WATERMELON
PEST MANAGEMENT
STRATEGIC PLAN (PMSP)

October 12, 2004
Immokalee, FL

REVISED - April 2007

Table of Contents

APPENDIX

Executive Summary

Florida ranks first in the U.S. in the production of watermelon, accounting for nearly 20 percent of national production. In 2004-2005, 819,000,000 pounds of watermelon valued in excess of $127 million were produced on 26,000 acres ($4,900/acre). The winter production is concentrated in several counties in southwest Florida with the rest scattered throughout the state as the weather warms in the spring. A revision to the PMSP meeting held in late 2004 was largely done to address the new viruses that have been found in Florida that affect watermelon.

Watermelon 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, watermelon does have a number of primary pests. The following pest concerns were placed on the "To Do" list.

Research Design and conduct trials for promising seed treatments to manage gummy stem blight.

Breed seedless varieties that have more resistance to gummy stem blight.

Determine if live microbial products have any utility for decreasing early-season diseases.

Examine the current susceptibility of eclipta to common herbicides and investigate possible resistance.

Investigate the transmission and distribution of new plant viruses SqVYV and CuLCrV.

Examine the effect of bensulide residues on common rotational partners of watermelon such as sweet corn and sugarcane.

Education Design and conduct an education program for nematode sampling, identification, and interpretation.

Design a sedge management fact sheet for strategies to reduce density of this weed.

Regulation Continue investigation into potential herbicide candidates (e.g.s-metolachlor).

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

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Leon Lucas

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Introduction

Florida ranks first in the U.S. in the production of watermelon, accounting for nearly 20 percent of national production. In 2004-2005, 819,000,000 pounds of watermelon valued in excess of $127 million were produced on 26,000 acres ($4,900/acre). This value has doubled since as early as 2002-2003. 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 at the University of Florida Institute of Food and Agricultural Sciences' Southwest Florida Research and Education Center in Collier County, Florida in late 2004. The revision to the plan was conducted by Extension specialists in early 2007 to mainly address issues with whitefly and the plant viruses that this insect vectors, but also weed control.

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 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 two-row 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).

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

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 which was problematic in the 80's and 90's due to viral transmission, but that the availability of (and high adoption of) the 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 lose 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, largely due to viral concerns which will be mentioned in the disease section. Additionally, 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 a nicotinoid, 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. 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.

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.

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 critical use exemption process made this chemical available through 2006 and probably through 2009. Growers on mulch have been resigned to pay ever-increasing costs 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.

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, since 2003, there has emerged a viral late-season vine decline and fruit rot disease. This disease is 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 other 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 five years growers have been trying "everything " (Table 2). 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 reduced inoculum levels early in the season. The group also believes research into live microbial products may have utility at transplant.

Since 2003, Florida watermelon growers have struggled with a late season vine decline disease. It is especially devastating financially as all inputs, including harvest in some cases, have been made to the crop at the time the disease becomes noticeable. Infection rates can rapidly increase from 10 to greater than 80 percent within one week. Recent research addresses the cause of this disease, which appears to be the result of viral infection of the plant.

Researchers from UF/IFAS, USDA, and the Florida Department of Agriculture and Consumer Services collaborated on studies to elucidate the nature of this disease. During a survey in Hillsborough County in 2003, a sample was collected from a squash plant expressing vein yellowing. This sample, one of forty taken from the same field, was found to be infected with a virus not previously described in Florida. It is described as a flexous rod-shaped virion of approximately 840 nm in length. The proposed name for the virus is Squash vein yellowing virus (SqVYV).

The host range (which excludes the Amaranthaceae, Apocynaceae, Asteraceae, Chenopodiaceae, Fabaceae, Malvaceae, and Solanaceae), coupled with analysis of its transmission (tested with both whiteflies and aphids), suggest that it is a whitefly-transmitted member of the genus *Ipomovirus* in the family *Potyviridae*. Although originally obtained from squash plants, the researchers were able to induce the watermelon vine decline disease and associated fruit necrosis in the greenhouse.

What this means to growers in terms of pest management is clear. As with many other vegetable crops in Florida, a serious whitefly-vectored disease place this pest into the primary category, with much less tolerance for its residence in the field. Consequently, more growers will probably be applying a neonicotinoid insecticide to their watermelon crop. This places more pressure on this group of materials, and anyone that is dealing with these must be aware of pesticide resistance. Consequently, research needs to be conducted on the transmission and spread of SqVYV in cucurbits, which includes watermelon.

In addition to SqVYV, another whitefly-transmitted virus that attacks cucurbits (Cucurbit leaf crumple virus) has been identified in squash in northeastern Florida in late 2006. This begomovirus (CuLCrV), has been reported in the western U.S. but it's distribution in Florida is not yet known. It would be prudent to examine the distribution and transmission of this virus on watermelon as well.

For watermelon fungicides (Table 2), there are no carbamate, organophosphate, carcinogen, PHI, or REI concerns with the currently registered materials.

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.

In addition to the actual watermelon field, growers are also reporting problems with the pasture areas that come before or after watermelon operations, in particular with tropical soda apple (TSA) during establishment. There are two options for controlling TSA: dicamba (Banvel®) at two quarts per acre ($35- 40), or triclopyr (Remedy®) at one quart per acre ($20). Both product labels require that the pasture be established before application. Particularly in bermudagrass, Remedy® can be very injurious if the plants are small. Weedmaster® (2,4-D + banvel) can be applied at up to two quarts per acre ($18/acre), which would suppress TSA growth until establishment is complete, at which time Remedy® could be used to completely control TSA.

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 has recently been labeled for watermelon and it is one such herbicide that can extend weed control past fruit set. Sulfentrazone is another post-emergent 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 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 (Table 3), there are no carbamate, organophosphate, carcinogen, PHI, or REI concerns with the currently registered materials, except for the long-term planting restrictions for bensulide.

Summary

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

Research

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. Investigate the transmission and distribution of SqVYV and CuLCrV.

5. Examine the current susceptibility of eclipta to common herbicides and investigate possible resistance.

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 investigation into potential herbicide candidates (e.g. s-metolachlor).

2. Determine if the 120-day plant back restriction of buprofezin (Courier®) can be reduced to a more realistic value (14 or 28 days).

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

Pests / Pest Management Tools	Mites	Thrips	SM	Aphids	FAW	CL	CEW	BA	SMC	GC	TB	WF	CB	Leafminer	WFB	Beetles	MC	Bugs
Registered materials																		
Abamectin (Agri-mek®)	G			F								F						
Azadirachtin (Neem)	F			F	F		F		G			P						
Azinphos-methyl (Guthion®)																		
Bacillus thuringiensis					G	G	G		G									
Beauveria bassiana (BotaniGard®)	P			P	P		P		P			P						
Bifenazate (Acramite®)	E																	
Bifenthrin (Capture®)	P			P	F		F					F						
Buprofezin (Courier®)												E						
Carbaryl (Sevin®)					F													
Cryolite (Kryocide®)															E			
Cyromazine (Trigard®)																		
Cyfluthrin (Baythroid®)																		
Diazinon																		
Dicofol (Kelthane®)	G																	
Dimethoate																		

Abbreviations:
SM = seedcorn maggot
FAW = fall armyworm
CL = cabbage looper
CEW = corn earworm
BA = beet armyworm
SMC = saltmarsh caterpillar

Abbreviations:
GC = granulate cutworm
TB = tobacco budworm
WF = whiteflies
CB = cucumber beetles
WFB = white-fringed beetle larvae
MC = mole cricket

Rating scale:
E = excellent;
G = good;
F = fair;
P = poor;

Rating scale:
? = research needed;
… = not used;
***** = used but not a stand alone management tool

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Dinotefuran (Venom®)																		
Endosulfan (Thiodan®)	F			F	F		F					F						
Esfenvalerate (Asana®)												F						
Fenpropathrin (Danitol®)	F			F	F	F	F		G			F						
Flonicamid (Beleaf®)																		
Imidacloprid (Admire®)				E								E						
Kaolin (Surround®)																		
Malathion	P			F	F	F	F											
Metaldehyde																		
Methomyl (Lannate®)				G	G	G	G											
Methoxyfenozide (Intrepid®)																		
Oils												G						
Oxamyl (Vydate®)																		
Oxydemeton (Metasystox®)				G														
Permethrin (Ambush®)					F							F						
Pyrethrins + Rotenone	P																	

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Pyrethrins + PBO				F	P		P		G			P						
Pymetrozine (Fulfill®)					E							G						
Pyriproxyfen (Knack®)												E						
Soaps												F						
Spinosad (Spintor®)		G			G	G	G											
Spiromesifen (Oberon®)																		
Sulfur	G																	
Thiamethoxam (Platinum®)				G								E						
New Chemistries - Pending																		
Deltamethrin (Decis®)																		
zeta-Cypermethrin (Mustang MAX®)																		

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Cultural/Non-chemical																		
Certified pest-free plants	EF			F														
Crop rotation																		
Removing ripe fruit from field																		
Resistant varieties	EF																	
Sanitation	G											G						
Traps																		
Weed control	G																	
Biological controls																		
Beneficial mites	E	G		P								P						
Damsel bugs				P	P	P	P	P	P			F						
Big-eyed bugs	P			P								F						
Ground beetles					P	P	P	P	P			P						
Lacewings	P			G	P	P	P	P	P			G						
Ladybird beetles	F			E								G						
Minute pirate bugs	P	E		F	P	P	P	P	P			F						

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Predatory mirids												G						
Parasitic wasps	P	P		G	P	F	F	F	F			E		E				
Predatory midges	P			G														
Predatory thrips	F																	
Spiders	P				P	P	P	P	P									
Syrphid fly larvae	P			G														

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Table 2. Efficacy ratings 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	0	XX	0
Bacillus pumilus (Sonata®)									
Bacillus subtilis (Serenade®)									
Boscalid (Pristine®)	0		XX	XX	0	X	0	X	
Chlorothalonil (Bravo®)	0		XX	XX	0	X	0	X	
Copper compounds	0		X	X	X	X	0	X	
Cyazofamid (Ranman®)		X	0	XX	0	0	0	0	
Cymoxanil (Tanos®)	0			XX					
Dimethomorph (Acrobat®)	0		0	XX	0	0	0	0	
Famoxadone (Tanos®)	0			XX					
Fenamidone (Reason®)				XX		X			
Fludioxonil (Scholar®)									
Fosetyl-Al (Aliette®)	0		0	X	0	0	0	0	
Kresoxim (Sovran®)									
Mancozeb	0		X	XX	0	X	0	X	
Maneb	0	X	X	X					
Mefenoxam (Ridomil Gold®)	X	XX	X	XX					
Myclobutanil (Nova®)	0		0	0	0	0	0	0	
Potassium bicarbonate									
Potassium phosphite									
Propamocarb (Previcur®)	XX			X					
Pyraclostrobin (Cabrio®)	0	X	XX*	XX	0	XX	0	XX	
Quinoxyfen (Quintec®)									
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									
Gliocladium catenulatum									
Hydrogen peroxide	0	0	0	0	0	0	0	0	0
Ipconazole (Vortex®)									
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 3. Efficacy ratings 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						
Carfentrazone (Aim®)				X	X		X	X	X
DCPA (Dacthal®)		S	S		S		S		
Diquat*		S	S	X	X		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		S	S	X
Terbacil (Sinbar)			X	X	X		X	X	
Sethoxydim (Poast®)	X	X	X						
PENDING									
s-Metolachlor (Dual®)	X	X	X	X	X	X**			X
Sulfentrazone (Spartan®)				X	X	X	X		X

*By Special Local Need permit
**Yellow nutsedge only
X = used for control of indicated weed
S = for suppression only of indicated weed
R=resistant