PI-52

UF UNIVERSITY of FLORIDA
IFAS Extension

Watermelon Pest Management Strategic Plan (PMSP)[1]

Mark A. Mossler[2]

Introduction

Florida ranks first in the U.S. in the production of watermelon, accounting for nearly 20 percent of national production. In 2001-2002, 759 million pounds of watermelon valued in excess of $62 million were produced on 23,000 acres ($2,700/acre). Concentrated production occurs in the southern region of the state during the winter months. As the spring arrives, plantings start northward and scatter out across the state. For this reason, a Pest Management Strategic Plan (PMSP) meeting for the Florida watermelon industry was conducted October 14, 2004 at the UF/IFAS Southwest Florida Research and Education Center in Collier County, Florida.

Both seeded and seedless watermelons are produced in Florida, but production of seedless varieties in Florida has been increasing, with estimates that these now comprise 80 percent of the production. Increases in national watermelon consumption have paralleled the availability of greater amounts of seedless watermelons in U.S. markets, and the popularity of seedless watermelons is expected to grow. In addition to being more convenient for the consumer, seedless varieties are sweeter and have a longer shelf life. Seedless varieties are sterile hybrids, the seeds of which have been produced by a cross between a normal watermelon and one that has been genetically changed through chemical treatment at the seedling stage. When pollinated with normal watermelon plants, seedless plants produce only the small, white undeveloped seedcoats, which are soft and tasteless and are eaten with the flesh of the watermelon. The parent watermelon of a seedless plant produces only five to ten percent as many seeds as the normal plant, resulting in a seed cost that is five to ten times greater than that of seeded hybrid varieties and ten to 100 times greater than that of standard, open-pollinated varieties. Seedless varieties require soil temperatures above 80°F (26.7°C) for germination, and both germination and seedling emergence are slower for seedless varieties.

Seedless varieties of watermelons are transplanted because of the high cost of hybrid seed. Generally, while growers in the southern half of the state tend to grow transplanted watermelons on plastic mulch, in the northern and western portions of the state (starting at around the Gainesville area), there is a wide mix of cultural practices used. While

1. This document is PI-52, one of a series of the Pesiticide Information Office, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Original publication date August 2005. Visit the EDIS Web Site at http://edis.ifas.ufl.edu.

2. M. A. Mossler, Assistant In, Doctor of Plant Medicine, Agronomy Department; Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL 32611.

approximately 30 percent of growers use direct seeding and bare ground culture, many others (70 percent) use transplants on plastic mulched beds, a practice that is increasingly utilized in north Florida. When plastic mulch is not used, the crop is grown on an open bed system, particularly when the soils are likely to flood.

When transplants are used, they are usually field ready in three to five weeks, after being grown in greenhouses. Bare-root transplants cannot be used. Instead, transplants are grown in planter flats to maintain the root and soil ball. Transplanting watermelons permits earlier harvesting, particularly if used with plastic mulch. Yields are also generally higher for transplanted watermelons, and the resulting plant uniformity makes cultivation easier. In a comparison of costs and returns from direct seeded versus transplanted watermelons grown on plastic mulch in north Florida in 1995, production costs for both methods were found to be similar. However, higher yields and a higher market price as a result of early harvest were shown to result in higher profitability of transplanted than of direct seeded watermelons. Direct seeding also has advantages, including lower labor requirements, the availability of precision planting, which has improved efficiency, and the possible production of greater vine area, which reduces sunburn.

In south Florida, watermelons are primarily grown on plastic mulch as a second crop in a double-cropping system, following tomato or pepper. The north Florida growers utilize the mulch to warm the soil, allowing them to plant earlier in the season and get their product into the market early. In addition to the ability to harvest earlier, the use of polyethylene mulch aids in weed control and improves the efficiency of water and fertilizer use. Plastic mulch is also a requirement for soil fumigation. When plastic mulch is used, a bed press shapes a smooth bed to maximize contact between the mulch and the bed surface, and fertilizer and soil-applied pesticides are added to the bed before the mulch is laid down. Plastic mulch measuring approximately 48 inches (122 cm) wide is placed on beds that are approximately 20 to 24 inches (51 to 61 cm) across the top. Mulch used for double-cropping needs to be able to survive two crop seasons.

Worker activities for the season commence with laying mulch, if this system is employed. Some seedless watermelon growers may use methyl bromide, but this is a small percentage ($\leq$ ten percent). Worker activities during fumigation include mostly tractor-driven related operations, such as cultivation, fertilization, operating the fumigation rig, and laying drip tape. The only field task is shoveling dirt on the mulch to bury it, which generally requires three people per end. The fumigation rig will cover about eight acres a day. With an average size farm of 40 acres, shovel crews would be needed about 40 hours (five days) a year. Placing emitters on the irrigation main line requires hand labor, and one worker can cover between 15 and 20 acres a day. Workers setting transplants (approximately 5 days for the forty acre farm) often wear latex gloves. Workers with poles also move vines out of row middles for the lay-by fertilizer application made at mid-season. When harvesting, one person walks the field to indicate which melons to pick, at which point the cutters (one or two per row) cut and turn the melon so the white belly is apparent. Two to three pickers per row then come after the cutters and melons are handled approximately three times before being placed in a box or truck, where one or two stackers work. Pickers/stackers are often ungloved and unshirted. Fields are generally picked once.

Pesticides are applied for the most part by ground application equipment, although some aerial application is used when appropriate. Since watermelon 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

Mites were not regarded as a major pest problem of watermelon production. Economically damaging outbreaks of spider mites occur only sporadically, and are weather influenced (encouraged by dry conditions). Although some of the newer miticides such as abamectin (Agri-mek®) and bifenazate (Acramite®) are registered for use in Florida watermelon, growers manage mites with sulfur and dicofol, due to economics (Table 1 and Table 2).

For watermelon miticides, there are no carbamate, organophosphate, carcinogen, PHI, or REI concerns with the currently registered materials. Spiromesifen is on the fourth quarter work plan for EPA's FY 2004 (Table 5) and the registrant for spiromesifen stated that the material should be registered by the end of the year (2004) at the latest (Table 6).

Insects

The lepidopteran larvae responsible for rindworm complex, and those that damage early growth, are sufficiently managed by the collection of materials that are registered for these pests in Florida watermelons. With the addition of growth regulators such as tebufenozide (Confirm®) and methoxyfenozide (Intrepid®) to spinosad (Spintor®) and *B.t.* products, growers report that they have the tools to manage these pests.

Aphids were recounted by the group as a pest that was problematic in the 80s and 90s due to viral transmission, but that the availability of (and high adoption of) nicotinoid insecticides had greatly reduced this problem. Growers from northern Florida noted that aphids were becoming an increasingly prevalent pest in this area, with associated viral transmission. The growers seem to think it may be linked to the use of nicotinoids in pine production, similar to the loss of susceptibility seen in whitefly infesting south central Florida tomato production fields as described in the next paragraph.

Whitefly (usually silverleaf whitefly) is a big concern for Florida watermelon growers. These pests cause melons to lose gloss, resulting in downgrades. These pests are increasingly reported by growers as increasing in prevalence. Currently, most watermelon transplants purchased have been treated at least once with imidacloprid (Provado®/Admire®), and growers believe that leaves open the possibility for an application 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, but rotational partners are needed. After imidacloprid has worn off, soaps and oils have been the historic materials, but oils may burn watermelon because of potential sulfur use on mites or for disease (oil + sulfur = burn). Pyriproxyfen (Knack®) is now available for whitefly control, and pymetrozine (Fulfill®) is also used for suppression of whitefly. Spiromesifen registration is pending (see "Mites" section) and this may provide another rotational partner for control of whitefly. Meeting members also mentioned buprofezin (Courier®) for this issue, as well as the 120-day plant back restriction for food crops not currently labeled for this material. Obviously, they requested a more realistic plant back value, if possible.

The main thrips pest problem is melon thrips, although growers reported chilli thrips (*Scirtothrips dorsalis*) as an emerging problem. It was believed that northern Florida may have more thrips pressure, as there is more agronomic rotation in this area as opposed to southern Florida, where watermelon is planted in previous pasture land. Flonicamid is on the fourth quarter of EPA's FY 2004 work plans, so this material should soon be available for thrips management, as well as other sucking insects.

For watermelon insecticides, there are no carbamate, organophosphate, carcinogen or REI concerns with the currently registered materials. As mentioned, growers expressed desire to have a more realistic plant back value when using buprofezin. Cyfluthrin is on the third quarter work plan of EPA's FY 2004 (Table 5).

Nematodes

As much as half of the watermelon grown on plastic mulch benefits from an initial application of methyl bromide, even though it is grown after the primary crop (such as tomato or pepper or eggplant), and approximately ten percent is newly fumigated. 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 on mulch 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 on mulch in southwest Florida still use methyl bromide as the primary fumigant. Growers on bare ground generally avoid nematicidal treatment due to the costs.

Growers were concerned about the loss of sterilants, and felt this was an area that needs active research and extension education, especially with regard to sampling, identification, and interpretation.

For watermelon 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

Because of the natural climatic difference between north and south Florida, differences exist in degree of vigor incorporated in the disease control programs by growers in different parts of the state. Disease control efforts also interact with market dynamics. Southern growers normally get higher prices because of early marketing but without these higher prices they could not afford to practice the intensive disease control program necessary for that area. Northern growers, on the other hand, usually get lower prices for watermelons because of market conditions, but fortunately, they do not need as intensive a spray program as do the growers in south Florida.

The key diseases reported by growers at the PMSP meeting were those listed in the crop profile, namely gummy stem blight and downy mildew. However, there has recently emerged a new disease that causes a late season vine decline and fruit rot. This disease is even more devastating because the causative organism has yet to be isolated and it occurs at a time when all inputs have been supplied (including harvest time in many cases). With regard to viruses, the group reported that watermelon mosaic virus 2 (WMV-2) affects nearly 90 percent of the acreage in northern Florida, but is manageable through aphid management. A small amount of zucchini yellow mosaic virus (ZYMV) is also seen throughout the state.

Members of the PMSP meeting recounted that many believed gummy stem blight was the worst disease until the vine decline disease emerged. These two diseases, alone or in combination, have so confused and frustrated watermelon growers that for the last three years growers have been trying “everything” (Table 3). Sometimes there is a good outcome and sometimes the crop does not produce.

The group affirmed that adequate gummy stem blight (GSB) control also resulted in downy mildew control. Currently, strobilurin fungicides and boscalid (Pristine®) have held back GSB, but it is known that the fungus is evolving tolerance to the strobilurin class of fungicides. Observations from growers and scouts suggest that even mancozeb is losing efficacy against GSB. When weather conditions are favorable and there is inoculum present, little can be done to contain GSB. The group requested more resistance to this disease in the breeding stock from the seed representatives or potentially new seed treatments other than thiram. Members also mentioned that some growers are bagging infected transplants and disposing of them in an effort to reduce inoculum levels early in the season. The group also believes research into live microbial products may have utility at transplant.

The meeting members stated that Dr. Pam Roberts was working with the late-season vine decline disease, and one consideration was that there may be a nutritional deficiency that triggers the disease. However, several growers reported that vines were in good vigor right up until the decline. Out of a plant lifespan of 90 days, the last 30 days are those susceptible to the decline. Fruit may look acceptable from the outside, but inside, a yellow to brownish ring is noted around the rind. The disease does not seem to be variety, irrigation, or field specific. It does seem to be a U.S. problem only at this point. Numerous national experts on cucurbit diseases have visited the infected areas and collected samples. The two organisms most often isolated from the infected plants and fruit are *Fusarium* and *Aphanomyces*, as well as other secondary pathogens. As of yet, researchers have been unable to fulfill Koch's

postulates on this disease. Consequently, it is very hard to counsel growers on management when the primary pathogen is unknown.

Perhaps one of the most perplexing aspects of the vine decline disease is its occurrence in plantings that are made to newly turned pasture. This type of site (long-term pasture) had historically been the most “disease-free” when growing a first crop of watermelons. The entire late season vine decline phenomenon has brought financial and emotional instability in the watermelon growing community. Growers questioned their future viability if this disease increases in magnitude and/or severity.

There has been some work with grafting watermelon to squash or gourd rootstock, as these cucurbits do not seem to be as greatly affected as watermelon by the vine decline organism. Five or six trials were mentioned by group participants, but they were unsure of the results of these studies.

The latest research has shown that filtrates (plant extract with bacteria and fungi excluded) from infected plants cause symptoms when inoculated into healthy plants, and the virus most associated with the disease is papaya ringspot virus type W (PRSV-W). However, when the PRSV-W was purified, it did not produce the same symptoms of vine decline. The results seem to indicate the presence of yet another virus or virus-like organism.

The president of the National Watermelon Association (NWA) circulated a needs paper which had been presented to USDA and congressional representatives in Washington, D.C. The NWA is requesting a microbiologist and plant pathologist for the USDA-ARS South Central Agricultural Laboratory in Lane, OK and a plant pathologist for the USDA-ARS U.S. Vegetable Laboratory in Charleston, SC. In addition to the vine decline disease, pertinent Florida-related research requests include work on *Fusarium oxysporum* f. sp. *niveum* and *Pythium*.

For watermelon fungicides, there are no carbamate, organophosphate, carcinogen, PHI, or REI concerns with the currently registered materials. Cyazofamid (Ranman®) is on the second quarter work plan of EPA s FY 2004, while fenamidone (Reason®) and fludioxonil (Scholar®) are on the third quarter work plan (Table 5).

Weeds

Competition from weeds can be severe in watermelon production, due to the slow growth rate of the crop early in the season, as well as its low planting density and low vining habit. Early season weed management is therefore essential. Weeds late in the season can reduce the efficiency of harvest, but yield loss from competition does not occur when weeds emerge later in the growth of the watermelon crop.

A herbicide gap exists for under mulch. Nutsedge will penetrate plastic mulch, and soon other plants will grow out these holes as well as old and current planting holes. Currently, only bensulide (Prefar®) and naptalam (Alanap®), or the mixture of the two, are available for use under mulch. However, even when used in conjunction, these materials generally fail to provide an entire season of weed control. An extension weed scientist (Dr. Bill Stall) stated that a current effort is being made to get s-metolachlor (Dual Magnum®) labeled at a rate of 0.67 pt/acre for under mulch weed control. Plant-back phytotoxicity does not appear to be a problem at this rate.

Growers also desired an herbicide which could be applied over the top of the plants just prior to fruit set to control sedges and broadleaf weeds. The grass products such as clethodim (Select®) and sethoxydim (Poast®) provide selective control of these weeds. Terbacil is one such herbicide, and efforts to make this available to Florida growers have been made (Section 18 request), but the request was denied due to insufficient economic needs documentation. Sulfentrazone is another pre-emergence material that could be used to control broadleaf and sedge weeds later in the season, but leaching concerns from regulatory groups have lead to a groundwater study that is now being conducted. Based on the outcome of the study, this material may perhaps be available to watermelon growers in the future.

A weed that is more prevalent than it has been historically is eclipta, and perhaps targeted response studies may be needed to see if this plant is becoming resistant to any of the main watermelon herbicides.

Paraquat-resistant nightshade is managed in row middles with carfentrazone (Aim®). One system that looks promising for nutsedge control consists of laying the plastic mulch, allowing nutsedge to come through, spraying with halosulfuron (Sandea®) waiting five days, and then setting transplants.

Watermelon 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 (desiccation).

For watermelon herbicides, there are no carbamate, organophosphate, carcinogen, PHI, or REI concerns with the currently registered materials, except for the long-term planting restrictions for bensulide. Carfentrazone (Aim®) was approved for use on cucurbits as of September 29, 2004 (Table 4).

Summary

Based on the input of the members of the Florida watermelon PMSP, the following items have been placed on the "To Do" list:

Reseach

1. Design and conduct trials for promising seed treatments to manage gummy stem blight.
2. Breed seedless varieties that have more resistance to gummy stem blight.
3. Determine if live microbial products have any utility for decreasing early-season diseases.
4. Examine the current susceptibility of eclipta to common herbicides and investigate possible resistance.
5. Place the desired staffing requested by the National Watermelon Assoc.
6. Examine the effect of bensulide residues on common rotational partners of watermelon such as sweet corn and sugarcane. Proper characterization of phytotoxicity may reduce the need for prolonged plant-back label restrictions.

Education

1. Design and conduct an education program for nematode sampling, identification, and interpretation.
2. Design a sedge management fact sheet for strategies to reduce density of this weed.

Regulation

1. Continue ongoing registrant/IR-4 registrations (spiromesifen, flonicamid, cyazofamid, fenamidone, and fludioxonil).
2. Continue investigation into potential herbicide candidates (terbacil and s-metolachlor).
3. Determine if the 120-day plant back restriction of buprofezin (Courier®) can be reduced to a more realistic value (14 or 28 days).

Watermelon PMSP List of Attendees

Watermelon Growers/Scouts

Mike Caruthers

David Coates

Jody & Laura Land

Leon Lucas

Patty Swilly, Everglades Farms

Extension Personnel

Kent Cushman, Southwest Florida Research and Education Center, UF/IFAS, 2686 SR 29 N, Immokalee, FL 34142-9515. Tel. (239) 658-3429

Gene McAvoy, Hendry Beach County Extension Office, PO Box 68, Labelle, FL 33975. Tel. (863) 674-4092

Research Personnel

Bill Stall, Department of Horticultural Sciences, UF/IFAS, Box 110690, Gainesville, FL 32611. Tel. (352) 392-1928 ext. 207

Governmental/Pest Management Centers Personnel

Mark Mossler, UF/IFAS FL Pest Management Center, PO Box 110710, Gainesville, FL 32611. Tel. (352) 392-4721,

Industry Personnel

Paul Sawyer, Siegers Seed Co.

John Nance

Table 1. Efficacy ratings for management tools against invertebrate pests - Florida watermelon.

Pest Management Tools	Pests								
	Mites	Thrips	Seedcorn maggot	Aphids	Fall armyworm	Cabbage looper	Corn earworm	Beet armyworm	Saltmarsh caterpillar
Registered Materials									
Abamectin (Agri-mek®)	G			F					
Azadirachtin (Neem)	F			F	F		F		
Azinphos-methyl (Guthion®)									
Bacillus thuringiensis					G	G	G		G
Beauveria bassiana (BotaniGard®)	P			P	P		P		P
Bifenazate (Acramite®)	E								
Bifenthrin (Capture®)	P			P	F		F		
Buprofezin (Courier®)									
Carbaryl (Sevin®)					F				
Cryolite (Kryocide®)									
Cyromazine (Trigard®)									
Diazinon									
Dicofol (Kelthane®)	G								
Dimethoate									
Endosulfan (Thiodan®)	F			F	F		F		
Esfenvalerate (Asana®)									
Fenpropathrin (Danitol®)	F			F	F	F	F		G
Imidacloprid (Admire®)				E					
Kaolin (Surround®)									
Malathion	P			F	F	F	F		
Metaldehyde									
Methomyl (Lannate®)				G	G	G	G		
Oils									
Oxamyl (Vydate®)									
Oxydemeton (Metasystox®)				G					
Permethrin (Ambush®)					F				
Pyrethrins + Rotenone	P								
Pyrethrins + PBO				F	P		P		G
Pymetrozine (Fulfill®)					E				
Pyriproxyfen (Knack®)									
Soaps									
Spinosad (Spintor®)		G			G	G	G		
Sulfur	G								

Table 1. Efficacy ratings for management tools against invertebrate pests - Florida watermelon.

Pest Management Tools	Pests								
	Mites	Thrips	Seedcorn maggot	Aphids	Fall armyworm	Cabbage looper	Corn earworm	Beet armyworm	Saltmarsh caterpillar
Thiamethoxam (Platinum®)				G					
New Chemistries - Pending									
Deltamethrin (Decis®)									
Flonicamid (Turbine®)									
Methoxyfenozide (Intrepid®)									
zeta-Cypermethrin (Mustang MAX®)									
Cultural/Non-chemical									
Certified pest-free plants	EF			F					
Crop rotation									
Removing ripe fruit from field									
Resistant varieties	EF								
Sanitation	G								
Traps									
Weed control	G								
Biological controls									
Beneficial mites	E	G		P					
Damsel bugs				P	P	P	P	P	P
Big-eyed bugs	P			P					
Ground beetles					P	P	P	P	P
Lacewings	P			G	P	P	P	P	P
Ladybird beetles	F			E					
Minute pirate bugs	P	E		F	P	P	P	P	P
Predatory mirids									
Parasitic wasps	P	P		G	P	F	F	F	F
Predatory midges	P			G					
Predatory thrips	F								
Spiders	P				P	P	P	P	P
Syrphid fly larvae	P			G					

Rating Scale: E = excellent; G = good; F = fair; P = poor; ? = research needed; ... = not used; * = used, but not a stand alone management tool.

Table 2. Efficacy ratings for management tools against invertebrate pests - Florida watermelon (continued).

Pest Management tools	Pests								
	Granulate cutworm	Tobacco budworm	Whiteflies	Cucumber beetles	Leafminer	White fringed beetle larvae	Beetles	Mole cricket	Bugs
Registered materials									
Abamectin (Agri-mek®)			F						
Azadirachtin (Neem)			P						
Azinphos-methyl (Guthion®)									
Bacillus thuringiensis									
Beauveria bassiana (BotaniGard®)			P						
Bifenazate (Acramite®)									
Bifenthrin (Capture®)			F						
Buprofezin (Courier®)			E						
Carbaryl (Sevin®)									
Cryolite (Kryocide®)						E			
Cyromazine (Trigard®)									
Diazinon									
Dicofol (Kelthane®)									
Dimethoate									
Endosulfan (Thiodan®)			F						
Esfenvalerate (Asana®)			F						
Fenpropathrin (Danitol®)			F						
Imidacloprid (Admire®)			E						
Kaolin (Surround®)									
Malathion									
Metaldehyde									
Methomyl (Lannate®)									
Oils			G						
Oxamyl (Vydate®)									
Oxydemeton (Metasystox®)									
Permethrin (Ambush®)			F						
Pyrethrins + Rotenone									
Pyrethrins + PBO			P						
Pymetrozine (Fulfill®)			G						
Pyriproxyfen (Knack®)			E						
Soaps			F						
Spinosad (Spintor®)									
Sulfur									
Thiamethoxam (Platinum®)			E						
New Chemistries - Pending									

Table 2. Efficacy ratings for management tools against invertebrate pests - Florida watermelon (continued).

Pest Management tools	Pests								
	Granulate cutworm	Tobacco budworm	Whiteflies	Cucumber beetles	Leafminer	White fringed beetle larvae	Beetles	Mole cricket	Bugs
Deltamethrin (Decis®)									
Flonicamid (Turbine®)									
Methoxyfenozide (Intrepid®)									
zeta-Cypermethrin (Mustang MAX®)									
Cultural/Non-chemical									
Certified pest-free plants									
Crop rotation									
Removing ripe fruit from field									
Resistant varieties									
Sanitation			G						
Traps									
Weed control									
Biological controls									
Beneficial mites			P						
Damsel bugs			F						
Big-eyed bugs			F						
Ground beetles			P						
Lacewings			G						
Ladybird beetles			G						
Minute pirate bugs			F						
Predatory mirids			G						
Parasitic wasps			E		E				
Predatory midges									
Predatory thrips									
Spiders									
Syrphid fly larvae									

Rating Scale: E = excellent; G = good; F = fair; P = poor; ? = research needed; ... = not used; * = used, but not a stand alone management tool.

Table 3. Indications for disease management products used on Florida watermelon.

Disease Management Product	Damping Off	Phytophthora	Gummy Stem Blight	Downy Mildew	Bacterial Fruit Blotch	Alternaria Leaf Spot	Fusarium Wilt	Anthracnose	Virus
Azoxystrobin (Amistar®)	X	X	XX*	XX	0	XX		XX	
Bacillus subtilis (Serenade®)									
Boscalid (Pristine®)	0		XX	XX	0	X	0	X	
Chlorothalonil (Bravo®)	0		XX	XX	0	X		X	
Copper compounds	0		X	X				X	
Cymoxanil (Tanos®)	0			XX					
Dimethomorph (Acrobat®)	0		0	XX	0	0	0	0	
Famoxadone (Tanos®)	0			XX					
Fosetyl-Al (Aliette®)	0		0	X	0	0	0	0	
Mancozeb	0		X	XX	0	X	0	X	
Maneb	0	X	X	X					
Mefenoxam (Ridomil Gold®)	X	XX		XX					
Myclobutanil (Nova®)	0		0	0	0	0	0	0	
Potassium bicarbonate									
Potassium phosphate									
Pyraclostrobin (Cabrio®)	0	X	XX*	XX	0	XX	0	XX	
Sulfur									
Thiophanate (Topsin®)	0		XX*	0	0	0	0	X	
Trifloxystrobin (Flint®)	0	X	0	0/X					
Triflumizole (Procure®)									
Zoxamide (Gavel®)									
PENDING									
Acibenzolar (Actigard®)									
Ampelomyces quisqualis									
Bacillus pumilus									
Cyazofamid (Ranman®)									
Fenamidone (Reason®)									
Fludioxonil (Scholar®)									
Gliocladium catenulatum									
Hydrogen peroxide									
Ipconazole (Vortex®)									

Table 3. Indications for disease management products used on Florida watermelon.

Disease Management Product	Damping Off	Phytophthora	Gummy Stem Blight	Downy Mildew	Bacterial Fruit Blotch	Alternaria Leaf Spot	Fusarium Wilt	Anthracnose	Virus
Kresoxim (Sovran®)									
Propamocarb (Previcur®)									
Streptomyces lydicus									
Tebuconazole (Folicur®)									
0 = not effective, X = effective for control of indicated disease, XX = highly effective for control of indicated disease. *numerous isolates resistant									

Table 4. Indications for weed management products used on Florida watermelon.

Weed Management Product	Texas Panicum	Goosegrass	Crabgrass	Pusley	Pigweeds	Nutsedges	Purslane	Morningglory	Bristly Starbur
Bensulide (Prefar®)	X	X	X	S	S		S		
Clethodim (Select®)	X	X	X						
Clomazone	S	X	X	S			S	S	S
DCPA (Dacthal®)		S	S		S		S		
Diquat*		S	S	X	X				X
Ethalfluralin +(Strategy®) Clomozone	X	X	X	X	X		X	S	S
Glyphosate	X	X	X		X	X			
Halosulfuron (Sandea®)				S	X	X	S	X	
Naptalam (Alanap®)				X	X		X		
Paraquat	X	R	X	S	X		X	S	X
Pelargonic acid (Scythe®)				S	X				X
Sethoxydim (Poast®)	X	X	X						
PENDING									
Terbacil (Sinbar)			X	X	X		X	X	X
Carfentrazone (Aim®)				X	X		X	X	X

Table 4. Indications for weed management products used on Florida watermelon.

Weed Management Product	Texas Panicum	Goosegrass	Crabgrass	Pusley	Pigweeds	Nutsedges	Purslane	Morningglory	Bristly Starbur
Sulfentrazone (Spartan®)				X	X	X	X		X
*By Special Local Need permit; X = used for control of indicated weed; S = for suppression only of indicated weed; R=resistant.									

Table 5. EPA 2004 Workplan for cucurbit pesticides.

Chemical Name	Quarter	Pesticide Type - Pests
Cyazofamid (Ranman®)	Second	Fungicide - *Phytophthora, Pythium*, downy mildew
Cyfluthrin (Renounce®)	Third	Insecticide - cucumber/flea/squash beetles
Dinotefuran (Stackle®)	Third	Insecticide - systemic non-nicotinoid insecticide controls sucking insects and beetles
Carfentrazone (Aim®)	Third	Herbicide - numerous broadleaf weeds
Fenamidone (Reason®)	Third	Fungicide - protectant and curative against water molds, ascomycetes, and *Alternaria*
Fludioxonil (Scholar®)	Third	Fungicide - drip irrigation for a number of soil-borne fungal diseases
Flonicamid (Turbine®)	Fourth	Insecticide - different site nicotinoid provides quick anti-feeding behavior in sucking pests
Iodomethane (Midas®)	Fourth	Fumigant - similar to methyl bromide
Spiromesifen (Oberon®)	Fourth	Insecticide - whiteflies and mites

Table 6. Pending watermelon pesticides from the New Pest Management Technologies (NPMT) database.

Chemical Name	Pesticide Type - Pests
Acibenzolar (Actigard®)	SAR Inducer - viruses
Ampelomyces quisqualis (AQ 10®)	Fungicide - hyperparasite of powdery mildew
Bacillus pumilus (Sonata®)	Fungicide - downy and powdery mildew, grey mold, *Sclerotinia* blight and rots
Carfentrazone (Aim®)	Herbicide - numerous broadleaf weeds
Cyazofamid (Ranman®)	Fungicide - water molds and downy mildew
Deltamethrin (Decis®)	Insecticide - beetles, catepillars, bugs
Fenamidone (Reason®)	Fungicide - water molds, ascomycetes, *Alternaria*
Fenpropathrin (Danitol®)	Insecticide - multi-pest pyrethroid
Fludioxonil (Scholar®)	Fungicide - numerous fungi including *Fusarium*
Gliocladium catenulatum (Prestop®)	Fungicide - *Pythium* and *Rhizoctonia*
Hydrogen peroxide	Fungicide - broad spectrum, fungi and bacteria
Ipconazole (Vortex®)	Fungicide - damping off
Kresoxim (Sovran®)	Fungicide - protectant and curative for many fungi
Methoxyfenozide (Intrepid®)	Insecticide - caterpillars
Propamocarb (Previcur®)	Fungicide - systemic activity against water molds
Streptomyces lydicus	Fungicide - damping off
Sulfentrazone (Spartan®)	Herbicide - both grass and broadleaf weeds
Tebuconazole (Folicur®)	Fungicide - numerous foliar diseases
zeta-Cypermethrin (Mustang MAX®)	Insecticide - beetles, caterpillars, bugs