



## Field Corn Production Guide<sup>1</sup>

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Field corn is important in Florida for both grain and silage. Production has declined over the past two decades because of limited opportunities for profit, increased financial risks with less insurance coverage as compared to cotton and peanut, reduction in infrastructure for handling, and higher production costs. Corn acreage in Florida in the late 1970s was around 750,000 acres. Acreage declined almost 50 percent in the 1980s to 350,000 acres and has averaged 80,00-120,000 acres in recent years. In the late 1970s and early 1980s, irrigated acres increased dramatically. Corn is still grown profitably in rotation with cotton and peanuts with yield benefits to each of the crops in the rotation. However, irrigation is essential to assure that profitable yields are made. The 2002 farm bill has improved prospects for growing corn at a profit. However, high U.S. production and carryover will keep prices down so that growers will need to look for ways to decrease production costs while increasing yield.

### Economics

Corn can be produced economically in Florida and is important for the livestock and dairy industries.

Budgets are available on the North Florida Research and Education Center web site at:  
<http://nfrec.ifas.ufl.edu/hewitt/budgets.htm>.

### Land Preparation

A good soil management program (1) protects the soil from water and wind erosion, (2) provides a good, weed-free seedbed for planting, (3) destroys hardpans or compacted layers that may limit root development, and (4) allows maintenance or even an increase of organic matter. All of these objectives can be met by using strip tillage into killed cover crops or old crop.

Water erosion is a significant problem on all soil types that have been tilled and have no cover crops during the high rainfall, winter months. Wind erosion can be a problem on sandy Coastal Plain soils in early spring when blowing sand can severely injure young corn plants. Crop residue left on the soil surface or a cover crop effectively reduces water erosion problems. Using minimum-till planting practices helps reduce soil loss and "sand blasting" from wind erosion. Conservation tillage is rapidly increasing in

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Southeastern crops including corn. Strip tillage leaves various amounts of previous crop residue or cover crop on the surface, improving water infiltration and reducing soil erosion.

Strip-tilling into a previous crop residue or cover crop is effective as long as the seedbed is not rutted from the previous harvesting operation or washed out by heavy rains. It is desirable to kill cover crops several weeks ahead of planting to reduce competition from the cover crop and to reduce cutworm and southern corn rootworm damage to young corn seedlings. However, many corn producers also have cattle that graze these fields up until the day that corn is planted, resulting in planting into live root systems. Therefore, insecticides need to be used to protect the young corn seedlings from cutworm and other soil insect damage. Insects are seldom a severe problem if cover crops are dead at planting time.

Since mulch from sod or crop residue conserves moisture, strip-till corn often yields more than conventional tilled, dryland corn in years when moisture is limited (Table 1). Residues of at least 3,000 pounds per acre are needed for effective erosion control. Research has shown that the more residue present, the more moderation of soil and plant canopy temperatures and the better the conservation of moisture. Water is usually the main limiting factor to corn production in Florida.

A compaction layer occurs naturally on Coastal Plain soils. This compacted layer restricts root growth and water and nutrient uptake by the plant and should be disrupted by deep turning, chisel plowing or by using an in-row subsoiler at planting. In-row subsoiling has increased irrigated corn yields over 50 percent on soils where no or limited irrigation occurs (Table 2 and Table 3). It enables corn to develop deeper root systems that make better use of subsoil moisture and improves the chances of recovering nutrients as they move through the soil.

Corn generally grows best in deep, well drained soils, although good yields have been obtained on a wide variety of soil types with irrigation. Land preparation to warm soils up is not necessary for corn, since corn is not as sensitive to cold soils as many crops.

## Hybrid Selection

Growers have only one chance to make the right decision on the right corn hybrid to use each year. Differences among hybrids in yield potential, maturity, standability, disease resistance, grain quality and adaptability can be obtained from university performance trials. Performance trials should be studied to make the right choice of hybrids for irrigated or non-irrigated corn production.

Disease resistance is a necessary component of hybrid selection for the deep south. Higher humidity, fluctuating water availability and higher plant populations under irrigation will favor many diseases. Hybrids should have resistance to southern corn leaf blight, anthracnose, grey leaf spots, common rust, southern rust, etc. Corn planted after corn is especially susceptible to leaf diseases, since there is a buildup of spores throughout the growing season. But corn that could survive later planting due to insects could fail to produce grain due to little disease resistance. Grain quality depends on shuck coverage to retard moisture and inhibit insect penetration into the ear and grain hardness.

Corn maturity is classified as early (short-season), medium (mid-season) or late (full-season). In general, the earliest maturing hybrids best adapted to Florida mature in about 115 days after emergence. Maturity will range up to 125 days for full-season hybrids. Early and medium maturing hybrids are usually better adapted to irrigated corn production because they (1) mature 1 to 2 weeks earlier, (2) are generally shorter and are less subject to lodging, (3) may need fewer irrigations, and (4) are more suitable for use in double-cropping than late or full-season hybrids. However, full season "tropical" hybrids are often grown after early season corn hybrids for silage. 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 which normally has better shuck coverage.

The results of hybrid evaluation tests for grain and silage are available from your county Extension office or on the EDIS web site at

<http://edis.ifas.ufl.edu/AG109>. Hybrid evaluation information is also available on the University of Georgia web site at

<http://www.griffin.peachnet.edu/swvt>. Consistent performance across several locations and years usually means wide adaptability. It is important, however, to compare hybrids within maturity groups. Growers should test new hybrids on their farms but should not plant an untried hybrid to large acreages.

Primary selection criteria when selecting a hybrid are:

- Grain yield
- Maturity
- Stalk strength
- Grain quality and disease and insect resistance.
- Silage yield and digestibility

Hybrids with transgenic and value added traits are available from many corn seed companies. These types of hybrids include Bt insect resistant hybrids, and those with resistance to herbicides such as Roundup, Liberty and IMI (imidazolinone). High-oil content corn hybrids are also available for planting in the southeast. Because they are priced higher than conventional hybrids, these hybrids should be used only where the specific trait is of economical benefit. In general, transgenic traits in corn have not shown to be the value that similar traits have been in cotton and soybeans. Late planted (May-July) tropical corn with the Bt gene has been shown to be very beneficial.

## Planting Growth and Development

To produce good irrigated corn yields an understanding of how corn grows and develops is needed if timely management decisions are to be made. Although growth rates vary among hybrids and with growing conditions, Table 4 is a general outline of corn development for a medium maturity hybrid in Florida.

## Planting Date

Corn growth and development are primarily dependent on temperature rather than day length. Successful germination requires a morning soil temperature of 55° F at a 2-inch depth for three consecutive days. This can range from early February in light sandy soils to mid March on cold, wet, heavy soils. Frost may still occur after these planting dates, but corn normally withstands frost damage to above ground tissue, since the growing point is still below the soil surface until corn reaches about 12 inches tall.

In Florida, planting dates for corn begin in late February and proceed to late April.

Advantages to early planting include:

- More stored soil moisture
- Higher yield potential
- Lower temperatures during pollination
- Longer daylengths at pollination
- Early harvest before cotton and peanuts
- Less insect and disease damage

When moisture is adequate, plant seed between 1 and 2 inches deep. When moisture is deeper than 2.5 inches, waiting for a rain may improve stands. In cold sandy soil, the depth may need to be closer to 1 to 1.5 inches. Germination time and emergence will vary with moisture and temperature from 5 to 30 days.

Data in Table 5 shows irrigated corn yields from two locations averaged over several hybrids. These are irrigated yields which tend to be fairly consistent from February through April, then decline rapidly in May and later plantings due to insect damage and disease. Non-irrigated corn may do best from late April planting if normal rainfall occurs in July and August. Non-irrigated corn is at risk each year since dry periods of three weeks or longer often occur.

## Plant Populations and Row Spacing

The optimum plant population varies with soil type, hybrid, irrigation, fertility and other management practices. Irrigated corn requires higher plant population than non-irrigated corn to fully utilize the potential of irrigation. Seeding rates depend on the hybrid, yield expectations and row width. Recommended plant populations for non-irrigated corn ranges from 16,000 to 24,000 plants/acre. Seeding rates for irrigated production usually range from 24,000 to 32,000 plants/acre. Seed companies normally provide a recommended population for each hybrid. Generally 24,000 to 30,000 plants/acre are recommended for most early and medium maturing hybrids with irrigation. Plant populations for the later maturing hybrids should be 22,000 to 26,000 plants/acre. Excessive populations increase seed costs and may reduce yield because of inadequate watering or rainfall and lodging. Plant 10 to 15% more seed/acre than is necessary to produce the desired plant population. Corn seed generally germinates at the rate of about 95%, and another 5-10% may be lost to insects, disease or other pests.

Studies reveal that increased yields can be obtained with more narrow rows at high plant populations. This allows plants to exploit more moisture, nutrients and light due to greater space between plants. It also helps weed control by shading the ground more quickly. Row widths of 30 to 36 inches are adequate for top irrigated yields. In some studies, twin rows yields have shown to be 5-10% higher than single rows; however, water and other factors usually limit yield more than plant population.

Count the number of kernels in one row for the indicated distance (Table 6) and multiply this number by 1,000 to get 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. New vacuum planters have excellent control in attaining a desired seed drop and plant populations. Whether old or new, well-maintained planters are necessary for evenly distributed plant population.

If corn is to be produced without irrigation, a yield potential of no more than 125 bushels per acre should be used for management purposes using lower plant populations. For sandy soils with limited irrigation, use the lower range of the recommended plant population for irrigated corn.

Corn has highest yield potential in about 15-inch rows. Equipment considerations, however, may limit the use of narrow rows, since adapting some equipment may not be practical. Narrow rows should be one consideration when purchasing new equipment.

## Fertilization

A good fertility program should be based on the soil fertility level as determined by soil tests and yield goal. **Fertilization programs not based on soil tests may result in excessive and/or sub-optimum rates of nutrients being applied.** Soil samples should be taken each fall to monitor the fertility level.

Coastal Plain soils are naturally acid and infertile. Therefore, substantial quantities of lime and fertilizer are required for optimum yields. Corn cut for silage requires more nutrients than corn grown for grain because cutting silage removes all of the nutrients from the field in the above-ground plant parts. The removal of potassium is especially large in comparison to grain harvest. A comparison is given in Table 7 of the nutrients contained in grain and stover.

## Lime

Many fields do not have to be limed for corn if grown in rotation with peanuts which are normally limed. Fields that have continuous corn or are rotated with other grass crops may become acid due to: (1) use of high amounts of nitrogen which is acid forming, (2) leaching of calcium and magnesium, and (3) nutrient removal by high-yielding crops, especially silage. Corn grows well in soil with a pH of 5.6-6.2. Soil with a pH below 5.2 can fix plant

nutrients, especially phosphorus, in forms unavailable to plants. Also, since most bacteria cannot live under very acid conditions, liming increases bacterial activity which break down soil organic matter to make soil nitrogen and other nutrients more available to the crop. Likewise, herbicide activity of triazine herbicides are most effective when the soil pH is between 5.8 and 6.5.

Magnesium is seldom a limiting nutrient in corn production if dolomitic limestone is used as the lime source. Corn often shows magnesium deficiency even when soil levels are adequate during the peak period of nitrogen uptake (40-70 days after planting) but symptoms usually disappear after 10-14 days.

### Nitrogen

Nitrogen is very mobile in sandy Coastal Plain soils, and can be lost if excessive rainfall occurs. To increase the efficiency of nitrogen recovery during the season, split applications of nitrogen are recommended. Nitrogen is typically the most limiting nutrient for high yields. A rough rule of thumb is that the crop needs 1.2 to 1.3 pounds of actual nitrogen for each bushel of corn produced. About 20 to 25 percent of the nitrogen needs of the crop can be applied at planting as a starter fertilizer near the row. 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 35 to 45 lbs/A at planting and the remainder when corn is 12 to 15 inches tall.

In addition, overhead irrigation may enable N to be applied later in the season through the irrigation water. No yield increase has been found from nitrogen applied after the silk-and-tassel period. If nitrogen is to be injected through the irrigation system, apply 30 to 40 pounds at planting and make a sidedress application of 30 to 50 pounds of nitrogen per acre when the corn is 12-15 inches tall. The remainder of applications may be made through the irrigation system on a bi-weekly basis until the total required nitrogen is applied in 3 to 5 applications and should be completed by tassel emergence. A typical nitrogen uptake curve shows that corn takes up about 15 lbs/acre of nitrogen by the time corn is about 15 inches tall. It starts a rapid uptake period at this time and will grow about 3 feet the next two weeks with

good moisture and take up about 80 lbs/acre of nitrogen during those two weeks, followed by another 50 lbs/acre of uptake in the next two weeks prior to tassel emergence. Therefore, at least 130 lbs/acre of nitrogen will need to be applied in the four weeks after corn reaches the 15-inch height range. Over the next 6 weeks of ear formation, corn will take up another 100-150 lbs/acre of nitrogen. However, if nitrogen is adequate until tassel emergence, no yield increase would be expected from additional nitrogen application after tassel emergence. Only grain N content is increased with N applied after tassel emergence.

### Phosphorus and potassium

Phosphorus and potassium should be applied according to a soil test. A 200 bushel crop can take up to 45 pounds of phosphorus and 250-300 pounds of potassium. Corn may exhibit phosphorus deficiency symptoms (stunted plants and purpling of leaves) on cool, wet soils that have high levels of soil test P. Generally, all the phosphate and, on most soils, all of the potash are applied at or before planting. Some or all of the phosphorus requirements may be obtained through the use of starter fertilizer. On deep sands, apply potash in split applications, 1/3 at planting and the remainder when corn is about 15 inches tall.

### Secondary and micronutrients

Corn requires about 20 to 30 pounds of sulfur per acre. On deep sands, apply sulfur in split applications with N. All sulfur should be applied in the sulfate form. Nitrogen sources with sulfur are usually sufficient to meet plant requirements.

Zinc and manganese deficiency can be prevented by using 2-3 lbs/A of the element if called for by soil tests. Do not use zinc unless soil test levels are low, since peanuts (if used in rotation) are very sensitive to high levels and can result in zinc toxicity and split stems. If needed, apply preplant or at planting in starter fertilizer as chelates.

Boron deficiencies can occur on sandy soil low in organic matter. Generally, use one pound per acre of boron applied in split applications. It is best to apply boron with the nitrogen applications.

## Fertilizer Placement

The main objective in fertilizer placement is to avoid injury to the young seedling and to get proper placement for most efficient root uptake. Band placement of N near the row at planting and on corn up to about 15 inches tall has been shown to be most efficient since the root system is limited.

Broadcasting potassium fertilizer is less expensive for labor and just as efficient as banding on soils with medium fertility. However, our research has shown that 25% less P and K may be used if applied in band vs. broadcast applications. Generally, all of the phosphorus is usually applied as a starter and all of the potassium is broadcast preplant or pre- and post-plant applications.

### Starter Fertilizer

Small amounts of nitrogen, phosphorus, sulfur, and micronutrients are often used as a starter fertilizer. The main advantage of starter fertilizer is better early-season growth, earlier dry down, and with many hybrids, higher yield. 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 chances of roots penetrating the fertilizer band and taking up needed nitrogen and phosphorus. Starter fertilizer can also be used in a surface dribble for strip till planting with the solution applied 2 inches to the side of the seed furrow for each 20 lbs of nitrogen used.

Currently, the most popular starter fertilizer is ammonium polyphosphate (10-34-0), a liquid. Monoammonium and diammonium phosphates are dry sources and equally effective. There is generally no advantage in using a complete fertilizer (NPK) as a starter, since applying nitrogen and phosphorus is the key to early growth. If soil test levels for P and K are high, a starter with 30-40 lbs/A of nitrogen and 15 lbs/A of P is adequate for starter application. Normally, 10 to 15 gallons of a starter fertilizer containing one third to one half 10-34-0 and the remainder as 28-0-0-5 has been effective for early corn growth. Corn will take up around 15-20 lbs/A of N and 5 lbs/A of P by the time corn is 15 inches tall. Therefore, high rates of starter P are not necessary

unless it is used to supply all of the P for the corn crop in a low soil test field.

## 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 and crop yield during the season. Plant analysis can be used to monitor the nutrient status of the plant and to confirm a suspected nutrient deficiency and aid in the adjustment of the fertilizer program in subsequent years.

## Fertility in Conservation Tillage

Fields that have been conventionally planted for several years may have adequate fertility levels. However, for conservation tillage, having the soil tested and applying needed lime and phosphorus are the most critical before a cover crop is planted. All the phosphorus needed can be applied for both a cover crop and the corn crop at the same time. However, some corn hybrids will respond to starter nitrogen and phosphorus at high soil P levels. On heavier soils, all the potassium necessary for a cover crop and corn crop can be applied at the same time. On lighter, sandier soils, the potash application should be split, with one-third applied in the fall for the cover crop and the rest at planting time and topdressed. When a small grain cover is planted in the fall, apply only 20 to 30 pounds of N before fall planting. If grass shows N deficiency in December or January, apply another 20-30 pounds. A starter fertilizer can be applied at planting to corn. The same basic fertility program can be used on conservation till planted corn as with conventional tillage as noted above.

## Irrigation

Research in the southeast has shown that irrigation significantly increases corn yields, although the increase may vary from year to year, depending on weather and other factors. Irrigation, when combined with other good production practices, should result in yields that are consistently 150 bushels per acre and greater. Non-irrigated corn yield

can range from 5% to 75% that of irrigated corn. It has been said that you pay for irrigation whether you have it or not (Table 8).

Total water needs for a corn crop vary from 20 to 24 inches during a season, depending on weather, plant density, fertility, days to maturity and soil type. Research has shown that it takes about 5,000 gallons of water to produce one bushel of corn grain. Ample moisture should be available in the root zone until physiological maturity (black layer) is reached (maximum dry weight of grain) which is about 60 days after tassel emergence.

Adequate drainage is necessary in depressions or low spots in fields to allow runoff water to be routed off the field in 24 hours or less. A coarse textured soil will need to be irrigated more frequently than a fine textured soil. Also, in general, fine textured (clay and silt loam) soils have a lower infiltration rate than coarse textured (sandy and sandy loam) soils. Typical Coastal Plain soils will hold from about 0.7 inch of water in per foot to about 1.6 inches of water. The key is to irrigate to avoid excessive runoff.

Corn is more responsive to irrigation than many crops. The water requirement of corn is greatest from tasseling through ear filling, requiring as much as 0.33 inches per day. Moisture stress prior to tasseling can cause a yield reduction of 10 percent to 40 percent; moisture stress between the tasseling and soft dough stages may result in a 20 percent to 50 percent yield loss; and moisture stress from the soft dough stage to maturity can cause a yield reduction of 10 percent to 35 percent. A rough rule of thumb is that corn requires about 1 inch of water every 7-10 days until it reaches 15 inches high, then an inch every 5-7 days until tassel emergence, and finally an inch every 3 days from tassel emergence until physiological maturity.

## Disease Management

Each year, corn yields are reduced in the southeast due to diseases. Diseases also lower the value and quality of the grain and may increase harvesting costs due to lodging. Generally, warm, wet weather favors leaf, ear and stalk diseases. Seedling diseases are usually worse during cool, wet

weather following planting. Among the diseases that can impact corn production are:

### Seedling Diseases

#### Root and Stalk Rots

Caused by several different fungi, these diseases can result in corn lodging and inferior ears from lodged plants on the ground and premature ripening on diseased stalks. Stalk rots typically result in greater damage in poorly drained soils and when drying conditions are slow due to poor air movement. Control practices include utilizing good cultural practices, planting recommended varieties with resistance to lodging, using early maturing varieties where lodging is severe and avoiding poorly drained fields. Diseases that fall into this category include *Pythium*, *Fusarium* stalk rot, and charcoal rot.

The soil-borne fungus disease *Fusarium* stalk rot normally begins soon after pollination and becomes more severe as plants mature. Symptoms include whitish-pink discoloration of the pith, stalk breakage and premature ripening.

Charcoal rot (caused by the fungus *Macrophomina*) can result in severe yield losses if hot, dry environmental conditions coincide with post-flowering growth stages. Symptoms usually start showing up on plants approaching maturity, appearing as brown water-soaked lesions on the roots that later turn black. The fungus moves into the plant's lower nodes, causing premature ripening and lodging. Numerous black sclerotia inside the stalk give the appearance of powdered charcoal. This disease can be dramatically reduced by irrigating before flowering begins. Also, a balanced fertility program can have a positive impact, since high nitrogen rates and low potassium rates increase charcoal rot severity. Resistant varieties are not available but planting varieties that possess high stalk strength helps reduce lodging.

## Foliar Diseases

### Leaf Blights or Leaf Spot

Caused by different species of the fungus *Helminthosporium*, these diseases favor wet or humid field conditions. Symptoms are lesions that are tan, oval to circular, and usually with concentric zones. The fungus also attacks ears causing a black, felty mold over kernels. Race two of southern corn leaf blight produce oblong, chocolate-colored spots up to 1 inch in length. Tolerance among corn varieties can vary. Control practices include planting recommended, resistant varieties.

### Ear and Kernel Rots

Some of the fungi that cause silk rots or leaf blights may also infect the ear, with symptoms including a pink, powdery mold growing over the surface of rotted grains (*Fusarium*) and dense, white mold growing between the rows of rotted kernels (*Diplodia*). Some protection can be obtained by planting varieties resistant to ear-feeding insects and lodging. Some hybrids may offer slight resistance. Early harvest and proper storage is helpful.

### Maize Dwarf Mosaic

First appearing on the youngest leaves as an irregular, light and dark green mottle that may develop into narrow streaks along veins, this disease is common in the Southeast. As plants mature, leaves become yellowish-green. Plants are sometimes stunted with excessive tillering, multiple ear shoots and poor seed set. Early infection, vectored by several species of aphids, may predispose plants to root and stalk rots. Some hybrids have resistance to virus diseases.

### Smut

This fungal disease is common and generally results in losses from 1 percent to 10 percent, although resistant varieties can cut losses significantly. All above-ground parts of the plant are susceptible, but the tender ears are most commonly attacked. Symptoms include 1/4 to 1/2 inch galls with a shiny greenish to silvery-white color. The interior of these galls darkens and turns into masses of powdery, dark brown-to-black spores. Affected plants may

appear reddish near maturity. Again, control is usually obtained by avoiding susceptible varieties, mechanical injury during plowing, and excessive nitrogen.

### Rusts

Common rust is generally found on plants relatively early in the season (before tasseling). It survives the winter on green corn or on wood sorrel and grows best in the cooler temperatures that are common early. Southern rust does not overwinter but is thought to come in annually on wind currents from Latin America. It is favored by the hot humid temperatures that occur later in the season. Both are characterized by the formation of pustules (small, raised blisters that contain rust-colored spores of the fungus) on leaves. Symptoms of both rusts may overlap. Common rust pustules are oval to elongate, often 1/4 inch long on leaves other than the lowest ones, and dark cinnamon brown. Southern rust pustule shape is circular, 1/6 to 1/8 inch in diameter, and tan-orange-brown in color.

Although it is rare in Florida, common rust will kill or severely damage corn plants, while southern rust can be devastating under favorable environmental conditions. Most commercial hybrids have some degree of resistance to common rust. There is little resistance to southern rust presently available. Currently, early planting is the primary defense. Rust is the most serious disease to corn planted in June and July. It often kills plants and can cause rapid dry down of corn planted late for silage.

## Nematode Management

Several nematode species are known to damage field corn in Florida. Most important is the sting nematode (*Belonolaimus longicaudatus*), whose distribution is limited to very sandy soils such as those typical of peninsular Florida. Stubby root (*Paratrichodorus* spp.), lesion (*Pratylenchus* spp.), lance (*Hoplolaimus* spp.), and root-knot (*Meloidogyne* spp.) nematodes may also affect field corn growth. Yield reductions by most kinds of nematodes parasitizing field corn are usually severest in the sandiest soils and in times of drought. Generally, well-irrigated field corn can tolerate considerable numbers of nematodes.



## Symptoms

Aboveground symptoms of nematode injury include stunting, thin stands, premature wilting under moderate heat or drought stress, and nutrient deficiency symptoms. Since nematode numbers can vary greatly within very short distances in the field, areas of stunted growth, yield reduction, and other aboveground symptoms of nematode damage vary greatly in shape, size, and distribution. Symptoms and yield loss are worse in soils that are sandy, dry, and infertile. Roots injured by nematodes are usually stunted, often with few fine secondary feeder roots. Root tips may be blunt and swollen. Sometimes tufts of many stunted lateral roots emerge near the main root tips. By damaging root tips as soon as they emerge, nematodes can be especially injurious to young seedlings. Even under moderate stress, nematode-damaged roots may cause young plants to die, resulting in a thin crop stand.

## Diagnosis

Nematode problems of field corn can be determined only by nematode assay. Prior to taking samples, contact your county extension agent for information concerning available sampling tools, shipment bags and proper procedures for submitting samples. Samples should not be taken when the soil is dusty dry or soggy wet. Two sampling strategies may be employed. A general survey should be performed every three to four years and soil samples should be taken soon after field corn has been harvested. A soil core (1-inch wide by 8-10 inches deep) should be taken for every 2-3 acres in a 20-acre block containing a uniform soil type and cropping history. The cores should be thoroughly mixed and a 1-pint sample extracted and placed in a sealed plastic bag and kept cool (not frozen) before immediate shipment to an advisory laboratory. In a more definitive strategy where a nematode problem is suspected, several soil cores from within and immediately around a poor growth site should be taken while the crop is still growing. Include portions of damaged roots with the soil sample. These samples should be processed as described above.

## Management

The worst nematode problems occur in fields where field corn and/or close relatives such as sorghum have been grown every year. Rotation to unrelated crops in successive years is usually better for all crops in the planting cycle, not just the cash crops for which crop rotations plans are primarily designed. Of all the agronomic crops commonly grown in rotation with field corn in Florida, peanut and tobacco are probably the best for reducing nematode pests of field corn. Several nematicides have been approved for management of nematodes of field corn (see EDIS Fact Sheet ENY-001 *Field Corn Nematode Management* <http://edis.ifas.ufl.edu/NG014>). A recommendation for their use is problematic due to the low monetary profit from this crop. Currently, there is probably no financial justification for applying nematicides to field corn if the crop is being grown for forage. If an irrigated field realistically can be expected to produce a profitable seed yield, growers must consider that nematicides may only help recover some portion of the original potential yield that would be lost to nematodes.

## Weed Control

Weed management can be enhanced with production practices such as crop rotation, timely planting, soil fertility management and cultivation. Many growers are using strip tillage planting on corn after winter grazing and do not cultivate but rely entirely on herbicides for weed control.

Fields with heavy johnsongrass infestations may not be suited for corn production. Controlling these weeds in a preceding year's planting of peanut or cotton may be required, or the use of transgenic hybrids that allow over-the-top applications of grass herbicide materials can make production of corn feasible in these fields.

Herbicides are needed to control weeds not controlled by the other practices. Rates may depend on soil texture, organic content and targeted weed species. Always read and follow label directions and precautions when using herbicides. Rates are per acre and maybe given in a range from coarse-textured to fine-textured soils. Refer to EDIS Fact Sheet

SS-AGR-02 *Weeds in the Sunshine: Weed Management in Corn* <http://edis.ifas.ufl.edu/WG007> for weed control recommendations.

## Insect Control

The economic threat insects pose to corn will vary from year to year, and any one of several insect species can cause yield losses, either by direct feeding or vectoring a plant virus such as maize dwarf mosaic. Control requires having a knowledge of insects and management options available. Effective insecticides are available for many insects that threaten corn. Always read and follow label directions and precautions when using insecticides. Since insect infestations are typically highest in late summer, early planted corn is likely to have fewer problems. Fall armyworm damage is usually light until July and August, first generation southwestern corn borer is lighter than second and third, and corn earworm damage is usually lighter in early planted corn. Refer to EDIS Fact Sheet ENY 401 *Insect Management in Field Corn* (<http://edis.ifas.ufl.edu/IG060>) for recommendations on specific insect control.

### Soil Insects

Several soil insects attack corn by feeding on germinating seed, roots or underground stems. If fields have a history of soil insect problems, an application of a soil insecticide may be justified. Among the most important:

#### Seed Corn Maggot

This is a small white maggot that feeds on corn seed, which can cause stand reduction or loss. The feeding may cause seed to fail to germinate or result in weakened seedlings that may die. Any condition that delays seed germination may increase damage from seed corn maggot, with damage greatest in cool, wet springs. Damage can be detected by digging in areas where plants have failed to emerge. Serious damage may require replanting. Systemic in-furrow insecticides aid in preventing infestations of seed corn maggots. Banded treatments should be incorporated lightly.

#### Southern Corn Rootworm

This pest, the larvae of the spotted cucumber beetle, damages corn when larvae feed on root systems. The feeding causes roots to be stubby, and tunneling is obvious where larvae have fed. Severe injury may cause plants to lodge, and a goosenecked appearance results as plants try to grow erect. Soil insecticides can control corn rootworms. Apply as directed either in-furrow or in a band 7 inches in front of press wheel and incorporate lightly at planting.

#### Wireworms

Wireworms feed on germinating seeds and the root system. Larvae are yellowish brown to brown and wire-like in appearance. Infestations appear heaviest in areas following sod.

#### Lesser Cornstalk Borers

This insect damages the plant by boring into the stalk. This boring causes dead-heart and may greatly reduce the stand. It tends to be more of a problem on sandier soils. Lesser cornstalk borer problems generally are reduced in conservation tillage.

#### White Grubs

Another root-system feeder, this grub causes plants to be stunted and reduces stands. Lodging and yield reductions also may result.

#### Cutworm

Several species of cutworms attack corn and cause similar plant injury, cutting plants down at the soil line. Damage often can be prevented by early seedbed preparation or early killing of the cover crop to allow natural control of worms. Applying an insecticide to the row when damage is first noticed may be needed. Insecticides should be applied at labeled rates when stands are threatened. Sprays should be directed to lower portions of plants and to soil around the base of plants. In reduced-tillage corn, the use of a soil-applied insecticide also helps suppress cutworm populations.

## Sugar Cane Beetles

This pest, which may be called rough headed corn stalk beetle, is black and about 1/2 inch long. It burrows into the ground and feeds on the corn stem about 1/2 to 1 inch below the soil surface, making a ragged hole in the stem. It tends to be most prevalent in low, wet spots in a field. Control is difficult.

## Chinch Bugs

Chinch bugs can be an occasional problem in corn, but when they reach threshold levels, they can be a serious problem. Chinch bugs are 1/5 to 1/6 inch long and have black wings with white covers crossed with a zigzag line. They are normally found near or below the soil line and behind leaf sheaths. Systemic in-furrow insecticides can provide control.

## Foliar Insects

### Corn Flea Beetles

Corn Flea Beetle may kill seedling corn by eating holes in leaves and severely weakening the plant. The pest hops like a flea and is small, black and about 1/6 inch long. Treatments should be made when beetles are abundant and affecting stand vigor.

### Fall Armyworm and Corn Earworms

Damage to corn whorl or buds may be caused by the corn earworm and fall armyworms. The corn earworm occasionally infests the whorl but is more likely to cause damage to developing ears. Bt corn and tropical corn have some resistance to these worms and may be a better choice for late plantings for silage. However, Bt corn has little disease resistance and yields may be severely reduced by late planting unless it has come from tropical germ plasm.

### Stink Bugs

Generally, the southern green stink bugs are observed feeding on corn. Research has shown that the stink bugs must feed when the developing ears are 1/2 inch to 3/4 inch long or less for significant damage to occur. The ears enter the susceptible period about two weeks before silking. Stink bugs pierce the plant with their beaks and inject a saliva

while simultaneously sucking out sap. When the ears are small, this feeding can result in the loss of the entire ear. When stink bugs are feeding on older ears, the latter may be seriously malformed, but this damage actually results from earlier feeding. Fields should be checked for stink bugs before the ear shoots have fully emerged. Scout for stink bugs by making counts in several areas of a field, but pay careful attention to field margins because this is where they normally infest first. Treat for stink bugs when 5 percent of the plants are infested. In some years, stink bugs can also be an early season problem. Growth and development of young corn plants can be affected by stink bug feeding. Treat corn less than 2 feet tall when 10 percent of the plants have one or more stink bugs.

## Harvesting and Drying

Ideally, corn should be harvested at between 15 and 18 percent moisture. Drying costs or high moisture discounts can cause some farmers to wait too long to harvest corn. For large corn acreage, harvesting should start at 25 percent moisture. Delaying harvest once corn reaches 25 percent will cause a loss of 1/3 bushel per day per 100 bushels of yield per acre. Corn that reaches 25 percent moisture in August will take 8 to 10 days to dry to a moisture of 19 to 20 percent. Thus, delaying harvest for 10 days during this period of years, cause losses of 4 to 5 bushels per acre. However, corn harvested at 25 percent moisture requires twice as much moisture to be removed as when harvested at 20 percent. There is generally a premium paid for grain delivered early which can help offset drying cost along with the higher yields. Preharvest and harvesting losses may vary, due to insect damage, lodging and ear dropage. Corn that remains in the field too long suffers weight shrinkage, damage and yield loss.

A well-adjusted combine equipped for corn is the first step toward a productive corn harvest. Rasp bars or rotors should be set to properly shell the corn from the cob without cracking kernels. Row spacing should match the corn header. Studies have shown that gathering losses can increase 2.5 bushels per acre if the gathering opening is 4 or 5 inches off the row.

Operate the corn header low enough that the gathering chains enter the row below the lowest ears. Lodged stalks may mean reducing the height so gathering points follow the ground contour. Slowing forward speed recovers more ears that drop easily from lodged stalks.

Corn often has high levels of aflatoxin due to being grown under stress conditions (moisture stress, insects, etc.). Early harvest and drying to 15 percent moisture within 24 hours after harvest will help reduce aflatoxin formation. Corn should be dried to 13% moisture or less if it is to be stored for several months to help prevent spoilage.

**Table 1.** Influence of Soil Preparation on Yield of Corn (bu/A).

<b>Irrigation Treatment</b>	<b>Conventional</b>	<b>Conservation Till</b>
Dryland	40	41
Limited <sup>1</sup>	100	111
Full <sup>2</sup>	161	173
<sup>1</sup> Irrigated from pre-tassel to post-silk <sup>2</sup> Irrigated from 4 weeks after emergence to physiological maturity. Source: Cassel and Waggoner, NC State Univ.		

**Table 2.** Influence of Tillage and Water Management on Corn Yield (bu/A).

<b>Tillage</b>	<b>Irrigation</b>	<b>Year 1</b>	<b>Year 2</b>	<b>Year 3</b>	<b>Avg</b>
Conventional	NO	70.9	29.7	22.9	41.2
Conventional	YES	113.9	136.8	138.3	129.7
Subsoil	NO	158.9	129.8	77.7	122.1
Subsoil	YES	154.9	161.6	149.4	155.3
Source: Cassel and Edward, NC State Univ..					

**Table 3.** Influence of Tillage on Corn Yields (bu/A)

<b>Year</b>	<b>Conventional</b>	<b>Chisel</b>	<b>Subsoil</b>	<b>LSD .05</b>
1	87.7	119.3	140.4	12
2	38.5	53.7	67.4	10.7
Source: Chancy and Kamprath, NC State Univ.				

**Table 4.** Outline of corn development for a medium maturity hybrid in Florida.

Days after Planting	Development Status of Corn Plant
3	Seed germination.
10	Seedling emergence. Primary roots developing.
17	Two leaves expanded. Primary roots functioning. Nodal (permanent) roots forming. Plant making food.
30	Four to six leaves expanded. Remaining leaves and nodal roots developing. Growing point near soil surface.
35	Six to eight leaves expanded. Tassel developing. Growing point two to three inches above ground.
40	Ten to 12 leaves expanded (bottom 4 lost). Ear shoots developing (maximum number of potential kernels on primary ear determined). Stalk growing fast. Brace roots developing.
45	Fourteenth leaf expanded. Rapid stalk growth continuing. Tassel not visible but nearly full size. Top two ear shoots developing rapidly. Silks forming at base of top ear shoot.
50	Sixteenth leaf expanded. Five to six bottom leaves lost. Tassel emerging. Top ear shoot and silks elongating (second ear normally does not fully develop).
60	All leaves expanded. Tassel emerged. Silks emerging. Pollination beginning. This is for early planted corn. Corn planted late may have emerged silks and tassels in 45-50 days.
65	Pollen shed complete. Kernels in blister stage.
75	Kernels in dough stage and rapidly increasing in weight.
90	Kernels at 50% milk stage.
105	Kernels in early dent stage.
115	Kernels fully dented.
120	Ear mature (black layer formed on 75% of kernels in middle of ear).
135+	Kernels ready for combining at 26 to 28% moisture.

**Table 5.** Influence of Planting Date on Corn Yield (FL and GA).

Year	Planting Date			
	Mid-Feb	Mid-March	Early April	Mid-May
	-----bu/A-----			
1	--	159	146	86

**Table 5.** Influence of Planting Date on Corn Yield (FL and GA).

Year	Planting Date			
	Mid-Feb	Mid-March	Early April	Mid-May
	-----bu/A-----			
2	--	153	139	104
3	--	95	66	30
4	--	131	113	87
5	218	226	186	--
6	232	218	188	--

**Table 6.** Length of Row Required for 1/1,1000 Acre at Various Row Widths.

Rows Widths Inches	Length of row for 1/1,000 acre
20	26 ft. 2 in.
30	17 ft. 4 in.
32	16 ft. 3 in.
36	14 ft. 6 in.
38	13 ft. 9 in.
40	13 ft. 1 in.

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

Nutrient	Grain	Stover	Total
	-----lbs-----		
Nitrogen	170	70	240
Phosphorus (as P <sub>2</sub> O <sub>5</sub> )	30	30	60
Potassium (as K <sub>2</sub> O)	48	192	240
Calcium	15	42	57
Magnesium	16	34	60
Sulfur	14	16	30
Zinc	0.15	0.54	0.69

**Table 8.** Irrigated Corn vs. Non-irrigated Corn Production in Two Different Soil Types (GA).

Year	Tifton soil		Bonifay soil	
	Irrigated	Non-irrigated	Irrigated	Non-irrigated
-----bu/A-----				
1	170.4	90/8	202.3	86.0
2	--	--	167.3	35.1
3	192.8	74.9	178.4	8.0
4	199.2	119.5	213.5	105.2
5	167.3	113.1	117.9	43.0
Avg	182.4	99.6	175.9	55.5