

**EGGPLANT
PEST MANAGEMENT
STRATEGIC PLAN (PMSP)**

**June 22, 2004
Fort Lauderdale, FL**

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Executive Summary

Florida ranks first in the U.S. in the production of eggplant. In 2000-2001, 41,000,000 pounds of eggplant valued in excess of \$14 million were produced on 1,600 acres (\$8,750/acre). Over half of the eggplant production occurs in Palm Beach and Dade counties with the remainder concentrated in several other counties in southwest Florida and a minor amount throughout the rest of the state.

Eggplant does well in Florida throughout the majority of the year and the crop can be grown in any season except summer. Although it is a hardy crop, eggplant does have a number of primary pests. Eggplant is in the fruiting vegetable crop group with tomato and pepper, but because it is a small acreage crop, it often lacks the tools that these other two crops have, either through regulatory or economic decisions. The future loss of methyl bromide is the largest IPM consideration for this production system. Additionally, resistance issues (generally for insecticide and miticides but also noted for herbicides) exist in this production system. The members of the PMSP meeting expressed confidence that these issues may well be addressed by a combination of research, education, and regulatory actions.

- Research** Construct and test an integrated mite management plan for eggplant.
- Determine the feasibility/utility of pinworm pheromone “attract and kill schemes.
- Examine the current levels of spinosad resistance in pinworm and melon thrips populations.
- Conduct efficacy/phytotoxicity trials for etoxazole, clofentezine, buprofezin, and novaluron.
- Education** Education of growers/pest managers with regard to new chemistries and resistance management of new chemistries
- Regulation** Continue processing ongoing registrant/IR-4 registration requests (abamectin, spiromesifen, pyridalyl, flumioxazin, and s-metolachlor).
- Continue investigation into the potential pesticide candidates etoxazole, clofentezine, buprofezin, cyromazine, and novaluron.
- Determine if the 14-day PHI for pyriproxyfen can be reduced to 7 days.

Eggplant PMSP List of Attendees

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Introduction

Florida ranks first in the U.S. in the production of eggplant. In 2000-2001, 41,000,000 pounds of eggplant valued in excess of \$14 million were produced on 1,600 acres (\$8,750/acre). Over half of the eggplant production occurs in Palm Beach and Dade counties with the remainder in several other counties in southwest Florida and throughout the state. For this reason, a Pest Management Strategic Plan (PMSP) meeting for the Florida eggplant industry was conducted at the University of Florida Institute of Food and Agricultural Sciences' Fort Lauderdale Research and Education Center in Broward County, Florida.

The main variety cultivated in Florida is 'Classic,' and to a lesser extent, 'Nightshadow.' Eggplant are normally planted in August and again in February to March in north Florida, in August to September and January to February in central Florida, and between August and February in south Florida. Eggplant can be grown year-round, and are often double cropped with pepper, cucumber, okra, or squash following eggplant harvest. The vegetable crop that follows eggplant in a double cropping production system depends upon prevailing environmental and economic factors. A spring crop of eggplant may also follow as a second crop after a fall crop of pepper or tomato. Plants are maintained from 12 to 20 weeks of age.

Eggplant does best on well-drained, fertile, sandy-loam soils at a pH of 6.0-6.5. Poorly drained soils may result in slow plant growth, reduced root systems, and low yields. Eggplant requires a long, warm, frost-free growing season (>50°F). The best temperatures are between 80°-90°F during the day, and 70°-80°F during the night; plant growth is curtailed at temperatures below 60°F. Additionally, soil temperature below 60°F restricts germination. However, most eggplant is started in the field from transplants.

Eggplant production practices are similar to tomato production (i.e., raised bed mulch system with seepage and/or trickle irrigation). Fields are plowed and disced to turn under old crop residue, followed by bed shaping, fumigating, fertilizing, and mulching. In Palm Beach County, water is maintained approximately 15 to 18 inches below soil surface to ensure seepage into the root zone. Maintaining a moist environment creates a nutritional concentration gradient. This gradient allows the banded nitrogen and potassium to diffuse into the soil and replace those nutrients which are lost to the plant. Fertilizers are directly injected for those growers using trickle irrigation. Plastic mulch helps retain nutrients by preventing leaching by natural rainfall.

Eggplant can be planted by direct field seeding or as transplants. Transplants are usually purchased by the grower and set by workers riding a transplanting aid. Stakes are placed in the rows when plants are 2 to 3 weeks old, and plants are "sandwiched" between two lines of plastic twine that are wrapped around each stake. This procedure is usually done by workers three to four times during the growth of the plant. Approximately 90 percent of eggplant grown in southeastern Florida is staked, either next to every plant or next to every other plant within the row. Upon maturity, eggplant acreage is usually picked once a week, and harvest may last six to eight weeks on any single plant. After the final harvest, plants may be killed with a pesticide

such as paraquat, glyphosate, or metam. Some growers may remove old vegetation by mowing, without the use of herbicides. If the price that eggplant receives is still appealing at the end of the growing season, a grower may hand-cut the old vegetation and ratoon the mature plants. Stakes can be removed by a stake puller and can be sterilized by steam or methyl bromide; however, growers often reinsert the opposite end of the stake in the ground for the second crop without sterilization.

Due to the frequency of harvest, preharvest intervals (PHIs) and restricted entry intervals (REIs) are important factors when growers select pesticides for use on eggplant. Pesticides are applied for the most part by ground application equipment, although some aerial application is used when appropriate. Since eggplant can be grown for ten months of the year, there are no “set” times at which pest management activities are conducted. Scouting and environmental conditions guide pesticide applications.

Mites

Spider mites of the family Tetranychidae (red mite and twospotted spider mite) are the main mite pests, and broad mites (family Tarsonemidae) are also a problem. Growers felt that mites were an increasingly problematic pest throughout the state. Growers in Dade County report that red mites are more prevalent early in the season, especially around avocado plantings, followed by the other mite species. Although new miticides such as abamectin (Agri-mek®), bifenazate (Acramite®), etoxazole (Zeal®), and hexythiazox (Savey®) are labeled for other crops, only bifenazate has been registered for use on eggplant so far, and this has occurred recently. Consequently, sulfur and endosulfan are the grower’s standard for mite management, with hesitant use of the restricted pesticides oxydemeton (Metasystox®) or fenbutatin (Vendex®). Growers report an average of 3 to 4 sulfur applications per crop but as many as 10 (once per week during the mite treatment period).

Now that bifenazate is labeled for use in eggplant, growers submitted that they would be receptive to a predatory mite program. Since all currently registered eggplant miticides (besides bifenazate) are non-selective (i.e., kill all mites), established predatory mites would also be lost by current management techniques. However, a selective miticide such as bifenazate would not affect predatory mites if plant-feeding mite populations get too high and must be treated. One issue is that none of these growers have experience with integrated mite management programs and such education may need to come from extension personnel that have this experience in strawberry mite management programs. Another nuance is that bifenazate only affects spider mites, which means broad mites must be managed by another chemical or biologically. Additionally, bifenazate is currently only registered for use once per season. The only materials registered for eggplant that claim broad mite control include bifenthrin (Capture®), fenbutatin, sulfur, and oils/soaps. For those growers that do not have endemic broad mite problems, an integrated mite management plan may be a possibility.

For eggplant miticides, there are no carbamate, organophosphate, carcinogen, PHI, or REI concerns with the currently registered materials. Abamectin is on the second quarter work plan for EPA's FY 2004 (Table 5) and the registrant has said that a crop group (fruiting vegetable) decision for abamectin should be issued by August, 2004 or by the end of the year at the latest. The PMSP meeting group also mentioned such materials as chlorfenapyr (Pylon®), clofentezine (Apollo®), and spiromesifen (Oberon®) as potential candidates. The registrant for spiromesifen stated that the material should be registered by the end of the year (2004) at the latest.

Insects

The two lepidopteran larvae (beet and southern armyworm) that were reported as pests in the crop profile as well as fall armyworm were confirmed by growers as the main "worm" problems in Florida eggplant production. With the addition of indoxacarb (Avaunt®) and methoxyfenozide (Intrepid®) to *B.t.* products, growers report that they have the tools to manage these pests. The other lepidopteran pest in eggplant is tomato pinworm, which is seen in south Florida, but not often noted in southwest Florida. Spinosad (Spintor®) is being used to control this pest in south Florida, usually to the maximum the label allows. Some meeting participants voiced concern with regard to resistance. Other materials are labeled for pinworm in eggplant (azadirachtin, indoxacarb, carbaryl, methomyl, methoxyfenozide, cryolite, pyrethroids). There is also a commercial pinworm pheromone, so the potential for management (attract and kill/male annihilation) using this material exists as well.

Whitefly (usually silverleaf whitefly) is a big concern for Florida eggplant growers. These pests vector Tomato Yellow Leaf Curl virus (TYLC) to tomato, and in an effort to be good stewards for local fruiting vegetable growers, they want to control them in their field. Whiteflies also carry broad mites, so this is yet another reason to control this pest. Currently, most eggplant transplants purchased have been treated at least once with imidacloprid (Provado®/Admire®), and growers believe that leaves open the possibility for two applications in the field. Recent University of Florida research has indicated a decreasing sensitivity to imidacloprid in whitefly. Consequently, there should probably be no more than one imidacloprid application in the field, but rotational partners are needed. After imidacloprid has worn off, soaps and oils have been the historic materials, but oils burn eggplant because of so much sulfur use (oil + sulfur = burn). They have currently begun employing pyriproxyfen (Knack®), which is now available for whitefly control, but would like a PHI of 7 days, rather than the current 14 days. Pymetrozine (Fulfill®) is also used for suppression of whitefly. Spiromesifen registration is pending (see mite section) and this may provide another rotational partner for control of whitefly. Meeting members also mentioned buprofezin (Applaud®) for this issue.

Vegetable leafminer is a pest of concern during the first three weeks after planting, and will destroy the seedlings if not controlled. In addition to causing injury to the young plants, the mines serve as infection courts for disease, specifically *Alternaria*. Cyromazine (Trigard®) is registered for both tomato and pepper, but not eggplant, and contacts have been made with the registrant regarding this use.

The main pest problem in Dade County eggplant production is melon thrips. These insects are observed much less frequently in the West Palm Beach area or in southwest Florida. Since spinosad is the main material for both this pest and pinworm, it is being “overused” in the opinion of some of the members. Members mentioned S-1812 (pyridalyl) as a potential for melon thrips management, and the registrant believes that this material will be available for eggplant growers in late 2004 or early 2005. This material is reported to control lepidoptera larvae as well as thrips. Novaluron was also mentioned as a potential candidate.

Aphids are indirectly managed with the current whitefly program (pymetrozine). Fire ants are a problem as they mutilate drip tape to get at the water during dry periods. The only fire ant bait currently registered that can be used in production eggplant is methoprene (Extinguish®).

Pepper weevil adults are common in eggplant. A question the group had was whether pepper weevil reproduces on eggplant. University of Florida fruiting vegetable expert Dr. David Schuster reported that pepper weevil does have the ability to reproduce on eggplant, but the preference for this crop is much lower than for pepper. It is usually seen when a pepper field is being grown/destroyed in the vicinity of the eggplant field.

Colorado potato beetle, like aphids, are being incidentally controlled by the whitefly program. Growers made a point that eggplant should not be grown in potato areas, and this includes potato indexing operations.

For eggplant insecticides, there are no carbamate, organophosphate, carcinogen or REI concerns with the currently registered materials. As mentioned, growers expressed desire to have a 7-day PHI for pyriproxyfen. One concern in terms of IPM may be that the use of spinosad is quite robust, and resistance monitoring may need to be initiated for pests such as pin worm and/or melon thrips. Abamectin is on the second quarter work plan of EPA’s FY 2004, cyfluthrin (Renounce®), dinotefuran (Stackle®), and fenpropathrin (Danitol®) are on the third quarter work plan, and flonicamid (Turbine®) and pyridalyl are on the fourth quarter plan (Table 5).

Nematodes

This arena of Florida eggplant production is in the greatest turmoil due to the phase out of methyl bromide. The methyl bromide replacement question is an entire multi-year program in itself, and the critical use exemption process has clouded the picture, as this program may or may not make limited quantities of methyl bromide available beyond the currently scheduled phase out date. At this point, growers have been resigned to pay dearly for methyl bromide as the quantity produced becomes less, or try the best alternative strategy currently available, which is viewed as an initial application of metam potassium followed by oxamyl (Vydate®) chemigation later in the season. The metam/oxamyl tandem is used in south Florida, while growers in southwest Florida still use methyl bromide as the primary fumigant.

Growers and scouts reported that models have been used to predict potential nematode problems, but that the highly variable nature of the populations did not correlate to the models' predictions. The main pest nematodes were reported to be root knot and stubby root. Members indicated that secondary crops planted after eggplant can have major nematode problems.

For eggplant nematicides, there are no carbamate, organophosphate, carcinogen, PHI, or REI concerns with the currently registered materials with the exception of the methyl bromide phase out. Iodomethane (Midas®) is on the fourth quarter work plan of EPA's FY 2004 (Table 5).

Diseases

The key diseases reported by growers at the PMSP meeting were those listed in the crop profile, namely *Alternaria* leaf spot, *Phomopsis* blight, and *Phytophthora* blight. *Verticillium* wilt is not currently observed, although this situation could change with the phase out of methyl bromide. Other problematic and emerging diseases include anthracnose and white mold. No viral problems were reported.

Members of the PMSP meeting reported that chloropicrin is generally not used in eggplant production. They also inquired as to why chlorothalonil was not registered for use in eggplant. An inquiry to the registrant (GB Biosciences via Syngenta) revealed that this is a regulatory obstacle in the fact that the "risk cup" for chlorothalonil is "full." Consequently, there is little chance of getting chlorothalonil registered for use in eggplant. This risk cup scenario is also the case for mancozeb.

For the foliar leaf spotting fungi, the grower's standard is copper and sulfur with the intermittent use of a strobilurin fungicide of some type. Maneb is available for eggplant production, but not mancozeb, again because of "risk cup" considerations. This is also the reason that zoxamide (formulated as a mixture with mancozeb and named Gavel®), although registered for use on fruiting vegetables, is not available for eggplant growers. Boscalid (Endura®) is a new fungicide recently registered for use in eggplant that manages early blight (*Alternaria solani*).

Phytophthora blight was reported by the group as a yearly occurring disease, with intensity governed largely by weather. In some years, this disease can decimate an entire field in four days. Mefenoxam (Ridomil Gold®) is used yearly in the management of this disease, and members also questioned why fosetyl-Al (Aliette®) was not registered for use in eggplant. Conversation with the registrant indicated that eggplant was too small of a crop to pursue independently, but if pepper were to get a label for fosetyl-Al, they may try to incorporate eggplant use under the fruiting vegetable crop group. Propamocarb (Previcur®) fungicide received a tolerance for fruiting vegetables on August 4, 2004. This material is a carbamate with systemic root uptake and dispersion throughout the plant. It affects *Phytophthora*, *Pythium*, *Alternaria*, and downy mildew, but must be mixed with another fungicide for resistance management.

For eggplant fungicides, there are no carbamate, organophosphate, carcinogen, PHI, or REI concerns with the currently registered materials.

Weeds

Weed pressure is a difficult management aspect for Florida eggplant growers for several reasons. First, no cultivation is performed after bedding. Consequently, any preemergence herbicide must control weeds for the entire crop period (up to five months). Secondly, a percentage of weed seeds are not affected by methyl bromide, and these will continue to germinate throughout the growing season. Since the methyl bromide alternatives (except for methyl iodide) don't control nutsedge, these weeds as well as the aforementioned dormant weeds will be a problem in rows during the later part of the season.

Another consideration with respect to weeds is their ability to harbor spider mites. Soon after transplants are set, weed seedlings appear. The potential for mite reinfestation is not great when the weed grows from transplant holes in the plastic mulch, because in that position miticide applications will kill resident mites on both the weeds and eggplant plants. However, weeds also grows in the row ends and field perimeter, and these areas are not treated. Consequently, spider mites can reinfest fields from these plants after miticide residues have decreased.

The most troublesome weed in the Dade County area is parthenium, while eclipta is the primary weed in the West Palm Beach and southwest Florida production areas. Higher densities of morningglory and lambsquarter are also being reported in all areas. The use of carfentrazone (Aim®) and clethodim (Select®) are the grower's standard with addition of halosulfuron (Sanda®) if sedges are present. Halosulfuron can also be applied postemergence as a directed spray to "clean-up" weedy row middles. However, parthenium is reportedly not being managed by carfentrazone. Additionally, glyphosate (Roundup®) is not controlling purslane

In eggplant production there are two distinct vegetation management areas, the bedded row itself and the middles between the rows. Residue trials for fruiting vegetable row middles have already been conducted for lactofen (Cobra®) and flumioxazin (Valor®), so these uses are pending and should soon be available. This is also the case for s-metolachlor (Dual Magnum®). The carfentrazone use in fruiting vegetables is by emergency exemption, which lasts through the next growing season, and the national label should be available soon. Oxyfluorfen (Goal®) was also mentioned by meeting members as an herbicide with potential for row middle weed control. Row middle trials with glufosinate (Rely®) appear very promising for this postemergence nonselective herbicide, controlling sedges and parthenium.

For bedded rows, few herbicides exist. The grass products such as clethodim and sethoxydim (Poast®) provide selective control of these weeds, but no postemergence herbicide exists for broadleaf weed control in the beds. It is believed that s-metolachlor may be a preemergence herbicide capable of controlling broadleaf (and grass) weeds in bedded eggplant.

Eggplant growers also use herbicides for crop destruction, as it believed that this is the one of the best IPM tools to reduce future pest pressures. In addition to glyphosate and paraquat, metam potassium is increasingly being used to accomplish this task (dessication).

For eggplant herbicides, there are no carbamate, organophosphate, carcinogen, PHI, or REI concerns with the currently registered materials.

Summary

Based on the input of the members of the Florida eggplant PMSP, the following items have been placed on the “To Do” list.

- Research**
1. Examine the possibility of constructing a joint research/extension plan for a integrated mite management program in eggplant.
 2. Design and conduct trials using pinworm pheromone to “attract and kill” borders or strips.
 3. Determine if pinworm and melon thrips are becoming resistant to spinosad.
 4. Conduct screening efficacy/phytotoxicity trials with etoxazole and clofentezine (mites), buprofezin (whitefly) and novaluron (melon thrips).
- Education**
1. Participate in the eggplant integrated mite management plan.
 2. Educate growers/pest managers with regard to spinosad (Spintor®) use and potential for resistance in several key pest species.
 3. Educate growers/pest managers with regard to resistance management both for strobilurins (azoxystrobin, pyraclostrobin, trifloxystrobin) and neonicotinoids (imidacloprid, acetamiprid, thiamethoxam).
 4. Educate growers to the issue that some potato growing activities may be in their area, and to be vigilant for Colorado potato beetle.
- Regulation**
1. Continue ongoing registrant/IR-4 registrations (abamectin, spiromesifen, pyridalyl, flumioxazin, and s-metolachlor).
 2. Continue investigation into the potential pesticide candidates (etoxazole, clofentezine, buprofezin, cyromazine, and novaluron).

3. Determine if the 14-day PHI for pyriproxyfen can be reduced to 7 days, possibly by Special Local Need permit.