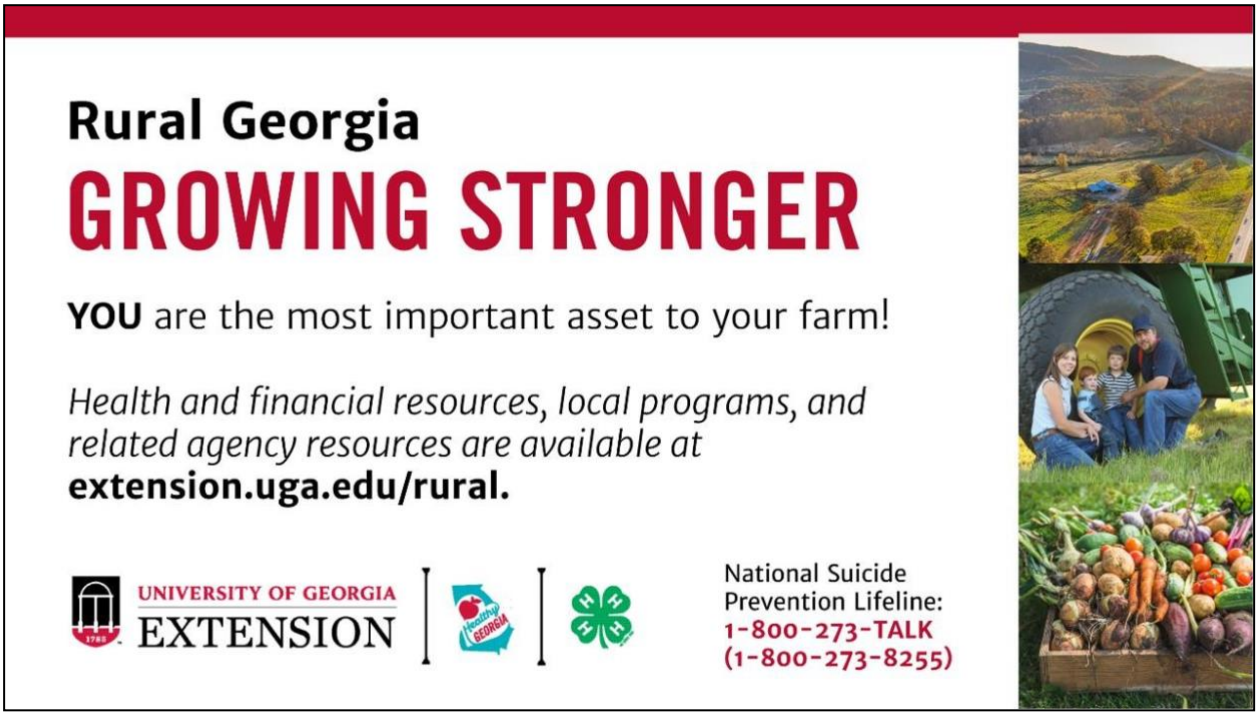
Georgia Corn Production Guide

2024

UNIVERSITY OF GEORGIA
EXTENSION



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CORN PRODUCTION IN GEORGIA

R. Scott Tubbs, Rome Ethredge, Henry Sintim

In 2023, corn was planted and harvested on more acreage in Georgia than in the previous 10 years (Table 1). In addition, the average grain yield of 183 bu/a was the largest recorded in the state of Georgia, barely eclipsing the previous record of 182 bu/a set in 2021. There were over 82 million bushels of corn grain produced in 2023 in Georgia, and between 67 and 81 million bushels were produced each year from 2020-2022. From 2014-2019, statewide production ranged between 43 and 56 million bushels. Corn is vital in row crop rotations in Georgia, ensuring the diversity and stability of farm income. It is the third-largest row crop, after cotton and peanut, and according to the 2023 Georgia AgSnapshots report, corn's economic value was $509.1 million, the eighth agricultural commodity by economic value in Georgia. Corn is also vital to Georgia's livestock and ethanol industries.

Table 1. Planted acres, harvested acres, average yield, and total production for Georgia corn over the last 11 years.

Year	Planted Acres	Harvested Acres	Yield (bu/a)	Total Production (million bu)
2023	500,000	450,000	183	82.35
2022	425,000	385,000	175	67.38
2021	480,000	445,000	182	80.99
2020	420,000	390,000	180	70.20
2019	395,000	350,000	160	56.00
2018	325,000	285,000	176	50.16
2017	290,000	245,000	176	43.12
2016	410,000	340,000	165	56.10
2015	330,000	285,000	171	48.74
2014	350,000	310,000	170	52.70
2013	510,000	465,000	175	81.38

The majority of Georgia corn production is dent corn or field corn and agronomic production practices vary by region. Across the state, most of the corn is grown on 30 to 36-inch row spacings with some growers going as wide as 40 inches and others going as narrow as 15 inches. In the Coastal Plain region, tillage systems are predominately conventional or strip-till, whereas the Piedmont and Mountain regions are predominately strip-till or no-till. Furthermore, in the Coastal Plain approximately 90% of the corn is irrigated, compared to approximately 50% and 10% for the Piedmont and Mountain regions, respectively. Irrigation is pivotal to achieve high-yielding corn in the Coastal Plain, where sandy soils with low water holding capacity dominate. Soils with greater water holding capacities and shallow water tables in river bottoms help offset the effects of drought in the Piedmont and Mountain regions.

Across all the different production systems, Georgia corn growers have demonstrated the ability to achieve great corn grain yields in the past. These yields have been achieved through the adoption of modern corn hybrids coupled with improved management technologies and careful attention paid to all production practices. There continue to be multiple growers in Georgia averaging well over 300 bushels in irrigated production systems, and even some acres reaching this mark with non-irrigated management. While many of these yields are achieved with help from favorable environmental conditions, they are still a product of great management systems.

As producers strive to increase corn yields, carefully consider and document all management decisions and practices throughout the growing season. Detailed field notes are not only a good way to understand what was done right during the growing season, it is just as important to know what went wrong. Understanding how management decisions affected production during one growing season may help prevent missteps in future years when climatic conditions are similar. The following chapters contain information gathered from years of research in Georgia and will hopefully assist with maximizing returns from your 2024 corn crop.

AGRONOMIC PRACTICES FOR CORN

R. Scott Tubbs, Dewey Lee

Soil Preparation

Your soil management program is the base on which your entire corn crop for the year is built. A good soil management program: 1) protects the soil from water and wind erosion, 2) provides a weed-free seedbed for planting, and 3) fractures root restricting subsoil hardpans or compacted layers. The land should be worked no more than is necessary to achieve a smooth seedbed, otherwise unacceptable moisture loss can occur and compacted layers can be reintroduced. Water erosion is of greatest concern during the winter months when high intensity rainfall occurs and there is minimal ground cover since crop residues are mostly removed and new plant growth (either planted cover or weeds) grows slowly in cooler weather. Your best defense against water erosion is crop residue left on the soil surface or a seeded cover crop, or adoption of no-tillage practices. Wind erosion is of greatest concern on sandy Coastal Plain soils when strong spring winds occur after tillage operations, and blowing sand can severely injure young corn plants. Your best defense against wind erosion and "sand blasting" of a young corn crop is the adoption of conservation tillage practices such as strip-till or slit-till.

Tillage

Compacted subsoil layers that restrict root growth are present in almost all Georgia soils. These compacted subsoil layers can restrict water intake of soils and nutrient uptake by the plant. Fracturing of the compacted layers is only achieved through deep tillage operations such as deep turning, V-ripping, paraplowing, chisel plowing, or subsoiling. Research at University and USDA-ARS locations has demonstrated that in-row subsoiling increased corn yields by more than 50% on soils with compacted subsoil layers. Fracturing the compacted layer allows strong, well-developed root systems, providing a greater area to explore moisture and nutrient availability.

Research from the Southeastern U.S. demonstrates that full-zone fracturing of compacted subsoil layers (such as by paraplow, V-ripper, or turn plow) results in corn yields equivalent to in-row subsoiling. Tillage studies conducted in Tifton, GA demonstrated that corn yields produced in conservation tillage systems can be equal to or greater than those with conventional tillage (Table 2). While soils with greater clay content (such as the Piedmont and Mountain regions) may not have to be subsoiled every year, sandy soils in the Coastal Plain may reconstitute compacted subsoil layers during a single season. For more information on conservation tillage, please see the Carbon Sequestration and Soil Health Section of this Production Guide.

Table 2. Corn yields from a tillage by crop rotation study conducted in Tifton, GA from 2003-2006.

Tillage	2003	2004	2005	2006	Avg.
Rip & Bed	163	178	189	203	184
Strip	165	198	195	202	190
Slit	148	195	200	199	186
No-till	153	157	156	149	154
Lsd $P \leq 0.10$	NS	30	29	17	

Stand Establishment

Once you have established your base soil program the next most critical aspect of achieving maximum yields and net returns is getting an acceptable plant stand. The sensitivity of corn to different aspects of planting, such as planting depth, variability in spacing, and excess downforce, means that any misstep in planting will likely lead to unacceptable stand establishment. You should inspect every component of your planter for proper setup and functionality prior to planting the first seed of the year. Utilize the vast knowledge base of your County Extension Agent, UGA Precision Ag Specialists, and planter companies to ensure all adjustments have been made properly for each field and field condition. In many instances, once the seed furrow is closed, the damage has been done and there is no correcting the issue for this season. Other key information to remember includes:

1) Calibrate your planter for proper seeding rates and seed drop.
2) Ensure that disc openers are accurately aligned.
3) Corn seed should be between 1.5 and 2-inches below the soil surface.
4) Ensure adequate down pressure to close the furrow but not so much as to induce crusting.
5) Ensure that the planter is level as you drive across the field.

Avoid planting when soil temperatures drop below 55° F at the 2-inch depth as this will have detrimental effects on seed germination. Variable seed emergence can reduce yields by as much as 10-20% depending on the length of the delay. Generally, the greatest yields are achieved in fields where all plants have emerged within 12-24 hours of one another.

Hybrid Selection

No single corn hybrid fits every field in Georgia. Every year there is a vast array of corn hybrids marketed by numerous companies in Georgia. Each hybrid varies from the others in relative maturity; lodging, disease, and insect resistance; grain quality; yield potential; and adaptability to differing geographical and production scenarios. Keep your production practices and field conditions in mind when selecting hybrids for the year. It's good to plant at least 3 different hybrids in any one year to provide genetic diversity and reduce risk against total devastation to an unforeseen pest outbreak.

Proper hybrid selection is probably the most important decision you will make in determining final yields. The best place to start when selecting corn hybrids is the previous year's Corn Hybrid Performance Bulletins (https://swvt.uga.edu). This data provides a good reference yield potential for the different regions in the state when grown under good production practices. Local data from County agents is valuable. After this consult your seed dealer's fact sheets and sales reps to determine which hybrids they recommend for your specific production system.

Any corn hybrid planted in Georgia should contain some level of resistance to leaf foliar diseases. This is especially true in irrigated environments where increased humidity levels, fluctuating water availability, and high populations will favor many diseases. Important foliar diseases to consider are northern and southern corn leaf blight, grey leaf spot, common rust, southern rust, anthracnose, and maize chlorotic dwarf virus.

High grain quality ratings are also necessary to provide an opportunity for better marketing scenarios for your crop. Grain quality measures are based on instances of ear rots and other pests which infect and infest the actual ears. Selecting a hybrid with good husks can decrease moisture and insect penetration and minimize subsequent developments of ear or kernel diseases. Furthermore, hybrids with higher grain quality ratings typically weather better during final dry-down.

Hybrid relative maturity is another important consideration you must make when choosing seeds for the coming year. Generally, hybrids are classified as early, medium, or late maturity. Early and medium maturing hybrids are typically better adapted to irrigated corn production than dryland production because they, 1) mature 2 to 3 weeks earlier, 2) generally grow shorter and are less subject to lodging, 3) may require less water due to the shorter growing season, and 4) are more suitable for use where large acreages may require a harvest spread to improve harvest efficiency. Another key consideration point when making relative maturity decisions is harvest timing. If you cannot harvest the field within 30 days of reaching physiological maturity (i.e., black layer) then you should consider spreading out relative maturities and/or planting dates. It is a good rule of thumb to not plant more in a day than you can combine in a day. However, it is common for spring weather patterns to dictate planting rate more so than harvest rate. If you must plant more acres in a day than can be harvested in a day, it is advisable to plant shorter and longer maturity hybrids in the same day to effectively space harvest timing.

Planting Dates

To increase your chances of avoiding yield-limiting disease pressure, corn should be planted as early as possible. At planting soil temperatures at the 2-inch depth should be at or exceed 55^o F. Germination progresses slowly at temperatures between 55 and 60^o F and emergence will take between 7 to 12 days. Conversely, germination will progress rapidly when corn is planted in soil temperatures greater than 60^o F and emergence will be prompt. If your 2-inch soil temperature is 55^o F or above but your forecasted weather could drop soil temperatures below this threshold, then planting should be delayed until warmer temperatures return. Pushing planting dates as early as possible also increases the risk of frost or freeze damage to emerging corn. Typically, corn can withstand severe frost or freeze damage without yield loss so long as the growing point is below the soil surface.

Optimum planting windows will vary based upon your location in Georgia. Corn planting can begin as early as mid-March in South Georgia but may not begin until mid-May in North

Georgia. Early planted corn will traditionally yield more than late planted corn regardless of region within the state. Delaying corn planting into the summer can dramatically decrease yield potential. Generally speaking, yields decline at a rate of ¾ bushels per day as you progress later in the planting window and can rise to about 2.5 bushels per day when planting after the optimal window. If corn planting is delayed into the summer, yield losses become much more dramatic. Studies in Tifton indicate that stress and disease tolerant hybrids planted under irrigation in late-May to early-June only yield approximately 50% of mid-March to early-April plantings.

Plant Population and Row Spacing

There is no one plant population to maximize yield and net returns across all fields in Georgia. Optimum populations vary according to soil type, hybrid, irrigation capabilities, and individual management practices. Generally speaking, irrigated cropping systems can support greater plant populations than dryland cropping systems. Current plant population recommendations for irrigated corn in Georgia are between 28,000 to 36,000 plants per acre. Depending on your row spacing, irrigated corn populations exceeding 36,000 plants per acre may reduce yields due to overcrowding and lodging. In dryland cropping systems current plant population recommendations are between 18,000 and 20,000 plants per acre in sandy soils. Those in regions with less sand content and more clay may be able to increase dryland plant populations slightly due to increased water holding capacity. Exceeding 20,000 plants per acre can work in dryland cropping systems on all soils in years of ample rainfall; however, the stress of additional plants per acre would increase the likelihood of unacceptable yield loss in years of normal or less than normal rainfall. Regardless of cropping system, seeding rates should exceed desired plant populations by at least 10%. This over-planting will result in near desired final plant populations after normal stand losses from uncontrollable factors.

Traditional row-spacings utilized in Georgia production is 36-inches. Many of the state's high yield corn growers have switched to narrower rows such as 30- and 20-inches and a few have even transitioned to 15-inch row spacing in corn. While row-spacings of 30 to 36- inches are adequate to reach top yields, research has indicated that narrower row-spacings are associated with greater corn yields (Table 3). Greater yields are achieved in narrow row-spacings by allowing plants to exploit more soil area for moisture and nutrients while producing a fuller canopy to maximize total sunlight capture.

Table 3. Row spacing effect on corn yield from corn grown in Tifton, GA.

Row-Spacing (in)	2003	2004	2005	2006	Avg.
			bu/acre		
20	255 a*	263 a	230 a	267 b	254
30	191 c	252 b	225 a	311 a	245
36	232 b	250 b	202 b	257 b	235
36 Twin	227 b	254 b	202 b	266 b	237

* Numbers in a column followed by the same letter are not significantly different at *P* = .10

If you want to achieve the yield benefits associated with narrow row corn production but do not want to or cannot invest the money in new implements, then twin-row production systems may be an option. In twin-row production systems it is crucial to achieve hardpan fracturing under the complete row and not just in the seed-row. Standard straight shank subsoilers will only fracture a 6 to 7-inch zone at best which does not cover both seed-rows within the single row. Switching to a paraplow subsoiler or v-ripper will provide fracturing under the entire row but could delay field entry depending on rainfall timing.

Table 4 illustrates plant populations at various row- and plant-spacings. This table should be used only to estimate plant populations and not take the place of planter calibration. To double check your calibration in the field, measure the distance found in Table 5 and count the total number of seeds in one row for that distance and multiply by 1,000 to get seed per acre. Repeat this procedure on several other row units to ensure proper setup across the planter.

Table 4. Approximate plant populations based on row-spacing and plant spacing within a row.

Within row Plant Spacing (in.)	Row Width (in.)				
	20	30	36	38	40
4.5			38,700	36,700	34,800
4.7			37,100	35,100	33,400
5.0		41,800	34,800	33,000	31,400
5.3		39,400	32,900	31,100	29,600
5.5		38,000	31,700	30,000	28,500
5.7		36,700	30,600	29,000	27,500
6.0		34,800	29,000	27,500	26,100
6.2		33,700	28,100	26,600	25,300
6.5		32,200	26,800	25,400	24,100
6.8		30,700	25,600	24,300	23,100
7.0		29,900	24,900	23,600	22,400
7.3		28,600	23,900	22,600	21,500
7.5		27,900	23,200	22,000	20,900
7.8	40,200	26,800	22,300	21,200	20,100
8.0	39,200	26,200	21,800	20,600	19,600
8.3	37,800	25,200	21,000	19,900	18,900
8.5	36,900	24,600	20,500	19,400	18,400
8.8	35,600	23,800	19,800	18,800	
9.0	34,800	23,200	19,400	18,300	
9.3	33,700	22,500	18,700	18,700	
9.5	33,000	22,000	18,300		
10.0	31,400	20,900			
10.3	30,500	20,300			
10.5	29,900	19,900			
10.7	29,300	19,500			
11.0	28,500	19,000			
11.5	27,300	18,200			
12.0	26,100				
12.5	25,100				
13.0	23,200				
13.5	23,200				
14.0					

Table 5. Row length required for 1/1,000th of an acre at common corn row-spacing in Georgia.

Row Width (in.)	Row Length for 1/1,000 acre
20	26 ft 2 in.
30	17 ft 4 in.
32	16 ft 3 in.
36	14 ft 6 in.
38	13 ft 9 in.
40	13 ft 1 in.

CORN GROWTH & DEVELOPMENT

R. Scott Tubbs, Dewey Lee

Understanding corn growth and development and how the plant interacts with each input is the most efficient way to profit from individual inputs. Your overall goal should be to provide each input necessary for your yield goal at or shortly before the time it is needed. Corn yield is a function of the interaction between the hybrid (genetics) and the environment. The growing environment includes soil factors such as texture, pH, cation exchange capacity, organic matter, and compaction; climactic factors such as sunlight, temperature, and water; and management factors such as crop protection and competition. Ultimately, the management of all stressors to the best of your ability is the key to obtaining maximum yields and net returns. Any stress the plant incurs can negatively affect growth rate and yield components thus reducing potential yields. While preventing all stress may not be practical, it is best to ensure that all practices you plan are conducted in a timely manner to have the best effect possible.

Figure 1 illustrates a growth and development timeline of a corn plant. It is important to understand that plant growth rate is driven by temperature. Measurements of cumulative heat, such as growing degree units, are used to relate temperature to corn growth and development.

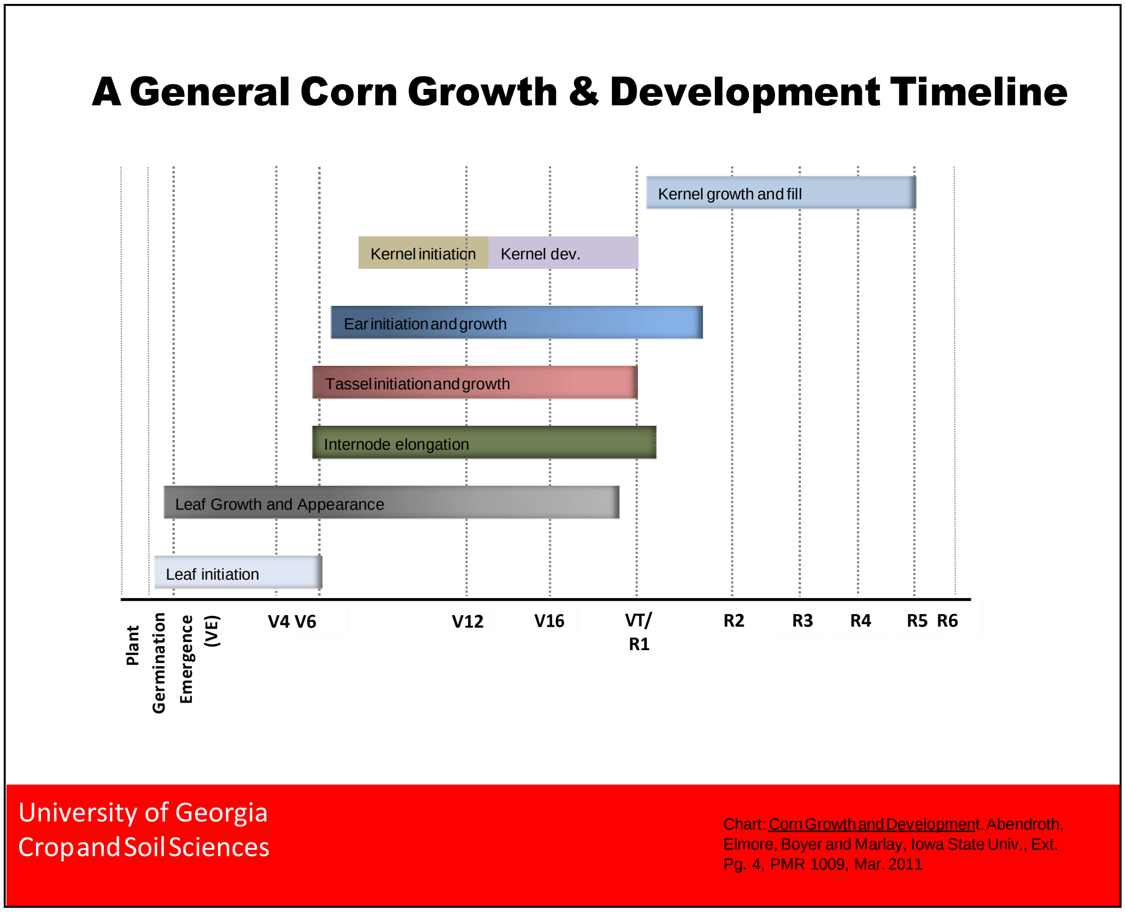

Figure 1. Typical growth and development timeline of a corn plant.

Corn moves rapidly through growth stages as it grows. In general, a corn plant may develop 18 to 20+ leaves depending upon hybrid. Typically, all leaf initiation is completed by the V6 growth stage when tassel development is initiated, followed shortly by initiation of the ear. At this point the plant will start determining the number of rows on the ear. Floret (potential kernels) initiation within a row soon follows and continues until 7-10 days prior to silk emergence. Potential kernels near the base of the ear develop first and progress towards the tip. Harvestable grain is directly related to kernels that pollinate and begin filling at the R1 growth stage.

Corn transitions from vegetative to reproductive growth relatively quickly. If a plant is not healthy during the V3 to V5 growth stages, it will not have time to recover by the time the next yield component is determined. Stress during this time can undermine the overall yield potential of the plant. Since growing degree units are used to relate temperature to the various growth stages, it is important to know the different stages and understand how to calculate GDUs.

The following equation is used to calculate GDUs through the growing season:

$$GDU = \frac{T_{max} + T_{min}}{2} - T_{base}$$

Where T_{max} is the maximum daily temperature but limited to 86 °F, T_{min} is the daily minimum temperature but limited to 50° F, and T_{base} is the base temperature set to 50 °F. For example, the calculation for a daily high temperature of 76° F and low temperature of 58 °F would be ((76 + 58) / 2) – 50 = 17 GDUs. If the daily high temperature exceeds 86 °F then you will not use the daily maximum temperature but the limit of 86 °F as the T_{max}.

When using GDUs to estimate corn growth stage, it is important to know the approximate number of GDUs required to advance from one growth stage to the next. Generally, a corn seedling will emerge between 90-120 GDUs in the early spring. After emergence, a new leaf collar will appear at approximately every 84 GDUs until V10-V11, at which point the appearance of new collars is accelerated at approximately every 56 GDUs.

While it is important to keep up with GDUs, you must recognize that GDU accumulation is variable in each year. The variability in GDU accumulation between 2012 and 2013 is shown in Figure 2. If you do not have a weather station on your farm, the easiest and most accurate source of weather data in Georgia is found at http://www.georgiaweather.net. Make sure to select the weather station nearest to your farm. The Georgia weather network can also calculate the number of GDUs for you. Select the icon “degree day calculator” and begin the calculation using the day of emergence with 50 °F as the base and 86 °F as the max. This tool will compare the current year with the previous three years. To be consistent, always note the day of emergence to make valid GDU comparisons each year. If you choose to use planting date, then always use planting date and not emergence. Whichever method you select just make sure to be consistent across all years when making comparisons.

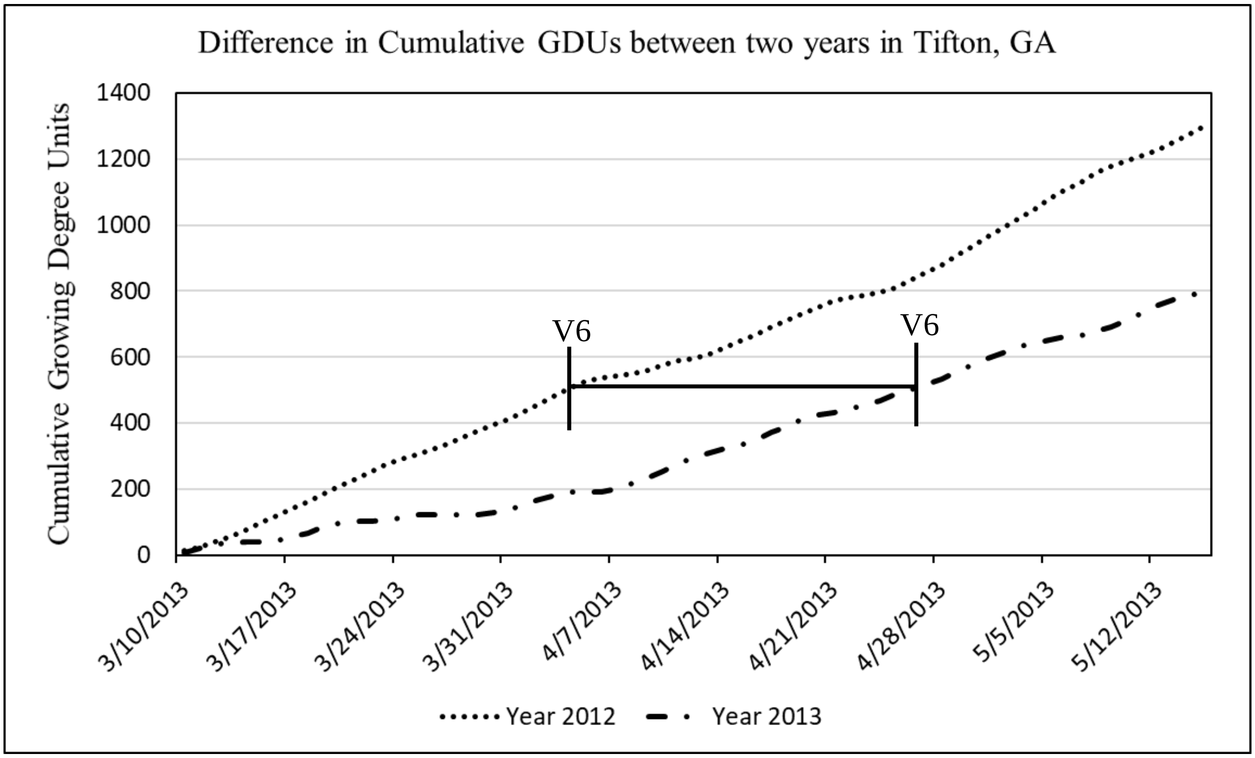

Figure 2. Variability in GDU accumulation between 2012 and 2013 in Tifton, GA.

The average number of days to accumulate GDUs required to reach various stages of growth is illustrated in Figure 3. After **emergence**, it took an average of 26-27 days to get to V4 but only averaged an additional 10 days to reach V6. This gives an idea of how quickly corn plants transition through growth stages and why small stress events can impact yield.

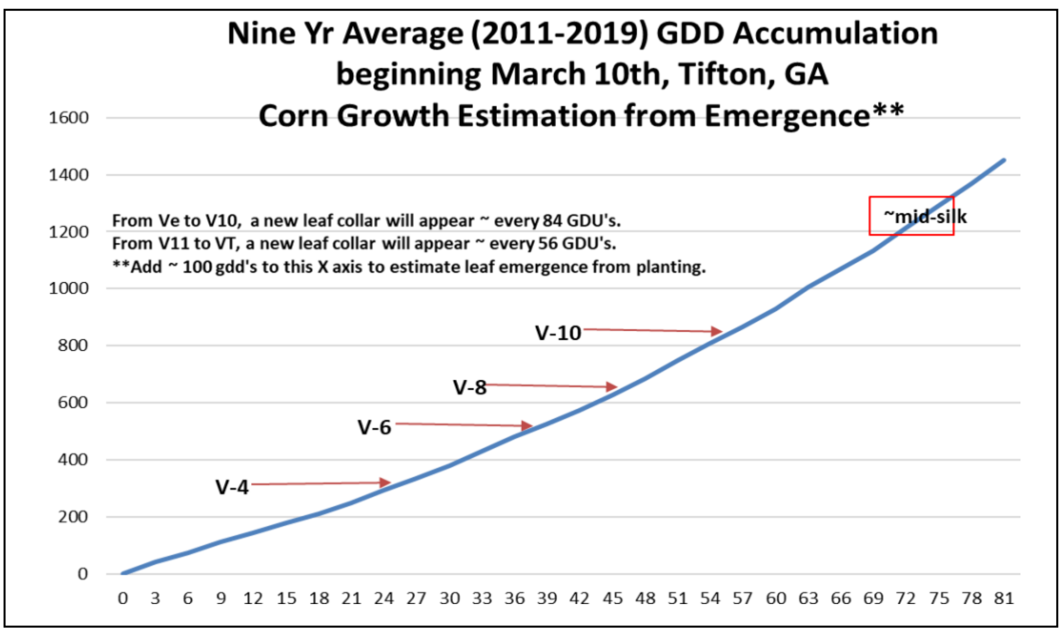

Figure 3. Average number of days after emergence to accumulate enough GDUs to reach specified corn growth stages in Georgia.

Finally, it is important to know how to identify each growth stage by looking at the plant in the field. Corn growth stages are split into V and R stages (Table 6). These letters designate is if the plant is in Vegetative growth stages or has transitioned into Reproductive growth. The most used method of determining vegetative growth stages is the "leaf collar method". In this method growth through the vegetative stages is determined by counting the total number of visible collars on fully developed leaves. To track your corn development, once you have 6 leaves, mark a few plants with a flag to come back to and break off that 6^{th} leaf to track onward V stages, since the lowermost leaves will begin to die off and can cause difficulty in identifying an accurate number of leaves that have developed. Corn enters reproductive growth stages once the silks emerge. Reproductive stages are determined based on the plant reaching specific landmarks with regards to pollination and kernel development. Reproductive growth stages begin with R1 and continue through R6.

Table 6. Selected corn growth stages with when they appear and a brief description of each growth stage.

Growth Stage	Appearance	Description
VE	Emergence	Coleoptile emerges the soil just prior to the first leaf collaring.
V3	3 collars	3 fully visible leaf collars. Nodal roots developing.
V6	6 collars	6 fully visible leaf collars, growing point now above ground. Tassel and ear development has begun and stress will affect yield potential.
V12	12 collars	Lower 3 – 5 leaves missing. Potential kernel number is being determined and stress will affect yield potential.
V15	15 collars	Potential kernel number is set.
VT	Tassel	Last tassel branch is visible. Pollination is occurring.
R1	Silking	Silks begin emerging. Yield potential VERY sensitive to stress.
R2	Blister	Ear length complete, kernel number is set.
R4	Dough	Kernels about 70% moisture.
R5	Dent	Top of kernel has begun to dent. Milk line visible and progressing downward.
R6	Maturity	Black layer formed at base of the kernel, plant has reached physiological maturity, moisture approximately 30 – 35%.

FERTILIZATION

Glen Harris and Henry Sintim

By nature, the soils of Georgia are acidic and infertile; therefore, substantial quantities of limestone and fertilizer are required for optimum fertility levels. Fertilizer recommendations are based on yield goals and crop utilization. Corn harvested for silage requires more fertilizer than corn grown for grain because silage removes from the field all the nutrients in the aboveground plant parts. The removal of potassium is especially great in corn harvested for silage compared to corn harvested for grain. A comparison is given in Table 7 of the nutrients contained in grain and the stover.

Table 7. Corn nutrient uptake in grain and stover of a 226 bu/ac yield in 2020 at Camilla, GA.

Nutrient	Grain	Stover	Total
		lb/acre	
Nitrogen	133	77.5	210
Phosphorus (as P_2O_5)	80.1	29.2	109
Potassium (as K_2O)	52.8	140	193
Magnesium	10.4	9.72	20.2
Calcium	0.98	11.8	12.8
Sulfur	10.5	6.51	17.0
Boron	0.04	0.05	0.09
Zinc	0.21	0.21	0.42
Manganese	0.07	0.29	0.36
Iron	0.15	0.26	0.41
Copper	0.03	0.04	0.07

Liming

Many Georgia corn fields are naturally acidic. This acidity is primarily because of (1) increased use of acidifying nitrogen fertilizer sources, (2) leaching of calcium and magnesium, and (3) nutrient removal by high-yielding crops. The advantages to liming such soils are:

- Corrects soil acidity – Corn grows well in soil with a pH between 6.0 and 6.5 but is inhibited by a soil pH less than 5.7.
- Supplies plant nutrients – All plants need calcium and magnesium for growth. Dolomitic liming materials containing these elements will increase the yield on soil low in either or both of these nutrients.
- Increases availability of other plant nutrients – Acid soils fix plant nutrients, especially phosphorus, in forms unavailable to plants. Liming acid soils will release fixed nutrients, making them more available to the growing crop.
- Promotes bacterial activity – They break down soil organic matter to make soil nitrogen and other nutrients more available. Since most bacteria cannot live under very acidic conditions, liming acidic soils increases bacterial activity.

On the sandy soils of the Coastal Plain area, magnesium is frequently a limiting nutrient. However, to be effective as a source of magnesium, dolomitic lime must be applied several months prior to planting. If soil test results show that magnesium levels are low and dolomitic limestone cannot be applied several months before planting, apply a supplemental application of 25 to 50 pounds of elemental magnesium per acre before planting.

Base Fertilization

Fertilizer recommendations depend on the soil fertility level as determined by soil tests and the yield goal. Fertilization programs not based on soil tests may result in excessive and/or sub-optimum rates of nutrients being applied. Take soil samples each fall to monitor the current fertility level. Use the yield goal to determine the quantity of nitrogen, phosphate, and potash to apply. At high yield levels, the balance of nutrients in relation to one another also is important.

Nitrogen

In sandy Coastal Plain soils, nitrogen is very mobile. If excessive rainfall occurs or excessive amounts of water are applied through the irrigation system, leaching losses of nitrogen can be quite drastic during the growing season. To increase the efficiency of nitrogen recovery during the season, split applications of nitrogen are recommended.

Apply 25 to 30 percent of the projected nitrogen needs before or at planting. The remaining nitrogen can be applied sidedress and/or injected through the center pivot systems (fertigation). If all the nitrogen is applied with ground equipment, apply 50 to 75 pounds per acre at or before planting under irrigated conditions and 20 to 50 pounds per acre in dryland environments and the rest when the corn is 12 to 16 inches tall.

If nitrogen is to be injected through the irrigation system, apply 40 to 60 pounds at or before planting and begin ground or injected applications of 30 to 60 pounds of nitrogen per acre when the corn is 8 to 12 inches tall. Continue on a bi-weekly basis until the total required nitrogen is applied. Three to five applications of nitrogen will be needed during the growing season.

Nitrogen applications after pollination are currently NOT recommended unless a severe nitrogen deficiency is detected. Studies are currently ongoing to determine whether nutrient application after pollination will be beneficial.

Phosphate and Potash

Apply all the phosphate and, on most soils, all the potash at or before planting. Some of the phosphate requirements may be obtained using starter fertilizer. On deep sands, you should probably apply potash in split applications, half at planting and half at layby.

Secondary and micronutrients

Corn requires a relatively large amount of sulfur, generally 20 to 30 pounds per acre. On deep sands, apply sulfur in split applications. All sulfur should be applied in the sulfate (SO_4) form. Applications with nitrogen may prove efficient.

Base magnesium fertilization on soil tests. If the level is low, apply 25 to 50 pounds per acre of water-soluble magnesium by layby.

Zinc deficiency can be prevented by using three pounds per acre of actual zinc. Do not use zinc unless soil test levels are low. If needed, apply pre-plant or at planting.

Boron deficiencies can occur on sandy soils low in organic matter. Generally, use one to two pounds per acre of boron applied in split applications. It is best to apply boron with the nitrogen application. The application of other essential nutrients should be based on plant analysis results.

Fertilizer Placement

The main objectives in fertilizer placement are to avoid injury to the young seedling and to use fertilizer nutrients efficiently. Fertilizer applied too close to the germinating seed or emerging plant will cause severe salt injury to the plant. With low soil moisture, the fertilizer salts will draw water away from the plant roots causing the plants to wilt. It is important though to apply your nitrogen in a band near the row (4 to 6 inches next to the row) particularly in soils where N easily leaches and where traffic rows restrict root growth.

Broadcasting fertilizer will help reduce the risk of fertilizer injury. Research shows that broadcasting fertilizer is less expensive and just as efficient as banding on soils with medium fertility. If soil tests low in phosphorus and potassium, it is better to place one-half of the needed fertilizer in a band near the row and broadcast the rest.

Starter Fertilizer

Small amounts of nitrogen and phosphorus are often used as a starter or "pop-up" fertilizer. The main advantage of starter fertilizer is better early season growth. Corn planted in February, March, or early April is exposed to cool soil temperatures, which may reduce phosphate uptake. Banding a starter fertilizer two inches to the side and two inches below the seed increases the chance of roots penetrating the fertilizer band and taking up needed nitrogen and phosphorus.

Deduct the amount of nitrogen and phosphorus used in a starter fertilizer from the total nitrogen and phosphorus needed for the season. Currently, the most popular starter fertilizer is ammonium polyphosphate (10-34-0). Monoammonium and diammonium phosphates are equally effective. There is generally no advantage in using a complete fertilizer (NPK) as a starter since applying phosphate is the primary objective. There is an advantage to using additional N such as 28-0-0-5, particularly in sandy soils to encourage growth as soils warm. Depending on your needs, a typical popup application is 6 to 7 gallons each of 10-34-0 and 28-0-0-5, as described above.

Animal Manure

Animal manures such as poultry litter and lagoon water can be an excellent source of nutrients for corn. It is important though to know the amounts of nutrients contained in the manure prior to deciding to use it as your main source of phosphorus and potassium. The majority of the nutrients contained in the manure are readily available in the season. Poultry litter contains approximately 3% N, 3% P_2O_5, and 2% K_2O (fertilizer value of 3-3-2). Based on this average, one ton of poultry litter contains 60 lbs of N, 60 lbs of P_2O_5, and 40 lbs of K_2O. On average, 60% N, 80% P, and 80% K of the nutrients in the poultry litter should be available in the first year. At least 25% of N should be available within the first two to three weeks after application and the remainder throughout the season. Assuming the unit price of N is $0.77/lbs, P_2O_5 is $0.63/lbs, and K_2O is $0.58/lbs, poultry litter can be valued around $76.70/ton.

However, growers get poultry litter for about $20-45/ton, making poultry litter an economical option. For more information on poultry litter, please see the Carbon Sequestration and Soil Health section of this Production Guide.

Plant Analysis

Soil tests serve as a sound basis for determining fertilizer requirements for corn; however, many factors such as nutrient availability, leaching, and crop management practices may require modification in a basic soil fertility program to maximize fertilizer use efficiency.

Plant analysis, a laboratory procedure used to determine the concentration of elements present in a plant, can be used to (1) monitor the nutrient status of the plant and evaluate the appropriateness of the fertilization program used, (2) confirm a suspected nutrient deficiency, or (3) detect low nutrient levels before growth is affected.

Plant analysis usually consists of determining the concentration of the following essential plant nutrients: nitrogen (N), phosphorus (P), potassium (K), magnesium (Mg), calcium (Ca), manganese (Mn), boron (B), copper (Cu), iron (Fe), zinc (Zn), and sulfur (S). The concentration found is a measure of the plant's nutrient status. The analysis is interpreted by comparing the concentration found to known standards for the plant part and stage of growth when sampled. When the concentration of an element falls outside the normally expected range, an evaluation and recommendation based upon the results and information with the sample are made. Information such as soil test level, soil type, fertilizer, and lime applied is essential to properly evaluate a plant analysis and make a valid recommendation.

Do not substitute plant analysis for a soil test but use it to determine (1) whether essential elements are present in low, adequate, or excessive amounts in the plant and (2) whether the proper ratio of certain elements exists. It is advisable to take plant samples throughout the growing season to monitor nutrient status and detect any deficiencies or imbalances. What actually gets into the plant is really what counts most. If a deficiency or imbalance is detected early enough, it can usually be corrected in time to improve yield.

You can access the UGA plant analysis handbook to know the reference sufficiency ranges for the various nutrients at the following url: http://aesl.ces.uga.edu/publications/plant/.

SCHEDULING AND MANAGING CORN IRRIGATION

Wesley Porter, Jason Mallard (SE District Water Agent), David Hall (SE District Water Educator), Phillip Edwards (SW District Water Agent), Daniel Lyon (SW District Water Educator)

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. Frequency and timing of water application have a higher impact on yields and operating costs than do total amount of water. 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. However, there is a misconception that irrigation scheduling equipment is too costly for the return. When properly utilized and coupled with grower experience, a scheduling method can improve the grower's chances of successful and profitable production.

The utilization of any irrigation scheduling method is typically better than no plan or method at all, particularly with corn. A good plan pays dividends in terms of yield, water-use efficiency (WUE) and net returns. In corn, irrigating too late causes yield loss while irrigating too much wastes energy, water, money and can leach or cause run-off of nutrients beyond the root zone. Unlike with cotton and peanuts, the addition of too much water to corn does not directly reduce yields, but it can reduce net income due to the added costs of additional irrigation applications without equivalent yield benefits. 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, 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 corn 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 soil 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 water holding capacity/and infiltration rate, expected daily water use of corn, and a rain gauge or access to nearby rainfall information. An example of a checkbook method calculation is presented after Table 8. The UGA Corn Checkbook was developed from a historical average of evapotranspiration. This method is very conservative and most often errors on the side of over irrigating rather than under irrigating. However, caution is advised when utilizing the checkbook method alone as it was developed from a historical average and may not adequately address water requirements during extreme weather conditions. Seasons with extended periods of these weather conditions such as several consecutive cloudy days or several days with higher than average temps will require adjustments to the checkbook method. The 2019, 2020, and 2022 production seasons were prime examples of years in which we had abnormally hot and dry weather. 2021 was a unique year in which overall rainfall was high, and dryland yields were low, due to a lack of rainfall during tassel. This shows that careful consideration to irrigation distribution is just as critical as total amount. Many irrigation scheduling and application issues were observed during these years because of this reason. In most "average" years these problems are masked by supplemental rainfall, the lack of rain during 2019 and 2020 made these problems very prevalent across the state. It should be noted that the Checkbook alone does not account for soil water holding capacity. Thus, when using the Checkbook, it is advised that soil information be considered to ensure adequate soil moisture is available to the crop. Checkbook type methods can be enhanced with other tools such as web-based schedulers or smartphone applications.

Systems such as Irrigator Pro (software by USDA www.irrigatorpro.org), or other scheduling apps such as the SI CropFit (formerly SmartIrrigation Corn App) (https://smartirrigationapps.org/) are typically free and available to help you make decisions regarding when to irrigate. Soil moisture measuring devices such as Meter® or Watermark® (capacitance vs. tensiometric respectively) sensors can be used in conjunction with corn growth curves to enhance irrigation scheduling as well. These devices provide instant readings of either soil moisture content or tension in the root zone and can be used to identify exactly when water is needed to replenish the root zone. Keep in mind that members of the UGA Extension Ag Water Team have first-hand experience with multiple sensor systems, so if you have questions, contact your county agent who can get you in touch with a member of this team.

Soil moisture sensors can range from $30 upward to $1500 plus per location in the field according to the technology available. While some options are inexpensive only requiring a hand-held monitor, others are more complex and send data through cellular technology to servers that can be access via cell phone apps and/or websites for easy interpretation. There are a variety of options available on the market today.

Tables 8 and 9 are provided to help you determine when to schedule irrigation by the checkbook method. The estimated daily water use of corn is shown in Table 8. This table also provides growth stage, days after planting and estimated water use in inches per day for hybrids with a relative maturity of 115-119 days. Irrigation should be terminated at or just after black layer. Table 9 provides examples of available water holding capacities of soils in Georgia.

Table 8. Estimated Water Use of Corn in Georgia.

Growth Stage	Days After Planting	Inches Per Day
Emergence and primary root developing.	0-7	.03
	8-12	.05
Two leaves expanded and nodal roots forming.	13-17	.07
	18-22	.09
Four to six leaves expanding. Growing point near surface. Other leaves and roots developing.	23-27	.12
	28-32	.14
	33-36	.17
Six to eight leaves.	37-41	.19
Tassel developing. Growing point above ground.	42-45	.21
10-12 leaves, bottom 2-3 leaves lost, stalks growing rapidly, ear shoots developing, potential kernel row number determined.	46-50	.23
	51-54	.25
12-16 leaves. Kernels per row and ear size determined. Tassel not visible but about full size. Top two ear shoots developing rapidly.	55-59	.27
	60-64	.29
Tassel emerging, ear shoots elongating.	65-69	.31
Pollination and silks emerging.	70-74	.32
	75-79	.33
Blister stage.	80-84	.33
Milk stage, rapid starch accumulation.	85-89	.34
Early dough stage, kernels rapidly increasing in weight.	90-94	.34
Dough stage.	95-99	.33
Early dent.	100-104	.30
Dent.	105-109	.27
Beginning black layer.	110-114	.24
Black layer (physiological maturity).	115-119	.21

The following example of the water balance or checkbook method demonstrates how to determine the correct amount and how frequently to irrigate.

Example:

Step 1. The soil type of the corn field is a Tifton soil series. In Table 9, look at the average available water holding capacity in in/ft increments (1.1 in/ft). Assuming a rooting depth of 24 inches (2 ft), the total available water is 2.2 inches (2 ft x 1.1 in/ft)

Step 2. The corn crop is 65 days old. From Table 8, the daily water use is about .31 inches/day

Step 3. Determine the irrigation by setting a lower limit of available water due to soil tension. For this example use 50% of allowable soil water depletion. In other words, only half of the water in the root zone will be allowed to be depleted or is plant available. Therefore, 1.1 inches of water will be needed to replace the soil water that was either used or lost.

Step 4. Determine the amount of irrigation to apply by dividing the amount replaced by an irrigation efficiency. Assuming 75% as the irrigation efficiency, the amount of irrigation required is 1.1/.75 = 1.47 or 1.5 inches.

Step 5. Determine the frequency of irrigation by dividing the amount of water replaced by water use per day. An example of frequency of water (either rainfall or irrigation) need:

1.1 in /.31 in per day = 3.5 days.

Step 6. Therefore, it is necessary to apply 1.5 inches of water every 3.5 days to maintain 50% available water for 65-day old corn.

Table 9. Examples of Available Water Holding Capacities of Soils in the Coastal Plain of Georgia.

Soil Series	**Description**	**Intake in./hr for Bare Soil***	**Available Water Holding Capacity In: in./ft Increments**
Faceville	Sandy Loam, 6-12"		1.3
Greenville	Moderate intake, but rapid in first zone	1.0	1.4
Marlboro			1.2 - 1.5
Cahaba	Loamy sand, 6-12"		1.0 - 1.5
Orangeburg	Loamy subsoil, rapid in first zone, moderate in second	1.2	1.0 - 1.3
Red Bay			1.2 - 1.4
Americus	Loamy Sand, 40 to 60 inches		1.0
Lakeland	Rapid permeability	2.0	0.8
Troup			0.9 - 1.2
Norfolk	Loamy sand,	1.3	1.0 - 1.5
Ochlocknee	12-18" rapid permeability		1.4 - 1.8
Dothan	Loamy sand and sandy loam 6-12",		1.0 - 1.3
Tifton	moderate intake	1.0	0.8 - 1.0
Fuquay	Loamy sand, 24 - 36"		0.6 - 8
Lucy	Rapid permeability in first zone, moderate in second		1.0
Stilson		1.5	0.9
Wagram			0.6 - 0.8

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

Fertigation/Chemigation

High yielding corn requires an intense management strategy. One-way producers are pursuing high yields are applying nitrogen through fertigation over several different applications. This is an excellent way to supply small amounts of N to your crop during critical times. Chemigation with insecticides and fungicides, when needed, can be a cost and time saver when comparing application rates by an airplane. Three major items to consider with fertigation/chemigation, are to first ensure the system meets GA EPD anti-syphon specs. Then ensure your water is being applied uniformly. This can be checked by completing a uniformity test with catch cans or by contacting your local county agent to set up a Mobile Irrigation Lab to be conducted. A test must be done prior or very soon after emergence, so keep this in mind if you even think chemigation or fertigation will be utilized. Lastly, if chemigating in corn, ensure your nozzles are located at least above the leaf with the ear.

Irrigation Scheduling

Probably the most important management decision about irrigation scheduling is yield potential and water availability. For growers targeting yields of less than 150 bushels per acre or with less than 5 inches of water available, watch for visual signs of stress that occur just prior to tasseling. This will be "leaf curling" typically occurring before noon. In this case a thorough application of water (up to 2.5 inches depending on soil type evenly distributed throughout a week) should be made as tassels begin to emerge and another application of similar amount two weeks later. Do not adjust this timing unless very heavy rainfall occurs. If water is still available a third application of the same amount could be made two weeks after the second application. This would be considered a deficient or limited irrigation strategy. **Yield maximization is not expected in this type of irrigation strategy. This strategy is not recommended unless there are very limited and specific cases.**

Corn growers who have yield goals of greater than 150 bushels per acre and have an adequate supply of water available (>7 gpm/acre of well capacity) should consider more advanced and precise methods of irrigation scheduling to help eliminate **ALL periods of drought stress**. Visual stress should never be a valid way to schedule irrigation if an adequate water supply is available. To effectively schedule irrigation, soil moisture monitoring with remote data access is highly recommended. Devices such as soil water potential sensors can be used to monitor water use and increase water-use efficiency by more accurately scheduling irrigation events. Irrigation should be triggered whenever soil moisture levels approach a recommended trigger level based on soil type. This system allows efficient water use and promotes high yield potentials. Observe and make decisions on irrigation frequency and amount at a minimum of a daily basis during peak water demand, based on soil moisture levels. Typically, these decisions can be reduced to three times per week for the first 50 to 60 days after planting. However, if it is dry during the early part of the season it is suggested that daily soil moisture checks be performed. The addition of an irrigation scheduling regime will increase the management intensity of the irrigation system. Thus, this should be expected and planned for once an advanced irrigation system is implemented. However, the extra time and labor required for these decisions will typically be rewarded by increases in yield and/or reductions in irrigation applied translating to an increase in WUE, thus net farm income. Keep in mind irrigation system capacity so that you can better match the crop requirements with the amount of irrigation available. For more in-depth irrigation scheduling information contact your UGA Extension County Agent.

WEED MANAGEMENT IN FIELD CORN

Eric P. Prostko

One of the most important aspects of field corn production is weed management. Uncontrolled weeds not only reduce corn yields through their competition for light, nutrients, and moisture, but they can severely reduce harvest efficiency. Before implementing a weed management plan for field corn, several factors need to be considered including weed species, rotational crops, and cost/A.

Georgia's Field Corn Weed Problems

The top 10 most troublesome weeds in Georgia field corn are as follows: 1) Texas panicum; 2) crabgrass; 3) morningglory species; 4) pigweed species; 5) sicklepod; 6) nutsedge species; 7) johnsongrass; 8) annual ryegrass; 9) Pennsylvania smartweed; and 10) Benghal dayflower.

Weed Competition in Field Corn

Uncontrolled weeds have caused field corn yield reductions in UGA weed science research trials that range from 16% to 56% (33% average). If a weed management program in field corn is going to be successful and economical, a thorough understanding of the competitive effects of weeds is important.

In regards to this area, three things must be considered: 1) How many weeds are there and when did the weeds emerge in relationship to the crop?; 2) How much yield loss are they actually causing?; and 3) When do the weeds need to be controlled in order to prevent significant yield losses?

Research has shown that weeds that emerge just prior to or at the same time as the corn crop cause greater yield losses than later emerging weeds. Consequently, the use of effective weed control programs from 20 to 45 days after planting (DAP) usually prevents yield losses due to weed competition. Weeds that emerge 45 DAP will likely not cause competition-related yield losses but can have a negative influence on seed quality and harvest efficiency (i.e. annual morningglory). Other research has shown that corn 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).

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 10 illustrates the influence of various weed species on corn yield:

Table 10. Number of weeds/100 feet of row that cause yield reductions in field corn.

Weed	Corn Yield Loss (%)					
	1	**2**	**4**	**6**	**8**	**10**
Cocklebur or giant ragweed	4	8	16	28	34	40
Pigweed or lambsquarters	12	25	50	100	125	150
Morningglory or velvetleaf	6	12	25	50	75	100
Smartweed or jimsonweed	10	20	40	60	70	80
Yellow Nutsedge	400	800	800+	800+	800+	800+

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

Field Corn Weed Management Strategies

The most effective weed management programs in corn use a combination of cultural, mechanical, and chemical control strategies. Cultural practices include such factors as planting date, planting rate, and row spacing. Cultural practices improve weed control by enhancing the competitive ability of the field corn. Mechanical practices, such as cultivation, are a non-chemical method for controlling weeds between rows. A multitude of herbicides are labeled for use in field corn and can be applied preplant incorporated (PPI), preemergence (PRE), postemergence (POST), and post-directed (PDIR). A complete update on the herbicides recommended for use in Georgia can be found at the end of this section.

Atrazine

The foundation of weed management systems in all field corn production systems is atrazine. Atrazine provides broad-spectrum control of many weeds with excellent crop safety. Atrazine can be applied PPI, PRE, or POST (up to 12" tall). Numerous pre-mixtures are available that contain atrazine + a grass herbicide (Bicep, Bullet, Guardsman, Lexar EZ, etc). Generally, these pre-mixtures will provide broad-spectrum weed control when applied PRE. However, they are usually not very effective for the control of Texas panicum. In order to protect both surface and groundwater, it is important to read and follow the label regarding the use of atrazine. When atrazine is applied PRE + POST, a total of 2.5 lb ai/A can be applied per year (2.5 qt/A of 4L or 44 oz/A of 90DF). When atrazine is applied only POST, a total of 2.0 lb ai/A can be applied per year (2 qt/A of 4L or 36 ozs/A of 90DF).

Atrazine-resistant (AR) Palmer amaranth was first confirmed in Macon County in 2007. AR-Palmer amaranth has also been confirmed in Berrien and Dodge Counties. Specific control recommendations for growers who are concerned about atrazine resistance are included later in this chapter.

Herbicide-Resistant Crop Management Systems

In 2023, it was estimated that 90% of the field corn acreage in the U.S. was planted using herbicide-resistant/stacked herbicide-insect resistant corn hybrid technologies. There are 3 types of herbicide-resistant technologies that can be used by Georgia field corn growers:

Roundup Ready Systems (RR)

Numerous hybrids are available that are resistant to over-the-top applications of glyphosate. Glyphosate provides broad-spectrum control of many grass and broadleaf weeds. Research in Georgia has shown that 2 applications of glyphosate, applied approximately 21 and 35 days after planting, are more effective than single applications. It is also recommended that atrazine be included in the RR corn system. Atrazine can be applied either preemergence or in combination with the first postemergence application of glyphosate in the RR corn system. Glyphosate-resistant Palmer amaranth (pigweed) has been discovered in Georgia. Consecutive plantings of RR crops should be avoided. Refer to the section on herbicide-resistant weeds later in this chapter for more information.

Liberty-Link® Systems (LL)

Liberty-link corn hybrids are tolerant of postemergence applications of Liberty (glufosinate). Liberty provides good control of many troublesome weeds including morningglory, Texas panicum, and sicklepod. Atrazine should always be included with Liberty to improve the spectrum of control and to provide residual weed control.

***Many (**not all**) field corn hybrids are available that contain both the RR and LL traits.*

Enlist™ Field Corn Production Systems (2,4-D tolerant field corn)

Corteva Agriscience, (formerly DowAgroSciences) has developed field corn hybrids that are tolerant to glyphosate, 2,4-D, and quizalofop (Assure). Collectively, the trait and herbicide are marketed as the Enlist™ Weed Control System. Deregulation of the Enlist™ field corn 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. Preliminary field trials were conducted in 2018 with promising results. It is unlikely that Enlist™ field corn systems will be marketed aggressively in Georgia until adapted corn hybrids are available. For more information about Enlist™ field corn, refer to the following web-page: https://www.enlist.com/en/traits/enlist-corn.html

Herbicide/Hybrid Interactions

Field corn hybrids are routinely screened by seed companies for tolerance to certain herbicide families/modes of action including amide (Harness, Dual), benzoic acid/phenoxy (Clarity, 2,4-D), HPPD (Balance Pro, Callisto), and sulfonylurea (Accent, Steadfast). Before using any herbicide, check with your corn seed supplier to determine a hybrid's tolerance. Recently it was determined in UGA research that ALS-herbicide formulations that contain the crop safener isoxadifen (Capreno, Steadfast Q), applied under weed-free conditions, can cause 4-5% yield losses when used on ***ALS-sensitive*** field corn hybrids such as DKC62-08 and DKC64-69.

Herbicide/Insecticide Interactions

Growers who prefer or need to use organophosphate (OP) soil insecticides (**Counter, Lorsban**) should not apply certain postemergence herbicides if these insecticides are used or severe crop injury can occur. Herbicides that interact with OP soil insecticides and ***cannot*** be used include the following: Accent; Acuron, Beacon; Callisto; Capreno; Halex GT; Revulin Q; Sandea; Sharpen; and Steadfast Q. Herbicides than ***can*** be used where a soil OP was applied include the following: 2,4-D; Atrazine; Dual Magnum; Clarity; Impact/Impact Z; Laudis; Liberty; Roundup (glyphosate); Shieldex; Status; Warrant, and Zidua. This negative interaction does not occur with other types of soil insecticides or seed treatments.

Herbicide/Disease Interactions

Growers who need to control johnsongrass should make sure that the planted corn hybrid has acceptable tolerance to maize dwarf mosaic virus (MDMV) and/or maize chlorotic dwarf virus (MCDV). Insect vectors (aphids, leafhoppers) will move from herbicide treated johnsongrass to the corn crop resulting in the increased incidence of these diseases.

Herbicide-Resistant Weeds

Herbicide-resistant 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 11). Populations of Palmer amaranth have been found in the state 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 herbicide-resistant weeds in your area.

Table 11. Herbicide Resistant Weeds in Georgia.

Weed	Year	Herbicide(s)	Site of Action (WSSA/HRAC Group #)
goosegrass	1992	Treflan	Microtubule inhib. (3)
prickly sida	1993	Scepter	ALS inhib. (2)
Italian ryegrass	1995	Hoelon, Poast	ACCase inhib. (1)
Palmer amaranth	2000	Cadre, Pursuit	ALS inhib. (2)
Palmer amaranth	2005	glyphosate	EPSP synthase inhib. (9)
Palmer amaranth	2008	Staple + glyphosate	ALS + EPSP (2 + 9)
large crabgrass	2008	Poast	ACCase inhib. (1)
Palmer amaranth	2008	atrazine	PS II inhib. (5)
Italian ryegrass	2009	Hoelon + Osprey	ACCase + ALS (1 + 2)
Palmer Amaranth	2010	atrazine + glyphosate + Staple + Cadre	PS II + EPSP + ALS (5+9+2)
spotted spurge	2014	Manor, Blade	ALS inhib. (2)
annual sedge	2016	Sandea, Plateau, Certainty, Monument	ALS inhib. (2)
yellow nutsedge	2018	Cadre	ALS inhib. (2)
Palmer amaranth	2022	Valor, Reflex, Cobra, Ultra Blazer	PPO inhib. (14)

Weed	Year	Herbicide(s)	Site of Action (WSSA/HRAC Group #)
Annual bluegrass	2022	Specticle	Cellulose synthesis inhib. (29)

Herbicide-resistant weeds can be managed by using a combination of strategies including tillage, crop rotation, narrow row patterns, mechanical cultivation, and utilizing herbicides with different modes of action. Specific herbicide recommendations for the control of glyphosate–resistant (GR) Palmer amaranth and ALS-resistance management in field corn are included later in this chapter.

Atrazine-resistant (AR) Palmer amaranth was first confirmed in Macon County in 2007. Originally, it was thought that AR-Palmer amaranth was limited to dairy farms that had a long history of continuous atrazine use. However, AR-resistance was recently discovered in Berrien and Dodge Counties (2013, 2014) in non-dairy cropping systems. If glyphosate-resistance is not an issue, AR-Palmer amaranth should be easily controlled with glyphosate. However, growers who are concerned about ALS, AR and GR-Palmer amaranth should consider the weed control programs provided later in this chapter.

High-Yield Production Systems and Herbicides

Growers who are trying to produce corn yields in excess of 250 Bu/A have expressed concern about the potential negative impacts of herbicides. Recent UGA research has shown that applications of commonly used herbicides, applied at labeled rates and recommended stages of growth (V3-V5), ***do not*** have a negative impact on field corn yield in high input environments. Refer to individual herbicide labels for specific information about time of application and corn stages of growth.

Rotational Crop Concerns

Advances in herbicide chemistry have led to the development of some exceptional families including the sulfonylurea's (Steadfast Q, Sandea), sulfonanilides (Python), triketones (Capreno, Callisto) and others. Many herbicides in these families are used in field corn. However, some of these herbicides have the potential to injure rotational crops if the appropriate replanting interval is not observed. Atrazine also has the potential to cause carryover problems to sensitive crops particularly when used in late plantings. Because of the diversity of crops grown in Georgia, producers must consider the potential effects that herbicides could have on a rotational crop the next year. This information is readily available on nearly all herbicide labels.

Annual Morningglory Control in Field Corn

One of the most troublesome weeds to control in field corn is annual morningglory. In Georgia, morningglories are particularly difficult to manage because residual herbicides do not provide full-season control and corn maturation in late June/July allows ample sunlight to reach the soil surface which stimulates late-season emergence/growth. In heavy infestations, complete control of morningglory is almost impossible in our environment. A few things to consider:

1) Use a PRE (1 qt/A) and POST (1.5 qt/A) application of atrazine (4 lb ai/gal). The second application of atrazine must be applied before the corn exceeds 12" in height. POST applications can be delayed until that time to extend residual control.
2) Consider using the Liberty-Link (LL) system. Generally, Liberty is more effective on morningglory than glyphosate. Atrazine can be tank-mixed with Liberty for residual control.
3) Other herbicides that can be tank-mixed with glyphosate to improve the control of morningglory include, 2,4-D, dicamba, Status, Aim, and ET.
4) Consider using a LAY-BY or PDIR application of Evik.
5) Consider using a harvest-aid such as Aim. Late-season applications of Aim will not completely remove morningglory plants from a field but will desiccate the vines enough to improve harvest. Aim has no effect on smallflower morningglory.
6) Harvest corn early before morningglory plants take over the field. Obviously, this management tactic will necessitate the use of on-farm drying/storage facilities.

Volunteer Peanut Control in Field Corn

Volunteer peanut plants can be one of the most difficult weeds to control in field corn. Peanut plants are sensitive to POST applications of glufosinate (Liberty), split applications of glyphosate (Roundup), or dicamba (Clarity, Engenia, Status). Lay-By/PDIR applications of ametryn (Evik) may also provide some control.

Volunteer RR Soybeans in RR Corn

Volunteer RR soybeans can occasionally be a problem in RR corn production systems. Generally, volunteer crops are more difficult to control than planted crops. Table 12 shows a sequential program that should be considered for the control of RR soybeans in RR corn:

Table 12. Suggested Herbicide Program for RR Soybeans in RR Corn.

Preemergence	Postemergence
Atrazine	Glyphosate + dicamba[1] or Sandea/Profine

[1]Various formulations of dicamba are registered for use in field corn. Refer to specific product labels for rates, timings, and off-target movement prevention.

Post-Harvest Weed Management

Since much of the field corn harvest in Georgia occurs in August and first frosts do not occur until November, there is ample time for weeds to produce seed during that time frame. Thus, it is of the upmost importance to implement a post-harvest weed management strategy to prevent weed-seed rain back into a field. Multiple years of in-crop weed control will be wasted if weeds are allowed to produce seed after corn harvest. Various strategies can be used including mowing, tillage, and/or herbicides. More specific information about the post-harvest control of troublesome weeds, such as Benghal dayflower/tropical spiderwort and Palmer amaranth, can be found in the latest edition of the ***Georgia Pest Management Handbook – Special Bulletin 28***.

Herbicide/Fungicide Tank-Mixtures in Field Corn

In 2019, fungicide/herbicide tank-mixture trials were initiated to evaluate field corn response and weed control. In these trials, Headline AMP, Stratego YLD, and Trivapro were tank-mixed with either Roundup + Atrazine + Prowl, Roundup + Laudis + Atrazine, or Halex GT + Atrazine + NIS and applied 23 DAP (V5, 8” tall, ~384 GDD’s after planting). Fungicides had no effect on weed control but crop injury (leaf necrosis) increased by 10-15% when fungicides were tank-mixed with Halex GT + Atrazine + NIS. In this trial, field corn yields were not significantly improved when fungicides were tank-mixed with herbicides applied at the V5 stage of growth.

UGA Recommended Field Corn Weed Control Programs

Generally, most herbicides registered in Georgia for field corn weed control will provide good to excellent control of many common weed species when applied according to labeled directions. But, before selecting a certain herbicide program, growers should answer the following questions: 1) What technologies am I planting (RR, LL, Enlist, conventional)? (Table 13); 2) Do I need in-furrow applications of Counter for soil insect/nematode control?; 3) Is atrazine still working for me?; and 4) What/when crops will be planted after the field corn is harvested?

Table 13. Herbicide Programs for Field Corn Weed Control.

Corn Hybrid/System	Preemergence (All Systems)	Early-Postemergence[1] (~17-30 DAP, V3-V5, ~279-411 GDDs)[2]	Layby / Directed / Hooded
Conventional	Atrazine[3] or Dual II Magnum or Warrant or Outlook	1. Prowl + Atrazine + Crop Oil, or 2. Atrazine + one of the following: Accent Q; Callisto; Capreno; Armezon/Impact/Impact Z; Laudis; Revulin Q; Shieldex; Steadfast Q	Evik or Paraquat
Liberty-Link®		Liberty + Atrazine + one of the following: Acuron (48 oz/A); Anthem Maxx; Dual Magnum; Outlook; Prowl; Warrant; Zidua	
Roundup Ready®		1. Glyphosate + Atrazine + one of the following: Anthem Maxx; Dual Magnum; Outlook; Prowl; Zidua; or 2. Glyphosate + Atrazine + one of the following: Callisto; Capreno; Armezon/Impact/Impact Z; Laudis; Revulin Q; Shieldex; Steadfast Q; or 3. Glyphosate + Atrazine or 2,4-D amine or dicamba; or 4. Acuron GT or Halex GT + Atrazine; or 5. Glyphosate + Acuron (48 oz/A)	

[1]When using Counter (INFR) for insect and nematode control, the following herbicides should NOT be applied POST: Accent Q, Acuron GT, Acuron, Callisto, Capreno, Halex GT, Revulin Q, and Steadfast Q.
[2]GDDs = growing degree-days from planting (50/86 °F).
[3]A maximum of 2.0 to 2.5 lb ai/A of atrazine can be applied in a single year depending upon application methods.

INSECT CONTROL IN FIELD CORN

David Buntin

Field corn in Georgia is subject to attack by many kinds of insect pests. Some of these insects are capable of completely destroying a corn crop. Corn yield is sensitive to plant population. As little as a 10% loss in stand will reduce yield potential. Consequently, insect management in corn focuses more on seedling insect pests causing stand loss than in other crops. Once corn plants are established and past the seedling stage (4+ leaf stage), corn can tolerate considerable leaf defoliation and some ear and kernel damage before significant yield loss occurs. However, in the last decade the most consistently serious pest of field corn has been stink bugs damaging corn ears and kernels.

Insect pest management in field corn consists of: **(1) prevention** of insect damage by crop management and using preventive insecticide in high-risk situations and **(2) regular monitoring** of the insect-pest infestations and treatment on a field by field basis as needed after plants have emerged. Certain crop management practices can help to minimize or prevent damage by some insects:

1. **Good Soil Conditions:** Good fertility, optimum soil pH, good field drainage, irrigation and other agronomic practices that promote rapid stand establishment and vigorous plant growth are important in minimizing losses from insect injury.
2. **Crop Rotation:** In general, rotation of corn with other summer crops helps prevent the buildup of corn pests from year to year. Most corn insect pests are highly mobile and therefore are not affected by rotation. But, billbug and western corn rootworm can be controlled by crop rotation.
3. **Plant at the recommended time:** Plantings of field corn at the recommended time often escapes serious damage by most insects.
4. **Control Certain Weeds:** Nutsedge, bahiagrass, and johnsongrass may enhance infestations by certain insects.
5. **Tillage:** Reduced-tillage production, previous-crop residue, sod, winter cover crop and/or heavy weed populations can increase the risk of damage by soil insects. Soil insects attacking seedlings usually are worse in reduced, strip-till and no-tillage production, where residue from previous crops, cover crops or weeds remains on the soil surface. Conventionally-tilled fields following winter cover crops or winter weeds should be fallowed for at least 2 weeks before planting.

Hybrid Selection

Planting a vigorous well-adapted high-yielding hybrid will help corn tolerate injury by insects. Different types of Bt traits which contain toxins from *Bacillus thuringiensis* (Bt) are available for control of either larvae of certain moth species or mid-season corn rootworms. The toxin usually is expressed season-long in the plant.

Herculex® I and Herculex Xtra

Contains the Cry1F toxin, which targets caterpillar pests including European and southwestern corn borers, fall armyworm, and other lepidopterans. Herculex I provides no protection against corn earworm damage to ears and kernels. Herculex Xtra also contains a toxin for corn rootworms. Resistance by fall armyworm to the Cry1F toxin is present in the Southeast, so Herculex corn may not be effective against fall armyworm. Herculex corn requires a 50% non-Bt corn refuge. Newer pyramided products are a better choice.

Triple Stacked Traits

These hybrids contain a Bt caterpillar trait, a Bt rootworm trait plus herbicide tolerance in a three-way stack. Products include Agrisure 3000GT or 3011, Herculex XTRA and YieldGard VT Triple. Most Triple stacked products have been replaced by pyramided products listed next. Triple stack corn requires a 50% non-Bt corn refuge.

Genuity® VT Triple PROTM, Genuity® VT Double PROTM, Genuity DroughtGard VT Double PRO

Contain two traits for caterpillar control, Cry1Ab and Cry2Ab. The combined traits provide good control of stalk borers and fall armyworm in the whorl, but also provides fair levels of control of corn earworm in the ear. VT Triple PRO also contains a gene for rootworm control but Double PRO products do not have rootworm control.

Genuity® SmartStax® and SmartStax®

An 8 gene combination that contains all the traits in Genuity VT Triple PRO plus all the traits in Herculex XTRA. SmartStax provides good control of all target pests listed in Table 14 except corn earworm where control is fair.

PowerCore®

Similar above-ground traits as SmartStax but without the rootworm traits.

Genuity® Trecepta™

Trecepta contain the genes in Genuity VT Double PRO plus Vip3A. The combined traits provide very good to excellent control of stalk borers and fall armyworm in the whorl, and also an excellent level of control of corn earworm in the ear.

Agrisure® Viptera™

Product series that contains the trait (Vip3A) for caterpillar especially corn earworm control. Specific Viptera products have a number designation which for southern hybrids will be 3110, 3111 and 3220. Depending on the product it also may be stacked with one or two traits for corn borer and corn rootworm control as well as tolerance to glyphosate and glufosinate herbicides.

Optimum® Intrasect™

A product for the southern U.S. that contains the two original corn borer proteins, in YieldGard-CB and Herculex 1, but does not contain rootworm traits. This product provides very good to excellent control of corn borers and fall armyworm in the whorl, but poor control of corn earworm in the ear.

Optimum Leptra™

Contains the two original corn borer proteins, in YieldGard-CB and Herculex 1, plus the Viptera trait, but does not contain rootworm traits. This product provides very good to excellent control of corn borers and fall armyworm in the whorl. It also provides very good control of corn earworm in the ear and prevents kernel damage.

Integrated or blend refuge-in-the-bag (RIB) products

Some seed companies also market RIB Bt corn products Georgia with a 5% or 10% non-Bt seed mixed or blended in the bag of a Bt product. They include Genuity® SmartStax® RIB , Genuity VT Double PRO RIB, Genuity Trecepta RIB, Agrisure Viptera 3220 and 3122, Optimum AcreMax and several other products. But RIB Bt corn products grown in cotton areas including all of Georgia require a 20% non-Bt structured refuge.

When to Use Bt Hybrids for Caterpillar Control

Hybrids with caterpillar Bt traits should be considered for planting when the planting time is after the recommended planting time when risk of caterpillar damage is greatest. Use of Bt corn permits planting of corn as a double-crop and at times later than previously recommended for susceptible corn. Planting corn with Bt traits during the recommended planting time may not provide a consistent yield benefit, because early plantings usually avoid most damage by fall armyworm, corn earworm and corn borers. Compare the agronomic performance of adapted susceptible hybrids and hybrids with Bt traits and plant the best high-yield adapted hybrid.

Bt Hybrids for Rootworm Control

Bt rootworm traits target midseason rootworms. The only midseason rootworm species in Georgia is the western corn rootworm, and it currently is present in the northern two thirds of the state. Western corn rootworm is only a pest when corn is grown continuously in the same field for several years, such as in dairy operations. Bt for rootworm control is NOT needed in Georgia where corn is rotated annually with other crops. Several types of Bt rootworm products are available with activity against rootworm larvae. Rootworm resistance reported in the Midwest to Bt traits currently is not a problem in Georgia. Rootworm Bt traits are not effective against wireworms, white grubs or southern corn rootworm in the seedling stage.

Table 14. Bt products with their associated traits and relative efficacy against major caterpillar/moth pests and rootworms. Efficacy ratings: N= None, P= Poor, PF= Poor-Fair, F= Fair, G= Good, VG= Very Good, E= Excellent.

Brand/ Product Name	Traits	Corn borers (stalks)	Cutworm (seedlings)	Lesser Cornstalk borer§ (seedlings)	Corn earworm (ear)	Fall armyworm (whorl)	Western corn rootworm (midseason roots)
Herculex I	Cry1F	E	G	G	P	G¶	N
Agrisure 3000GT Agrisure 3011A	Cry1Ab Cry3A	E	P	G	P	F	G
YieldGard VT Triple	Cry1Ab, Cry3Bb	E	P	G	P	F	G
Herculex XTRA	Cry1F, Cry34/35Ab1	E	G	G	P	G	VG
Genuity VT Triple Pro	Cry1A.105, Cry2A, Cry3Bb	E	P	VG	PF	G	G
Genuity VT Double Pro	Cry1A.105, Cry2A	E	P	VG	PF	G	N
Genuity Trecepta	Cry1A.105, Cry2A Vip3A	E	VG	VG	E	E	N
Genuity SmartStax Dow SmartStax	Cry1A.105, Cry2A, Cry1F, Cry3Bb, Cry34/35Ab1	E	G	VG	PF	VG	VG
PowerCore	Cry1A.105, Cry2A, Cry1F	E	G	VG	PF	VG	N
Agrisure Viptera 3110	Cry1Ab, Vip3A	E	G	G	E	E	N
Agrisure Viptera 3111	Cry1Ab, Vip3A, mCry3A	E	G	G	E	E	G
Agrisure Viptera 3220	Cry1Ab, Cry1F, Vip3A	E	VG	VG	E	E	N
Optimum Intrasect	Cry1Ab, Cry1F	E	G	VG	P	G	N
Optimum Leptra	Cry1Ab, Cry1F, Vip3A	E	VG	VG	E	E	N

§Lesser cornstalk borer is not specifically listed as a target pest for most Bt product labels.

¶Herculex still provides suppression of fall armyworm in the whorl in early plantings but high levels of resistance to Cry1F can occur making Herculex not effective for fall armyworm especially in later plantings.

Bt Hybrid Refuge Requirements

All corn seed with Bt traits will have details of the refuge requirements and options for planting the refuge for that hybrid on the seed bag tag. General refuge requirements for Bt corn for caterpillar control in cotton growing areas such as Georgia are as follows:

- Bt products with a single gene for above-ground (corn borer) control (Herculex, Triple stack, etc) must have a 50% non-Bt structured refuge. Stacked products with two or more above-ground (caterpillar) genes have a 20% structured non-Bt refuge requirement.
- Bt refuge-in-the-bag (RIB) products, if grown in cotton areas including all of Georgia, still require a 20% non-Bt structured refuge.
- For Bt corn products with above-ground traits only (no rootworm traits), the non-Bt corn refuge must be planted within ½ mile of the Bt corn.
- For Bt products for below ground containing a rootworm trait(s), the refuge must be planted in the same field or adjacent to the Bt corn.
- Bt and non-Bt corn can be planted as in-field strips of 4 or more consecutive rows. Strips of 1 to 3 rows are not allowed.
- Check with seed dealers, seed company, or the www.irmcalculator.com for complete Bt corn refuge requirements.

Before and At Planting

Insects that live in the soil, including wireworms, white grubs, rootworms, seedcorn maggots, whitefringed beetle larvae, lesser cornstalk borer and other, can damage corn seeds and seedlings. These insects cannot be controlled once corn seed has been planted. Rotated, conventionally tilled corn with good weed control generally has the least risk of serious early-season insect damage, although insect damage can still occur under these conditions. Several factors increase the risk of damage by soil insects and the need for an at-planting insecticide to prevent damage.

1. Planting continuous corn in the same field.
2. Planting in no-till or minimum-till situations (such as strip till) where residue of the previous crop remains on the soil surface.
3. Planting following small grains, winter cover crops or sod of any type especially in reduced tillage situations.
4. Late-planting (more than 1 month after the recommended planting time).
5. Planting on light soils following periods of drought (lesser cornstalk borer).
6. When planting on heavier soils following extended wet periods.
7. Planting in fields with certain weeds. Southern corn billbug damage often is associated with nutsedge infestations and sugarcane beetle builds can up on bahiagrass. Leafhoppers and aphids serve as vectors of corn viruses from johnsongrass to field corn.

Insecticides for Use At-Planting

Table 15 shows efficacy ratings for at-planting insecticide options.

Seed Treatments

Systemic seed treatments are available as commercial seed dealer application. Seed corn from nearly all seed companies will be automatically treated with a systemic insecticide seed treatment. Poncho 250 or Cruiser 250 are the standard base rates. Untreated seed or seed treated with a higher rate must be ordered from the seed dealer early, usually in December of the previous year. Cost for seed treatments varies per acre between irrigated and dryland corn based on differences in seed planting rate.

Poncho (clothianidin) 250

Provides good control of most soil insects but has variable control or not effective against corn billbug, cutworms, and stink bugs. Also provides systemic control for 2-3 weeks after planting of aphids, leafhoppers, and moderate infestations of chinch bugs. The insecticide component of Acceleron™ on corn is clothianidin.

Cruiser (thiamethoxam) 250

Provides fair to good control of most soil insects, but is not effective against corn billbug, cutworms, sugarcane beetle and stink bugs. Also provides systemic control for 2-3 weeks after planting of aphids, leafhoppers, and moderate infestations of chinch bug. PPST 250 also contains thiamethoxam.

PPST 250 Plus Lumivia

Contains Cruiser 250 (thiamethoxam) plus chlorantraniliprole (=rynaxypyr). Lumivia adds improved control of white grubs and cutworms over thiamethoxam alone.

Poncho 500 / Cruiser 500

The 500 rate should provide more consistent control under moderate to severe infestations and also improve control of insects like stink bugs, chinch bugs and sugarcane beetle. Acceleron™ seed treatment with Poncho 500 also is available combined with VOTiVO™ for nematode control. Likewise, Cruiser 500 is available as Avicta Complete Corn™ which also contains a nematicide and fungicides.

Poncho 1250 / Cruiser 1250

Consider use for control of billbug and cutworms and in fields with a history of serve infestations of soil insects. Also, may provide suppression of light to moderate infestations of western corn rootworm.

Imidacloprid (various brands)

Available at rates of 0.16, 0.60 and 1.34 mg a.i./kernel. The low rate is too low for most pests in Georgia. The 0.60 mg rate is effective against wireworms, sou. corn rootworm, seedcorn maggots, and usually white grubs. In most cases, Poncho or Cruiser at the equivalent rate provides control of a broader range of soil insect pests.

Granular Insecticides

Granular insecticides require the use of specialized application equipment. The best method where **only** wireworms, seedcorn maggots, grubs and southern corn rootworms are a problem is an in-furrow application where the label allows. For insects that feed at or near the soil surface (lesser cornstalk borer, cutworms, billbugs, sugarcane beetle), the best placement (where the label allows) is in a T-band or a narrow band (6 to 8 inches) behind the planter shoe and in front of the press wheel. Since most labels specify a covered-band application, in-furrow applications are the only option in no-till plantings.

Counter (terbufos) 20G

Available as a Lock'nLoad or Smartbox closed handling system. Apply as in-furrow, T-band or band. Most effective against beetle type insects; not a good choice for cutworms and lesser cornstalk borer. Counter also provides fair to good nematode suppression. Interactions with ALS herbicides such as Accent and Option may cause severe injury. Check herbicide product label for restrictions.

Phorate / Thimet (phorate) 20G

Apply as T-band or band application, and do not apply in-furrow due to risk of seed injury. Because of the risk of seed injury, Counter 20G is a better choice for soil insect control. Interactions with ALS herbicides may cause severe injury; see herbicide labels for restrictions.

Liquid injected insecticides

Several liquid insecticides are labeled for at-planting use in corn. They should be applied in-furrow using specialized application equipment or applied in the open seed furrow using flat-fan nozzles oriented with the row. See product dealer to obtain equipment.

Capture (bifenthrin) 2EC, LFR (1.5)

Fair to very good control of soil insects. No systemic activity or activity against nematodes. Capture LFR may be tank mixed with liquid fertilizers according to label directions. Premixing to determine compatibility is recommended. Tank mixes should be continuously agitated.

Force (tefluthrin) CS

Apply in-furrow or band. Force is a pyrethroid insecticide and is effective against most soil insects. No systemic activity, no nematode activity and no herbicide interactions. Force tends to breakdown quickly in warm, sandy soils.

Table 15. Relative efficacy[1] of seed treatments and soil insecticides for at-planting use in corn.

Product[2, 3]	Seedcorn maggot	Sou. Corn rootworm	Wireworm	White Grubs	Lesser cornstalk borer	Cutworm	Chinch bug	Corn Billbug	Sugarc ane beetle
Counter 20G	E	E	E	E	P,nl	P,nl	F	F	P,nl
Force 3G	E	E	E	F-G	F	G	P,nl	P	P,nl
Capture 1.15G	E	E	E	G	F,nl	G	P,nl	P,nl	P,nl
Capture 2EC LQ	E	E	E	G	F,nl	G	P,nl	P,nl	G,nl
Poncho 250 Acceleron ST	G	E	G	F	G,nl	P-F	F-G	P,nl	F
Poncho 500 Acceleron with Poncho Vitivo Nipsit Inside ST	E	E	G	E	G,nl	P-F	G	F	G
Poncho 1250 Poncho Vitivo 1250 NipsIt Inside ST	E	E	E	E	E,nl	F-G	E	G	G
Cruiser 250 ST PPST	G	G,nl	G	F	G,nl	P	F	P,nl	P
PPST 250 + Lumivia ST	E	G-E, nl	G	G	G,nl	E	F	F-G, nl	P
Cruiser Maxx Corn 500 Avicta Complete corn 500 ST	E	E	G	G	G,nl	P	F	P,nl	P-F
Cruiser Maxx 1250 Avicta Complete corn ST	E	E	E	E	E,nl	F	G	G	F
Imidacloprid[4] ST 0.60 mg rate	E	G,nl	F-G	F-G	P,nl	P,nl	F	P,nl	P,nl

[1]Rating: P indicates poor or no activity; F indicates fair activity; G indicates good activity; E indicates excellent activity.
[2]G = granule insecticide; LQ = Products require specialized equipment for liquid injection in-furrow; ST = seed treatments, applied by seed dealers.
[3]nl = indicates the insect pest is not listed on the product label. Ratings in boxes with nl are listed if data from trials is available.
[4]Numerous brands.

Seedling Stage Corn

Corn fields should be checked about 1 to 2 weeks after planting to verify that plants are emerging and to determine the kinds and numbers of insects present and whether control is needed. Yield loss occurs when as few as 10% of plants are destroyed or damaged so severely as to prevent normal stalk and ear development. Look for insects around the plants, on the plants, and in the soil around the stem and roots; look for dead, dying and lodged plants. Severe damage to the young seedlings can occur in few days if not controlled.

Billbugs

Reddish-brown or black weevil type beetles with long curved snouts. Billbug feed at the base of the stalk just below the soil surface where they chew holes through the stem killing the growing point. Billbugs move by crawling and mostly cause damage in non-rotated corn following corn, in fields next to last year's corn or in fields with heavy infestations of nutsedge. At-planting banded insecticide treatments such as Counter 20G may aid in control. Systemic seed treatments, Poncho or Cruiser, are only effective at the 1250 rate. Foliar application of an insecticide directed at the stalk and base of the plant are available.

Sugarcane beetles

Black and about ½ inch long. They gouge large holes in the stalk just below the soil surface. Damage usually occurs over a short period of time when beetles are active. This insect can build up on bahiagrass and other grassy weeds in or near corn fields. Notes on insecticide use for billbugs also apply to sugarcane beetle, except Poncho 250 and 500 rates will provide fair and good control, respectively. Rescue treatments are not effective.

Cutworms

Larvae of various moth species. They cut leaves and entire corn seedling off near the soil line. They typically spend the day under soil or plant residue in the field. Infestations often are associated with reduced tillage with plant residue on the soil surface and/or fields with weed infestations the previous year or before planting. Environmental conditions causing slow seedling growth may enhance damage by cutworms. Treat when 10% of plants are cut and worms are present. Bifenthrin insecticides can be applied before planting as a broadcast application, and numerous insecticides are available for use as a band or T-band over the row at-planting. Low rate of systemic seed treatments, Poncho and Cruiser, are not effective. Some Bt products also will suppress or prevent cutworm damage.

Lesser cornstalk borer

Moth larvae that prefers hot, dry conditions and conventional tillage. Late planted corn is at more risk from attack. Moths are highly attracted to burnt stubble. Larvae bore into the side of seedling plants. They live in a silken tube that is covered with soil particles. Poncho and Cruiser seed treatments and several Bt traits provide good control. For non-Bt hybrids, only pyrethroid insecticides are available at planting as a band or T-band over the row. Lesser cornstalk borer is very difficult to control after plant emergence.

Chinch bugs

Small true bugs with black and white X-patterned wings as adults. Nymphs are reddish gray with a white band across their back. Chinch bugs suck sap from roots, leaves and stems causing stunting wilting and deformation of seedling plants. Chinch bugs are favored by hot dry conditions and by reduced tillage following grassy winter crops or weeds. Treat chinch bugs when 3 to 5 bugs per plant occur on 20% of plants. Systemic seed treatments of Poncho and Cruiser need the 500 rate to provide more consistent control. Large infestations may require spraying seedlings. Directed spray at the base of plants using plenty of water is recommended for chinch bug control after planting.

Stink bugs

Feed by piercing and sucking sap from corn seedlings. Common species in Georgia are the Southern green, green, and brown stink bugs. Feeding in the seedling stage stunts and deforms developing whorls. New leaves do not expand properly and are trapped in the previous leaf causing "buggy-whip" type damage. Stink bugs are very difficult to scout in the seedling stage. About 10% seedling damage is economically important. Most at-planting insecticides are not effective in preventing stink bug damage. Systemic seed treatments, Poncho and Cruiser at the 500 or 1250 rates are needed for control.

Thrips

Tiny black or yellow insects. They feed on leaves where they can cause discoloration of leaves of seedling plants. Unless damage is severe, plants grow out of this damage by the 6-leaf stage with no measurable yield loss. Poncho and Cruiser seed treatments do not provide effective control. Some foliar insecticides will aid in control of thrips on seedling corn.

Whorl Stage Corn

Once corn plants reach the 5 - 7 leaf stage they are large enough to escape damage by most seedling pests. Most insects of importance during the whorl stage defoliate the whorl and leaves. These include grasshoppers, armyworms, corn earworm, cereal leaf beetles and others. Whorl stage corn is very tolerant to defoliation. Table 16 may be helpful in assessing the yield loss potential from defoliation at different stages whorl development.

Table 16. Yield loss Potential in Bushels Per Acre from Defoliation.

Leaf stage	**Percent leaf Area Destroyed**				
	20	**40**	**60**	**80**	**100**
5	0	0	1	4	6
7	0	1	4	6	9
9	0	2	6	9	13
11	1	5	9	14	22
13	1	6	13	22	34

15	2	9	20	34	51
17	4	12	27	45	70

Source: J. van Duyn, North Carolina State University.

Whorlworms (Fall armyworm, corn earworm, true armyworm, and other armyworms)

Infest whorls where they chew large holes in expanded and unfurling leaves. These caterpillars as a group are sometimes called 'budworms'. Armyworms lay masses of eggs on the leaves whereas corn earworm lays single eggs. Small larvae cause window-pane or shot-hole type injury before moving to infest the whorl. Larvae tunnel in the whorl causing large holes to develop as the leaves unfold and expand. Control should be initiated when 25% of the plants in a field are infested and larvae are present. Use ground equipment and apply as much finished spray per acre as possible directed down into the whorls. Cone type nozzles producing large sized droplets will aid control. Most Bt corn products listed above will prevent serious damage by whorlworms.

Cereal leaf beetle

A pest of winter small grains in the spring. Newly emerged adults leave small grain crops as they mature and move to adjacent grass crops such as corn. Adults chew long, thin, irregular lines in leaves of seedling and whorl-stage corn. Corn fields immediately next to small grain fields are most heavily infested. Beetles typically occur along the field edge initially and often can be controlled by treating the first 50 - 100 ft of the corn field edge.

Grasshoppers

Feed on many different plants and usually are a problem in dry years. Adults are very mobile and hard to control. Nymphs should be controlled if they are numerous and causing excessive defoliation. Grasshoppers typically occur along the field edge initially and often can be controlled by treating the first 50 - 100 ft of the corn field edge.

Mid-Season Stalk-Boring and Root-Feeding Insects

European corn borer, Southwestern corn borer and Southern cornstalk borer

Caterpillars of moths that tunnel inside corn stalks during the whorl and ear fill stages. Eggs are laid in masses on leaves. Small larvae feed in foliage before tunneling into the stalk. Once in the stalk, they cannot be controlled using insecticides. Stalk borers usually are not serious insect pests of corn in most of Georgia. The southwestern corn borer only occurs in the northwestern part of the state and can cause significant stalk damage. All above-ground Bt trait products are very effective in controlling these insects. Foliar sprays using moth pheromone traps and egg sampling can be used to control corn borers in non-Bt corn.

Western corn rootworm

Present in the northern two thirds of Georgia. (Note: the other major rootworm species in the Midwest, the northern corn rootworm, does not occur in Georgia). Larvae feed on root tips causing root pruning which reduces root activity and yield potential. In severe cases most of the roots are destroyed causing the plants to lodge or fall over in a 'gooseneck' appearance. Western corn rootworm feeds almost exclusively on corn. Adults are attracted to and feed on silks where severe damage may interfere with pollination. Females lay eggs in the soil in corn fields. Eggs over-winter and hatch the next year to damage roots of the following corn crop. Therefore, western corn rootworm is ONLY a pest of continuous corn. Crop rotation is a very effective method for controlling this insect in Georgia. Hybrids with Bt rootworm traits and at-planting insecticides also are available for use in continuous corn fields with a history of rootworm damage.

Ear Formation, Tasseling/Silking, and Kernel-fill Stages

Stink bugs

During ear formation and pollination is the most important foliar pest of corn in Georgia. They can cause feeding damage to small developing ears before silking. This type of feeding injury usually deforms ears into a C or boomerang shape. These ears fail to develop properly and may be more susceptible to infection by diseases. Treat during the ear elongation / vegetative tassel stage (stage V12 to VT) if 1 stink bug per 8 plants is present. During silking/pollination to blister stages (R1 – R2), stink bugs feed through the husk and damage individual kernels. Control is warranted if populations reach 1 bug per 4 plants. Use pyrethroid insecticides if southern green and green stink bugs are prevalent. If brown stink bugs are prevalent, a high rate of bifenthrin will provide about 75-90% control.

Corn rootworm adults, Japanese beetles, and grasshoppers

Can clip corn silks thereby interfering with pollination. Silk damage or removal by insect feeding can cause poor seed set and partially filled ears. Damage must be severe to justify control with insecticides. Insecticidal control may be needed if: (1) most ears are infested AND (2) silks are being clipped to within an inch of the ear tip AND (3) 2 or more Japanese beetles or 5 or more rootworm beetles per ear are present.

Aphids

Seldom require control on field corn in Georgia. Corn leaf aphid is the most common aphid occurring on field corn in Georgia. Natural enemies such as lady beetles and parasites are usually effective in regulating them at non-damaging levels. Consider control if heavy aphid infestations occur and leaves appear to be drying and dying over large areas of the field, or aphids on the tassels and silks appear likely to interfere with pollination. Poncho and Cruiser seed treatments also provide control on seedlings for a few weeks after emergence.

Sugarcane aphid, which is a new severe pest of sorghum, may occur on corn but normally does not build up to damaging levels on corn. Transform WG and Sivanto prime are not labeled for aphid control in corn.

Corn earworm and Fall armyworm

Larvae feed on developing kernels in corn ears. Corn earworm feeding damage usually is confined to the tips of the ears on non-Bt plants. Several small larvae may infest an ear, but because larvae are cannibalistic, usually only one or two larvae complete development per ear. Corn earworm feeding activity tends to open up the husks, which provides entry for kernel diseases and secondary insects such as sap beetles. In on-time plantings, infestations usually are low <50% of ears, but can reach 50% to 100% of ears in some years. Yield loss from one larva per ear generally is about 3 to 4%. Later plantings have greater infestations than earlier planting, with infestations usually being more than 90% infested ears and often having more than one larva per ear, so yield loss may exceed 4%. Fall armyworm damage in the ear is similar to corn earworm but several fall armyworms may complete development in a single ear. Therefore, damage during fall armyworm outbreaks can be much more severe than by corn earworm. Early-planted corn escapes ear infestation by fall armyworm.

Because larvae are protected within the husk, using insecticides to control corn earworm and fall armyworm in the ear is difficult and most likely not economical in field corn.

Bt hybrids with the Vip3A protein (Agrisure Viptera 3110, 3111, or 3220, Optimum Leptra, or Genuity Trecepta) are highly effective at preventing corn earworm damage. Efficacy of Genuity VT Triple PRO, Genuity VT Double PRO, and SmartStax has recently declined in Georgia due to resistance so control may only be fair and not be good in later plantings. Triple stack products and Optimum Intrasect™ only provide limited suppression of corn earworm in the ear, and Herculex I is not effective in preventing kernel damage.

Maize weevils

Naturally infest corn in Georgia as corn matures in the field. Maize weevils are very small brown beetles with a distinct snout. Larvae feed inside individual kernels and destroy the kernel contents. Maize weevil can also cause serious losses in stored corn if not properly managed. Timely harvest is the most effective tool for minimizing maize weevil infestations in the field. Insecticide control in the field before harvest is not recommended. Instead, corn should be treated as it is placed in storage and managed to reduce the temperature of stored grain.

Relative Efficacy of Foliar-applied Insecticides

Tables 17 and 18 list the relative efficacy (1 = very good, 5 = not effective) of registered insecticides for control of insect pests after plant emergence. ‘nl’ means the product is not labeled for control of that insect. Specific insecticide recommendations, rates and precautions are available in the Georgia Pest Management Handbook, commercial edition at: http://www.ent.uga.edu/pmh/Com_Corn.pdf. But read the label before application in case changes are made to the label since the time of this publication was prepared.

Table 17. Relative efficacy of post-emergence insecticides for control of above-ground (seedling, whorl, stalk, ear) corn insect pests.

Insecticide	Fall armyworm larvae*	True armyworm larvae	Corn Billbug adults	Chinch bug	Corn earworm larvae in ear*	Cutworm larvae	European corn borer larvae**	SW corn borer larvae**
Asana XL	nl	2	nl	4	3	1	3	2-3
Baythroid XL	3	2	nl	3	3	1	3	2-3
Tombstone	3	2	nl	2	3	1	3	2-3
Fastac 0.83	3	2	nl	2	3	1	3	2-3
Brigade 2EC (bifenthrin)	2	2	nl	1	3	1	3	2-3
Delta Gold 1.5EC	2	2	nl	3	3	1	3	2-3
Declare	3	2	nl	3	3	1	3	2-3
Warrior II (=Karate) Zeon	3	2	nl	3	3	1	3	2-3
Pounce 25 WP	4	2	nl	nl	4	2	4	4
Mustang Maxx	3	2	nl	3	2	1	3	3
Sevin XLR Plus	4	1	nl	5	3	3-4	?	?
Lannate LV	2	1	nl	nl	3	nl	?	?
Intrepid 2F	nl	2	nl	nl	nl	nl	1-2	1-2
Prevathon 0.43 Vantacor	1	nl	nl	nl	1	nl	1	1
Radiant 1SC	2	1	nl	nl	2	nl	2-3	2-3
Tracer 4SC	3	1	nl	nl	2	nl	3	3
Oberon	nl	nl	nl	nl	nl	nl	nl	nl
Onager (1.0)	nl	nl	nl	nl	nl	nl	nl	nl
Zeal 72WSP	nl	nl	nl	nl	nl	nl	nl	nl
Mixtures								
Besiege	1	1	nl	3	2	1	1	1
Consero	2	1	nl	3	2	1-2	3	3
Hero / Steed	3	1-2	4	2	2	1	2	2
Intrepid Edge	2	2	nl	nl	2	nl	1	1

Ratings range from 1-5: 1 = Very Effective and 5 = Not Effective; 1 = Standard; 3 = Fair; 5 = Poor; (2 = very good – fair, and 4 = fair to not effective). 'nl' indicates an insect pest is not listed on the product label. '?' indicates efficacy not determined.

*Insecticide must be able to reach the target pests. Ratings relate to applications made to the target pest before it enters the stalk or ear.

**Targeted for second generation larvae before they bore into the stalk or ear.

Table 18. Relative efficacy of post-emergence insecticides for control of above-ground (seedling, whorl, stalk, ear) corn insect pests (cont.).

Insecticide	Flea beetle (adult)	Grass-hopper	Japanese beetle, Rootworm adults	Lesser cornstalk borer larvae*	Green or Southern Green stink bug	Brown stink bug	Spider mites
Asana XL	2	1-2	2	nl	nl	nl	nl
Baythroid XL	2	1-2	1-2	nl	1-2	3 hr	nl
Tombstone	2	1-2	1-2	nl	1-2	3 hr	nl
Fastac 0.83	2	1-2	1-2	nl	1-2	3 hr	nl
Brigade 2EC (bifenthrin)	2	1-2	1-2	nl	1-2	3 hr	3
Delta Gold 1.5EC	2	1-2	2	nl	1-2	4 hr	nl
Declare	2	1-2	1	4	1-2	3-4 hr	nl
Warrior II (Karate) Zeon	2	1-2	1	4	1-2	3-4 hr	nl
Pounce 25 WP	?	nl	?	nl	nl	nl	nl
Mustang Maxx	2	1-2	1	nl	1-2	4 hr	nl
Sevin XLR Plus	1-2	3	1	nl	nl	nl	nl
Lannate LV	-	nl	1-2	nl	nl	nl	nl
Intrepid 2F	nl	nl	nl	nl	nl	nl	nl
Prevathon 0.43 Vantacor	nl	nl	nl	nl	nl	nl	nl
Radiant 1SC	nl	nl	nl	nl	nl	nl	nl
Tracer 4SC	nl	nl	nl	nl	nl	nl	nl
Oberon	nl	nl	nl	nl	nl	nl	1-3
Onager (1.0)	nl	nl	nl	nl	nl	nl	2-3
Zeal 72WSP	nl	nl	nl	nl	nl	nl	2-3
Mixtures							
Besiege	2	2	1	nl	1-2	3-4 hr	nl
Consero	2	1-2	2	?	2	3-4 hr	3-4
Intrepid Edge	nl	nl	nl	nl	nl	nl	nl
Hero / Steed	1-2	1-2	1	?	1-2	4 hr	3

Ratings range from 1-5: 1 = Very Effective and 5 = Not Effective; 1 = Standard; 3 = Fair; 5 = Poor; (2 = very good – fair, and 4 = fair to not effective). 'nl' indicates an insect pest is not listed on the product label. '?' indicates efficacy not determined. 'hr' indicates the efficacy ratings is reflective of the insecticide applied at a high rate.

*Insecticide must be able to reach the target pests. Ratings relate to applications made to the target pest before it enters the stalk or ear.

**Targeted for second generation larvae before they bore into the stalk or ear.

CORN DISEASE AND NEMATODE MANAGEMENT

Bob Kemerait

General Disease Management Steps for Corn Production

If you take nothing else away from this disease and nematode section, please consider the points below as you develop a disease and nematode management program for the upcoming corn season.

1. A "La Niña" climatic pattern is affecting the southeastern United States again during the 2023-2024 winter. This is the third such winter in a row. La Niña winters are characterized by typically warmer and drier conditions. As of February 2023, plant parasitic nematodes were found to be active in fields to be planted to corn and other crops. Nematodes were a problem for corn growers in Georgia in 2023. Corn growers should be prepared again in 2024 and use nematicides where appropriate. In addition to Telone II, Counter 20G, Velum, and nematicide seed treatments, Averland (abamectin) is also labeled for field corn in Georgia. Research continues to make the most accurate recommendations for Averland.
2. Consider planting corn hybrids that are resistant to problematic diseases. Educate yourself before you make a final seed selection as to whether a variety is resistant or susceptible to diseases such as Diplodia ear rot, grey leaf spot, southern corn leaf blight, northern corn leaf blight, or southern rust.
   NOTE: Growers can significantly reduce the threat of diseases like northern corn leaf blight, southern rust and Diplodia ear rot by selecting resistant hybrids. Disease ratings for important diseases should be available for each hybrid from the seed companies.
3. Plant early to help reduce rust, stalk and ear rot problems (Field molding and aflatoxin contamination also appear to be worse on later plantings where insect damage is usually greater). Charcoal rot, a disease that can cause serious damage to the stalk and significant lodging, is most severe under drought stress. Thus, it is typically more problematic on later planted corn.
   NOTE: Severity of southern rust is typically less severe on early-planted corn; northern corn leaf blight tends to be more problematic on early-planted corn; southern corn leaf blight and northern corn leaf SPOT are more common on later planted corn.
4. Use approved fungicides on susceptible hybrids to reduce losses to disease and protect yield. The timing of fungicide applications is critical for disease management.
   NOTE 1: For management of some diseases, for example northern and southern corn leaf blights, the best timing of fungicide application is during mid-vegetative growth stages (approximately V6-V8). For management of southern corn rust, applications made at tassel or just prior to tassel are often appropriate. Consult your local county agent for timely, in-season updates on southern corn rust in Georgia or follow on the Internet at https://corn.ipmpipe.org/southerncornrust/.
   NOTE 2: To avoid problems with ear deformation, fungicides applied prior to tassel should not be mixed with adjuvants or crop oils.

NOTE 3: For management of northern and southern corn leaf blights, growers should use a broad-spectrum fungicide prior to tassel. Broad-spectrum fungicides include strobilurins, strobilurin-triazole premixes, strobilurin-SDHI premixes and strobilurin-SDHI-triazole mixes.
NOTE 4: Tar spot caused by the fungus *Phyllachora maydis* was found for the first time in Georgia in 2021 and was widespread by late in the season (September-November) in both 2021 and 2022. While the future impact of tar spot for corn production in Georgia is not known, producers should be prepared to a) scout their fields for this disease and b) prepare for timely fungicide applications to reduce for risk of substantial yield loss.

5. Follow the Georgia Southern Corn Rust Sentinel Plot Program (supported by the Georgia Commodity Commission for Corn) at **https://corn.ipmpipe.org/southerncornrust/**to determine when and where southern corn rust has been observed in Georgia and how this impacts your decision to apply a fungicide (or not). UGA Extension will also report detection of other diseases on this site, to include northern corn leaf blight, southern corn leaf blight and northern corn leaf spot.
6. Corn growers in Georgia have access to an expanding arsenal of fungicides for protection against diseases like southern corn rust, southern corn leaf blight, and northern corn leaf blight. These fungicides include Adastrio (7-9 fl oz/A) from FMC, Veltyma (7-10 fl oz/A) from BASF and Lucento (3-5.5 fl oz/A) from FMC. Adastrio is a combination of azoxystrobin, flutriafol, and flindapyr. Veltyma is a combination of the Revysol and Headline. Lucento is a combination of Bixafen + Topguard. Two additional products include DELARO Complete (a combination of prothioconazole, trifloxystrobin, and fluopyram) from Bayer CropScience which is to be applied at a rate of 8.0-12.0 fl oz/A, and Xyway LFR from FMC. Xyway LFR (flutriafol) is an at-plant, 2X2 inch application (15.2 fl oz/A) for management of southern corn leaf blight, northern corn leaf blight, and grey leaf spot.
   NOTE: Xyway LFR should not come in direct contact with the seed. Growers may also hear more about Miravis Neo (Miravis + azoxystrobin + propiconazole) from Syngenta for management of northern and southern corn leaf blights.
7. Chemigation has proven effective in management of foliar diseases of corn in recent studies. Calibration of equipment is critical for effective chemigation; also- growers should recognize that the appropriate amount of water for chemigation of corn is about 0.1 inch/A (a tenth of an inch/A). For more information contact your local county agent.
8. Even with the best of efforts, leaf diseases of corn can be difficult to manage. For example, in 2014, some growers expressed frustration that southern corn rust was severe in their fields despite using a fungicide program. Due to the aggressiveness of southern rust during that season, it was nearly impossible to stop the disease. However, fungicide programs were effective in slowing the development and spread of the disease and this resulted in improved yields for the growers. In 2014, effective use of fungicides increased yields by as much as 70 bu/A in our state. Where disease occurs early in a season, or when multiple diseases affect the crop at the same time, the most effective fungicide programs may require more than one application of fungicide.

9. Sample your fields for nematodes, especially where growth is stunted (or has been in the past) despite adequate water and fertilizer, to determine if plant-parasitic nematodes are a problem. Sting, stubby-root, and root-knot nematodes often go undetected without adequate soil sampling and are the most important nematodes affecting corn in Georgia. Unchecked, plant parasitic nematodes can reduce yields significantly in a field.
10. Plant-parasitic nematodes are an important, and often under-recognized, problem for corn growers in Georgia. Damage from nematodes was especially severe in the 2022 corn crop because of the mild winter; damage could be equally severe in 2024. Important nematodes affecting corn in Georgia include root-knot (southern and peanut), stubby-root, and sting. Growers should use appropriate soil sampling and use of nematicides (Telone II, Counter 20G, Velum, Propulse, Averland, AVICTA Complete Corn) to minimize losses. The importance of plant-parasitic nematodes, especially the root-knot and stubby-root nematodes, is becoming increasingly apparent to corn producers.
11. Plant seed treated with a fungicide to reduce seed rots.
    NOTE: Seed-treatment nematicides (AVICTA Complete Corn and NemaStrike) are also available for management of nematodes at low-to-moderate populations. AVICTA Complete Corn has been tested for a number of years at the University of Georgia.
12. Rotate to non-cereal crops to prevent a build-up of certain disease organisms, including fungi, bacteria and nematodes.
    NOTE: Unfortunately, corn is affected by southern root-knot nematodes. Peanut is one of the few common crops grown in Georgia that is not susceptible to the southern root-knot nematode.
13. Destroy old crop residues to help reduce problems from disease organisms that overwinter in crop residue.
    NOTE: Fungi that cause leaf blights, gray leaf spot and anthracnose all survive in crop reside.
14. Follow good fertilization practices, include starter fertilizers, and a good liming program to promote vigorous seedling growth (Healthy plants are less susceptible to many diseases.)
15. Subsoil under-the-row to reduce compaction and promote root growth.
    NOTE: Tillage may also help to reduce damage from plant-parasitic nematodes by displacing them from the immediate root-zone of developing seedlings.

The "Bottom Line": Recommendations for the 2024 season

1. The amount of disease growers experience in their 2024 corn crop will largely be the combined result of a) the weather, especially as tassel approaches and beyond, b) crop rotation, c) use of fungicides, d) variety selection and e) planting date. Shorter corn rotations increase threat from northern corn leaf blight, southern corn leaf blight, and plant-parasitic nematodes. Earlier planting date reduces the risk to losses from rust, stalk rots and aflatoxin.
2. It is recommended that all corn producers consult the information that is available about the corn varieties that they will plant in 2024 to determine reported resistance to disease. This is especially important for diseases like northern corn leaf blight and Diplodia ear rot.
   NOTE 1: Varieties with low resistance to northern corn leaf blight can benefit from a fungicide program that begins during vegetative growth prior to tassel. However, fungicide programs

are less effective at managing northern corn leaf blight than using resistant hybrids.
NOTE 2: If a corn variety is susceptible to Diplodia ear rot, then growers should be aware that this disease could be devastating in a field when temperatures are cooler and wetter during silking and grain-fill and there is no fungicide program to protect against it.

3. All corn growers who produce their crop under irrigation (or when rainfall is plentiful) should recognize the potential benefits from protecting their crop with a fungicide program. Though UGA Extension recommendations do not call for a "blanket" fungicide application on every corn field in the state, every corn grower should consider the opportunity for such.
4. Planting date plays a significant role in the level of disease likely to affect a corn crop. Corn planted in March or early April is less likely to be severely affected by disease than is later planted corn. In most years (but not 2014), much less disease developed in earlier planted corn than in later planted corn. Generally, the benefit of treating early-planted corn with a fungicide was approximately 5-15 bu/A. The benefit of treating later-planted corn was 10-50 bu/A. I consider applying fungicides on early-planted corn to be an "insurance policy". I consider use of fungicides on later-planted corn to be essential and an "investment".
5. Best timing of a fungicide application for management of northern corn leaf blight or southern corn leaf blight is between the 6th and 10th true leaf stages (V6-V10). From recent field studies, fungicide applications at these growth stages are more effective at reducing the severity of northern corn leaf blight than is an application delayed until first tassel.
Note 1: To avoid increased risk to deformation of ears, growers should NOT include a crop oil or adjuvant when spraying corn with a fungicide prior to tassel.
Note 2: Fields planted to a corn hybrid susceptible to northern corn will most likely benefit from such an application.
6. The best timing of a fungicide application for management of southern corn rust is typically around first tassel (VT). However, when southern rust has been reported in the area (as per reports from the corn sentinel plots) an earlier application may be warranted.
7. Where the threat of disease is severe, a second application 2-3 weeks following tassel may be important and profitable. For a crop planted later in the year, an earlier fungicide application, around the V6-V10 growth stage, can help to reduce the severity of southern rust and leaf blights and protect yield. Growers should follow the results of our UGA Southern Rust Sentinel Plot Program at https://ext.ipipe.org/ throughout the season to determine where rust has been found.

Corn and Nematode Disease Management for Georgia

Grower appreciation for the value of disease and nematode management is the fruit of research results from the University of Georgia, improved corn commodity prices, availability of new fungicides and nematicides and an increased respect for the damage that diseases and nematodes can cause in a corn field.

Based upon research conducted at the University of Georgia, I estimate that the use of fungicides to protect a corn crop against southern corn rust typically increases yield by 5-25 bu/A (more in some years) depending upon how early disease affects the crop and the number of times fungicides are applied during the season. Although the effect of northern and southern corn leaf blights are not as well documented in Georgia, results from repeated field trials demonstrate that use of fungicides can result in similar increases in yield as for southern rust.

It is my estimation that use of nematicides to protect a corn crop from damaging populations of root-knot, stubby-root, and sting nematodes can easily increase yields by 10 to 40 (or more) bu/A. The magnitude of the yield increase is related to the size of the nematode population, the yield potential of the crop, and the type of nematicide that is used, e.g., Poncho-VOTiVO vs. Avicta Complete Corn vs. Propulse or Velum vs. Averland vs. Counter 20G vs. Telone II. The top yield increases are expected when Telone II is used to protect the corn crop where high populations of parasitic nematodes exist.

Growers who invest significant resources into seed costs, irrigation, weed and insect control and soil fertility cannot afford to ignore the impact of diseases and nematodes on their crop. Although every corn grower in Georgia may not need to use a fungicide or nematicide in 2023, it is important that every corn grower who has the potential for good-to-excellent yields at least CONSIDER the value of disease and nematode management in his or her fields.

Corn grown in Georgia is susceptible to a number of diseases that are caused by fungi, bacteria, and viruses. Also, it has become clear from research conducted in recent years that plant parasitic nematodes can also cause significant yield losses on corn. Although rarely resulting in total crop loss, diseases such as seed rots, seedling blights, leaf spots, rust diseases, leaf blights, root rots, stalk rots, nematode damage and ear rots are important because they can lead to significant losses of yield and losses in quality. Mycotoxins such as aflatoxin and fumonisins are produced by fungi (often belonging to the genera *Aspergillus* and *Fusarium*) that infect the kernels. Presence of mycotoxins may result in feed that is unsafe for consumption by humans or livestock.

Foliar Diseases of Corn

Growers in Georgia typically did not use fungicides for management of foliar diseases on field corn in the past. However, solid research conducted over the past dozen years clearly demonstrates that losses can be minimized by implementing sound disease management practices. Sizeable yield increases (e.g. 25 bu/A) are attainable when growers deploy approved fungicides at the proper time when warranted by the presence of disease, especially southern corn rust, northern corn leaf blight and also southern corn leaf blight. The arsenal of fungicides available to corn growers in Georgia continues to grow and now includes Tilt and other propiconazole products, tebuconazole products, and combination products to include Stratego, Stratego YLD, Affiance, Zolera, Headline, Headline AMP, Priaxor, Aproach, Aproach Prima, Quadris, Quilt, Quilt Xcel, EVITO, EVITO T, Fortix, Affiance, Domark (tetraconazole) Trivapro (propiconazole, solatenol and azoxystrobin), Cover XL (azoxystrobin + propiconazole), Lucento (Bixafen + Topguard), Veltyma, and. Adastrio (azoxystrobin + Bixafen + Topguard. These fungicides will be discussed in greater detail later. Efficient disease management practices integrate the use of resistant varieties, cultural practices, crop rotation, and judicious use of fungicides or nematicides.

NOTE: The introduction of southern rust in Georgia, as observed via scouting and our sentinel plot network, will result in recommendations for use of fungicides in affected areas. This is because of the explosive nature of southern rust. For example, if southern rust is detected in one field, it is advised that growers apply fungicides to neighboring fields whether the disease is found in them or not.

Although fungicides are important tools for the management of northern corn leaf blight, growers should understand that simply finding this disease in small amounts does not necessarily mean a fungicide application is needed. Nearly every field in the state will have some level of northern corn leaf blight; timely fungicide applications are advised in situations where this disease is likely to develop further. Such occurs most often when a susceptible variety is planted and conditions are favorable for disease development (e.g., ample rainfall).

Southern Corn Rust Sentinel Plots

Since 2009, the Georgia Corn Commission has sponsored a sentinel plot monitoring program for the early detection of southern rust. Because the southern rust disease is unable to survive for any length of time in the absence of a living host (mainly corn), the disease does not successfully overwinter in our state after the last corn has been killed by cold weather. Therefore, southern rust must become re-established in our state each year, typically by airborne spores from southern Florida, the Caribbean, and Mexico. Each year, the University of Georgia establishes "sentinel" plots across the state that include two corn hybrids, one which is susceptible to both races of ***Puccinia polysora*** (southern rust pathogen) and one which is only susceptible to the new race of ***P. polysora.*** Leaf samples are collected weekly from each of these plots and are analyzed for rust diseases and also for leaf blights in our diagnostic clinic in Tifton. Early detection of southern corn rust in sentinel plots is critical and allows growers to make timely, protective fungicide applications. In years where rust does not appear in sentinel plots, growers can delay and even omit fungicide applications from a disease management program.

Using Fungicides to Manage Corn Diseases: Lessons Learned

1. Sentinel plots sponsored by the Georgia Corn Commission effectively allow us effectively detect early development and spread of southern rust.
2. Based upon early detection of southern corn rust in sentinel plots, much of the corn acreage in Georgia was treated with fungicide in 2010, 2012, 2014, 2015, 2016 and 2017 to protect against southern corn rust and, possibly, northern corn leaf blight; in one fungicide trial yields were increased by nearly 25 bu/A where a single, well-timed fungicide was applied. It was determined based upon sentinel plots in 2011, 2013 and 2018 that southern rust did not develop until late in the season. Use of fungicides was not recommended on most of the corn crop in Georgia and was typically only recommended on very late-planted corn.
3. Based upon results from our sentinel plot program, both the "old race" and the "new race" (capable of overcoming resistance in some hybrids) were widespread across Georgia in 2010, 2012 and 2013.

A New race of Puccinia polysora, the fungus that causes southern corn rust

To manage southern rust in Georgia, many corn growers have planted "rust resistant varieties" such as P33M52. In 2008, southern rust was able to overcome resistance in some commercial fields in Georgia. Southern rust samples collected in Burke County appear to have been of a race that was sensitive to, and thus controlled by, the *Rpp9* gene for rust resistance that is found in varieties such as P33M52. Southern rust samples collected in Macon County were of a different race-type than those found in Burke County. Rust isolates from Macon County were able to overcome the resistance conferred on a variety like P33M52. The more virulent race of the southern rust pathogen continues to be found annually in Georgia.

It is not known conclusively how or when a second race of southern rust was introduced into Georgia, a race that can overcome resistance in some important corn hybrids. There is speculation that the second race was introduced from somewhere in the Caribbean via tropical storm Fay; however, this remains conjecture. Spores of the southern rust pathogen are unlikely to survive in Georgia during the winter because of freezing temperatures and because there are no corn plants upon which to grow. Therefore, the southern rust spores from both race types will have to be reintroduced into Georgia each season.

Fungicides for Foliar Disease Management

There are currently a number of fungicides that are labeled to manage diseases of corn.

Note 1: Always read and follow the label for use of these fungicides.

Note 2: Use of a combination product, typically a strobilurin product and a triazole (and with PRIAXOR, a strobilurin + SDHI chemistries) fungicide tends to broaden the spectrum of activity and is recommended especially for management of northern corn leaf blight.

Note 3: Strobilurin fungicides (and combination products) tend to have longer protective windows than do triazole fungicides alone.

1. **Tilt** (propiconazole) (2.0-4.0 fl oz/A for leaf blights; 4.0 fl oz/A for rust diseases)
2. **Tebuconazole 3.6F** (various products, 4.0-6.0 fl oz/A for leaf blights and rust diseases)
3. **Quadris** (azoxystrobin) (9.2-15.4 fl oz/A for leaf blights and 6.2-9.2 fl oz/A for rust diseases)
4. **AzoxyStar** (azoystrobin) (6.0-15.4 fl oz/A)
5. **Quilt** (azoxystrobin + propiconazole) (7.0-14.0 fl oz/A for leaf blights and 10.5-14.0 fl oz/A for rust diseases)
6. **Quilt Xcel** (azoxystrobin + propiconazole) (10.5-14.0 fl oz/A for leaf blights and rust diseases)
7. **Custodia** (tebuconazole + azoxystrobin) (9-12.9 fl oz/A)
8. **Cover XL** (azoxystrobin + propiconazole) (10.5-14.0 fl oz/A)
9. **Trivapro** (azoxystrobin + propiconazole + solatenol) (13.7 fl oz/A for foliar disease)
10. **Stratego** (trifloxystrobin + propiconazole) (10.0-12.0 fl oz/A for leaf blights and 7.0-10.0 for rust diseases)
11. **Stratego YLD** (trifloxystrobin + prothioconazole) (4-5 fl oz/A for leaf blight and rust diseases)
12. **DELARO Complete** (trifloxystrobin + prothioconazole + fluopyram) (8.0-12.0 fl oz/A)

13. **Headline** (pyraclostrobin) (9.0-12.0 fl oz/A for leaf blights and 6.0-9.0 fl oz/A for rust diseases)
14. **Headline AMP** (pyraclostrobin + metconazole) (10 fl oz/A for leaf blight and rust diseases)
15. **Priaxor** (pryraclostrobin + fluxapyroxad) (4.0-8.0 fl oz/A for leaf blight and rust diseases)
16. **Veltyma** (pyraclostrobin + Revysol) (7-10 fl oz/A for leaf blight and rust diseases)
17. **Xyway LFR** (flutriafol) is an at-plant, 2X2 inch application (15.2 fl oz/A) for control of northern and southern corn leaf blights and grey leaf spot)
18. **Lucento** (Bixafen + flutriafol) (3-5.5 fl oz/A for leaf blight and rust diseases)
19. **Adastrio** (Bixafen + flutriafol + azoxystrobin) (7-9 fl oz/A)
20. **Aproach** (picoxystrobin) (3.0-4.0 fl oz/A for early season use, 6.0-12.0 fl oz/A for applications VT and beyond for leaf blight and rust diseases)
21. **Aproach Prima** (picoxystrobin + cyproconazole) (3.4-6.8 fl oz/A for leaf blight and rust diseases)
22. **FORTIX** (flutriafol + fluoxastrobin) (4.0-6.0 fl oz/A for leaf blight and rust diseases)
23. **Zolera FX** (tetraconazole + fluoxastrobin) (4.4-6.8 fl oz/A)
24. **EVITO 480SC** (fluoxastrobin) (4.0-5.7 fl oz/A for leaf blights and 2.0-5.7 fl oz/A for rust diseases)
25. **EVITO T** (fluoxastrobin + tebuconazole) (4.0-9.0 fl oz/A for leaf blight and rust diseases)
26. **Affiance** (tetraconazole + azoxystrobin) (10.0-17.0 fl oz/A for leaf blight and rust diseases)
27. **Domark 230ME** (tetraconazole) (4.-0-6.0 fl oz/A for leaf blight and rust diseases)

Based upon research trials conducted by the UGA Cooperative Extension, growers are most likely to see a yield benefit (and an increase in profit) from using a fungicide on field corn when:

1. Southern rust infects the crop (or in cases of severe outbreaks of northern or southern corn leaf blight) early in the season.
2. The grower plants a variety that is susceptible to southern rust or when race of southern rust is present that is able to overcome the resistance found in a “resistant” variety.
3. The grower is able to apply the fungicide before it has spread significantly within the field.
4. The corn crop in the field has otherwise good-to-excellent yield potential.

Note: Severe outbreaks of northern corn leaf blight in some fields have also warranted treatment with fungicide. It is recommended that a grower consider use of a fungicide to protect a corn crop if northern corn leaf blight is affecting the crop as it reaches tasseling or the variety is known to be susceptible to this disease. A product including a strobilurin and or SDHI will likely improve management of this disease when applied early enough.

Based upon research trials conducted by the UGA Extension, growers are unlikely to see an increase in yield or profit from using a fungicide on corn if:

1. Southern rust and/or northern corn leaf blight are not present or threatening.
2. In absence of northern corn leaf blight, the grower plants a variety resistant to southern rust AND only the resistance is believed to protect against strains of rust present in state.
3. Environmental conditions, such as drought, have already greatly reduced the yield potential in a field.

   Note: Despite the physiological effects that use of a strobilurin fungicide may have on a corn crop, our research has been unable to determine any consistent benefit to applying a strobilurin fungicide to a field if southern rust is not an issue. Our recommendation is that fungicides should be applied to a corn crop primarily IF southern rust is a factor or if a disease like southern or northern corn leaf blight affects the crop at an early growth stage.

Fungicide recommendations for managing southern rust and northern corn leaf blight include:

1. Apply appropriate fungicide at labeled rate either prior to appearance of rust or when it first appears in the field. Apply fungicide to control northern corn leaf blight if disease appears to be spreading early in reproductive growth. If Northern Corn Leaf Blight is observed on 3rd leaf below ear leaf, it is indication that it could be beneficial to use a fungicide to protect the crop.
2. We continue to investigate the value to the grower in terms of disease control that are obtained by treating corn during vegetative growth stages, for example around the V5 growth stage. To date, fungicide applications at the V5-V6 growth stage on corn planted in the spring had little impact on yield or disease control. However, the V5-V6 application has some benefit for reducing disease and improving yields on late-planted corn. This is because later-planted corn will be affected much earlier in its growth and development than is spring-planted corn.
3. Second fungicide application may be warranted 2-3 weeks after initial application IF weather conditions favor spread of disease and corn is still some time away from harvest maturity.
4. Southern corn rust can result in significant yield losses in corn and a susceptible variety should be protected with a fungicide before disease is established in a field. Many growers ask, "At what growth stage is my corn crop safe from rust?" Currently we have little specific data to answer this question; however the general recommendations from Dr. Kemerait and Dr. Dewey Lee are that a corn crop is likely to benefit from protection from southern rust until the ears reach the R4 "dough" growth stage. Southern rust is less likely to adversely affect the corn crop if it occurs after the corn has reached the dough stage.

Common Smut

Common smut, caused by the fungus *Ustilago maydis*, is perhaps the most visually dramatic disease to affect field corn in Georgia. As its name implies, this disease is abundant around the state, though it rarely causes severe losses. The disease is recognized by the large, dark, tumor-like galls that form on the ears, leaves, stalks, and tassels that fill with fungal spores. Common smut has been found to be most severe when corn is planted next to wheat fields and when stink bugs have moved from wheat fields into corn. The primary management tactic is too plant varieties which have resistance to this disease.

Nematodes

Historically, the impact of plant parasitic nematodes, such as root-knot ("southern" and "peanut"), stubby-root, stunt, sting, and Columbia lance, has been overlooked by many field corn producers in Georgia. Many hoped that the damage caused to the corn crop by nematodes was not extensive enough to warrant use of nematicides. However, recent studies indicate that nematodes are causing greater damage to the state's corn crop than previously believed and the use of nematicides is warranted in some fields. In some of the trials conducted in 2008, 2009, 2010, 2011, 2012 and 2015, yield increases associated with the use of the fumigant Telone II have led not only to better growth, higher plant vigor and better use of available nutrients, but also yields that add economic value to the grower's crop. In 2023 growers will have Telone II, Counter 20G, Velum, Propulse, Averland, and AVICTA Complete Corn for consideration to use for management of nematodes in their corn fields.

Nematodes damage the corn crop in Georgia by causing significant damage to the root system. The damaged root systems are less efficient at water and nutrient uptake by the corn plant and this in turn multiplies stresses, for example drought that may affect the crop. Nematode damage to corn can be reduced by (1) rotating with crops not susceptible to nematodes that damage corn, (2) using cultural practices which reduce plant stress, (3) sub-soiling under-the-row to promote root growth, and (4) using nematicides in fields diagnosed by field observation and/or soil sample assay to have nematode populations that cannot be controlled well enough by other recommended practices. Problem nematodes in corn include sting, stubby root, southern and peanut root-knot, and the Columbia lance. Field corn is not a host for the reniform nematode that causes damage on cotton.

Research will continue in 2023 to determine benefits of using a nematicide to minimize the impact of nematodes in a corn field. Possible benefits include increased yield, more vigorous growth early in the season, early transition to reproductive growth, stress reduction and thus less need for irrigation, healthier stalks, and earlier harvest. Counter 20G insecticide/nematicide and the fumigant Telone II have been used on field corn in Georgia. Use of nematicide seed treatments like AVICTA Complete Corn, NemaStrike, and PONCHO VOTiVO will become more common in the future. The largest and most consistent yield benefits observed thus far have been when Telone II is used to protect the corn crop from nematodes.

Products currently labeled for management of nematodes affecting corn

1. **Telone II:** (3 gal/A) excellent control
2. **Counter 20G:** (5.25 lb/A) fair-to-good control
3. **Propulse:** fair-to-good control
4. **Velum:** fair-to-good control
5. **Averland (abamectin):** testing continues, rating unknown at this time.
6. **AVICTA Complete Corn:** (seed treatment) has provided fair control in UGA trials
7. **NemaStrike:** (seed treatment)
8. **PONCHO VOTiVO:** (seed treatment)

Management of Nematodes

1. Data continues to accumulate documenting the yield benefits that can result from the use of nematicides in appropriate fields infested with nematodes.
2. Root-knot nematodes are the most common plant-parasitic nematodes affecting corn in our state; it is likely we have underestimated the losses associated with stubby-root nematodes.
3. Use of Telone II has provided the most consistent increases in plant vigor, early crop development, and yields compared to other nematicides. Use of Telone may also result in improved utilization of available nutrients.
4. Use of other nematicides, such as Counter 20G, Propulse, Velum, and AVICTA Complete Corn,

can be effective in fields where nematode populations are at an appropriate level.

Plant parasitic nematodes that affect field corn are widespread across the production areas of Georgia and can reach damaging levels in specific fields. In a recent field survey conducted by county agents and supported by Corteva Agriscience, root-knot and stubby-root nematodes were found in over half of all fields that were sampled.

In a field study conducted in 2007 in Seminole County, high populations of the southern root-knot nematodes severely affected the growth of the corn in the field. Use of Telone II, 3 gal/A, or Counter insecticide-nematicide (7 lb/A in-furrow at planting time) reduced early season levels of nematodes both in the soil and in the roots of the corn. Fumigation with Telone II led to dramatic increases in growth and also resulted in treated plants reaching tasseling approximately nine days ahead of corn not planted in fumigated soil. However at harvest, yields were similar in plots treated only with Poncho seed treatments, Counter, or Telone II + Poncho seed treatment.

Multiple nematode management studies have been conducted in corn fields in Georgia in 2008, 2009, and 2010. In the most important studies, results from 2007 were verified. Management of plant parasitic nematodes with a product like Telone II can result in better root growth, better overall plant growth, better nutrient uptake, less time to reach reproductive growth stages and maturity, and significant increases in yield.

Field trials conducted in 2010 confirmed much of the same information from 2007, 2008, and 2009. Use of appropriate nematicides in fields where these pests are damaging can increase yields, increase growth rates, and other important factors. Further research in 2010 demonstrated that yield in plots fumigated with Telone II were not adversely affected when rates of fertilizer applied at lay-by were significantly reduced. Such results are further evidence that use of a highly effective nematicide like Telone II may enhance nutrient utilization in fields affected by nematodes. In 2009 and 2010, use of a new nematicide seed treatment from Syngenta, AVICTA Complete Corn, also helped to improve growth and yield in some trials.

Growers who will plant field corn where nematodes affecting the crop are believed to have reached damaging levels are encouraged to consider the use of a nematicide such as Telone II (3 gal/A) for pre-plant fumigation, Counter 20G, Propulse, Velum, or AVICTA Complete Corn seed treatment at planting. Growers are cautioned that we still have much to learn about AVICTA Complete Corn and Poncho VOTiVO. In the past, growers who used Counter would not need to use an insecticidal seed treatment like Poncho because Counter is effective against the same early-season insect pests. However, now most commercial corn seed will be pre-treated with an insecticide seed treatment, thus increasing the expense to the grower. Still, use of Counter can provide benefits to the grower in fields where nematodes damage the corn. Growers who use Counter at planting should not use an ALS herbicide in order to avoid phytotoxicity to the crop.

Fumigation with Telone II, 3 gal, per acre PRIOR to planting can help the growth of the corn crop; however the full benefits to yield at harvest and the economic analysis continue to be investigated. Where nematode populations caused significant damage to the corn crops in 2009 and 2010 field studies, use of Telone II led to important yield increases that brought economic benefits to the grower.

Ear and Kernel Rots and Mycotoxin Production

Many different types of fungi attack corn kernels and may cause losses in yield and grain quality; however species of *Aspergillus*, *Fusarium*, and *Penicillium* produce toxins (mycotoxins) that make corn unsafe for animal or human consumption. Mycotoxins are a normal byproduct of the growth and development of these fungi. Toxins may be produced by the fungi while the crop is in the field or after harvest and during storage. The presence of mycotoxins in the field is related to environmental conditions and other factors, such as damage caused by birds and insects. Insects that invade and damage the ear of corn carry the spores of fungi such as *Aspergillus* and *Fusarium* from the environment into the ear of corn, or create wounds that are readily colonized by these fungi. Also, spores from these fungi may be deposited on the silks and grow down the silk tissue to infect the kernels. Infected kernels are often easily identified because of fungal growth associated with them. For example, kernels infected with *Aspergillus* may show masses of yellow and green spores while those infected with *Fusarium* have whitish-pink-red growth on the kernels. Mycotoxin contamination in storage results from improper drying or storage conditions that support fungi growth. To help prevent formation of mycotoxins, corn must be dry, insect free and have air movement regulated to avoid moisture accumulation.

Aflatoxin and Afla-Guard

Aflatoxin, produced by two closely related fungi, *Aspergillus flavus* and *Aspergillus parasiticus*, is a major problem for corn and peanut production in Georgia. Extreme heat and drought during the growing season, insect damage, and improper storage all can increase the risk of contamination with aflatoxin. High temperatures in 2010 certainly increased the risk for corn and peanut production. The high temperatures and dry conditions made aflatoxin an even greater problem in 2011. However, cooler and wetter conditions in 2012 made aflatoxin less important in Georgia's field corn production.

Contamination with mycotoxins (e.g. aflatoxin) is favored by (1) drought and temperature stress of the plants in the field, (2) nitrogen deficiency, (3) insect damage to ears, (4) physical damage during harvest, (5) inadequate drying before storage, (6) holding wet corn on trailers too long without adequate cooling and ventilation before drying, (7) moisture build-up in bins during storage, (8) insect damage in storage and (9) poor sanitation. Avoiding these situations will help reduce the risk of mycotoxin contaminated corn. Corn varieties with adequate husk cover over the kernels will be less damaged by insects such as weevils, worms, and thrips, and thus less likely to be contaminated by aflatoxin. Corn is most susceptible to contamination by aflatoxins during periods of sustained drought, water stress, and high temperature. Contamination can be reduced using irrigation and minimizing fertilizer stress.

Syngenta Crop Protection has now acquired Afla-Guard which is a no-toxigenic strain of *Aspergillus flavus* that can compete for colonization of the corn or peanuts with the native, toxigenic strains found in the field. Afla-Guard is applied at some point between the V10-V12 and R1 growth stages, or approximately 14 days prior to tasseling up to the onset of silking. The rate for application is 10-20 lb/A of product. The efficacy of Afla-Guard to minimize the levels of aflatoxin in corn in Georgia continues to be evaluated. The University of Georgia will develop detailed recommendations once a larger data set is available.

Seed Rots and Seedling Blights

As seeds germinate and seedlings develop, corn is susceptible to rot and disease that may kill young plants or leave them stunted and nonproductive. Symptoms of seed rot and seedling disease include poor, "skippy" stands and presence of plants with poor growth that never reach the genetic potential of the variety planted, despite acceptable management practices.

Seed rot and seedling blight are caused by fungal pathogens, some of which may be present on the seed even before it is planted. Once these fungal pathogens infect the seed or seedling, decay, lesions, stunting, and chlorosis are likely to occur. Common seedling pathogens include species of *Pythium*, *Fusarium*, *Penicillium*, and *Rhizoctonia*.

An important tactic to control seed rot and seedling blight is to plant only high-quality seed that has been treated with a labeled fungicide. Fungicide seed treatments are an important tool in the battle to fight seedling diseases. Poor quality seed, such as that produced under drought conditions or which has mechanical damage, is more likely to be susceptible to these problems. Poor seed is likely to produce seedlings with less vigor and greater fungal infection than healthy, undamaged seed. Additional steps to protect against seedling blight include rotation with non-grass crops, planting in warm soils that promote rapid germination and seedling growth, and the avoidance of deep planting. Also, it is important to bury crop residues that act as a nutrition source and that allow pathogens to survive between crops.

Root Rots

Although typically not a major problem for corn producers in Georgia, root-rot diseases can cause significant loss in some fields. Species of the soilborne fungi *Pythium*, *Rhizoctonia*, and *Fusarium*, that are factors in seedling blights can also cause root rot in corn. Root rot results from the interaction of a complex of soilborne fungi, bacteria, nematodes, and root feeding insects and thus may require use of integrated pest management. Symptoms of root rot include visible lesions, discoloration and degradation of the root system, cankers on the adventitious crown and brace roots of large plants and yellowing and stunting of the whole plant. The severity of root rot can be reduced by improving drainage in a field, rotation with non-host crops, good weed control, and control of parasitic nematodes.

Stalk Rot

The stalk rot-lodging complex can be a costly corn disease in Georgia. This disease is caused by several different fungal pathogens as well as bacterial pathogens. Stalk rot describes such maladies as stalk breakage, stalk lodging, and premature death of the plant. In the most general sense, this rot is an internal decay of the pith tissue of the stalk, though plants with rotted stalks often have root rot as well. Losses result from poor grain fill associated with premature plant death, difficulty in the mechanical harvest of lodged plants, and rot that occurs when ears contact the soil. The incidence and severity of stalk rot is related to fertility and growing conditions during the season. If conditions are favorable for growth early in the season, corn plants will produce a large number of kernels. These kernels later become a sink for the carbohydrates produced through photosynthesis. If a plant is unable to produce all of the carbohydrates needed for optimal health and development because of environmental stresses or poor fertility, the grain sink (ear) has priority over other tissues. Without adequate carbohydrates, cells in the root and lower stem senesce and are more easily colonized by opportunistic stalk-rotting organisms.

Stalk rots are differentiated based upon the pathogen and symptoms that are associated with the disease. Fungal pathogens cause Gibberella, Diplodia, Anthracnose, Fusarium, and Pythium stalk rots and Charcoal rot. General symptoms of fungal stalk rot include wilt and disintegration of internal pith tissue. Bacterial stalk rot is caused by *Erwinia chrysanthemi* pv. *zeae*. Bacterial stalk rot is easily identified by plants that suddenly lodge in midseason with one to several internodes above the soil line dark brown, water soaked, soft or slimy, with a foul odor.

Although no direct controls are available, losses to stalk rot can be reduced by (1) planting early and harvesting before lodging occurs, (2) planting good-standing hybrids, (3) maintaining a balanced fertility level, (4) avoiding extremely high plant populations, and (5) preventing moisture stress. A balanced and continuous supply of nitrogen is needed throughout the season to maintain the health of the pith tissue. Adequate potassium is needed to maintain normal photosynthesis and the cell walls of pith tissue. High plant populations have been associated with an increase in the severity of stalk rot.

HARVESTING AND DRYING CORN

Paul Sumner

When to Harvest

One general principle applies to all of the available options: the grain should be dried or delivered quickly, preferably within 24 to 48 hours of harvest. Equipment and operations that have worked well when corn was harvested at 22% moisture content may not work so well when the corn is wetter. Combines often have much greater capacity than driers when the corn is very wet. The options available for handling high moisture grain fall into three general categories:

1. ***Dry on the farm***. - Where adequate drying equipment is available, this option maybe chosen. Drying capacity, economics, and convenience and are major factors in this decision. Higher moisture contents can substantially reduce drying capacities so that factor should be carefully considered when evaluating the choices.
2. ***Deliver to Elevator or other Buyer***. - Buyers may or may not be able to handle wet grain. If they accept wet grain their capacity will be limited. The major factor in choosing this option is usually one of economics although delivery may also be important. Various combinations of price discounts, weight shrinkage and drying charges are used to compensate the buyers for their drying cost and for the weight lost during drying. These discounts and charges will vary from one buyer to another and may change with time. Good decisions cannot be made if current and accurate information about wet grain discounts is not available.
3. ***Custom Drying***. - In some places there may be limited access to a custom drying arrangement. This would most likely involve a neighbor who may not have started or has already finished his harvest or a peanut buying point. Costs for such a service would be a drying charge and handling fee. Custom services could be used to boost drying capacity or as a supplement for systems that were not designed to handle high moisture corn.

The length of the harvest period is highly dependent on the size of the operation, combine speed and capacity, efficiency of harvesting-hauling-handling-drying-storage system, and weather.

Drying

Drying is one of the oldest methods of preserving food and feedstock. It is simply the removal of moisture from a product, usually by forcing dry air through the material.

Air serves two basic functions in grain drying. First, the air supplies the necessary heat for moisture evaporation; second, the air serves as a carrier of the evaporated moisture. The amount of moisture which can be removed from corn depends on the moisture content of the corn, and the drying air relative humidity and temperature.

Air temperature determines to a large extent the total water-carrying capacity of the drying air. Hot air can hold more moisture than cold air. For example, a pound of air at 40˚F can hold only 40 grains of moisture (7000 grains = 1 pound) while a pound of 80ºF air can hold 155 grains - almost a four-fold increase.

Relative humidity also plays an important part in the drying process. Air at 100˚F and 50 percent relative humidity can absorb 60 more grains of moisture per pound of air than it can at 75 percent humidity.

When grain is placed in a drier and air is forced through the grain, a drying zone is established at the point where the air enters the facility (Figure 4). The drying zone moves uniformly through the grain in the direction of air flow at a rate depending on the volume, temperature and relative humidity of the air and the moisture content of the grain.

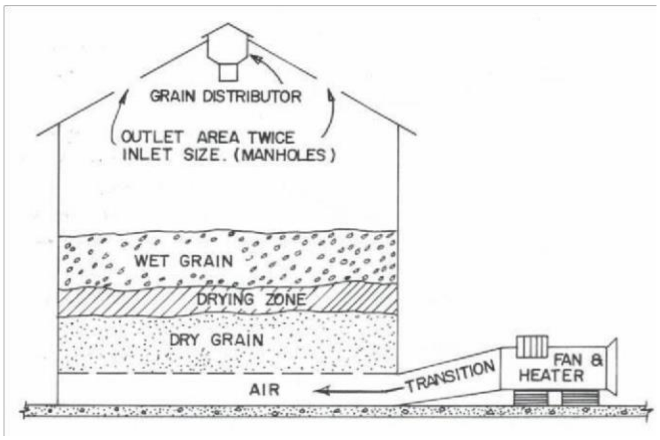

Figure 4. Grain is dried from the point of air entry with the drying front moving in the direction of air flow. The wetter grain occurs where the air leaves the grain layer.

Batch-in-Bin Drying

In this method a two to four foot layer of grain is placed in a drying bin. The layer (batch) is rapidly dried then cooled and removed. A new batch is then placed in the bin and the process repeated.

Fan requirements: medium to high (40 CFM/sq. ft. @ 3 inches static pressure)

Heat requirements: medium (120 – 140°F.)

Batch Drying

Batch drying involves special drying equipment which holds a relatively thin layer of grain (1-2 feet). Some models recirculate the grain during drying for uniform moisture removal. Grain is normally dried, cooled and then removed.

Fan requirements: very high (50 - 100 CFM/sq. ft.)

Heat requirements: medium high (160 – 180°F)

Continuous Flow Drying

A thin layer of grain ($^2/3$ - 1½ ft.) moves continuously through the drier; first through a drying section then through a cooling section. Continuous loading and unloading is required.

Fan requirements: very high (75 - 125 CFM/sq. ft.)

Heat requirements: very high (180 – 200°F)

Peanut Wagons (Batch Drying)

Peanut wagons/trailers have been used extensively in Georgia for many years to dry high moisture peanuts. Peanuts have a different density and drying characteristics than grain products but grain (corn) can be dried in the units. The main difference between drying peanuts and corn is the drying temperatures and resistance to air flow. The drying air temperatures for peanuts should not exceed 95°F. Most peanut dryer thermostats have a set point range between 70 and 140°F. The LP burners used can increase air temperature by 50 to 70°F. Therefore, maximum drying temperature that could be obtained with 85°F ambient air temperature is 135 to 155°F. The resistance to air flow is approximately 2.5 to 3 inches static pressure for 2 feet of corn depth compared to peanuts of 0.5 inches static pressure for 4 feet depth of peanuts. Peanut wagons can be 14, 21, 28 or 45 feet in length. The CFM/Bushel of corn ranges from 25-60 CFM/bushel (50-100 CFM/ft^2) at a depth of 2 feet.

Suggestions for Drying Corn in Peanut Wagons

- Only fill peanut wagons to a maximum of 2 feet or grain fill line.
- Set thermostat to highest setting - 140°F. (If burner is capable of higher temperature rise replace thermostat for a higher range setting – 160-180ºF)
- Drying time will depend on air condition and drying temperature. Figure 5 and 6.

The amount of LP required to dry corn can be estimated by the graph in figures 7 and 8. Graphs 5 and 7 are based on 85°F and 85 percent relative humidity ambient air being forced through the grain at a rate of 50 CFM/ft^2 of floor area. Graphs 6 and 8 are based on 85°F and 85 percent relative humidity air being forced through the grain at a rate of 100 CFM/ft^2. When the air flow rate is increased drying time is reduced but fuel usage per bushel will increase because of removing the moisture faster.

Corn dryers range in capacity from a few hundred to several thousand bushels per day. Producers should size dryer to match daily combine capacity and harvest moisture target levels.

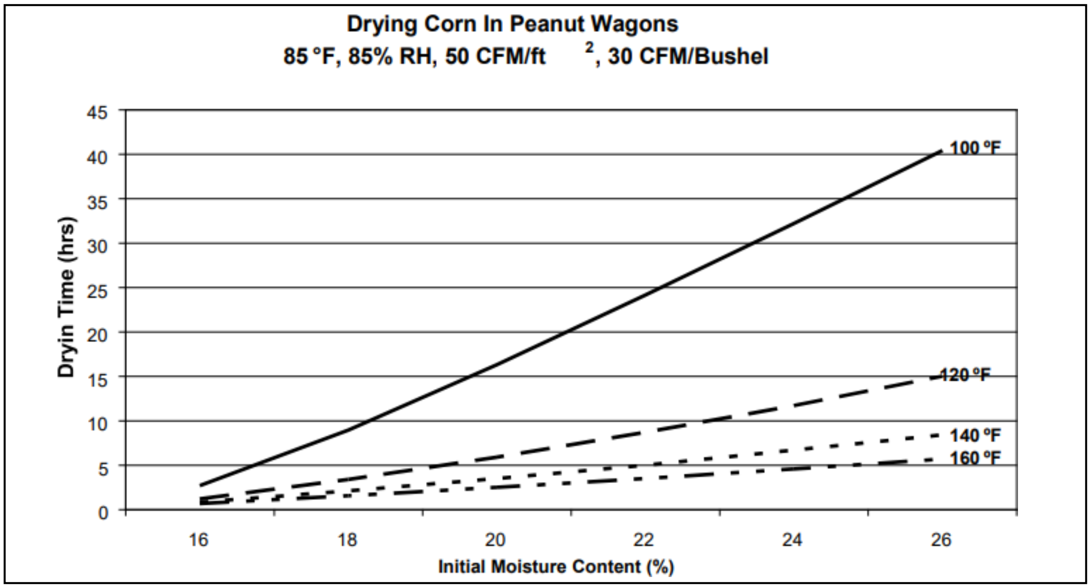

Figure 5. Estimated total drying time for corn with air at 85°F and 85 percent relative humidity, 30 CFM/Bushel, 50 CFM/ft^2 of floor area.

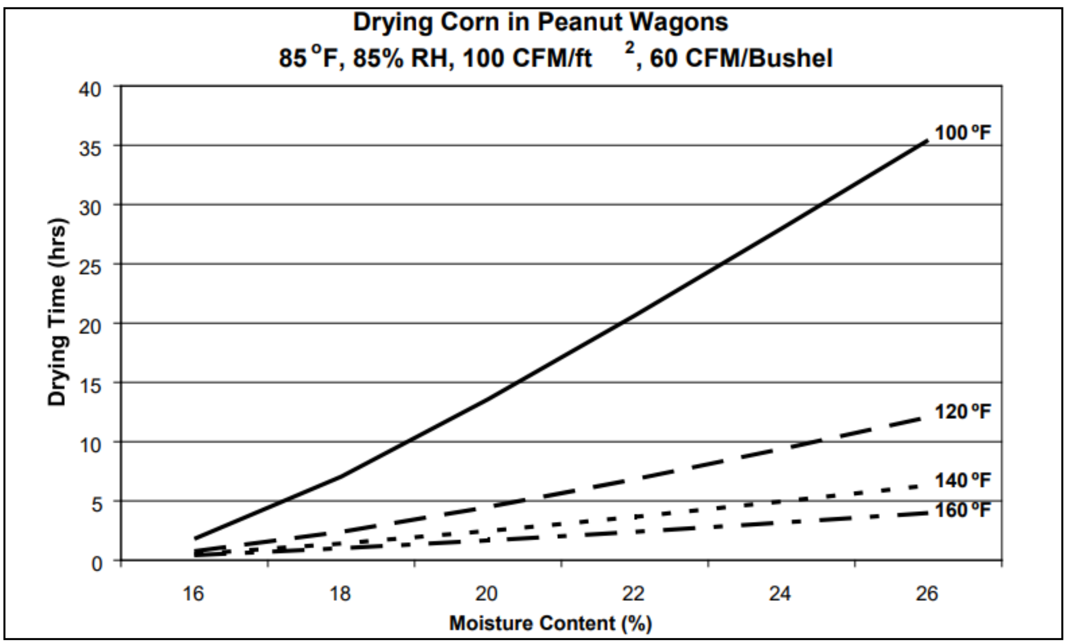

Figure 6. Estimated total drying time for corn with air at 85°F and 85 percent relative humidity, 60 CFM/Bushel, 100 CFM/ft^2 of floor area.

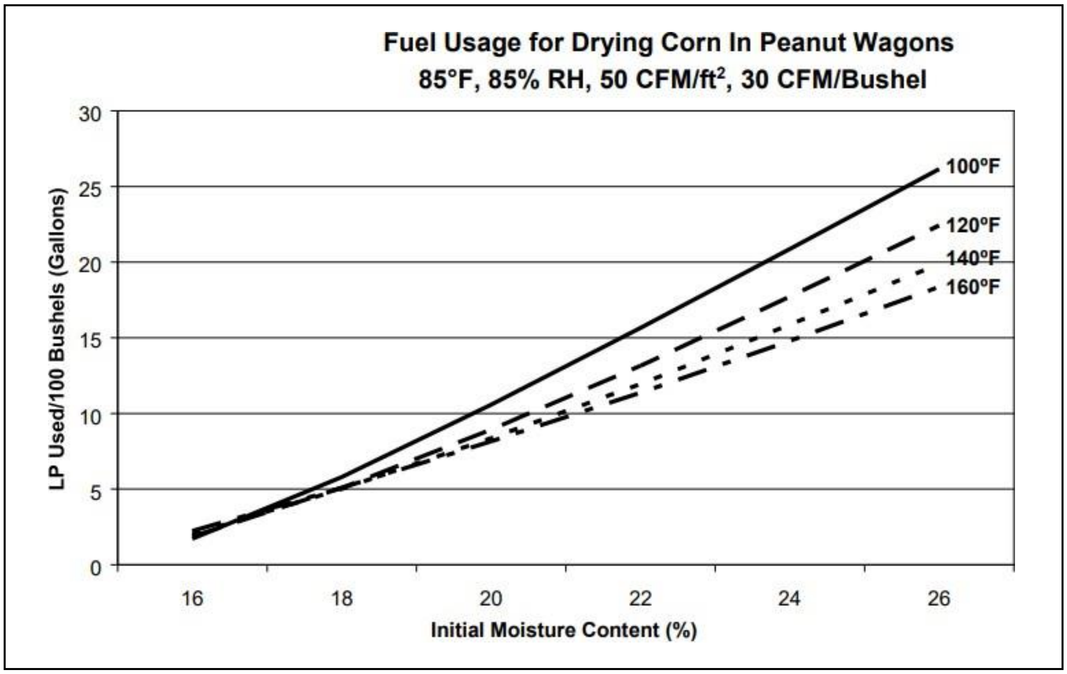

Figure 7. Estimated LP fuel use for corn with air at 85ºF and 85 percent relative humidity, 30 CFM/Bushel, 50 CFM/ft2 of floor area.

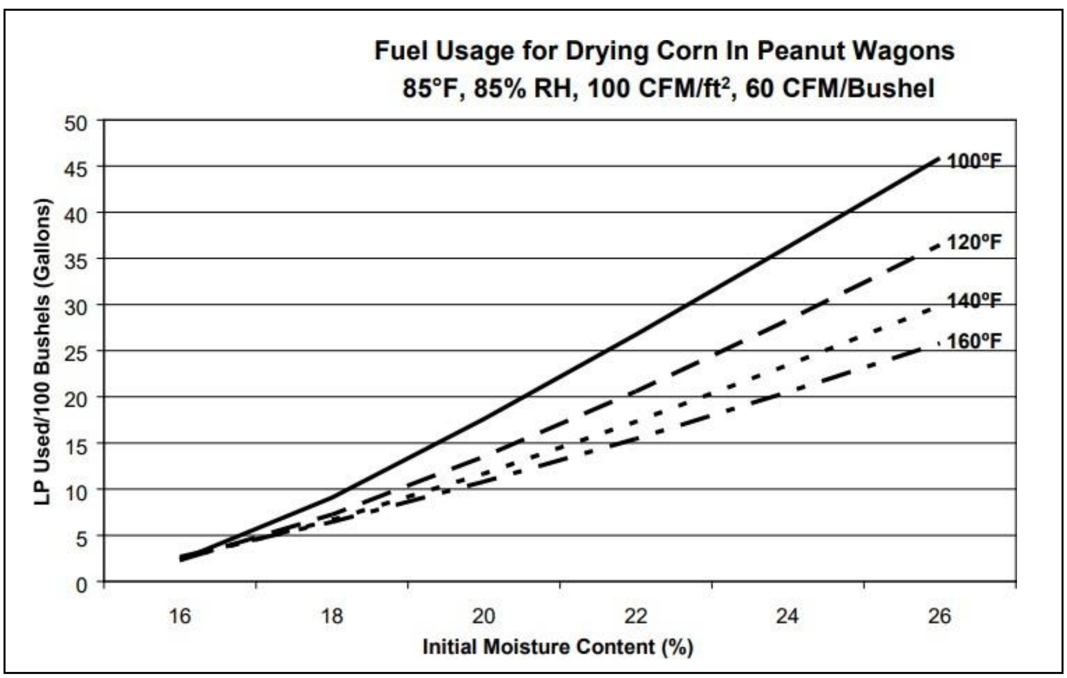

Figure 8. Estimated LP fuel use for corn with air at 85ºF and 85 percent relative humidity, 60 CFM/Bushel, 100 CFM/ft^2 of floor area.

PROTECTING STORED CORN

Michael Toews

The key to storing grains and other commodities on the farm is to make storage conditions unfavorable for the survival of stored grain insects and molds. Procedures described below are designed to reduce the initial number of insects in the bin, slow the development of any remaining insects, and apply corrective measures to reduce insect populations if necessary. Following these steps will also greatly reduce stored grain molds and associated mycotoxins.

Empty Bin Preparation

- Clean storage bins thoroughly inside and out to eliminate starter colonies of insects. Remove any weeds, crop debris, or clutter around the facility to reduce insect and rodent activity. All grain residues from the previous year should be removed from inside the facility as soon as the old crop is shipped.
- Seal any gaps or holes in the sides and roof of the bin using caulk or polyurethane foam. Check to make sure the bottom seal with the concrete is intact. Prevent water from flowing underneath the bin by applying plastic roof cement.
- Apply an EPA-approved insecticide on the floors and sides of empty storage bins to eliminate insects hiding in cracks and crevices and to create a first line of defense against any insects that do find their way into the bin. Spray the outside of the bin to a height of 3 ft, and the surrounding concrete, gravel, or sod to a distance of 6-10 ft surrounding the bin. Insecticides shown in Table 19 are labeled for empty bin treatments.
- Eventually, insects will build up on fines and broken kernels that accumulate under the perforated bin floor. Bins with false floors should be fumigated if the grain debris cannot be removed. Place the fumigant over the empty floor and then cover with a plastic tarp (6 ml or thicker) to contain and hold the gas. Fumigation should only be conducted by trained and licensed applicators. Read the label and the applicator's manual. You will need to prepare a fumigation management plan before you fumigate.
- Don't forget to clean out harvesting and loading equipment such as combines, trucks and augers at the end of each harvest season. If not clean, insects will reproduce in the small amounts of grain left in the equipment and then be conveyed into the new crop grain.

Table 19. Insecticides labelled for empty bin treatments.

Insecticide	Rate	MOA	Remarks
beta-cyfluthrin **Tempo SC Ultra**	0.25-0.5 fl oz/gal/1000 sq ft	3A	Apply to all interior surfaces of storage bin and allow to dry before filling bins.
deltamethrin Centynal EC	0.25-1.5 fl oz/gal/1000 sq ft	3A	Apply to wall and floor surfaces of grain bins and warehouses prior to storing or handling grain.
deltamethrin **D-Fense SC**	0.25-1.5 fl oz/gal/1000 sq ft	3A	Use for exterior perimeter treatment only.
deltamethrin **Suspend SC**	0.25-1.5 floz/gal/1000 sq ft	3A	Apply finished spray to equipment, wall and floor surfaces of grain bins and warehouses prior to storing or handling grain.
Deltamethrin **Suspend PolyZone**	0.25-1.5 fl oz/gal/1000 sq ft	3A	Apply to wall and floor surfaces of grain bins and warehouses prior to storing or handling grain.
Deltamethrin + piperonyl butoxide + s-methopren	1-6 fl oz/gal/1000 sq ft	3A + 7A	Apply to wall and floor surfaces of grain bins and warehouses prior to storing or handling grain.
diatomaceous earth **Insecto**	Dust: 1 lb/1000 sq ft		Apply at least 2-3 days before filling bin. Use aeration fan or other air supply to apply dust.
diatomaceous earth **Dryacide 100**	Dust: 1-3 lb/1000 sq ft Slurry: 1.5 lb/1.5 gal/100 sq ft		Apply as a dust with a hand or power duster or as a slurry spray.
diatomaceous earth **Protect-It**	Dust: 0.6 lb/1000 sq ft Slurry: 1.5 lb/1.5 gal/100 sq ft		Apply 2 weeks before filling bins. Use a dust blower or bin fan to reach all surfaces, cracks and crevices. Apply slurry as a fine mist.
Pyriproxyfen **Nyguard IGR Concentrate**	0.8-2.4 tsp/gal/1500 sq ft 4-12 ml/gal/1500 sq ft	7C	This product will not kill adults but will control immatures. May be mixed with an adulticide.
s-methoprene **Diacon-D IGR**	1.5 oz/1000 sq ft	7A	This product will not kill adults, but will control immatures; applicators must wear a dust mask and protective gloves.
s-methoprene **Diacon IGR**	Fogging Treatment: 1 ml/1000 sq ft 0.2 tsp/1000 sq ft Pressure Spray: 2 ml/1000 sq ft 0.4 tsp/1000 sq ft	7A	Apply fogging treatment in water or oil in a cold aerosol generator. Diacon IGR is an insect- growth regulator that interferes with the development of insects. It will not kill adult insects. Apply as a pressure spray in low-pressure sprayer to all areas that may harbor insect pests.

Store Only Clean and Dry Grain

- Store the grain at the appropriate moisture content. Insects and molds require moisture to survive. A general guide to proper moisture content is shown in Table 20.
- Store clean grain. Removing or equally dispersing fine particles and other foreign material will increase aeration efficiency and the effectiveness of grain protectants and fumigants. The following steps contribute to clean grain: effective in-season weed control, properly adjusted combines, use of a grain pre-cleaner, coring the bin after it has been loaded, and use of a mechanical spreader at the top of the bin.
- Once the grain is in the bin, make sure the surface is level and the bin is not over filled. Leave a few feet of the straight side of the bin as air space to facilitate aeration and monitoring. If your bin does not have a spreader, unloading one or more loads of grain will help level the central peak as well as uniformly distribute fine particles that otherwise accumulate in the center of the bin.

Table 20. Recommended maximum moisture content for grain in aerated storage bins.

	Expected Storage Time		
Commodity	**6 Months**	**6-12 months**	**>12 months**
Corn and grain sorghum	14%	13%	12%
Soybeans	13%	12%	11%
Small grains	12%	11%	10%
Edible beans	14%	12%	10%

Application of Grain Protectants

- Growers who will be storing for more than 6 months should strongly consider application of a grain protectant (Table 21). Apply an approved grain protectant directly to the moving grain stream at the bottom of the bucket elevator or auger so the material has an opportunity to contact as many kernels as possible as the grain is moved.
- UGA Extension recommends that grain be conditioned with a cooling cycle or similar procedure before applying the protectant. However, recent data suggests that deltamethrin (Centynal EC or Defense SC) and spinosad (Sensat) are heat stable up to 200° F, while s-methoprene (Diacon IGR) and pirimiphos-methyl (Actellic 5E) were degraded by high heat.
- Position the insecticide nozzle as close to the auger flighting as possible to minimize insecticide drift.

Table 21. Insecticides labelled for direct application to grain as a grain protectant.

Insecticide	Rate (corn)	MOA	Remarks
pirimiphos-methyl **Actellic 5E**	8.6-11.5 fl oz	1B	Labeled for use on shelled corn, popcorn and grain sorghum only. DO NOT use if grain has been previously treated with Actellic or if Actellic will be used as a topdress treatment.
deltamethrin **Centynal EC**	8.5 fl oz	3A	Labeled for use on barley, corn, oats, popcorn, rice rye, grain sorghum, and wheat.
deltamethrin **D-Fense SC**	8.5 fl oz	3A	Labeled for use on barley, corn, oats, popcorn, rice, rye, grain sorghum, and wheat.
s-methoprene **Diacon IGR**	1.8-7 fl oz	7A	Labeled for use on wheat, corn, grain sorghum, barley, rice, oats, peanuts, and sunflower. Will not control weevils. Diacon IGR is an insect-growth regulator that interferes with the development of insects; it will not kill adult insects. Treat existing insect populations with an adulticide before or at the same time as applying Diacon IGR. Apply only once to grain of known treatment history. Use highest rates for maximum residual. Lowest rate provides shorter residual.
s-methoprene **Diacon-D IGR**	8-10 lb	7A	Labeled for use on cereal grains, corn, sunflower, canola, legumes, popcorn, wheat, spices, grain sorghum, rice, cocoa, peanuts, oats and millet. Will not control weevils. Diacon-D IGR is an insect-growth regulator that interferes with the development of insects. It will not kill adult insects. Treat existing insect populations with adulticide before or at the same time as applying Diacon-D IGR. Apply only once to grain of known treatment history.
deltamethrin + s-methoprene **Diacon IGR PLUS**	9-18 fl oz	3A+7A	Labeled for use on barley, corn, oats, popcorn, rice, rye, sorghum and wheat.
deltamethrin + s-methoprene + pipronyl butoxide **Gravista**	35.6 fl oz	3A+7A	Labeled for use on barley, corn, oats, popcorn, rice, rye, sorghum and wheat. Gives better knock down and longer lasting protection than Diacon IGR PLUS alone.
diatomaceous earth **Dryacide 100**	1-2 lb/ton		Thoroughly mix with grain. For use on grains, soybeans, peanuts, popcorn, and others (see label). Diatomaceous earth products are less effective when used on grain with increased moisture content and under humid conditions; diatomaceous earth is known to decrease test weight and grain flowability.
diatomaceous earth **Insecto**	1 lb/ton 1-2 lb/ton (infested)		Apply uniformly as a dust on grains, soybeans, peanuts, popcorn, and others (see label). See note above.
diatomaceous earth **Protect-It**	9.6 to 18 lb		Uniformly treat grain as it is loaded into bin. For use on grains, soybeans, peanuts, popcorn, and others (see label). See note above.
spinosad **Sensat**	9.8 fl oz	5	Labeled for use on barley, bird seed, corn, foxtail millet, pearl millet, proso millet, oats, sorghum, triticale and wheat.

Insect Management

- Stored grain insects thrive in warm grain. The hotter it is, the faster insects feed, grow and reproduce. Conversely, stored grain insects quit developing when temperatures are below 60°F. Grain temperatures are optimally managed using thermostatically controlled aeration that enables the fans to operate only when the outside air temperature is cooler than the set point. Once the grain reaches the set point temperature, set the thermostat to the next cooler set point. Growers in the deep south should use temperature set points of 75°F, 65°F and 45°F, whereas growers north of a line between Columbus and Savannah should use 70°F, 60°F and 40°F. It is important not to let the grain freeze as this will result in "sweating" when the grain warms in the spring. Temperature cables, moisture sensor cables, and automated aeration controllers make aeration more efficient.
- Initiate a systematic and thorough insect-monitoring system. Check the grain every 21 days from spring to fall and monthly in winter for the presence of insects. Five trier samples or probe traps should be sufficient on each sampling date.
- If you begin to find insects such as weevils or lesser grain borers, sell the grain, move the grain to another bin and apply a grain protectant as you move it, or fumigate the grain (Table 22). Read the fumigant label and applicator guide carefully. Follow the instructions provided because the label is the law. Aluminum phosphide is the most frequently used on-farm fumigant. It requires the preparation of a fumigation management plan before any fumigant is applied. If there are leaks in the bin, the fumigant cannot be held long enough to kill the insects. Seal all openings before loading the bin, including the aeration fan, top vents, eaves, roof entry door and side entry door. *Many fumigation attempts fail because the gas is not held long enough.* Read the fumigant label to determine how long it will take the fumigant to reach a lethal level. It may take a day or two to reach the desired concentration; therefore, leave the bin sealed for the recommended length of time. A closed-loop fumigation can make fumigation more efficient and safe. In this method, fumigant is circulated in a pipe outside the bin from the top to the bottom and then drawn up through the grain to the surface:

Table 22. Grain Fumigants.

Product	Rate	Remarks
aluminum phosphide pellets **Weevil-Cide** 60% pellets **Phosfume2** 60% pellets **Phostoxin** 60% pellets	Farm bins: 350-725 pellets/1000 cu ft	All formulations of aluminum phosphide now require you to prepare a written fumigation management plan. **READ THE LABEL AND THE APPLICATORS MANUAL CAREFULLY BEFORE USING ALUMINUM PHOSPHIDE.** Many on-farm fumigations fail because the bin is not sealed adequately. Seal bin as tightly as possible. Use higher doses for older, less well-sealed grain bins.
aluminum phosphide tablets **Weevil-Cide** 60% tablets **Phosfume2** 60% tablets **Phostoxin** 60% tablets	Farm bins: 70-145 tablets/1000 cu ft	Dosage must be based on the capacity of the grain bin, not on the amount of grain in storage, unless the surface of the grain is tarped after aluminum phosphide application. If grain is tarped, dose can be based on the volume of the grain in storage. All formulations of aluminum phosphide are **RESTRICTED USE** pesticides. Dosage rate varies with the site. See the Applicators Manual that is part of the label.
Phostoxin tablet prepack	See label	Phostoxin tablet prepack is a **RESTRICTED USE** pesticide.
cylinderized phosphine + carbon dioxide gas **Eco2fume Fumigant Gas**	See label	Eco2Fume is a mixture of phosphine and carbon dioxide gases that are packaged in compressed gas cylinders; it is labeled for use by certified applicators only. It is a restricted use insecticide and requires specialized training and equipment. Eco2Fume is a **RESTRICTED USE** pesticide.
pure phosphine gas **Vaporph3os**	See label	Vaporph3os is a **RESTRICTED USE** pesticide and requires specialized training and equipment for application. It is pure phosphine gas that is blended with carbon dioxide on site.
cylinderized sulfuryl fluoride **Profume**	See Label	To be blended with carbon dioxide or forced air on site. Contact Cytec Industries for more details (905-374-5899). Profume is a **RESTRICTED USE** insecticide. See label and applicators manual.

CARBON SEQUESTRATION & SOIL HEALTH

Henry Sintim, Glen Harris, R. Scott Tubbs

Increasing soil carbon and overall soil health will improve the productivity and resilience of farming systems. However, the process is slow, taking as much as 10 years to observe remarkable improvement. It is recommended that efforts to increase soil carbon and overall soil health must also sustain or increase productivity and economic profitability in the short and long term.

Management practices to improve soil health tend to also increase soil carbon. It is important to note, however, that not all soil properties can be affected by management practices. Soil properties not affected by management practices are considered inherent or use-invariant properties, and they include soil texture and the type of clay. They are affected by soil-forming factors such as climate, parent material, time, and biota. Soil properties that are affected by management practices are considered dynamic or use-dependent properties. Examples include soil structure, infiltration, and organic matter, and can be considered as aggrading, sustaining, or degrading over time (Figure 1).

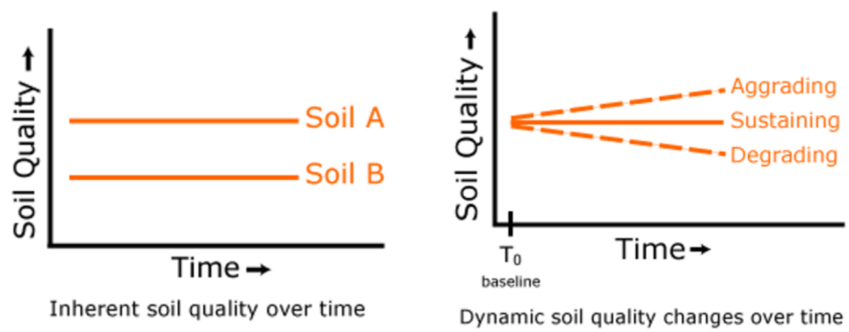

Figure 1: Depiction of inherent and dynamic soil properties and how they change over time. *From Andrews and Wander, 2011, http://www.soilquality.org/basics/inherent_dynamic.html*

The principles to manage and improve soil health include minimizing soil disturbance, maximizing biodiversity, maximizing soil cover, and maximizing living roots. For corn production in Georgia, research has shown the use of poultry litter, conservation tillage, and cover crops to be good management practices to improve soil health without adversely impacting productivity.

Poultry Litter

Poultry litter is a mixture of poultry manure and bedding material. Georgia continues to be the leading producer of broilers in the U.S. for the past decade, with production of 1.31 billion heads in 2022. According to the Georgia 2023 Ag Snapshot, broiler production contributed $4.2 billion to the agricultural economy of the state, and approximately, three out of every four Georgia counties are involved in poultry and egg production.

The nutrient content of poultry litter can vary depending on the type of bird, feed type and ration, number and duration of growing cycles, and mode of storage and handling of the litter. It is highly recommended that the nutrient content of poultry litter be analyzed before determining application rates and value. Also, consider applying poultry litter as pre-plant incorporated, and closer to the planting season, to get the most value and reduce nutrient losses. See the 'Fertilization' section of this production guide for information on poultry litter application in corn. The UGA-AESL broiler litter fertilizer worksheet is a useful tool to help calculate the value of broiler litter based on prevailing retail selling prices of inorganic N, P, and K fertilizers and the nutrient content from the laboratory analyses (https://aesl.ces.uga.edu/calculators/BroilerLitter/). Besides being a cheaper source of nutrients that would reduce production costs, the long-term use of poultry litter could increase soil carbon and improve the biological activities of soil. Moreover, poultry litter will replenish the soil micronutrients which are typically mined from crop harvest because they are not routinely applied.

Conservation Tillage

Tillage is a land preparation practice that entails the mechanical process of loosening and aerating the soil. Tillage improves soil tilth by breaking up soil crust and increasing soil porosity, which is important to encourage root growth and overall crop productivity. Tillage is also a very important weed control measure, especially in organic systems where the use of herbicides is prohibited. However, intensive tillage systems over the long term will pulverize the soil and enhance soil erosion, leaching, and the rapid mineralization of organic matter. Thus, there has been a great interest in conservation tillage systems. Conservation tillage is a general term based on the principles of (a) minimum disturbance of soil, (b) retention of crop residues on the soil surface, and (c) reduced or no traffic on the field. Conservation tillage may comprise no-tillage, strip tillage, mulch tillage, and many more. The retention of crop residues on the soil surface under conservation tillage acts as organic mulch and protects the soil against raindrop impact, which otherwise would have disintegrated and promoted soil erosion.

Conservation tillage systems have a direct impact on soil carbon retention in the soil. The minimum soil disturbance helps to reduce the breakdown of soil organic matter and crop residues. Conservation tillage systems also have positive impacts on the diversity and activities of soil fauna. More importantly, conservation tillage systems reduce greenhouse gas emissions by minimizing the use of fossil fuels. This is critical because every field has a maximum soil carbon level that can be sequestered and maintained at equilibrium. The benefits of reduced fossil fuel use and subsequent reduction in greenhouse gas emissions will continue as long as conservation tillage systems are implemented. In the Sustainable Agriculture Research and Education (SARE) Handbook Series 15, it was estimated that the conversion from moldboard plowing to conservation tillage systems could keep about 20 pounds of carbon per acre per year from entering the atmosphere through the reduction in fossil-fuel usage. Also, conservation tillage may reduce production costs.

It is important to recognize that there are limitations with conservation tillage systems. If not properly implemented, conservation tillage can lead to soil compaction and increased pressure of certain pests, especially certain weeds, diseases, and insects. It is highly recommended to use a soil penetrometer to monitor soil compaction. Penetrometer readings above 300 psi within a 12-inch soil depth indicate a soil compaction problem.

Cover Crops

The USDA-NRCS defines cover crops in the Conservation Practice Standard Code 340, as "grasses, legumes, and forbs planted for seasonal vegetative cover." Cover crops are considered a conservation practice because they are planted to (a) reduce erosion from wind and water; (b) maintain or increase soil health and organic matter content, reduce water quality degradation by utilizing excessive soil nutrients, (c) suppress excessive weed pressures and break pest cycles, (d) improve soil water use efficiency, and (e) minimize soil compaction. The residues of cover crops are a source of organic carbon when incorporated into the soil. The residence time of added carbon from cover crops will depend on the type of cover crop, and a suite of management practices and climatic conditions. Wet and hot climatic conditions, as well as cover crops with a low carbon-to-nitrogen ratio, will facilitate rapid carbon loss. Also, management practices that disturb the soil will cause cover crop residues to decompose at a faster rate.

As the cover crop is a conservation practice, growers are highly encouraged to take advantage of the USDA-NRCS Environmental Quality Incentives Program (EQIP) (https://www.nrcs.usda.gov/programs-initiatives/eqip-environmental-quality-incentives). The program provides technical and financial assistance to agricultural producers and forest landowners to address natural resource concerns. Cover crop adoption comes with a cost so taking advantage of the EQIP program will help offset some of the cost. Given the unique attributes of various cover crops, cover crop mixes can be used to satisfy multiple purposes in one planting. For instance, in a rye-clover cover crop mix, the rye can provide a high-quality residue and give better weed suppression, whereas the clover can supply a good amount of nitrogen (about 20-90 lbs/ac N) if well managed and allowed to grow for a prolonged period. Corn is planted early in southeast and southwest Georgia, which does not provide ample time for the cover crop to develop. Thus, consider planting the cover crops as early as possible in the fall.

Corn Budgets

Developed by Amanda Smith and Guy Hancock

Enterprise budgets are estimates of future costs given current market conditions. You are encouraged to enter your own prices to best estimate your 2024 cost of production. When used with your own numbers these are an effective tool for planning. Cost estimates are current as of Dec 2023. Due to volatility in input markets, prices may change rapidly.

Non-Irrigated Corn, South Georgia, 2024

Estimated Costs and Returns

Expected Yield: 85 bushel Your Yield ____________

Variable Costs	Unit	Amount	$/Unit	Cost/ Acre	$/ bushel	Your Farm
Treated Seed	thousand	20	$ 3.90	$ 78.00	$ 0.92	
Lime	ton	0.25	$ 55.00	$ 13.75	$ 0.16	
Fertilizer						
Nitrogen	pounds	100	$ 0.70	$ 70.00	$ 0.82	
Phosphate	pounds	40	$ 0.65	$ 26.00	$ 0.31	
Potash	pounds	60	$ 0.50	$ 30.00	$ 0.35	
Weed Control	acre	1	$ 14.90	$ 14.90	$ 0.18	
Insect Control	acre	1	$ 8.45	$ 8.45	$ 0.10	
Disease Control	acre	1	$ 12.00	$ 12.00	$ 0.14	
Preharvest Machinery						
Fuel	gallon	5.3	$ 4.00	$ 21.32	$ 0.25	
Repairs and Maintenance	acre	1	$ 18.04	$ 18.04	$ 0.21	
Harvest Machinery						
Fuel	gallon	2.5	$ 4.00	$ 10.13	$ 0.12	
Repairs and Maintenance	acre	1	$ 10.20	$ 10.20	$ 0.12	
Labor	hours	1.1	$ 15.00	$ 16.47	$ 0.19	
Crop Insurance	acre	1	$ 35.00	$ 35.00	$ 0.41	
Land Rent	acre	1	$ -	$ -	$ -	
Interest on Operating Capital	percent	$182.13	8.75%	$ 15.94	$ 0.19	
Drying - 8 Points	bushel	93	$ 0.28	$ 26.12	$ 0.31	
Total Variable Costs:				**$ 406.32**	**$ 4.78**	
Fixed Costs						
Machinery Depreciation, Taxes, Insurance and Housing						
Preharvest Machinery	acre	1	$ 49.55	$ 49.55	$ 0.58	
Harvest Machinery	acre	1	$ 49.31	$ 49.31	$ 0.58	
General Overhead	% of VC	$406.32	5%	$ 20.32	$ 0.24	
Management	% of VC	$406.32	5%	$ 20.32	$ 0.24	
Owned Land Cost, Taxes, Cash Payment, etc.	acre	1	$ -	$ -	$ -	
Other __________________	acre	1	$ -	$ -	$ -	
Total Fixed Costs				**$ 139.49**	**$ 1.64**	
Total Costs Excluding Land				**$ 545.81**	**$ 6.42**	
Your Profit Goal			$		/bushel	
Price Needed for Profit			$		/bushel	

Sensitivity Analysis of Non-Irrigated Corn

Net Returns Above Variable Costs Per Acre
Varying Prices and Yields (bushel)

Price \ bushel/Acre	-25%	-10%	Expected	+10%	+25%
	64	77	85	94	106
$4.75	-$103.50	-$42.94	-$2.57	$37.81	$98.37
$5.00	-$87.57	-$23.82	$18.68	$61.18	$124.93
$5.25	-$71.63	-$4.69	$39.93	$84.56	$151.50
$5.50	-$55.69	$14.43	$61.18	$107.93	$178.06
$5.75	-$39.75	$33.56	$82.43	$131.31	$204.62

Estimated Labor and Machinery Costs per Acre

Preharvest Operations

Operation	Acres/Hour	Number of Times Over	Labor Use* (hr/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
Fert Appl (Liquid) 6R-36 with Tractor (120-139 hp) 2WD 130	9.2	1	0.14	0.73	$ 2.76	$ 5.53
Spray (Broadcast) 60' with Tractor (120-139 hp) 2WD 130	35.5	2	0.07	0.38	$ 0.92	$ 2.12
Total Preharvest Values			**0.79**	**5.33**	**$ 18.04**	**$ 49.55**

Harvest Operations

Operation	Acres/Hour	Number of Times Over	Labor Use* (hr/ac)	Fuel Use (gal/ac)	Repairs ($/ac)	Fixed Costs ($/ac)
Header - Corn 6R-36 with Combine (200-249 hp) 240 hp	6.5	1	0.19	1.90	$ 8.54	$ 44.87
Grain Cart Corn 500 bu with Tractor (120-139 hp) 2WD 130	10.6	1	0.12	0.63	$ 1.66	$ 4.44
Total Harvest Values			**0.31**	**2.53**	**$ 10.20**	**$ 49.31**

* 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 Corn, Strip Tillage, South Georgia, 2024

Estimated Costs and Returns

Expected Yield: 85 bushel   Your Yield ____________

Variable Costs	Unit	Amount	$/Unit	Cost/ Acre	$/ bushel	Your Farm
Treated Seed	thousand	20	$ 3.90	$ 78.00	$ 0.92	
Cover Crop Seed	bushel	1.5	$ 18.50	$ 27.75	$ 0.33	
Lime	ton	0.25	$ 55.00	$ 13.75	$ 0.16	
Fertilizer						
Nitrogen	pounds	100	$ 0.70	$ 70.00	$ 0.82	
Phosphate	pounds	40	$ 0.65	$ 26.00	$ 0.31	
Potash	pounds	60	$ 0.50	$ 30.00	$ 0.35	
Weed Control	acre	1	$ 17.05	$ 17.05	$ 0.20	
Insect Control	acre	1	$ 8.45	$ 8.45	$ 0.10	
Disease Control	acre	1	$ 12.00	$ 12.00	$ 0.14	
Preharvest Machinery *						
Fuel	gallon	3.6	$ 4.00	$ 14.41	$ 0.17	
Repairs and Maintenance	acre	1	$ 11.15	$ 11.15	$ 0.13	
Harvest Machinery						
Fuel	gallon	2.5	$ 4.00	$ 10.13	$ 0.12	
Repairs and Maintenance	acre	1	$ 10.20	$ 10.20	$ 0.12	
Labor	hours	0.9	$ 15.00	$ 12.95	$ 0.15	
Crop Insurance	acre	1	$ 35.00	$ 35.00	$ 0.41	
Land Rent	acre	1	$ -	$ -	$ -	
Interest on Operating Capital	percent	$188.42	8.75%	$ 16.49	$ 0.19	
Drying - 8 Points	bushel	93	$ 0.28	$ 26.12	$ 0.31	
Total Variable Costs:				**$ 419.44**	**$ 4.93**	
Fixed Costs						
Machinery Depreciation, Taxes, Insurance and Housing						
Preharvest Machinery *	acre	1	$ 29.39	$ 29.39	$ 0.35	
Harvest Machinery	acre	1	$ 49.31	$ 49.31	$ 0.58	
General Overhead	% of VC	$419.44	5%	$ 20.97	$ 0.25	
Management	% of VC	$419.44	5%	$ 20.97	$ 0.25	
Owned Land Cost, Taxes, Cash Payment, etc.	acre	1	$ -	$ -	$ -	
Other __________________	acre	1	$ -	$ -	$ -	
Total Fixed Costs				**$ 120.64**	**$ 1.42**	
Total Costs Excluding Land				**$ 540.08**	**$ 6.35**	
Your Profit Goal			$		/bushel	
Price Needed for Profit			$		/bushel	

* 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 $2.40/ac.

Developed by Amanda Smith and Guy Hancock

Sensitivity Analysis of Non-Irrigated Corn, Strip Tillage

Net Returns Above Variable Costs Per Acre
Varying Prices and Yields (bushel)

Price \ bushel/Acre	-25%	-10%	Expected	+10%	+25%
	64	77	85	94	106
$4.75	-$116.63	-$56.07	-$15.69	$24.68	$85.25
$5.00	-$100.69	-$36.94	$5.56	$48.06	$111.81
$5.25	-$84.75	-$17.82	$26.81	$71.43	$138.37
$5.50	-$68.82	$1.31	$48.06	$94.81	$164.93
$5.75	-$52.88	$20.43	$69.31	$118.18	$191.50

Estimated Labor and Machinery Costs per Acre

Preharvest Operations

Operation	Acres/Hour	Number of Times Over	Labor Use** (hr/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
Fert Appl (Liquid) 6R-36 with Tractor (120-139 hp) 2WD 130	9.2	1	0.14	0.73	$ 2.76	$ 5.53
Spray (Broadcast) 60' with Tractor (120-139 hp) 2WD 130	35.5	2	0.07	0.38	$ 0.92	$ 2.12
Total Preharvest Values			**0.55**	**3.60**	**$ 11.15**	**$ 29.39**

Harvest Operations

Operation	Acres/Hour	Number of Times Over	Labor Use** (hr/ac)	Fuel Use (gal/ac)	Repairs ($/ac)	Fixed Costs ($/ac)
Header - Corn 6R-36 with Combine (200-249 hp) 240 hp	6.5	1	0.19	1.90	$ 8.54	$ 44.87
Grain Cart Corn 500 bu with Tractor (120-139 hp) 2WD 130	10.6	1	0.12	0.63	$ 1.66	$ 4.44
Total Harvest Values			**0.31**	**2.53**	**$ 10.20**	**$ 49.31**

** 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 Corn, South Georgia, 2024

Estimated Costs and Returns

Expected Yield: 200 bushel Your Yield ____________

Variable Costs	Unit	Amount	$/Unit	Cost/Acre	$/ bushel	Your Farm
Treated Seed	thousand	32	$ 3.90	$ 124.80	$ 0.62	
Lime	ton	0.5	$ 55.00	$ 27.50	$ 0.14	
Fertilizer						
Nitrogen	pounds	240	$ 0.70	$ 168.00	$ 0.84	
Phosphate	pounds	100	$ 0.65	$ 65.00	$ 0.33	
Potash	pounds	200	$ 0.50	$ 100.00	$ 0.50	
Weed Control	acre	1	$ 14.90	$ 14.90	$ 0.07	
Insect Control	acre	1	$ 8.45	$ 8.45	$ 0.04	
Disease Control	acre	1	$ 12.00	$ 12.00	$ 0.06	
Preharvest Machinery						
Fuel	gallon	5.3	$ 4.00	$ 21.32	$ 0.11	
Repairs and Maintenance	acre	1	$ 18.04	$ 18.04	$ 0.09	
Harvest Machinery						
Fuel	gallon	2.5	$ 4.00	$ 10.13	$ 0.05	
Repairs and Maintenance	acre	1	$ 10.20	$ 10.20	$ 0.05	
Labor	hours	1.1	$ 15.00	$ 16.47	$ 0.08	
Irrigation*	applications	8	$ 11.25	$ 90.00	$ 0.45	
Crop Insurance	acre	1	$ 20.00	$ 20.00	$ 0.10	
Land Rent	acre	1	$ -	$ -	$ -	
Interest on Operating Capital	percent	$353.41	8.75%	$ 30.92	$ 0.15	
Drying - 8 Points	bushel	220	$ 0.28	$ 61.46	$ 0.31	
Total Variable Costs:				**$ 799.19**	**$ 4.00**	
Fixed Costs						
Machinery Depreciation, Taxes, Insurance and Housing						
Preharvest Machinery	acre	1	$ 49.55	$ 49.55	$ 0.25	
Harvest Machinery	acre	1	$ 49.31	$ 49.31	$ 0.25	
Irrigation	acre	1	$ 135.00	$ 135.00	$ 0.68	
General Overhead	% of VC	$799.19	5%	$ 39.96	$ 0.20	
Management	% of VC	$799.19	5%	$ 39.96	$ 0.20	
Owned Land Cost, Taxes, Cash Payment, etc.	acre	1	$ -	$ -	$ -	
Other ________________	acre	1	$ -	$ -	$ -	
Total Fixed Costs				**$ 313.78**	**$ 1.57**	
Total Costs Excluding Land				**$ 1,112.97**	**$ 5.56**	
Your Profit Goal			$		/bushel	
Price Needed for Profit			$		/bushel	

* Weighted average of diesel and electric irrigation application costs. Electric is estimated at $9/appl and diesel is estimated at $16/appl when diesel costs $4/galon.

Developed by Amanda Smith and Guy Hancock

Sensitivity Analysis of Irrigated Corn

Net Returns Above Variable Costs Per Acre
Varying Prices and Yields (bushel)

Price \ bushel/Acre	-25%	-10%	Expected	+10%	+25%
	150	180	200	220	250
$4.75	-$86.69	$55.81	$150.81	$245.81	$388.31
$5.00	-$49.19	$100.81	$200.81	$300.81	$450.81
$5.25	-$11.69	$145.81	$250.81	$355.81	$513.31
$5.50	$25.81	$190.81	$300.81	$410.81	$575.81
$5.75	$63.31	$235.81	$350.81	$465.81	$638.31

Estimated Labor and Machinery Costs per Acre

Preharvest Operations

Operation	Acres/Hour	Number of Times Over	Labor Use** (hr/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
Fert Appl (Liquid) 6R-36 with Tractor (120-139 hp) 2WD 130	9.2	1	0.14	0.73	$ 2.76	$ 5.53
Spray (Broadcast) 60' with Tractor (120-139 hp) 2WD 130	35.5	2	0.07	0.38	$ 0.92	$ 2.12
Total Preharvest Values			**0.79**	**5.33**	**$ 18.04**	**$ 49.55**

Harvest Operations

Operation	Acres/Hour	Number of Times Over	Labor Use** (hr/ac)	Fuel Use (gal/ac)	Repairs ($/ac)	Fixed Costs ($/ac)
Header - Corn 6R-36 with Combine (200-249 hp) 240 hp	6.5	1	0.19	1.90	$ 8.54	$ 44.87
Grain Cart Corn 500 bu with Tractor (120-139 hp) 2WD 130	10.6	1	0.12	0.63	$ 1.66	$ 4.44
Total Harvest Values			**0.31**	**2.53**	**$ 10.20**	**$ 49.31**
** 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 Corn, Strip Tillage, South Georgia, 2024

Estimated Costs and Returns

Expected Yield: 200 bushel   Your Yield ____________

Variable Costs	Unit	Amount	$/Unit	Cost/Acre	$/ bushel	Your Farm
Treated Seed	thousand	32	$ 3.90	$ 124.80	$ 0.62	
Cover Crop Seed	bushel	1.5	$ 18.50	$ 27.75	$ 0.14	
Lime	ton	0.5	$ 55.00	$ 27.50	$ 0.14	
Fertilizer						
Nitrogen	pounds	240	$ 0.70	$ 168.00	$ 0.84	
Phosphate	pounds	100	$ 0.65	$ 65.00	$ 0.33	
Potash	pounds	200	$ 0.50	$ 100.00	$ 0.50	
Weed Control	acre	1	$ 21.35	$ 21.35	$ 0.11	
Insect Control	acre	1	$ 8.45	$ 8.45	$ 0.04	
Disease Control	acre	1	$ 12.00	$ 12.00	$ 0.06	
Preharvest Machinery *						
Fuel	gallon	3.6	$ 4.25	$ 15.31	$ 0.08	
Repairs and Maintenance	acre	1	$ 11.15	$ 11.15	$ 0.06	
Harvest Machinery						
Fuel	gallon	2.5	$ 4.25	$ 10.76	$ 0.05	
Repairs and Maintenance	acre	1	$ 10.20	$ 10.20	$ 0.05	
Labor	hours	0.9	$ 13.50	$ 11.66	$ 0.06	
Irrigation **	applications	7	$ 11.25	$ 78.75	$ 0.39	
Crop Insurance	acre	1	$ 20.00	$ 20.00	$ 0.10	
Land Rent	acre	1	$ -	$ -	$ -	
Interest on Operating Capital	percent	$356.34	8.75%	$ 31.18	$ 0.16	
Drying - 8 Points	bushel	220	$ 0.28	$ 61.46	$ 0.31	
Total Variable Costs:				**$ 805.31**	**$ 4.03**	
Fixed Costs						
Machinery Depreciation, Taxes, Insurance and Housing						
Preharvest Machinery *	acre	1	$ 29.39	$ 29.39	$ 0.15	
Harvest Machinery	acre	1	$ 49.31	$ 49.31	$ 0.25	
Irrigation	acre	1	$ 135.00	$ 135.00	$ 0.68	
General Overhead	% of VC	$805.31	5%	$ 40.27	$ 0.20	
Management	% of VC	$805.31	5%	$ 40.27	$ 0.20	
Owned Land Cost, Taxes, Cash Payment, etc.	acre	1	$ -	$ -	$ -	
Other ________________	acre	1	$ -	$ -	$ -	
Total Fixed Costs				**$ 294.23**	**$ 1.47**	
Total Costs Excluding Land				**$1,099.54**	**$ 5.50**	
Your Profit Goal			$		/bushel	
Price Needed for Profit			$		/bushel	

* 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 $2.40/ac.
** Weighted average of diesel and electric irrigation application costs. Electric is estimated at $9/appl and diesel is estimated at $16/appl when diesel costs $4/gal.

Developed by Amanda Smith and Guy Hancock

Sensitivity Analysis of Irrigated Corn, Strip Tillage

Net Returns Above Variable Costs Per Acre
Varying Prices and Yields (bushel)

Price \ bushel/Acre	-25%	-10%	Expected	+10%	+25%
	150	180	200	220	250
$4.75	-$92.81	$49.69	$144.69	$239.69	$382.19
$5.00	-$55.31	$94.69	$194.69	$294.69	$444.69
$5.25	-$17.81	$139.69	$244.69	$349.69	$507.19
$5.50	$19.69	$184.69	$294.69	$404.69	$569.69
$5.75	$57.19	$229.69	$344.69	$459.69	$632.19

Estimated Labor and Machinery Costs per Acre

Preharvest Operations

Operation	Acres/Hour	Number of Times Over	Labor Use*** (hr/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
Fert Appl (Liquid) 6R-36 with Tractor (120-139 hp) 2WD 130	9.2	1	0.14	0.73	$ 2.76	$ 5.53
Spray (Broadcast) 60' with Tractor (120-139 hp) 2WD 130	35.5	2	0.07	0.38	$ 0.92	$ 2.12
Total Preharvest Values			**0.55**	**3.60**	**$ 11.15**	**$ 29.39**

Harvest Operations

Operation	Acres/Hour	Number of Times Over	Labor Use*** (hr/ac)	Fuel Use (gal/ac)	Repairs ($/ac)	Fixed Costs ($/ac)
ader - Corn 6R-36 with Combine (200-249 hp) 240 hp	6.5	1	0.19	1.90	$ 8.54	$ 44.87
Grain Cart Corn 500 bu with Tractor (120-139 hp) 2WD 130	10.6	1	0.12	0.63	$ 1.66	$ 4.44
Total Harvest Values			**0.31**	**2.53**	**$ 10.20**	**$ 49.31**

*** 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.

For More Budgets

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