean loopers will sometimes require treatment and should be scouted closely. Control of VBC and GCW will lower the risk of having to treat soybean loopers based on defoliation since two of the three most common foliage feeding caterpillars have been removed from the system.

Risk of Common Soybean Insect Pests by Production System

Soybeans are planted from April to early August in Georgia. Risk associated with commonly encountered insect pests varies in each of these production systems (Table 15). The risk of kudzu bug infestations is higher on early planted soybeans compared with late planted soybeans. The risk of stink bugs and foliage feeding caterpillars is higher on later planted soybeans. Ultra-late planted soybeans should be scouted frequently for foliage feeders, especially beet armyworm.

Table 15. Insect Infestation Risk in Georgia based on production system and planting date.

Production System	Planting Date	Insect Pest RISK		
		Kudzu Bug	Stink Bugs	Foliage Feeders
Early Season	April	High	Moderate	Low
Full Season	May	Moderate	Moderate	Moderate
Double Crop	June	Low	High	High
Ultra-Late	July/Aug	Low	High	High

Table 16. Sweep net and drop sheet thresholds for soybean insects.

Insect Pest	Sweep Net (Avg/25 sweeps)	Drop Sheet (Avg/foot of row)
Kudzu Bug	25 immatures	
Stink Bug*	3 bloom to mid pod fill	0.33
	9 mid-pod fill to maturity	1
Velvetbean Caterpillar	38	8
Green Cloverworm	38	8
Corn Earworm	5	2
Soybean Looper	19	8
Threecornered Alfalfa Hopper	50	6
Mites: Treat for mites if infestations become general over the field and leaf discoloration is becoming evident.		

*Soybean grown for seed production, 1 stink bug per 6 row feet will justify control

Table 17. Insecticide options with recommended rates for different insect pests

Pest	Insecticide	MOA	Formulation Per Acre	Lbs. Active Per Acre	REI/PHI (Hours or Days)	Remarks and Precautions
Bean Leaf Beetles	alpha-cypermethrin Fastac CS	3A	2.8–3.8 oz	0.018–0.025	12 H/ 21 D	Bean leaf beetles are foliage feeders and damage the plant by chewing holes in the leaves and occasionally feeding on stems and pods. Defoliation Threshold: Treat when 30 percent foliage loss has occurred and beetles are present prior to bloom or when 15 percent foliage loss has occurred and beetles are present after bloom. Pod Feeding Threshold: Treat if 50 percent of the plants have pod feeding prior to R6.
	bifenthrin	3A	2.1–6.4 oz	0.033–0.1	12 H/ 18 D	
	Brigade 2EC	1A	2.1–6.4 oz	0.5–1	12 H/ 21 D	
	Discipline 2EC	3A	1–2 pt	0.0125–0.022	12 H/ 21 D	
	carbaryl Sevin 4F	3A	1.6–2.8 oz	0.0075–0.0125	24 H/ 45 D	
	beta-cyfluthrin Baythroid XL 1	3A	0.77–1.28 oz	0.015–0.025	24 H/ 30 D	
	gamma-cyhalothrin Declare 1.25	3A	0.96–1.6 oz	0.0175–0.025	12 H/ 21 D	
Beet Armyworms	chlorantraniliprole Prevathon 0.43	28	14–20 oz	0.047–0.067	4 H/	Defoliation Threshold: Treat when 30 percent foliage loss has occurred and larvae 1/2" or longer are present prior to bloom or when 15% foliage loss has occurred and larvae 1/2" or longer are present after bloom. Beet armyworm infestations sometimes occur on seedling soybeans, especially on ultra-late planted soybeans.
	indoxacarb Steward 1.25 EC	22	5.6–11.3 oz	0.055–0.1	1 day	
	methoxyfenozide Intrepid 2F	18	4–8 oz	0.06–0.12	12 H/ 21 D	
	novaluron Diamond 0.83 EC	15	6–12 oz	0.039–0.077	4 H/	
	spinetoram Radiant 1SC	5	2–4 oz	0.0156–0.0313	14 D	
	spinosad Blackhawk	5	1.7–2.2 oz	0.038–0.049	12 H/ 28 D	
Blister Beetles	alpha-cypermethrin Fastac CS	3A	1.7–2.2 oz	0.018–0.025	12 H/ 21 D	Blister beetles are rarely a problem in soybeans. However, large numbers can cause extensive defoliation. Blister beetles may congregate in isolated areas of fields. Defoliation Threshold: Treat when 30% foliage loss has occurred and beetles are present prior to bloom or when 15% foliage loss has occurred and beetles are present after bloom.
	carbaryl Sevin 4F	1A	2.8–3.8 oz	0.5–1	12 H/ 21 D	
	beta-cyfluthrin Baythroid XL 1	3A	1–2 pt	0.0125–0.022	12 H/ 21 D	
	gamma-cyhalothrin Declare 1.25	3A	1.6–2.8 oz	0.0125–0.015	24 H/ 45 D	

Table 18. Insecticide options with recommended rates for different insect pests continued

PEST	INSECTICIDE	MOA	FORMULATION PER ACRE	LBS. ACTIVE PER ACRE	REI/PHI (Hours or Days)	REMARKS AND PRECAUTIONS
Blister Beetles (continued)	lambda-cyhalothrin Warrior II Zeon 2.08 Silencer 1	3A	1.6–1.92 oz 3.2–3.84 oz	0.025–0.03	24 H/ 30 D	
	zeta-cypermethrin Mustang Maxx .8EC	3A	2.8–4oz	0.0175–0.025	12 H/ 21 D	
Corn Earworms	alpha-cypermethrin Fastac CS	3A	2.8–3.8 oz	0.018–0.025	12 H/ 21 D	Corn earworm infestations are rare in Georgia soybeans and typically occur in more northern areas of the state. Corn earworms may feed on the foliage or more importantly may damage developing pods. Defoliation Threshold: Treat when 30% foliage loss has occurred and larvae 1/2" or longer are present prior to bloom or when 15% foliage loss has occurred and larvae 1/2" or longer are present after bloom. Sweep Net Threshold: 5 larvae/25 sweeps. Drop Cloth Threshold: 2 larvae/1 ft of row.
	bifenthrin Brigade 2EC Discipline 2EC	3A	2.1–6.4 oz	0.033–0.10	12 H/ 18 D	
	carbaryl Sevin 4F	1A	2.1–6.4 oz	0.5–1.5	12 H/ 21 D	
	beta-cyfluthrin Baythroid XL 1	3A	1–3 pt	0.0125–0.022	12 H/ 21 D	
	chlorantraniliprole Prevathon 0.43	28	1.6–2.8 oz	0.047–0.067	4 H/ 1 D	
	gamma-cyhalothrin Declare 1.25	3A	14–20 oz	0.0075–0.0125	24 H/ 45 D	
	lambda-cyhalothrin Warrior II Zeon 2.08 Silencer 1	3A	0.77–1.28 oz	0.015–0.025	24 H/ 30 D	
	esfenvalerate Asana XL .66EC	3A	0.96–1.6 oz	0.03–0.05	12 H/ 21 D	
	indoxacarb Steward 1.25 EC	22	5.6–11.3 oz	0.055–0.1	48 H/ 14 D	
	methomyl Lannate 2.4 LV	1A	0.75–1.5 pt	0.225–0.45	4 H/	
	spinetoram Radiant 1SC	5	2–4 oz	0.0156–0.0313	28 D	
	spinosad Blackhawk	5	1.7–2.2 oz	0.038–0.049	4 H/	
	zeta-cypermethrin Mustang Maxx .8EC	3A	2.8–4 oz	0.0175–0.025	28 D	
Cutworms	alpha-cypermethrin Fastac CS	3A	1.3–3.8 oz	0.018–0.025	12 H/ 21 D	Treat when 10% of stand is lost and larvae are present.
	bifenthrin Brigade 2EC Discipline 2EC	3A	2.1–6.4 oz	0.033–0.10	12 H/ 18 D	
	chlorpyrifos Lorsban 4E	1B	2 pt	1	24 H/ 28 D	

Table 19. Insecticide options with recommended rates for different insect pests continued

PEST	INSECTICIDE	MOA	FORMULATION PER ACRE	LBS. ACTIVE PER ACRE	REI/PHI (Hours or Days)	REMARKS AND PRECAUTIONS
Cutworms (continued)	beta-cyfluthrin Baythroid XL 1	3A	0.8–1.6 oz	0.0065–0.0125	12 H/ 21 D	
	gamma-cyhalothrin Declare 1.25	3A	0.77–1.28 oz	0.0075–0.0125	24 H/ 45 D	
	lambda-cyhalothrin Warrior II Zeon 2.08 Silencer 1	3A	0.96–1.6 oz	0.015–0.025	24 H/ 30 D	
	zeta-cypermethrin Mustang Maxx .8EC	3A	1.92–3.2 oz	0.008–0.025	12 H/ 21 D	
Fall Armyworms	chlorantraniliprole Prevathon 0.43	28	14–20 oz	0.047–0.067	4 H/	Defoliation Threshold: Treat when 30% foliage loss has occurred and larvae 1/2" or longer are present prior to bloom or when 15% foliage loss has occurred and larvae 1/2" or longer are present after bloom.
	indoxacarb Steward 1.25EC	22	5.6–11.3 oz	0.055–0.1	1 day	
	methomyl Lannate 2.4LV	1A	1.5 pt	0.45	48 H/ 14 D	
	novaluron Diamond 0.83 EC	15	6–12 oz	0.039–0.077	12 H/ 28 D	
	spinetoram Radiant 1SC	5	2–4 oz	0.0156–0.0313	4 H/	
	spinosad Blackhawk	5	1.7–2.2 oz	0.039–0.049	28 D	Fall armyworm may sometimes feed on pods. If pod feeding is observed treat when populations reach 2 larvae/1 ft of row.
Grasshoppers	*alpha-cypermethrin* Fastac CS	3A	3.2–3.8 oz	0.02–0.025	12 H/ 21 D	Grasshoppers are primarily foliage feeders but may also feed on pods. In reduced tillage fields, immature grasshoppers may emerge from egg pods oviposited in the soil the previous fall. Adult grasshoppers migrating into soybeans initially build on field edges. Immature (wingless) grasshoppers are easier to control than adults.
	bifenthrin Brigade 2EC Discipline 2EC	3A	2.1–6.4 oz 2.1–6.4 oz	0.033–0.1	12 H/ 18 D	
	acephate Orthene 97	1B	0.5 lb	0.48	24 H/ 14 D	
	beta-cyfluthrin Baythroid XL 1	3A	2–2.8 oz	0.0155–0.022	12 H/ 21 D	
	gamma-cyhalothrin Declare 1.25	3A	1.28–1.54 oz	0.0125–0.015	24 H/ 45 D	
	lambda-cyhalothrin Warrior II Zeon 2.08 Silencer 1	3A	1.6–1.92 oz 3.2–3.84 oz	0.025–0.03	24 H/ 30 D	
	zeta-cypermethrin Mustang Maxx .8EC	3A	3.2–4 oz	0.02–0.025	12 H/ 21 D	Defoliation Threshold: Treat when 30% foliage loss has occurred and grasshoppers are present prior to bloom, or when 15% foliage loss has occurred and grasshoppers are present after bloom.

Table 20. Insecticide options with recommended rates for different insect pests continued

PEST	INSECTICIDE	MOA	FORMULATION PER ACRE	LBS. ACTIVE PER ACRE	REI/PHI (Hours or Days)	REMARKS AND PRECAUTIONS
Japanese Beetles	*lambda-cyhalothrin* Warrior II Zeon 2.08 Silencer 1	3A	1.6–1.92 oz 3.2–3.84 oz	0.025–0.03	24 H/ 30 D	Japanese beetles are foliage feeders and are most often observed infesting soybean in northern areas of Georgia. Defoliation Threshold: Treat when 30% foliage loss has occurred and beetles are present prior to bloom, or when 15% foliage loss has occurred and beetles are present after bloom.
	zeta-cypermetrin Mustang Maxx .8EC	3A	2.8–4 oz	0.0175–0.025	12 H/ 21 D	
Kudzu Bugs	acephate Orthene 97	1B	0.75–1 lb	0.5–0.97	24 H/ 14 D	Kudzu bugs have sucking mouthparts and feed on the main stem and petioles. Current recommendations include interrupting the development of each generation of kudzu bug by applying an insecticide to target the immature stage of the insect. Kudzu bug infestations are generally higher on early planted soybeans. Sweep Net Threshold: 1 immature kudzu bug/sweep. Samples should be taken from all areas of the field, including edges and the middle, taking care not to bias sampling along border rows where populations build initially. Visual Inspection Threshold: As an alternative to sweep-net sampling, visual inspections of insect density lower in the canopy will suffice. If immature kudzu bugs are easily and repeatedly found on leaf petioles and/or main stems, treatment is likely warranted.
	alpha-cypermethrin Fastac CS	3A	3.2–3.8 oz	0.02–0.025	12 H/ 21 D	
	bifenthrin Brigade 2EC Discipline 2EC	3A	5.12–6.4 oz 6.4 oz	0.08–0.1	12 H/ 18 D	
	clothianidin Belay 2.13	4A	3–4 oz	0.05–0.067	12 H/ 21 D	
	gamma-cyhalothrin Declare 1.25	3A	1.28–1.54 oz	0.0125–0.015	24 H/ 45 D	
	lambda-cyhalothrin Warrior II Zeon 2.08	3A	1.92 oz	0.03	24 H/ 30 D	
	zeta-cypermethrin Mustang Maxx .8 EC	3A	4 oz	0.025	12 H/ 21 D	
Lesser Cornstalk Borers	*chlorpyrifos* Lorsban 15G Lorsban 4E	1B	8 oz/1,000 ft of row 2 pt	1	24 H/ 28 D	Treat when 10 percent of seedlings are infested with larvae. The risk of lesser cornstalk borer is greatest during hot dry periods. Infestations are more common in conventionally tilled sandy soils. The risk of lesser cornstalk borer is also high when previous crop residues are burned prior to planting. See label for details on application.
Loopers, Soybean	*chlorantraniliprole* Prevathon 0.43	28	14–20 oz	0.047–0.067	4 H/ 1 D	Soybean looper is a foliage feeder that has 2 pairs of abdominal prolegs. Soybean loopers are highly resistant to pyrethroid insecticides and should not be used for control. Defoliation Threshold: Treat when 30% foliage loss has occurred and larvae 1/2" or longer are present prior to bloom or when 15% foliage loss has occurred and larvae 1/2" or longer are present after bloom. Sweep Net Threshold: 19 larvae/25 sweeps. Drop Cloth Threshold: 8 larvae/1 ft of row.
	indoxacarb Steward 1.25 EC	22	5.6–11.3 oz	0.055–0.1	12 H/ 21 D	
	methoxyfenozide Intrepid 2F	18	4–8 oz	0.06–0.12	4 H/ 14 D	
	spinetoram Radiant 1SC	5	2–4 oz	0.0156–0.0313	4 H/ 28 D	
	spinosad Blackhawk	5	1.1–2.2 oz	0.025–0.049	4 H/ 28 D	
Mites	*bifenthrin* Brigade 2EC Discipline 2EC	3A	5.12–6.4 oz 5.12–6.4 oz	0.08–0.1	12 H/ 18 D	Mites are an occasional problem in Georgia soybeans. The presence of mites should be confirmed with a hand lens on damaged leaves prior to treating. Treat if infestations become general over the entire field and leaf discoloration is becoming evident. Spot treatment of infested areas is also an option.
	dimethoate Dimethoate 4EC	1B	1 pt	0.5	48 H/ 21 D	

Table 21. Insecticide options with recommended rates for different insect pests continued

PEST	INSECTICIDE	MOA	FORMULATION PER ACRE	LBS. ACTIVE PER ACRE	REI/PHI (Hours or Days)	REMARKS AND PRECAUTIONS
Silverleaf Whiteflies	*pyriproxyfen* Knack 0.86	7C	8–10 oz	0.0537–0.0671	12 H/ 7 D	Silverleaf whitefly is difficult to control with insecticides. Early detection and conservation of natural controls are important. Apply when 50 percent of fully expanded trifoliates are infested with immatures. Late and ultra late planted soybeans are at greatest risk of whitefly infestations. Immatures typically infest the lower trifoliates and move up the plant as the season progresses.
	flupyradifurone Sivanto Prime 1.67	4D	10.5–14 oz	0.1369–0.1826	4 H/ 21 D	
Stink Bugs	*acephate* Orthene 97	1B	0.5–1 lb	0.5–0.97	24 H/ 14 D	Stink bugs damage developing seeds with their sucking mouthparts. Southern green, green, and brown stink bugs are the most common species observed in soybean. Bloom to Mid Pod-Fill (R1–R4): Sweep Net Threshold: 3 stink bugs/25 sweeps. Drop Cloth Threshold: 0.33 stink bugs/1 ft of row. After Mid Pod-Fill (R5–R6.5 + 7 days): Sweep Net Threshold: 9 stink bugs/25 sweeps. Drop Cloth Threshold: 1 stink bug/1 ft of row. *If soybeans are being grown for seed, 1 stink bug/6 ft of row will justify control measures. Diamond is an insect-growth regulator and will not control adults.
	alpha-cypermethrin Fastac CS	3A	3.2–3.8 oz	0.02–0.025	12 H/ 21 D	
	beta-cyfluthrin Baythroid XL 1	3A	1.6–2.8 oz	0.0125–0.022	12 H/ 21 D	
	bifenthrin Brigade 2EC Discipline 2EC	3A	2.1–6.4 oz 2.1–6.4 oz	0.033–0.1	12 H/ 18 D	
	clothianidin Belay 2.13	4A	3–6 oz	0.05–0.1	12 H/ 21 D	
	gamma-cyhalothrin Declare 1.25	3A	1.28–1.54 oz	0.0125–0.015	24 H/ 45 D	
	lambda-cyhalothrin Warrior II Zeon 2.08 Silencer 1	3A	1.6–1.92 oz 3.2–3.84 oz	0.025–0.03	24 H/ 30 D	
	novaluron Diamond 0.83 EC	15	6–12 oz	0.039–0.077	12 H/ 28 D	
	zeta-cypermethrin Mustang Maxx .8EC	3A	3.2–4 oz	0.02–0.025	12 H/ 21 D	
Sugarcane Beetles	The treatments for lesser cornstalk borer give helpful control.					Sugarcane beetles are a rare and sporadic pest of soybeans in Georgia.
Three-cornered Alfalfa Hoppers	*acephate* Orthene 97	1B	0.75–1 lb	0.73–0.97	24 H/ 14 D	Three-cornered alfalfa hoppers feed on the main stem above the soil surface in seedling soybeans. Soybeans are most susceptible to main stem girdling when plants are less than 12" in height. Girdling of the main stem may cause plants to lodge. Damaged plants may also lodge in the future as a result of damage during the seedling stage. Threshold (seedling soybeans): treat soybeans less than 12" in height when 10% of the plants are infested with nymphs and/or adults or stand is being reduced below recommended plant population and bugs are present. Both adults and nymphs may also feed on the petioles of leaves, blooms, and pods of reproductive soybeans. Threshold (reproductive soybeans): Sweep Net Threshold: 50 bugs/25 sweeps. Drop Cloth Threshold: 6 bugs/1 ft of row.
	alpha-cypermethrin Fastac CS	3A	2.8–3.8 oz	0.018–0.025	12 H/ 21 D	
	carbaryl Sevin 4F	1A	0.2 pt	1	12 H/ 21 D	
	beta-cyfluthrin Baythroid XL 1	3A	1.6–2.8 oz	0.0125–0.022	12 H/ 21 D	
	gamma-cyhalothrin Declare 1.25	3A	0.77–1.28 oz	0.0075–0.0125	24 H/ 45 D	
	lambda-cyhalothrin Warrior II Zeon 2.08 Silencer 1	3A	0.96–1.6 oz 1.92–3.2 oz	0.015–0.025	24 H/ 30 D	
	zeta-cypermethrin Mustang Maxx .8E	3A	2.8–4 oz	0.0175–0.025	12 H/ 21 D	

Table 22. Insecticide options with recommended rates for different insect pests continued

PEST	INSECTICIDE	MOA	FORMULATION PER ACRE	LBS. ACTIVE PER ACRE	REI/PHI (Hours or Days)	REMARKS AND PRECAUTIONS
Velvetbean Caterpillars	*alpha-cypermethrin* Fastac CS	3A	2.8–3.8 oz	0.018–0.025	12 H/ 21 D	Velvetbean caterpillars are foliage feeders that have 4 pairs of abdominal prolegs; larvae become very active when prodded. Velvetbean caterpillars are voracious feeders and generally occurs during late season. Defoliation Threshold: Treat when 30% foliage loss has occurred and larvae 1/2" or longer are present prior to bloom or when 15% foliage loss has occurred and larvae 1/2" or longer are present after bloom. Sweep Net Threshold: 38 larvae/25 sweeps. Drop Cloth Threshold: 8 larvae/1 ft of row. Preventive applications of Dimilin should be made at the late R2 or R3 growth stage. R3 is defined as beginning pod, 3⁄16" pod at 1 of the 4 uppermost nodes on the main stem with a fully developed trifoliate.
	carbaryl Sevin 4F	1A	1–2 pt	0.5–1	12 H/ 21 D	
	beta-cyfluthrin Baythroid XL 1	3A	1.6–2.8 oz	0.0125–0.022	12 H/ 21 D	
	chlorantraniliprole Prevathon 0.43	28	14–20 oz	0.047–0.067	4 H/ 1 D	
	gamma-cyhalothrin Declare 1.25	3A	0.77–1.28 oz	0.0075–0.0125	24 H/ 45 D	
	lambda-cyhalothrin Warrior II Zeon 2.08 Silencer 1	3A	0.96–1.6 oz 1.92–3.2 oz	0.015–0.025	24 H/ 30 D	
	diflubenzuron Dimilin 2L	15	2–4 oz	0.03–0.06	12 H/ 21 D	
	esfenvalerate Asana XL .66EC	3A	2.9–5.8 oz	0.015–0.03	12 H/ 21 D	
	methomyl Lannate 2.4 LV	1A	0.4–0.75 pt	0.12–0.225	48 H/14 D	
	methoxyfenozide Intrepid 2F	18	4–8 oz	0.06–0.12	4 H/14 D	
	novaluron Diamond 0.83 EC	15	6–10 oz	0.039–0.064	12 H/ 28 D	
	spinetoram Radiant 1SC	5	2–4 oz	0.0156–0.0313	4 H/28 D	
	spinosad Blackhawk	5	1.1–2.2 oz	0.025–0.049	4 H/28 D	
	zeta-cypermethrin Mustang Maxx .8EC	3A	2.8–4 oz	0.0175–0.025	12 H/ 21 D	

PREMIXED OR CO-PACKAGED INSECTICIDE PRODUCTS

Products listed below are available as premixes or co-packages of 2 insecticidal active ingredients. When using premixed or co-packaged products, be sure all active ingredients are necessary. Unnecessary applications or reduced rates may lead to or intensify insecticide resistance. Labeled rates are listed with product names. However, see label for specific rates for target pests.

- *bifenthrin*, *imidacloprid* (Brigadier: 3.8–6.1oz)
- *imidacloprid*, *cyfluthrin* (Leverage: 2.8–3.2 oz)
- *chlorantriniliprole*, *lambda-cyhalothrin* (Besiege: 5–10 oz)
- *lambda-cyhalothrin*, *thiamethoxam* (Endigo: 3.5–4.5 oz)
- *chlorpyrifos*, *lambda-cyhalothrin* (Cobalt Advanced: 11–38 oz)
- *methoxyfenozide*, *spinetoram* (Intrepid Edge: 4–6.4 oz)
- *chlorpyrifos*, *bifenthrin* (Tundra Supreme: 5.6–16.8 oz)
- *spinosad*, *gamma-cyhalothrin* (Consero: See label)
- *zeta-cypermethrin*, *chlorpyrifos* (Stallion: 3.75–11.75 oz)
- *zeta-cypermethrin*, *bifenthrin* (Hero: 2.6–10.3 oz)

CONSERVE NATURAL ENEMIES

Reserve broad spectrum insecticides for late season use. Broad spectrum insecticides disrupt beneficial insects and spiders which suppress insect pest populations.

INSECT CONTROL TERMINATION

Generally, insect control can be terminated for foliage-feeding caterpillars, kudzu bugs, and stink bugs at R6 + 7 days (R6.5). The R6 growth stage is defined as: full seed, pod contains a green seed that fills the pod cavity at one of the four uppermost nodes on the main stem with a fully developed trifoliate leaf. R7 is defined as beginning maturity, one normal pod on the main stem that has reached mature pod color, normally brown or tan depending on variety. When terminating insect controls, insect populations should be below threshold levels.

Table 23. Relative efficacy of different Insecticide options for Specific insect pests

Insecticide	Bean Leaf Beetle	Beet Armyworm	Blister beetle	Corn Earworm	Cutworm	Fall Armyworm	Grasshopper	Green cloverworm	Japanese Beetle	Kudzu Bug	Lesser Cornstalk Borer	Soybean Looper	Spider mite	Stinkbug Southern green	Stinkbug brown	Three-Cornered Alfalfa Hopper	Velvet Bean Caterpillar	Predators	Parasite	Chemical Class	REI(Hours)
Acephate, **Orthene 97**	3	5	4	4	2	4	2	4	—	2	—	4	5	2	2	2	3	H	H	1B	24
alpha–cypermethrin, **Fastac CS**	2	4	2	2	2	3	2	1	2	2	—	4	5	1	3	2	1	E	E	3A	12
beta–cyfluthrin, **Baythroid XL 1**	C	4	2	2	2	3	2	1	2	3	—	4	5	1	3	2	1	H	M	3A	12
Bifenthrin, **Brigade 2, Discipline 2, Fanfare 2**	2	4	2	2	2	3	2	1	2	1	—	4	2	1	2	2	1	H	M	3A	12
Carbaryl, **Sevin 4F**	2	4	3	3	4	3	3	2	2	2	—	5	5	4	4	3	2	E	E	1A	12
Chlorantraniliprole, **Prevathon 0.43**	5	1	5	1	3	1	3	1	—	5	—	1	5	5	5	5	1	E	E	28	4
Chlorpyirifos, **Lorsban 4, Lorsban 15G**	3	3	4	4	1	3	3	3	—	3	2	4	4	4	4	4	3	H	H	1B	24
Clothianidin, **Belay 2.13**	2	5	3	5	5	5	5	5	—	2	—	5	5	2	3	3	5	E	E	4A	12
Diflubenzuron, **Dimilin 2L**	5	4	5	5	5	4	3	1	—	5	—	4	5	5	5	5	1	E	E	15	12
Dimethoate, **Dimethoate 4**	3	5	3	5	5	4	4	4	—	4	—	5	3	4	4	3	4	M	H	1B	48
Esfenvalerate, **Asana XL 0.66**	2	4	3	2	2	3	2	1	2	3	—	4	5	2	4	2	1	H	M	3A	12
gamma–cyhalothrin, **Declare 1.25**	2	4	2	2	2	3	2	1	2	2	—	4	5	1	3	2	1	H	M	3A	24
Indoxacarb, **Steward 1.25**	5	1	5	1	3	1	5	1	—	5	—	1	5	4	4	5	3	M	E	22	12
lambda-cyhalothrin, **Warrior II Zeon 2.08, Silencer 1**	2	4	2	2	2	3	2	1	2	1	—	4	5	1	3	2	1	H	M	3A	24
Methomyl, **Lannate LV 2.4**	3	3	4	2	4	2	4	1	—	—	—	3	5	3	3	3	1	H	M	1A	48
Methoxyfenozide, **Intrepid 2F**	5	1	5	5	4	3	5	1	—	5	—	2	5	5	5	5	1	E	E	18	4
Novaluron, **Diamond 0.83EC**	—	2	—	4	5	1	3	1	—	—	—	3	5	3	3	—	1	M	E	15	12
Spinosad, **Tracer 4**	5	2	5	2	3	2	5	1	—	5	—	2	5	5	5	5	1	E	M	5	4
zeta-cypermetherin, **Mustang Maxx 0.8**	2	4	2	2	2	3	2	1	2	2	—	4	5	1	3	2	1	H	M	3A	12

1—Very Effective; 5—Not Effective; E—Easy; M—Moderate; H—Hard

SOYBEAN DISEASE AND NEMATODE CONTROL

Bob Kemerait

Disease and Nematode Outlook for 2023

Soybean producers in Georgia should begin preparation now to protect their crop against fungal diseases and nematodes in the upcoming season. Climatic conditions during the winter of 2022-2023 have been unseasonably warm because of a strong La Niña phenomenon. Parasitic nematodes that can affect soybean crops are already active in South Georgia and producers should be prepared to protect their crop with a nematode-resistant variety or an appropriate nematicide. Because of a Christmas freeze, it is unlikely that kudzu foliage or Asian soybean rust have survived into 2023. However, because of a mild winter there is an increased risk of early re-introduction of the disease during the growing season. Growers should prepare to deploy appropriate fungicide programs, if justified, as early as the R1 bloom stage. Soybean rust sentinel plots, funded by the Georgia Commodity Commission for Soybeans, will be established again in 2023 to give growers advanced warning of development and spread of rust across the state.

Again, a mild winter and warmer soils into the growing season will greatly affect the potential for damage from nematodes. Growers should recognize that there is a greater urgency to protect this year’s soybean crop from nematodes, either by planting resistant varieties or by use of nematicides, whether fumigation, in-furrow products, or seed treatments.

In 2023, especially if rainfall is abundant during the growing season, growers should remain vigilant and prepared to manage Asian soybean rust and other diseases like frogeye leaf spot, anthracnose and Phomopsis pod and stem blight. Rainfall is a critical factor for many fungal diseases. Growers should note there is increasing risk of fungicide resistance issues for frogeye leaf spot to strobilurin products used alone (examples would be Headline, Quadris, Abound, Aproach, and generic formulations of azoxystrobin and pyraclostrobin). For this reason, growers applying fungicides to manage frogeye leaf spot should use products with mixed modes of action.

Nematodes continue to affect soybeans in Georgia. Aside from resistant varieties, growers can consider using nematicides like Telone II and AVICTA seed treatment. Growers also have access to Ag Logic 15G (aldicarb), Velum (fluopyram) and ILeVO seed treatment (fluopyram).

Root-knot and sting nematodes are the most important nematodes affecting soybeans in Georgia. However, in partnership with the Soybean Cyst Nematode (SCN) Coalition, significant effort will be made in 2023 to assess the impact of this plant-parasitic nematode in Georgia and to provide education on management using resistant varieties to the growers.

Charcoal rot, caused by the soilborne fungal pathogen *Macrophomina phaseolina*, has been increasingly problematic in recent years, especially when soybeans are under environmental stress. This disease is characterized by poor growth and even plant death in specific areas of the field. It can be diagnosed by splitting the lower stem with a knife and observing gray discoloration and small, black, pepper-grain-like structures imbedded in the tissue. We have no management options for charcoal rot other than efforts to minimize stress, especially drought stress.

The Soybean Rust Sentinel Plots will continue in 2023. We in UGA Extension are grateful for support of such an important program from the Georgia Commodity Commission for Soybeans. This program continues to provide an effective tool for early notice of development and spread of ASR. By effectively managing rust, growers may achieve better control of other diseases as well, such as anthracnose, Phomopsis pod and stem blight, frogeye leaf spot, and Cercospora blight. A list of fungicides currently labeled for control of Asian soybean rust and other diseases of soybeans is presented table 24. Growers can follow the updates from the sentinel plots on the Internet at https://soybean.ipmpipe.org/soybeanrust/.

Newer fungicides available for soybeans include DELARO Complete from Bayer CropScience, Aproach and Aproach Prima from CORTEVA, Fortix and Zolera FX from UPI, Priaxor and Revytek from BASF, Miravis Top (not for rust) from Syngenta, Lucento from FMC, and Affiance from Gowan. More specific discussion on fungicide use in soybeans will follow; however, growers are reminded that best management practices for protecting soybeans from disease include: 1) Follow reports from Soybean Rust Sentinel Plots through your county agent, 2) Use the late-bloom-to-early pod growth stages as a potential target for initial fungicide application, 3) Recognize that fungicides including a mixture of products (e.g., SDHI, strobilurin and triazole chemistries) provide a broader spectrum of activity against disease and longer protective windows than fungicides like propiconazole (Tilt, Bumber) and tebuconazole alone. Trivapro (propiconazole, azoxystrobin and solatenol) is labeled for use on corn and soybeans by Syngenta.

Azoxystrobin (the active ingredient in Quadris fungicide and a component of Quilt, Quilt Excel and Quadris TOP) went “off-patent” in June of 2014 and there has been an increase of generic “Quadris” products on the market. Azoxystrobin is also a component of Affiance and other fungicides. Related strobilurin fungicides can also be found in products like Fortix, Zolera FX , Headline, Priaxor and many other fungicides.

Growers are reminded that it remains critically important to use these products carefully and according to label. Fungicide resistance occurs when a fungicide that was used to control a fungal pathogen becomes ineffective, often from overuse. It is important that growers are careful with use of strobilurin fungicides. The pathogen causing frogeye leaf spot has already developed resistance to strobilurin fungicides in some areas of the United States; there is concern that it could be present in Georgia as well.

Southern stem blight, also known as “white mold” in Georgia, was severe in peanuts in 2010, 2011 and 2012; the disease was also commonly observed in fields planted to soybean. The unusually high soil temperatures throughout much of the 2010 and 2011 seasons were largely to blame for the outbreak of southern blight. Southern blight was less of a problem in 2013 when cooler temperatures were observed over much of the growing season. Though no research has been conducted at University of Georgia on management of southern blight in soybeans using fungicides, fungicides may be effective management tools when the disease is severe. Fungicides labeled for management of southern blight on soybeans include Quadris, Headline, and EVITO.

Nematodes are an important threat to soybean production in Georgia. Soybean yields in the state are routinely compromised by root-knot, reniform, and Columbia lance nematodes, and perhaps sting and cyst nematodes as well. A recent survey of 107 soybean fields across Georgia found root-knot nematodes in at least 36 fields, cysts nematodes in 10 fields, and reniform nematodes in five fields. Root-knot nematodes were found in fields across the state; cyst and reniform were found in more localized areas. For example, cyst nematodes were found most in Washington, Burke, and Screven Counties; reniform nematodes in Calhoun and Sumter Counties.

The first line of defense for protection from plant-parasitic nematodes is crop rotation; however, crop rotation is difficult for management of nematodes that affect soybeans. This is because one or more of the important nematodes affecting soybeans will also affect most of our suitable rotation crops (e.g., cotton, corn, and peanuts). The second line of defense will be the use of soybean varieties with some level of nematode resistance. Though none of our soybean varieties are immune to nematodes, growers can plant varieties with improved resistance to cyst and southern root-knot nematodes. **Note:** resistance to the peanut root-knot nematode and the reniform nematode is rare in our soybean varieties. This resistance, as a part of an over-all nematode management plan, will help minimize yield losses and reduce nematode populations in a field compared to populations when a susceptible variety is planted. The third line of defense in management of nematodes on soybeans is the use of appropriate nematicides. Growers can use the soil fumigant Telone II (3 gal/A). The seed-treatment nematicide AVICTA Complete Beans is available from Syngenta. AgLogic 15G (aldicarb) and Velum are also labeled for soybeans.

Tebuconazole, the active ingredient in products such as Folicur, Orius, Muscle, Tebustar, Tebuzol, etc., remains a popular fungicide for soybeans grown in Georgia. The popularity of this product is based on proven efficacy in management of rust, its cost per application (3-4 fl oz/A), and because delays in natural defoliation are not attributed to this fungicide. However, growers must recognize that tebuconazole is NOT a perfect fungicide. Growers should consider other fungicides when deciding to spray soybeans as 1) there are better fungicides for managing soybean rust, 2) there are more effective fungicides for managing anthracnose and other important diseases, and 3) there are fungicides, typically strobilurin fungicides, that offer a longer protective window, e.g. three weeks as opposed to two weeks.

Phomopsis pod and stem blight (*Diaporthe phaseolorum* var. *sojae*) and **anthracnose** (*Colletortrichum* spp.) have been devastating in some fields in Georgia in recent years, for example in Sumter, Terrell and Marion Counties. In such fields, the effects of these diseases were much more severe than Asian soybean rust. Inoculum (spores) from these fungal pathogens can survive in the field amongst the crop debris and the pathogens can also be born on infected seed as well. Although little research has been conducted in Georgia to assess management of these diseases, timely applications of effective fungicides has been reported as an important control measure for at least anthracnose. Both diseases are easily spread by wind and splashing rain that helps to move the fungal spores within a field. **NOTE:** Where fields have been affected by Phomopsis and/or anthracnose in the past, growers should choose fungicides with proven efficacy in managing these diseases and controlling Asian soybean rust. Also, growers should ensure that the timing of the fungicide application is appropriate for all of these diseases.

Cercospora blight: Late in the season growers may begin observing upper leaves turn purple followed by significant defoliation.The p etioles (leaf stems) may also develop deep purple lesions and seed may be stained a purple color. The fungal pathogen *Cercospora kikuchii* is likely the cause of these symptoms and can lead to a reduction in yield and quality. In field studies at the University of Georgia, less Cercospora leaf blight is frequently observed in plots which have been treated with a fungicide to protect against soybean rust than in unsprayed plots.

Crop rotation: If the acreage planted to soybeans increases in Georgia, the time between soybean crops will likely decrease and peanuts and soybeans are more likely to be planted in shorter rotations with each other. Should this occur, growers can expect greater problems with Cylindrocladium black rot/Red crown rot and possibly peanut root-knot nematode. Increased plantings of soybeans may also increase problems with southern root-knot nematodes, reniform nematodes, and Columbia lance nematodes on future cotton crops.

Asian Soybean Rust

Asian soybean rust remains an important concern to soybean producers across Georgia. Growers should remember that if fungicides to control Asian soybean rust are needed, these applications will also control other diseases (e.g., frogeye leaf spot, Cercospora blight, Phomopsis pod and stem blight, and anthracnose).

Bottom-line comments for managing Asian soybean rust in Georgia:

1. Asian soybean rust can (and does) limit yields in some soybean fields in Georgia most years.
2. Asian soybean rust has occurred in every county in Georgia over the past 10 years. Soybean rust is most likely to be found on soybeans and kudzu.
3. Soybean producers are advised to protect their crop with a fungicide IF 1) the crop has reached reproductive growth, 2) Asian soybean rust has been detected locally or is likely to be found locally, 3) environmental conditions are favorable for development and spread of rust, and 4) the crop has potential for adequate yield.
4. Asian soybean rust is less likely to be a problem in fields with poor growth and plants stunted by drought or other factors than fields with good growth, heavy foliage, and a closed canopy.
5. Some growers automatically plan fungicide applications as soybeans reach the R3/pod formation growth stage. They reason that since they will already be applying Dimilin and boron during this time period and because the crop is susceptible to rust, it just makes sense to tank-mix the fungicide for good timing and to save a trip across the field. This is a good strategy, especially when other diseases may occur during this time. However, if soybean rust does not develop until later, the R3 fungicide application may not be needed.
6. In some studies, a single, well-timed application of an effective fungicide may be all that is needed to adequately protect a grower’s crop from soybean rust. However, depending upon the timing of arrival of the soybean rust pathogen and the impact of weather it may be necessary to make a second fungicide application 2-4 weeks after the first application.
7. To know where soybean rust is present in Georgia, growers should consult their county agent.

Spread of Asian Soybean Rust

Soybean rust is spread from infected plants to non-infected plants by spores. Spores germinate in approximately 6-7 hours with suitable leaf wetness and temperatures between 59 and 86°F. Pustules form in 5-10 days and new spores are formed in 10-21 days. Spores are spread by wind-blown rain and can be carried great distances in upper air currents.

Resistant Soybean Varieties

Currently, we have no commercial varieties that are resistant to soybean rust.

Alternative Hosts

Phakopsora pachyrhizi (the fungus that causes Asian soybean rust) infects plants other than soybeans including kudzu, snap beans, lima beans, cowpeas, and over 90 other legume species. **NOTE:** peanut is NOT a host for the Asian soybean rust. Alternative hosts are important because they allow the disease to survive and spread even in the absence of soybeans. Thus, the disease may spread to regions where soybeans do not occur and survive when soybeans are not planted.

Survival of the Asian Soybean Rust

Survival of the rust pathogen is an important component in determining the threat of soybean rust in the coming season. The soybean rust pathogen does not survive for long without a living host. As most kudzu freezes back in Georgia each winter, it is very unlikely that soybean rust will survive in Georgia or northern Florida to any appreciable amount during the winter. However, the rust pathogen will survive in central and southern Florida, provided alternative hosts are present. The disease can then be reintroduced into Georgia as it is spread up the peninsula.

Detection of Asian Soybean Rust

Early detection of symptoms of soybean rust is an important tool in managing this disease. The initial symptoms begin on the bottom of leaves as gray lesions that change to red or tan. These early symptoms can be difficult to detect because they are fairly non-descript; however, early disease detection is essential to most effectively treat it. Lesions can spread from foliage to petioles, stems, and pods. Spores are produced in mature lesions on the undersides of leaves. Once spores are visible, it is likely that other infections exist which have not formed lesions.

Lessons from the field

It is very difficult to identify the very early infections of soybean rust in a field and early detection can be likened to "finding a needle in a haystack." Based on efforts since 2004, effective detection of the earliest infections will require patience and use of a dissecting microscope. It is highly doubtful that growers, consultants, or county agents will find the earliest introductions of soybean rust in a field. Therefore, soybean rust sentinel plots (funded by the Georgia Soybean Commission) will be carefully monitored again in 2023 to provide advanced warning to growers.

In 2023, growers, consultants, and agents should continue to monitor the soybean crop and kudzu carefully. Suspicious samples should be submitted to the Plant Disease Diagnostic Clinic in Tifton. Any finds of soybean rust in 2023 by researchers at University of Georgia will be passed along to the County Agents and reported on the national USDA website at www.sbrusa.net.

Management of Asian Soybean Rust with Fungicides

There are several fungicides labeled for management of Asian soybean rust. Those fungicides are likely effective in managing other soybean diseases as well. Fungicides labeled for the management of Asian soybean rust are presented in Table 24.

Strobilurins, Triazoles, and SDHI fungicides

The most important chemistries that growers use to manage soybean rust are strobilurins (azoxystrobin, pyraclostrobin, and trifloxystrobin), triazoles (tebuconazole, tetraconazole, flutriafol, flusilazole, metconazole, myclobutanil, propiconazole and cyproconazole) and SDHIs (a component of fungicides such as Priaxor and Revytek). Here are some notes on these fungicides:

1. Strobilurin and SDHI fungicides, unless tank-mixed with a triazole, are generally used as "protectants" and must be applied before rust infection occurs.
2. Strobilurin and SDHI fungicides are reported to remain active in fields longer than triazole fungicides after application (3 weeks vs. 2 weeks), though we do not have clear data on this.
3. Triazole fungicides have protectant and limited curative properties. "Curative properties" refers to the ability to eliminate or reduce some very recent infections.
4. Propiconazole (i.e., ,Tilt, PropiMax, and Bumper) is a weaker fungicide against rust than other triazoles such as tebuconazole (Folicur et al.), myclobutanil (Laredo), tetraconazole (Domark) cyproconazole (Alto), flutriafol (Topguard), metconazole (Caramba) and flusilazole (Punch).

NOTE: Fungicides like MIRAVIS TOP, LUCENTO, PRIAXOR and TRIVAPRO also contain fungicides of the "SDHI" class which increases efficacy and reduces risk for resistance to develop.

Lessons from the field

Based upon fungicide trials conducted in Georgia since 2005, we have learned the following lessons:

1. Asian soybean rust can be effectively managed with the fungicides currently available to soybean growers in Georgia.
2. Producers who protect crops with timely fungicide applications do not need to worry about spores coming to their fields from kudzu or neighboring fields where fungicides were not applied. In field trials, soybeans treated with fungicides remained nearly disease-free for extended periods despite devastated, unsprayed, plots next to them.
3. In UGA fungicide trials, chlorothalonil products were less effective than other fungicides for the control of rust. Although chlorothalonil is labeled for the control of soybean rust, the University of Georgia's Cooperative Extension advises growers that optimum timing for application of this fungicide to control rust is unclear and to use it cautiously. Chlorothalonil remains an effective tool against diseases such as frogeye leaf spot.
4. **NOTE:** Headline and likely other strobilurin fungicides such as Quadris, Quadris Xtra, Quilt, EVITO, Stratego, etc. produced what we refer to as a "greening" effect. Foliage in plots sprayed with these fungicides remained greener longer than plots sprayed with other fungicides and took considerably longer to defoliate. This did not seem to affect the % moisture of the soybeans at harvest; however, the delay in defoliation did make harvest more difficult. Some growers have used harvest-aides such as paraquat to defoliate the crop and hasten harvest. Also note that the greening effect is more pronounced where some fungicides (e.g. Headline) have been used and less pronounced (sometimes much less pronounced) where other strobilurin fungicides mentioned above have been applied.
5. Where tebuconazole products were applied in our studies, we sometimes observed foliar symptoms described as "interveinal chlorosis". The foliage on these plants looked like plants that have been affected by nematodes or by sudden death syndrome. **NOTE:** No yield reductions were associated with these symptoms; tebuconazole provides excellent control of Asian soybean rust.

Application Timing

Fungicide application timing to manage soybean rust is critical. It is unlikely that growers in Georgia can afford to spray fungicides on soybean without imminent threat of Asian soybean rust or some other disease such as frogeye leaf spot. However, soybean rust can be a very unforgiving disease if fungicide applications are delayed too long once it threatens. Where applications were delayed in fungicide trials, significant reductions in yield often occurred.

Based on field studies conducted in Georgia, it appears that early reproductive growth (early bloom (R1-R2) through early pod (R3) stages) is an important time for rust management. To date, soybean rust has not been detected prior to early bloom and is typically found as soybeans reach early pod set and beyond.

Lessons from the field

Listed below are thoughts about fungicide applications timing for management of soybean rust.

1. Timing fungicide applications ahead of introduction of Asian soybean rust into a field is critical in the successful management of the disease.
2. From field observations, it appears that early reproductive growth is a critical period in the management of soybean rust. A well-time fungicide application with an appropriate fungicide during this period is CRITICAL for maximum rust control IF the disease is threatening.
3. If rust has not been detected in the local region (as assessed with sentinel plots and careful scouting), it is recommended that soybean growers delay fungicide applications for control of soybean rust until the threat from the disease is more imminent, unless the grower is protecting against some other disease, such as frogeye leaf spot, anthracnose, or Phomopsis blight. If growers want to take a more conservative approach, they may choose to apply their first fungicide at the same time as a Dimilin application timed at the R2-R3 growth stage.
4. If rust has been detected in the local area, or is thought to be likely, growers are advised to initiate fungicide applications once the crop reaches first bloom.
5. A second fungicide application should be considered 2-4 weeks after the first application unless the crop has reached maturity or weather has been unfavorable for disease spread.
6. From field studies, it is clear that the FIRST fungicide application is more important than the second. Growers should not miss the opportunity to achieve excellent control of rust by using a less effective product in the first application if rust threatens.

Steps to manage Soybean Rust in 2023

1. Early detection is critical. If a sample that could be Asian soybean rust is found it should be taken to the local county Extension agent and reported to Dr. Bob Kemerait.
2. Sentinel soybean plots will be planted in April and monitored around the state to provide early detection and warnings of the disease. Kudzu sentinel plots will also be monitored.
3. Fungicide programs to effectively manage rust will be developed and disseminated through the Cooperative Extension Service to the growers.
4. Improper use of fungicides will increase the risk for developing fungicide resistance.
5. Fungicides labeled for managing foliar diseases of soybean are included below in Table 24.

Foliar Diseases other than Asian Soybean Rust

Grower complaints for Frogeye leaf spot and downy mildew are common in some years. Many growers who felt they had a good soybean crop were concerned about losses that could be associated with the foliar diseases and called the Extension Service for recommendations on fungicides for the control of this disease. Our recommendations are as follows:

1. In most situations, control of Frogeye leaf spot with a fungicide will not be economically justified. Growers should focus on using a resistant variety.
2. Currently, it is not economically justified to control downy mildew with fungicides.
3. Growers who want to use a fungicide for managing the disease should use the fungicide on irrigated land and only when they expect exceptional yields, typically 45 bu/A or greater.
4. Fungicide sprays should begin when the symptoms first start to appear or in the range of the R3 (1/4 inch pod) to the R5 (1/8 inch seed) growth stages.
5. If a grower waits too long to begin spraying (i.e. the diseases are rampant in the field), the fungicides will not help him.
6. In addition to many of the fungicides labeled for the control of Asian soybean rust, Topsin-M (thiophanate methyl) is labeled for control of foliar diseases such as frogeye leaf spot.

“Plant Health Benefits” of Fungicides

Many soybean growers in Georgia are aware that at least one fungicide, Headline, is noted not only for its fungicidal qualities, but also for its reported “plant health” benefits. There is no question that applications of Headline on soybeans keep the leaves greener longer and delays natural defoliation. However, it’s not clear that this “greening” effect improves yields consistently enough, in the absence of disease, to justify the expense. In Georgia we have not seen an increase in yield where Headline was used in the absence of disease. Growers who wish to apply Headline with anticipation of improved yields simply from better “plant health” should do so with caution.

Table 24. Fungicides labeled for soybean foliar disease management. Always read and follow official label for use of these fungicides.

Chemical and Formulation	Rate per Acre
Quadris 2.08F (azoxystrobin)	6.2-15.4 fl oz/A, includes frog eye leaf spot and soybean rust
AzoxyStar (azoxystrobin)	6-15.5 fl oz/A
Quadris Xtra	4.0-6.8 fl oz for management of soybean rust; 5.0-6.8 fl oz for other foliar diseases.
Quilt (azoxystrobin + propiconazole)	14-20 fl oz (for management of foliar diseases to include soybean rust.)
Cover XL (azoxystrobin + propiconazole)	10.5-21.1 fl oz
Quadris TOP SBX (azoxystrobin + difenoconazole)	8-14 fl oz/A (for management of foliar diseases to include soybean rust.)
Alto (cyproconazole)	2.75-5.5 fl oz. For control of Soybean rust use 2.75-4.0 fl oz/A. For other foliar diseases use 4.0- 5.5 fl oz/A.
Domark 230 ME (tetraconazole)	4.0-5.0 fl oz (for management of foliar disease to include soybean rust.)
Affiace (azoxystrobin + tetraconzole)	10.0-14.0 fl oz/A (for management of foliar diseases to include rust.)
Tebuconazole	3.0-4.0 fl oz (for management of foliar disease to include soybean rust.)
Headline (pyraclostrobin)	6.0-12.0 fl oz (for management of foliar disease to include soybean rust.)
Priaxor (pyraclostrobin +fluxapyroxad)	4.0-8.0 fl oz/A (for management of foliar diseases to include soybean rust and target spot)
Revytek (pyraclostobin + fluxapyroxad + mefentrifluconazole	8 fl oz/A
Propiconazole (Tilt or Bumper)	4.0-6.0 fl oz (for management of soybean rust and other foliar diseases.)
Stratego (trifloxystrobin + propiconazole)	10.0 fl oz/A (for management of soybean rust and other foliar diseases.)
Stratego YLD (trifloxystrobin + prothioconazole)	4.0-4.65 fl oz (for management of soybean rust and other foliar diseases.)
FORTIX (fluoxastrobin + flutriafol)	4.0-6.0 fl oz/A (for management of soybean rust and other diseases of soybean.)
EVITO (fluoxastrobin)	2.0-5.7 fl oz/A
EVITO T (fluoxastrobin tebuconazole)	4.0-6.0 fl oz/A
Topguard (flutriafol)	7.0-14.0 (for management of soybean rust and other foliar diseases).
Aproach (picoxystrobin)	6.0-12.0 fl oz/A (for management of soybean rust and other foliar diseases.)
Aproach Prima (picoxystrobin + cyproconazole)	5.0-6.8 fl oz/A (for management of soybean rust and other foliar diseases to include target spot.)
Zolera FX (fluoxastrobin + tetraconazole)	4.4-6.8 fl oz/A (for management of soybean rust and other foliar diseases to include target spot.)
TRIVAPRO benzovindiflupyr (solatenol) + azoxystrobin + propiconazole	13.7-20.7 fl oz/A
MIRAVIS TOP adepidyn + difenoconazole	9.0-13.7 fl oz/A (for soybean rust, use Trivapro rather than Miravis Top)
LUCENTO flutriafol + bixafen	3.0-5.5 fl oz/A
Topsin-M 70WP (thiophanate methyl)	Rate: ½ -1 lb/A (controls frog eye leaf spot and other foliar diseases but NOT soybean rust)
Topsin-M 4.5 FL (thiophanate methyl)	10-20 fl oz/A (controls frog eye leaf spot and other foliar diseases but NOT soybean rust)
Bravo Weather Stik	1-2 ¼ pts/A (for management of foliar disease including suppression of rust)
Echo 720	Rate: 1-2 ¼ pts/A (for management of foliar disease including rust)
Equus 720	1-2 ¼ pts/A (for management of foliar diseases including rust).
Bravo Ultrex	0.9-2.2 lb/A (for management of foliar diseases including rust)
Equus DF	0.9-2.2 lb/A (for management of foliar diseases including rust)
Echo 90DF	0.875-2.0 lb/A ((for management of foliar diseases including rust)

Note 1: Prior to discovering Asian soybean rust in Georgia, foliar fungicides were not generally recommended on soybeans. Results of Georgia research on foliar fungicides have been inconsistent. Before applying fungicides, growers should consider current yield potential in the field and potential for further disease spread.
Note 2: The presence of the Asian soybean rust in Georgia has greatly affected disease control recommendations.
Note 3: Asian soybean rust can develop vary rapidly in a field when enough spores are present and environmental conditions are favorable. Once a soybean crop reaches reproductive growth stages, growers should be prepared to treat with fungicides very quickly as soon as the disease is likely to be present in the area.
Note 4: The key to successfully managing Asian soybean rust is use of effective fungicides in a timely manner before the disease becomes established in a field.
Note 5: Higher rates of a product provide greater residual activity and may reduce the need for later sprays to manage rust.
Note 6: "Headline SBR" is no longer available commercially, but growers can tank-mix 3.1 fl oz tebuconazole with 4.7 fl oz Headline to create a similar product.

Seedling Diseases and Seed Treatments

Over the years, seedling diseases have reduced soybean yields 0.5 to 1%. *Rhizoctonia* or *Pythium* are usually the pathogens responsible, but *Rhizoctonia* damage is far more common than *Pythium* damage in soybean fields. Non-uniform stands and/or death of plants soon after emergence are the problems caused by these diseases. Typical symptoms are reddish to dark brown lesions at the base of the stem or on the roots.

Seedling diseases are usually associated with poor quality seed and cool, wet soils. Seed rots and seedling diseases are rarely a problem if high quality seed are planted in well drained, warm soils. However, increased incidence of seed-borne diseases such as anthracnose shows a need for general fungicide treatment of soybean seed (Table 25). Commercial seed treatment is the most effective, but on-farm treatment is acceptable. Rotation should be used in combination with seed treatment for control of these diseases.

A good stand is essential to ensure maximum production. See the "Cultural Practices" section of this guide for information about proper soybean stands.

Table 25. Soybean Seed Treatments

Common Names (Compounds)	Remarks and Precautions
Dynasty (azoxystrobin, Syngenta) Trilex (trifloxystrobin, Bayer Crop Science) Captan Thiram Thiabendazole Molybdenum Carboxin PCNB Metalaxyl *Bacillus subtilis*	Use according to label recommendations.

Fusarium Wilt

Symptoms: Fusarium wilt occurs in midseason during hot weather. The disease is rarely found in seedlings and is more common in sandy soils. Initial aboveground symptoms include a general wilting. The disease may progress rapidly with leaves becoming chlorotic (yellow) then withering. Unlike many soybean diseases, Fusarium wilt can kill plants. Fusarium wilt can be identified in the field by cutting into the stem just above the soil line to observe the condition of the vascular tissue: Fusarium wilt causes tan or brown discoloration in the vascular tissue whereas healthy tissue is white. Fusarium wilt is often exacerbated by root-knot nematode or soybean cyst nematode damage though the presence of the nematodes is not necessary for Fusarium wilt to occur. Drought can enhance disease development.

Control: In fields with a history of Fusarium wilt, crop rotation may help reduce disease pressure. If soybean cyst or root-knot nematodes are present, varieties resistant to those nematodes should be grown. Genetic resistance to Fusarium wilt has been documented, but varieties are not routinely screened and Fusarium wilt resistance information is rarely reported.

If a variety is reported to have Fusarium wilt resistance, it should be grown in fields with a history of Fusarium wilt.

Stem Canker

Symptoms: Symptoms of stem canker are first evident when the soybean plant is in the early reproductive stage. Symptoms appear as small, reddish brown lesions at the base of a petiole on the lower stem. If conditions favor disease development, these lesions elongate laterally along the stem and may, or may not, girdle the stem. Generally, there is a distinct border between the lesion and healthy stem tissue. Foliar symptoms (similar to red crown rot and/or sudden death syndrome) can appear as the season progresses and are expressed as an interveinal chlorosis (yellowing) which becomes necrotic (brown with dead tissue). This disease can cause premature death of plants which significantly reduces yields.

Control: Use crop rotation, resistant varieties, and destruction (plowing under) of infected crop residue to reduce stem canker incidence and severity. Even in fields where stem canker has never occurred, resistant varieties should be grown. All Georgia recommended varieties have fair to good resistance to stem canker. Do not plant susceptible varieties. Some weeds can serve as hosts for the stem canker fungus, so when incorporating fallow into a rotation, it should be as "weed free" as possible.

Pod and Stem Blight

Symptoms: The fungal pathogen of pod and stem blight remains latent in the plant throughout most of the growing season, and symptoms are usually not evident until near harvest. There may be evidence of small black dots along the stems and pods as plants reach maturity. The dots are pycnidia (a fungal reproductive structure) of *Diaporthe phaseolorum* var. *sojae*, the causal agent of pod and stem blight. These pycnidia are more abundant during periods of wet weather.

Control: Rotate with corn and plow down residues. Plant high quality, treated seed. Plant late or during a time that allows maturation during a dry period. Plant resistant varieties may be available. Do not delay harvesting. Maintain adequate potash to minimize moldy seed.

Anthracnose

Symptoms: The plant is susceptible to the fungus at all growth stages, but initial symptoms usually appear during the early reproductive stages. Symptoms are predominantly on the stems and pods in the form of brown to black blotches. As the disease progresses the lesions (blotches) contain black fruiting structures of the fungus. These structures (acervuli) produce minute spines that are easily seen with a hand lens and are very good diagnostic characteristics of this disease. Foliar symptoms are rare, but occur after prolonged periods of high humidity. They include necrosis (browning) of the laminar veins, leaf rolling, petiole cankering, and premature defoliation.

Control: Use disease-free seed and a fungicidal seed treatment. Plow under infected crop residue and rotate the field to something other than soybean.

Red Crown Rot

Symptoms: Symptoms of red crown rot usually appear during the early reproductive stage. The symptoms are expressed as an interveinal chlorosis in the foliage. Prior to harvest, a close examination of the base of the stem may reveal the presence of brick red perithecia, which are fungal fruiting structures that look like clusters of small, red balls. These structures allow the fungus to survive and spread.

Control: Red crown rot is caused by the same fungal pathogen responsible for Cylindrocladium black rot (CBR) in peanut. Therefore, DO NOT rotate soybean with peanut in fields that have problems with red crown rot. This disease is favored by moderate soil temperatures (70 to 85°F) and wet (field capacity) soil. Disease severity is often greater in heavy soils. Management practices reducing red crown rot are as follows: 1) rotate (3-5 years) with any crop except peanut (peanut is highly susceptible), and 2) delay planting. After working in fields infested with this fungus, remove soil from equipment before moving to another field.

Nematodes

Take soil samples prior to harvest (typically August or September) to determine if economically damaging nematodes are present. Nematode populations decline following harvest, so do not delay sampling or you may fail to identify nematode problems. Do not sample overly dry soil and protect samples to keep them from getting too hot or dry. Several species of nematode can damage soybean, but root-knot nematodes and soybean cyst nematode are the most common problems in Georgia. In some parts of Georgia, reniform and Columbia lance nematodes are common and cause significant damage to soybean. Sting nematodes are not common and are limited to very sandy sites, but they can be extremely damaging where they occur.

For some nematode species, damage can be determined by examining soybean roots prior to harvest. Root-knot nematode damage can be identified by the presence of root galls. Root galls differ from nitrogen nodules by the fact that galls are caused by swelling of the root tissue and cannot be removed from the root, but nodules are located on the side of the root and can easily be broken off. If roots are gently washed free of soil, soybean cyst nematodes can be seen as small white specks on the roots (they are much smaller than nodules). As cysts age, they get darker and may appear golden, tan, or brown.

Root-knot nematode is the most commonly occurring nematode problem in soybean in Georgia, and three different species (Southern, Peanut and Javanese root-knot) cause damage here. Many fields in the Coastal Plain region of Georgia are infested with one or more species of these nematodes, and heavy infestations can cause severe damage and, in extreme cases, even plant death. The most common and widespread is the Southern root-knot nematode, which is found in all counties where soybean is grown. For predictive purposes, assume that root-knot nematodes detected in cotton or corn fields are southern root-knot. Peanut root-knot is common in areas with significant peanut production. Javanese root-knot is found less commonly in some areas of South Georgia. Many soybean varieties have genetic resistance to one or more of these root-knot species. The level of resistance to these three species is given in variety recommendations. It is critical to select varieties with resistance to the root-knot species present in your field. Anyone using the early soybean production system should be aware that few varieties in early maturity groups have root-knot nematode resistance. An example of a soybean variety with resistance to the southern root-knot nematode is 'Prichard RR'.

Historically, soybean cyst nematode was present in almost all counties where soybean is grown in Georgia. Over the past 20 years, however, the distribution of soybean cyst nematodes in Georgia is much more restricted. In the midwestern US, soybean cyst can cause significant yield losses with no above-ground symptoms. It seems unlikely here, but Georgia soils typically have much lower fertility and organic matter; however, it may be possible.

Sixteen different races of soybean cyst nematode are theoretically possible, but there are only three races of significance in Georgia. Race 3 is the most widespread race of soybean cyst nematode in Georgia. Much less commonly, race 9 or 14 is identified. In Georgia, populations often shift readily between races 9 and 14. University of Georgia variety recommendations include a rating of the level of resistance to the species of root-knot and the races of soybean cyst nematode common in Georgia. Even if you do not have a soybean cyst nematode infestation, rotation with crops other than soybean is extremely helpful in reducing losses from other diseases.

Columbia lance, reniform, and sting nematodes cause economic damage in some counties. Nematicides can provide good control, but they are expensive. Rotation with peanuts is an excellent control for these nematodes, but peanuts are susceptible to many of the same soilborne fungal disease problems.

The reniform nematode is a growing problem in Georgia and can cause significant yield loss in soybean and cotton. Corn and peanuts are non-hosts for the reniform nematode. Most soybean varieties are very susceptible to the reniform nematode, but some soybean varieties have extremely effective reniform nematode resistance and others have moderate resistance. If reniform nematodes are present, a highly resistant variety should be chosen to minimize soybean losses and to reduce reniform levels in the field. A highly resistant soybean variety can reduce reniform populations as effectively as a non-host crop such as corn. Reniform nematodes are not believed to have races, but a population may be able to overcome reniform resistance in soybean if resistant soybeans are grown for several consecutive years. Crop rotation can be used to minimize this possibility.

Both fumigant and non-fumigant nematicides are registered for use on soybeans and either type can provide effective nematode control. Resistant varieties are available for root-knot, soybean cyst, and reniform nematodes, and those varieties should be grown if these nematodes are present. Nematicides may be necessary if sting or Columbia lance nematodes are present, though it is probably better economically to avoid such fields. Root-knot resistant soybean still suffers some yield loss in heavily infested fields, and research shows that yields of root-knot resistant varieties may be increased by nematicides.

Historically, nematicides have not been economically feasible in most situations, but they may be an option in high profit potential situations such as production of foundation or certified seed. Given better prices for soybeans in the recent past, more growers may consider use of nematicides to manage nematodes and to increase yields. Nematicides are not recommended as a general soybean production practice unless production potential is excellent and the price for soybeans makes this added expense worthwhile.

Table 26. Soybean nematode control options. Always read and follow official product labels.

Product Name	Rate per Acre[1] Amount of Formulation	Rate per Acre[1] Pounds Active Ingredient	Ounces per 1000 row feet[2]	Remarks and Precautions
Preplant Injected				
Telone II	3 – 5 gals		30 – 50 fl oz	Inject 8 inches deep beneath future row. Wait seven days between application and planting.
Preplant or At Planting				
AgLogic 15G	Granular in-furrow insecticide/nematicide	7 lbs/acre		
ILeVO	Seed Treatment			ILeVO can contribute to the management of nematodes and Sudden Death Syndrome
AVICTA Complete Bean	Seed Treatment			AVICTA Complete Bean is a combination of abamectin and thiomethoxam + additional fungicides. Research continues to develop more specific recommendations for this product on soybeans grown in Georgia.

Harvesting, Drying, and Storing Soybean in Georgia

Richard Roth

Producing a high-quality soybean crop is one thing. Harvesting those soybeans with minimum losses and then drying and storing them in a way that maintains quality until the soybeans are marketed is another. A reduction in harvest losses of three bushels per acre when harvesting three acres per hour can result in a savings of $117 per harvesting hour based on $13 per bushel. Proper drying and storage will maintain quality soybeans and assure minimum losses.

Harvesting

Harvesting Losses

The grain-combine harvester has been used for soybeans since the mid-twenties but little progress was made in reducing harvesting losses until about 1970. Until then, the average combine using a rigid grain platform header resulted in as much as 10 percent losses during the harvesting operation. The introduction of attachments such as the floating cutter bar and pick-up reel reduced harvesting losses to 7 or 8 percent. Combine headers that have a built-in, flexible cutter bar have been designed and developed specifically for use in soybeans can reduce harvest losses to about 4 percent of yield.

The types of harvesting losses should be identified and measured so that proper combine adjustments can be made to increase soybean harvesting efficiency.

Preharvest losses are those that occur from natural causes before harvest. These losses result from soybeans that have fallen to the ground by the time harvest begins. If soybeans that are ready for harvest are subjected to several alternating periods of wet and dry weather, preharvest losses could be as high as 25 percent.

Gathering or header losses are soybeans that are not gathered into the combine. These losses are caused by the action of the cutter bar, reel and auger and account for more than 85 percent of the total soybean losses at harvest. There are four kinds of gathering losses. Shatter losses are shelled soybeans and detached soybean pods that are shattered from stalks by the header. Stubble losses are soybeans in pods remaining on the stubble because of operating the cutterbar too high, etc. Stalk losses are soybeans remaining in pods attached to stalks that were cut but not delivered into the combine. Lodged losses are soybeans remaining in pods attached to stalks that were not cut or that were cut at heights greater than that of the stubble.

Soybeans are easy to thresh, separate and clean. Soybeans can be rubbed out of the pod readily and their size and shape are ideal for cleaning. Even so, small errors in the adjustment of the combine can result in disastrous losses during the threshing, separating, and cleaning operations. Threshing or cylinder losses occur when shelled soybeans are carried out the back of the machine with the stalks. Separating losses are usually insignificant unless the combine is overloaded. Cleaning or shoe losses occur when shelled soybeans are carried over the chaffer or top sieve and out the back of the combine.

Measuring Losses

Harvesting losses can be measured by enclosing a ten square foot area with a rectangular frame and counting the soybeans remaining in that area after harvest. A count of 40 beans within the frame represents approximately one bushel per acre. Make the frame from heavy cord or cloth line so it can be coiled and carried on the combine. The length of the frame should be equal to the cutting width of the combine header (Table 27). Make four pins 3 to 4 inches long from No. 9 wire and tie them to the frame to mark the corners. The pins should be pushed into the ground to hold the frame tight.

Table 27. Frame Width Based on Combine Header Width

Header Width (feet)	Frame Width (inches)
16	7.5
18	6.75
20	6
22	5.5
24	5

The procedure for determining field losses can be done by operating the combine in the normal way, move into the crop until well away from the edge of the field. Then, the combine should be stopped, the platform drive disengaged, the platform raised and the combine backed up 15 to 20 feet. In measuring total losses the frame should be placed across the harvested rows behind the combine and the loose soybeans, soybeans in pods on or off the stalks, and soybeans on the stubble inside the frame should be counted. This figure divided by 40 represents an estimate of the losses in bushels per acre, and it includes both preharvest and harvest losses. If the loss is near 3 percent of the yield, continue harvesting.

To measure preharvest losses, the frame should be placed across the rows of standing soybeans in front of the combine and loose soybeans and soybeans in pods on the ground should be counted and divided by 40. To determine the total harvesting losses, the preharvest losses should be subtracted from the total losses found behind the combine.

Reducing Losses

Preharvest losses can be minimized by planting shatter-resistant varieties and early harvest. Soybeans should be harvested shortly after their moisture content first reaches 14-16 percent.

Header designs play an important role in reducing harvesting losses. The row-crop header has proven to be more efficient than platform type headers. Of the platform type headers, the flexible floating cutterbar header is the most efficient but slightly less efficient than the row-crop header.

The flexible floating cutterbar header has several features that enable it to reduce soybean losses: its long dividing points help prevent problems that occur in lodged soybeans; its extended platform and low profile reduce shatter and stalk losses; and its large-diameter auger rapidly moves plant material to the center and helps reduce stalk losses.

To take full advantage of the time available for harvesting, make all necessary repairs and major adjustments well before the harvest season. The combine should be thoroughly repaired, lubricated and adjusted as instructed in the operator's manual. Reduction in gathering losses can be accomplished only if the header is adjusted to cut close to the ground to avoid leaving soybeans on the stubble and shattering them from the stalks. To further reduce shatter losses, set the header to handle the soybeans as gently as possible. Rough handling by the header's cross auger and by the slat conveyors in the feeder housing can thresh a substantial percentage of the soybeans before they reach the combine cylinder. These soybeans can be lost if the slope of the header's deck is improperly adjusted, the deck is not tight, or if the plant material is not fed uniformly into the combine cylinder.

Almost all gathering losses are caused by the action of the knife and reel. The knife must be kept sharp, and broken or badly worn sections replaced. Plates should be adjusted to minimize knife vibration. The guards should be aligned and the knife clips adjusted so the knife can move freely and cut efficiently.

Proper reel adjustments are particularly necessary to keep losses low. If the reel turns too fast, it will shatter soybeans excessively. If the reel turns too slowly, it may drop stalks or allow them to be recut. A pick-up reel can help reduce harvesting losses. The speed of the pick-up reel should be 50 percent greater than ground speed. A 42-inch reel should rotate at about 12 revolutions per minute (rpm) for each 1 mph of forward speed.

The reel axle should be eight to 12 inches ahead of the sickle on most headers. With a pick-up reel and floating cutter bar, the reel axle should be about eight inches ahead of the sickle. Several manufacturers are now providing headers with a built-in, flexible cutter bar. When harvesting short plant material, the reel axle should be moved nearer the cutter bar.

To prevent excessive threshing and separating losses and to still keep the soybeans clean, the threshing and separating mechanisms must be kept properly adjusted. The single most important item to check is the separator speed. In each combine a particular shaft serves as a starting point for checking the operation speed. In some machines this starting point is the cylinder beater cross-shaft; in others it is the primary counter shaft. Most combines are designed to operate at the proper speed when the speed control lever of the engine is in the maximum position. Adjustment is needed if the separator is not running at the proper speed with the control level in this position.

To determine the procedure for adjusting engine speed, the operator's manual should be used or adjustments should be made by a local dealer. A small deviation from the correct engine speed can affect the operation of the cleaning and separating units making it impossible to get soybeans clean and keep losses to a minimum.

Before taking the combine to the field, the cylinder speed, the cylinder-concave clearance, the sieve settings, and the speed and opening of the cleaning fan should be adjusted. If the operator's manual is followed closely in making these adjustments, only minor adjustments should have to be made in the field.

The cylinder and fan speed must be adjusted to fit threshing conditions. When the moisture content of the soybeans is above 13 percent, they are usually tough; so the cylinder speed may have to be increased to 600 rpm. As soybeans dry, lower the cylinder speed to reduce breakage; 450 to 550 rpm should be high enough for soybeans that are below 13 percent in moisture content.

Drying and Storing Soybean

Drying soybeans has two principal advantages. Drying permits harvesting the grain as soon as it is ripe and mature to avoid field losses and it places the grain in a condition for safe storage reducing storage losses from heat damage and molds. Drying is the universal method of conditioning wet grain to preserve its quality and nutritive value for feed and food and its germination for seed.

Soybeans should be harvested promptly when they are mature to reduce field losses and lessen chances of damage from bad weather. However, at this stage soybeans contain too much moisture for safe storage. With adequate drying methods, soybeans can be harvested at a moisture content as high as 20 percent.

However, when drying from 20 percent to a safe moisture content, a large amount of water must be removed increasing the cost of the drying operation. High moisture grain loses this moisture rapidly in the field; thus, for maximum returns soybeans should be harvested when they have reached approximately 14 to 16 percent moisture content. The percent weight reduction when drying grain and soybeans can be easily estimated (Table 28).

Table 28. Percent Reductions in Weight of Soybeans from Drying

Original Moisture Content (%)	Final Moisture Content (%)					
	10	11	12	13	14	15
	Weight Reduction (%)					
16	6.7	5.6	4.5	3.4	2.3	1.2
17	7.8	6.7	5.7	4.6	3.5	2.3
18	8.9	7.9	6.9	5.8	4.7	3.6
19	10.1	9.0	8.0	6.9	5.8	4.7
20	11.0	10.1	9.0	8.1	7.0	5.8

For example, soybeans with an original moisture content of 16 percent dried to a final moisture content of 11 percent lose approximately 5.6 percent from the original weight. On 1,000 pounds of soybeans (original weight), the loss would be 56 pounds and the final dried weight, 944 pounds.

The recommended maximum moisture content for one year of safe storage of soybeans in Georgia is 11 percent in north Georgia and 10 percent below the fall line. Note that this is the maximum moisture content to be found anywhere in the storage bin and is not the average for all the beans in the bin.

The two principal factors involved in the safe storage of soybeans are moisture content and temperature. The amount of moisture in soybeans determines whether or not mold damage will occur. The higher the moisture and temperature, the faster mold growth and more rapid the spoilage of soybeans will occur. Insect damage is also less in dry, stored soybeans.

Low temperatures offset the effects of high moisture, particularly as it affects the development of molds and insects. Cooling is one of the greatest benefits gained from moving and turning soybeans in elevators. This can be accomplished more effectively by aeration which cools soybeans so that damp soybeans can be held in storage for weeks or even months.

In all practical soybean drying systems, air is used as a medium for removing moisture as it is evaporated. Evaporation of the moisture requires heat energy that is normally supplied by the air forced through the soybeans. When dry air is forced up through a deep layer of wet soybeans, drying starts at the bottom where the air first enters. As the flow of air continues, more of the soybeans begin to dry, so that a layer known as the "drying zone" is formed. The drying zone continues to move upward through the wet soybeans until it is passed through the surface layer.

Relative humidity of drying air determines the moisture to which grain will dry. At a given temperature and relative humidity, there is a corresponding moisture content below which grain will not dry. This property is referred to as the "equilibrium moisture content" (table 29).

Table 29. Soybean equilibrium moisture content by air temperature and relative humidity.

Air Temp (°F)	Relative Humidity (%) 20	35	55	70	80	90
	Moisture Content (%)					
40	6.3	8.5	11.0	13.5	15.5	19.5
60	5.8	8.0	10.0	12.0	14.0	17.5
80	4.5	7.0	9.0	11.0	13.0	15.8
100	4.0	6.0	8.2	10.3	12.2	14.5

The safe maximum temperature of the heated air for drying any grain is determined by the final use of the grain. For soybeans to be milled for oil and those to be used for food, the temperatures in heated-air batch driers should be limited to 130°F. Soybeans to be used for seed should not be exposed to air over 110°F.

For in-storage drying, temperatures of the drying air over 100°F are seldom encountered. However, the initial moisture content and the time of exposure of the wet grain to this higher temperature above the drying zone become important factors. The greater the moisture content of the soybeans, the greater the air flow required per bushel to dry it to a safe moisture content before mold attach can set in.

Stored soybeans should be aerated to keep them at a cool, uniform temperature. If stored in bins equipped for drying, all the soybeans can be cooled to a uniform temperature in about 10 to 15 hours. The soybeans should be cooled immediately after drying is completed and the cooling repeated every two months during the winter and once in the spring on a cool, dry day. After each cooling, all openings to the plenum under the floor should be closed and a tight cover put over the fan inlet to prevent any outside air circulating through the grain. The air can be forced up through the grain as in drying, provided condensation does not occur on the bin roof. It is not always necessary to pull the air through the grain as in aerating grain with smaller fans, in which case pulling is essential. The purpose of aeration is to keep the grain at a uniform cool temperature which prevents "top sweating" in the top layer of grain in the center of the bin.

Mechanical injury to soybean seed should be avoided as it is an important cause of decline in germination and vigor. Injury to soybean seed results primarily from impacts of the seed with hard surfaces or other seed. The extent and severity of mechanical damage are related to the moisture content of the seed, the velocity of the seed at the moment of impact, and the degree of hardness of the impacted surface. A single 10-foot drop of seed with less than 12 percent moisture against a metal surface can reduce germination by as much as 10 to 15 percent. Seeds with 14 percent or more moisture are relatively unaffected by impacts resulting from drops as high as 20 feet.

Soybeans for use other than seed are also affected by dropping into a bin if moisture content is too low. A certain amount of splitting will occur each time they are dropped. Soybeans should be handled as little and as gently as possible.

Safety

Good safety habits are a must for anyone who operates a modern combine or who is involved in soybean storage and hauling.

Always keep the combine clean because field trash around the exhaust system can cause fires. Before a combine is lubricated or adjusted or cleaned, all drives should be disengaged and the engine stopped.

Grain drying and handling can be dangerous. Transport augers can hit power lines, unguarded augers can catch hands or feet, and fans and shafts can catch unsuspecting victims. A deadly hazard exists for anyone in a grain bin as deaths occur every year from suffocation and injuries caused by unloading augers. Power to the unloading auger should be disconnected before entering bins. A knotted safety rope hanging near the center of the bin offers greater protection, and a second person who can help should be standing by. Air pockets sometimes form when grain bridges over unloading augers due to spoiled grain and moisture. This crusted surface should not be walked over because the pocket can collapse. Wear an effective dust mask when exposed to grain dust.

2023 Soybean Production Budgets

Amanda Smith

		Irrigated Soybeans				
		South Georgia, 2023				
[[Due to extreme volatility in input markets, prices may change rapidly. These are current as of Jan 2023. You are encouraged to enter your own prices to best estimate your 2023 cost of production.]]						
		Estimated Costs and Returns				
Expected Yield:		60	bushel	Your Yield		
Variable Costs	**Unit**	**Amount**	**$/Unit**	**Cost/Acre**	**$/bushel**	**Your Farm**
RR Seed	bag	1	$ 60.00	$ 60.00	$ 1.00	
Inoculant	acre	1	$ 6.50	$ 6.50	$ 0.11	
Lime	ton	0.33	$ 60.00	$ 19.80	$ 0.33	
Fertilizer						
Phosphate	pounds	40	$ 0.80	$ 32.00	$ 0.53	
Potash	pounds	80	$ 0.75	$ 60.00	$ 1.00	
Boron	pounds	0.5	$ 6.80	$ 3.40	$ 0.06	
Weed Control	acre	1	$ 32.30	$ 32.30	$ 0.54	
Insect Control	acre	1	$ 3.10	$ 3.10	$ 0.05	
Disease Control *	acre	1	$ 18.00	$ 18.00	$ 0.30	
Preharvest Machinery						
Fuel	gallon	4.8	$ 4.25	$ 20.36	$ 0.34	
Repairs and Maintenance	acre	1	$ 15.74	$ 15.74	$ 0.26	
Harvest Machinery						
Fuel	gallon	1.8	$ 4.25	$ 7.53	$ 0.13	
Repairs and Maintenance	acre	1	$ 8.17	$ 8.17	$ 0.14	
Labor	hours	0.9	$ 13.50	$ 12.42	$ 0.21	
Irrigation**	applications	5	$ 13.50	$ 67.50	$ 1.13	
Crop Insurance	acre	1	$ 13.00	$ 9.00	$ 0.15	
Land Rent	acre	1	$ -	$ -	$ -	
Interest on Operating Capital	percent	$ 187.91	7.5%	$ 14.09	$ 0.23	
Total Variable Costs:				**$ 389.91**	**$ 6.50**	
Fixed Costs						
Machinery Depreciation, Taxes, Insurance and Housing						
Preharvest Machinery	acre	1	$ 45.08	$ 45.08	$ 0.75	
Harvest Machinery	acre	1	$ 33.43	$ 33.43	$ 0.56	
Irrigation	acre	1	$ 135.00	$ 135.00	$ 2.25	
General Overhead	% of VC	$ 389.91	5%	$ 19.50	$ 0.32	
Management	% of VC	$ 389.91	5%	$ 19.50	$ 0.32	
Owned Land Cost, Taxes, Cash Payment, etc.	acre	1	$ -	$ -	$ -	
Other ________________	acre	1	$ -	$ -	$ -	
Total Fixed Costs				**$ 252.50**	**$ 4.21**	
Total Costs Excluding Land				**$ 642.40**	**$ 10.71**	
Your Profit Goal			**$**		**/bushel**	
Price Needed for Profit			**$**		**/bushel**	

* In the case of Asian Soybean Rust or other disease, add $15-$30 for additional fungicide sprays.

** Weighted average of diesel and electric irrigation application costs. Electric is estimated at $8/appl and diesel is estimated at $16/appl when diesel costs $4.25/gal.

Sensitivity Analysis of Irrigated Soybeans

Net Returns Above Variable Costs Per Acre

Varying Prices and Yields (bushel)

	-25%	-10%	Expected	+10%	+25%
Price \ bushel/Acre	45	54	60	66	75
$8.50	**-$7.41**	**$69.09**	**$120.09**	**$171.09**	**$247.59**
$9.50	**$37.59**	**$123.09**	**$180.09**	**$237.09**	**$322.59**
$10.50	**$82.59**	**$177.09**	**$240.09**	**$303.09**	**$397.59**
$11.50	**$127.59**	**$231.09**	**$300.09**	**$369.09**	**$472.59**
$12.50	**$172.59**	**$285.09**	**$360.09**	**$435.09**	**$547.59**

Estimated Labor and Machinery Costs per Acre

Preharvest Operations

Operation	Acres/Hour	Number of Times Over	Labor Use**** (hrs/ac)	Fuel Use (gal/ac)	Repairs ($/ac)	Fixed Costs ($/ac)
Heavy Disk 21' with Tractor (180-199 hp) MFWD 190	10.3	2	0.24	1.90	$ 7.52	$ 21.82
Disk Harrow 32' with Tractor (180-199 hp) MFWD 190	16.3	1	0.08	0.60	$ 2.34	$ 6.78
Bed-Disk (Hipper) 6R-36 with Tractor (180-199 hp) MFWD 190	9.6	1	0.13	1.02	$ 2.23	$ 6.95
Plant - Rigid 6R-36 with Tractor (120-139 hp) 2WD 130	9.5	1	0.13	0.70	$ 2.28	$ 6.35
Spray (Broadcast) 60' with Tractor (120-139 hp) 2WD 130	35.5	3	0.11	0.57	$ 1.37	$ 3.18
Total Preharvest Values			0.69	4.79	$ 15.74	$ 45.08

Harvest Operations

Operation	Acres/Hour	Number of Times Over	Labor Use**** (hrs/ac)	Fuel Use (gal/ac)	Repairs ($/ac)	Fixed Costs ($/ac)
Header - Corn 12R-30 with Combine (200-249 hp) 240 hp	10.8	1	0.12	1.14	$ 6.51	$ 28.99
Grain Cart Soybean 500 bu with Tractor (120-139 hp) 2WD 130	10.6	1	0.12	0.63	$ 1.66	$ 4.44
Total Harvest Values			0.23	1.77	$ 8.17	$ 33.43

**** Includes unallocated labor factor of 0.25. Unallocated labor factor is percentage allowance for additional labor required to move equipment and hook/unhook implements, etc.

Irrigated Soybeans, Strip Tillage
South Georgia, 2023

[[Due to extreme volatility in input markets, prices may change rapidly. These are current as of Jan 2023. You are encouraged to enter your own prices to best estimate your 2023 cost of production.]]

Estimated Costs and Returns

Expected Yield:		**60** bushel	Your Yield			

Variable Costs	Unit	Amount	$/Unit	Cost/Acre	$/bushel	Your Farm
Cover Crop Seed	bushel	1.5	$ 17.00	$ 25.50	$ 0.43	
RR Seed	bag	1	$ 60.00	$ 60.00	$ 1.00	
Inoculant	acre	1	$ 6.50	$ 6.50	$ 0.11	
Lime	ton	0.33	$ 60.00	$ 19.80	$ 0.33	
Fertilizer						
Phosphate	pounds	40	$ 0.80	$ 32.00	$ 0.53	
Potash	pounds	80	$ 0.75	$ 60.00	$ 1.00	
Boron	pounds	0.5	$ 6.80	$ 3.40	$ 0.06	
Weed Control	acre	1	$ 45.05	$ 45.05	$ 0.75	
Insect Control	acre	1	$ 3.10	$ 3.10	$ 0.05	
Disease Control *	acre	1	$ 18.00	$ 18.00	$ 0.30	
Preharvest Machinery **						
Fuel	gallon	3.1	$ 4.25	$ 13.00	$ 0.22	
Repairs and Maintenance	acre	1	$ 8.86	$ 8.86	$ 0.15	
Harvest Machinery						
Fuel	gallon	1.8	$ 4.25	$ 7.53	$ 0.13	
Repairs and Maintenance	acre	1	$ 8.17	$ 8.17	$ 0.14	
Labor	hours	0.7	$ 13.50	$ 9.25	$ 0.15	
Irrigation***	applications	4	$ 13.50	$ 54.00	$ 0.90	
Crop Insurance	acre	1	$ 13.00	$ 13.00	$ 0.22	
Land Rent	acre	1	$ -	$ -	$ -	
Interest on Operating Capital	percent	$ 180.83	7.5%	$ 13.56	$ 0.23	
Total Variable Costs:				**$ 400.72**	**$ 6.68**	
Fixed Costs						
Machinery Depreciation, Taxes, Insurance and Housing						
Preharvest Machinery ***	acre	1	$ 24.91	$ 24.91	$ 0.42	
Harvest Machinery	acre	1	$ 33.43	$ 33.43	$ 0.56	
Irrigation	acre	1	$ 135.00	$ 135.00	$ 2.25	
General Overhead	% of VC	$ 400.72	5%	$ 20.04	$ 0.33	
Management	% of VC	$ 400.72	5%	$ 20.04	$ 0.33	
Owned Land Cost, Taxes, Cash Payment, etc.	acre	1	$ -	$ -	$ -	
Other ________________	acre	1	$ -	$ -	$ -	
Total Fixed Costs				**$ 233.41**	**$ 3.89**	
Total Costs Excluding Land				**$ 634.13**	**$ 10.57**	
Your Profit Goal			**$**		**/bushel**	
Price Needed for Profit			**$**		**/bushel**	

* In the case of Asian Soybean Rust or other disease, add $15-$30 for additional fungicide sprays.

** Rip, strip and plant in one pass. Performing rip, strip and plant as separate operations increases preharvest fuel use by 0.6 gal ($1.35/ac), labor costs by $0.85/ac, and repairs by $0.90/ac. Fixed costs would increase by $2.50/ac.

*** Weighted average of diesel and electric irrigation application costs. Electric is estimated at $8/appl and diesel is estimated at $16/appl when diesel costs $4.25/gal.

Sensitivity Analysis of Irrigated Soybeans, Strip Tillage

Net Returns Above Variable Costs Per Acre

Varying Prices and Yields (bushel)

	-25%	-10%	Expected	+10%	+25%
Price \ bushel/Acre	45	54	60	66	75
$8.50	**-$18.22**	**$58.28**	**$109.28**	**$160.28**	**$236.78**
$9.50	**$26.78**	**$112.28**	**$169.28**	**$226.28**	**$311.78**
$10.50	**$71.78**	**$166.28**	**$229.28**	**$292.28**	**$386.78**
$11.50	**$116.78**	**$220.28**	**$289.28**	**$358.28**	**$461.78**
$12.50	**$161.78**	**$274.28**	**$349.28**	**$424.28**	**$536.78**

Estimated Labor and Machinery Costs per Acre

Preharvest Operations

Operation	Acres/Hour	Number of Times Over	Labor Use***** (hrs/ac)	Fuel Use (gal/ac)	Repairs ($/ac)	Fixed Costs ($/ac)
Spin Spreader 5 ton with Tractor (120-139 hp) 2WD 130	23.8	1	0.05	0.28	$ 0.70	$ 1.98
Disk Harrow 32' with Tractor (180-199 hp) MFWD 190	16.3	1	0.08	0.60	$ 2.34	$ 6.78
Spray (Broadcast) 60' with Tractor (120-139 hp) 2WD 130	35.5	1	0.04	0.19	$ 0.46	$ 1.06
ST Plant Rigid 6R-36 with Tractor (180-199 hp) MFWD 190	6.9	1	0.18	1.42	$ 3.99	$ 11.92
Spray (Broadcast) 60' with Tractor (120-139 hp) 2WD 130	35.5	3	0.11	0.57	$ 1.37	$ 3.18
Total Preharvest Values			0.45	3.06	$ 8.86	$ 24.91

Harvest Operations

Operation	Acres/Hour	Number of Times Over	Labor Use***** (hrs/ac)	Fuel Use (gal/ac)	Repairs ($/ac)	Fixed Costs ($/ac)
Header - Corn 12R-30 with Combine (200-249 hp) 240 hp	10.8	1	0.12	1.14	$ 6.51	$ 28.99
Grain Cart Soybean 500 bu with Tractor (120-139 hp) 2WD 130	10.6	1	0.12	0.63	$ 1.66	$ 4.44
Total Harvest Values			0.23	1.77	$ 8.17	$ 33.43

***** Includes unallocated labor factor of 0.25. Unallocated labor factor is percentage allowance for additional labor required to move equipment and hook/unhook implements, etc.

Non-Irrigated Soybeans

South Georgia, 2023

[[Due to extreme volatility in input markets, prices may change rapidly. These are current as of Jan 2023. You are encouraged to enter your own prices to best estimate your 2023 cost of production.]]

Estimated Costs and Returns

Expected Yield: **30** bushel   Your Yield ________

Variable Costs	Unit	Amount	$/Unit	Cost/Acre	$/bushel	Your Farm
RR Seed	bag	1	$ 60.00	$ 60.00	$ 2.00	
Inoculant	acre	1	$ 6.50	$ 6.50	$ 0.22	
Lime	ton	0.33	$ 60.00	$ 19.80	$ 0.66	
Fertilizer						
Phosphate	pounds	40	$ 0.80	$ 32.00	$ 1.07	
Potash	pounds	80	$ 0.75	$ 60.00	$ 2.00	
Boron	pounds	0.5	$ 6.80	$ 3.40	$ 0.11	
Weed Control	acre	1	$ 29.50	$ 29.50	$ 0.98	
Insect Control	acre	1	$ 3.10	$ 3.10	$ 0.10	
Disease Control *	acre	1	$ -	$ -	$ -	
Preharvest Machinery						
Fuel	gallon	4.8	$ 4.25	$ 20.36	$ 0.68	
Repairs and Maintenance	acre	1	$ 15.74	$ 15.74	$ 0.52	
Harvest Machinery						
Fuel	gallon	1.8	$ 4.25	$ 7.53	$ 0.25	
Repairs and Maintenance	acre	1	$ 8.17	$ 8.17	$ 0.27	
Labor	hours	0.9	$ 13.50	$ 12.42	$ 0.41	
Crop Insurance	acre	1	$ 22.00	$ 22.00	$ 0.73	
Land Rent	acre	1	$ -	$ -	$ -	
Interest on Operating Capital	percent	$ 150.26	7.5%	$ 11.27	$ 0.38	
Total Variable Costs:				**$ 311.78**	**$ 10.39**	
Fixed Costs						
Machinery Depreciation, Taxes, Insurance and Housing						
Preharvest Machinery	acre	1	$ 45.08	$ 45.08	$ 1.50	
Harvest Machinery	acre	1	$ 33.43	$ 33.43	$ 1.11	
General Overhead	% of VC	$ 311.78	5%	$ 15.59	$ 0.52	
Management	% of VC	$ 311.78	5%	$ 15.59	$ 0.52	
Owned Land Cost, Taxes, Cash Payment, etc.	acre	1	$ -	$ -	$ -	
Other ________________	acre	1	$ -	$ -	$ -	
Total Fixed Costs				**$ 109.68**	**$ 3.66**	
Total Costs Excluding Land				**$ 421.47**	**$ 14.05**	
Your Profit Goal			**$**		**/bushel**	
Price Needed for Profit			**$**		**/bushel**	

* In the case of Asian Soybean Rust or other disease, add $15-$30 for additional fungicide sprays.

Sensitivity Analysis of Non-Irrigated Soybeans

Net Returns Above Variable Costs Per Acre

Varying Prices and Yields (bushel)

	-25%	-10%	Expected	+10%	+25%
Price \ bushel/Acre	23	27	30	33	38
$8.50	**-$120.53**	**-$82.28**	**-$56.78**	**-$31.28**	**$6.97**
$9.50	**-$98.03**	**-$55.28**	**-$26.78**	**$1.72**	**$44.47**
$10.50	**-$75.53**	**-$28.28**	**$3.22**	**$34.72**	**$81.97**
$11.50	**-$53.03**	**-$1.28**	**$33.22**	**$67.72**	**$119.47**
$12.50	**-$30.53**	**$25.72**	**$63.22**	**$100.72**	**$156.97**

Estimated Labor and Machinery Costs per Acre

Preharvest Operations

Operation	Acres/Hour	Number of Times Over	Labor Use*** (hrs/ac)	Fuel Use (gal/ac)	Repairs ($/ac)	Fixed Costs ($/ac)
Heavy Disk 21' with Tractor (180-199 hp) MFWD 190	10.3	2	0.24	1.90	$ 7.52	$ 21.82
Disk Harrow 32' with Tractor (180-199 hp) MFWD 190	16.3	1	0.08	0.60	$ 2.34	$ 6.78
Bed-Disk (Hipper) 6R-36 with Tractor (180-199 hp) MFWD 190	9.6	1	0.13	1.02	$ 2.23	$ 6.95
Plant - Rigid 6R-36 with Tractor (120-139 hp) 2WD 130	9.5	1	0.13	0.70	$ 2.28	$ 6.35
Spray (Broadcast) 60' with Tractor (120-139 hp) 2WD 130	35.5	3	0.11	0.57	$ 1.37	$ 3.18
Total Preharvest Values			0.69	4.79	$ 15.74	$ 45.08

Harvest Operations

Operation	Acres/Hour	Number of Times Over	Labor Use*** (hrs/ac)	Fuel Use (gal/ac)	Repairs ($/ac)	Fixed Costs ($/ac)
Header - Corn 12R-30 with Combine (200-249 hp) 240 hp	10.8	1	0.12	1.14	$ 6.51	$ 28.99
Grain Cart Soybean 500 bu with Tractor (120-139 hp) 2WD 130	10.6	1	0.12	0.63	$ 1.66	$ 4.44
Total Harvest Values			0.23	1.77	$ 8.17	$ 33.43

*** Includes unallocated labor factor of 0.25. Unallocated labor factor is percentage allowance for additional labor required to move equipment and hook/unhook implements, etc.

Non-Irrigated Soybeans, Strip Tillage
South Georgia, 2023

[[Due to extreme volatility in input markets, prices may change rapidly. These are current as of Jan 2023. You are encouraged to enter your own prices to best estimate your 2023 cost of production.]]

Estimated Costs and Returns

Expected Yield: **30** bushel — Your Yield ______

Variable Costs	Unit	Amount	$/Unit	Cost/Acre	$/bushel	Your Farm
Cover Crop Seed	bushel	1.5	$ 17.00	$ 25.50	$ 0.85	
RR Seed	bag	1	$ 60.00	$ 60.00	$ 2.00	
Inoculant	acre	1	$ 6.50	$ 6.50	$ 0.22	
Lime	ton	0.33	$ 60.00	$ 19.80	$ 0.66	
Fertilizer						
Phosphate	pounds	40	$ 0.80	$ 32.00	$ 1.07	
Potash	pounds	80	$ 0.75	$ 60.00	$ 2.00	
Boron	pounds	0.5	$ 6.80	$ 3.40	$ 0.11	
Weed Control	acre	1	$ 42.25	$ 42.25	$ 1.41	
Insect Control	acre	1	$ 3.10	$ 3.10	$ 0.10	
Disease Control *	acre	1	$ -	$ -	$ -	
Preharvest Machinery **						
Fuel	gallon	3.1	$ 4.25	$ 13.00	$ 0.43	
Repairs and Maintenance	acre	1	$ 8.86	$ 8.86	$ 0.30	
Harvest Machinery						
Fuel	gallon	1.8	$ 4.25	$ 7.53	$ 0.25	
Repairs and Maintenance	acre	1	$ 8.17	$ 8.17	$ 0.27	
Labor	hours	0.7	$ 13.50	$ 9.25	$ 0.31	
Crop Insurance	acre	1	$ 22.00	$ 22.00	$ 0.73	
Land Rent	acre	1	$ -	$ -	$ -	
Interest on Operating Capital	percent	$ 147.93	7.5%	$ 11.09	$ 0.37	
Total Variable Costs:				**$ 332.45**	**$ 11.08**	
Fixed Costs						
Machinery Depreciation, Taxes, Insurance and Housing						
Preharvest Machinery ***	acre	1	$ 24.91	$ 24.91	$ 0.83	
Harvest Machinery	acre	1	$ 33.43	$ 33.43	$ 1.11	
General Overhead	% of VC	$ 332.45	5%	$ 16.62	$ 0.55	
Management	% of VC	$ 332.45	5%	$ 16.62	$ 0.55	
Owned Land Cost, Taxes, Cash Payment, etc.	acre	1	$ -	$ -	$ -	
Other ________________	acre	1	$ -	$ -	$ -	
Total Fixed Costs				**$ 91.58**	**$ 3.05**	
Total Costs Excluding Land				**$ 424.03**	**$ 14.13**	
Your Profit Goal			**$**		**/bushel**	
Price Needed for Profit			**$**		**/bushel**	

* In the case of Asian Soybean Rust or other disease, add $15-$30 for additional fungicide sprays.

** Rip, strip and plant in one pass. Performing rip, strip and plant as separate operations increases preharvest fuel use by 0.6 gal ($1.35/ac), labor costs by $0.85/ac, and repairs by $0.90/ac. Fixed costs would increase by $2.50/ac.

Sensitivity Analysis of Non-Irrigated Soybeans, Strip Tillage

Net Returns Above Variable Costs Per Acre

Varying Prices and Yields (bushel)

	-25%	-10%	Expected	+10%	+25%
Price \ bushel/Acre	23	27	30	33	38
$8.50	**-$141.20**	**-$102.95**	**-$77.45**	**-$51.95**	**-$13.70**
$9.50	**-$118.70**	**-$75.95**	**-$47.45**	**-$18.95**	**$23.80**
$10.50	**-$96.20**	**-$48.95**	**-$17.45**	**$14.05**	**$61.30**
$11.50	**-$73.70**	**-$21.95**	**$12.55**	**$47.05**	**$98.80**
$12.50	**-$51.20**	**$5.05**	**$42.55**	**$80.05**	**$136.30**

Estimated Labor and Machinery Costs per Acre

Preharvest Operations

Operation	Acres/Hour	Number of Times Over	Labor Use**** (hrs/ac)	Fuel Use (gal/ac)	Repairs ($/ac)	Fixed Costs ($/ac)
Spin Spreader 5 ton with Tractor (120-139 hp) 2WD 130	23.8	1	0.05	0.28	$ 0.70	$ 1.98
Disk Harrow 32' with Tractor (180-199 hp) MFWD 190	16.3	1	0.08	0.60	$ 2.34	$ 6.78
Spray (Broadcast) 60' with Tractor (120-139 hp) 2WD 130	35.5	1	0.04	0.19	$ 0.46	$ 1.06
ST Plant Rigid 6R-36 with Tractor (180-199 hp) MFWD 190	6.9	1	0.18	1.42	$ 3.99	$ 11.92
Spray (Broadcast) 60' with Tractor (120-139 hp) 2WD 130	35.5	3	0.11	0.57	$ 1.37	$ 3.18
Total Preharvest Values			0.45	3.06	$ 8.86	$ 24.91

Harvest Operations

Operation	Acres/Hour	Number of Times Over	Labor Use**** (hrs/ac)	Fuel Use (gal/ac)	Repairs ($/ac)	Fixed Costs ($/ac)
Header - Corn 12R-30 with Combine (200-249 hp) 240 hp	10.8	1	0.12	1.14	$ 6.51	$ 28.99
Grain Cart Soybean 500 bu with Tractor (120-139 hp) 2WD 130	10.6	1	0.12	0.63	$ 1.66	$ 4.44
Total Harvest Values			0.23	1.77	$ 8.17	$ 33.43

**** Includes unallocated labor factor of 0.25. Unallocated labor factor is percentage allowance for additional labor required to move equipment and hook/unhook implements, etc.