# A GUIDE TO CORN PRODUCTION IN GEORGIA

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# CORN PRODUCTION IN GEORGIA

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Corn production in Georgia has remained relatively steady in the past ten years (table 1). As farm production declined and shifted to a cotton/peanut rotation pre-2000, corn remained an important crop to many as a benefit in the land rotation and vital to the diversity and stability of farm income. Today, corn remains the third largest row crop in the state and provides over $200 million in revenue for the agriculture economy. Georgia corn is vital to the states livestock and ethanol industry. On average, Georgia farmers produce more than 55 million bushels per year.

**Table 1. Planted Corn Acreage in Georgia for Selected years**

| Year | Planted Acres | Harvested Acres | Yield (bu/a) |
|---|---|---|---|
| 2010 | 295,000 | 245,000 | 146 |
| 2011 | 345,000 | 270,000 | 159 |
| 2012 | 345,000 | 310,000 | 180 |
| 2013 | 510,000 | 465,000 | 175 |
| 2014 | 350,000 | 310,000 | 170 |
| 2015 | 330,000 | 285,000 | 181 |
| 2016 | 410,000 | 365,000 | 175 |
| 2017 | 290,000 | 245,000 | 176 |
| 2018 | 325,000 | 285,000 | 176 |
| 2019* | 390,000 | 345,000 | 168* |

*preliminary-subject to revision

## Corn in Georgia

The majority of corn produced in the state is field corn best known as dent corn. Previous estimates by the Georgia Agricultural Statistics Service and UGA Cooperative Extension indicate that approximately 77% of Georgia's field corn is irrigated. Surveys by the Georgia Agricultural Statistics Service show that non-irrigated yields from 1999 to 2008 on average were only 48% of irrigated yields. The typical weather patterns and often extended periods of dry conditions during the spring and summer result in significantly reduced yields in the highly weathered, sandy soils of Georgia. As production costs increase, irrigation has become more important to stabilize yield potential and reduce the economic risk associated with unpredictable weather patterns and coarse-textured soils that hold very little moisture.

Water is the most significant of all variable climatic factors that affect corn production. Research at The University of Georgia Coastal Plain Experiment Station show that severe, drought condition that were most damaging to corn yields since 1938 were clustered into two periods, the early 1950s and most of the 1980s. During the survey period, dryland production was predicted to be 38-64% of non-stressed yields.  Unfortunately, in corn production, yield-reducing droughts have become the norm rather than an exception.  Fortunately, climatic variations over the last few years have provided enough rainfall to supply enough water for growers to harvest some dryland production.   The majority of dryland production is located in north Georgia where irrigation is more difficult. The majority of irrigated corn is located in the southwestern coastal plain counties and the eastern upper coastal plain counties.

Irrigation can eliminate water stress during periods of insufficient rainfall, and can enable the crop to fully utilize fertilizer and other inputs to improve profitability.  However, irrigation as with any other management tool must be used effectively and efficiently to achieve its maximum potential.  **See the irrigation management and scheduling section** in this guide for details on efficient irrigation techniques.

The decision to irrigate changes the way a corn crop is managed to maximize return on investment. Cultural practices such as hybrid selection, plant population, fertility level, and crop protection all change under irrigation.  It is wise to always review your previous year's successes and failures. Use the UGA budget tools to calculate input cost per bushel harvested. Identify limitations as well as areas of greater potential within your system, and adjust management practices accordingly to optimize efficiency and profitability. Corn can be a very profitable crop yet it requires attention to details and timely management.

In recent years, farmers in Georgia and across the country have demonstrated that modern corn hybrids coupled with improved management technologies and irrigation are capable of producing yields not heard of 10 years ago. Indeed, two producers/managers, Randy Dowdy of Georgia and David Hula of Virginia, have produced world record productions on small acreages demonstrating the capabilities and benefits of modern science when great attention to detail is applied in the management of inputs on modern hybrids. Each year these yields are being challenged as growers across the country learn more about the science of corn production. In 2019, The National Corn Growers Association (NCGA) received official yield entries from 115 producers that exceeded 300 + bushels per acre.  In addition, four farms recorded 400+ bushels and three growers produced over 500+ bushels per acre.  In addition, a new state yield record in Georgia of 552 bushels per acre was recorded on the Dowdy farm near Valdosta, GA.  A new world record of 616 bu/ac was set by David Hula of Virginia.  NCGA verified that the 27 national top yielding producers in both dryland and irrigated categories averaged more than 383 bushels per acre, compared to the projected national average of 167 bushels per acre in 2019.  This demonstrates the capabilities of today's hybrids when great management intersects with excellent environmental conditions.

Carefully read the following chapters in this guide.  Record your efforts this year so as to note the timing of each practice or input by date and by growing degree unit.  This way, you can repeat your successes and, also acknowledge the reason for any failures.  Use this information to change or adopt those practices in the future that give you a better return on your investment.

# AGRONOMIC PRACTICES FOR CORN

*Corey Bryant and Dewey Lee*

## Soil Preparation

A good soil management program: (1) protects the soil from water and wind erosion, (2) provides a weed-free seedbed for planting, and (3) disrupts hardpans or compacted layers that may limit root development. To conserve moisture and reduce compaction, work the land no more than necessary to achieve these objectives. Water erosion is a significant problem on many Georgia soils during the high rainfall, winter months. Wind erosion can be a problem on sandy Coastal Plain soils in early spring, and blowing sand can severely injure young corn plants. Crop residue left on the soil surface or a **seeded cover crop** can effectively reduce water erosion problems and improve soil quality and have a positive effect on plant growth. Using minimum-till planting practices such as strip-till or slit-till can also reduce soil losses and "sand blasting" from wind erosion.

## Tillage

Compaction layers or traffic pans (dense areas) are present in many, if not most, of the sandy, Coastal Plain soils in Georgia. These traffic pans restrict root growth and thus affect water and nutrient uptake by the plant. Traffic pans or dense soils should be disrupted either by deep turning, V-ripping, paraplowing, chisel plowing or by in-row subsoiling during planting. Research at many universities and USDA-ARS have demonstrated that in-row subsoiling has increased corn yields over 50% on soils where traffic pans were present. This disruption of compacted layers enables corn plants to develop deeper root systems, accessing more sub-soil moisture and improving the recovery of nutrients.

Research in the southeastern U.S. also demonstrates that a full-zone fracturing of compacted soils, as achieved by a paraplow, V-ripper or turn plow, results in corn yields equivalent to in-row subsoiling. Under current fuel and equipment cost, it is more cost effective to perform some type of tillage that disrupts plow pans than to plant strictly no-till without in-row subsoiling.

The results of several years of tillage studies conducted in Tifton, demonstrate that corn yields produced under conservation tillage methods are equal to or better than those with conventional tillage such as rip & bed (Table 2). It is important to recognize that hard pan disruption is needed on soils that consistently reconstitute the hard pan during the production season.

**Table 2. Tillage X Crop Rotation Study, 2003-2006, Lang Farm, Tifton, GA**

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

## Stand Establishment

Do not underestimate the importance of good plant stands. Improper establishment will have a negative impact on yield as corn can be sensitive to planting depth, thick populations, highly variable spacing, and delayed emergence. Inspect and service your planter and replace worn parts. Utilize the expertise that planter companies have to gain insights on properly adjusting all parts to changing soil and weather conditions as to optimize the operation. Ensure that coulters and disc openers are aligned accurately and the planter is level when you begin planting. Calibrate the planter for a proper seed drop. Make sure seed is between 1.5 and 2 inches deep. Avoid too much down pressure but make sure the furrow is closed properly. Check you speed to ensure that seed spacing is correct so as to avoid differences in plant emergence. Speed can increase your stand spacing so optimize your planting speed according to your seed density and the ability to reduce the spacing differences at seed drop.

Avoid planting when soil temperatures drop below $55^0$F. Variable plant emergence can reduce yields as much as 10 to 20% depending on the establishment delay of neighboring plants. Delayed plants cannot compete with older, better established plants. A field where all plants emerge within 12 to 24 hours of the first emerging plant is considered a successful stand that may provide a high yield potential for you to manage.

## Hybrid Selection

A wide range of hybrids are marketed in Georgia each year. Differences exist in yield potential, maturity, lodging resistance, disease resistance, grain quality and adaptability to different geographic areas of the state. **Keep the hybrid characteristics that best fit your farm** in mind when you select hybrids for planting.

Appropriate hybrid selection for any production system is crucial. A quick look at any of the previous year Corn Hybrid Performance Bulletins (**www.swvt.uga.edu/corn.html**) demonstrate as much as 50 to 60 bushels difference in any given year. Hybrids for irrigation should have the genetic potential to perform at high plant densities and respond to water and other inputs such as increased fertility. Hybrids with strong stalks and roots are needed under higher densities and yield levels to allow the corn crop to dry down with minimal harvest loss due to lodging. Higher populations suggest the need for hybrids that can tolerate crowding and still maintain stalk quality and ear development. Dryland hybrids on the other hand require good stress tolerance with good grain quality. Each company that sells hybrids generally makes distinctions between hybrids that perform better under one production system or another.

Leaf disease resistance is a necessary component of hybrid selection particularly in irrigated corn and continuous corn situations. Higher humidity, fluctuating water availability and higher plant populations under irrigation will favor many diseases. It is important to select hybrids with a high degree of resistance to a variety of stresses. Important corn diseases to consider are: northern and southern corn leaf blight, anthracnose, grey leaf spot, common rust, southern rust, and maize chlorotic dwarf virus. It is best to explore these differences with each of the companies providing the hybrids, as they change frequently.

Hybrids with high-grain quality at harvest are necessary to provide a better market for the crop. Grain quality depends on resistance to ear rots and other pests. Good husk cover reduces moisture and insect penetration, and minimizes damage from subsequent development of ear or kernel diseases. In addition, hybrids with higher grain quality typically weather better during dry-down.

Hybrid maturity is another important consideration. Hybrids are generally classified as early (short-seasoned), medium (mid-season) or late (full-season) maturity. Early and medium maturing hybrids are usually 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 due to the shorter growth season and (4) are more suitable for use where large acreages may require a harvest spread to improve harvest efficiency. If the farm work load normally prevents harvesting early to medium maturing hybrids within 30 days after physiological maturity (black layer) consider planting a later maturing hybrid.

Today, hybrid seed companies identify proprietary hybrids that are genetically similar but differ in one or more traits (Bt, Roundup resistance, Liberty Link, etc) which they distinguish from the conventional parent line. When examining these hybrids for possible use, care should be taken to ensure other equally important characteristics have not been altered, i.e. disease resistance, root strength, etc.

The results of annual hybrid evaluation tests at several locations throughout the state are available from your county Extension office. Information on most of the traits can be found in the Corn Performance Trial Bulletin **(http://www.swvt.uga.edu/corn.html)**. Consistent performance is most important and growers should evaluate hybrid performance data over at least three years at several locations. It is important however, to compare hybrids within maturity groups. Growers should test new hybrids on their farms but should not plant them initially to large acreages. Through continued evaluation of new hybrids, you can select hybrids which will contribute and enhance production under your unique management conditions.

## Planting Dates

Plant corn as soon as temperature and moisture become favorable for seed germination and seedling growth. Soil temperature in the seed zone should be 55°F or greater before planting. Corn seed will sprout slowly at 55°F while germination is prompt at 60°F. One should delay planting if cold weather drops soil temperatures below 55°F at the two-inch soil level. It is generally safe to plant if soil temperatures are 55°F and higher, and warm temperatures are in the forecast. Extremely early planting introduces a risk to frost or freeze damage and subsequent loss of stands. Usually, as long as the growing point is below ground level, corn can withstand a severe frost or freezing damage without yield reduction. It is best therefore to monitor soil conditions and weather if your desire is to plant as early as possible. Generally, it takes corn seed 7 to 12 days to emerge when planted in soils at 55°F.

Early-planted corn typically out-yields late-planted corn. Depending on your location, planting dates may range from early March in south-Georgia to mid-May in north Georgia. Early planting helps avoid periods of low rainfall and excessive heat during pollination, both of which lead to internal water stress during critical periods of corn development. Early planting is essential when double cropping soybeans, grain sorghum, millet or vegetables following irrigated corn.

As planting is delayed into the summer, corn yields decline. In general, yields decline at ¾ a bushel per day rising to about 2.5 bushels per day when planted in later portion of a typical planting window. In the southern coastal plains area, mid-April to early-May could be considered a later planting window. Studies in Tifton, under irrigation, demonstrate that stress-tolerant and disease-resistant hybrids yield about 50% of normal when planted in late-May or early-June. Therefore, late planting is very risky with a high degree of failure.

**Plant Populations and Row Spacing**

The optimum population for a given situation varies with soil type, hybrid, the ability to supply irrigation water and other management practices. Irrigated corn requires higher plant population than dryland corn. Generally, 28,000 to 36,000 plants/acre are recommended for most intensively grown hybrids. Excessive populations increase seed costs and may reduce yield because of crowding and lodging. Plant 10% more seed/ac than is necessary to produce the desired plant population for any particular hybrid. This over-planting will result in a harvest plant population near the desired level after a normal stand loss due to uncontrollable factors. Optimum plant populations for dryland production generally range from 18,000 to 20,000 in sandy type soils. Greater plant populations may provide higher yields in years of ample rainfall; however, the stress of plant populations above 20,000 in drier years would increase the risk of yield loss due to plant competition.

Most farm equipment in Georgia is set to plant in 36" rows. Wider rows, 38 to 40" rows usually result in little space between plants within a row. This creates in-row competition for water and nutrients**. Studies conducted in corn reveal that yields increase as rows narrow at high plant populations (Table 3).** This allows plants to exploit more moisture, nutrients and light due to greater space between plants. Narrow row spacing also helps weed control by shading the lower canopy. Row widths of 30 to 36 inches are adequate for top yields in Georgia. Twin-row configurations vary in Georgia from 7 inches to 12 inches between the twins on 36 to 30-inch centers. It is very important to achieve a complete hardpan disruption under each row. Most winged subsoil shanks will only fracture a 6 to 7-inch span, and therefore will not completely cover the width of the twin row configuration. Paraplowing or v-ripping will provide full root zone fracturing of the hard pan, but these methods can result in delayed field entry if high levels of rainfall occur.

**Table 3. Yield of corn in various row widths, Tifton GA**

| Row-Spacing | 2003 | 2004 | 2005 | 2006 | Avg. |
|---|---|---|---|---|---|
| 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 |

LSD $P \leq 0.10$

Table 5 illustrates plant populations at various row widths and plant spacings. This table can be used to estimate plant populations. To check the calibration, measure off the indicated distance found in Table 4, avoid the first 40 to 50 feet seeded to allow planter seed drop to become uniform. Count the number of kernels in one row for the indicated distance and multiply this number by 1,000 to get the population/acre. Check several rows to be certain each planter unit is working properly. It is always best to double check the planter to ensure seed drop is providing the desired populations. Vacuum-type planters have excellent control in attaining desired plant populations when properly adjusted. Whether old or new, well-maintained planters are necessary for evenly distributed plant populations.

**Table 4. Length of Row Required for 1/1,000 Acre at Various Row Widths.**

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

Table 5. **Approximate Plant Populations at Various Row Widths and Plant Spacing within a row.**

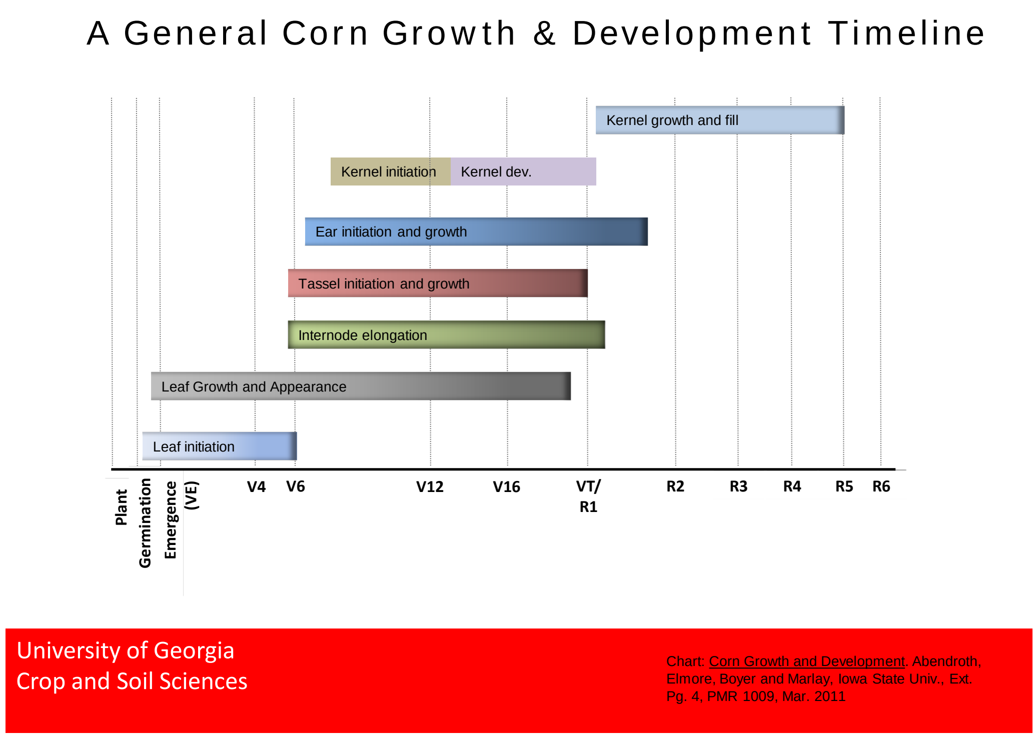
| **Within row Plant Spacing (in.)** | **Row-Spacing (in.)** | | | | |
|---|---|---|---|---|---|
| | **20** | **30** | **36** | **38** | **40** |
| 4.5 | | | 38,700 | 36,700 | 34,800 |
| 4.7 | | | 37,100 | 35,100 | 33,400 |
| 5.0 | | 41,800 | 34,800 | 33,000 | 31,400 |
| 5.3 | | 39,400 | 32,900 | 31,100 | 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 | 32,100 |
| 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 | 19,6000 |
| 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 | | | | | |
| 14.5 | | | | | |
| 15.0 | | | | | |

# Corn Growth and Development

*Corey Bryant and Dewey Lee*

The most efficient means to profit from each individual management practice is to understand how the plant interacts with each input. The goal should be to provide all the inputs necessary to meet a certain yield goal at or 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 bulk density (compaction), climatic factors such as sunlight, temperature, and water, and management factors, such as crop protection and competition. Ask the question: Is the plant protected from disease pathogens, insects, naturally formed hardpans, nematodes, and other stress? As a grower, do you manage the crop to prevent stress? Any stress can negatively affect the plant growth rate and the yield components thus affecting yield potential. While it may not be practical to prevent all stress, it is best to ensure that all practices you plan are conducted in a timely manner to have the best effect possible.

The figure below 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.




Corn moves through growth stages very rapidly. Leaves are initiated and continue to grow while the reproductive structures (tassel and ears) are initiated and growing. The plant's first four to five leaves are visible inside the corn seed. Upon germination, they will begin to grow while the rest are initiated. In general, a corn plant may develop 18 to 20+ leaves. Typically, all leaf initiation is completed by the V6 stage when the tassel is initiated, followed shortly by initiation of the ear. The number of rows on an ear will begin to develop around V7. The initiation of florets (potential kernels) within a row soon follows and continues growing until 7 to 10 days prior to silk emergence. Potential kernels near the base of the ear develop first and progress towards the tip of the embryonic ear. The total numbers of harvestable grains are related to those kernels that pollinate and begin filling at the R1 stage.

As you can imagine, it does not take long to transition from the vegetative stages to the reproductive growth. If a plant is not healthy during the V3 to V5 stage, it will not have time to recover by the time the next yield component (number of rows) is determined. Stress during this time can undermine the overall yield potential of the plant. Since growing degree units (GDUs) are used to relate temperature to the various growth stages, it is important to recognize the different stages and understand how to calculate GDUs:

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

Where $T_{max}$ or maximum temperature is limited to 86°F, $T_{min}$ or minimum temperature is limited to 50°F, and $T_{base}$ or base temperature is set to 50°F. Here is an example: The high temperature for the day is 76 degrees and the low was 58 degrees. Then the calculation would be (76 + 58) ÷ 2 = 67. Then subtract $T_{base}$ (50°) from the average temperature 67° as follows: 67 - 50 = 17 to get 17 GDUs. Notice though that 86° is the maximum. So if the high temperatures exceed the maximum then you only use the $T_{max}$. Example: The high temperature is 95 and the low is 69. Then the formula would be as follows. (86 + 69) ÷ 2 = 77.5 Then (77.5 – 50 $T_{base}$) = 27.5 GDUs. In this example while 95 was the maximum daily temperature, 86 was used as $T_{max}$ is limited to 86°F.

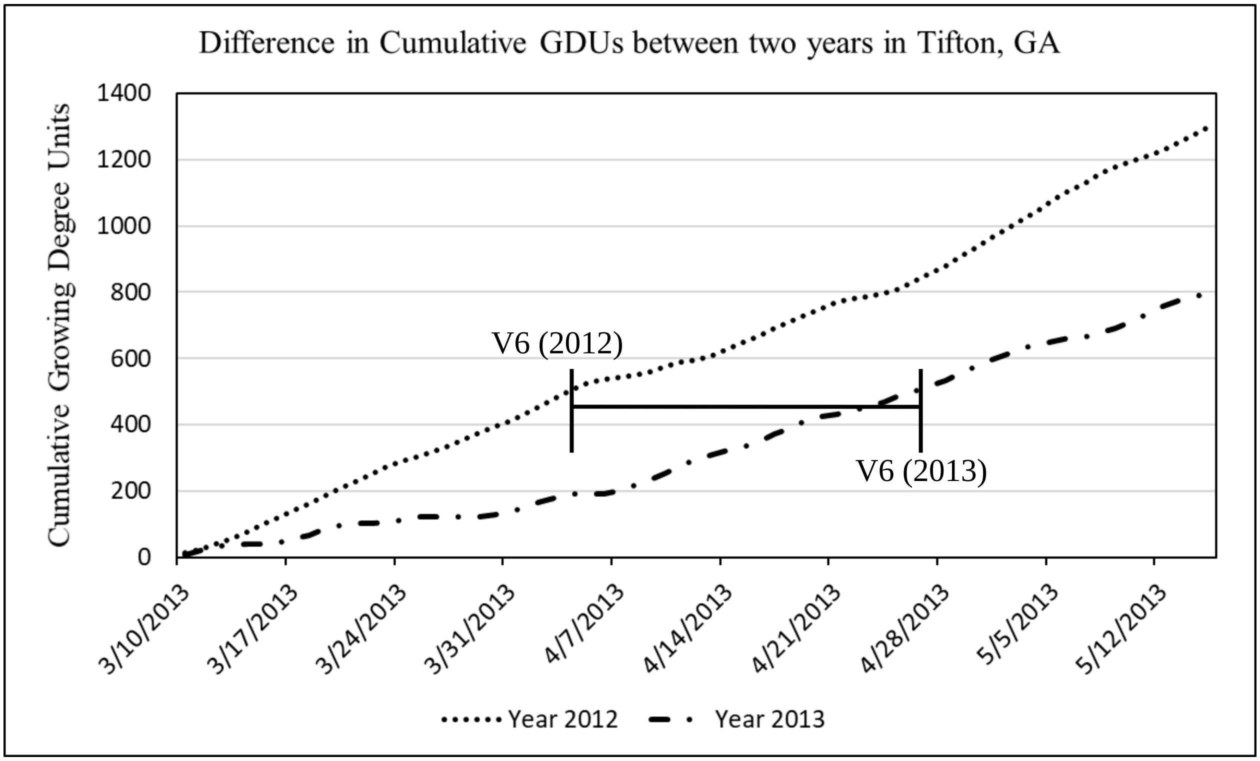
Most maturity information is based on the leaf collar method, where fully emerged leaves (uppermost mature leaf with a visible collar) are used to stage vegetative development. In general, a seedling will emerge between **90 and 120 GDUs** in the early spring. After emergence a new leaf collar will appear about every 84 GDUs until V10 to V11 at which the appearance of new collars is accelerated at approximately every 56 GDUs. Several growth stages and brief descriptions are provided in table 6.

**Table 6. Corn Growth Stages and Descriptions**

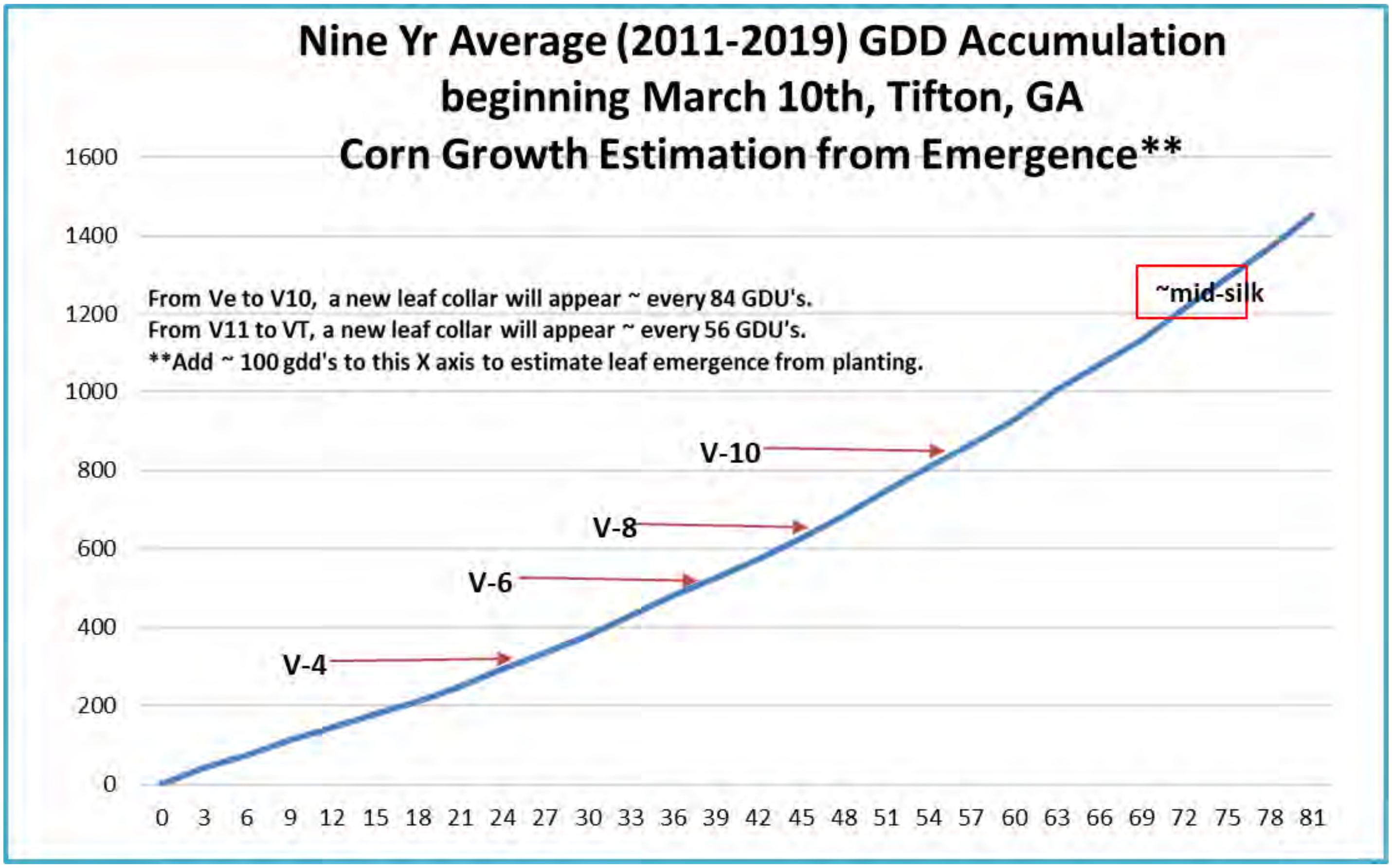
| Growth Stage | Appearance | Descriptions |
|---|---|---|
| VE | emergence | Coleoptile emergences through the soil just prior to the first leaf collaring |
| V3 | 3 collars | 3 leaves have fully visible leaf collars. Nodal roots are developing. |
| V6 | 6 collars | 6 leaves have visible collars and the growing point is above ground. The tassel and ear development is starting. Stress will affect the early reproductive phase. |
| V12 | 12 collars | The lower 3 to 4 leaves are likely missing. The numbers of potential kernels are being determined. Stress will reduce yield potential. |
| V15 | 15 collars | Potential kernel number is set. |
| VT | tassel | Last tassel branch is visible. Pollination occurring prior to full emergence. |
| R1 | silking | Silks beginning to emerge. VERY sensitive to stress. |
| R2 | blister | Ear length complete. Max potential kernel size is set. |
| R4 | dough | Kernel is about 70% moisture. |
| R5 | dent | Top of the kernel begins to dent. Starch line forming and progresses downward. |
| R6 | phys. mat. | Black layer formed and visible by cutting through the kernel. Moist. ~30-35%. |

While it is important to keep up with the GDUs, recognize that the accumulation is variable each year. The graph below demonstrates the variability between 2012 and 2013. In Georgia, the easiest and most accurate source of weather conditions can be found at http://www.georgiaweather.net. Select a station nearest your farm. Choose the icon "degree day calculator" and begin the calculation using the day of emergence and 50°F as the base and 86°F max. This will compare the current year with the previous three years. To be consistent, always note the day of emergence in order to make valid GDU comparisons each year. If you choose to use planting date, then always use planting date and not emergence. The illustration below uses accumulated GDU's from emergence and not planting. To compare the illustration to GDU's from planting, add ~ 100 to the scale on Y axis on the left.

The example below demonstrates the differences between years if a plant emerged on March 10th of each year. The horizontal line at GDU 504 is when the V6 growth stage is expected. In 2012, the V6 stage was reached approximately 25 days after emergence. However, it was much cooler in 2013, and the V6 was not reached for more than 45 days after emergence. For this reason, it is best to use GDUs after emergence and not number of days after emergence to accurately estimate the growth stage. However, if you find it difficult to be in your fields at or near emergence, on average, corn will emerge in approximately 100 + gdds after planting.  Make sure to add this to your calculations so as to correct for the number of gdds in total.




The graph below illustrates the average number of days to accumulate GDUs to reach various stages of growth.  After **emergence,** it took an average of 26 to 27 days to get to V4 but on average it took only 10 more days to get to V6.  If the crop is nutrient deficient at V4, it would take time to eliminate the deficiency in 10 days at which point, the reproductive phase has begun.  For this reason, top corn production requires preventing stress from planting to harvest to capture the most yield potential for that year.




The estimate of above corn growth stage is based on ISU publication PMR 1009 entitled "Corn Growth and Development" (Abendroth et al., 2011). The above graph assumes crop emergence after 100-105 GDD although scientific literature states emergence can occur after 90–120 accumulated GDD depending on many environmental factors such as ground cover, tillage practices, soil type, and solar radiation, etc. The above graph assumes the corn plant emerged on March 10$^{th}$ as a point of illustration. If you use the information above, you can add 100 gdds to average GDU on the left-hand side of the graph to estimate stages from days from planting rather than emergence.

## Fertilization

*Glen Harris*

By nature, soils of Georgia are acid 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 above ground plant parts. The removal of potassium is especially great in comparison to grain harvest. A comparison is given in Table 7 of the nutrients contained in grain and the stover.

**Table 7. Pounds of Nutrients Removed by the Grain and Stover of a 180-Bushel Corn Crop**

| Nutrient | Grain | Stover | Total |
|---|---|---|---|
| | ——— lbs/acre ——— | | |
| Nitrogen | 170 | 70 | 240 |
| Phosphorus (as $P_2O_5$) | 70 | 30 | 100 |
| Potassium (as $K_2O$) | 48 | 192 | 240 |
| Calcium | 15 | 42 | 57 |
| Magnesium | 16 | 34 | 60 |
| Sulfur | 14 | 16 | 30 |
| Zinc | 0.15 | 0.54 | 0.69 |

### Liming

Many Georgia corn fields are naturally acid. This acidity is primarily because of (1) increased use of nitrogen in acid forming 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 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 acid conditions, liming acid soils increases bacterial activity.

Moreover, dolomitic limestone can be a source of magnesium. 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 NOT recommended unless a severe nitrogen deficiency is detected.**

**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 through the use of 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 applications. 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 through 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 on-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. However, total phosphate requirements of the corn crop can often be supplied in the starter fertilizer. Since nutrients applied in starter fertilizers are a part of the total fertilizer program, using this recommended practice is not very costly.

Currently, the most popular starter fertilizer is ammonium polyphosphate (10-34-0). Monoammonium and diammonium phophates 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 making a decision 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. If you are using poultry litter, in general, you should be able to use about 65% of the nitrogen and 80% of the phosphorus and potassium contained in the litter the first year. For example, if you analysis is 50-50-50 per ton, and you apply two tons per acre, then credit your fertility program 65 lbs of nitrogen, phosphorus, and potassium the first year. At least 25% of the nitrogen should be available within the first two to three weeks after application and the remainder throughout the season.

## 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 kown 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, is made. Information such as soil test level, soil type, and 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 at the following url: http://aesl.ces.uga.edu/publications/plant/.

# SCHEDULING AND MANAGING CORN IRRIGATION

*Wesley Porter, Dewey Lee, Reagan Noland, and Corey Bryant*

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 major impact on yields and operating costs. To schedule irrigation for the most efficient use of water and to optimize production, it is necessary to frequently determine soil moisture conditions throughout the root zone of the crop being grown. A number of 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 field as the crop grows. The objective is to maintain a record of incoming and outgoing water so that an adequate balanced amount is maintained for crop growth. Growers require certain basic information to use a checkbook method. This information typically includes the soil type of the field and/or soil 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 10. 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 (either wet or dry) years. This means that in years that are drier than average the checkbook method would tend to under-irrigate and during years that are wetter than average it would tend to over-irrigate. The 2019 production season was a prime example of a year in which we had abnormally hot and dry weather. Many irrigation scheduling and application issues were observed during 2019 because of this reason. In most "average" years these problems are masked by supplemental rainfall, the lack of the rain during 2019 made these problems very prevalent across the state.

Checkbook type methods can be enhanced with other tools or methods such as the EASY pan method. The UGA EASY (Evaporation based Accumulator for Sprinkler enhanced Yield) Pan is designed to be easy to build and operate, economical, and representative of the water used by the crop in humid areas. A couple of its unique operating characteristics is the ability to read the unit from a distance and the fact that no record keeping is required. This makes the Easy Pan a simple tool for scheduling irrigation. The float based mechanism is designed to represent both the effective root depth of a crop and the soil water holding capacity. The covering screen on the pan unit is designed to limit evaporation to a level similar to the evapotranspiration rate (water use) of the particular crop being grown.

Expert systems such as Irrigator Pro (software by USDA www.irrigatorpro.org), or other scheduling software are 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 identify exactly when water is needed to replenish the root zone.

Soil moisture sensors (measuring devices) range in prices from $30 to $40 per sensor to $1000 + per sensor based on probe type and associated data logging and telemetry capabilities. With these probes, data loggers (additional expense) will be needed to log the data as the software is designed to accumulate the information. Each data logger collects information from several probes that might be used in the field. Some devices have the ability to collect and send information either through cellular, radio, or other wireless technology and will vary in price and abilities. Thus, collection of information becomes simple and data can be directly imported into your home computer, laptop, tablet, or smart phone. A few notable companies are: Meter (www.metergroup.com); Irrometer (www.irrometer.com); and AquaSpy (www.aquaspy.com). There are many other available devices on the market, it is up to the individual user to determine which type fits their individual situation and need.

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 10. 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 11 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<br>8-12 | .03<br>.05 |
| Two leaves expanded and nodal roots forming. | 13-17<br>18-22 | .07<br>.09 |
| Four to six leaves expanding. Growing point near surface.<br>Other leaves and roots developing. | 23-27<br>28-32<br>33-36 | .12<br>.14<br>.17 |
| Six to eight leaves.<br>Tassel developing. Growing point above ground. | 37-41<br>42-45 | .19<br>.21 |
| Ten to twelve leaves expanded. Bottom 2-3 leaves lost. Stalks growing rapidly. Ear shoots developing. Potential kernel row number determined. | 46-50<br>51-54 | .23<br>.25 |
| Twelve to sixteen leaves. Kernels per row and size of ear determined. Tassel not visible but about full size. Top two ear shoots developing rapidly. | 55-59<br>60-64 | .27<br>.29 |
| Tassel emerging, ear shoots elongating. | 65-69 | .31 |
| Pollination and silks emerging. | 70-74<br>75-79 | .32<br>.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 check-book 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 11, 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 10, 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. 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" Moderate intake, but rapid in first zone | 1.0 | 1.3 |
| Greenville | | | 1.4 |
| Marlboro | | | 1.2 - 1.5 |
| Cahaba | Loamy sand, 6-12" Loamy subsoil, rapid in first zone, moderate in second | 1.2 | 1.0 - 1.5 |
| Orangeburg | | | 1.0 - 1.3 |
| Red Bay | | | 1.2 - 1.4 |
| Americus | Loamy Sand , 40 to 60 inches Rapid permeability | 2.0 | 1.0 |
| Lakeland | | | 0.8 |
| Troup | | | 0.9 - 1.2 |
| Norfolk | Loamy sand, 12-18" rapid permeability | 1.3 | 1.0 - 1.5 |
| Ochlocknee | | | 1.4 - 1.8 |
| Dothan | Loamy sand and sandy loam 6-12", moderate intake | 1.0 | 1.0 - 1.3 |
| Tifton | | | 0.8 - 1.0 |
| Fuquay | Loamy sand, 24 - 36" | 1.5 | 0.6 - 8 |
| Lucy | | | 1.0 |
| Stilson | | | 0.9 |
| Wagram | | | 0.6 - 0.8 |

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

## 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.

Thus, if your field has a low yield potential, i.e. less than 150 bushels per acre or if you have a limited supply of water to you should not irrigate until you see "leaf curl" at the tassel stage. At this point apply 2-2.5 inches of water every 14 days (1-1.25 inches back-to-back may be necessary) until you receive a heavy rainfall or run out of water. In this case you would be deficit irrigating, and should not expect true irrigated yields from this field, as the irrigation would be strictly supplemental.

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 irrigations. 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 county agent.

# WEED MANAGEMENT IN FIELD CORN

*Eric 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 also 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% (34% 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 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.

The following table 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 2019, it was estimated that 89% of the field corn acreage in the United States 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 including Roundup Ready (RR) and Liberty-Link (LL).

***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.

Several field corn hybrids are now available that contain both the RR and LL technologies.

***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 will be 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.

## 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; Engenia (dicamba), Impact; Laudis; Liberty; Roundup (glyphosate); Status; Warrant, and Xtendimax (dicamba). 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 2). 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 |
|---|---|---|---|
| goosegrass | 1992 | Treflan | Microtubule inhibitor |
| prickly sida | 1993 | Scepter | ALS inhibitor |
| Italian ryegrass | 1995 | Hoelon, Poast | ACCase inhibitor |
| Palmer amaranth | 2000 | Cadre, Pursuit | ALS inhibitor |
| Palmer amaranth | 2005 | glyphosate | EPSP synthase inhibitor |
| Palmer amaranth | 2008 | Staple + glyphosate | ALS + EPSP |
| large crabgrass | 2008 | Poast | ACCase inhibitor |
| Palmer amaranth | 2008 | atrazine | PS II inhibitor |
| Italian ryegrass | 2009 | Hoelon + Osprey | ACCase + ALS |
| Palmer Amaranth | 2010 | atrazine + glyphosate + Staple + Cadre | PS II + EPSP + ALS |
| spotted spurge | 2014 | Manor, Blade | ALS inhibitor |
| yellow nutsedge | 2018 | Cadre | ALS inhibitor |

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 (V2-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 that are 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 due to the fact that 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, Clarity, 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, Fexapan, Status, Xtendimax). 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. The following sequential program 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 including Clarity, Engenia, Fexapan, Status, and Xtendimax. 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 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) was 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 Weed Control Programs

Generally, most herbicides registered for use 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, a grower should answer the following 4 questions: 1) What technologies am I planting (RR, LL, Enlist, conventional)?; 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. UGA Recommended Herbicide Programs for Field Corn Weed Control - 2020[1].

| Corn Hybrid/System | Preemergence | Early-Postemergence[1] (~17-30 DAP, V3-V5 stage, ~279-411 GDD's[2] ) | Layby/Directed (if needed) |
|---|---|---|---|
| ***Conventional*** | Atrazine[3] or Dual II Magnum or Warrant | 1) Prowl + Atrazine + Crop Oil or<br>2) Atrazine + ***<u>One</u>*** of the following: Callisto, Capreno, Impact/Impact Z, Laudis, Revulin Q, or Steadfast Q | Evik |
| ***Liberty-Link*** | Atrazine or Dual II Magnum or Warrant | 1) Liberty + Atrazine + ***<u>One</u>*** of the following: Prowl, Dual Magnum, Warrant, Zidua, Anthem Maxx or Acuron (40 oz/A) | |
| ***Roundup Ready*** | Atrazine or Dual II Magnum or Warrant | 1) Glyphosate + Atrazine + (Prowl or Dual Magnum or Warrant or Zidua or Anthem Maxx) or<br>2) Glyphosate + Atrazine + (Capreno or Impact/Impact Z or Laudis or Revulin Q or Steadfast Q) or<br>3) Glyphosate + Atrazine + (2,4-D or dicamba) or<br>4) Halex GT + Atrazine<br>5) Glyphosate + Acuron (48 oz/A) | |

***[1]Refer to the latest edition of the Georgia Pest Management Handbook – Special Bulletin 28 for additional information about application rates and precautions.***

***[2]When using Counter (INFR) for insect and nematode control, the following herbicides should <u>NOT</u> be applied POST: Acuron, Callisto, Capreno, Halex GT, Revulin Q, and Steadfast Q. A maximum of 2.0 to 2.5 lb ai/A of atrazine can be applied in a single year depending upon application methods.***

**[3]GDD's = growing degree days from planting (50°/86° F).**

# INSECT CONTROL IN FIELD CORN

*David Buntin*

Field corn in Georgia is subject to attack by many different 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 preventive insecticide use 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:

- **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.
- **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.
- **Plant at the recommended time:** Plantings of field corn at the recommended time often escapes serious damage by most insects.
- **Control Certain Weeds:** Nutsedge, bahiagrass, and johnsongrass may enhance infestations by certain insects.
- **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** contain the Cry1F toxin, which targets caterpillar pests including European and southwestern corn borers, fall armyworm, and other lepidopterans. Conversely, Herculex I provides little 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 Bt corn may not be effective against fall armyworm.
- **Triple Stacked Traits:** These hybrids contain a Bt caterpillar trait, a Bt rootworm trait plus herbicide tolerance or a three-way stack. Products with stalk protection, root protection and herbicide tolerance include Agrisure 3000GT or 3011, Herculex XTRA and YieldGard VT Triple. Most Triple stacked products have been replaced by pyramided products listed next.

- **Genuity® VT Triple PRO™**, **Genuity® VT Double PRO™, 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® by Dow** is an 8 gene combination and contain all the traits in Genuity VT Triple PRO plus all the traits in Herculex EXTRA. SmartStax provides good control of all target pests listed in Table 1 except corn earworm where control is fair.
- **PowerCore® by Dow** is similar to SmartStax but without the rootworm traits. Adapted hybrids with PowerCore may be available in 2020 or later.
- **Genuity® Trecepta™** is new in 2020 and contains 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™** is a 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™** by Pioneer is a product for the southern U.S. It 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. Optimum® Intrasect™ XTRA also has the rootworm trait in Herculex® XTRA.
- **Optimum Leptra™** by Pioneer 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% non-Bt seed mixed or blended in the bag of a Bt product. They include Genuity® SmartStax® RIB Complete, REFUGE ADVANCED Powered by SmartStax®, and several other products. **But RIB Bt corns products is 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 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.**

| 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 | Excellent | Good | Good | Poor | Good¶ | None |
| Agrisure 3000GT Agrisure 3011A | Cry1Ab Cry3A | Excellent | Poor | Good | Poor | Fair | Good |
| YieldGard VT Triple | Cry1Ab Cry3Bb | Excellent | Poor | Good | Poor | Fair | Good |
| Herculex XTRA | Cry1F Cry34/35Ab1 | Excellent | Good | Good | Poor | Good | Very Good |
| Genuity VT Triple Pro | Cry1A.105, Cry2A, Cry3Bb | Excellent | Poor | Very Good | Poor-Fair | Good | Good |
| Genuity VT Double Pro | Cry1A.105, Cry2A | Excellent | Poor | Very Good | Poor-Fair | Good | None |
| Genuity Trecepta | Cry1A.105, Cry2A Vip3A | Excellent | Very Good | Very Good | Excellent | Excellent | None |
| Genuity SmartStax Dow SmartStax | Cry1A.105, Cry2A, Cry1F Cry3Bb, Cry34/35Ab1 | Excellent | Good | Very Good | Fair | Very Good | Very Good |
| PowerCore | Cry1A.105, Cry2A, Cry1F | Excellent | Good | Very Good | Fair | Very Good | None |
| Agrisure Viptera 3110 | Cry1Ab, Vip3A | Excellent | Good | Good | Excellent | Excellent | None |
| Agrisure Viptera 3111 | Cry1Ab, Vip3A, mCry3A | Excellent | Good | Good | Excellent | Excellent | Good |
| Agrisure Viptera 3220 | Cry1Ab, Cry1F, Vip3A | Excellent | Very Good | Very Good | Excellent | Excellent | None |
| Optimum Intrasect | Cry1Ab, Cry1F | Excellent | Good | Very Good | Poor-Fair | Good | None |
| Optimum Leptra | Cry1Ab, Cry1F, Vip3A | Excellent | Very Good | Very Good | Excellent | Excellent | None |

*§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:** In 2019, 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 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:

**Seed Treatments:** Systemic seed treatments are only 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. Untreated seed or seed treated with a higher rate must be ordered with 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.

- <u>Poncho (clothianidin) 250</u>: 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 bug. The insecticide component of Acceleron™ on corn is clothianidin.
- <u>Cruiser (thiamethoxam) 250</u>: 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 rynaxypyr. Lumivia adds improved control of white grubs and cutworms over thiamethoxam alone.
- <u>Poncho 500 / Cruiser 500:</u> 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.
- <u>Poncho 1250 / Cruiser 1250</u>: 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.
- <u>Imidacloprid (various brands):</u> 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.

- <u>Counter (terbufos) 20G</u>: 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.
- <u>Lorsban (chlorpyrifos) 15G</u>: Apply as a T-band or band for control of cutworms and lesser cornstalk borer. Less effective against beetle type insects, wireworms and grubs. The label states that Lorsban is compatible with ALS herbicides; see herbicide labels for restrictions.
- <u>Phorate / Thimet (phorate) 20G</u>: 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. Chlorpyrifos (Lorsban 4E and similar products) is no longer labeled for use at-planting.

- <u>Capture (bifenthrin) 2EC, LFR(1.5)</u>: 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.
- <u>Force (tefluthrin) CS</u>**:** 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] | Seed-Corn maggot | Southern corn root-worm | Wire-worm | White Grubs | Lesser corn-stalk borer | Cut-worm | Chinch bug | Corn Bill-bug | Sugar-cane beetle |
|---|---|---|---|---|---|---|---|---|---|
| Counter 20G | E | E | E | E | P, nl | P, nl | F | F | P, nl |
| Lorsban 15G | E | E | G | G | G | G | P | P | P |
| 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 |
| Poncho 250 ST | G | E | G | F | G, nl | P-F | F-G | P, nl | F |
| Poncho 500 ST | E | E | G | E | G, nl | P-F | G | F | G |
| Poncho 1250 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 or Avicta Complete corn ST | E | E | G | G | G, nl | P | F | P, nl | P-F |
| Cruiser Maxx 1250 or Avicta Complete corn | 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 damage 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 2 to 3 days if not controlled.

**Billbugs** are 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** are 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** are 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. Chlorpyrifos or bifenthrin insecticides can be applied as a broadcast application before planting, and numerous insecticides are available for use at-planting for control of cutworms. 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** is a larva of a moth. It 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, chlorpyrifos (Lorsban and similar products) 15G applied as a band or T-band at planting also is an option, but dry conditions and lack of moisture may limit activity. Lesser cornstalk borer is very difficult to control after plant emergence.

**Chinch bugs** are 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 Poncho and Cruiser at the 250 rate will control low to moderate infestations, but the 500 rate provides 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 5% 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 good control.

**Thrips** are 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. The following table 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.**

| | **Percent leaf Area Destroyed** | | | | |
|---|---|---|---|---|---|
| **Leaf stage** | **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 in control. Most Bt corn products listed above will prevent serious damage by whorlworms.

**Cereal leaf beetle** is 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** are 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 caterpillar 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** is 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** 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 4 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 2 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.

**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 larva completes 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 are variable 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 hybrds 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 so control may only be fair and not be good in later plantings. Triple stack products and Optimum Intrasect™ only provide limited suppression (<50%) 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

The following table lists the relative efficacy (1 = very good, 5 = not effective) of register 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 army-worm larvae* | True army-worm larvae | Corn Billbug adults | Chinch bug | Corn earworm larvae in ear* | Cut-worm larvae | European corn borer larvae** | South-western 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 | ? | ? |
| Lorsban 4E | 2 | 1 | 4 | 2 | 4 | 1-3 | ? | ? |
| Lannate LV | 2 | 1 | nl | nl | 3 | nl | ? | ? |
| Intrepid 2F | nl | 2 | nl | nl | nl | nl | 1-2 | 1-2 |
| Prevathon 0.43 | 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 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Cobalt Advanced | 2 | 1 | 4 | 2 | 2 | 1-3 | 3 | 2-3 |
| Hero / Steed | 3 | 1-2 | 4 | 2 | 2 | 1 | 2 | 2 |
| Intrepid Edge | 2 | 2 | nl | nl | 2 | nl | 1 | 1 |
| Stallion | 2 | 1 | 4 | 2 | 2 | 1 | 3 | 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.

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

| 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 (high rate) | nl |
| Tombstone | 2 | 1-2 | 1-2 | nl | 1-2 | 3 (high rate) | nl |
| Fastac 0.83 | 2 | 1-2 | 1-2 | nl | 1-2 | 3 (high rate) | nl |
| Brigade 2EC (bifenthrin) | 2 | 1-2 | 1-2 | nl | 1-2 | 3 (high rate) | 3 |
| Delta Gold 1.5EC | 2 | 1-2 | 2 | nl | 1-2 | 4 (high rate) | nl |
| Declare | 2 | 1-2 | 1 | 4 | 1-2 | 3-4 (high rate) | nl |
| Warrior II (Karate) Zeon | 2 | 1-2 | 1 | 4 | 1-2 | 3-4 (high rate) | nl |
| Pounce 25 WP | ? | nl | ? | nl | nl | nl | nl |
| Mustang Maxx | 2 | 1-2 | 1 | nl | 1-2 | 4 (high rate) | nl |
| Sevin XLR Plus | 1-2 | 3 | 1 | nl | nl | nl | nl |
| Lorsban 4E | - | 1-2 | 1-2 | 3 | nl | nl | nl |
| Lannate LV | - | nl | 1-2 | nl | nl | nl | nl |
| Intrepid 2F | nl | nl | nl | nl | nl | nl | nl |
| Prevathon 0.43 | 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 (high rate) | nl |
| Consero | 2 | 1-2 | 2 | ? | 2 | 3-4 (high rate) | 3-4 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Cobalt Advanced | 2 | 3 | 1-2 | 3 | 1-2 | 3 (high rate) | nl |
| Intrepid Edge | nl | nl | nl | nl | nl | nl | nl |
| Hero / Steed | 1-2 | 1-2 | 1 | ? | 1-2 | 4 (high rate) | 3 |
| Stallion | 1-2 | 1-2 | 1 | 3 | 1-2 | 4 (high rate) | nl |

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.

# CORN: CORN INSECT CONTROL

| PEST | MATERIAL AND FORMULATION | MOA | AMOUNT PER ACRE OR PER 1000 FT OF ROW | LB. ACTIVE INGREDIENT PER ACRE | REI/PHI (Hours or Days) | REMARKS AND PRECAUTIONS |
|---|---|---|---|---|---|---|
| Preplant treatment for soil insects | *bifenthrin*<br>Brigade, Discipline, Fanfare, other brands 2EC | 3A | 3-4 fl oz | 0.047-0.062 | 24 H/<br>30 D | Use *bifenthrin* for grubs, wireworms, seedcorn maggot, and cut-worms. Broadcast using 20 GPA before planting and immediately incorporate into top 3” of soil. Plant crop as soon as possible after treatment. May be tank mixed with preplant herbicides. |
| | *chlorpyrifos*<br>Lorsban, Chlorpyrifos, Lorsban Advanced 3.755<br>(cutworms, armyworms only) | 1B | 2 pt | 1 | 24 H/<br>35 D | Use *chlorpyrifos* for cutworm and armyworm control in conservation tillage areas. Broadcast using 20 GPA before planting. Plant crop as soon as possible after treatment. |
| Soil Insects<br>At-planting: wireworm, grubs, S. corn rootworm, seed corn maggot, fire ants<br><br>(Also see sections for billbugs, cutworms, lesser cornstalk borer, and mid-season rootworms for these pests) | **SEED TREATMENTS** | | | | | All of these materials at the listed rates provide helpful control, but may not provide complete protection if population pressure is great. Risk of severe infestation is greater in reduced/no tillage, fallow land, following sod, poor soil conditions for seedling growth, and late-planted corn.<br><br>**NOTE:** Poncho and Cruiser are commercially applied seed treatments. The low rate may not provide good protection under severe infestations. These products also suppress aphids and chinch bugs on seedlings. Both insecticides available in combination with various fungicides under several brand names. Avicta Complete Corn contains Cruiser 500. Acceleron for corn contains Poncho 250 and Acceleron with VITiVO contains Poncho 500.<br><br>**NOTE:** At-planting treatment rates are for 1000 ft of row in 30- 40” rows. Per acre rates vary with row spacing; See labels for per acre rates for specific row spacing and for row spacings fewer than 30” apart.<br><br>**NOTE:** Apply Counter 20G as a T-band or in-furrow. Counter will interact with ALS-inhibiting herbicides like Accent, Beacon, and Option to cause severe plant injury. See corn weed section of this handbook and product labels for specific herbicide interactions and precautions.<br><br>**NOTE:** Phorate / Thimet (phorate) 20G also are labeled but not listed. Apply as a band application only; in-furrow applications may cause plant injury and stand loss. Due to the risk of plant injury, Counter 15G is a better choice. Phorate / Thimet will interact with ALS-inhibiting herbicides as noted for Counter.<br><br>**NOTE:** Apply Lorsban 15G at planting as a T-band or in-furrow. For wireworms apply in-furrow or use an insecticide seed treatment with T-band applications. Lorsban 15G is compatible with ALS-inhibitor herbicides. See corn weed section of this handbook and product labels for specific herbicide interactions and precautions.<br><br>**NOTE:** Apply Force 3G and *bifenthrin* products as an open- furrow T-band or in-furrow. Force and *bifenthrin* do not interact with ALS herbicides. |
| | *clothianidin*<br>Poncho 250, Acceleron, NipsIt Inside<br>Poncho 500, Acceleron with Poncho Vitivo; NipsIt Inside Poncho 1250; Acceleron with Poncho Vitivo 1250; PPST+Poncho 1250; NipsIt Inside | 4A | 0.25 mg (ai)/seed<br>0.5 mg (ai)/seed<br>1.25 mg (ai)/seed | –<br>–<br>– | 12 H/<br>– Not listed | |
| | *imidacloprid*<br>Gaucho 600, Attendant 600, Axcess, other brands | 4A | 0.6 mg (ai)/seed<br>1.34 mg (ai)/seed | | 12 H/<br>– | |
| | *thiamethoxam*<br>Cruiser 250 (5FS), PPST 250<br>Cruiser 1250 (5FS)<br>Cruiser 500 (5FS) | 4A | 0.25 mg (ai)/seed<br>1.25 mg (ai)/seed<br>0.5 mg (ai)/seed | –<br>–<br>– | 12 H/<br>45 D | |
| | *thiamethoxam + chlorantraniliprole*<br>PPST 250 Plus Lumivia | 4A | 0.25 mg (ai)/seed<br>+ 0.25 mg (ai)/seed | | 12 H/<br>45 D | |
| | **AT-PLANTING TREATMENT** | | | | | |
| | *bifenthrin*<br>Brigade, Capture, Fanfare, Discipline, other brands 2EC | 3A | 0.15-0.3 fl oz/1000 ft of row | 0.0023-0.0046/<br>1000 ft lb (ai)/A varies with row spacing | 24 H/<br>30 D | |
| | Capture LFR 1.5 | | 3.4-13.6 fl oz/A OR<br>0.2-0.78 fl oz/1000 ft of row | 0.04-0.16 lb (ai)/A | | |
| | Capture 3RIVE 3D | | 0.23-0.92 fl oz/1000 ft row | 0.05-0.2 | 12 H/<br>30 D | |
| | Capture 1.15G, similar products | | 6.4-8 oz /1000 ft | Varies w/row spacing | 24 H/<br>30 D | |
| | *chlorethoxyfos + bifenthrin*<br>Smart Choice 5G Smartbox | 11B +<br>3A | 3-3.5 oz / 1000 ft of row | Varies | 48 H/<br>– | |
| | *chlorpyrifos*<br>Lorsban 15G | 1B | 8 oz / 1000 ft | Varies | 12 H/<br>35 D | |
| | *tefluthrin*<br>Force 3G<br>Force CS | 3A | 4-5 oz /1000 ft of row<br>0.46-0.57 fl oz/1000 ft row | Varies | 12 H/<br>– | |
| | *terbufos*<br>Counter 20G | 1B | 4.5-6 oz / 1000 ft | Varies | 48 H/<br>30 D | |

## CORN INSECT CONTROL

| PEST | MATERIAL AND FORMULATION | MOA | AMOUNT PER ACRE OR PER 1000 FT OF ROW | LB. ACTIVE INGREDIENT PER ACRE | REI/PHI (Hours or Days) | REMARKS AND PRECAUTIONS |
|---|---|---|---|---|---|---|
| Soil Insect Mid-season: Western corn rootworm | **AT-PLANTING TREATMENT** | | | | | Western corn rootworm can be a problem in non-rotated corn in northern and central Georgia. Hybrids with Bt-rootworm traits are available and are effective against mid-season rootworms but are NOT effective against other soil insects. Bt-rootworm traits have a 20% refuge requirement.<br><br>**At-Planting Treatments:** Apply at-planting in a 6-7” band or T-band (if label permits) over the open seed furrow in front of the planter press wheel. Counter and Force can be applied in-furrow. For no-till where no incorporation is obtained with the press wheel, use Lorsban, or Counter in-furrow at indicated rates.<br><br>**NOTE:** Rates are for 30-40” row. See label for rates for specific row spacing. Most products cannot be used at the listed rate in less than 30 inch rows without exceeding the maximum labeled amount/A. See label for narrow rows.<br><br>**NOTE:** Poncho 1250 is available as a commercially applied seed treatment. Provides suppression only of western corn rootworms.<br><br>**NOTE:** Counter may interact with ALS herbicides like Accent and Beacon to cause plant injury. See corn weed control section of this handbook and product labels for herbicide interactions and precautions. |
| | *chlorethoxyfos + bifenthrin*<br>Smart Choice 5G Smartbox | 11B + 3A | 3-3.5 oz/1000 ft of row | Varies | 48 H/<br>– | |
| | *chlorpyrifos*<br>Lorsban 15G | 1B | 8 oz/1000 ft | Varies | 12 H/<br>35 D | |
| | *clothianidin*<br>Poncho 1250 | 4A | 1.25 mg (ai)/seed | – | 12 H/<br>– | |
| | *tefluthrin*<br>Force 3G<br>Force CS | 3A | 4-5 oz /1000 ft of row<br>0.46-0.57 fl oz/1000 ft row | Varies | 12 H/<br>– | |
| | *terbufos*<br>Counter 20G | 1B | 4.5-6 oz/1000 ft | Varies | 48 H/<br>30 D | |
| Soil Insects: Billbug, Sugarcane beetle | **SEED TREATMENTS/AT-PLANTING TREATMENT** | | | | | Beetles feed on seedling plants at or below soil line causing dead or dead-hearted plants. Generally problems are worse in reduced tillage, when a winter cover crop is used. Billbugs are often associated with nutgrass infestation and sugarcane beetle is often associated with bahiagrass infestation.<br><br>**At-Planting treatments:** Apply Counter as a T-band application. Apply Capture LFR in-furrow or in a 5-7” open furrow T band for sugarcane beetle control. Poncho 1250 and Cruiser 1250 are available only as a commercial seed treatment. Poncho 500 may<br>also provide suppression of billbug. Poncho 250 also provides fair-good control of sugarcane beetle.<br><br>**NOTE:** Counter may interact with ALS herbicides like Accent and Beacon to cause plant injury. See corn weed control section of this handbook and product labels for herbicide interactions and precautions.<br><br>**Post-emergence control:** Stand loss of 10% justifies control. Direct liquid sprays at base of plant using at least 25 gal/A of spray. Generally rescue treatments for sugarcane beetle are not effective. |
| | *bifenthrin*<br>Capture LFR | 3A | 3.4-6.8 fl oz | 0.04-0.08 lb ai | 12 H/<br>– | |
| | *clothianidin*<br>Poncho 500<br>Poncho 1250<br>NipsIt Inside | 4A | 0.50 mg (ai)/seed<br>1.25 mg (ai)/seed<br>See label | –<br>–<br>– | 12 H/<br>– | |
| | *terbufos*<br>Counter 20G | 1B | 4.5-6 oz/1000 ft | Varies | 48 H/<br>30 D | |
| | *thiamethoxam*<br>Cruiser 1250 | 4A | 1.25 mg (ai)/seed | – | 12 H/<br>45 D | |
| | *gamma cyhalothrin*<br>Declare 1.25<br>Proaxis 0.5 | 3A | 1.54 fl oz<br>3.84 fl oz | 0.015<br>0.015 | 24 H/<br>21 D | |
| | *lambda cyhalothrin*<br>Warrior II Zeon 2.08<br>Silencer, Lambda T, others 1CS | 3A | 1.92 fl oz<br>3.84 fl oz | 0.03<br>0.03 | 24 H/<br>21 D | |

## CORN INSECT CONTROL

| PEST | MATERIAL AND FORMULATION | MOA | AMOUNT PER ACRE OR PER 1000 FT OF ROW | LB. ACTIVE INGREDIENT PER ACRE | REI/PHI (Hours or Days) | REMARKS AND PRECAUTIONS |
|---|---|---|---|---|---|---|
| Soil Insects:<br>Lesser cornstalk borer | **PREPLANT/SEED TREATMENTS/AT-PLANTING** | | | | | Lesser cornstalk borer larvae tunnel into the seedling plant below the soil line causing dead or dead-hearted plants Larvae spin silken tubes at plant base. Hot, dry conditions, clean tillage, and late planting favor infestations. Difficult to control after planting; at-planting treatments are most effective.<br><br>**At-Planting:** Apply Lorsban 15G as a T-band and incorporate around seed.<br><br>**Post-emergence:** Direct spray at full rate in a band around base of plants and lightly incorporate. Apply before larvae enter plants. A rescue treatment once larvae tunnel into plants is rarely effective.<br><br>**NOTE:** Hybrids with Bt traits also may provide useful control. |
| | *chlorpyrifos*<br>Lorsban 15G | 1B | <br>8 oz/1000 ft | Varies | 24 H/<br>21 D | |
| | *clothianidin*<br>Poncho 500<br>Poncho 1250<br>NipsIt Inside | 4A | <br>0.5 mg (ai)/seed<br>1.25 mg (ai)/seed<br>See label | <br>–<br>–<br>– | 12 H/<br>– | |
| | *chlorpyrifos*<br>Lorsban, Nufos, other 4E,<br>Chlorpyrifos 4E | 1B | <br>2 pt | 1 | 24 H/<br>35 D | |
| | *gamma cyhalothrin*<br>Declare 1.25<br>Proaxis 0.5 | 3A | <br>1.54 fl oz<br>3.84 fl oz | <br>0.015<br>0.015 | 24 H/<br>21 D | |
| | *lambda cyhalothrin*<br>Warrior II Zeon 2.08<br>Silencer, Lambda, others 1 | 3A | <br>1.92 fl oz<br>3.84 fl oz | <br>0.03<br>0.03 | 24 H/<br>21 D | |
| Chinch bug | **AT-PLANTING** | | | | | **At-planting treatments:** Low (250) rates of Poncho and Cruiser seed treatments as applied at planting for soil insect control may suppress chinch bugs for up to 25 days after planting. Poncho 500, 1250, and Cruiser 1250 may control chinch bugs for several weeks after planting.<br><br>Counter 20G for suppression of light to moderate infestations.<br><br>**Post-emergence treatments:** Treat if bugs become numerous and wilting leaves are noticed. Usually not important after seedling stage. Chinch bug infestations are difficult to control. Treatment after boot stage is rarely effective. |
| | *clothianidin*<br>Poncho 250<br>Poncho 500<br>NipsIt Inside 5 | 4A | <br>0.25 mg (ai)/seed<br>0.5 mg (ai)/seed<br>See label | <br>–<br>–<br>– | 12 H/<br>– | |
| | *terbufos*<br>Counter 20G | 1B | <br>4.5-6 oz/1000 ft | Varies | 48 H/<br>30 D | |
| | *thiamethoxam*<br>Cruiser 250<br>Cruiser 1250 | 4A | <br>0.25 mg (ai)/seed<br>1.25 mg (ai)/seed | <br>–<br>– | 12 H/<br>45 D | |
| | *chlorpyrifos*<br>Lorsban, Nufos, other 4E,<br>Chlorpyrifos 4EC<br>Lorsban 75WG | 1B | <br><br>2 pt<br>1.33 lb | <br><br>1<br>1 | 24 H/<br>35 D | |
| | *gamma cyhalothrin*<br>Declare 1.25<br>Proaxis 0.5 | 3A | <br>1.54 fl oz<br>3.84 fl oz | <br>0.015<br>0.015 | 24 H/<br>21 D | |
| | *lambda cyhalothrin*<br>Warrior II Zeon 2.08<br>Silencer, Lambda T,<br>others 1CS | 3A | <br>1.92 fl oz<br>3.84 fl oz | <br>0.03<br>0.03 | 24 H/<br>21 D | |

# CORN INSECT CONTROL

| PEST | MATERIAL AND FORMULATION | MOA | AMOUNT PER ACRE OR PER 1000 FT OF ROW | LB. ACTIVE INGREDIENT PER ACRE | REI/PHI (Hours or Days) | REMARKS AND PRECAUTIONS |
|---|---|---|---|---|---|---|
| Aphids<br>(foliar treatments) | *bifenthrin*<br>Brigade, Capture, Fanfare, Discipline, other brands 2EC | 3A | 2.1-6.4 fl oz | 0.05-0.10 | 24 H/<br>30 D | Aphids seldom require control on field corn in Georgia. Natural enemies, mainly lady beetles, usually move in and rapidly control aphid infestations. During silking and tasseling, treat if aphids are so abundant they appear likely to interfere with pollination.<br><br>**NOTE:** Poncho and Cruiser seed treatments as applied at planting for soil insect control will control aphids on seedling corn for up to 30 days after planting. |
| | *dimethoate*<br>Dimethoate 2.67EC<br>Dimethoate 4E, 400 | 1B | <br>0.5 pt<br>2-3 pt | <br>0.25<br>0.5-0.75 | 48 H/<br>42 D | |
| | *esfenvalerate*<br>Asana XL, Adjourn 0.66EC | 3A | 5.8-9.6 fl oz | 0.03-0.05 | 12 H/<br>21 D | |
| | *flupyradifurone*<br>Sivanto Prime | 4D | 7-10.5 fl oz | 0.091-0.137 fl oz | 4H/<br>21 D | |
| | *sufloxaflor*<br>Transform WG | 4C | 0.75-1.5 oz | 0.023-0.047 | 24H/<br>7 D | |
| Armyworms:<br>True armyworm<br>Fall armyworm | *alpha-cypermethrin*<br>Fastac CS 0.83 | 3A | 1.8-3.8 fl oz | 0.012-0.025 | 12 H/<br>30 D | Reduced tillage and grassy weeds favor infestations. Seedling plants, treat if 25% of plants show defoliation including window-panning type defoliation and larvae are present. Treat within 48 hours.<br><br>Whorl stage plants, treat when 30% of the plants are infested. Use ground equipment and apply at least 20 gal of finished spray/A directed down into the whorls. Nozzles with large droplet size will aid in control.<br><br>**NOTE:** Bt-corn, especially YieldGard-CB, generally is not effective against true armyworm. See seed dealer for refuge requirements of Bt corn hybrids. |
| | *bifenthrin*<br>Brigade, Capture, Fanfare, Discipline, other brands 2EC | 3A | 2.1-6.4 fl oz | 0.033-0.01 | 24 H/<br>30 D | |
| | *beta-cyfluthrin*<br>Baythroid XL 1.0EC | 3A | 2.8 fl oz | 0.022 | 12 H/<br>21 D | |
| | *chlorantraniliprole*<br>Prevathon 0.43<br>(Fall armyworm only) | 28 | 14-20 fl oz | 0.047-0.09 | 4 H/<br>21 D | |
| | *chlorpyrifos*<br>Lorsban, Nufos, others 4E<br>Chlorpyrifos 4EC<br>Lorsban 75WG | 1B | <br>1-2 pt<br>2 pt<br>1.33 lb | <br>0.5-1<br>1<br>1 | 24 H/<br>35 D | |
| | *deltamethrin*<br>Delta Gold 1.5EC | 3A | 0.8 fl oz | 0.009 | 12 H/<br>21 D | |
| | *esfenvalerate*<br>Asana XL, Adjourn 0.6 6EC<br>(True armyworm only) | 3A | 9.6 fl oz | 0.05 | 12 H/<br>21 D | |
| | *gamma cyhalothrin*<br>Declare 1.25<br>Proaxis 0.5 | 3A | <br>1.54 fl oz<br>3.84 fl oz | <br>0.015<br>0.015 | 24 H/<br>21 D | |
| | *lambda cyhalothrin*<br>Warrior II Zeon 2.08<br>Silencer, Lambda T, others 1CS | 3A | <br>1.92 fl oz<br>3.84 fl oz | <br>0.03<br>0.03 | 24 H/<br>21 D | |
| | *methomyl*<br>Lannate, Annihilate, other brands 2.4LV | 1A | 0.75-1.5 pt | 0.225-0.45 | 48 H/<br>21 D | |
| | *methoxyfenozide*<br>Intrepid 2F<br>(True armyworm only) | 18 | 4-16 fl oz | 0.06-0.25 | 24 H/<br>30 D | |

## CORN INSECT CONTROL

| PEST | MATERIAL AND FORMULATION | MOA | AMOUNT PER ACRE OR PER 1000 FT OF ROW | LB. ACTIVE INGREDIENT PER ACRE | REI/PHI (Hours or Days) | REMARKS AND PRECAUTIONS |
|---|---|---|---|---|---|---|
| Armyworms: True armyworm Fall armyworm (*continued*) | *spinetoram* Radiant 1SC | 5 | 3-6 fl oz | 0.234-0.0469 | 4 H/ 28 D | |
| | *spinosad* Blackhawk (36%) | 5 | 1.67-3.3 oz | 0.038-0.075 | 4 H/ 28 D | |
| | *zeta-cypermethrin* Mustang Maxx, Respect | 3A | 4 fl oz | 0.025 | 12 H/ 30 D | |
| Corn earworms, Fall armyworms (**In ears**) | *chlorantraniliprole* Prevathon 0.43 | 28 | 14-20 fl oz | 0.047-0.09 | 4 H/ 21 D | Corn earworm and fall armyworm in ears are difficult to control. Usually not economical to keep these insects out of the ears using insecticides. Apply Prevathon when eggs are being laid on silks and before larvae move into the ear. Bt-trait in Genuity, Trecepta, Agrisure Viptera, and Optimum Leptra will reduce infestation and ear/kernel damage by corn earworm and fall armyworm. Other single Bt traits are not effective in preventing ear damage. |
| | *methoxyfenozide + spinetoram* Intrepid Edge | 5 + 18 | 8-12 fl oz | | 24 H/ 28 D | |
| | Bt-trait corn Genuity Trecepta Agrisure Viptera Optimum Leptra | 11A | Insecticide produced in plant | | | |
| Cutworms | *alpha-cypermethrin* Fastac CS, other brands 0.83 | 3A | 1.8-3.8 fl oz | 0.012-0.025 | 12 H/ 30 D | Several species including black, dingy and variegated cutworms. Reduced tillage conditions, plant residue, winter cover crops, and winter grassy weeds favor infestation.<br><br>**Pre-plant** broadcast application within 2 weeks of planting may provide helpful control of large cutworms. Use intermediate to highest rate listed. Most products can be tank mixed with a pre-plant herbicide.<br><br>**At planting** apply insecticide as a band or T-band over the row. Check label for specific banding directions.<br><br>**NOTE:** Poncho 1250 as applied at planting for soil insect control also will reduce cutworm damage.<br><br>**NOTE**: Some Bt traits are effective at preventing cutworm damage. |
| | *beta-cyfluthrin* Baythroid XL 1EC | 3A | 1.6 fl oz | 0.013 | 12 H/ 21 D | |
| | *bifenthrin* Bifenthrin, Capture, Discipline, Fanfare, other brands 2EC | 3A | PPI & PRE: 3-4 fl oz/A (0.047-0.062 lb AI) POST: 2.1-6.4 fl. oz/A (0.033-0.10) | 0.033-0.10 | 24 H/ 30 D | |
| | *chlorpyrifos* Lorsban, Nufos, other 4E<br>Chlorpyrifos 4EC<br>Lorsban 75WG | 1B | 1-2 pt<br>2 pt<br>1.33 lb | 0.5-1<br>1<br>1 | 24 H/ 35 D | |
| | *cyfluthrin* Tombstone 2 | 3A | 1.6 fl oz | 0.025 | 12 H/ 21 D | |
| | *deltamethrin* Delta Gold 1.5EC | 3A | 0.8 fl oz | 0.009 | 12 H/ 21 D | |
| | *esfenvalerate* Asana XL, Adjourn 0.66EC | 3A | 9.6 fl oz | 0.05 | 12 H/ 21 D | |
| | *gamma cyhalothrin* Declare 1.25<br>Proaxis 0.5 | 3A | 1.54 fl oz<br>3.84 fl oz | 0.015<br>0.015 | 24 H/ 21 D | |
| | *lambda cyhalothrin* Warrior II Zeon 2.08<br>Silencer, Lambda T, others 1CS | 3A | 1.28-1.6 fl oz<br>1.92-3.2 fl oz | 0.02-0.025<br>0.02-0.025 | 24 H/ 21 D | |
| | *permethrin* others 3.2EC | 3A | 4-6 fl oz | 0.1-0.15 | 12 H/ 30 D | |
| | *zeta-cypermethrin* Mustang Maxx, Respect 0.8EC | 3A | 2.8-4 fl oz/A or 0.16 fl oz/1000 ft | 0.014-0.025 | 12 H/ 7 D | |

## CORN INSECT CONTROL

| PEST | MATERIAL AND FORMULATION | MOA | AMOUNT PER ACRE OR PER 1000 FT OF ROW | LB. ACTIVE INGREDIENT PER ACRE | REI/PHI (Hours or Days) | REMARKS AND PRECAUTIONS |
|---|---|---|---|---|---|---|
| European corn borer, Southwestern corn borer | *bifenthrin*<br>Bifenthrin, Capture, Fanfare, Discipline, other brands 2EC | 3A | 2.1-6.4 fl oz | 0.033-0.10 | 24 H/<br>30 D | **EUROPEAN CORN BORER:** Insecticides must be applied before larvae bore into stalks. Whorl stage (1st generation), treat if numerous egg masses are found in the field (treat just as eggs hatch) or when 50% of the plants have leaf feeding and live, small larvae are found. Tasseling stage (2nd generation), treat when the corn is in the early-tasseling stage and moths are active in the field.<br><br>**SOUTHWESTERN CORN BORER:** Currently restricted to northwestern Georgia. Infestations usually worse in late-planted fields. Comments on European corn borer also apply to southwestern corn borer.<br><br>**NOTE:** All Bt-corn products currently on the market are very effective against both borer species. See seed dealer for refuge requirements of Bt corn hybrids.<br><br>**NOTE:** Blackhawk/Tracer is most effective against small larvae. |
| | Bt-trait corn | 11A | Insecticide produced in plant | | | |
| | *chlorantraniliprole*<br>Prevathon 0.43 | | 14-20 fl oz | 0.047-0.09 | 4 H/<br>21 D | |
| | *chlorpyrifos*<br>Lorsban, Nufos, other 4E<br>Chlorpyrifos 4EC<br>Lorsban 75WG | 1B | 1-2 pt<br>2 pt<br>1.33 lb | 0.5-1<br>1<br>1 | 24 H/<br>35 D | |
| | *gamma cyhalothrin*<br>Declare 1.25<br>Proaxis 0.5 | 3A | 1.28-1.54 fl oz<br>3.20-3.84 fl oz | 0.0125-0.015<br>0.0125-0.015 | 24 H/<br>21 D | |
| | *lambda cyhalothrin*<br>Warrior II Zeon 2.08, Silencer, Lambda T, others 1CS | 3A | 1.6-1.92 fl oz<br>3.2-3.84 fl oz | 0.025-0.003<br>0.025-0.003 | 24 H/<br>21 D | |
| | *methoxyfenozide*<br>Intrepid 2F | 18 | 4-16 fl oz | 0.06-0.25 | 24 H/<br>30 D | |
| | *methoxyfenozide + spinetoram*<br>Intrepid Edge | 5 + 18 | 4-12 fl oz | | 24 H/<br>28 D | |
| | *spinosad*<br>Blackhawk (36%) | 5 | 1.67-3.3 oz | 0.038-0.075 | 4 H/<br>28 D | |
| Grasshoppers | *alpha-cypermethrin*<br>Fastac CS, other brands 0.83 | 3A | 2.7-3.8 fl oz | 0.017-0.025 | 12 H/<br>30 D | Generally, a problem in reduced tillage and along field margin. Products listed are most effective against small to medium sized nymphs. Adults are highly mobile and may re-infest soon after treatment. |
| | *beta-cyfluthrin*<br>Baythroid XL 1EC | 3A | 2.1-2.8 fl oz | 0.0165-0.022 | 12 H/<br>21 D | |
| | *bifenthrin*<br>Bifenthrin, Capture, Discipline, Fanfare, other brands 2EC | 3A | 2.1-6.4 fl. oz | 0.033-0.10 | 24 H/<br>30 D | |
| | *chlorpyrifos*<br>Lorsban, Nufos, other 4E<br>Chlorpyrifos 4EC<br>Lorsban 75WG | 1B | 0.5-2 pt<br>0.5-2 pt<br>1.33 lb | 0.25-1<br>0.25-1<br>1 | 24 H/<br>35 D | |
| | *cyfluthrin*<br>Tombstone 2 | 3A | 2.1-2.8 fl oz | 0.033-0.044 | 12 H/<br>21 D | |
| | *deltamethrin*<br>Delta Gold 1.5EC | 3A | 1.5 fl. oz | 0.018 | 12 H/<br>21 D | |
| | *dimethoate*<br>Dimethoate 400, 4EC | 3A | 1 pt | 0.5 | 48 H/<br>28 D | |
| | *esfenvalerate*<br>Asana XL, Adjourn 0.66EC | 3A | 5.8-9.6 fl oz | 0.03-0.05 | 12 H/<br>21 D | |

## CORN INSECT CONTROL

| PEST | MATERIAL AND FORMULATION | MOA | AMOUNT PER ACRE OR PER 1000 FT OF ROW | LB. ACTIVE INGREDIENT PER ACRE | REI/PHI (Hours or Days) | REMARKS AND PRECAUTIONS |
|---|---|---|---|---|---|---|
| Grasshoppers<br>(*continued*) | *gamma cyhalothrin*<br>Declare 1.25<br>Proaxis 0.5 | 3A | 1.02-1.54 fl<br>3A3AG RG AW G | 0.01-0.015<br>0.01-0.015 | 24 H/<br>21 D | |
| | *lambda cyhalothrin*<br>Warrior II Zeon 2.08, Silencer,<br>Lambda T, others 1CS | 3A | 1.28-1.92 fl. oz<br>2.56-3.84 fl oz | 0.02-0.03<br>0.02-0.03 | 24 H/<br>21 D | |
| | *zeta-cypermethrin*<br>Mustang Maxx, Respect<br>0.8EC | 3A | 2.72-4 fl oz | 0.017-0.025 | 12 H/<br>7 D | |
| Beetle Adults:<br>Cereal Leaf beetles,<br>Flea beetles,<br>Japanese beetle,<br>Corn rootworm<br>adults | *alpha-cypermethrin*<br>Fastac CS 0.83 | 3A | 2.7-3.8 fl oz | 0.017-0.025 | 12 H/<br>30 D | LEAF FEEDING by CEREAL LEAF BEETLES, FLEA BEETLES, JAPANESE BEETLES: Leaf feeding on whorl stage plants usually in late spring. Cereal leaf beetles move out of maturing small grain fields and infest nearby corn fields. Usually only border rows are damaged and may need control. Treat if beetles become numerous and their feeding damage exceeds 25% leaf area loss.<br><br>SILK FEEDING by JAPANESE BEETLE, CORN ROOTWORM ADULTS: Feeding on silks by beetles during pollination. Treat if 2 or more Japanese beetles or 5 or more rootworm beetles are present AND most silks are being clipped to within an inch of the ear tip.<br><br>**NOTE:** During pollination, Sevin (*carbaryl*) has a bee caution. Notification of beekeepers in the area may be needed. See label for details. |
| | *beta-cyfluthrin*<br>Baythroid XL 1EC | 3A | 2.1-2.8 fl oz | 0.0165-0.022 | 12 H/<br>21 D | |
| | *bifenthrin*<br>Bifenthrin, Capture, Fanfare,<br>Discipline, other brands 2EC | 3A | 2.1-6.4 fl oz | 0.033-0.10 | 24 H/<br>30 D | |
| | *carbaryl*<br>Sevin, other brands 4.0 | 1A | 1-2 qt | 1-2 | 24 H/<br>48 D | |
| | *cyfluthrin*<br>Tombstone 2 | 3A | 1.6-2.8 fl oz | 0.025-0.044 | 12 H/<br>21 D | |
| | *gamma cyhalothrin*<br>Declare 1.25<br>Proaxis 0.5 | 3A | 1.02-1.54 fl oz<br>2.56-3.84 fl oz | 0.01-0.015<br>0.01-0.015 | 24 H/<br>21 D | |
| | *lambda cyhalothrin*<br>Warrior II Zeon 2.08<br>Silencer, Lambda T,<br>others 1CS | 3A | 1.28-1.92 fl oz<br>2.56-3.84 fl oz | 0.02-0.03<br>0.02 -0.03 | 24 H/<br>21 D | |
| | *permethrin*<br>others 3.2EC | 3A | 4-6 fl oz | 0.1-0.15 | 12 H/<br>21 D | |
| | *zeta-cypermethrin*<br>Mustang Maxx, Respect<br>0.8EC | 3A | 2.72-4 fl oz | 0.017-0.025 | 12 H/<br>7 D | |
| Spider Mites | *bifenthrin*<br>Bifenthrin, Capture, Fanfare,<br>Discipline, other brands 2EC | 3A | 5.12-6.4 fl oz | 0.08-0.10 | 24 H/<br>30 D | MITES: Treat if infestations become widespread, leaf discoloration is evident, and 1-2 lower leaves are dying. *Bifenthrin* products: Use 6.4 fl oz rate alone OR use 5.1 fl oz rate tank mixed with *dimethoate* at 0.5 lb (AI)/A. |
| | *dimethoate*<br>Dimethoate 2.67EC<br>Dimethoate 4E, 400 | 1B | Tank mix *dimethoate* at 0.5 lb (AI)/A with *bifentrhin* | | 48 H/<br>42 D | |
| | *etoxazole*<br>Zeal 72WSP | 10B | 1-3 oz | 0.045-0.135 | 12 H/<br>21 D | |

## CORN INSECT CONTROL

| PEST | MATERIAL AND FORMULATION | MOA | AMOUNT PER ACRE OR PER 1000 FT OF ROW | LB. ACTIVE INGREDIENT PER ACRE | REI/PHI (Hours or Days) | REMARKS AND PRECAUTIONS |
|---|---|---|---|---|---|---|
| Spider Mites (*continued*) | *hexythiazox*<br>Onager 1 | 10A | 10-24 fl oz | 0.078-0.1875 | 12 H/<br>30 D | Apply at first sign of mites before population begins to build. |
| | *propargite*<br>Comite II 6 | 12C | 1.5-2.25 pt | 1.125-1.6875 | 13 H/<br>30 D | Only apply to dry foliage. Do not tank mix; do not use an oil-based surfactant. See label for additional restrictions. |
| | *spiromesifen*<br>Oberon 2SC<br>Oberon 4SC, | 23 | 5.7-8.5 fl oz<br>2.85-8 fl oz | 0.087-0.13<br>0.087-0.25 | 13 H/<br>30 D | Use 8.5 fl oz rate for large infestations. A NIS adjuvant is beneficial. |
| Stink bugs | **BROWN STINK BUGS** | | | | | SEEDLING STAGE: Treat if 5% of seedling plants have damage and stink bugs are present. Poncho 250, 500, and 1250 will suppress stink bug damage to seedlings for a few weeks after planting.<br><br>EAR STAGE: Corn is most sensitive to stink bug injury during ear formation before silking. Treat if 25% (1/4) of plants in the ear zone are infested with stink bugs.<br><br>KERNEL FILL: During early kernel filling bugs feed through the husk damaging individual kernels. Treat if 50% (1/2) of ears are infested.<br><br>**NOTE:** Use pyrethroids (Baythroid, Capture, Delta Gold, Fastac CS, Mustang, Karate, Warrior, Declare, Proaxis, Tombstone) if southern green stink bug is present. These products are less effective against brown stink bug.<br><br>**NOTE:** Bidrin as used on cotton is not registered for use on corn. |
| | *bifenthrin*<br>Bifenthrin, Capture, Discipline, Fanfare, others 2EC | 3A | 6.4 fl oz | 0.10 | 12 H/<br>30 D | |
| | *bifentrhin + zeta cypermethrin*<br>Hero<br>Speed | 3A | 10.3 fl oz<br>4.7 fl oz | *bifenthrin* 0.10<br>*bifenthrin* 0.10 | 12 H/<br>30 D | |
| | **GREEN/SOUTHERN GREEN STINK BUGS** | | | | | |
| | *alpha-cypermethrin*<br>Fastac CS, other brands 0.83 | 3A | 3.2-3.8 fl oz | 0.020-0.025 | 12 H/<br>30 D | |
| | *beta-cyfluthrin*<br>Baythroid XL 1EC | 3A | 2-2 8 fl oz | 0.015-0.022 | 12 H/<br>21 D | |
| | *bifenthrin*<br>Bifenthrin, Capture, Discipline, Fanfare, other brands 2EC | 3A | 3.2-6.4 fl oz | 0.05-0.10 | 24 H/<br>30 D | |
| | *cyfluthrin*<br>Tombstone 2 | 3A | 2.1-2.8 fl oz | 0.033-0.044 | 12 H/<br>21 D | |
| | *gamma cyhalothrin*<br>Declare 1.25<br>Proaxis 0.5 | 3A | 1.28-1.54 fl oz<br>3.20-3.84 fl oz | 0.0125-0.015<br>0.0125-0.015 | 24 H/<br>21 D | |
| | *lambda cyhalothrin*<br>Warrior II Zeon 2.08, Silencer, Lambda T, others 1CS | 3A | 1.6-1.92 fl oz<br>3.2-3.84 fl oz | 0.025-0.03<br>0.025-0.03 | 24 H/<br>21 D | |
| | *zeta-cypermethrin*<br>Mustang MAX, Respect 0.8EC | 3A | 3.2-4 fl oz | 0.02-0.025 | 12 H/<br>7 D | |

| PEST | MATERIAL AND FORMULATION | MOA | AMOUNT PER ACRE OR PER 1000 FT OF ROW | LB. ACTIVE INGREDIENT PER ACRE | REI/PHI (Hours or Days) | REMARKS AND PRECAUTIONS |
|---|---|---|---|---|---|---|
| Thrips | **SEEDLING CONTROL** | | | | | Treat if field is heavily infested and new leaves show excessive damage. Rarely causes yield loss on field corn. Seed treatments provide suppression; low (250) rate usually not effective.<br><br>**NOTE:** Blackhawk/Tracer 4SC as applied for fall armyworm may provide helpful control. |
| | *clothianidin*<br>Poncho 500<br>Poncho 1250<br>NipsIt Inside 5 | 4C | <br>0.50 mg (ai)/seed<br>1.25 mg (ai)/seed<br>See label | <br>–<br>–<br>– | 12 H/<br>– | |
| | *thiamethoxam*<br>Cruiser Extreme 1250 | 4C | 1.25 mg (ai)/seed | – | 12 H/<br>45 D | |
| | **FOLIAR TREATMENT** | | | | | |
| | *chlorpyrifos*<br>Lorsban, Chlorfos,<br>Chlorpyrifos 4E | 1B | 1-2 pt | 0.5-1 | 24 H/<br>35 D | |

**Premixed or Co-Packed Insecticides**: Products listed are available as premixes or co-packages of two insecticide active ingredients. User should check mixture labels for active ingredient, specific use rates, target pests, and precautions.

| BRAND NAME (ACTIVE INGREDIENTS) | RANGE OF FORMULATION RATES |
|---|---|
| Besiege (*lambda-cyhalothrin*, *clorantraniliprole*) | 5-10 fl oz/A |
| Cobalt Advanced (*chlorpyrifos*, *gamma-cyhalothrin*) | 6-38 fl oz/A |
| Consero (*spinosad*, *gamma-cyhalothrin*) | 2-3 fl oz/A |
| Hero (*zeta-cypermithrin*, *bifenthrin*)<br>Steed (*zeta-cypermithrin*, *bifenthrin*) | 2.6-10.3 fl oz/A<br>2.5-4.7 fl oz/A |
| Intrpid Edge (*methoxyfenozide*, *spinetoram*) | 4-12 fl oz/A |
| Stallion (*chlorpyrifos*, *zeta-cypermethrin*) | 3.75-11.75 fl oz/A |

**Bt-TRAITS FOR CORN:** Most corn hybrids now contain one or more Bt traits. Some traits target caterpillar pests including corn borers, cutworms, fall armyworm, and corn earworm in the whorl, and corn earworm and fall armyworm in the ears. Hybrids with two or three stacked traits for caterpillar control will be available for the 2011 season. Hybrids also may contain one or more Bt traits for control of western corn rootworms that attack roots during mid-season. Bt-rootworm traits are effective against mid-season rootworms but are NOT effective on seedlings against southern corn rootworm or other soil insects such as wireworms and white grubs. Depending on specific traits, refuge requirements for hybrids with Bt traits are either 20% or 50% of the corn acreage on a farm. Check with seed supplier for a complete list of resistant management restrictions. A table listing various combinations of Bt traits and relative efficacy against pests in Georgia is in the Insect Control section of the current Georgia Corn Production Handbook and on the Georgia Grain web page.

## CORN INSECT CONTROL

# INSECTICIDE USE RESTRICTIONS FOR FIELD CORN

| INSECTICIDE | BRAND NAME | DAYS TO GRAIN HARVEST | DAYS TO GRAZING OR SILAGE HARVEST | RESTRICTED ENTRY INTERVAL (REI, HOURS) | MAXIMUM AMOUNT ALLOWED PER ACRE PER CROP | REMARKS |
|---|---|---|---|---|---|---|
| *alpha-cypermethrin* | Fastac CS | 30 | 60 | 12 | 11.4 fl oz | |
| *bifenthrin* | Brigade, Capture, Bifenthrin, Discipline, Fanfare 2E | 30 | 30 | 24 | 19.2 fl oz | Use of *bifenthrin* is prohibited in all coastal counties. |
| *beta cyfluthrin* | Baythroid XL 1EC | 21 | 0 | 12 | 11.2 fl oz<br>(4 applications) | Only 1 application from early dent to 21 days before harvest. |
| *carbaryl* | Sevin, Carbaryl 4 | 48 | 14 | 2<br>4 | 8 qt | Bee caution. Beekeeper notification may be needed. See label for details. |
| *chlorantraniliprole* | Coragen 1.67SC<br>Prevathon 0.43 | 14 | 14<br>1 (grazing) | 4 | 15.4 fl oz | Do not apply fewer than 7 days apart. |
| *chlorpyrifos* | Lorsban 15G | 35 | 14 | 12 | 13.5 lb | |
| *chlorpyrifos* | Lorsban 4E, others | 35 | 14 | 24 | 15 pt | |
| *chlorethoxyfos + bifenthrin* | Smart Choice 5G | at-planting only | – | 48 | 1 application/year | In-furrow only. Do not apply as a surface band application. Registration in Georgia expected by 2013. |
| *clothianidin* | Poncho 600 sold as Poncho 250 and Poncho 1250 | Not Listed | Not Listed | 0 | seed treatment | Commercially applied. See label for plant back restrictions. |
| *cyfluthrin* | Tombstone 1 | 21 | 0 | 12 | 11.2 fl oz | Only 1 application from early dent to 21 days before harvest. |
| *deltamethrin* | Delta Gold 1.5EC | 21 | 12<br>21 (fodder) | 12 | 8.1 fl oz<br>(5 applications) | Do not apply fewer than 21 days apart. |
| *dimethoate* | Dimethoate | 42 | 14 | 48 | 3 applications | Do not apply during pollen shed. |
| *esfenvalerate* | Asana XL, Adjourn | 21 | Not Listed | 12 | 48 fl oz | Do not apply more than 0.25 lb (ai) per acre per season. |
| *gamma cyhalothrin* | Declare 1.25,<br>Proaxis 0.5 | 21 | 21 | 24 | 0.48 pt<br>0.96 pt | See label for additional restrictions. |
| *hexythiazox* | Onager | 30 | 20 | 12 | 1 application | 15-20 GPA by ground or 5 GPA by air; see label. |
| *lambda cyhalothrin* | Warrior II Zeon 2.08,<br>Silencer, other brands 1 | 21 | 21 | 24 | 0.96 pt<br>0.48 pt | See label for restrictions. |
| *methozyfenozide* | Intrepid 2F | 21 | 21 | 4 | 64 fl oz | |
| *spiromesifen* | Oberon 4SC | 30 | 5 | 12 | See label | |
| *permethrin* (foliar) | Permethrin | 30 | 0 | 12 | 24 fl oz | |
| *methomyl* | Lannate 2.4LV, 90SP | 21 | 3 | 48 | 2.25 lb ai | |
| *phorate* | Phorate, Thimet 20G | 30[1] | 30 | 48 | 1 application;<br>6.5 lb/A | Do not apply in-furrow or after cultivation. |

| INSECTICIDE | BRAND NAME | DAYS TO GRAIN HARVEST | DAYS TO GRAZING OR SILAGE HARVEST | RESTRICTED ENTRY INTERVAL (REI, HOURS) | MAXIMUM AMOUNT ALLOWED PER ACRE PER CROP | REMARKS |
|---|---|---|---|---|---|---|
| *propargite* | Comite II | 30 | 30 | 7 days | 1 application | Only apply to dry foliage, DO NOT tank mix, do not use an oil-based surfactant. Use minimum of 20 GPA by ground and 5 GPA for aerial applications. |
| *spinosad* | Tracer 4SC<br>Blackhawk 36% | 28 | 7 | 4 | 6 fl oz<br>8.3 oz | Most effective against small larvae. |
| *spiromesifen* | Oberon 2SC | 30 | 5 | 12 | 17 fl oz and<br>2 applications | Use at least 10 GPA by ground and 5 GPA by air. |
| *terbufos* | Counter 20G | 30[1] | 30[1] | 48 | 6.5 lb | Make only 1 application. |
| *tefluthrin* | Force 3G | Not Listed | Not Listed | 0 | 1 application | Granules must be incorporated into soil. |
| *thiamethoxam* | Cruiser 5FS | Not Listed | – | 12 | Seed treatment | Commercially applied; see label for plant back restrictions. Some formulations may contain fungicides. |
| *zeta-cypermethrin* | Mustang Maxx, Respect | 7 | 7 | 12 | 16 fl oz | |

[1] Not listed for at-planting application.

# CORN NEMATODE CONTROL

Bob Kemerait, Extension Plant Pathologist

| CHEM ICAL | Rate/A | REMARKS AND PRECAUTIONS |
|---|---|---|
| AVICTA Duo Corn (seed treatment) | | AVICTA Duo Corn is a combination of abamectin and thiamethoxam. |
| BIOST Nematicide 100 | 6-8 fl oz/100 cwt | BIOST Nematicide 100 is a seed treatment. BIOST Nematicide 100 is derived from the bacterium, *Burkholderia rinojensis*. The active ingredient is 'Heat Killed' *Burkholderia rinojensis*. |
| Counter 15G | 7 lb | *Apply in furrow as row treatment. DO NOT exceed 8.7 lb/A regardless of row spacing. ALS-inhibiting herbicides should not be used if Counter 15G has been applied to the corn at planting.<br>**REI is 48 hours. REI increases to 72 hours in areas where average rainfall is less than 2" a year. Do not graze or cut for forage within 30 days of treatment.** |
| Counter 20G | 5.25 lb | Apply in-furrow as row treatment. DO NOT exceed 6.5 lb/A regardless of row spacing. ALS-inhibiting herbicides should not be used if Counter 20G has been applied to the corn at planting.<br>**REI is 48 hours. REI increases to 72 hours in areas where average rainfall is less than 2" a year. Do not graze or cut for forage within 30 days of treatment.** |

| | | |
|---|---|---|
| PONCHO VOTiVO (seed treatment) | | PONCHO VOTiVO is a systemic insecticide and biological seed treatment for use on corn to control insect pests and plant pathogenic nematodes listed on the label to include lance, root-knot, stubby-root, stunt, and sting nematodes. |
| Telone II | 3 gal | Apply Telone II at least 7 days prior to planting by injecting 12” below the soil surface.<br>**REI is 5 days post application.** |

*NOTE: Granules should be incorporated for best results.

# CORN DISEASE AND NEMATODE MANAGEMENT UPDATE FOR 2020

*Bob Kemerait, Department of Plant Pathology*

## GENERAL DISEASE MANAGEMENT STEPS for CORN PRODUCTION in 2020:

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

1. 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. There will be at least two new fungicides available to corn grower in 2020 to aid in their battles against leaf diseases, especially southern corn rust and northern corn leaf spot. These fungicides include Veltyma (7-10 fl oz/A) from BASF and Lucento (3-5.5 fl oz/A). Veltyma is a combination of the Revysol and Headline. Lucento is a combination of Bixafen + Topguard.
2. **Sample your fields**, especially where growth was stunted 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.
3. **Follow the Georgia Southern Corn Rust Sentinel Plot Program** (supported by the Georgia Commodity Commission for Corn) at **https://ext.ipipe.org/** to determine 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 sight, to include northern corn leaf blight, southern corn leaf blight and northern corn leaf spot.
4. **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. Testing on NemaStrike began in 2018. Note that a seed-treatment nematicide such as NemaStrike will not have the efficacy to control nematodes as would a product such as Counter 20G.
5. As from above, plant-parasitic nematodes are an important, and often under-recognized, problem for corn growers in Georgia. 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, AVICTA Complete Corn, or NemaStrike) to minimize losses. The importance of plant-parasitic nematodes, especially the root-knot and stubby-root nematodes, is becoming increasingly apparent to corn producers.
6. **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.
7. **Plant hybrids that are resistant to problematic diseases.** Educate yourself before you make a final seed selection; at least so that you are not surprised.

**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.

8. **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.

9. 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.

10. 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.)

11. 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.

12. Use approved fungicides on susceptible hybrids to reduce losses to disease and protect yield. 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.

   **NOTE 2:** UGA Extension has statewide sentinel plots to for early detection of southern corn rust. Daily updates of monitoring efforts for southern corn rust can be found at http://scr.ipmpipe.org. In years where southern rust has not been found, growers can likely delay fungicide applications for this disease. In areas where southern rust is confirmed present, or likely present, growers are advised to consider timely applications of effective fungicides.

   **NOTE 3:** To avoid problems with ear deformation, fungicides applied prior to tassel should not be mixed with adjuvants or crop oils.

   **NOTE 4:** 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.

13. 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.

14. Even with the best of efforts, leaf diseases of corn can be difficult to manage. 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.

**The "Bottom Line": Recommendations for the 2020 season:**

1. The amount of disease that growers will experience in their corn crop in 2020 will largely be the combined result of a) the weather, especially as tassel approached and beyond, b) crop rotation, c) use of fungicides, d) variety selection and e) planting date. Shorter corn rotations will increase the 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 2020 to determine reported resistance to disease. This is especially important for diseases like northern corn leaf blight and Diplodia ear rot.
    a. **If a variety has low resistance to northern corn leaf blight then a fungicide program that begins during vegetative growth prior to tassel could be very beneficial. However, a fungicide program is less effective at managing northern corn leaf blight than is use of a resistant hybrid.**
    b. **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 field of corn in the state, it is recommended that every corn grower 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".
    a. Note 1: Severity of southern corn rust may actually diminish on cron planted very late in the season as development of this disease slows as temperatures begin to drop in late summer and early fall.
    b. Note 2: Growers should always follow the detection of southern corn rust (results of the sentinel plot survey for southern corn rust sponsored by the Georgia Commodity Commission for Corn can be viewed at **https://ext.ipipe.org/**) to ensure that fungicide applications are timely for this disease.

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 rust than is an application delayed until first tassel.

a. Note 1: In order 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.

b. Note 2: Fields planted to a corn hybrid susceptible to northern corn will most likely benefit from such an application.

6. 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) and 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.

All corn growers in Georgia must respect the possible impact from plant-parasitic nematodes to their crop. Increasing years between corn crops in a field can help to reduce the impact of the stubby-root nematode and, depending upon the crop used for rotation, the impact of the southern root-knot and peanut root-knot nematodes. In addition to crop rotation, corn growers can protect their crop with the use of products like Telone II, Counter 20G, AVICTA Complete Corn and NemaStrike. Sampling for nematodes is an important tool for growers so that they understand not only the types of nematodes, but also the population size in the field. Both the type and the number will affect the best selection of best management practices.

**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. 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 2020, 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), and Veltyma**. 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. The results are distributed to our county agents and also posted on the Internet at **https://ext.ipipe.org/**. 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 20183 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.

**Tilt** (propiconazole) (2.0-4.0 fl oz/A for leaf blights; 4.0 fl oz/A for rust diseases)

**Tebuconazole 3.6F** (various products, 4.0-6.0 fl oz/A for leaf blights and rust diseases)

**Quadris** (azoxystrobin) (9.2-15.4 fl oz/A for leaf blights and 6.2-9.2 fl oz/A for rust diseases)

**AzoxyStar** (azoystrobin) (6.0-15.4 fl oz/A)

**Quilt** (azoxystrobin + propiconazole) (7.0-14.0 fl oz/A for leaf blights and 10.5-14.0 fl oz/A for rust diseases)

**Quilt Xcel** (azoxystrobin + propiconazole) (10.5-14.0 fl oz/A for leaf blights and rust diseases)

**Custodia** (tebuconazole + azoxystrobin) (9-12.9 fl oz/A)

**Cover XL** (azoxystrobin + propiconazole) (10.5-14.0 fl oz/A)

**Trivapro** (azoxystrobin + propiconazole + solatenol) (13.7 fl oz/A for foliar disease)

**Stratego** (trifloxystrobin + propiconazole) (10.0-12.0 fl oz/A for leaf blights and 7.0-10.0 for rust diseases)

**Stratego YLD** (trifloxystrobin + prothioconazole) (4-5 fl oz/A for leaf blight and rust diseases)

**Headline** (pyraclostrobin) (9.0-12.0 fl oz/A for leaf blights and 6.0-9.0 fl oz/A for rust diseases)

**Headline AMP** (pyraclostrobin + metconazole) (10 fl oz/A for leaf blight and rust diseases)

**Priaxor** (pryraclostrobin + fluxapyroxad)  (4.0-8.0 fl oz/A for leaf blight and rust diseases)

**Veltyma** (pyraclostrobin + Revysol) (7-10 fl oz/A for leaf blight and rust diseases)

**Lucento** (Bixafen + Topguard) (3-5.5 fl oz/A for leaf blight and rust diseases)

**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)

**Aproach Prima** (picoxystrobin + cyproconazole) (3.4-6.8 fl oz/A for leaf blight and rust diseases)

**FORTIX** (flutriafol + fluoxastrobin) (4.0-6.0 fl oz/A for leaf blight and rust diseases)

**Zolera FX** (tetraconazole + fluoxastrobin) (4.4-6.8 fl oz/A)

**EVITO 480SC** (fluoxastroibin) (4.0-5.7 fl oz/A for leaf blights and 2.0-5.7 fl oz/A for rust diseases)

**EVITO T** (fluoxastrobin + tebuconazole) (4.0-9.0 fl oz/A for leaf blight and rust diseases)

**Affiance** (tetraconazole + azoxystrobin) (10.0-17.0 fl oz/A for leaf blight and rust diseases)

**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 has planted 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.

5. **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 the absence of northern corn leaf blight, the grower has planted a variety that is resistant to southern rust AND only the resistance is believed to protect against the strains of rust present in the state.
3. Environmental conditions, such has 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 an appropriate fungicide at labeled rate either prior to appearance of rust in a field or when it first appears in the field.  Apply a fungicide to control northern corn leaf blight if this disease appears to be spreading early in reproductive growth.  If Northern Corn Leaf Blight is observed on the 3$^{rd}$ leaf below the 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 a corn crop during vegetative growth stages, for example around the V5 growth stage. To date, a fungicide application 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 had some benefit for reducing disease and improving yields on late-planted corn.  This is because the later-planted corn will be affected much earlier in its growth and development than is spring-planted corn.
3. A second fungicide application may be warranted 2-3 weeks after the initial application IF weather conditions still favor the spread of the disease and the corn crop 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 2019 growers will have Telone II, Counter 20G, AVICTA Complete Corn, NemaStrike and PONCHO VOTiVO 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 2019 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 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 now include:**

Telone II (3 gal/A) excellent control

Counter 20G (5.25 lb/A) fair-to-good control

AVICTA Complete Corn (seed treatment) still being evaluated; has provided fair-to-good control in UGA trials

NemaStrike (seed treatment)

PONCHO VOTiVO (seed treatment) still under evaluation

**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 plant-parasitic nematodes affecting corn in our state; it is likely that we have also 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 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 Dow Agrosciences, 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 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 the fungal growth that is 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 the growth of the fungi. To help prevent the formation of mycotoxins, corn must be dry and free of insects and air movement regulated to avoid the accumulation of moisture.

**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 to 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.

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 the seed germinates and seedlings develop, corn is susceptible to rot and disease that may kill the young plant or leave it stunted and nonproductive. Symptoms of seed rot and seedling disease in a field include poor, “skippy” stands and the presence of plants with poor growth that are never able to reach the genetic potential of the variety planted, despite otherwise 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 a bacterial pathogen. 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 come in contact with 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.

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.

# 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 may be 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 the 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 1). 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.

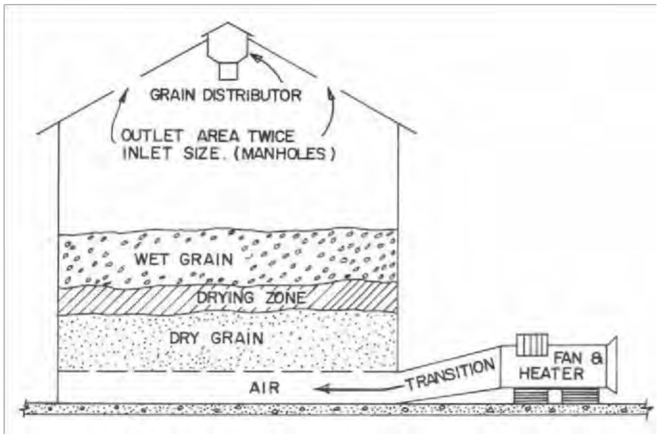



**Figure 1. Grain is dried from the point of air entry with the drying front moving in the direction of air flow. The wetter grain occurs where the air leaves the grain layer.**

<u>Batch-in-Bin Drying</u>

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.).

<u>Batch Drying</u>

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$^0$F).

<u>Continuous Flow Drying</u>

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$^0$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. 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 95ºF. Most peanut dryer thermostats have a set point range between 70 and 140ºF. The LP burners used have the capability of increasing air temperature by 50 to 70ºF. Therefore maximum drying temperature that could be obtained with an 85ºF ambient air temperature is 135 to 155ºF. 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 - 140ºF. (If the burner is capable of a higher temperature rise replace thermostat for a higher range setting – 160-180ºF)
- Drying time will depend on air conditions and drying temperature. Figure 2 and 3.

The amount of LP required to dry corn can be estimated by the graph in figures 4 and 5.

Graphs 2 and 4 are based on 85ºF and 85 percent relative humidity ambient air being forced through the grain at a rate of 50 CFM/$ft^2$ of floor area. Graphs 3 and 5 are based on 85ºF 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 their dryer(s) to match daily combine capacity and harvest moisture target levels.**

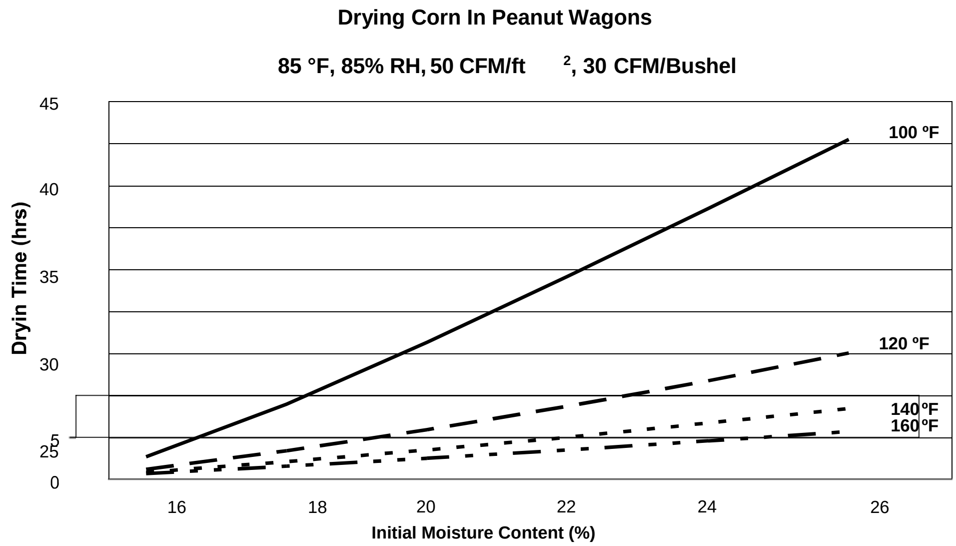



**Figure 2. Estimated total drying time for corn with air at 85ºF and 85 percent relative humidity, 30 CFM/Bushel, 50 CFM/ft2 of floor area.**

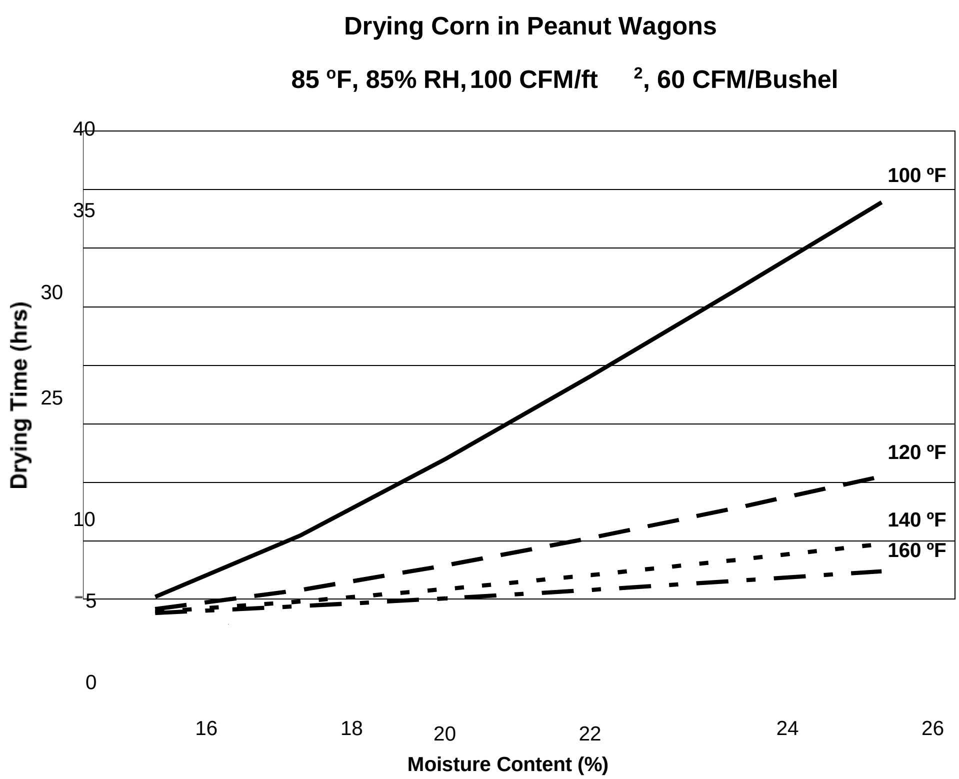



**Figure 3 Estimated total drying time for corn with air at 85ºF and 85 percent relative humidity, 60 CFM/Bushel, 100 CFM/ft2 of floor area**

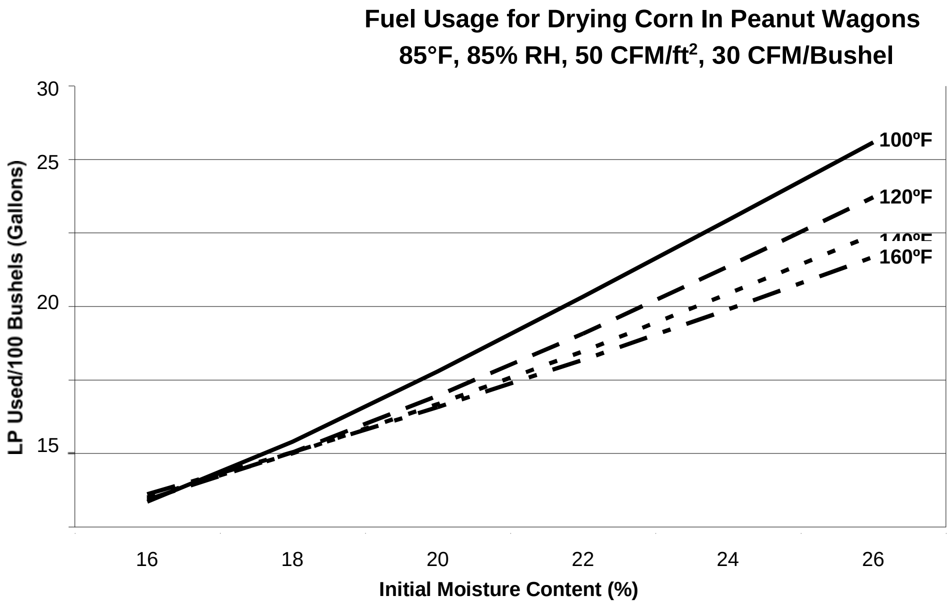



**Figure 4. Estimated LP fuel use for corn with air at 85ºF and 85 percent relative humidity, 30 CFM/Bushel, 50 CFM/ft2 of floor area.**

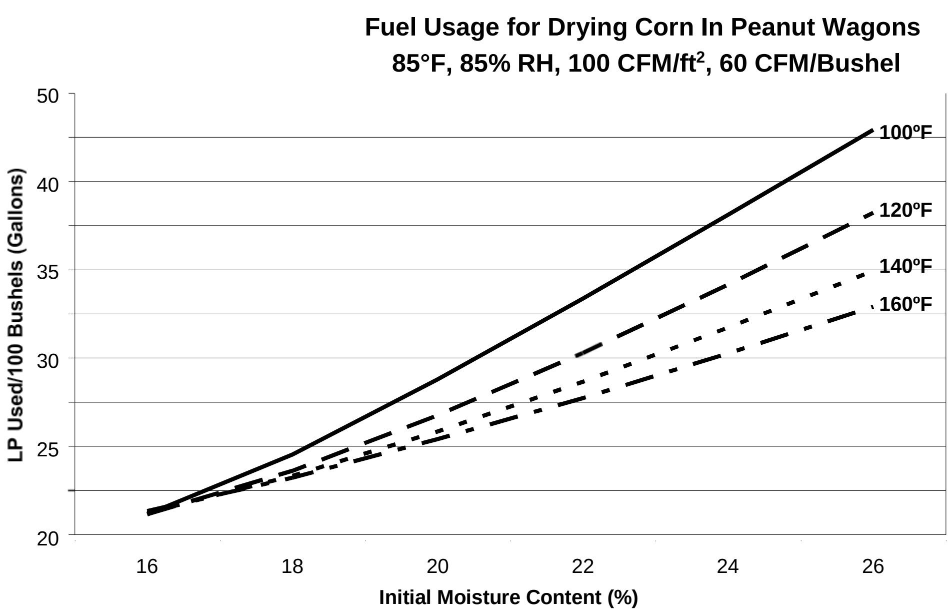



**Figure 5. Estimated LP fuel use for corn with air at 85ºF and 85 percent relative humidity, 60 CFM/Bushel, 100 CFM/ft$^2$ of floor area.**

# PROTECTING STORED CORN

*Michael Toews, UGA Entomology*

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 1 are labeled for empty bin treatments.

**Table 18. 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. |
| *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. |
| *deltamethrin + chlorpyrifos methyl* Storcide II | 1.8 fl oz/gal/1000 sq ft | 1B+3A | Application can only be made from outside the bin using automated spray equipment. |
| *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. |

- Eventually, insects will build up on fine and broken kernels that accumulate under the perforated bin floor. Bins with false floors should be fumigated if the grain debris cannot be removed. Cover with a plastic tarp (6 ml or thicker) to contain and hold the gas. Place the fumigant over the empty floor under the tarp. Fumigation should only be conducted by trained and licensed applicators. Read the label and the applicators 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 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.

**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 2.

**Table 19. 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% |

- 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.

**Application of Grain Protectants**

- Growers who will be storing for more than 6 months should strongly consider application of a grain protectant (Table 3). 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 20. Insecticides labelled for direct application to grain as a grain protectant**

| Insecticide | Rate | MOA | Remarks |
|---|---|---|---|
| pirimiphos-methyl<br>Actellic 5E | 8.6-11.5 fl oz (corn)<br>8.6-11.5 fl oz (grain sorghum) | 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<br>Centynal EC | 8.5 fl oz (corn)<br>9.1 fl oz (wheat)<br>4.9 fl oz (oats)<br>8.5 fl oz (grain sorghum)<br>8.5 fl oz (rye) | 3A | Labeled for use on barley, corn, oats, popcorn, rice rye, grain sorghum, and wheat. |
| deltamethrin<br>D-Fense SC | 8.5 fl oz (corn)<br>9.1 fl oz (wheat)<br>8.5 fl oz (oats)<br>8.5 fl oz (grain sorghum)<br>8.5 fl oz (rye) | 3A | Labeled for use on barley, corn, oats, popcorn, rice, rye, grain sorghum, and wheat. |
| s-methoprene<br>Diacon IGR | 1.8-7 fl oz (corn)<br>1.8-7 fl oz (wheat)<br>1-4 fl oz (peanuts)<br>1-4 fl oz (oats)<br>1.8-7 fl oz (grain sorghum) | 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<br>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 +<br>s-methoprene<br>Diacon IGR PLUS | 9-18 fl oz (corn)<br>9.6-19.2 fl oz (wheat)<br>5.2-10.3 fl oz (oats)<br>8-16 fl oz (grain sorghum)<br>9-18 fl oz (rye) | 3A+7A | Labeled for use on barley, corn, oats, popcorn, rice, rye, sorghum and wheat. |
| diatomaceous earth<br>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<br>1-2 lb/ton (if infested) | | Apply uniformly as a dust on grains, soybeans, peanuts, popcorn, and others (see label). See note above. |
| diatomaceous earth Protect-It | 18 lb (wheat, beans, peas)<br>9.6 lb (oats)<br>16.8 lb (rye) | | 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 (corn)<br>10.5 fl oz (wheat)<br>5.9 fl oz (oats)<br>9.8 fl oz (grain sorghum) | 5 | Labeled for use on barley, bird seed, corn, foxtail millet, pearl millet, proso millet, oats, sorghum, triticale and wheat. |
| deltamethrin + chlorpyrifos-methyl Storcide II | 12.4 fl oz (wheat)<br>11.6 fl oz (grain sorghum)<br>6.6 fl oz (oats) | 1B+3A | Dilute with water or an FDA-approved food grade mineral oil or soybean oil. For use on wheat, barley, oats, rice, and grain sorghum. |

## 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 4). 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 21. Grain Fumigants

| Product | Rate | Remarks |
|---|---|---|
| aluminum phosphide pellets Weevil-Cide 60% pellets, Phosfume2 60% pellets, or 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.<br><br>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. |
| aluminum phosphide tablets* Weevil-Cide 60% tablets, Phosfume2 60% tablets, or Phostoxin 60% tablets | Farm bins: 70-145 tablets/1000 cu ft | |
| Phostoxin Tablet Prepac (33 tablets)** | 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. |

# 2020 CORN OUTLOOK AND COST ANALYSIS

*Adam N. Rabinowitz Ph.D. and Amanda R. Smith*

## Corn Supply and Demand Highlights

- **Acreage** - U.S. corn plantings decreased by 1.1% to 89.1 million acres in 2018. Harvested acres were down 1.1% from 2017 to 81.8 million. Georgia corn growers planted nearly 12.1% more acres for a total of 325,000 acres in 2018 and harvested 275,000 acres.

- **Corn Production Slightly Lower -** U.S. corn production in 2018 is projected to be the second highest on record, behind 2016. The U.S. average yield is projected to increase to a record 178.9 bushels per acre. Total production would equal 14.6 billion bushels, up less than 0.2% from 2017. Georgia production is projected to have increased 8% to 46.5 million bushels. The Georgia average yield for 2018 is projected at 169 bushels per acre.

- **Corn Use Increasing-** Total corn use for the 2018/19 marketing year is projected at 15 billion bushels, up 1.6% from the previous year. Total use for the 2017/18 marketing year was 14.8 billion bushels.

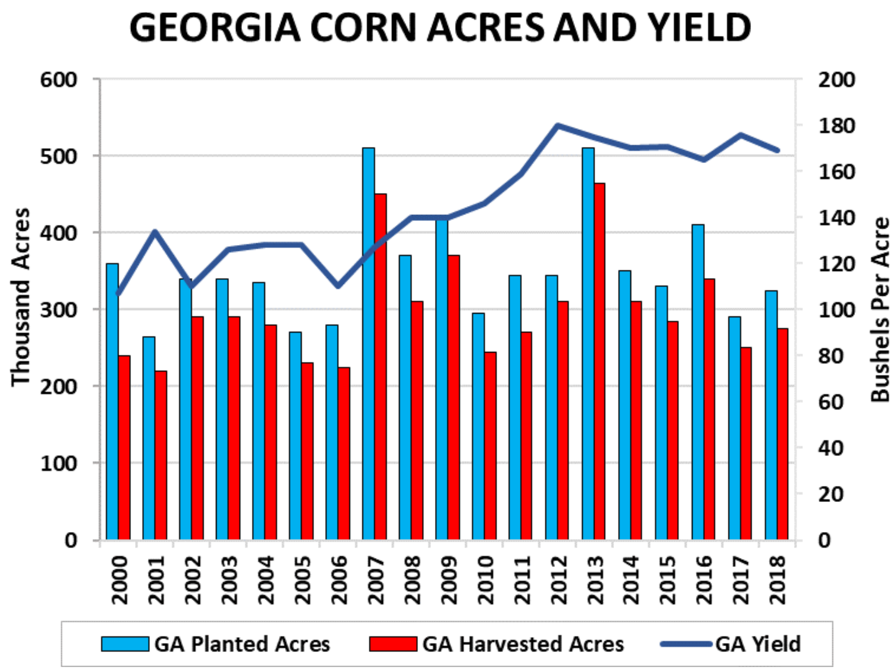
- **Exports Remain Strong –** The major export destinations for U.S. corn in recent years continues to be Mexico and Japan. With respect to global production, the Ukraine has become the second largest exporter of corn. Exports of Brazilian corn have been impacted by the increase in soybean exports from Brazil.

- **Stocks on the Decline –** While production remains strong, the projected increased demand will result in an ending stock decrease to an estimated 1.8 billion bushels. This is down 22% from the high two years ago resulting in U.S. prices that are projected to start increasing to the high $3 per bushel range.

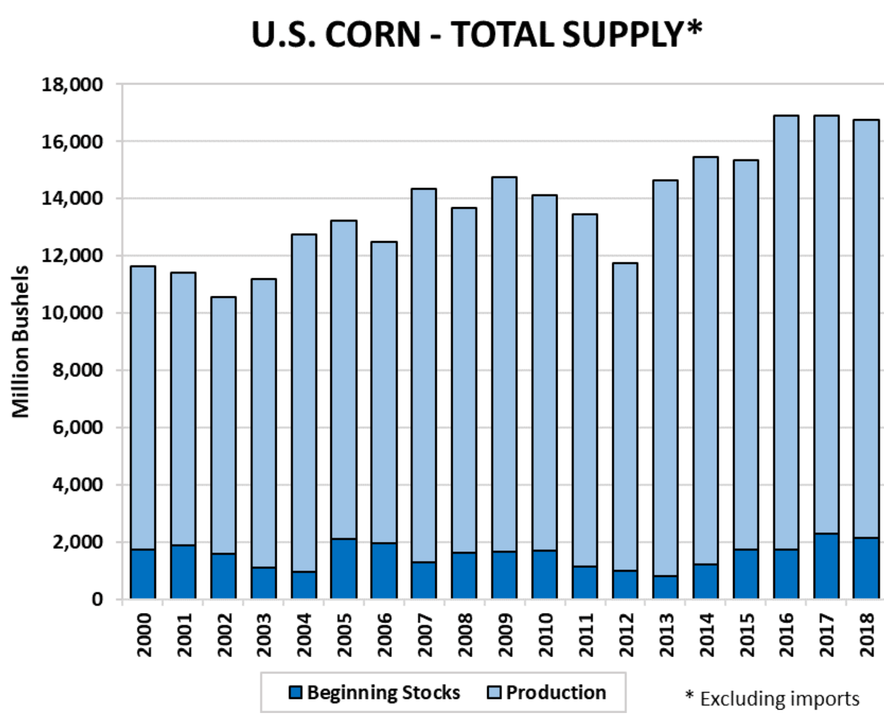
- **2019 Crop -** The 2019 crop could increase in acreage given continued uncertainty around soybean exports to China. U.S. Corn Futures for 2019 are close to $4 per bushel providing an opportunity for the price of corn in Georgia to range between $4.50 and $4.60.

## 2018 Crop Review and 2019 Outlook

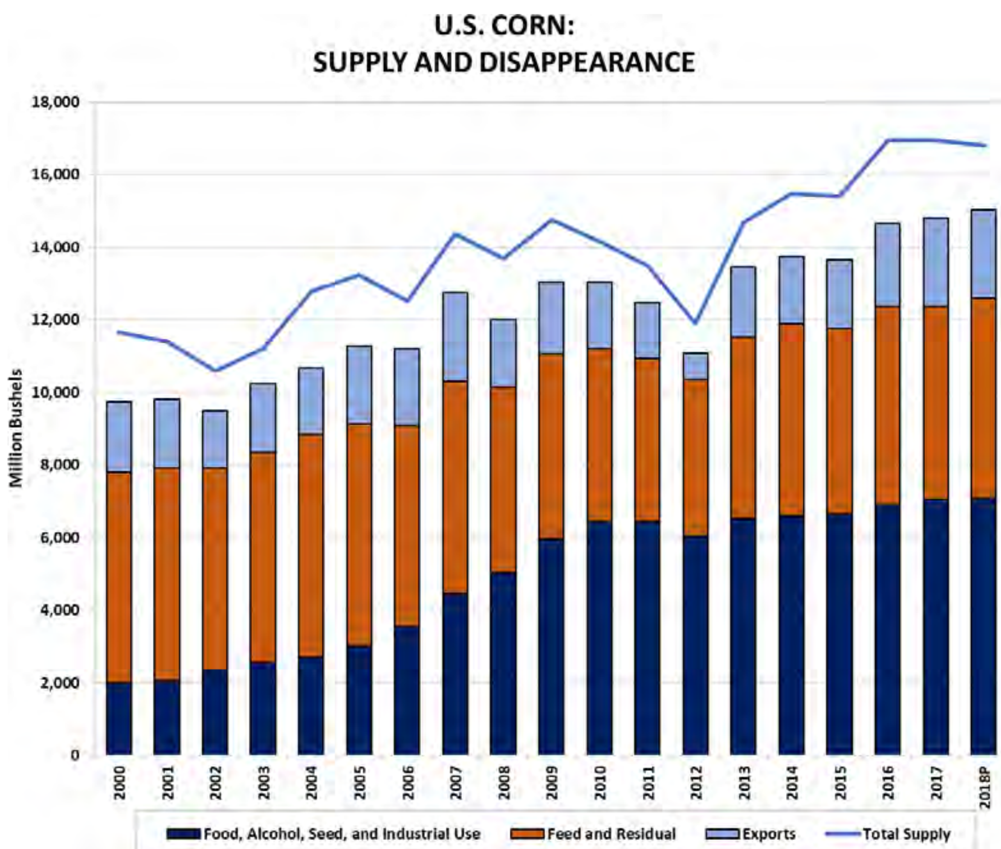
Georgia growers planted 325,000 acres of corn in 2018. Harvested acres for grain were estimated at 275,000. The state average yield is projected at 169 bushels per acre, 4.1% below the previous year. Corn grain production in Georgia is estimated at 46.5 million bushels, up 8% from 2017. As one can see from the graph below, GA corn yields have consistently been close to or above 170 bushels per acre since 2012. Planted acres, however, have been on the low end for the decade, a function of lower corn prices in recent years especially compared to prices of other crops in Georgia.




Total U.S. corn production is projected slightly up in 2018 to 14.6 billion bushels, an increase of less than 0.2% from 2017. The slight increase in production is a result of a projected record yield of 178.9 bushels per acre, even though planted and harvested acres decreased about 1.1%. Ending stocks of corn are projected down at the end of the2018/19 marketing year, but are still significantly higher than 2010-2013.

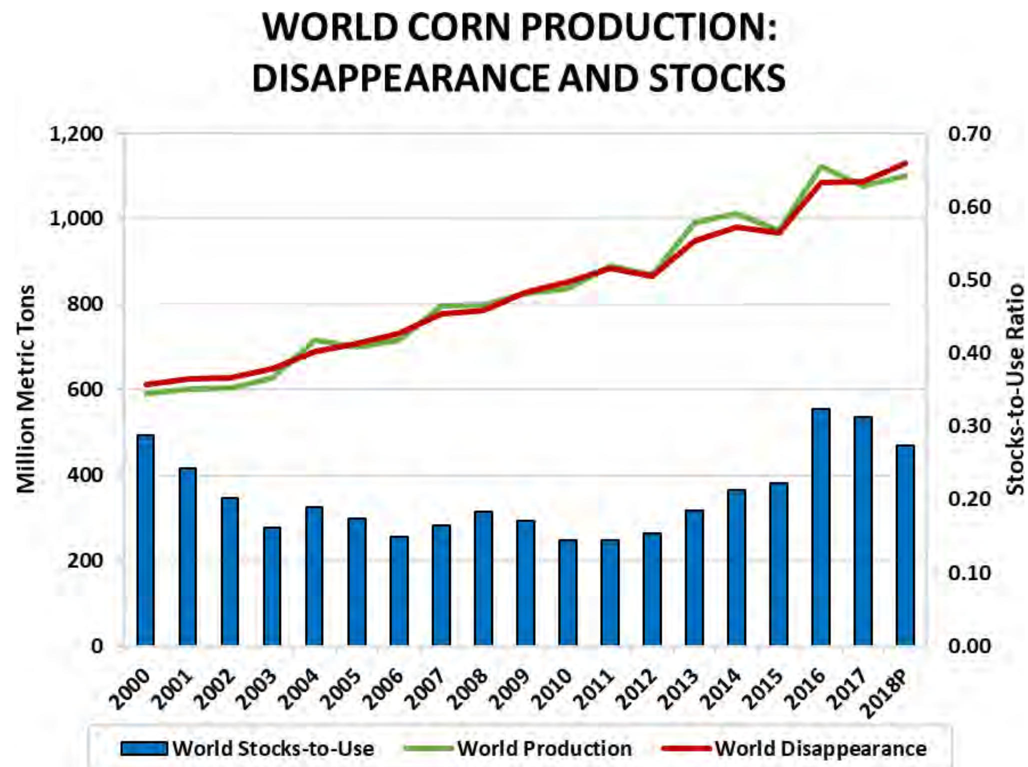


Total use of U.S. corn increased in 2017/18 to 14.8 billion bushels. Projections for 2018/19 indicate a further increase to 15 billion bushels. All major use categories are projected to increase with exports expected up from 2.4 billion bushels to 2.5 billion bushels. There is also a continued increasing trend in food, seed, and industrial use to over 7 billion bushels and an increase in feed and residual uses to 5.5 billion bushels.




Exports have been strong to start the marketing year, especially to Japan, South Korea, and Taiwan. Some of this has occurred because shipments from Brazil have been slower than usual due to Brazil exporting more soybeans. Additionally, the lack of U.S. soybean exports to China have opened up opportunities for corn exports out of similar channels. Competition from South America and record supplies in the Ukraine are expected to slow the pace of exports, although an overall increase in exports is expected. The Ukraine has become the second largest exporter of corn in the world, following the U.S. Meanwhile, Mexico and Japan are the two two destinations for U.S. corn.

The U.S. Corn market continues to hold a large supply but is staying fairly stable for a few years while use continues to increase. Therefore, there is potential for a small increase in prices due to the projected decreasing ending stocks. Some additional U.S. exports could help prices, although the most significant event at this point is going to be the usual risk that weather events create during the year. Expect prices to move up slightly with larger swings possible if any significant weather event limits the 2019 crop.




**2019 Price Outlook in Georgia**

Once the corn acreage is known early in the year, the market will be driven by weather and yield estimates. The most probable outlook right now is for corn prices to be just under $4 per bushel based on current futures market prices; giving an opportunity to price corn in Georgia around $4.50-$4.60 per bushel during 2019.

**Cost of Production**

Variable costs for 2019 are projected to be higher with dryland corn up 3.4% and irrigated corn up 5.4%.

<u>Seed, Fertilizer and Chemicals</u> - Seed cost is the same as last year in the budgets, however, other costs are increasing. Fertilizer prices are expected to be up significantly. Nitrogen is estimated at $0.50/lb versus $0.44/lb last year. Phosphate is up to $0.44/lb from $0.38/lb, and Potash is up to $0.32/lb from $0.29/lb. Chemical costs are estimated to be flat or down. Weed costs are projected up 0.4%, while disease control is projected down 0.6%. The bigger change is for insect control which is projected down 4.4%.

<u>Cost of Borrowed Funds</u> – The interest rate charged in the corn budgets is at 6.3%, reflecting a conservative estimate but also the risk of inflation and low prices for row crops. The prime lending rate has seen steady increases in the past few years. An increase of

0.25% in December 2015 was the first movement in 7 years. During the 3 years following that increase we have seen 8 addition increases of 0.25% to a prime rate of 5.5% as of December 20, 2018. The increases in the prime rate are an indication that some farmers may see increases in their own lending rate, but a farmer in good financial standing can probably get a lower rate than reflected in the budgets.

Fuel and Energy Costs – Energy prices are projected to be higher in 2019. The 2019 budgeted price is $2.50 per gallon verses $2.25 in the 2018 budgets. The irrigated corn budget charges an average of $9.20 per acre-inch of water reflecting a 50/50 ratio of diesel and electric power sources. This is up from the $8.90 per acre-inch of water that was budgeted in 2018.

Labor and Repairs – Operator labor rates increased to $13.25 per hour with a $0.25 per hour increase from 2018. Machinery repairs are expected to decrease in 2019.

**Sources**

United States Department of Agriculture Economic Research Service, Feed Outlook, December 13, 2018.

United States Department of Agriculture Foreign Agricultural Service, Grain: World Markets and Trade, December 2018.

United States Department of Agriculture National Agricultural Statistics Service, Quick Stats Database, Accessed December 18, 2018.

## Irrigated Corn, Strip Tillage South Georgia, 2020

### Estimated Costs and Returns

Expected Yield: **200** bushel Your Yield _______

| Variable Costs | Unit | Amount | $/Unit | Cost/Acre | $/bushel | Your Farm |
|---|---|---|---|---|---|---|
| Treated Seed | thousand | 32 | $ 3.65 | $ 116.80 | $ 0.58 | ________ |
| Cover Crop Seed | bushel | 1.5 | $ 17.00 | $ 25.50 | $ 0.13 | ________ |
| Lime | ton | 0.5 | $ 45.00 | $ 22.50 | $ 0.11 | ________ |
| Fertilizer | | | | | | |
| *Nitrogen* | pounds | 240 | $ 0.50 | $ 120.00 | $ 0.60 | ________ |
| *Phosphate* | pounds | 100 | $ 0.40 | $ 40.00 | $ 0.20 | ________ |
| *Potash* | pounds | 200 | $ 0.35 | $ 70.00 | $ 0.35 | ________ |
| Weed Control | acre | 1 | $ 19.00 | $ 19.00 | $ 0.10 | ________ |
| Insect Control | acre | 1 | $ 9.50 | $ 9.50 | $ 0.05 | ________ |
| Disease Control | acre | 1 | $ 19.45 | $ 19.45 | $ 0.10 | ________ |
| Preharvest Machinery * | | | | | | |
| *Fuel* | gallon | 3.6 | $ 2.50 | $ 9.00 | $ 0.05 | ________ |
| *Repairs and Maintenance* | acre | 1 | $ 9.59 | $ 9.59 | $ 0.05 | ________ |
| Harvest Machinery | | | | | | |
| *Fuel* | gallon | 2.5 | $ 2.50 | $ 6.33 | $ 0.03 | ________ |
| *Repairs and Maintenance* | acre | 1 | $ 8.43 | $ 8.43 | $ 0.04 | ________ |
| Labor | hours | 0.9 | $ 13.50 | $ 11.66 | $ 0.06 | ________ |
| Irrigation** | applications | 7 | $ 8.65 | $ 60.55 | $ 0.30 | ________ |
| Crop Insurance | acre | 1 | $ 14.00 | $ 14.00 | $ 0.07 | ________ |
| Land Rent | acre | 1 | $ - | $ - | $ - | ________ |
| Interest on Operating Capital | percent | $ 281.16 | 6.0% | $ 16.87 | $ 0.08 | ________ |
| Drying - 8 Points | bushel | 220 | $ 0.28 | $ 61.46 | $ 0.31 | |
| **Total Variable Costs:** | | | | **$ 640.64** | **$ 3.20** | |

| Fixed Costs | Unit | Amount | $/Unit | Cost/Acre | $/bushel | Your Farm |
|---|---|---|---|---|---|---|
| Machinery Depreciation, Taxes, Insurance and Housing | | | | | | |
| *Preharvest Machinery* * | acre | 1 | $ 25.57 | $ 25.57 | $ 0.13 | ________ |
| *Harvest Machinery* | acre | 1 | $ 41.04 | $ 41.04 | $ 0.21 | ________ |
| *Irrigation* | acre | 1 | $ 130.00 | $ 130.00 | $ 0.65 | ________ |
| General Overhead | % of VC | $ 640.64 | 5% | $ 32.03 | $ 0.16 | ________ |
| Management | % of VC | $ 640.64 | 5% | $ 32.03 | $ 0.16 | ________ |
| Owned Land Cost, Taxes, Cash Payment, etc. | acre | 1 | $ - | $ - | $ - | ________ |
| Other ________________ | acre | 1 | $ - | $ - | $ - | |
| **Total Fixed Costs** | | | | **$ 260.67** | **$ 1.30** | |
| **Total Costs Excluding Land** | | | | **$ 901.31** | **$ 4.51** | |
| **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.

**Average of diesel and electric irrigation application costs. Electric is estimated at $7/appl and diesel is estimated at $12.50/appl when diesel costs $2.50/gal.

*Developed by Amanda Smith and Adam Rabinowitz.*

## Sensitivity Analysis of Irrigated Corn, Strip Tillage

### Net Returns above Variable Costs per Acre

*Varying Prices and Yields (bushel)*

| Price \ bushel/Acre | -25% 150 | -10% 180 | Expected 200 | +10% 220 | +25% 250 |
|---|---|---|---|---|---|
| $3.50 | **-$115.64** | **-$10.64** | **$59.36** | **$129.36** | **$234.36** |
| $3.75 | **-$78.14** | **$34.36** | **$109.36** | **$184.36** | **$296.86** |
| $4.00 | **-$40.64** | **$79.36** | **$159.36** | **$239.36** | **$359.36** |
| $4.25 | **-$3.14** | **$124.36** | **$209.36** | **$294.36** | **$421.86** |
| $4.50 | **$34.36** | **$169.36** | **$259.36** | **$349.36** | **$484.36** |

**Estimated Labor and Machinery Costs per Acre**
**Preharvest Operations**

| Operation | Acres/Hour | Number of Times Over | Labor Use*** (hrs/ac) | Fuel Use (gal/ac) | Repairs ($/ac) | Fixed Costs ($/ac) |
|---|---|---|---|---|---|---|
| Spin Spreader 5 ton with Tractor (120-139 hp) 2WD 130 | 23.8 | 1 | 0.05 | 0.28 | $ 0.64 | $ 1.81 |
| Disk Harrow 32’ with Tractor (180-199 hp) MFWD 190 | 16.3 | 1 | 0.08 | 0.60 | $ 1.84 | $ 5.35 |
| Spray (Broadcast) 60’ with Tractor (120-139 hp) 2WD 130 | 35.5 | 1 | 0.04 | 0.19 | $ 0.43 | $ 0.99 |
| ST Plant Rigid 6R-36 with Tractor (180-199 hp) MFWD 190 | 6.9 | 1 | 0.18 | 1.42 | $ 3.63 | $ 10.84 |
| Fert Appl (Liquid) 6R-36 with Tractor (120-139 hp) 2WD 130 | 9.2 | 1 | 0.14 | 0.73 | $ 2.20 | $ 4.60 |
| Spray (Broadcast) 60’ with Tractor (120-139 hp) 2WD 130 | 35.5 | 2 | 0.07 | 0.38 | $ 0.86 | $ 1.98 |
| Total Preharvest Values | | | 0.55 | 3.60 | $ 9.59 | $ 25.57 |

**Harvest Operations**

| Operation | Acres/Hour | Number of Times Over | Labor Use*** (hrs/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 | $ 7.03 | $ 37.27 |
| Grain Cart Corn 500 bu with Tractor (120-139 hp) 2WD 130 | 10.6 | 1 | 0.12 | 0.63 | $ 1.39 | $ 3.76 |
| Total Harvest Values | | | 0.31 | 2.53 | $ 8.43 | $ 41.04 |

*** 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, 2020

### Estimated Costs and Returns

Expected Yield: **85** bushel Your Yield________

| Variable Costs | Unit | Amount | $/Unit | Cost/Acre | $/bushel | Your Farm |
|---|---|---|---|---|---|---|
| Treated Seed | thousand | 20 | $ 3.65 | $ 73.00 | $ 0.86 | ____________ |
| Cover Crop Seed | bushel | 1.5 | $ 17.00 | $ 25.50 | $ 0.30 | ____________ |
| Lime | ton | 0.25 | $ 45.00 | $ 11.25 | $ 0.13 | ____________ |
| Fertilizer | | | | | | |
| *Nitrogen* | pounds | 100 | $ 0.50 | $ 50.00 | $ 0.59 | ____________ |
| *Phosphate* | pounds | 40 | $ 0.40 | $ 16.00 | $ 0.19 | ____________ |
| *Potash* | pounds | 60 | $ 0.35 | $ 21.00 | $ 0.25 | ____________ |
| Weed Control | acre | 1 | $ 15.00 | $ 15.00 | $ 0.18 | ____________ |
| Insect Control | acre | 1 | $ 9.50 | $ 9.50 | $ 0.11 | ____________ |
| Disease Control | acre | 1 | $ 19.45 | $ 19.45 | $ 0.23 | ____________ |
| Preharvest Machinery * | | | | | | |
| *Fuel* | gallon | 3.6 | $ 2.50 | $ 9.00 | $ 0.11 | ____________ |
| *Repairs and Maintenance* | acre | 1 | $ 9.59 | $ 9.59 | $ 0.11 | ____________ |
| Harvest Machinery | | | | | | |
| *Fuel* | gallon | 2.5 | $ 2.50 | $ 6.33 | $ 0.07 | ____________ |
| *Repairs and Maintenance* | acre | 1 | $ 8.43 | $ 8.43 | $ 0.10 | ____________ |
| Labor | hours | 0.9 | $ 13.50 | $ 11.66 | $ 0.14 | ____________ |
| Crop Insurance | acre | 1 | $ 24.00 | $ 24.00 | $ 0.28 | ____________ |
| Land Rent | acre | 1 | $ - | $ - | $ - | ____________ |
| Interest on Operating Capital | percent | $ 154.86 | 6.0% | $ 9.29 | $ 0.11 | ____________ |
| Drying - 8 Points | bushel | 93 | $ 0.28 | $ 26.12 | $ 0.31 | |
| **Total Variable Costs:** | | | | **$ 345.12** | **$ 4.06** | |

| Fixed Costs | Unit | Amount | $/Unit | Cost/Acre | $/bushel | Your Farm |
|---|---|---|---|---|---|---|
| Machinery Depreciation, Taxes, Insurance and Housing | | | | | | |
| *Preharvest Machinery ** | acre | 1 | $ 25.57 | $ 25.57 | $ 0.30 | ____________ |
| *Harvest Machinery* | acre | 1 | $ 41.04 | $ 41.04 | $ 0.48 | ____________ |
| General Overhead | % of VC | $ 345.12 | 5% | $ 17.26 | $ 0.20 | ____________ |
| Management | % of VC | $ 345.12 | 5% | $ 17.26 | $ 0.20 | ____________ |
| Owned Land Cost, Taxes, Cash Payment, etc. | acre | 1 | $ - | $ - | $ - | ____________ |
| Other _________________ | acre | 1 | $ - | $ - | $ - | |
| **Total Fixed Costs** | | | | **$ 101.12** | **$ 1.19** | |
| **Total Costs Excluding Land** | | | | **$ 446.24** | **$ 5.25** | |
| **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 Adam Rabinowitz.*

## Sensitivity Analysis of Non-Irrigated Corn, Strip Tillage

Net Returns Above Variable Costs Per Acre

*Varying Prices and Yields (bushel)*

| | -25% | -10% | Expected | +10% | +25% |
|---|---|---|---|---|---|
| **Price \ bushel/Acre** | 64 | 77 | 85 | 94 | 106 |
| $3.50 | **-$122.00** | **-$77.37** | **-$47.62** | **-$17.87** | **$26.75** |
| $3.75 | **-$106.06** | **-$58.25** | **-$26.37** | **$5.50** | **$53.31** |
| $4.00 | **-$90.12** | **-$39.12** | **-$5.12** | **$28.88** | **$79.88** |
| $4.25 | **-$74.19** | **-$20.00** | **$16.13** | **$52.25** | **$106.44** |
| $4.50 | **-$58.25** | **-$0.87** | **$37.38** | **$75.63** | **$133.00** |

**Estimated Labor and Machinery Costs per Acre**
**Preharvest Operations**

| Operation | Acres/Hour | Number of Times Over | Labor Use** (hrs/ac) | Fuel Use (gal/ac) | Repairs ($/ac) | Fixed Costs ($/ac) |
|---|---|---|---|---|---|---|
| Spin Spreader 5 ton with Tractor (120-139 hp) 2WD 130 | 23.8 | 1 | 0.05 | 0.28 | $ 0.64 | $ 1.81 |
| Disk Harrow 32' with Tractor (180-199 hp) MFWD 190 | 16.3 | 1 | 0.08 | 0.60 | $ 1.84 | $ 5.35 |
| Spray (Broadcast) 60' with Tractor (120-139 hp) 2WD 130 | 35.5 | 1 | 0.04 | 0.19 | $ 0.43 | $ 0.99 |
| ST Plant Rigid 6R-36 with Tractor (180-199 hp) MFWD 190 | 6.9 | 1 | 0.18 | 1.42 | $ 3.63 | $ 10.84 |
| Fert Appl (Liquid) 6R-36 with Tractor (120-139 hp) 2WD 130 | 9.2 | 1 | 0.14 | 0.73 | $ 2.20 | $ 4.60 |
| Spray (Broadcast) 60' with Tractor (120-139 hp) 2WD 130 | 35.5 | 2 | 0.07 | 0.38 | $ 0.86 | $ 1.98 |
| Total Preharvest Values | | | 0.55 | 3.60 | $ 9.59 | $ 25.57 |

**Harvest Operations**

| Operation | Acres/Hour | Number of Times Over | Labor Use*** (hrs/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 | $ 7.03 | $ 37.27 |
| Grain Cart Corn 500 bu with Tractor (120-139 hp) 2WD 130 | 10.6 | 1 | 0.12 | 0.63 | $ 1.39 | $ 3.76 |
| Total Harvest Values | | | 0.31 | 2.53 | $ 8.43 | $ 41.04 |

** 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 South Georgia, 2020

Estimated Costs and Returns

Expected Yield: **85** bushel Your Yield _______

| Variable Costs | Unit | Amount | $/Unit | Cost/Acre | $/bushel | Your Farm |
|---|---|---|---|---|---|---|
| Treated Seed | Thousand | 20 | $ 3.65 | $ 73.00 | $ 0.86 | ________ |
| Lime | Ton | 0.25 | $ 45.00 | $ 11.25 | $ 0.13 | ________ |
| Fertilizer | | | | | | ________ |
| *Nitrogen* | Pounds | 100 | $ 0.50 | $ 50.00 | $ 0.59 | ________ |
| *Phosphate* | Pounds | 40 | $ 0.40 | $ 16.00 | $ 0.19 | ________ |
| *Potash* | Pounds | 60 | $ 0.35 | $ 21.00 | $ 0.25 | ________ |
| Weed Control | Acre | 1 | $ 12.50 | $ 12.50 | $ 0.15 | ________ |
| Insect Control | Acre | 1 | $ 9.50 | $ 9.50 | $ 0.11 | ________ |
| Disease Control | Acre | 1 | $ 19.45 | $ 19.45 | $ 0.23 | ________ |
| Preharvest Machinery | | | | | | ________ |
| *Fuel* | Gallon | 4.9 | $ 2.50 | $ 12.27 | $ 0.14 | ________ |
| *Repairs and Maintenance* | Acre | 1 | $ 12.94 | $ 12.94 | $ 0.15 | ________ |
| Harvest Machinery | | | | | | ________ |
| *Fuel* | Gallon | 2.5 | $ 2.50 | $ 6.33 | $ 0.07 | ________ |
| *Repairs and Maintenance* | Acre | 1 | $ 8.43 | $ 8.43 | $ 0.10 | ________ |
| Labor | Hours | 1.0 | $ 13.50 | $ 14.10 | $ 0.17 | ________ |
| Crop Insurance | Acre | 1 | $ 24.00 | $ 24.00 | $ 0.28 | ________ |
| Land Rent | Acre | 1 | | | | ________ |
| Interest on Operating Capital | Percent | $ 145.38 | 6.0% | $ 8.72 | $ 0.10 | ________ |
| Drying – 8 points | Bushel | 93 | $ 0.28 | $ 26.12 | $ 0.31 | |
| Total Variable Costs | | | | $ 325.61 | $ 3.83 | |

### Fixed Costs

| | | | | | |
|---|---|---|---|---|---|
| Machinery Depreciation, Taxes, Insurance and Housing | | | | | |
| *Preharvest Machinery* | acre | 1 | $ 35.36 | $ 35.36 | $ 0.42 |
| *Harvest Machinery* | acre | 1 | $ 41.04 | $ 41.04 | $ 0.48 |
| General Overhead | % of VC | $ 325.61 | 5% | $ 16.28 | $ 0.19 |
| Management | % of VC | $ 325.61 | 5% | $ 16.28 | $ 0.19 |
| Owned Land Cost, Taxes, Cash Payment, etc. | acre | 1 | $ - | $ - | $_____ |
| Other ________________ | acre | 1 | $ - | $ - | $ - |
| **Total Fixed Costs** | | | | **$ 108.96** | **$ 1.28** |
| **Total Costs Excluding Land** | | | | **$ 434.57** | **$ 5.11** |
| Your Profit Goal | | | | $________ | /bushel |
| Price Needed for Profit | | | | $ | /bushel |

*Developed by Amanda Smith and Adam Rabinowitz.*

## Sensitivity Analysis of Non-Irrigated Corn

Net Returns Above Variable Costs Per Acre

*Varying Prices and Yields (bushel)*

| Price \ bushel/Acre | -25% 64 | -10% 77 | Expected 85 | +10% 94 | +25% 106 |
|---|---|---|---|---|---|
| $3.50 | **-$102.48** | **-$57.86** | **-$28.11** | **$1.64** | **$46.27** |
| $3.75 | **-$86.55** | **-$38.73** | **-$6.86** | **$25.02** | **$72.83** |
| $4.00 | **-$70.61** | **-$19.61** | **$14.39** | **$48.39** | **$99.39** |
| $4.25 | **-$54.67** | **-$0.48** | **$35.64** | **$71.77** | **$125.95** |
| $4.50 | **-$38.73** | **$18.64** | **$56.89** | **$95.14** | **$152.52** |

**Estimated Labor and Machinery Costs per Acre**
**Preharvest Operations**

| Operation | Acres/Hour | Number of Times Over | Labor Use** (hrs/ac) | Fuel Use (gal/ac) | Repairs ($/ac) | Fixed Costs ($/ac) |
|---|---|---|---|---|---|---|
| Heavy Disk 27' with Tractor (180-199 hp) MFWD 190 | 13.2 | 2 | 0.19 | 1.48 | $ 4.23 | $ 12.29 |
| Disk Harrow 32' with Tractor (180-199 hp) MFWD 190 | 16.3 | 1 | 0.08 | 0.60 | $ 1.84 | $ 5.35 |
| Bed-Disk (Hipper) 6R-36 with Tractor (180-199 hp) MFWD 190 | 9.6 | 1 | 0.13 | 1.02 | $ 1.80 | $ 5.55 |
| Plant-Rigid 6R-36 with Tractor (120-139 hp) 2WD 130 | 9.5 | 1 | 0.13 | 0.70 | $ 2.01 | $ 5.60 |
| Fert Appl (Liquid) 6R-36 with Tractor (120-139 hp) 2WD 130 | 9.2 | 1 | 0.14 | 0.73 | $ 2.20 | $ 4.60 |
| Spray (Broadcast) 60' with Tractor (120-139 hp) 2WD 130 | 35.5 | 2 | 0.07 | 0.38 | $ 0.86 | $ 1.98 |
| Total Preharvest Values | | | 0.73 | 4.91 | $ 12.94 | $ 35.36 |

**Harvest Operations**

| Operation | Acres/Hour | Number of Times Over | Labor Use*** (hrs/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 | $ 7.03 | $ 37.27 |
| Grain Cart Corn 500 bu with Tractor (120-139 hp) 2WD 130 | 10.6 | 1 | 0.12 | 0.63 | $ 1.39 | $ 3.76 |
| Total Harvest Values | | | 0.31 | 2.53 | $ 8.43 | $ 41.04 |

* 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.

*Developed by Amanda Smith and Adam Rabinowitz.*

## Irrigated Corn South Georgia, 2020

## Estimated Costs and Returns

Expected Yield: **200** bushel Your Yield _______

| Variable Costs | Unit | Amount | $/Unit | Cost/Acre | $/bushel | Your Farm |
|---|---|---|---|---|---|---|
| Treated Seed | thousand | 32 | $ 3.65 | $ 116.80 | $ 0.58 | ________ |
| Lime | ton | 0.5 | $ 45.00 | $ 22.50 | $ 0.11 | ________ |
| Fertilizer | | | | | | |
| *Nitrogen* | pounds | 240 | $ 0.50 | $ 120.00 | $ 0.60 | ________ |
| *Phosphate* | pounds | 100 | $ 0.40 | $ 40.00 | $ 0.20 | ________ |
| *Potash* | pounds | 200 | $ 0.35 | $ 70.00 | $ 0.35 | ________ |
| Weed Control | acre | 1 | $ 12.50 | $ 12.50 | $ 0.06 | ________ |
| Insect Control | acre | 1 | $ 9.50 | $ 9.50 | $ 0.05 | ________ |
| Disease Control | acre | 1 | $ 19.45 | $ 19.45 | $ 0.10 | ________ |
| Preharvest Machinery | | | | | | |
| *Fuel* | gallon | 4.9 | $ 2.50 | $ 12.27 | $ 0.06 | ________ |
| *Repairs and Maintenance* | acre | 1 | $ 12.94 | $ 12.94 | $ 0.06 | ________ |
| Harvest Machinery | | | | | | |
| *Fuel* | gallon | 2.5 | $ 2.50 | $ 6.33 | $ 0.03 | ________ |
| *Repairs and Maintenance* | acre | 1 | $ 8.43 | $ 8.43 | $ 0.04 | ________ |
| Labor | hours | 1.0 | $ 13.50 | $ 14.10 | $ 0.07 | ________ |
| Irrigation* | applications | 8 | $ 8.65 | $ 69.20 | $ 0.35 | ________ |
| Crop Insurance | acre | 1 | $ 14.00 | $ 14.00 | $ 0.07 | ________ |
| Land Rent | acre | 1 | $ - | $ - | $ - | ________ |
| Interest on Operating Capital | percent | $ 274.01 | 6.0% | $ 16.44 | $ 0.08 | ________ |
| Drying - 8 Points | bushel | 220 | $ 0.28 | $ 61.46 | $ 0.31 | |
| **Total Variable Costs:** | | | | **$ 625.92** | **$ 3.13** | |

| Fixed Costs | | | | | | |
|---|---|---|---|---|---|---|
| Machinery Depreciation, Taxes, Insurance and Housing | | | | | | |
| *Preharvest Machinery* | acre | 1 | $ 35.36 | $ 35.36 | $ 0.18 | ________ |
| *Harvest Machinery* | acre | 1 | $ 41.04 | $ 41.04 | $ 0.21 | ________ |
| *Irrigation* | acre | 1 | $ 130.00 | $ 130.00 | $ 0.65 | ________ |
| General Overhead | % of VC | $ 625.92 | 5% | $ 31.30 | $ 0.16 | ________ |
| Management | % of VC | $ 625.92 | 5% | $ 31.30 | $ 0.16 | ________ |
| Owned Land Cost, Taxes, Cash Payment, etc. | acre | 1 | $ - | $ - | $ - | ________ |
| Other ________________ | acre | 1 | $ - | $ - | $ - | |
| **Total Fixed Costs** | | | | **$ 268.99** | **$ 1.34** | |
| **Total Costs Excluding Land** | | | | **$ 894.91** | **$ 4.47** | |
| **Your Profit Goal** | | | | **$___________** | **/bushel** | |
| **Price Needed for Profit** | | | | **$** | **/bushel** | |

*Average of diesel and electric irrigation application costs. Electric is estimated at $7/appl and diesel is estimated at $12.50/appl when diesel costs $2.50/gal.

*Developed by Amanda Smith and Adam Rabinowitz.*

## Sensitivity Analysis of Irrigated Corn

### Net Returns Above Variable Costs Per Acre

*Varying Prices and Yields (bushel)*

| | -25% | -10% | Expected | +10% | +25% |
|---|---|---|---|---|---|
| **Price \ bushel/Acre** | 150 | 180 | 200 | 220 | 250 |
| $3.50 | **-$100.92** | **$4.08** | **$74.08** | **$144.08** | **$249.08** |
| $3.75 | **-$63.42** | **$49.08** | **$124.08** | **$199.08** | **$311.58** |
| $4.00 | **-$25.92** | **$94.08** | **$174.08** | **$254.08** | **$374.08** |
| $4.25 | **$11.58** | **$139.08** | **$224.08** | **$309.08** | **$436.58** |
| $4.50 | **$49.08** | **$184.08** | **$274.08** | **$364.08** | **$499.08** |

**Estimated Labor and Machinery Costs per Acre**

**Preharvest Operations**

| Operation | Acres/Hour | Number of Times Over | Labor Use** (hrs/ac) | Fuel Use (gal/ac) | Repairs ($/ac) | Fixed Costs ($/ac) |
|---|---|---|---|---|---|---|
| Heavy Disk 27’ with Tractor (180-199 hp) MFWD 190 | 13.2 | 2 | 0.19 | 1.48 | $ 4.23 | $ 12.29 |
| Disk Harrow 32’ with Tractor (180-199 hp) MFWD 190 | 16.3 | 1 | 0.08 | 0.60 | $ 1.84 | $ 5.35 |
| Bed-Disk (Hipper) 6R-36 with Tractor (180-199 hp) MFWD 190 | 9.6 | 1 | 0.13 | 1.02 | $ 1.80 | $ 5.55 |
| Plant-Rigid 6R-36 with Tractor (120-139 hp) 2WD 130 | 9.5 | 1 | 0.13 | 0.70 | $ 2.01 | $ 5.60 |
| Fert Appl (Liquid) 6R-36 with Tractor (120-139 hp) 2WD 130 | 9.2 | 1 | 0.14 | 0.73 | $ 2.20 | $ 4.60 |
| Spray (Broadcast) 60’ with Tractor (120-139 hp) 2WD 130 | 35.5 | 2 | 0.07 | 0.38 | $ 0.86 | $ 1.98 |
| Total Preharvest Values | | | 0.73 | 4.91 | $ 12.94 | $ 35.36 |

**Harvest Operations**

| Operation | Acres/Hour | Number of Times Over | Labor Use*** (hrs/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 | $ 7.03 | $ 37.27 |
| Grain Cart Corn 500 bu with Tractor (120-139 hp) 2WD 130 | 10.6 | 1 | 0.12 | 0.63 | $ 1.39 | $ 3.76 |
| Total Harvest Values | | | 0.31 | 2.53 | $ 8.43 | $ 41.04 |

** 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.