

Crop Profile for Cotton in Florida

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Production Facts

- In 2007, there were 207 cotton farms in Florida with reported acreage of 72,422 acres. Over ninety percent of the acreage was reported as being non-irrigated. The yield in irrigated cotton (576 pounds per acre) was nearly 100 pounds less per acre than that of non-irrigated cotton (672 pounds per acre) (1).
- In 2008, Florida cotton production was 122,000 bales (nearly sixty million pounds) harvested from 65,000 acres. The price per pound (52 cents a pound) received equated to a crop value of slightly over thirty million dollars. Acreage planted in 2009 (65,000 acres) is slightly less than that planted in 2008 (67,000 acres) (2).
- Florida cotton production has increased from a low in the early nineties (approximately 75,000 bales) and peaked at 166,000 bales in 2006 (3).
- In 2008, Florida ranked 15th out of the 17 states reporting cotton statistics. Florida accounts for one percent of cotton grown in the U.S. (4). In 2008, the average yield for the U.S. cotton crop was 803 pounds per acre, while it was 916 pounds per acre in Florida (2,5).

Production Regions

All of the cotton acreage in Florida resides in the panhandle area. Jackson and Santa Rosa counties together account for two-thirds of the cotton production while six others including Calhoun, Escambia, Holmes, Okaloosa, Walton, and Washington account for most of the remainder (6).

Production Practices

Cotton is the fruit of the cotton plant (*Gossypium hirsutum*) and a natural cellulosic fiber. Total harvested acres in the U.S. have decreased greatly since historic highs, but growers have maintained and even increased production levels because of higher yields. In its native habitat, cotton is a woody perennial plant that does not die in the fall. Instead, the plant becomes dormant during periods of drought and resumes growth with the return of favorable rainfall. This characteristic is partially responsible for cotton's reputation as a dry-weather crop. Over time, cotton has been adapted and bred to react as an annual (7).

Cotton is a slow-growing crop which can be prone to competition from plants and feeding by insects and nematodes. Cotton has the highest chemical input historically for a row crop, and consequently, much effort has been placed into pest management strategies for this crop. A survey just prior to the introduction of genetically modified cotton reported that over half of growers reported that total expenses for pest management, including application labor, materials and equipment, represented 20 percent or more of their total direct costs of production, while the remainder indicated it was between eleven and 20 percent (7).

However, modern cotton pest management has been simplified and is a combination of prophylaxis during early seedling development and pest toxin production during plant growth. Chemical needs are still reported for the drying and harvest preparation at the end of the season.

As cotton is planted by seed, seed treatments have become the foundation of the nematode, soil insect, and soil disease management plan. Mid- and late-season lepidopteran management is often less of a concern with *B.t.* cotton, which has been highly adopted. Plant feeding bugs are now the primary pest which may require applications of non-selective materials.

Glyphosate-resistant cotton has also been widely adopted in Florida production. Whereas weed management previously depended on an average of four herbicides, glyphosate now controls the cotton weed spectrum in Florida, as glyphosate-resistant weeds have not yet been identified in the state. A dinitroaniline herbicide may be used for early-season weed control and some other may be employed for specific weed situations. Most cotton is on a cotton/peanut rotation with one or two-years between peanuts (8,9).

Few fungicides are applied during the growing season. Approximately a third of Florida growers use a strobilurin fungicide for hard lock and leaf spots (10).

Worker Activities

Cotton is cultivated mechanically. Consequently, there are no worker activities for this crop.

Insect/Mite Management

Insect/Mite Pests

With the advent of modified cotton, insect pressures have changed while mites remain at the same level of concern. Less important are insects which try to reproduce inside the plant (such as the boll) or chew on the plant, while those that pierce-feed on the maturing bolls (mostly aphids and bugs) have become the primary pests (9).

MELON/COTTON APHID (*Aphis gossypii*)

In the south, and at least as far north as Arkansas, sexual forms are not important. Females continue to produce offspring without mating so long as weather allows feeding and growth. Unlike many aphid species, melon aphid is not adversely affected by hot weather. Melon aphid can complete its development and reproduce in as little as a week, so numerous generations are possible under suitable environmental conditions (11).

Melon aphid has a very wide host range. At least 60 host plants are known in Florida, and perhaps 700 host plants world-wide. It can be a serious pest on watermelons, cucumbers, and cantaloupes, and to a lesser degree squash and pumpkin. In the south, cotton is an important host, which explains the second common name, A cotton aphid (11).

Melon aphid feeds on the underside of leaves, or on growing tip of vines, sucking nutrients from the plant. The foliage may become chlorotic and die prematurely. The feeding also causes a great deal of distortion and leaf curling, hindering photosynthetic capacity of the plant. In addition, they secrete a great deal of honeydew which provides a substrate for growth of sooty mold, impairing the photosynthetic capacity of the foliage further (11).

TARNISHED PLANT BUG (*Lygus lineolaris*)

The tarnished plant bug is among the most damaging of the true bugs and is known to transmit plant diseases. The bug uses needle-like mouthparts to extract plant juices. Their feeding causes terminal growth to be yellowed or distorted thereby reducing plant growth and causing them to appear unthrifty. Leaves from damaged buds are sometimes ragged and discolored. Flowers from damaged buds sometimes fail to develop on one side or the whole bud aborts. The appearance of plant parts damaged by feeding has led to several terms, such as Acrazy cotton@ and Abushy-top.@ Adults and nymphs feed by sucking plant juices and a watery saliva is simultaneously injected into the feeding site to aid in the breakdown of plant tissues. Symptoms appear within a few weeks after feeding injury. Generally, apical dominance is lost and weak multiple leaders appear (12).

WHITEFRINGED BEETLES (*Naupactus* spp.)

Originally from South America, three species of this beetle comprise the complex observed in Florida. Whitefringed beetles have been associated with over 385 plant species. The most common hosts are cotton, peanut, okra, and other members of the bean family. The persistence of whitefringed beetle populations in an area of land is noteworthy and speaks for the difficulty of achieving control (13).

Chemical Control

The high adoption of genetically-modified insect-resistant cotton has greatly altered the manner in which chemical products are used. Fewer different materials are applied less frequently (2). There are also a number of compounds that are used as seed treatments.

Insecticides and miticides registered for use on Florida cotton include abamectin, acephate, acetamiprid, aldicarb, azadirachtin, *Bacillus thuringiensis*, *Beauveria bassiana*, bifenazate, bifenthrin, buprofezin, carbaryl, chlorpyrifos, cyfluthrin, cyhalothrin, cypermethrin, deltamethrin, dicofol, dicrotophos, diflubenzuron, dimethoate, dinotefuran, endosulfan, esfenvalerate, etoxazole, fenpropathrin, fenpyroximate, flonicamid, hexythiazox, imidacloprid, indoxacarb, insecticidal oils, insecticidal soaps, kaolin, malathion, methidathion, methomyl, methoxyfenozide, methyl parathion, naled, oxamyl, oxydemeton, phorate, phosmet, profenfos, proparagite, pymetrozine, pyrethrins, pyriproxyfen, spinosad, spiromesifen, sucrose octanoate, sulfur, tebufenozide, thiamethoxam, and thiodicarb.

About half of the planted cotton seed is treated with aldicarb (as a soil application) or a seed treatment containing either thiodicarb + imidacloprid or thiamethoxam + abamectin. The trend towards using aldicarb is decreasing while treated seed use is increasing (14). There is typically one application during bloom unless the crop historically suffers from hardlock, in which case one to three applications (with a fungicide) may be made during this period (9,10). Dicrotophos is an insecticide applied to a large portion of the crop (15).

Cultural Control

The most commonly practiced form of cultural pest control is crop rotation. The planting of grasses (particularly Bahiagrass) creates an environment that is not conducive to cotton pest feeding (11,12).

Weed and Plant Growth Regulator Management

Weed Pests

Since cotton is a slow-growing plant, weeds will quickly outcompete this crop if weed management is not employed. The advent of herbicide tolerant cotton plants has greatly simplified weed management in cotton. Since the herbicides to which these crops are resistant are non-selective (e.g. glyphosate and glufosinate), weed spectrum is less a concern than growth stage. Typically, one or two herbicides are used rather than the three to four used historically (7). There is no evidence of glyphosate-resistant weeds in the state to this point (8).

Cotton requires about 155 days of growth from planting to harvest in Florida. Important management decisions have to be made throughout the growing season, and decisions about defoliation and boll opening can affect quality and storage time if the crop is put into modules. Stain from poorly defoliated plants or regrowth and moisture from the green tissue cause the greatest loss in quality. Experience with harvest aids (boll openers, regrowth retardants, desiccants, and mature and juvenile foliage removal) has shown that timing of the defoliant should be based on yield potential and quality of the mature unopened bolls while considering the potential yield and fiber loss of the bolls which are already open. The largest bolls are generally those set early and low nearest the main stem on the plant. Where fruiting was hindered by early insect damage, it may be desirable to wait as long as possible to allow the top crop to develop. A crop that set

and retained most of the early fruit may be ready for defoliation at 50 percent open bolls (16).

Where large acreage has to be harvested, growers may sacrifice some of the more immature bolls that contribute little to the final yield so that harvest can begin before adverse weather conditions reduce overall yield and quality of the crop. Bolls set in mid-summer are usually larger and mature in 40 to 50 days, while the bolls set in August can take 60 days or longer to mature and often contribute little to final yield if the crop had a normal fruiting season. The late flowers look attractive and may give the appearance of adding to the final yield of the crop, but should not be given preference over the fruit that was set during the first three to four weeks of bloom. It has been shown many times that the fruit set during the first 4 weeks of bloom normally contributes 90 to 95% of the total yield of the cotton crop (16).

Estimating the number of mature, open bolls in the field is helpful in scheduling the defoliant and boll opener. Ten mature bolls per foot of row will produce a bale of cotton under good growing conditions. More bolls will be needed if they are higher on the plant and less if they are lower on the plant. Counts should include (1) open bolls, including cracked bolls; (2) green bolls that are mature and string out when cut with a knife; and (3) immature bolls that are harvestable or will mature while conditions are favorable (16).

The crop should be defoliated in stages where large acreage is to be harvested. Harvest aids should be applied approximately 12 to 14 days ahead of picking. A four-row picker can pick about 40 acres a day in the early part of the season but will pick less later in the season due to shorter days (16).

Chemical Control

All Florida cotton is glyphosate tolerant, although a third to half of the growers use some other type of material for early season weed control or when specific weeds become problematic. Pendimethalin, trifluralin, and pyriithiobac are popular choices for early season weed control (8,15).

There are a number of herbicides labeled for use on cotton including bromoxynil (GM cotton no longer available), carfentrazone, clethodim, clomazone, dacthal, dicamba, diuron, EPTC, fenoxaprop, fluazifop, flumioxazin, fluometuron, glufosinate (GM cotton), glyphosate (GM cotton), lactofen, linuron, metolachlor, MSMA, norflurazon, oxyfluorfen, paraquat, pelargonic acid, pendimethalin, prometryn, pyraflufen, pyriithiobac, quizalofop, sethoxydim, thifensulfuron, tribenuron, trifloxysulfuron, and trifluralin.

Materials that act as plant growth regulators (defoliant, desiccant, or boll ripener) include *Bacillus cereus*, chlorate, cyclanilide, diuron, endothall, ethephon, ethylene, gibberellic acid, IBA, kinetin, MCDS, mepiquat, pyraflufen, thidiazuron, and tribufos. Regional use data reflect growth regulator use by all growers, including materials such as *Bacillus cereus*, cyclanilide, diuron, ethephon, mepiquat, thidiazuron, and tribufos (15).

Disease Management

Disease Pathogens

Disease and fungicide use in Southeastern cotton has historically been low. However, Florida growers have been facing increasing pressure in the form of cotton hardlock. Hardlock of cotton is when the fiber does not fluff out as the boll opens at maturity and looks like wedges of an orange when broken apart. Although the quality of the cotton fiber may not be severely affected, conventional spindle harvesting equipment is not able to capture the fiber and bring it into the harvester. The hardlocked cotton is knocked from the plant and falls to the ground or is strung out of the boll giving the appearance of poor harvesting procedures (17).

Hardlock of cotton seriously affects yield in many areas of the southeastern United States, and can be devastating in the panhandle of Florida. In 2002 it caused over \$20,000,000 in lost yield, reducing Florida's average yield from 650 lb/acre to less than 400 lb/acre (17).

Hardlock is associated with high nitrogen, high plant density, high temperature and humidity, insect damage, and seed rot. Because bolls affected by hardlock are not harvested by conventional pickers, farmers will not even attempt to harvest some fields with severe hardlock. Studies indicate that the quality of the fiber is adequate, but attempting to *Ascrap*® the field by running the picker a second time to get the hardlock cotton often results in little lint and increased trash at the gin and discounted cotton (17).

Hardlock is differentiated from the traditional boll rots. Boll rots usually are the product of insect damage or pathogen activity after the bolls have opened or early in the season when the carpel turns brown or black and never opens. Boll rots occur during wet weather when the cotton boll or fiber is colonized by a number of pathogens, although only a few fungi are responsible for the majority of infections. These include *Alternaria gossypina*, *Curvularia* spp., *Diplodia gossypina*, *Helmithosporium gossypii*, *Fusarium* spp., and *Phomopsis* (17).

Florida researchers have shown that the majority of hardlock is caused by the fungal pathogen *Fusarium verticillioides*, also known as *F. moniliforme*. This is the same organism that causes corn ear rot. The main route of infection is through the cotton flowers, and fungicides applied to the flowers will control the disease (17).

Chemical Control

Currently, approximately a third of Florida cotton growers are using a fungicide (pyraclostrobin) for control of hardlock. However, all of the cotton seed planted is treated - often with a suite of fungicides for management during emergence and early growth. Fungicides used in seed treatments include azoxystrobin, carboxin, chloroneb, difenoconazole, fenamidone (in furrow), fludioxonil, ipconazole, maneb, mefenoxam, myclobutanil, PCNB, TCMTB, thiram, and triadimenol. Additionally, coppers, etridiazole, mancozeb, and phosphite are registered for disease control in cotton.

Biological Control

Bacillus subtilis is registered for use in this crop.

Nematode Management

Nematode Pests

Plant-parasitic nematodes are microscopic roundworms, found in soils, which attack plant roots. General signs of nematode damage include stunting, premature wilting, leaf yellowing, root malformation, and related symptoms characteristic of nutrient deficiencies. Stunting and poor stand development tend to occur in patches throughout the field as a result of the irregular distribution of nematodes within the soil.

The nematode pests of cotton in Florida are the cotton root-knot nematode (*Meloidogyne incognita* race 3), the reniform nematode (*Rotylenchulus reniformis*), and the sting nematode (*Belonolaimus longicaudatus*). These nematodes annually cause major losses in Florida cotton production. In addition, they are important for increasing the incidence and severity of *Fusarium* wilt on cotton. Though root-knot nematodes may be found in all soils where cotton is grown, reniform nematodes are found mostly in fine-textured soil with less than 80 percent sand, and sting nematodes are essentially confined to soils with more than 80 percent sand. Root-knot nematodes are known to infest at least 60 percent of cotton fields in the Florida panhandle, and the incidence of reniform nematode is approximately 50 percent in the same area. The incidence of sting nematode is not clearly known but this nematode is more likely to be found with cotton when grown in the deep sandy soils of Florida. Field infestations containing more than one of the problem nematodes, particularly root-knot and reniform nematodes, are common (18).

Chemical Control

Currently, about half of the Florida cotton acreage is treated for nematodes, either in the form of a seed treatment or soil treatment. Seed treatments are increasingly popular (14). Common seed treatment compounds are thiodicarb and abamectin. Aldicarb, dichloropropene, oxamyl, and dried solids of *Myrothecium verrucaria* are registered for soil and/or foliar treatment.

Contact

Mark Mossler is a Doctor of Plant Medicine in the Agronomy Department's Pesticide Information Office at the University of Florida's Institute of Food and Agricultural Sciences. He is responsible for providing pest management and pesticide information to the public and governmental agencies. Dr. Mossler can be reached at UF/IFAS PIO, Box 110710, Gainesville, FL 32611, telephone: (352) 392-4721, e-mail: plantdoc@ufl.edu.

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