PI-57

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Florida Crop/Pest Management Profile: Okra[1]

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Production Facts

- Okra (*Abelmoschus esculentus*) is a native to northeastern Africa in the general area of Ethiopia and Sudan (1).
- In 2004, Florida okra production was estimated at 1,500 acres of commercial production (2,3). The majority is planted in southern Florida in the summer, but okra production occurs ten months of the year in the state.
- Retail sale occurs on a small scale throughout the state during the summer months (4).
- Okra is a "scavenger" crop. It is planted in beds or fields where more valuable crops had been previously cultivated to scavenge any fumigation benefits or residual fertilizer (4).
- Yields range from less than 18,000 pounds/acre to over 30,000 pounds/acre. Prices range as high as $18/bushel, which is 30 pounds (2,5).

Production Regions

Okra can be grown throughout the state, but commercial production is concentrated in the Dade County area and bordering counties. Okra requires warm weather to flourish. Consequently, it is grown throughout the state during the summer, but only in southern Florida during the spring and autumn. Harvest extends from March through November, but most of the production occurs in the summer months (4,6).

Production Practices

Okra is grown as an annual crop in Florida, but it can be "held" for numerous months by mowing the plants and allowing regrowth. This is done only if the price received for okra is at the high range. In Florida, okra can be started by seed as early as January or as late as September, but it is generally stagger-planted from March through May. Seed are used almost exclusively for planting. Although hybrid seeds exist that would yield more fruit at an earlier date, the cost ($80 per pound) discourages use in comparison to the

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traditional cultivar (Clemson Spineless 80 at a cost of $2 per pound). Although the seed may be planted in cooler weather (generally not less than 55°F), okra requires warm weather for optimal growth. Growers who try to "rush" or "push" the window of okra planting often incur failures due to plant stress in the colder weather. The optimum pH for okra is 6.5. With row spacing of 36 inches and between plant distance of two inches (not recommended but practiced) to one foot, plant densities range from 15,000 to over 88,000 plants per acre. Seeds are generally sown at a depth of one-half to one inch, which may require from two to twelve pounds of seed per acre. It generally takes two months for okra to bear harvestable pods (1,4).

Fertility practices for okra depend on whether the plants are grown on mulch or bare ground. Generally, nitrogen and potassium are split two or three times throughout the season to account for rapid loss under Florida conditions. These mid-season fertilization procedures are accomplished with a fertilizer wheel or by fertigation. Irrigation is supplied by water cannon or by drip (1).

Worker Activities

Since okra is a secondary crop, minimal worker activities are necessary. The ground is either directly seeded (the vast majority) or transplants are set. Transplants are set by workers by hand. Workers setting transplants (approximately three days for a forty-acre farm) often wear latex gloves. The only remaining hand labor includes harvest. Okra can be picked every other day during the fruiting window, and several times more if the crop is mowed and allowed to regrow (4).

Pest Management

Diseases are the primary pest concern in okra production due to the quality discount on blemished pods; but viruses are not generally observed in this crop. Insects, mites, nematodes and weeds also reduce okra yields over the season (4).

Insect/Mite Management

Insect/Mite Pests

The primary pests in okra production are lepidoptera larvae (caterpillars), aphids, thrips, whiteflies, and stinkbugs. Mites are also considered primary pests in okra. Occasional or minor arthropod pests include cucumber beetles (4,6).

BEET ARMYWORM (*Spodoptera exigua*). Larvae emerge from egg masses in three to four days. They feed in groups during the first instar and then disperse on the wind using silken threads. Larvae enter the soil to pupate after two to three weeks of feeding. Adults emerge in 7 to 10 days. Consequently, generations can be spawned monthly (7).

SOUTHERN ARMYWORM (*Spodoptera eridania*). As with beet armyworm, larvae emerge from egg masses in three to four days. They feed in groups during the first instar and then disperse on the wind. Larvae enter the soil to pupate after two to three weeks of feeding. Adults emerge in 7 to 8 days, creating one life cycle in less than a month in some cases. It has been noted that the insecticide spinosad is no longer controlling this caterpillar at historic rates (7,8).

FALL ARMYWORM (*Spodoptera frugiperda*). Adults can be seen along the north Florida coast during all months but are most abundant from April to December. The fall armyworm does not enter diapause and cannot survive extended periods of low temperatures, instead maintaining populations in warmer areas from which adults move northward in the spring. Eggs are laid in masses of 100 to 150, and each moth may lay over a thousand eggs in total. Control at the egg stage is extremely difficult, due to the protective covering over the mass and its position on the underside of leaves. Although the life cycle of the fall armyworm can be completed in about 30 days during the summer, it can take 60 days in the spring and fall and up to 90 days during the winter (7,8).

CORN EARWORM (*Helicoverpa zea*). These caterpillars, also called tomato fruitworms and cotton bollworms, attack a wide variety of vegetable and field crops. They can destroy seedlings by feeding on the crown and they can affect mature okra by boring

into pods where they are difficult to find or control. Females lay their eggs singly or in small groups of less than five on leaves. The eggs are not protected. The generational time for this pest is similar to armyworms (monthly). Insecticide management is important, since the corn earworm has a history of developing resistance to various insecticides in several classes (7).

CABBAGE LOOPER (*Trichoplusia ni*). Young cabbage looper larvae feed on the lower okra leaves and can bore into pods. Eggs are deposited singly or in small groups of up to seven. Females can produce 300 to 600 eggs in their two-week life span. Larvae emerge from eggs in 3 to 4. Larvae develop for two to four weeks, and then spin cocoons on the host plant for pupation. Adults emerge in five to ten days (7).

APHIDS [green peach aphid (*Myzus persicae*), spirea aphid (*Aphis spiraecola*), potato aphid (*Macrosiphum euphorbiae*), and *Uroleucon pseudambrosiae*, among others]. Aphids are a primary pest for two reasons. Aphids feed by piercing plant tissue with their needle-like mouthparts (stylets) and sucking out water and nutrients from the vascular system of the plant. Feeding damage and toxins in the saliva result in thickening, crumpling, and downward curling of leaves. Heavy aphid attack may kill very young plants. Aphids also deposit large amounts of honeydew on the plant surface, which encourages the growth of sooty mold. A short life cycle and asexual reproduction by live birth allows aphid populations to increase rapidly in Florida (7).

MELON THRIPS (*Thrips palmi*) Thrips are small (usually less than 2 mm in length) insects that attack a number of crops. Eggs are deposited on plant tissues, usually hatching in two weeks, with nymphs becoming mature in another two weeks. Females lay fertilized and unfertilized eggs, with unfertilized eggs developing into males. These insects can produce several generations in a year (9,10). Damage to the plant is caused by the feeding of both adults and larvae on leaves, stems, flowers, and fruit, removing sap with their rasping mouthparts.

Melon thrips is present in south Florida during the entire growing season, but is most abundant between December and April. Each female thrips produces an average of 50 eggs, which are deposited in slits the female makes in the leaf tissue. Infestation appears first on the older leaves (particularly near the midrib and veins) at the bottom of the plant. Populations move upward to the younger leaves as food reserves in the older leaves are exhausted. Consequently, larvae are found first on the older leaves. After passing through two larval instar stages in about four to five days (at 79 to 90°F), the larva drops to the ground, where it passes the prepupal and pupal stages in a soil chamber it has constructed. After three to four days, the adult emerges and seeks new host plant leaves on which to feed. Direct feeding damage from thrips degrades the quality of the fruit by causing scab formation. Leaf feeding can cause serious defoliation (9).

Melon thrips is resistant to many insecticides. In addition, the use of broad-spectrum insecticides may increase populations of melon thrips by killing its natural enemies (particularly pirate bugs of the genus *Orius*), which are thought to contribute to thrips management in the field. Use of insecticides also requires thorough spray coverage and is not effective against the protected egg and pupal stages (9).

SILVERLEAF WHITEFLY (*Bemisia argentifolii*) This insect has become a significant pest of eggplant, cucumber, squash, succulent bean, tomato, and okra in south Florida. This pest is most abundant between December and May (9), although it may be seen over the whole season. Whitefly infestations may also result in sooty mold formation from the accumulation of honeydew on leaves. This fungus is more commonly seen on leaves, but can also occur on fruit, discoloring them. As the whitefly migrates from crop to crop throughout the year, populations commonly peak on the state's crops at the time of harvest. In south-central Florida, populations build on fall vegetables and move directly to overlapping spring crops (11).

Whiteflies attack over 500 species of plants, and have been observed to reproduce on at least 15 crops and 20 weed species in Florida. Females deposit eggs on the underside of leaves and are capable of laying from 50 to 400 eggs, averaging around 160. The tiny (0.2 mm long) eggs are attached by a stalk to the leaf and are smooth and whitish yellow, but turn brown just before hatching in about 5 to 7 days. After

hatching, the nymph, called a crawler, moves a short distance. Later nymphal stages are sedentary. They pierce the plant with their mouthparts and remain in place, sucking the plant juices. These nymphs are found on the underside of the leaf and may even cover the entire surface. This insect goes through four instar stages, appearing thin, flat, and greenish-yellow. The pre-adult stage (pupa) has conspicuous red eyes and a convex body (12).

SOUTHERN GREEN STINKBUG (*Nezara viridula*) Found throughout the world, the southern green stinkbug attacks over 30 families of plants, though the preference is for legumes and crucifers. The bugs also are attracted to those crops setting pods or fruit. The bug is able to complete a lifecycle in as little as 45 days, and four to five generations are possible in a year. As insecticides are becoming more specific for certain pests, these bugs are becoming a more prominent pest in certain vegetable crops. The feeding of both immature and mature stink bugs is most prominent on young succulent tissue. After feeding, the wounded site becomes hard and darkened. Fruit may become deformed or drop from the plant. The bugs also can infect the fruit with pathogens (7).

MITES (*Polyphagotarsonemus latus*, *Tetranychus urticae*) The broad mite, *Polyphagotarsonemus latus*, is a major pest of okra. Additionally, the twospotted spider mite, *Tetranychus urticae*, is a potential problem. Broad mites are cosmopolitan in distribution. They feed by piercing plant cells and sucking the sap that leaks from the wound. Photosynthesis is reduced, and water balance is affected. Additionally, some of the terminal leaves and flower buds develop deformed. Blooms abort, leaves become discolored and thickened, and young foliage or fruit are often malformed and rust-colored. The life cycle from egg to adult lasts 4 to 6 days. Eggs are oval, approximately 0.7 mm long, and hatch in 2 to 3 days. The larvae feed for 1 to 3 days, and then go into the resting pupal stage. Adults are very small (1.5 mm) and difficult to see without a hand lens. Females may live as long as 10 days and lay an average of 2 to 5 eggs per day (20 to 50 eggs per female). Unfertilized eggs develop into males. The broad mite may be dispersed by climbing onto the legs and bodies of adult whiteflies. Some studies have shown synthetic pyrethroids to be ineffective against mites and resistance by the twospotted spider mite to many insecticides has been reported (7,13,14).

CUCUMBER BEETLES [striped cucumber beetle (*Acalymma vittatum*) and spotted cucumber beetle (*Diabrotica undecimpunctata howardi*)]. Cucumber beetles prefer to feed on cucurbit plants like squash, cucumber, and cantaloupe, but can also feed on a wide range of crops, including corn, beet, pea, sweet potato, okra, lettuce, onion, cabbage, potato, tomato. Spotted cucumber beetle, whose larvae are known as southern corn rootworm, is the more general feeder, having been recorded from over 200 species of crops, grasses, and weeds. Feeding damage from adult cucumber beetles results in ragged holes in the leaves, and the beetles may also feed on stems. The larvae, which are found in the soil, feed on roots (7).

Cucumber beetles may have multiple generations each year. The life cycle of the striped cucumber beetle may be as short as 40 days under optimal conditions. Each female striped cucumber beetle deposits between 400 and 500 eggs in soil cracks. After larvae feed for two weeks or more, pupation takes place over a week or less. Adults can be long-lived (60 days or more).

Chemical Control

Insecticides and miticides registered for okra in Florida as of 2004 are azadirachtin, *Bacillus thuringiensis* (B.t.), bifenazate, carbaryl, corn earworm virus, imidacloprid, kaolin, malathion, methoxyfenozide, oils, permethrin, pyrethrins +/- rotenone, soaps and spinosad. Methoprene is available for fire ant control (15). Some of the more widely used materials are mentioned below.

AZADIRACHTIN (Neemix®). Azadirachtin is a natural compound derived from the neem tree (*Azadirachta indica*) that has insect growth regulator activity. The compound is used to manage caterpillars, aphids, thrips, and whiteflies. The price of azadirachtin is $2,119 per pound of active ingredient and the approximate cost per maximum labeled application (0.04 lb ai/A) is $90.00 per acre (16,17). Azadirachtin may be applied up to the day of harvest (PHI=0 days), and the restricted entry

interval (REI) under the Worker Protection Standard is 4 hours.

Bacillus thuringiensis. The biopesticide *Bacillus thuringiensis* (*B.t.*) is an important management tool for Florida okra growers, who use it in the management of problematic caterpillars (armyworms, velvetbean caterpillar, corn earworm). *B.t.* is a naturally occurring soil bacterium that produces spores and crystalline bodies that act as stomach poisons to the insects that consume it. The most common formulations are highly specific for caterpillars and therefore do not harm beneficial organisms. However, it is most effective against smaller larvae. The median price of *B.t.* is $10.00 per pound, which is often near the application rate on an acre basis (16). *B.t.* may be applied up to the day of harvest (PHI=0 days), and the REI is 4 hours.

SPINOSAD (Spintor®). Spinosad is a microbial fermentation product that is toxic to select insects, and as such, has negligible effects on populations of certain beneficial arthropods. Okra growers use it to manage mainly lepidopteran larvae, melon thrips, and leafminers. The price of spinosad is $262.50 per pound of active ingredient, and the approximate cost of a maximum labeled application (0.125 lb ai/A) is $32.82 (16,18). The REI is 4 hours and the PHI is one day. The label states that other chemistries should be used after three consecutive spinosad applications and there is a 0.45 lb ai/A limit per crop.

METHOXYFENOZIDE (Intrepid®). Methoxyfenozide is an insect growth regulator that acts as a molt accelerator. These compounds only affect caterpillars and okra growers use them to manage lepidopteran larvae. The price of methoxyfenozide is $115.56 per pound of active ingredient, and the approximate cost of a maximum labeled application (0.25 lb ai/A) is $28.89 (16,18). The REI is 4 hours and the PHI is one day. There is a 1.0 lb ai/A per season application limit.

MALATHION. Malathion is an organophosphate compound which causes death by interfering with proper nerve transmission. Malathion is used to manage certain species of aphids. The median price of malathion is $5.44 per pound of active ingredient and the approximate cost of a maximum labeled application (1.25 lb ai/A) is $6.80 per acre (16,19). The label recommends that no applications be made after pod formation. The PHI is one day and the REI is 12 hours.

Alternative Chemicals

Over the past few years, there have been a few “reduced risk” materials registered for use on okra. Spinosad and methoxyfenozide are examples of this trend. These materials are generally more selective that those of historic use. These materials are currently being assessed for fit into established IPM systems.

Cultural Control

Scouting is the number one cultural practice employed in okra production. Other practices include using mulches, removing field and perimeter vegetation, and plowing in residue as measures to clean up refugia and reduce local pest populations such as southern armyworm and thrips. Altering planting date and rotating pesticides and crops are additional cultural control methods.

Biological Control

There is a measure of natural parasitism for most all of the okra pests in Florida. However, most don't control the pests at a rate that will preclude economic damage. Gemstar® is an insecticidal virus for corn earworm available for use in okra and organisms like *Beauveria bassiana* are also being evaluated for pest management.

Disease Management

Disease Pathogens

In years of particularly wet weather, diseases constitute the most serious pest problem on okra in Florida. The state's warm, moist climate creates conditions ideal for disease development. The most important diseases of okra are damping off (caused by *Pythium* and/or *Rhizoctonia*), cercospora leafspot, southern blight (caused by *Sclerotium rolfsii*), white mold (*Sclerotinia sclerotiorum*), and blossom blight/wet rot (*Choanephora cucurbitarum*). Powdery mildew (caused by *Oidium asteris-punicei)* is problematic during winter, when conditions are cool and dry (except for dew). Alternaria and

verticillium wilt are sometimes seen in soils with high pH values (3,4,6,20).

DAMPING OFF (*Pythium* sp., *Rhizoctonia* sp.). As previously stated, okra growers in southern Florida have adopted a high seeding rate. Due to this practice, damping off is more common in this area, also at the times when growers are trying to "push" the season by planting in soil that is too cold. Most of the seed is treated with thiram, but this protection quickly erodes under plant density stress. If the stand is affected to a great extent, the grower may choose to replant (3,20).

LEAF SPOT (*Cercospora abelmoschi*). Cercospora leaf spot is generally a warm weather disease. It generally affects less than 5 percent of the acreage on average, but it is an aggressive fungus once established. Infected leaves will often roll (making fungicide coverage difficult), wilt, and abscise. Even though various fungi in this genera are listed on the azoxystrobin label, this material does not mitigate the spread of the fungus (3,20).

SOUTHERN BLIGHT (*Sclerotium rolfsii*). Southern blight occurs during warm and humid weather and has the potential to explode in the field centers, often as is this is the least-scouted area. The plants exhibit a progressive wilt as the fungus infects the roots and lower stem. A coarse white fungal mat can often be observed at the soil line. It can be controlled with a basal spray of azoxystrobin, but the fungi produces sclerotia which may resist degradation for many years in the field. Some growers rotate with grass crops such as sorghum or sudangrass, which are not fungal hosts, to alleviate the pressure from this fungus as well as deep plow the resting structures (3,20).

WHITE MOLD (*Sclerotinia sclerotiorum*). White mold is a diseases of okra if the cooler part of the okra season is also wet. The presence of small, black resting structures (sclerotia) and a cottony, white mass (mycelium) are characteristic of the pathogen. Sclerotia, which are able to survive between crop cycles, are the source of inoculum infesting individual fields from year to year (3).

POWDERY MILDEW (*Oidium asteris-punicei*). When the cooler part of the okra season is also dry (exept for dew), the fungus coats the upper and lower leaf surfaces with a white coating of mycelium. Severe infection will cause the leaves to roll upward and scorch. It is manageable with azoxystrobin or stylet oil (3,20).

BLOSSOM BLIGHT/WET ROT (*Choanephora cucurbitarum*). Both young and old blossoms, young fruit, and wounded leaf tissues may become infected and appear water soaked. Newly opened blooms will split and collapse. Fruit may become infected and covered with a dense white mycelium that is whisker-like. Affected parts will often soften and fall to the ground. Culturally, control is obtained by thinning out the stand to increase air circulation, which runs counter to the high seeding rate (3,20).

Chemical Control

Fungicides registered for okra in Florida as of 2004 are azoxystrobin, *Bacillus subtilus*, mefenoxam (seed treatment only), potassium bicarbonate, phosphoric acid solutions, and sulfur. Some growers use petroleum oil for powdery mildew control. A few of the more widely used materials are mentioned below.

AZOXYSTROBIN (Amistar®). Okra growers in Florida generally use azoxystrobin twice during the season. Azoxystrobin is a naturally-derived compound that is used for control of damping off and powdery mildew as well as southern blight and white mold. The median price of azoxystrobin is $118.76 per pound of active ingredient and the approximate cost per maximum labeled application (0.25 lb ai/A) is $29.69 per acre (16,21). The label calls for rotation to another class of chemistry after a single foliar application, and a total of four applications of that class (QoI) may be applied per season. Azoxystrobin may be applied up to the day of harvest and the REI is 4 hours. No more than 1.0 pounds of active ingredient per acre may be applied during a season.

SULFUR. Sulfur is used as a prophylactic control agent for a number of disease pathogens. The median price of sulfur is $0.88 per pound and the approximate cost per labeled application (10 lb/A) is $8.80 per acre (16,22). The REI for sulfur is 24 hours and there is no PHI.

Alternative Chemicals

In addition to strobilurin fungicides such as azoxystrobin, several other fungicides have been registered for use in okra. Both potassium bicarbonate and potassium phosphites have shown utility in managing fungi such as powdery mildew.

Cultural Control

As okra is a “scavenger” crop and has low inputs, cultural practices often have the biggest impact. Date of planting, seeding rate, green manure usage, and rotation are all practices reported by okra growers (3).

Biological Control

An area of active biological pest management is control of white mold with another type of fungi (*Coniothyrium minitans*). Continuing research is helping to determine the best time and manner to introduce this agent to the field.

Nematode Management

Nematode Pests

Nematodes are microscopic roundworms present in the soil which feed on plant roots and damage the tissue. Okra is very susceptible to both root-knot and sting nematodes, as well as reniform nematode. In south Florida, water and soil conditions lead to restrictions on nematicides that can be applied. As already mentioned, okra is planted as a secondary crop following a primary crop which has generally received some type of nematicidal treatment. For those growers attempting to manage nematodes just prior to seeding (about 20 percent), dichloropropene is the only chemical option, or they avoid nematode-infested cropland (4,23).

Weed Management

Weed Pests

Since okra is grown throughout the state during the warm season of the year, quick growing weeds can be a serious consideration. A variety of weeds are problematic for Florida okra producers, including nutsedges (yellow and purple), annual grasses such as goosegrass, and annual broadleaf weeds, such as amaranth, pusley and purslane. Unfortunately, there are very few herbicides labeled for okra, and some have been lost during reregistration (24).

AMARANTH (*Amaranthus* spp.). Amaranths (pigweeds) are annual broadleaf herbs with erect stems that can grow to six feet tall. Several species of amaranth are present in okra growing areas, including livid amaranth (*Amaranthus lividus*), smooth pigweed (*Amaranthus hybridus*), and spiny amaranth (*Amaranthus spinosus*). Amaranths reproduce solely by seed, producing tiny, dark seeds. They flourish in open areas with bright sunlight (25).

NUTSEDGE (*Cyperus* spp.). Yellow nutsedge (*C. esculentus*) and purple nutsedge (*C. rotundus*) are problems in Florida okra production. Both of these perennial sedges are found in disturbed habitats throughout Florida and the southeast U.S. Yellow nutsedge may produce some seed but reproduces primarily by rhizomes and tubers. The parental plant develops rhizomes, which end in bulbs or tubers that produce new plants. Tuber production is favored by low nitrogen levels and high temperatures (80 to 91°F or 27 to 33°C). The plant is tolerant of high soil moisture but is intolerant of shade. Purple nutsedge is also able to reproduce from tubers when conditions are harsh, making it difficult to control. Unlike the rhizomes of yellow nutsedge, purple nutsedge rhizomes growing off the parent plant produce new plants in a series ("tuber-chains"). The plant also reproduces by seed to a limited degree. Although purple nutsedge is also intolerant of shade, it is able to survive a wide range of environmental conditions, growing well in nearly all soil types and over a range of soil moisture, soil pH, and elevation. Purple nutsedge is also able to survive extremely high temperatures (25).

GOOSEGRASS (*Eleusine indica*). Goosegrass is similar in appearance to crabgrass (*Digitaria* spp.), but grows more densely. It is also a summer annual, and it favors sunny, moist conditions. Reproducing by seed, it flowers from July to October (25).

FLORIDA PUSLEY (*Richardia scabra*). Florida pusley is a loosely branched annual that stands erect or lies flat on the ground. Its hairy stems and oppositely arranged leaves are often rough in

texture, particularly along the main veins. The plant is often mixed with Brazilian pusley (*R. brasiliensis*). Florida pusley reproduces by seed and blooms in any month in the absence of frost (26).

PURSLANE (*Portulaca oleracea*). Purslane is a broadleaf summer annual with a single taproot from which arise multiple branched, purplish-red stems that often form large mats. Clusters of small leaves are found at the end of its branches. The plant reproduces by seed, flowering from August to October. Being resistant to drought, it is difficult to kill. However, it is susceptible to frost injury (25,27).

Chemical Control

As stated earlier, okra is often planted on land that was under plastic mulch production, after the mulch has been removed. In this case, weeds that do emerge can be treated with one of the two available post-emergent herbicides (glyphosate or pelargonic acid). The one available pre-emergence herbicide is trifluralin (24).

Alternative Chemicals

Several herbicides, such as carfentrazone and sethoxydim, are pending for use on okra.

Cultural Control

The use of soil previously treated with fumigant and/or herbicide is the most common cultural control method for weed control.

Key Contacts

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