1987 Florida Tomato Institute



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Introductory Remarks

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Greetings and welcome to the Twenty-Sixth Annual Florida Tomato Growers Institute.

Many changes have occurred in the tomato industry over the past 26 years. What we must now do is plan for the next quarter century. The ever increasing demands placed on Florida tomato growers by urbanization will necessitate many changes over the next few years. This will include, but is not limited to, more careful use of land, water, and pesticides, more intense care for the environment, and maintenance of a high quality product for the consumer.

To meet these demands IFAS continues to broaden its research effort on tomatoes. Plant breeding and genetics have long been a priority. These effects have been greatly expanded in the past three years by the addition of two faculty, one at Gainesville, Eduardo Vallejos and one at Homestead, Yan Narayarran to work on tomato genetics in the areas of low temperature of tolerance, stress tolerance, and nitrogen assimilation. This is an addition to Jay Scott's extensive tomato breeding program at Bradenton which encompasses among other things disease resistance, hot set ability, fruit quality improvement, and stress tolerance. This summer the Lyle C. Dickman Endowed Chair for Plant Improvement was fully funded, and it is hoped that a fourth person can be added to work on tomato improvement by 1988.

As today's program develops tomato producers will be exposed to IFAS's efforts on pest control methods to effectively improve control of bacterial disease, soil diseases, insects, and weeds. In order to stay ahead of the water issue, IFAS has clearly initiated a strong program on water conservation through the use of drip irrigation and you will learn how to use chemicals and fertilizer more efficiently through this system as a bonus. IFAS has long worked with federal and state agencies to improve the labeling, use, and handling of pesticides. This will clearly be a dominant portion of future research programs and the topic of much discussion in future Tomato Institute meetings.

IFAS is committed to help maintain consumer demand by improved tomato fruit quality. This has been a key issue in our plant breeding, postharvest, and marketing studies for the past several years. Fruit quality continues to be an issue for a better understanding by both producers and consumers of what factors lead to the highest quality fruit. This is an educational as well as a continuing research effort. It includes studies on fruit ripening, softening, sizing, storage, and transportation, as well as procedures necessary for consumers to follow to allow their produce to reach optimum quality. The IFAS staff sincerely hopes that this year's Tomato Institute is informational to all those who attend. We look forward to hearing your needs in an effort to better serve you.

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A Comparison of Drip and Seep Irrigation on Tomato Production in Southwest Florida

P.H. Everett, G.A. Clark, C.E. Arnold, F.T. Izuno and J. Grimm

The expansion of citrus, vegetable and sugarcane acreage on the sandy soils of south Florida is increasing the water demand for crop production. By reducing the amount of water required per acre, existing water sources can continue to meet agricultural water requirements and the demand for new sources will be reduced.

Current methods (seep or overhead) of vegetable irrigation in south Florida require substantial withdrawal of water from surface and/or underground sources. The seep method, which predominates on the sandy flatwood soils, has an overall efficiency of between 30 and 50 percent. There is a need to reduce the volume of water required by the use of more application efficient irrigation systems. Drip systems utilize much less water than the traditional systems and have an overall efficiency of 70 to 90 percent.

The objective of this work was to evaluate two irrigation systems, drip and seep, for water usage and for their effect on tomato production on sandy flatwood soils of southwest Florida.

FIELD LAYOUT

Each of the two irrigation systems was installed on 1.5 acre field blocks at the Southwest Florida Research and Education Center in Immokalee. The drip and seep blocks were separated by a 360-foot wide buffer zone and a 5-foot deep perimeter ditch. This was done to reduce the influence of the high water table in the seep block on soil moisture in the drip block. A seep system was also installed for the drip irrigated block to provide irrigation prior to bedding, fumigation and mulching. This initial irrigation is necessary if rainfall is insufficient to provide adequate soil moisture to form the plant beds and to increase the effectiveness of the soil fumigant. Lateral irrigation/drainage ditches in both blocks were spaced 100 feet apart. The area between lateral ditches contained twelve 300-foot long plant beds in

the following configuration: 3 beds, a drive middle, 6 beds, a drive middle and 3 beds. Plant beds were 3 feet wide, 6 inches high and 6 feet from center to center. The water table in the seep block was maintained, as near as possible, at 15-18 inches below the top of the plant bed. Irrigations in the drip block were scheduled to maintain favorable soil moisture in the plant beds by monitoring field tensiometers placed at 6 and 12-inch depths in the plant beds. Adjustments were made to increase or decrease irrigation times as indicated by tensiometer readings. An irrigation controller/clock was used for irrigation timing. The general irrigation schedule used for drip irrigated tomatoes is shown in Table 1.

In addition to the tensiometers, flowmeters were used to measure water input, flumes to determine tailwater runoff, water level recorders to give a continuous measurement of water table level, and observation wells to monitor water table level throughout the seep and drip irrigated fields. The bottom of the casing for both the water level recorders and the observation wells was set at 36-inches below the top of the plant beds. The observation wells were to aid in maintaining the watertable at the proper depth in the seep field and to assist in evaluating the influence of the natural water table on soil moisture in the drip field.

Tomato Culture

After the two fields were laid-out and wells and lateral ditches installed, the water table was raised to obtain sufficient soil moisture for the bedding operation. This was necessary because the natural water table was low due to dry weather in November and the first 3 weeks of December, 1986. Plant beds were formed, fumigated, fertilized and mulched on January 5, 1987. Grower practices were simulated as close as possible in all of these operations.

Fertilization - Plants grown with the two irrigation systems received the same amounts (235-110-395 lbs/A N-P₂0₅-K₂0) of fertilizer, but timing and method of application were different. For the seep system, all fertilizer was applied preplant as follows: 1,100 pounds/acre (based on 7,260 linear bed feet) of a 5-10-10 + micros was applied on the flat in a 30 inch wide band and bedded-over to a depth of 6-7 inches; then 950 pounds/acre of a 19-0-30 fertilizer was placed on the bed surface in two narrow bands 10 inches to each side of the

plant row. For the drip system, 23% of the nitrogen (55 1b/A), 28% of the potassium (110 1bs/A) and 100% of the phosphorus and micronutrients were applied in the bed as dry fertilizer. The remaining nitrogent (77%) and potassium (72%) were applied as liquid fertilizer (5-0-8) through the drip lines (fertigation). Fertigation began 3 weeks after transplanting and was applied twice daily on Monday, Wednesday and Friday. This schedule continued for 12 consecutive weeks. During this period the following percentages of the total fertigation nitrogen and potassium were applied each week: 1,3,4,6,8,9,11,15,11,11,11, and 10. Drip tubing was placed on the bed surface 8-9 inches from the plant row and had an 18-inch emitter spacing. Each emitter had a delivery capacity of 0.55 gal/hour. Drip tubes were cleaned weekly by injecting household bleach (5% sodium hypochlorite) to obtain a minimum concentration of 1.5 ppm free chlorine at the ends of the drip lines.

Crop Establishment - Tomato crops in both the drip and seep irrigated fields were established by transplanting container grown tomato seedlings (cv 'Sunny') on January 28, 1987. Water table levels in both fields were maintained by seep irrigation until February 9. After this the only irrigation applied to the drip field was through the tubes. Once drip irrigation was started on February 10, an effort was made to keep the water table below 36 inches. This was successful except for a 10 day period (3/27 to 4/6) following 4.50 inches of rain during the last week of March. Tomato plants were pruned twice (2/23 and 3/10), staked and tied. A standard spray program for diseases and insects was used throughout the crop season.

Tomatoes were harvested by a commercial picking crew on April 30 and again on May 11. Tomatoes were graded, sized and packed by a commercial packing house. Yield, fruit size and grade shown in this report were taken from pack-out sheets obtained from the packing house.

Weather Conditions - Rainfall during February (3.39") and March (8.04") was above normal, while April (0.07") was very dry. Temperatures were cool during February, March and into the first week of April, when minimum and maximum temperatures averaged 45 degrees and 68 degrees Fahrenheit, respectively.

RESULTS

Plant height measurements were made weekly during a 6-week period beginning March 3 and ending April 7 (Table 2). Although growth rate (inches/week) was similar among plants grown with the two irrigation systems, those grown with drip were taller on each of the 6 dates for which measurements were taken.

Yield, grade and size of tomato fruit grown with drip or seep irrigation are shown in Tables 3, 4 and 5. For the combined yield from the two harvests (Table 5), drip irrigated tomatoes produced a total (all sizes and grades) of 213 boxes/acre more than those grown with seep irrigation. Most of this yield increase (193 boxes/acre) was in No. 1 5x6's and larger, indicating an overall size increase for the tomatoes grown with drip irrigation.

Total gross sales (Table 6) of drip irrigated tomatoes was \$1,561/acre more than for seep irrigated tomatoes. This was due both to increase yield and to premimum price for larger tomatoes. However, because of higher yields, harvest, hauling and packing cost was \$691/acre higher for drip irrigated tomatoes. Initial cost of a drip system is approximately \$400/acre more than for a seep system. If this is added to the increased cost of harvesting and packing there was a \$470/acre increase in favor of the drip over the seep system.

Tomato leaf samples were collected monthly from six 10-plant plots in each of the irrigation blocks. These samples were analysed for nitrogen (N), phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg). Overall N, P and Mg content were higher in plants grown with seep irrigation, while Ca content was lower (Table 7). There was no difference in K content between the two irrigation systems on any of the sample dates. Although there were differences in plant nutrient uptake the values for all five elements with either irrigation system are considered adequate for good tomato production.

During a 75-day period beginning February 10 and ending May 11, 97.1 acre inches of water was applied to the seep field and 6.0 acre inches to the drip field. The amount applied to the seep field is higher than normal because the

field blocks was not fully representative of large field scale operations.

At the end of the crop season the uniformity of flow in the drip tubes was determined to be 95.1% and for the emitters 96.2%. This indicates that clogging was not a problem during this test.

ACKNOWLEDGEMENT: This work supported by the South Florida Water Management District.

Table 1. Irrigation schedule for drip irrigated tomatoes

igo. a		Duration per cycle	Total Duration/day	Volume*
Period	Cycles/day	(min.)	(min.)	(gal/Acre)
2/20-3/18	2	20	40	1479
3/18-4/11	2	30	60	2218
4/11-4/23	2	40	80	2958
4/23-4/27	2	50	100	3697
4/27-5/11	3	50	150	5546

^{*1} Acre = 7260 linear bed feet. Average flow rate was 55 gpm.

Table 2. Difference in plant height between drip and seep irrigated tomatoes during a six week period.

			Plant H	eight ^l			
Irrigation	3/3	3/10	3/17	3/25	4/1	4/7	
	inches						
Drip	13.8	18.0	21.4	28.2	31.6	31.9	
Seep	12.8	16.3	19.5	25.4	29.8	30.1	
Difference	1.0	1.7	1.9	2.8	1.8	1.8	
and the second s							

Figures are averages of 60 plants

Table 3. Yield, grade and size of tomato fruit grown with drip or seep irrigation (1st Harvest)

Irrigation	Fruit	Fr	uit Siz	e	
Type	Grade	6 x 7	6 x 6	* 5x6	Total
			25#	bx/Acre-	
Drip	No. 1	19	120	538	677
-	No. 2	1	39	185	225
	Total	20	159	723	902
Seep	No. 1	23	175	442	640
•	No. 2	19	33	116	168
	Total	42	208	558	808

Table 4. Yield, grade and size of tomato fruit grown with drip or seep irrigation (2nd Harvest)

Irrigation	Fruit	Fr	uit Siz	e	
Type	Grade	6x7	6x6	5 x6	Total
			25#	bx/Acre-	
Drip	No. 1	96	195	219	510
•	No. 2	80	120	143	343
	Total	176	315	362	853
Seep	No. 1	129	179	122	430
	No. 2	97	111	96	304
	Total	226	290	218	734

Table 5. Yield, grade and size of tomato fruit grown with drip or seep irrigation (1st and 2nd harvest combined)

Irrigation	Fruit	. Fr	Fruit Size			
Type	Grade	6 x 7	6x6	* 5x6	Total	
			25#	bx/Acre-		
Drip	No. 1	115	315	757	1187	
-	No. 2	81	159	328	568	
	Total	196	474	1085	1755	
Seep	No. 1	152	354	564	1070	
	No. 2	116	144	212	472	
•	Total	268	498	776	1542	

Table 6. Sales by grade and fruit size for tomatoes grown with drip or seep irrigation (1st and 2nd harvest combined)

Irrigation	Fruit	Fr	Fruit Size		
Type	Grade	6x7	6x6	5 x 6	Total
			Dolla	ars/Acre	
Drip	No. 1	537	1845	4980	7362
	No. 2	242	678	1506	2426
	Total	779	2523	6486	9788
Seep	No. 1	714	1953	3628	6295
	No. 2	329	621	982	1932
	Total	1043	2574	4610	8227

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Table 7. Mineral composition of tomato leaves from plants grown with two irrigation systems

		Mg	 t t	0.57	0.89	0.10	0.16
	1 28	Ca		3.47 0.30 2.83 0.57	3.49 0.38 2.50 0.89	0.08 0.31 0.10	NS
	April 28	Ъ		0.30	0.38	0.08	NS
		N			3.49	NS	
		Mg		3.79 0.41 1.53 0.45	0.52	0.04	0.07
ampled	1 1	Ca		1.53	1.13	0.24	0.07 0.38 0.07
Date sampled	Date samp April 1	Ъ	-2	0.41	4.52 0.61 1.13 0.52	0.47 0.05 0.24 0.04	0.07
		N		3.79	4.52	0.47	NS
		Mg		5.46 0.70 2.22 0.74	0.73	NS	
	h 3	Ca		2.22	1.64	0.21	0.33
	March 3	Ъ	1	0.70	5.98 0.84 1.64 0.73	0.35 0.13 0.21 NS	NS
		N		5.46	5.98	0.35	NS
		Irrigation		Drip	Seep	LSD 5%	1%

FUTURE OF DRIP IRRIGATION DELIVERY OF INSECTICIDES AND NEMATICIDES

J.W. NOLING

Chemigation refers to the injection and delivery of agricultural chemicals through an irrigation system. The technology was originally developed for the injection of fertilizers in 1958 and has since evolved into injection of herbicides, fungicides, insecticides, and nematicides. Most chemigation research since 1958, has focused on center pivot or overhead type irrigation delivery systems. The flexibility of overhead systems, which allow application of both soil and foliar applied chemicals, confer an important advantage for control of foliar pests and pathogens which appear later during crop growth. More recently drip irrigation systems have been used to deliver insecticides and nematicides as well as broad spectrum fumigant materials to control soil insects, nematodes, fungi, and weeds. In general the results from these studies have demonstrated that chemigation of insecticides and nematicides is both feasible and effective when the drip irrigation and chemical injection systems are properly installed, calibrated and operated, and when the proper chemicals were utilized and applied uniformly. In this regard chemigation is no different from conventional pesticide application systems. Effective control of plant pests will always be contingent upon the care and precautions taken to insure proper soil conditions and accurate calibration and delivery of pesticides.

Most chemigation studies which have evaluated non-fumigant nematicides on mulched beds of the primary crop have not always been consistant, either for controlling intended pests or for obtaining consistant economic returns to the grower. For example, some nonfumigant nematicides applied at low concentrations through a drip irrigation system have failed to control nematodes and even allowed nematode populations to resurge to higher levels following a reduction in pesticide concentration after continued or subsequent irrigations. Injection of nematicides into the drip tube has not always significantly reduced nematode populations or improved tomato yields when compared with conventional surface applications of nonfumigant nematicides. Neither has chemigation proved to be generally superior to preplant mulched fumigation with methyl bromide and chloropicirin.

Even with preplant mulched fumigation, control of all soilborne pests and pathogens is seldom complete and pest problems frequently develop in the second crop. With all facts considered, chemigations most useful role thus appears to be in multiple cropping systems in which a second chemigated crop is grown immediately following a fumigated primary crop. Because the mulch and irrigation lines are already in place, pesticides can be targeted to areas of maximum root growth, areas where soil dwelling insects and nematodes have developed and subsequently where plant damage occurs. Applications can also be made to areas where roots absorb systemic materials for control of above ground plant pests.

HOVEMENT OF WATER AND PESTICIDES

Chemigated pesticides are delivered to the plants rooting zone within a limited wetted area near the drip emmitters. For a single emmitter a small, circular wetted area may only be visible at the soil surface in many of the coarse sands characteristic of tomato production in Florida. With depth the cross-sectional area of the wetted zone generally increases, typically forming the general shape and appearance of an 'onion bulb'. The vertical and horizontal movement of water

in the plant bed following irrigation is dependent on many factors, the most important of which is soil type (hydraulic conductivity & water holding capacity), initial soil moisture conditions, soil compaction, presence of shallow subsurface impermiable layers and water table, and rate and volume of water delivery.

For water introduced at uniform points on the soil surface a wetted strip usually developes parallel to the drip line. For mulched tomatoes with drip emitter spacings of 12 inches and bed widths of 36 inches, the entire plant bed maybe wetted during an irrigation cycle. However, in dry seasons with little or no rainfall and declining water tables, limited movement of water into the shoulder of the tomato bed has been observed even when two drip lines per bed have been used to supply irrigation water. On Rockdale soils, with similar bed design and drip emmitter spacings, the wetted zone may be a semicircle no greater than 9 inches in radius for individual emitters. The shape of the wetted zone tends to be hemispherical, with a dry zone perpendicular to the drip tube and at depth, midway between emitters.

On sandy soils, the efficacy of drip chemigation is limited by the width and depth of the wetting pattern and the distribution of pesticide within the wetted zone. Factors which affect water infiltration and radial movement will also affect the location of the chemical in the soil. For example, overlapping patterns of coverage for adjacent emitters do not concentrate pesticides when water fronts meet midway between emitters. As water fronts collide, water and the chemicals contained in them, move outward and downward, forming irregularly shaped wetted bands, rather than individual circles. Many other factors also affect pesticide transport through soil including chemical solubility, organic matter adsorption, and microbial degradation.

Pesticides applied with irrigation water are carried by water into the soil but are generally not moved throughout the entire wetted zone but only a proportion of the distance moved by the water itself. In a movement study with Nemacur and Vydate, Vydate was shown to move almost twice the distance Nemacur moves. Although similar levels of control were achieved in treated areas, Vydate significantly increased the total treated soil volume within the rooting zone of the plant. In other studies, limited horizontal movement of irrigation water in a Myakka fine sand has prevented the efficient utilization of fertilizers banded further than 4 inches from the drip tube. This would at the same time similarly influence soil pest control within the bed for banded, surface applied pesticides.

STATUS AND GENERAL REVIEW

Both federal (EPA) and state agricultural agencies (DACS) currently permit application of nematicides and insecticides through irrigation systems (including drip) provided: 1) necessary backflow, antisiphon irrigation equipment is installed, 2) the treated crop is contained on the pesticide label, and 3) the label does not prohibit irrigation injection. This is somewhat surprising since the labels for most pesticides contain little or no information with respect to basic procedures for injection and application. Some chemical companies have adopted a more conservative philosophy and do not currently recommend, or only reluctantly so, the low volume irrigation delivery of their products. The effectiveness of treatment, phytotoxic effects, as well as the movement, dissipation and degradation of the chemical within soil has not been adequately studied to encourage chemigation treatment at this time. Other

factors also may make certain chemicals unsuitable such as water insolubility, precipitate formation, potential damage to components of the drip irrigation system and potential for groundwater contamination.

Most insecticides registered for use on tomato in Florida are labelled for foliar or fruit feeding insect pests and are not systemic in activity, or only weakly so. Soil application via drip irrigation does not represent proper use of these chemicals when applied for control of foliar feeding insect pests. Other materials, such as Vydate on chrysanthemum, have reduced leafminer and leafhopper damage when injected into the irrigation lines but increased the number of mites and aphids compared to nontreated controls. In the same test, populations of stubby root, sting and root-knot nematode were also significantly reduced while in other tests Vydate had no effect. Other preplant soil insecticides, which have yet to be adequately tested in a drip system, may prove to be effective for control of mole crickets, wireworms and white grubs which develop after fumigation of the primary crop.

Nematicides currently available for use on tomato in Florida are few in number. Metham sodium (Vapam) has been studied the most intensively and is the only nematicide with specific label instructions for injection via sprinkler irrigation system. It is used extensively in potato producing areas of the northwest with center pivot irrigation systems for control of root knot nematode. In California, Vapam injected through center pivot and drip irrigation systems reduced soil populations of Rhizoctonia, Pythium and Fusarium, although control decreased at depths greater than 3-5 inches. For tomato fields infested with wilt fungi, this may represent a serious shortcoming since wilt symptoms may only be delayed until roots develop into deeper soil layers.

In Florida, Vapam has been applied through bi-wall drip tubing buried to a depth of 2 inches as a broad spectrum preplant soil treatment. Root galling severity caused by the root-knot nematode decreased and Flora-Dade tomato yields increased by 45% following treatment. In other studies with Vapam, weed control over the full width of the bed was excellent but was ineffective for control of Verticillium wilt. In yet other studies, Vapam increased marketable yield of Walter tomato by 23% when the bi-wall tube was buried 2 inches beneath the bed surface; but only 5% when the tube was placed on the bed surface beneath the mulch. Root-knot nematode control increased as the tube placement in the soil increased from the soil surface to a depth of 4 inches and as the broadcast application rate increased from 50 to 100 gallons per acre.

Drip irrigation systems have also been successfully used to deliver soil fumigants nematicides such as Methyl Bromide and Chloropicrin into mulched beds through bi-wall tubing prior to planting using a hot gas method. Excellent weed and root-knot nematode control have been obtained and tomato and okra yields significantly increased. Application of fumigant nematicides through micropore tape has been ineffective for controlling nematodes or improving yields due to a rapid loss and poor linear distribution of the fumigant along the tape.

CALIBRATION AND INJECTION

For proper calibration growers must have field specific information regarding the size and shape of the wetted area, particularly as they relate to the quantity and duration of a single application of irrigation water. The amount of chemical injected into the drip irrigation system would then be calculated according to the surface area of each acre actually wetted by emitters.

Calculation of pesticide rates are frequently based entirely on bed width and assumptions of uniform movement and distribution of the pesticide throughout the wetted zone which, in fact, seldom occurs. When pesticide rates are calibrated based solely on bed width and not wetted zone, then pesticides may be applied at phytotoxic levels in the volume of the tomato bed in which the pesticide is distributed. This occurred when Nemacur was being used experimentally as a postplant nematicide. Poor root growth occurred in areas where nematodes were controlled due to phytotoxic effects of Nemacur as well as in areas where nematodes were nematodes were not exposed to the chemical.

When the entire bed is wetted during an irrigation cycle, the amount of chemical injected per acre is a simple proportion (bed width/row spacing) of the maximum broadcast rate of application. When the entire bed is not wetted, then the calculation becomes more complex since the maximum cross sectional area of the wetted zone or the average width of the wetted band must be determined. The average width of the wetted band is then related to row width to determine what proportion of the broadcast rate to apply.

Once the overall pesticide rate has been calculated (based on surface wetted acre), the next step is determining when and for what duration the chemical will be injected into the irrigation cycle. Chemicals injected too early in the irrigation cycle may be effectively pushed out of the rooting zone with continued application of water. If injected over a short period, the chemical may form only a narrow semicircular band of effective control around each emmitter. The injection time must also reflect the time required to flush the chemical from the irrigation lines. Ideally, the chemication operation will disperse and maintain the chemical throughout the entire rooting zone of the plant, at toxic concentrations, for sufficient time to be effective.

Different injection periods have been evaluated to determine whether better results would be obtained by applying chemicals in higher concentrations in a single application at the beginning of the crop or by spreading the application of lower concentrations over a longer time period. Vydate applied over a 25 day period was found to be more effective than over a five day period in improving tomato yield. Experimental use of Furadan and Mocap have performed better when the dose was spread over the growing season than when the same total amount of chemical was applied in the soil prior to planting. It is unlikely that the introduction of nematicides into the root zone for the entire crop season will prove to be neccessary to achieve maximum yield increase. Preplant nematode control practices have repeatedly been shown to be more effective than postplant aaplications for nematode control and increasing yield, since nematodes that become established within root tissues, may be shielded from the pesticide in the soil and survive the treatment.

A waiting period for subsequent irrigations is another important factor which is frequently overlooked and strongly influences pest control. In one Florida study a mandatory 5 day waiting period was essential for adequate nematode control. An irrigation delay is required because the effects of many nematicides are cumulative such that nematode mortality increases as exposure time increases. And more importantly, the effects can be reversible once the pesticide has been flushed from the environment which surrounds the nematode. In this case the objective may be to maintain lower concentrations over an extended time through repeated applications. However, in Florida soils with low organic matter and water holding capacity, water availability to the plant may be compromised to retain chemicals within the plant rooting zone. An irrigation delay may be

particularly severe for plants when weather conditions are hot and dry and plant water demand is high.

FUTURE

The use of a drip irrigation system for the delivery of pesticides appears to be a promising approach for precision application of pesticides to the root zone of plants and for controlling insects and nematodes prior to planting and for postplant applications to infested crops to salvage yield. For Florida tomato producers the future of chemigation appears to lie in its use for multiple cropping systems, enhancing yields of the 2nd crop, and in conjunction with soil fumigation and film mulch with the primary crop.

Another distinct advantage of chemigation includes potential reduction in pesticide use and costs. Pesticides applied under a plastic mulch via drip irrigation may not be subjected to the same degree to leaching rains, runoff, wind dispersal and pesticide volitalization, or for black plastic, photodegradation. If managed properly, the effective concentration of chemicals in the soil may therefore be maintained for a longer period of time than for other conventional application methods. Some preliminary evidence also suggests that the rates of pesticide application may be reduced to levels considerably less than current delivery practices without sacrificing pest control.

The level of pest control that is achieved is related primarily to pesticide concentration, outward radial movement which determines total treated soil volume, and residence time of the chemical in the soil. Very little information is available at present regarding optimal strategies for injection of pesticides to maximize pest control and yield. Considerably more information is needed regarding pesticide movement and longevity in the soil in order to determine optimal irrigation frequency and number of pesticide applications. An effective pesticide dosage concept, which relates pesticide concentration and exposure time to levels of pest control, needs to be developed. The effective dosage concept is needed to provide guidelines for determining optimal pesticide rate and pesticide injection schedules.

The risks associated with chemigation, such as the downward transport of pesticides to groundwater, should also be of primary concern. Once in the soil, pesticides may be transported by water through the various soil strata down to groundwater. Highly permeable sandy soils with low organic matter, and shallow groundwater are typical of Florida tomato production and those usually associated with high risk of groundwater contamination. Presently there is no evidence to suggest that all pesticides will move completely and uniformly (both vertically and horizontally) with the water front in the wetted zone of the plant bed. There is evidence, however, to suggest downward movement in the water front and out of the plant rooting zone with excessive irrigation. In this regard widespread adoption of chemigation should proceed cautiously but progressively, and adopted when effective soil insect and nematode control can be achieved, when consistant economic returns to the grower can be demonstrated and environmental and human health concerns resolved.

NEMATICIDES REGISTERED FOR USE ON FLORIDA TOMATO

Row Application (6' row spacing - 36" bed)5

PRODUCT	BROADCAST (Rate)	RECOMMENDED CHISEL SPACING	CHISELS Per Row	rate/acre	RATE/1000 Ft/Chisel
FUMIGANT NEMA	TICIDES				
Methyl Browid	•				
98-2	240-400 lb	12"	2	129-200 1bs	8.2-13.7 1b
80-20	225-350 1b	12"	2 2 2 2 2 2 2	112-175 lbs	7.7-12.0 lb
75-25	240-375 1b	12"	2	120-187 lbs	8.2-12.9 lb
7~30	300-350 1b	12"	2	150-175 lb≡	10.3-12.0 15
67-33	225-375 lb	12"	2	112-187 lbs	7.7-12.9 1b
57-43	350-375 lb	12"	2	175-187 lbs	10.3-12.9 15
50-50	340-400 1b	12"	. 2	175-25G lbs	10.3-17.2 16
Chloropicrin	1 300-500 1ь	12"	2	150-250 1bs	10.3-17.2 lb
Telone II 2	12-15 gal	12"	2	6-7.5 gal	39.7-66.1 fl oz
Vapan	50-100 gal	5"	3	25-50 gal	1.1-2.2 gal
Vorlex 201 3	30-50 gal	8"	2	6.7-11.1 gal	58.8-97.9 fl oz
NON-FUNIGANT	NEMATICIDES				
Dasanit 4	66.7-134 1b			11.1-22.3 1b	1.5-3 lb

Vydate L - treat soil before or at planting with any other appropriate nematicide or a Vydata transplant water dranch followed by Vydata foliar sprays at 7-14 day intervals through the season; do not apply within 7 days of harvest; refer to directions in appropriate "state labels", which must be in the hand of the user when applying pesticides under state registrations.

Rates are believed to be correct for products listed when applied to mineral soils. Higher rates may be required for muck (organic) soils. Growers have the final responsibility to guarantee that each product is used in a manner consistent with the label. The information was compiled by the author as of August 1, 1987 as a reference for the commercial Florida tomato grower. The mentioning of a chemical or propietary product in this publication does not constitute a written recommendation or an andorsement for its use by the University of Florida, Institute of Food and Agricultural Sciences, and does not imply its approval to the exclusion of other products that may be suitable. Products mentioned in this publication are subject to changing Environmental Protection Agency (EPA) rules, regulations, and restrictions. Additional products may become available or approved for use.

Prepared by: J. W. Noling, Extension Namatology, CREC, Lake Alfred, FL

^{1.} If treated area is tarped, dosage may be reduced by 33%.

^{2.} The manufacturer of Telone II and Telone C-17 has suspended their sale and distribution in all of Florida south of and including Dixie, Gilchrist, Marion, Volusia, and Flager Counties.

^{3.} Vorlex used at higher rate for weeds, fungi, nematodes and soil insects.

^{4.} Early season suppression of nematodes - apply uniformly in 12" band over row before planting, incorporating immediately to 4-6' depth.

^{5.} Rate/acre estimated for row treatments to help determine the approximate amounts of chemical needed per acre of field. If rows are closer, more chemical will be needed per acre; if wider, less.

EFFECT OF IRRIGATION METHOD ON THE EPIDEMIC DEVELOPMENT OF BACTERIAL SPOT OF TOMATO

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Bacterial spot of tomato caused by <u>Xanthomonas campestris</u> pv. <u>vesicatoria</u> is one of the most serious diseases of fresh market tomatoes in Florida. Control costs and losses associated with reduced yields and quality of fruit contribute to the economic importance of this disease (4). The rate of bacterial spot development is dependent on the availability of a dispersal mechanism to move the pathogen from plant-to-plant. Bacterial pathogens have been shown to be dispersed by splashing water or wind-driven rain.

Overhead irrigation is a commonly used practice in some areas of tomato production in Florida. Water is delivered from large volume, centrally located water guns which distribute water onto the crop in a circular pattern. Although there are some advantages to using overhead irrigation systems, they may be an important dispersal mechanism for the bacterial spot pathogen and may provide a disease-favorable environment for the development of disease epidemics. In contrast to overhead systems, drip irrigation does not suggest an obvious bacterial dispersal mechanism. Thus, rate of disease development may be reduced with subsequent increase in yield and/or lower costs for chemical control measures.

The analysis of the spatial pattern of disease distribution in a population of plants may indicate whether or not overhead irrigation and/or natural rainfall may be dispersal mechanisms. If the distribution of diseased plants is clustered, then plant-to-plant spread of the disease is likely and would suggest that splashing water may be an important vector for the bacterium. If on the other hand diseased plants are randomly distributed within the plant population, plant-to-plant spread of the disease had not occurred.

The objectives of this study were to compare the rate of disease development during tomato bacterial spot epidemics under different irrigation methods and to determine if diseased plants occur randomly or nonrandomly within the plant population.

MATERIALS AND METHODS

Rate of disease development. Tomato plots were prepared using conventional cultural practices for Rockdale soil in Dade Co. (2). Seven beds, each 1.8 m wide and 15 m long, were prepared for each plot. Each bed was amended with 2270 kg/ha of 8-16-16 fertilizer, covered with black plastic mulch, and fumigated with methyl bromide. Cultivar 'Duke' was direct seeded using a plug mix medium at a 0.3 m plant spacing. Three weeks after planting each hill was thinned to one plant.

Irrigation treatments included overhead gun, overhead sprinkler and drip irrigation systems. Treatments were arranged in a completely randomized design with four replications and were initiated at planting. Treatments overhead gun and overhead sprinkler, were applied twice weekly with the total volume of water roughly equivalent to 2.54 cm/week. The drip treatment was applied approximately every other day for 2-4 hrs/day. During periods of rainfall exceeding 2.54 cm/week, irrigation treatments were not applied.

Percent leaf area diseased was assessed weekly for nine weeks beginning five weeks after planting. Disease progress curves were linearized and rates of disease development were compared among irrigation systems. Yield of large, medium, and small fruit were compared among irrigation systems.

Analysis of distribution patterns. The randomness of occurrence of plants infected with bacterial spot within each plot was determined. The position, as well as the presence or absence of disease symptoms for each plant was recorded five weeks after planting. Disease incidence data were analyzed for each bed by using ordinary runs analysis (3). A run was defined as a succession of infected or uninfected plants. For example, if diseased plants in a row of plants are identified by a "l" and healthy plants within that same row are identified by a "0", a sequence of nine plants may look like 0,0,1,0,1,1,0,1. In this row of plants there are six runs (00,1,0,11,0,1). Runs analysis compares the actual number of runs with an expected number of runs that would occur if the disease were distributed randomly.

In addition to runs analysis, the variance and mean of disease incidence data for each plot were compared. If disease occurred randomly, then the variance would equal the mean, and disease occurrence would follow a Poisson distribution (1). In a clumped distribution of diseased plants, the variance would be greater than the mean and disease occurrence would follow a negative binomial distribution. The K value of the negative binomial

distribution gives a measure of aggregation and was calculated for each plot.

RESULTS AND DISCUSSION

Rate of disease development. Disease progress increased exponentially for each irrigation system during the season (Fig. 1). Amount of disease at harvest differed among irrigation systems with overhead sprinkler having the most disease followed by overhead gun. Drip irrigation had the least disease of all the treatments at the end of the season. The lack of differences between the overhead and drip treatments during the first four rating weeks may be due to the unusually frequent occurrences of rainfall which masked the treatments. If rainfall had not occurred as frequently as it did, greater differences in irrigation systems may have been observed.

To compare the rate of disease development among treatments, data were linearized using the loge transformation. Linear regression was used to calculate the apparent infection rate for each irrigation system (Fig. 2). Coefficient of determination (r²) was above 0.95 for each regression. Comparisons of the rate parameters using t-tests (Table 1) indicated that the rate of disease development was significantly slower under drip irrigation even though initial inoculum was higher in the drip plots. If an assumption is made that rate of development is independent of initial disease, then a regression line can be ploted with common initial inoculum for each irrigation treatment (Fig. 3).

Yield comparisons (Table 2) indicated that number of medium sized fruit and total number of fruit were significantly greater (P < 0.05) under drip irrigation. The number of large fruit was greater in the drip treatment and was statistically different at P < 0.07.

Analysis of distribution patterns. Tests for randomness indicated plant-to-plant spread of the disease and was dependent on the disease incidence at the time of observation. Runs analyses interpreted disease patterns to be nonrandom in approximately 61% of the tomato beds with at least 1 diseased plant (Table 3). In all plots, variance was greater than the mean (Table 4). Disease distribution was therefore clumped and may be described by the negative binomial distribution. K values of the negative binomial approached zero and suggested a highly clumped disease distribution. The plant-to-plant spread of the disease may have occurred due to splashing water or to the hand thinning of the plants.

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TABLE 1. Comparison of regression parameter estimates for the increase of bacterial spot on tomato under different irrigation methods

_	_	er comparisons
Comparison	Slope(b ₁)	Intercept(b ₀)
Drip vs Sprinkler	2.07 ^{*a} 3.21**	b
Drip vs Overhead Sprinkler vs Overhead		5.68***

a Critical t $_{05,68}$ value = 1.99; ns = not significant; * = $P \le .05$, ** = $P \le .01$, and *** = $P \le .001$.

b No comparison was made because slopes were significantly different.

TABLE 2. Effect of irrigation method on yield of large, medium, and small tomato fruit

Yield (kg/ha) ______ Large^a Small Total Medium Treatment ---------9488 a^b 8342 a 789 a 18619 a 6675 a Sprinkler 4906 b 597 a 12179 b 6280 b 951 a 14504 b Overhead 7271 a

a Fruit diameter size: large > 6.5 cm,
 medium = 5.5 - 6.5 cm, and small < 5.5 cm.
b Means not followed by a common letter differ significantly (P ≤ 0.05) as determined by Duncan's Multiple Range Test.</pre>

TABLE 3. Runs analyses to test for randomness of occurrence of plants within rows exhibiting symptoms of tomato bacterial spot

Treatment	No. of rows with observed runs < expected	No. of rows with observed runs not < expected	Average Disease Incid. (%)
Drip Sprinkler Overhead	19 13 14	9 9 11	23.5 16.3 11.5

TABLE 4. Calculation of variances, means and K values to determine patterns of disease spread within tomato plots infected with bacterial spot^a

Plot	Mean	Variance	K
		*	
1	1.82	2.56	4.48
2	2.34	6.35	1.37
3	1.88	3.99	1.68
4	3.40	7.13	3.09
5	2.06	2.82	5.58
6 ,	3.11	7.52	2.19
7	0.34	0.76	0.28
8	0.37	1.01	0.22
9	1.77	2.53	4.12
10	0.97	1.50	1.78
11	0.46	1.26	0.26
12	1.03	2.50	0.72

A K values of negative binomial distribution represent a measure of aggregation and is calculated as mean² / variance - mean. As K --> 0, clumping increases.

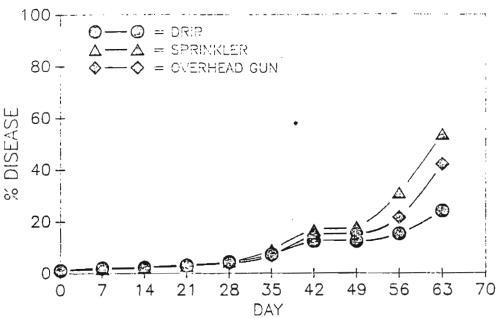


Fig. 1 Disease progress curves of tomato bacterial spot under three irrigation systems.

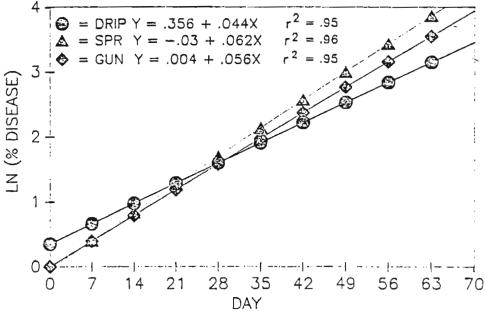


Fig. 2 Linear regressions of tomato bacterial spot over time under three irrigation systems.

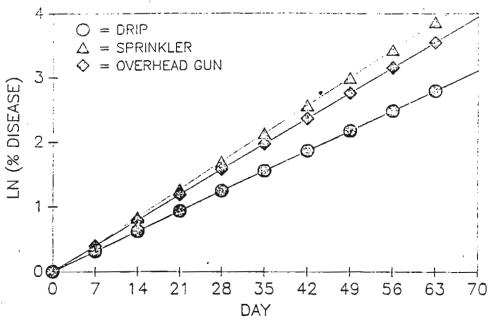


Fig. 3. Linear regressions of tomato bacterial spot over time adjusted to common intercepts for three irrigation systems.

TARGET SPOT, EARLY BLIGHT, AND BACTERIAL SPOT: IDENTIFICATION AND CONTROL

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Target spot, caused by the fungus Corynespora cassiicola, was first reported on tomato in Florida in 1972 (Blazquez, C. H. 1972. Target spot of tomato. Plant Dis. Reptr. 56:243-245). The disease thereafter occurred sporadically and remained unimportant in the Manatee-Ruskin area until the fall of 1987 when it resulted in severe foliage and fruit loss. It appears that target spot on the West Coast of Florida will be a serious fall crop disease developing concomitantly with bacterial spot, caused by Xanthomonas campestris pv vesicatoria. Because bacterial spot and target spot require different control strategies, it is important to distinguish between them to ensure maximum disease protection. This is very difficult because the symptoms of target spot and bacterial spot, as well as those of early blight (Alternaria solani), are similar. Diagnostic characteristics and control chemicals are given in Table 1 to help in the identification and control of these three diseases. Nonetheless, field identification remains difficult and chancy at best. It is recommended, therefore, that a positive ID be made in a disease clinic or laboratory.

Table 1. Symptoms and chemical control of target spot, early blight, and bacterial spot of tomato in Florida.

	TARGET SPOT		EARLY BLIGHT		BACTERIAL SPOT
÷	Even distribution of spots on leaf blade.	1.	1. Even distribution.	1:	Uneven distribution. Clustering of spots, especially near tip of blade.
2.	Numerous leaf spots involving the entire leaf blade.	2.	Widely scattered.	2.	Numerous leaf spots.
	Entire plant affected from bottom to top at the same time.	÷	Disease occurs first on the bottom of the plant and progresses upward.	e e	Entire plant may be affected from bottom to top at the same time.
4.	Older leaf spots may develop faint concentric rings.	4	Leaf spots develop pronounced dark concentric rings, espectally on the older leaves.	4	No concentric rings.
5.	Bright yellow haloes around leaf spots, especially around the young lesions near the stem tip.	5.	5. Dull yellow haloes.	5.	Dull yellow haloes to none around ma- ture lesions, none around young spots.
•	Medium brown colored leaf spots, 8 mm in size when mature. May coalesce and involve entire leaf.	•	Dark brown, large spots 16 mm when mature.		Small dark, water- soaked spots, 3-5 mm in size.

8. Elongate narrow streaks on stem, no concentric rings. May coalesce.

Elongate to round stem lesions

8

with concentric rings.

- 9. Numerous small lesions causing blight of flowers, peduncles, and pedicels.
- Large concentric lesions involving calyx, fruit, and peduncle.
- Large brown lesions with concentric rings at stem end often involving calyx.

11. Control: (Maneb +
 zinc) + copper, man cozeb + copper.

10. Fruit lesions variable 10. Lar depending on fruit matur— rin ity:
 a. specks, similar to spray damage.
 b. crescent—shaped craters.

c. large lesions, with lens-shaped cracks.

Control: Chlorothalonil, 11. Control: same as target spot.
 maneb + zinc, mancozeb.

- . Underside dark brown and greasy.
- 8. Small specks on stem, may coalesce.
- Small lestons on flowers, peduncles, may coalesce.
- 10. Brown, raised, rough, scabby lesions, may have whitish to yellow haloes.

CONTROL OF NIGHTSHADE AND OTHER WEEDS IN TOMATO ROW MIDDLES

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Although the use of polyethylene film mulch and soil fumigants have done much to increase tomato production and eliminate most weeds from the bed, control of weeds in the row middles is still a significant problem for growers. Advances in chemical weed control over the past years have done much to solve many of the early weed problems; however, nature has responded to these changes and provided us with several weeds which, having increased their populations over the years, have become serious pests. This increase in population is due, in part, to decreased competition from other more easily controlled weeds. Thus, weeds, such as nightshade in west central and south Florida, parthenium on the east coast, and morningglory in the Quincy area, have begun to adversely affect tomato production in the state.

Currently, growers rely predominately on Lexone (Sencor), paraquat, and Devrinol for weed control in tomato middles, with the bulk of the acreage treated with paraquat, a lesser amount treated with Lexone (Sencor), and a very small percentage of the acreage receiving Devrinol. Paraquat is favored because of the flexibility it offers the grower with regard to timing of application, the broad spectrum of weeds controlled, and the lack of any soil residue to affect rotational crops or even the tomato crop. rapidity of results is also important; with paraquat, what you see is what you get, so to speak. However, paraquat has its It does not control everything, for example disadvantages. nightshade, parthenium, and smartweed, nor is it the safest pesticide with which to work. Applications prior to transplanting can result in damage to transplants, if those plants come into contact with paraquat residue on polyethylene mulch. Significant damage can occur from exposure to residual paraquat as much as 5 days after time of application with the time period varying with season of the year. Relying on paraquat can be an expensive approach to weed control because it may require three or more applications during the season which may occur at a time when labor is needed for other operations.

Lexone or Sencor (same active ingredient, different manufacturers) provides good season-long control of most broadleaf weeds, except nightshade. Grass control is usually good for the first half of the season, then an application of paraquat frequently becomes necessary to eradicate grasses which emerge prior to first harvest. The greatest drawback to Lexone (Sencor) is the injury some growers experience early in the season,

particularly in the fall when the soil is frequently saturated with water from rainfall. This injury is almost always the greatest in the wet spots in a field and can occur to plants which have just been set or to those which have become established, although most frequently associated with young transplants. Combine this with the occassional injury observed on cucurbits and other rotational or double-cropping crops, and it is easy to understand why many growers will not use Lexone (Sencor). This early season injury can be minimized greatly by waiting until plants are established and by not applying herbicide when prolonged, rainy weather is expected. However, as mentioned, nightshade is often not controlled with Lexone (Sencor).

Devrinol can provide good control of grass and broadleaf weeds, excluding nightshade, parthenium, and morningglory; however, it frequently does not. The failure of Devrinol is tied to its photosensitivity. That is, sunlight rapidly degrades this compound unless it is moved or mixed into the soil soon after application. Since overhead irrigation is generally not available in west central and southwest Florida, growers must rely on rainfall to incorporate or "activate" this herbicide when applied to the soil surface. This rainfall is required on the day of application in order to assure good weed control. Unfortunately, even in August no one can guarantee that it will rain on any given day. Without that rainfall, herbicidal activity is rapidly lost with Devrinol. Even when everything goes just right, weed control may vary.

Purple nutsedge is almost everyone's problem sooner or later. Other than high rates of methyl bromide, there is little a grower can do safely to control nutsedge. Results obtained by growers with Roundup have varied from excellent to crop loss. Thus, herbicidal control of nutsedge in row middles is not considered feasible during the cropping season at this time.

Among the many weed species which are pests in tomato production, nightshade has rapidly become a major problem in production fields in southwest and west central Florida. This rapid spread is believed to be due to current herbicide practices, most notable of which is the use of herbicides, such as Devrinol, which do not control this weed. Growers have reported lack of nightshade control with Paraquat, Sencor/Lexone, and other Tabeled herbicides. Sencor and Paraquat have provided poor to fair control in research when applied to nightshade seedlings in the 2 to 4 leaf stage of development. Application of Paraquat to larger plants will not adequately control nightshade. For several years growers in the Immokalee - Naples area have reported what they believed to be the development of resistance to paraquat by nightshade. Originally some believed this resistance to be the result of nightshade plants being hardened off by cold or other stresses; however, recent preliminary research by Stall and Kostewicz of the Vegetable Crops Department at the University of FLorida indicates that copper sprays for bacterial control may be a major factor in this reduction in control. It appears that copper has an inhibitory effect on paraquat efficacy. In greenhouse experiments, when paraquat was applied without copper to nightshade plants with no residual copper on the leaves, all of the leaves were dessicated and fell off, the plant stem died back, and regrowth was minimal.

When copper was applied to the foliage, the amount of damage obtained decreased to the point where leaf dessication was minimal. When plants were subjected to three foliar applications of copper prior to paraquat application, most of the leaves were dessicated and fell off of the plant, but stem regrowth was rapid. When treated with six pre-sprays, paraquat dessicated fewer leaves. It appears that growth stage or age of nightshade makes little difference in initial kill, but older plants do resprout much quicker. In addition to studying the effect of copper residue on the leaves on paraquat efficacy, they have also determined that when paraquat and copper are tank-mixed no nightshade control is obtained.

Problems also exist with preemergence control of nightshade. Due to the close genetic relationship between tomato and nightshade, any herbicide which will control nightshade will usually injure tomato. Tomato production with polyethylene mulch may allow one to apply herbicides which would normally be injurious to tomato, provided the spray material is directed at the row middles and does not contact tomato plant foliage or roots. Generally, in mulched, seepage irrigated tomato production, plant roots are confined to the bed for much of the season. This allows us to consider use of otherwise injurious herbicides in row middles. Research conducted at the Gulf Coast Research and Education Center-Bradenton and the Southwest Florida Reseach and Education Center-Immokalee has emphasized selection of herbicides which have low water solubility and thus less potential for movement into the bed.

Over the past 6 years a number of herbicides, both alone and in combination, have been evaluated for use in mulched tomato production. Results of some of this work were reported at the Tomato Institute in 1985. Since then many additional tests have been conducted to evaluate various products, improve use knowledge for several, and to provide necessary data in support of registration of several new herbicides. Among the herbicides evaluated over this time period, the most promising are Fusilade and Poast for postemergence grass control, Cinch for preemergence grass control and partial control of some broadleaf weeds, and Goal for pre- and early postemergence control of grass and broadleaf weeds, most notably nightshade.

Overall, Lexone (Sencor) consistently has provided very effective broadleaf weed control, with the exception of nightshade. In experimental plantings, tank mixing Lexone (Sencor) with paraquat has improved nightshade control; however, the level of control is only fair at best. Deficiences in grass control can be overcome with timely applications of Fusilade, Poast, or paraquat; however, Fusilade or Poast provide maximum crop safety in the event of spray drift and good postemergence grass control if applied before grass gets too large.

Amiben, which is labelled for nightshade control in tomatoes, has performed poorly in experiments and is not considered an acceptable herbicide for this purpose. On the other hand, Goal has consistently provided excellent control of nightshade in tests on experiment stations and growers' farms. Goal may be applied preor early postemergence for effective nightshade control; however, applications made prior to or soon after tomato transplanting may

not provide good weed control past midseason. Thus, if a grower applies Goal early in the season, a second application may be needed. Therefore, one management approach which has been successful in research has been to delay application until weeds are 6 inches in height or taller so that the herbicide is present in sufficient quantity by the end of the season. However, in cases where nightshade is larger than the 4 leaf stage, frequently Goal will completely defoliate the plants, but sometimes there remains a green stem which may renew growth later in the season. The short residual life of Goal in our soils is advantageous from the standpoint that it may mean less potential problems from herbicide residue for rotational or double-cropped crops, a problem common with Lexone (Sencor).

Another problem with Goal is that grass control frequently is only fair. For this reason, Goal alone will not provide the weed control needed and must be augmented with either another preemergence herbicide, such as Lexone (Sencor) or Devrinol, or postemergence applications of paraquat or one of the postemergence grass controlling herbicides. While evaluating various other herbicides in two component tank mixes with Goal, Lexone (Sencor), or Devrinol, it was observed that certain combinations altered the efficacy of the two components. Most interesting were combinations of Goal and the postemergence grass controlling herbicides, Fusilade, Poast, Whip, and Acclaim. In these experiments a tank mix of Goal + Fusilade (later Fusilade 2000) consistently provided rapid, excellent postemergence control of nightshade and other weeds: whereas, tank mixing Goal with the other postemergence herbicides did not have a similar effect. Certain combinations of Goal and other postemergence grass controlling herbicides actually decreased efficacy in some tests. The weed control provided with the tank mix of Goal and Fusilade was better and the tank mix displayed more rapid contact kill or "burn down" of emerged weeds than that obtained with individual applications of these herbicides on an equal rate basis. Additionally, larger weeds were controlled with the tank mix. Where Goal alone would leave a green stem of nightshade when plants were one foot tall, a tank mix of Goal and Fusilade would completely kill the stem and often only bare ground Safe application of spray preparations containing Goal requires use of a shielded sprayer or directed spray to prevent contact with tomato plant foliage which could result in considerable crop injury.

Cinch has been tested in tomatoes and other crops and has shown considerable promise for preemergence control of annual grasses, such as crabgrass and goosegrass. Generally, it has been safe on tomatoes even when applied to the bed pre— and posttransplant. Early postemergence applications to grasses have also been effective for control of emerged and germinating grass; however, the application must be before grass plants are much larger than one inch or control is lost. Although developed as a grass controlling herbicide, Cinch has also controlled some broadleaf weeds; however, the broadleaf control has not been as consistent as that for grasses. Interestingly, in research involving tank mixing Cinch with Lexone or Goal, it was found that not only was preemergence grass control enhanced, but with Lexone, nightshade

control was improved greatly. This improvement was to a level comparable to Goal in some tests. Thus, tank mixes containing Cinch may be worthy of further exploration should the manufacturer continue product development.

Although a significant problem, nightshade is not the only weed problem confronting growers. A few years ago parthenium was only occasionally found in tomato row middles on the east coast. However, with improved control of other weeds and changes in weed control strategies, parthenium has rapidly become a major concern to growers in that production area. A large part of this problem resulted from a natural increase in populations and growers discontinuing use of Sencor (Lexone). Although Sencor (Lexone) is quite effective on parthenium when applied preemergence, its residues are equally effective on the main rotational crop of tomatoes in that area, beans. In order to alleviate problems in bean production encountered where beans followed tomatoes, herbicides other than Sencor were used. Once uncontrolled, the parthenium population increased dramatically. Paraquat will not control this weed; however, diquat will. Preemergence or early postemergence applications of Goal will also control parthenium. Hopefully, the short effective residual life of Goal will be of Currently, an IR-4 project is underway for the registration of diquat for use in tomato middles for control of parthenium.

Morningglory is a weed pest confronting some growers in north Florida, particularly in the Quincy area. This weed is often found right along the edge of the mulch film where herbicidal control appears to break down the earliest. When uncontrolled, morningglory can be a strong competitor with tomatoes. Devrinol will not control morningglory; whereas, Lexone (Sencor) sometimes does and sometimes does not. Pre- and early postemergence applications of Goal have proven to be effective for morningglory control. Research has been initiated at the Gulf Coast Research and Education Center to evaluate other herbicides for morningglory control in tomato middles. Selection of candidate herbicides is following the same procedure as that for nightshade control by evaluating only those which are less soluble in water and, therefore, would move the least in the soil water.

Tank mixes of Lexone + Cinch, Goal + Cinch and Goal + Fusilade show considerable promise for use in mulched tomatoes. combining Cinch with Lexone or Goal, the poor preemergence grass control occassionally obtained can be overcome and full season weed control is provided. Where nightshade is a problem, Goal has consistently provided good to excellent control. More than one application of Goal may be required to provide acceptable season-long weed control; however, this may be considered an advantage as it indicates that residues of Goal have a relatively short life in our soils, which translates into less potential problems from herbicide residues for rotational or double cropped crops as is observed often with Lexone (Sencor). Fusilade or Poast provides excellent postemergence control of annual and many perennial grass weeds. It is hoped that these herbicides will be registered soon. Diquat will control parthenium as will Goal or Lexone (Sencor). Control of morningglory can be obtained with Goal; however, additional work needs to be done in north Florida to fully address the crop safety factor.

This research is continuing with emphasis on collection of data to further evaluate these herbicides and to provide supportive documentation for registration of these promising new materials for weed control in row middles of mulched tomatoes. The federal IR-4 program has played a role in securing registration of Goal and diquat for tomato middles and currently a Section 18 registration request for Goal has been submitted to the Florida Department of Agriculture and Consumer Services for consideration. It is hoped that Fusilade and Poast will also be labeled in the near future, while Cinch is in the early developmental stages and is not close to registration at this time.

Note: Mention of a specific proprietary product does not constitute an endorsement by the authors or the University of Florida. Goal, Cinch, diquat, Poast, and Fusilade 2000 are not labeled for use on tomatoes and growers are advised to not use these products until this research has been completed and the products are labeled. NEW PESTS AND POSSIBLE NEW INSECTICIDES FOR USE ON TOMATOES

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Tomato production in Florida, like any other agricultural production system, is dynamic, constantly changing and adapting to new situations and problems. Management of pests within the production system should also be dynamic, requiring adaptation to new pest situations.

Two insect pests currently threaten to require changes in pest management in Florida tomato production, the western flower thrips (Frankliniella occidentalis (Pergande)) and the sweetpotato white-fly (Bemisia tabaci (Gennadius)). Both of these pests are a threat, not only because of their direct attack on plants and their resistance to insecticides, but also because of their potential to transmit virus diseases.

WESTERN FLOWER THRIPS

The western flower thrips was first described from specimens collected from California in the late 1800s and was restricted to the western half of the country. In recent years the thrips has moved to the southeastern U.S., being first recorded in Georgia in 1981 (Beshear 1983) and Florida in 1982 (Denmark, personal communication). It has since been collected from the panhandle to Miami. The western flower thrips was first collected from tomato in the Quincy area in 1985 but has not been collected on tomato in other production areas (Denmark, personal communication). Populations at Quincy are currently low (Tappan, personal communication).

Western flower thrips adults are minute, elongated (0.5 mm) insects. Their wings have a feathery fringe and their bodies are generally light yellow. Eggs are inserted into the more tender plant tissues such as stems, buds and flower parts (Bailey 1938). The immature stages, called nymphs, begin feeding immediately upon hatching from the eggs. When they are full grown, they drop to the soil where the form non-feeding, resting stages (pre-pupae and pupae. Adults emerge to complete the life cycle. At 85°F, the egg to adult developmental time is about 2 weeks (Lubinkof & Foster 1977).

The western flower thrips has a host range of at least 140 plant species including numerous weeds and cultivated hosts (Bryan & Smith 1956). Using their rasping-sucking mouthparts, they scrape the tissue

surface and suck the juices that exude. The thrips occurs primarily in the flower where they feed on nectar, pollen grains, anthers, ovaries or small fruit. While some believe that flower thrips improve pollination, populations of about 10 per flower of a thrips (F. bispinosa (Morgan)) closely related to western flower thrips have resulted in increased bloom drop on tomato (Schuster, unpublished data). On grapes, feeding on developing berries results in scarring. Oviposition on young grapes results in scars surrounded by a light halo (Yokoyama 1977). This damage is similar to what was observed on tomatoes in the Quincy area in 1985.

In addition to direct damage, the western flower thrips is an efficient vector of tomato spotted wilt virus. The virus has been documented from Jackson, Santa Rosa, Okaloosa, Jefferson, Walton, Washington and Alachua counties on crops including gladiolus, peanut, tomato, tobacco and watermelon (Simone 1987, Sprenkel 1986). The disease has been recorded from at least 200 plant species around the world and has been shown to be dessiminated by eight other thrips species besides western flower thrips (McRitchie 1986). At least two of these, the tobacco thrips (F. fusca (Hinds)) and the onion thrips (Thrips tabaci Lindeman) also occur in Florida. Although the tomato spotted wilt virus occurs in the Quincy tomato production area, it has not yet been observed in other production areas. The thrips which predominate in central and southern Florida are F. bispinosa and F. cephalica (Crawford). It is not known whether these closely related species can transmit the virus. The symptoms of the virus vary considerably depending upon the host plant. The foliage of infected tomato plants have thickened veins, downward curled leaves and ring spots. Green fruit have light green rings with raised centers and appear lumpy. Infected plants are stunted.

Resistance of the western flower thrips to insecticides applied for their control has often been suggested but has not been well documented. Recent insecticide trials on a variety of crops indicate that there are a number of insecticides registered for use on tomato that are effective for controlling the thrips. These include Thiodan® on tomato (Oetting 1986), Monitor® on cotton (Graves et al. 1987) and Vydate®, Lannate® and Cygon® on the ornamental torenia (Neal et al. 1984). On lettuce, Lannate, Guthion® and Phosdrin® were effective in reducing thrips numbers but were ineffective in reducing the incidence of tomato spotted wilt virus (Cho et al. 1986). This emphasizes the importance of integrating insecticides with other measures for managing the thrips-virus complex.

Western flower thrips-infested tomato plants in the Quincy area in 1985 were associated with wheat plantings. Adults apparently migrated to the tomatoes in large numbers as the wheat ceased flowering, indicating the importance of not planting tomatoes near or

adjacent to alternative thrips hosts. Thorough management of weeds both within and adjacent to tomato fields should be practiced. Common beggar tick (spanish needle) is a common weed in central and south Florida and is an excellent host of the thrips. Reflective mulch (black plastic painted with aluminum paint) resulted in reduced thrips numbers and tomato spotted wilt virus incidence (Greenough 1985). Reflective mulches have also been effective in delaying the appearance of aphid-borne virus diseases as well (George & Kring 1971).

SWEETPOTATO WHITEFLY

The sweetpotato whitefly has been noted in Florida since the late 1800s but has only been considered a pest in the state during the past year (Price 1987). The insect is distributed throughout the tropical world and attacks at least 500 species of plants including numerous weeds and cultivated vegetable, agronomic and ornamental crops (Greathead 1986). Vegetables most often attacked include those in the families Solanaceae (including tomato, eggplant and pepper) and Cucurbitaceae (including cucumber, melons and squash). The adults are small insects about 1 mm long with pale yellow bodies and white wings. They resemble small flies but are actually more closely related to aphids since they have piercing-sucking mouthparts. Adults prefer the younger leaves and deposit minute, cigar-shaped eggs on the lower surfaces of these leaves. The eggs are attached to the leaves by short stalks. immature stages are usually called nymphs and also have piercingsucking mouthparts. The newly hatched nymphs have well-developed legs and are the only mobile nymphs. After finding a suitable feeding site on the lower leaf surface, these "crawlers" attach to feed and usually do not move again. The subsequent three nymphal stages appear as flattened, oval scales and are not mobile. final immature stage (resting or pupal stage) is more convex and elliptical and has large, conspicuous red eyes (Lopez-Avila 1986). The developmental time from egg to adult at 80°F on tomato is about 4 weeks (Coudriet et al. 1985). Because of the delay between the time of egg deposition and the completion of development, the immature stages, particularly the pupal stage, may be found on lower, older leaves, especially on rapidly growing plants (Ohnesorge et al. 1980).

Nymphal and adult whiteflies damage plants by sucking their sap. Chlorotic spots may appear on the upper leaf surfaces and affected plants may become unthrifty. All whitefly stages beyond the egg stage also produce honeydew upon which sooty mold can grow. In addition, the sweetpotato whitefly is a known vector of about 19 virus diseases (Brunt 1986). In 1981, an estimated \$8 million in damage occurred on cantaloupe, melons and squash in

California (Duffus & Flock 1982). Estimates of yield losses of lettuce ranged from 50 to 75 percent. Sweetpotato whitefly-transmitted viruses affecting tomato include tomato yellow leaf curl in the middle east and tomato yellow mosaic and tomato golden mosaic in tropical America (Brunt 1986).

Fortunately, no viruses in Florida are known to be transmitted by whiteflies; however, the possibility exists that viruses presently attacking weeds could be disseminated to crop plants or that other whitefly-vectored viruses could be imported into Florida. The whitefly has been a serious pest in the vegetable producing desert valleys of California when populations have migrated from cotton, other crops and weeds (IPM Manual Group 1985); however, no whitefly-vectored virus has been reported on tomato there.

During the past year, the sweetpotato whitefly has been a serious pest of ornamental greenhouse and saranhouse crops, particularly poinsettia. A heavy field infestation was discovered this spring on eggplant in the Boynton Beach area. The eggplant had been double-cropped with cucumber, although the cucumber crop had senesced by the time the whitefly infestation was first reported. Later, a crop of Chinese melon on an adjacent farm was found to be heavily infested. Thus, both of these infestations on field-grown vegetables may have been associated with cucurbit crops. Active but less severe infestations of the whitefly were found on every other vegetable farm inspected in the vicinity including those growing tomato, pepper, cucumber and snap beans.

Insecticides have most often been used to manage the sweetpotato whitefly, especially on cotton. Resistance to organophosphate and synthetic pyrethroid insecticides has been reported in California (Prabhaker et al. 1985). The effectiveness of selected insecticides is being evaluated at Bradenton on poinsettia both in the laboratory using lab-reared sweetpotato whiteflies and in the greenhouse using a naturally occurring population. Results to date indicate that, of insecticides currently registered for use on tomatoes, Thiodan, Lindane®, Ambush® (either alone or combined with Butacide®) and Pyrenone® provide very good kill of whitefly adults in the laboratory. These same insecticides plus Monitor, Cygon and Asana® also indicated adult control in the greenhouse. Ambush, Asana, Pyrenone and Vydate resulted in the most consistent reductions in the numbers of nymphs surviving to adult emergence in the greenhouse. Thus, registered insecticides are available for the management of this pest on tomato. Reports from greenhouse growers indicate that the effectiveness of any given insecticide may vary from one whitefly population to another. Growers who encounter this pest on tomato should alternate insecticides of different chemical classes to reduce the potential for the development of resistance. Thiodan

and Lindane are chlorinated hydrocarbons, Pyrenone is pyrethrum, Ambush and Asana are pyrethroids, Monitor and Cygon are phosphates, and Vydate is a carbamate. Thorough coverage of foliage, particularly the lower, older leaves, is essential to control nymphs and pupae.

Biological control of the sweetpotato whitefly has been studied in many parts of the world. About 25 species of parasites and 15 species of predators have been recorded attacking the whitefly (Lopez-Avila 1986). Increases in whitefly populations have been observed following the applications of non-selective insecticides (Matthews 1986). It has been suggested that this might occur because of the reduction in numbers of small, wasp-like parasites which attack the immature stages. We have recently recovered a parasite attacking sweetpotato whitefly immatures on tomato plants in a greenhouse. At least half of the immatures were parasitized. Although the parasite has been observed on the whitefly on weeds in the immediate vicinity of the greenhouse, it is not known whether this parasite can survive or be effective outside a greenhouse. There is little information available regarding the impact of specific insecticides on parasites of the whitefly. Thus, broad-spectrum insecticides should be used as sparingly as possible to avoid causing whitefly populations to increase.

Cultural manipulations may aid in the management of the sweetpotato whitefly on tomato. Since the insect can survive on a wide
range of weed species, weeds should be thoroughly managed both in
and around fields. Tomatoes should not be planted adjacent to or
following cucurbits since these crops may result in greater numbers
of whiteflies migrating to the tomatoes. As with the wester flower
thrips, reflective mulches may reduce the numbers of invading adult
sweetpotato whiteflies that alight on tomato plants.

NEW INSECTICIDES

Pesticides remain the major tools in the management of pests on tomatoes. Over-reliance on pesticides may lead to the resurgence of pests due to the development of pest resistance to the pesticides or to the reduction of natural enemies which normally help control the pests.

A tomato pest management program has been developed for insects, as well as other pests. The program is based upon regular sampling (scouting) to determine the abundance of the various life stages of specific pests. Insecticides selected for recommendations are those that are toxic to the life stages of the insect pests and those that are least toxic to naturally occurring parasite species. The goal is to maximize insect control by integrating insecticide control with biological control.

A leafminer (Liriomyza trifolii (Burgess)) is well known to Florida tomato producers and has apparently developed resistance to pesticides registered for its control. New insecticides are being investigated for their ability to control the leafminer directly. In addition, both new and old insecticides are being evaluated for their toxicity to Diglyphus intermedius (Girault), a common and abundant parasite attacking leafminers in tomato.

Trigard® is a recently developed insecticide that is effective in controlling leafminers and is available for use on tomatoes in Florida until December 31, 1987 under a section 18 emergency exemption. This insecticide interferes with the normal growth and development of leafminer larvae resulting in their death (Schuster and Everett 1983). Since Trigard has demonstrated low toxicity to adults, larvae and pupae of D. intermedius (Schuster, unpublished data), its control of leafminers should be complemented by biological control.

Abamectin (avermectin) is a new insecticide that is registered for use on certain ornamentals (formulated as $Avid^{\otimes}$) but is not available for use on tomatoes. This insecticide is also effective in controlling leafminers. Laboratory experiments have shown that abamectin results in incomplete egg hatch, kills larvae, kills adults and inhibits feeding and oviposition of adult females (Schuster & Everett 1983, Schuster & Taylor 1987a). The effects on oviposition, egg hatch and larval mortality were found to persist in the field on tomato for at least a week (Schuster & Taylor 1987b). Abamectin is moderately toxic to all life stages of D. intermedius and has also demonstrated effectiveness against tomato pinworm larvae (Schuster, unpublished data), the western flower thrips (Oetting 1986), the sweetpotato whitefly, aphids and mites (Price 1983).

Larvin® is a new insecticide that has about the same spectrum of activity as Lannate. Larvin is less toxic to leafminer parasites than Lannate (Schuster, unpublished data) and, thus, should be less likely to result in increased leafminer populations.

Among the older, registered insecticides evaluated, Ambush and Lannate were highly toxic to all stages of *D. intermedius*, Monitor was highly toxic to adults but moderately toxic to larvae and pupae, Pydrin® and Thiodan were moderately toxic to all life stages and Dipel was not toxic to any life stage. Insecticides with the least toxicity to the leafminer parasite should be selected for use whenever possible to reduce the possibility of inducing leafminer populations to increase.

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IR-4: SECURING PESTICIDE LABELS FOR

THE TOMATO INDUSTRY

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Federal pesticide labels may be obtained by way of FIFFRA mandated 24(c), Section 18 or Section 3 procedures. The State Local Need (SLN) label can be secured through a 24(c) process as long as a pesticide tolerance or exemption is in place for the proposed use. A crisis or emergency exemption label can be obtained without a tolerance, but it is restricted to a small geographic area and is effective for one year or less. The Section 3 label is a full Federal registration but requires a great deal of support data.

Normally, the manufacturer, who expects to sell enough pesticide to return a profit, carries out the necessary research and development for a tolerance and label. But, when the pesticide use is limited as with minor or specialty crops and potential financial returns are small, manufacturers are unwilling to allocate funds for label development. Without other support, many needed pesticide uses would never be labelled.

The Interregional Research Project No. 4 (IR-4) is funded by the USDA to coordinate research, compile data and assist in the labelling of pesticides, as well as animal drugs and biological materials for minor and specialty uses. The project is administered by a coordinating staff at National Headquarters, Rutgers University, and four regional Leader Laboratories as well as a USDA Agricultural Research Service minor-use unit.

The Southern Regional IR-4 Leader Laboratory is located in the Pesticide Research Laboratory, IFAS, University of Florida, Gainesville. It administers to the minor-use pesticide needs in 13 southern states plus Puerto Rico and The Virgin Islands.

The IR-4 network facilitates work through a liaison representative designated by the Agriculture Experiment Station Director in each state. Liaison representatives solicit pesticide

clearance needs or requests (PCR's) from research scientists, extension agents, state agencies, commodity groups and growers. Each PCR is screened for pertinent label information such as formulation, directions for use, harvest interval and safety precautions. Comments from potential registrants and EPA are reviewed and protocols are prepared for researchable pesticide requests. Regional and state IR-4 officials work closely with federal, state and university research cooperators to develop required efficacy, phytotoxicity and residue data.

Data must be collected from the primary growing areas or sites where the pesticide use is intended. It has been determined that most eggplants, for example, are grown commercially in Florida and New Jersey. Data supporting a national pesticide label for use on eggplant must, therefore, be developed from those states.

Since tomatoes are grown commercially in so many states, data supporting new pesticide labels must be collected from a large number of sites. At the very minimum, performance and residue data must be generated from California and Florida plus Michigan or Ohio, Pennsylvania or New Jersey, New York or Maryland. Field trials are usually established in a randomized complete block design to collect efficacy and phytotoxicity data from non-treated, X and 2X treated plots replicated four times. Fruit harvested at specified days after last application are frozen immediately and shipped to laboratories for analysis.

During the past ten years, IR-4 has received over 90 requests for pesticide labels needed in the commercial production of tomatoes. Pesticide manufacturers and IR-4 have been successful in labelling 30% of these uses while 24% have been withdrawn from consideration due to poor efficacy, plant safety concerns or other problems. The 23 needs listed in Table 1 are being researched by the pesticide industry or IR-4 and are in various stages of label development.

The IR-4 project has provided national leadership in the registration of pesticides. Data generated from IR-4 have resulted in more than 60 tolerances, yearly, and many hundreds of new pesticide use labels.

Table 1. Status of IR-4 Requests for Pesticide Labels on Tomatoes

PESTICIDE (Manufacturer)	USE	STATUS
Ambush, Pounce (ICI, FMC)	Leafminer in green- house	NJ trial
Ammo, Cymbush (FMC, ICI)	Fruitworm .	Mfg. petition with EPA
Avid (MSD)	Russet mite	Mfg. trial; no registered uses
Blazer (BASF)	Black nightshade	Need residue data
Diquat (Chevron)	Parthenium weed	FL trial
Fusilade (ICI)	Grass weeds	Data pkg. with ICI
Fungaflor (Janssen)	Botrytis	Need data
Goal (Rohm & Haas)	Nightshade	Residues at R&H
Lexone, Sencor (Dupont, Mobay)	Weeds	Need residue method
Lorsban (Dow)	Fruitworm	Dow project
N-serve (Dow)	Nitrification	Toxicology studies in progress
Nemacur (Mobay)	Nematodes/tomato transplants	Mobay tolerance pending
Mesurol (Mobay)	Slug bait	Need data
Omite (Uniroyal)	Mites	EPA data gaps
Phosvin (Bell)	Mice bait	Need data
Plictran (Dow)	Mites	EPA data gaps
Poast (BASF)	Grass weeds	BASF petition with EPA
Prowl (Amcy)	Weeds	EPA data gaps
Rovral (Rhone Poulenc)	Gray mold, leaf blight	R.P. project
Terrazole (Uniroyal)	Plug mix application	Tolerance established
Trigard (Ciba Geigy)	Leafminer, leafroller	C.G./FL project
Vendex (Dupont)	Mites	IR-4 trials in progress
Vitavax (Uniroyal)	Southern blight	FL project

Heat Tolerant Tomato Variety Outlook

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Breeding tomato varieties which can produce high levels of marketable fruit under Florida's summer and early fall weather High temperatures and frequent conditions is a difficult task. rainfall limit fruit set and reduce fruit quality, especially of large-fruited types. The genetics of high temperature fruit set is complex and the large fruit that do set must have a high level of resistance to cracking and weather checking (black shoulder) which are induced by the frequent summer rains. Furthermore, several tomato diseases thrive under these conditions, most notably bacterial spot incited by Xanthomonas campestris pv. vesicatoria. It is difficult to incorporate all of these desirable traits into a The use of hybrids between large-fruited, heat single line. sensitive parents and (smaller fruited) heat tolerant parents is a feasible approach to speed up the development of commercially acceptable heat tolerant varieties (1). These hybrids generally have a lower fruit number than the heat tolerant parent but an Thus, hybrid yields are comparable to the increased fruit size. heat tolerant parent but the crop value is greater since large fruit bring higher prices.

For more than six years, much effort has been made in the IFAS tomato breeding program to develop heat tolerant tomato varieties. The objective of this report is to summarize the present state of heat tolerant variety development and provide some idea as to the types of varieties which may be forthcoming in the future.

Fla. 7164 is a heat tolerant, experimental hybrid that is now being tested extensively at IFAS experiment stations and commercial farms in all growing districts in the state. Last fall, Fla. 7164 was tested on a large scale on two commercial farms in North Florida. The "fall crop" in this area is field planted in July and harvested late September to early October and thus it is subject to extensive high temperature conditions. Fla. 7164 performed quite well under these conditions especially on "Farm A", the farm with the high production inputs such as plastic mulch, fumigation, and staking (Table 1).

This year seed was produced for commercial testing but the seed had low germination which ranged from about 20 to 55 percent. To determine if there was a genetic problem with the germination of the hybrid seed, an experiment was conducted during the summer of 1987 comparing 7164 seed from the commercial source to locally produced hybrid, reciprocal hybrid, and parental seed. There was low seedling emergence (33%) with the commercial seed lot of Fla. 7164 but greater than 90% emergence for locally produced (breeder) hybrid

or reciprocal hybrid 7164 seed (Table 2). The female parent had significantly less emergence than the hybrid or 'Sunny', but since the hybrids derived from this parent were normal in germination, there does not seem to be a genetic problem with the seed of the experimental variety.

Other heat tolerant hybrids are being tested at several IFAS locations. If any of them demonstrate any advantage over Fla. 7164, seed will be increased for advanced trials. Present hybrids do not have resistance to bacterial spot. This resistance is being incorporated into both heat tolerant and heat sensitive inbreds. However, it may be some time before commercially acceptable heat tolerant, bacterial spot resistant hybrids are available. In the shorter term, heat tolerant hybrids with intermediate bacterial spot resistance (tolerance) may become available.

Several experiments have demonstrated that hybrids between bacterial spot resistant and susceptible parents are intermediate in resistance between the parents. It may be easier to obtain one good bacterial spot resistant parent for a heat tolerant hybrid than two, and thus crosses of resistant parents with susceptible parents would result in bacterial spot tolerant varieties. It is also possible to develop bacterial spot tolerant inbreds which are intermediate to resistant and susceptible inbreds. Hybrids derived from a tolerant and susceptible parent would have a low level of tolerance. Hybrids derived from two tolerant parents would be tolerant. between resistant and tolerant parents should be nearly as resistant as the resistant parent. Any of these levels of resistance would be better than the current variety situation where there is susceptibililty to bacterial spot. Ultimately, resistance is the best answer, but in order to combine bacterial spot resistance with adequate horticultural type and fruit setting ability, varieties with intermediate levels of resistance are likely to come first.

Our parental source of bacterial spot resistance is also resistant to bacterial wilt caused by <u>Pseudomonas solanacearum</u>. Several breeding lines are still carrying this resistance as well as bacterial spot resistance. It appears that the bacterial wilt resistance we are working with is a dominant characteristic and this would be passed on to a hybrid from a resistant parent crossed with a bacterial wilt susceptible parent. A single dominant gene for resistance to Fusarium wilt race 3 has also been discovered (2). Heat sensitive breeding lines carrying this resistance are being developed and could be used to make heat tolerant, Fusarium wilt race 1, 2 and 3 resistant hybrids. Initial race 3 resistant hybrids would carry bacterial spot tolerance at best since race 3 and bacterial spot resistances are being incorporated into separate inbreds.

In summary, only Fla. 7164 is in advanced trial and it is not released yet. If it merits release, this will be done late this year. The Florida Seed Foundation has contracted for at least 50 pounds of seed for next year. The discussion regarding the disease resistant, heat tolerant hybrids was given to put the research into

perspective. It is not possible to predict when and if such varieties may become a reality. Florida 7164, or varieties similar to it, may overcome fruit set limitations due to hot weather and possibly cold weather. This needs investigation. However, a heavy infestation of bacterial spot may negate the fruit setting ability. If acceptable bacterial spot resistant, heat tolerant varieties are developed, it could make for an interesting marketing situation in Florida.

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Table 1. Commercial Packouts of Fla. 7164 Tomatoes on Two Farms in North Florida, Fall 1987.

				Marke	Marketable Yield	ield			
						5x6 and			
	Production	Acres	Total Yield	#1	#22	larger	6x6	6x7	7x7 (%)
raim.	rections	1100	ליין המו החוופלעיל	è	1	(8)	(8)	(2)	0
¥	plastic mulch fumigated staked	18	. 2050	80.4	80.4 12.6	63.0	27.6 9.2	9.5	0.2
Ø	no mulch nematicide staked	9	1411	94.6	94.6 5.4	55.2	42.7 2.1	2.1	1

ZFarm A had 7.0% high color, Farm B #2 category includes #3 fruit.

Table 2. Fla. 7164 Germination Test, Summer 1987. Bradenton, Fla.

Genotype	Emergence - 2 weeks (%)
Sunny	89
Fla. 7164 - commercial	31
Fla. 7164 - breeder stock	98
Recip. 7164 - breeder stock Fla. 7164 - female parent Fla. 7164 - male parent	94 52 97
IS	0 .05 12.3

HEALTHY SEED

John E. Cross Asgrow Seed Company, Kalamazoo, Michigan 49001

Healthy produce comes from healthy crops which start with healthy seed. Healthy seed is the result of the following six steps.

- 1. Planting clean seed stock. Frequently this is produced in an isolated environment and has been assayed and treated.
- 2. Carefully selected seed fields. Uncontaminated fields where recommended procedures are followed.
- Using recommended cultural practices. These include use of furrow irrigation and appropriate pesticides.
- 4. Field inspection with trained inspectors. The seed crops are carefully inspected several times during the growing and harvesting season.
- 5. Seed testing where recognized test procedures are available.
- 6. Registered seed treatments. Unfortunately there are few effective registered bactericides.

Asgrow follows the above practices in producing healthy seed, and confirms these practices with outside experts. However, in spite of these practices, we cannot guarantee that every seed is "disease free".

Growers should follow four steps in producing healthy crops:

- 1. Plant healthy seed.
- 2. Control weed hosts. Tomato pathogens can frequently survive on plant materials or Solanaceous weeds.
- 3. Avoid disease transfer from adjoining infected crops.
- 4. Use registered chemicals. This includes insecticides which can control the insects which can spread pathogens.

ARRIVAL CONDITION OF FLORIDA TOMATOES AT TERMINAL MARKETS

D. D. Gull Vegetable Crops Department, IFAS Gainesville, FL 32611

Extolling the virtues of Florida tomatoes is not a favorite subject of the press. Récently, The Readers Digest entered the foray but their tone was more conciliatory and contained more facts. A number of buyers of Florida tomatoes also harbour reservations concerning quality of our leading vegetable crop. Our growers produce only a quality product that is available to the mass of consumers in the U.S. at times when otherwise they would have to be imported or would be unavailable. Somewhere in between these extremes of quality, the true Florida tomato exists.

Consumer satisfaction with food products and marketing services have been evaluated (4). Tomatoes got the highest dissatisfaction rating of the 31 individual products in the survey. Consumers criticized price, ripeness, taste, and appearance. Consumers were also unhappy with the price of beef, pork, potatoes and milk. This particular survey was taken in March, a time when tomatoes were being provided from Florida or imported, and thus transportation costs were highest and duration of merchandising was longest. A valid question would be how Florida tomatoes compare with those produced at other locations.

Thousands of fresh fruit and vegetable shipments are examined on the New York market each year by trained inspectors of the USDA. These inspections are paid for by receivers or shippers who request the service. Most inspections are conducted on fresh produce shipments whose condition for acceptability is being questioned.

About 70,000 metric tons of fresh tomatoes are delivered annually to metropolitan New York, placing the commodity among the top 10 volume leaders of fresh fruits and vegetables. Florida supplies about 45 percent each year and California supplies about 25 percent; remainder comes mainly from Mexico, Puerto Rico. southeastern states, New York and neighboring states. During the period from 1972 to 1984, over 9,000 shipments of fresh tomatoes were inspected on the New York market and the results certified. These inspected shipments made up about 11 percent of all tomato arrivals on the New York market. During this same 8 year period, 2729 shipments from Florida were inspected.

Diseases that originate in the field were not common,

although late blight rot and phytophthora rot were reported in fairly substantial numbers, considering all shipments, but the number of shipments affected from Florida was less than 1 percent for each of the two rots.

Postharvest diseases, disorders and injuries constitute the major deviation from normal. Table 1 is a tabulation of the various disorders which were reported by USDA inspectors on the New York market from 1972 - 1984.

Table 1. Tomato disorders and incidences reported in USDA inspections of 9059 shipments on the New York market, 1972 - 1984 (2).

PARASITIC DISEASES	Percent
Sour/watery rot	35
Gray mold rot	28
Bacterial soft rot	25
Decays (unknown)	24
Alternaria rot	8
Rhizopus soft rot	2
PHYSIOLOGICAL DISORDERS	
Soft fruit	66
Sunken discoloration	37
Misshapen/cat face	28
Growth cracks	12
Surface discoloration	2
INJURIES	
Shoulder scars	37
Grade defects	16
Bruise damage	14
Insect injury	3

Although these were the leading disorders that were identified, they do not signify any comparison between production locations. Historically, buyers and handlers have contended that Florida products are more perishable and non-uniform in pack as compared to products from other production areas. Certified inspection of tomatoes at the New York market does not support this assertion. Further elaboration of the data shows a comparison of tomatoes produced in three major areas, California, Florida and Mexico, as reported by USDA inspectors (Table 2).

Table 2. Leading disorders reported by USDA inspections of tomato shipments to the New York market from California, Florida and Mexico, 1972 - 1984 (2).

		Diseases	and p	ercent of	shipments	affected
	Ship-	Sour	Gray	Bact	Decays	Alternaria
Source	ments	rot	mold	S. rot	unknow.	rot
CA	2763	32	31	27	. 27	6
FL	2729	39	26	26	25	9
MX	1186	30	24	31	22	11

	Disorde	ers and perc	ent of shipme	ents affected
	Soft	Sunken	Misshapen	Growth
Source	fruit	discolor.	/cat face	cracks
CA	66	28	34	13
FL	60	47	. 32	15
MX	83	33	31	16

		percent of	shipments affected
	Shoulder	Grade	Bruise
Source	scars	defects	<u>damage</u>
CA	52	45	17
FL	38	44	16
MX .	44	43	18

Overall, Florida tomatoes were just as good as those produced in California or Mexico and shipped to the New York market, as judged by USDA inspectors. Based on the data obtained, there are areas where we could improve our pack.

Sour rot was the most frequently occurring disease and tomatoes from Florida contained a slightly higher incidence as compared to fruits from California or Mexico. On green fruits, the disease lesions are usually firm and have a dull, greasy, and water-soaked appearance. Sour rot in ripe or ripening fruits is soft and watery and is often followed by bacterial soft rot. Of the other 4 major diseases reported, the occurrence on Florida tomatoes was not greater than, and in some cases less, as compared to other tomatoes.

Florida tomatoes were more firm than those coming from California or Mexico. However, our tomtoes had the highest incidence of sunken discoloration. Before 1977 the term sunken discoloration, described a condition usually found at the shoulders of the tomato that was distinguished by the inspectors from shoulder scars. Starting in 1977 the term sunken discoloration also included the condition previously described as shoulder scars.

It is of particular interest to note that of the injuries scored, Florida fruits contained the lowest

incidence of shoulder scars. In view of scoring before and after 1977 mentioned above, the possibility exists that inspectors categorized more of our fruit as sunken discoloration instead of shoulder scars. In view of this existing confusion, if one combines sunken discoloration and shoulder scars then Florida tomatoes did not contain any more defects than fruits from California or Mexico.

Florida tomatoes had the same percentage of grade defects and bruise damage as fruits from California or Mexico. These data by USDA inspectors refute the assertions that Florida tomatoes are not as good as those packed in California or Mexico.

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LESSONS LEARNED FROM RESTRICTING SALES OF LOW

QUALITY TOMATOES

John J. VanSickle

Federal Marketing Order 966 proposes quality regulations that must be approved by the U.S. Secretary of Agriculture for fresh tomatoes shipped from Florida and for all tomatoes imported during most of the winter and spring seasons. These regulations are one tool used by the marketing order to provide orderly market conditions. Past regulations adopted by the marketing order have included the elimination of sales of small tomatoes beginning in the most recent season. Results indicate that this restriction has benefitted Florida growers with increased revenues for tomatoes. The gains in revenues resulting from decreased supplies and improved quality perception have more than offset the losses in revenues from restricting sales of small tomatoes.

EARL L. BUTZ

Dean Emeritus of Agriculture, Purdue University Secretary of Agriculture, USDA - 1971-76

Earl Butz's long career, first as an educator, then in public service, has taken him more than three million miles, to more than 50 nations, to all 50 of the United States, in touch with audiences of 1.5 million persons — all in the tireless pursuit of promoting American agriculture and the free enterprise philosophy.

Today, as dean emeritus of agriculture at Purdue University and former U.S. Secretary of Agriculture, he continues to promulgate his message about the wisdom of the market system as the most effective means of obtaining high quality food and fiber for consumers and acceptable income for farmers.

A native of Noble County, Indiana, Dr. Butz attended Purdue on a 4-H scholarship, graduating in 1932. He earned a doctorate in agricultural economics at Purdue in 1937, the same year he married Mary Emma Powell, a home demonstration agent in North Carolina. Dr. Butz also holds three honorary doctorates. Joining the Purdue faculty in 1937, he served briefly as a research fellow with the Brookings Institution in Washington in 1943. He was head of the Purdue Department of Agricultural Economics from 1946 to 1954.

Dr. Butz was Assistant Secretary of Agriculture from 1954 to 1957, under the Eisenhower Administration. He returned to Purdue in 1957 to serve as dean of agriculture. In 1968 he was named dean of continuing education and vice president of the Purdue Research Foundation.

Dr. Butz served as U.S. Secretary of Agriculture from 1971 to 1976. As such, his goals were to keep America the world's best fed nation, improve farm income, strengthen rural America, minimize federal encroachment and keep open farm export markets.

Dr. Butz currently serves as consultant to a number of businesses and trade organizations, lecturing to 100-125 audiences annually. He was the first Secretary of Agriculture in a third of a century to receive the American Farm Bureau Federation Award for Distinguished Service to Agriculture.

TOMATO VARIETIES FOR FLORIDA

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Variety selection, often made several months before planting, is one of the most important management decisions made by the grower. Failure to select the most suitable variety or varieties may lead to loss of yield or market acceptability.

The following characteristics should be considered in selection of tomato varieties for use in Florida:

- * Yield The variety selected should have the potential to produce crops at least equivalent to varieties already grown. The average yield in Florida is currently about 1250 25-pound cartons per acre. The potential yield of varieties in use should be much higher than average.
- * Disease Resistance Varieties selected for use in Florida must have resistance to Fusarium wilt, Race I and Race II; Verticillium wilt; gray leaf spot; and some tolerance to bacterial soft rot. Available resistance to other diseases may be important in certain situations.
- * Horticultural Quality Plant habit, jointlessness and fruit size, shape, color, smoothness and resistance to defects should all be considered in variety selection.
- * Adaptability Successful tomato varieties must perform well under the range of environmental conditions usually encountered in the district or on the individual farm.
- * Market Acceptability The tomato produced must have characteristics acceptable to the packer, shipper, wholesaler, retailer and consumer. Included among these qualities are pack out, fruit shape, ripening ability, firmness and flavor.

Current Variety Situation

Many tomato varieties are grown commercially in Florida but only a few represent most of the acreage.

'Sunny' is the leading variety, accounting for over two-thirds of the state's acreage. The proportion of acreage in which 'Sunny' is planted has gradually increased in each of the last four years. 'Sunny' accounts for almost all the commercial acreage in southwest Florida and the east coast, and almost 90% of the Palmetto-Ruskin acreage. Most of the north Florida acreage is in 'Sunny'.

'Duke' is the most important variety in Dade county, accounting for about three-fourths of the acreage there. A few acres of 'Duke' are grown

in the other production areas. Although the 'Duke' acreage in Dade County seems to be remaining constant, statewide acreage is declining. Overall, 'Duke' acreage is less than 20% of the statewide total.

'FTE-12' accounts for a little less than 20% of the Dade County acreage and 5% of the statewide acreage, making it the third most important variety overall. There appears to be a decline in 'FTE-12' acreage in Dade County and statewide in the past few years. Only a few acres of 'FTE-12' are grown outside of Dade County.

'BHN 26' and 'Castlehy 1035' acreage increased in Palmetto-Ruskin and Dade County, respectively, in the 1986-87 season. On the other hand, the acreage of 'Flora-Dade' and 'Hayslip' markedly decreased as compared to 1985-86. Small acreages of 'Floratom II', 'Pacific', and 'Freedom' were also grown in the 1986-87 season.

1986-87 Variety Trial Results

Tomato variety trial results are reported from the Gulf Coast Research & Education Center, Bradenton; Southwest Florida Research & Education Center, Immokalee; and Ft. Pierce Agricultural Research & Education Center in the fall of 1986 and spring of 1987. Many varieties were evaluated at all locations in both seasons, other varieties were evaluated only at certain locations.

Variety trials were conducted at three locations in fall 1986 (Table 1). The top five varieties for earliness, total yield, and fruit size are listed. Varieties or experimental lines, in addition to the standard varieties, that performed well in three or more catagories were: IFAS 7182 and Floratom II. At Immokalee, Floratom II performed well in three categories and Bingo in two categories. At Ft. Pierce, IFAS 7181 performed well in two categories.

In the spring 1987 trials (Table 2), IFAS 7168 performed well in five categories, IFAS 7181 in four, and IFAS 7178 and IFAS 7182 each performed well in three categories. At Immokalee, Royal Flush performed well in two categories.

In most of the trials, half or more of the leading entries did not differ significantly from one another. This indicates that there are many excellent varieties available today. Growers will need to continue to evaluate varieties under their own conditions to ascertain those that perform best for them.

Table 1. Fall 1986 Tomato Variety Trial Summary

rce (5)	Fruit	Size	IFAS 7182 Duke IFAS 7192 IFAS 7178 IFAS 7181	
Ft. Pierce (5)	Total	Yield	IFAS 7181 Horizon IFAS 7182 Duke IFAS 7131	
	Fruit	Size	Gator Bingo Floratom II	
Immokalee (2)	14	Total	All Star PSR 76184 Pacific Summer Flavor 6000 Floratom II	
	Yield	Early	Bingo Royal Flush Floratom II Pacific Summer Flavor 5000	
	Fruit	Size	IFAS 7182 Piedmont IFAS 7192 Summit	
Bradenton (4)	Yield	Total	All Star Sunny IFAS 7182 Duke Freedom	
	Y	Early	Freedom IFAS 7182 Duke All Star Sunny	

Table 2. Spring 1987 Tomato Variety Trial Summary

rce(5)	Fruit	Size	-	-	IFAS 7182	•	1
Ft. Pierce (5)	Total	Yield	IFAS 7182	Sunny	IFAS 7168	IFAS 7181	Horizon
	Fruit		Bingo	Summer Flavor 5000	IFAS 7178	Jackpot	PSR 76184
Immokalee (1)	Į.	Total	Pacific	Royal Flush	IFAS 7168	Hybrid 26	IFAS 7181
	Yiel	Early	IFAS 7181	Pacific	Horizon	Royal Flush	IFAS 7168
	Fruit	Size	IFAS 7178	Duke	IFAS 7196	IFAS 7168	Pacific
Bradenton (3)	ield	Total	IFAS 7182	All Star	Sunny	IFAS 7181	Pacific
	,	Early	XPH 5031	Horizon	Freedom	Duke	Pacific

RECOMMENDED VARIETIES

The varieties listed have performed well in IFAS trials conducted in various locations. Those varieties designated as FOR TRIAL should be evaluated in trial plantings before large-scale production is attempted.

All Star (NF,CF) Petoseed. A midseason, jointed, determinate hybrid. Fruit are large, globe-shaped, and green shouldered. Resistant: Verticillium Wilt, Fusarium Wilt (Race 1 and 2), Gray Leaf Spot, Alternaria Stem Canker. FOR TRIAL.

Duke (EC, CF, SF, SWF) Petoseed. An early, determinate, jointless hybrid. Fruit are large, green shouldered, and moderately flat-round shaped. Resistant: Verticillium Wilt, Fusarium Wilt (Race 1 and 2), Gray Leaf Spot, Alternaria Stem Canker.

Flora-Dade (SF,CF) IFAS. A midseason to late, jointless, determinate, open-pollinated variety. Fruit are medium-large, green shouldered, and round. Resistant: Verticillium Wilt, Fusarium Wilt (Race 1 and 2), Gray Leaf Spot.

Freedom (CF) Abbott & Cobb. An early midseason, determinate, jointless hybrid. Fruit are large, deep-globe shaped, and smooth. Resistant: Verticillium Wilt. Fusarium Wilt (Race 1 and 2).

FTE 12 (SF, SWF, CF) Petoseed. An early to midseason, jointless, determinate hybrid developed for members of the Florida Tomato Exchange. Moderately large fruit have green shoulders and are flat-round shaped. Resistant: Verticillium Wilt, Fusarium Wilt (Race 1 and 2), Gray Leaf Spot, Alternaria Stem Canker.

Hayslip (CF) IFAS. A late, jointless, moderately large-vined determinate, open-pollinated variety. Large fruit are slightly ridged, have deep-green shoulders, are a deep-globe shape and have smooth blossom ends. Resistant: Verticillium Wilt, Fusarium Wilt (Race 1 and 2), Gray Leaf Spot.

Horizon (F) IFAS. An early, jointless, small-vined determinate, open-pollinated variety. Slightly oblate-globe shaped fruit are large size and have light-green shoulders. The plants have a concentrated fruit set. Resistant: Verticillium Wilt, Fusarium Wilt (Race 1 and 2), Gray Leaf Spot. FOR TRIAL.

Independence (SWF) Abbott & Cobb. An early to midseason, jointless, determinate hybrid. Large fruit have green shoulders and are deep-globe shape. Resistant: Verticillium Wilt, Fusarium Wilt (Race 1 and 2). FOR TRIAL.

Pacific (SWF, CF, NF) Asgrow. Large, smooth-globe, green-shouldered fruit are produced on determinate plants. Jointed. Hybrid. Resistant: Alternaria, Fusarium Wilt (Race 1 and 2), Verticillium Wilt (Race 1), Gray Leaf Spot. FOR TRIAL.

Summer Flavor Brand 5000 (SWF) Abbott & Cobb. A mid-season, jointed, determinate hybrid. Large, oblate fruit. Resistant: Verticillium Wilt, Fusarium Wilt (Race 1 and 2), Root Knot Nematode. FOR TRIAL.

Sunny (F) Asgrow. A midseason, jointed, determinate, hybrid. Fruit are large, flat-globular in shape, and are green shouldered. Resistant: Verticillium Wilt, Fusarium Wilt (Race 1 and 2), Alternaria Stem Canker, Gray Leaf Spot.

CHERRY TYPE

Cherry Grande (NF,CF,SWF) Petoseed. A jointed, determinate hybrid. Fruit are deep red, green shouldered, globe shaped, and have an average diameter of 1 1/4 to 1 1/2 in. Resistant: Verticillium Wilt, Fusarium Wilt (Race 1), Alternaria Stem Canker, Gray Leaf Spot.

Castlette (CF, SWF) ARCO. A jointless, medium-vine determinate hybrid. Bright-red fruit are green shouldered, deep-globe shaped, and about 1 1/4 in. in diameter. Resistant: Verticillium Wilt, Fusarium Wilt (Race 1).

Red Cherry Large (CF, SWF) Petoseed. A jointed, indeterminate, open-pollinated variety. Green shouldered, deep-globe fruit are about 1 1/4 in. in diameter. Resistant: Alternaria Stem Canker.

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Institute of Food and Agricultural Sciences • University of Florida

VEC-TO1.87

W. M. Stall, Vegetable Crops Department

Weeds are a major problem in tomato production in Florida. Weeds can reduce yields through direct competition for light, moisture and nutrients as well as harbor insects and diseases that attack tomatoes.

Tomatoes are present in the field in some area of Florida every month of the year. Over this period the variable climatic conditions influence the diversity of weed species present and their severity. Growers should plan a total weed control program that integrates chemical, mechanical and cultural methods to fit their weed problems and production practices.

Herbicide performance depends on weather, irrigation, soil as well as proper selection for weeds species to be controlled and accurate application and timing. Obtain consistent results by reading the herbicide label and other information about the proper application and timing of each herbicide. To avoid confusion between formulations, suggested rates listed are stated in pounds active ingredient per acre (lbs ai/acre). On rockdale and sandy soils with low organic matter the lower rates should be applied. All herbicides listed below have been tested in research trials in Florida with successful results.

When applying a herbicide for the first time in a new area, use in a small trial basis first.

Before application of a herbicide, CAREFULLY READ AND FOLLOW THE LABEL.

TOMATOES

Herbicide	Labelled crops	Time of application	Rate	(lbs.ai./acre)
Chloramben (Amiben)	Tomatoes (established)	Postemergence or posttransplan	t	3.0

Granular formulation may be applied to cultivated non-mulched transplanted or established direct seeded tomatoes. Plants should be at the 5-6 leaf stage. Apply only when foliage is dry. Will not control established weeds.

Tomatoes	postplanting	3.0
	or posttransplanting	

A special local needs 24 (c) label for Florida. Apply once per crop season after existing weeds in row middles have been removed. Label states control of many annual grasses and broadleaf weeds. Among these are crabgrass, goosegrass, lambsquarter, wild mustard, black nightshade, pigweed, purslane, common ragweed and Flabeggarweed.

DCPA (Dacthal)	Established tomatoes	Posttransplanting after crop establishment (non-mulched)	6.0 to 8.0
_		Mulched row middles after crop establishment	6.0 to 8.0

Controls germinating annuals. Apply to weed-free soil 6-8 weeks after crops is established and growing rapidly or to moist soil in row middles after crop establishment. Note label precautions of replanting non registered crops within 8 months.

Diphenamid (Enide)	Tomatoes	Pretransplant Preemergence	3.0 to
	•	Postemergence	4.0
		Posttransplant	
		Incorporated	

Controls germinating annuals. Apply to moist soil I week before or within 4 weeks after transplanting crop. Incorporate 0.5 to 2 inches. May be applied as directed band over "plug" planting or to mulched row middles. Label states control of many grasses and broadleaf weeds including spiny ameranth, bermudagrass, goosegrass, seedling johnsongrass, lambsquarter, pigweed, purslane, Fla. pusley and others.

Herbicide	Labelled crops	Time of Rate	(lbs.ai./acre)
Metribuzin	Tomatoes	Postemergence	0.25
(Sencor)		Posttransplanting	to
		after establishment	0.5

Controls small emerged weeds after transplants are established or direct seeded plants reach 5-6 true leaf stage. Apply in single or multiple applications with minimum of 14 days between treatments and a maximum of 1.0 lb. ai/acre within a crop season. Avoid applications for 3 days following cool, wet or cloudy weather to reduce possible crop injury.

Metribuzin Tomatoes	Directed spray in	,	0.25
(Sencor Lexone)	row middles		to
			1.0

Apply in single or multiple applications with a minimum of 14 days between treatments and maximum of 1.0 lb. ai acre within crop season. Avoid applications for 3 days following cool, wet or cloudy weather to reduce possible crop injury. Label states control of many annual grasses and broadleaf weeds including, lambsquarter, fall panicum, ameranthus sp., Fla. pusley, common ragweed, sicklepod, and spotted spurge.

Napropamid	Tomatoes	Preplant incorporated	1.0
(Devrinol)			to
			2.0

Apply to well worked soil that is dry enough to permit thorough incorporation to a depth of 1-2 inches. Incorporate same day as applied. For direct seeded or transplanted tomatoes.

Tomatoes	Surface treatment	2.0

Controls germinating annuals. Apply to bed tops after bedding but before plastic application. Rainfall or overhead irrigate sufficient to wet soil I inch in depth should follow treatment within 24 hours. May be applied to row middles between mulched beds. A special local needs 24(c) label for Florida. Label states control of weeds including Texas panicum, pigweed, purslane. Fla. pusley, and signalgrass.

Herbicide	Labelled crops	Time of application	Rate	(lbs.ai./acre)
Paraquat (Ortho paraquat Gramoxone	Tomatoes	Premergence Pretransplant		0.5 to 1.0
Controls	emerged weeds.	Use a non-ionic s	preader	and thoroughly
	Tomatoes	Post directed spray in row mi	lddle	0.5

Controls emerged weeds. Direct spray over emerged weeds 1 to 6 inches tall in row middles between mulched beds. Use a non-ionic spreader. Use low pressure and shields to control drift. Do not apply more than 3 times per season.

Trifluralin	Tomatoes	Pretransplant	0.75
(Treflan)	(except	incorporated	to
	Dade County)		1.0

Controls germinating annuals. Incorporate 4 inches or less within 8 hours of application. Results in Florida are erratic on soils with low organic matter and clay contents. Note label precautions of planting non-registered crops within 5 months. Do not apply after transplanting.

Seeded		
Tomatoes	Post directed	0.75
(except		to
Dade County)		1.0

For direct seeded tomatoes, apply at blocking or thinning as a directed spray to the soil between the rows and incorporate.

TOMATO PLANT DISEASE CHEMICAL CONTROL GUIDE

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Crop	Chemical	Rate/A	Minimum days to harvest	Pertinent Diseases listed on label	Pertinent Diseases not listed on the label but also controlled	Special Remarks
Tomato	Benlate	1/2- 1 lb.	NTL	Gray mold Leaf mold White mold (Sclerotinia) Phoma leaf spot	Target spot Rhizoctonia fruit rot	Field & Greenhouse,
	Botran 75 W	i lb/100 gal water	뒫	Botrytis stem canker		Seedlings or newly set transplants may be injured by drenching. Greenhouse use only.
··	Bravo 720	1 1/2 - 3 pts.	Ę	Early blight Late blight Gray leaf spot Leaf mold Septoria leaf spot Gray mold Black mold Rhizoctonia fruit rot	Phoma teaf spot Target spot Rhizoctonia fruit rot Bacterial spot and speck (when combined with Kocide 101, Tri-basic Copper Sulfate, or CP-Basic Copper TS-53-WP, Champion, or Blue Shield)	Do not use with Copper Count-N in concentrated spray mixtures.
	Manzate 200 Flowable	1.3 - 2.5 qts.	5	Same as Dithane M-45	See as Dithane M-45	

Crop	Chemical	Rate/A	Minimum days to harvest	Pertinent Diseases listed on label	Pertinent Diseases not listed on the label but also controlled	Special Remarks
Tomatoes (conl'd)	Dithane FZ	Field 0.8- 2.4 q1s greenhouse 4.5-6.1 f1 oz/5000 sq ft.	so.	Leaf mold Early blight Late blight Gray leaf spot Septoria leaf spot Bacterial spot (use 1.2 qts combined with copper fungicides as in Dithane M-45)	See Dithane M-45	Do not use on young plants in greenhouse to avoid injury.
	Dithane M-45	1 1/2 - 3 lbs.	70	Late blight Early blight Gray leaf spot Leaf mold Bacterial spot	Septoria leaf spot Leaf mold Phoma leaf spot Bocterial spot (See under Bravo 720)	-69-
	Penncozeb	1 1/2 - 3 lbs.	5	Early blight Late blight Gray leaf mold Leaf mold	See Dithane M-45	Field or green-house. Do not use on young tender plants under glass.
	Dithane M-22 Special	Field 1-3 1bs. Greenhouse .253 lbs/ 5000 sq ft.	5	Leaf mold Early blight Late blight Grey leaf spot Septoria leaf spot Bocterial spot	See Dithane M-45	

Crop	Chemical	Rate/A	Minimum days to harvest	Pertinent Diseases listed on label	Pertinent Diseases not listed on the label but also controlled	Special Remarks
Tomatoes (cont'd)	Maneb 80	3 lbs.	5	Early blight Late blight Septoria leaf spot Gray leaf spot	See Dithane M-45	Do not use on young plant in greenhouse as Injury may occur.
	Ridomil-Bravo 81 W	1 1/2 - 2 lbs.	Ę	Early blight Late blight Grey leaf spot		
	Manzate 200	1 1/2 - 3 lbs.	50	Early blight Late blight Gray leaf spot Gray leaf mold Bacterial spot	See Dithane M-45	-70-
	Manex	1.2-1.6 q1s.		Leaf mold Early blight Late blight Gray leaf spot Septoria leaf spot	Target spot Phoma leaf spot	Field or greenhoùse.
	;					

Crop	Chemical	Rate/A	Minimum days to harvest	Pertinent Diseases listed on label	Pertinent Diseases not listed on the label but also controlled	Special Remarks
Cont'd)	Dyrene (not for use in greenhouse)	2-5 lbs.	NTL	Botrytis Early blight Late blight Septoria leaf spot		If temperatures exceed 85°D F do not use more than 1 lb if tank mixed with a copper fungicide.
	Kocide 101, Blue Shield or Champion WP	2-4 lbs.	Z Z	Early blight Bocterial speck Bocterial spot	See Dithane M-45	Minimum days to harvest is 5 if used with a Dithane or Manzate fungicide
	Kocide 606 or Champion FL	2 2/3 - 5 1/3 pts.	JĘN JĘN	Early blight Bocterial speck Bacterial spot	See Dithane M-45	Same as Kocide 101
	Tri-basic Copper Sulfate	2-4 lbs.	I Z	Bacterial spot Bacterial carker Early blight Late blight Leaf mold Septoria Stemphyllium leaf spot	See Dithane M-45	Same as Kocide 101
	CP-Basic Copper TS-53 WP	2-4 lbs.	NTL	Same as Tri-basic Copper sulfate	See Dithane M-45	Same as Kocide 101.
	JMS Stylet Oil	3 qts.	N TT	Potato virus Tobacco etch virus Pepper mottle virus	Tomato yellows	Must be applied with gound rig at 400 psi using Tee Jet TX5 SS nozzles. READ LABEL

Crop	Chemical	Rate/A	Minimum days to harvest	Pertinent Diseases listed on label	Pertinent Diseases not listed on the label but also controlled	Special Remarks
Tomatoes (cont'd)	Ridomil 2E ¹ (Soil application)	2-4 pts. (Broadcast only)	PPI treat- ment for plant beds	Pythium damping off in plant beds Late blight Phytophlhora stem canker		May not be a necessary treatment for Pythium It beds are fumigated prior to seedling and recontamination of fumigated soil is avoided. Not for use in greenhouses.
	Ridomil 2E ¹ (Soil application)	4-8 pts. ² (Broadcast rate)		Pythium damping off for field	Phytophthora stem canker Late blight	Same as entry above.
	Copper-Count-N	1/3 - 3/4 gal.	NTL	Bacterial spot		Mix with a Maneb fungicide.
	Ridomil 2E ^I (Soil application)	4 pts. ³ (Broadcast rate)		Phytophthora or Pythium fruit rots	Late blight	Same as entry above.

Do not apply more than 12 pints Ridomil 2E/season.

PPI (via mechanical device) or POPI (via irrigation) broadcast or banded.

Soil surface 4-8 weeks before harvest followed by irrigation. If plastic used on beds, apply as a band next to bed in middles if roots have developed beyond plastic. Ridomil translocates upward in plant from roots. If plastic not used, band on soil below drip line.

Crop	Chemical	Rate/A	Minimum days to harvest	Pertinent Diseases listed on label	Pertinent Diseases not listed on the label but also controlled	Special Remarks
Tomatoes (cont'd)	Ridomil MZ-58 ¹ (Foliar spray)	Cont'd) (Foliar spray) 2 lbs.		Late blight Phytophthora stem Only Dithane canker A-45, Manzate Pythium fruit rot Dithane M-22 may be tank mixed with Ridomil MZ-58. Do not apply more than 2 ths A of Manzate or Dithane than 2 ths Ridomil MZ-58. Ridomil MZ-58.	Phytophthora stem canker Pythium fruit rot	Only Dithane M-45, Manzate 200, Manzate or Dithane M-22 may be tank mixed with Ridomil MZ-58. Do not apply more than 2 lbs A of Manzate of Dithane fungicides with Ridomil MZ-58.

LEGAL INSECTICIDES
FOR CONTROL OF INSECTS
ON TOMATOES

Prepared by Freddie A. Johnson, Professor, Extension Entomologist, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida 32611.

TOMATOES (Revised 7-27-87)

INSECT

aphids

INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
allethrin (Pyrellin SCS)	1% 11quid (EC)	1-1 1/2 pts.	see label
carbaryl (Sevin)	5 B	20-40 lbs.	0
allethrin (Pyrellin SCS)	1% 11quid (EC)	1-1 1/2 pts.	see label
aliphatic petroleum (JMS-Stylet 011)	97.6% EC	see label.	see label
azinphosmethyl (Guthion)	2 S (EC)	2-3 pts.	0
demeton (Systox)	2 EC	1-1 1/2 pts./ 100 gal.	3
diazinon	4 EC	1/2 pt.	1
dimethoate (Cygon, Defend)	4 EC	1/2-1 pt.	7
disulfoton (D1-Syston)	15 G	8-23.4 oz./1000 ft. row (any row space)	30 e)
endosulfan (Thiodan) (green peach aphid)	3 EC	2/3 qt.	1
esfenvalerate (Asana) (potato aphid)	1.9 EC	1.7-3.4 ozs.	1
<pre>fenvalerate (Pydrin) (potato aphid)</pre>	2.4 EC	5 1/3-10 2/3 ozs.	1
lindane (Isotox-lindane)	25 WP	1 1b.	do not apply after fruits start to form

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
aphids (cont.)	malathion	5 EC	1 pt./100 gal.	1
	metham1dophos (Monitor)	4 EC	1 1/2-2 pts.	7
	methomyl (Lannate, Nudrin)	1.8 L	2-4 pts.	1
	mevinphos (Phosdrin)	4 EC	1/4-1/2 pt.	1
	methyl parathion	4 EC	1-3 pts.	15
	parathion	7 EC	1-2 pts.	10
	phosphamidon	8 EC	1/2 pt.	10
	pyrethrins + piperonyl butoxide (Pyrenone) (green peach aphid)	66% liquid (EC)	2-6 oz./100 gal.	0
		:		
armyworms (also see	allethrin (Pyrellin SCS)	1% liquid EC	1-1 1/2 pts.	see label
orner specific types of armyworms)	carbary1 (Sevin)	5 B	20-40 lbs.	0
	diazinon	4 EC	3/4-1 pt.	9
	fenvalerate (Pydrín) (Southern, Sugarbeet Western Yellow-Striped)	2.4 EC	5 1/3-10 2/3 ozs.	1
	methomyl (Lannate, Nudrin) methyl parathion	1.8 L 4 EC	1-2 pts. 1-3 pts.	1 15

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
armyworms (cont.)	parathion (up to 3rd instar)	4 BC	1-2 pts.	10
	trichlorofon (Dylox, Proxol)	5 B	20 lbs.	28
(fall armyworms)	carbaryl (Sevin)	80 WP	1 1/2-2 1/2 lbs.	0
,	diazinon	4 EC	3/4-1 pt.	7
	methomyl (Lannate, Nudrin)	1.8 L	2 pts.	
	methoxychlor	2 EC	2-6 qts	1-3 1/2 qts.
(southern armyworms)	diazinon	4 EC	3/4-1 pt.	1
	esfenvalerate (Asana)	1.9 EC	1.7-3.4 ozs.	1
	fenvalerate (Pydrin)	2.4 EC	5 1/3-10 2/3 ozs.	1
	methomyl (Lannate, Nudrin)	1.8 L	2-4 pts.	1
	permethrin* (Ambush) (Pounce)	2 EC 3.2 EC	3.2-12.8 ozs. ul 2-8 ozs. o	up to day of harvest
(beet armyworms)	esfenvalerate (Asana) (Sugarbeet armyworm)	1.9 EC	1.7-3.4 ozs.	1
	<pre>fenvalerate (Pydrin) (Sugarbeet armyworm)</pre>	2.4 EC	5 1/3-10 2/3 ozs.	1

TOMATOES

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
(beet armyworms)	methomyl (Lannate, Nudrin)	1.8 L	2-4 pts.	
(-2005)	permethrin* (Ambush) (Pounce)	2 EC 3.2 EC	3.2-12.8 ozs. 2-8 ozs.	up to day of harvest
(yellow striped	azinphosmethyl (Guthion)	2 S (EC)	3-6 pts.	14
armyworms)	endosulfan (Thiodan)	3 EC	1 1/3 qts.	1
	esfenvalerate (Asana) (Yellow-striped armyworm)	1.9 EC	1.7-3.4 ozs.	. 1
	fenvalerate (Pydrín) (Western Yellow Stríped)	2.4 EC	5 1/3-10 2/3 ozs.	-
banded cucumber	azinphosmethyl (Guthion)	2 S (EC)	1 1/2-2 pts.	0
Deetle	diazinon	4 EC	3/4-1 pt.	1
	lindane (Isotox-lindane) larvae	25 WP	1-2 lbs.	Preplant (soil)
beetles	allethrin (Pyrellin SCS)	1% 11quid (EC)	1-1 1/2 pts.	See label,
blister beetle	cryolite (Kryocide)	96 WP	15-30 lbs.	wash fruit
	endosulfan (Thiodan)	3 EC	2/3 qt.	1

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
blister beetle (cont.)	methoxychlor	2 EC	2-6 qts.	1-3 1/2 qts. 7-3 1/2+ qts.
	parathion	4 EC	1-2 pts.	10
cabbage looper	Bacillus thuringiensis Bactospeine, Bactur, Dipel, Sok, Stan-Guard, Thuricide)	See individual labels.	labels.	0
	cryolite (Kryocide)	96 WP	15-30 lbs.	wash fruit
	endosulfan (Thíodan)	3 EC	1 qt.	1
	esfenvalerate (Asana)	1.9 EC	1.7-3.4 ozs.	1
	fenvalerate (Pydrin)	2.4 EC	5 1/3-10 2/3 ozs.	1
	methomyl (Lannate, Nudrin)	1.8 L	2-4 pts.	1
	methyl parathlon	4 EC	2-3 pts.	15
	permethrin* (Ambush) (Pounce)	2 EC 3.2 EC	3.2-12.8 ozs. · 2-8 ozs.	up to day of harvest
Colorado potato beetle	azinphosmethyl (Guthion)	2 S (EC)	1 1/2 pts.	0
	carbaryl (Sevin)	80 WP	2/3-1 1/4 lb.	0

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
Colorado potato beetle (cont.)	disulfoton (Di-Syston)	8 EC	1.2-3.5 fl. oz./ 1000 ft. row (any row spacing) or 1-3 pts./A (38" row spacing)	30
	disulfoton (Di-Syston)	15 G	8-23.4 oz./1000 ft. row (any row spacing) or 6.7-20 lbs./A (38" row spacing)	30
	endosulfan (Thiodan)	3 EC	2/3 qt.	1
	esfenvalerate (Asana)	1.9 EC	1.7-3.4 ozs.	1
	fenvalerate (Pydrin)	2.4 EC	5 1/3-10 2/3 ozs.	1
	methoxychlor	2 EC	2-6 qts.	1-3 1/2 qts. 7-3 1/2+ qts.
	parathion	4 EC	1-2 pts.	10
	Penncap-M	2 EC	4 pts.	15
	permethrin* (Ambush) (Pounce)	2 EC 3.2 EC	3.2-12.8 ozs. 2-8 ozs.	up to day of harvest
	phosphamidon	8 EC	1/2 pt.	10
	pyrethrins + piperonyl butoxide (Pyrenone)	66% liquid (EC)	2-6 oz./100 gal.	0
	rotenone (Rotenox)	5% 11qu1d	2/3 gal.	0

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
corn earworm (See also tomato fruitworms)	azinphosmethyl (Guthion)	2 S (EC)	3-6 pts.	14
crickets	carbaryl (Sevin)	5 B	20-40 lbs.	0
	trichlorfon (Dylox, Proxol)	5 B	20 lbs.	28
cutworms	allethrin (Pyrellin SCS)	1% liquid (EC)	1-1 1/2 pts.	see label
	carbaryl (Sevin)	80 WP	2 1/2 lbs.	0
	carbaryl (Sevin)	. S B	20-40 lbs.	0
	diazinon	14 G	14-28 lbs.	preplant
	diazinon	4 EC	2-4 qts.	preplant
	esfenvalerate (Asana)	1.9 EC	1.7-3.4 ozs.	1
	fenvalerate (Pydrin)	2.4 EC	5 1/3-10 2/3 ozs.	1
	lindane (Isotox-lindane)	25 WP	1-2 lbs.	preplant (soil)
	<pre>methomyl (Lannate) (varigated cutworm)</pre>	1.8 L	2 pts.	1
	<pre>permethrin* (Ambush)</pre>	2 EC 3.2 EC	3.2-12.8.ozs. 2-8 ozs.	up to day of harvest
	<pre>trichlorfon (Dylox, Proxol) (surface feeding cutworms)</pre>	5 B	20 lbs.	28

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
darkling ground beetles	carbaryl (Sevin)	8 S	20-40 lbs.	0
Drosophila	azinphosmethyl (Guthion)	2 S (EC)	1 1/2-2 pts.	0
(iruic files)	diazinon	4 EC	1/2-1 1/2 pts.	-
	malathion	2 EC	2 1/2 pts.	7
	naled (Dibrom)	8 EC	1 pt.	1
European corn borer	azinphosmethyl (Guthion)	2 S (EC)	2-3 pts.	0
	carbaryl (Sevin)	80 WP	1 1/4-2 1/2 lbs.	0
flea beetles	azinphosmethyl (Guthion)	2 S (EC)	2-3 pts.	0
	carbaryl (Sevin)	80 WP	2/3-1 1/4 lbs.	0
	<pre>carbophenothion (Trithion) (potato flea beetle)</pre>	8 EC	1/2-1 pt.	7
	cryolite (Kryocide)	96 WP	15-30 lbs.	wash fruit
	disulfoton (Di-Syston)	8 EC	1.2-3.5 fl. oz./ 1000 ft. row (any row spacing) or 1-3 pt./A (38" row spacing)	30

TOMATOES

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
flea beetles (cont.)	disulfoton (Di-Syston)	15 G	8-23.4 oz./1000 ft. row (any row spacing) or 6.7-20 lb./A (38" row spacing)	30
	endosulfan (Thiodan)	3 EC	2/3 qt.	1
	esfenvalerate (Asana)	1.9 EC	1.7-3.4 ozs.	Ţ
	fenvalerate (Pydrin)	2.4 EC	5 1/3-10 2/3 ozs.	1
	methyl parathion	4 EC	1-3 pts.	10 - 1 pt. 15 - 1+ pt.
	methoxychlor	2 EC	2-6 qts.	1 - 3 1/2 qts. 7 - 3 1/2+ qts.
	naled (Dibrom)	8 EC	1 pt.	1
	parathion	4 EC	1-2 pts.	10
	Penncap-M	2 EC	2-4 pts.	15
	phosphamidon	8 EC	1/2 pts.	. 01
	pyrethrins + piperonyl butoxide (Pyrenone)	66% liquid (EC)	2-6 oz./100 gal.	0
garden symphylans	fonofos (Dyfonate)	10 G	20 lbs.	preplant, broadcast

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
grasshoppers	azinphosmethyl (Guthion)	2 S (EC)	2-3 pts.	0
	carbaryl (Sevin)	5 B	20-40 lbs.	0
	esfenvalerate (Asana)	1.9 EC	1.7-3.4 ozs.	1
	fenvalerate (Pydrin)	2.4 EC	5 1/3-10 2/3 ozs.	1
	mevinphos (Phosdrin)	4 EC	1/2-1 pt.	1
	parathion	4 EC	1-2 pts.	10
hornworms	azinphosmethyl (Guthlon)	2 S (EC)	3-6 pts.	14
(tomato hornworms)	Bacillus thuringiensis Bactospeine, Bactur, Dipel, Stan-Guard, Sok, Thuricide)	See individual labels.	labels.	0
	carbaryl (Sevin)	80 WP	1 1/4-2 1/2 1bs.	0
	cryolite (Kryocide)	96 WP	15-30 lbs.	wash fruit
	endosulfan (Thiodan)	3 EC	2/3-1 1/3 qts.	-
	esfenvalerate (Asana)	1.9 EC	.85-1.7 ozs.	1
	fenvalerate (Pydrin)	2.4 EC	2 2/3-5 1/3 ozs.	1

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
hornworms (tomato hornworms)	methomyl (Lannate)	1.8 L	2-4 pts.	1
(cont.)	naled (Dibrom)	8 EC	1 pt.	1
	Penncap-M	2 EC	4 pts.	15
	permethrin* (Ambush) (Pounce)	2 EC 3.2 EC	3.2-12.8 ozs. 2-8 ozs.	up to day of harvest
	trichlorfon (Dylox, Proxol)	80 SP	20 oz.	21
Jachnos		80 WP	1 1/4-2 1/2 1bg	
Tacenage	_		.801 2/1 7-4/1 1	Þ
leafhoppers	allethrin (Pyrellin SCS)	1% liquid EC	1-1 1/2 pts.	see label
	azinphosmethyl (Guthion)	2 S (EC)	2-3 pts.	0
	carbaryl (Sevin)	80 WP	2/3-1 1/4 lbs.	0
	<pre>carbophenothion (Trithion) (potato leafhopper)</pre>	8 EC	1/2-1 pt.	7
	disulfoton (DiSyston)	8 EC	1.2-3.5 fl. oz./ 1000 ft. row (any row spacing) or 1-3 pts./A (38" row spacing)	30

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
leafhoppers (cont.)	disulfoton (D1-Syston)	15 G	8-23.4 oz./1000 ft. row (any row spacing) or 6.7-20 lbs./A (38" row spacing)	30
	dimethoate (Cygon, Defend)	4 EC	1/2-1 pt.	7
,	methoxychlor	2 EC	2-6 qts.	1 - 3 1/2 qts. 7 - 3 1/2+ qts.
	methyl parathion	4 EC	1-2 pts.	15
	mevinphos (Phosdrin)	4 EC	1/2-1 pt.	1
leafminers	allethrin (Pyrellin SCS)	1% 11quid (EC)	1-1 1/2 pts.	see label
	azinphosmethyl (Guthion)	2 S (EC)	1 1/2-2 pts.	0
	carbophenothion (Trithion)	8 EC	1/2-1 pt.	7
	diazinon	4 EC	1/2 pt.	1
	diazinon	50 WP	1/2 lb.	1
	dimethoate (Cygon, Defend)	4 EC	1/2-1 pt.	7
	disulfoton (Di-Syston)	8 EC	1.2-3.5 fl. oz./ 1000 ft. row (any row spacing) or 1-3 pts/A (38" row spacing)	30

TOMATOES

leafminers
(cont.)

INSECT

INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
disulfoton (DiSyston)	15 G	8-23.4 oz./1000 ft. row (any row spacing) or 6.7-20 lbs./A (38" row spacing)	30
ethion	4 BC	1 pt.	2
fenvalerate (Pydrin)	2.4 EC	10 2/3 ozs.	1
lindane (Isotox-lindane)	25 WP	1 1/2 lbs.	Do not apply after fruit starts to form.
methamidophos (Monitor) (adults)	4 EC	1 1/2-2 pts.	7
naled (Dibrom)	8 EC	1 pt.	
oxamyl (Vydate L)	2 EC	2-4 pts./100 gal.	7
parathion	4 EC	1-2 pts.	10
Penncap-M	2 EC	2-4 pts.	15
permethrin* (Ambush) (Pounce)	2 EC 3.2 EC	3.2-12.8 ozs. 2-8 ozs.	up to day of harvest

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
leafminers (cont.)	phorate (Thimet)	20 G	11.3 oz./1000 ft. row (min. 38" spacing)	at planting
	phosphamidon	8 EC	1/2 pt.	10
	trichlorfon (Dylox, Proxol)	80 SP	20 oz.	21
loopers	allethrin (Pyrellin SCS)	1% 11quid (EC)	1-1 1/2 pts.	see label
(See also cabbage looper)	methomyl (Lannate, Nudrin)	1.8 L	2-4 pts.	1
mites	allethrin (Pyrellin SCS)	1% 11quid (EC)	1-1 1/2 pts.	see label
	carbophenothion (Trithion) 4 (russet, tropical & two-spotted mites)	4 EC tes)	1-2 pts.	7
	demeton (Systox)	2 EC	1-1 1/2 pts./100 gal.	,al. 3
	dicofol (Kelthane)	1.6 EC	1-2 qts.	2
	disulfoton (Di-Syston)	일 8	1.2-3.5 fl. oz./ 1000 ft. row (any row spacing) or 1.3 pts. (38" row spacing)	30
	disulfoton (Di-Syston)	15 G	8-23.4 oz./1000 ft. row (any row spacing) or 6.7-20 lbs./A (38" row spacing)	30

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
mites (cont.)	ethion (tropical, two-spotted, and tomato russet mites)	4 EC	1 pt.	2
	methyl parathion	4 EC	1-2 pts.	15
	wevinphos (Phosdrin)	4 EC	1/2 - 1 pt.	
	naled (Dibrom)	8 EC	1 pt.	1
(tomato russet mite)	endosulfan (Thiodan)	3 EC	1 1/3 qts.	
	malathion	25 WP	2~4 lbs.	1
	methyl parathion	4 EC	1-3 pts.	15
	parathion	4 EC	1-2 pts.	10
	sulfur (Kolospray)	81% WP	7 lbs.	0
	sulfur (Magneticide)	F F	1/2-1 gal.	0
(spider mite)	malathion	5 EC	1 1/2 pts./100 gal.	gal, l
mole crickets	diazinon	15 G	7 lbs.	preplant
	diazinon	4 EC	1 qt.	preplant, broadcast

INSECT	INSECTICIDE	FORMILATION	RATE/ACRE	MIN. DAYS TO HARVEST
pinworm	allethrin (Pyrellin SCS)	1% 11quid (EC)	1-1 1/2 pts.	see label
(tomato pinworm)	azinphosmethyl (Guthion)	2 S (EC)	3-6 pts.	14
	carbaryl (Sevin)	80 WP	1 1/4-2 1/2 lbs.	0
	cryolite (Kryocide)	96 WP	15-30 lbs.	wash fruit
	esfenvalerate (Asana)	1.9 EC	1.7-3.4 ozs.	J
	fenvalerate (Pydrin)	2.4 EC	5 1/3-10 2/3 ozs.	1
	methamidophos (Monitor) (suppression of low populations)	4 EC	1 1/2-2 pts.	7
	methomyl (Lannate, Nudrin)	1,8 L	2-4 pts. (ground application only)	
	Penncap-M	2 EC	4 pts.	15
	permethrin* (Ambush) (Pounce)	2 EC 3.2 EC	3.2-12.8 ozs. 2-8 ozs.	up to day of harvest
plant bugs	allethrin (Pyrellin SCS)	1% liquid (EC)	1-1 1/2 pts.	see label
	carbaryl (Sevin)	80 WP	1 1/4-2 1/2 1bs.	0
	methyl parathion	4 EC	2 pts.	15
	parathion	4 EC	1-2 pts.	10
potato flea beetle	carbophenothion (Trithion)	8 EC	1/2-1 pt.	7

TOMATOES

INSECT	INSECTICIDE	PORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
potato psyllid	carbophenothion (Trithion)	4 EC	1-2 pts.	7
	endosulfan (Thiodan)	3 D	33 lbs.	1
	methyl parathion	4 EC	1-3 pts.	15
	parathion	4 EC	1-2 pts.	10
salt marsh caterpillar	trichlorfon (Dylox, Proxol)	5 B	20 lbs.	28
gnqwos	carbaryl (Şevin)	5 B	20-40 lbs.	0
stinkbugs	azinphosmethyl (Guthion) (green stinkbugs)	2 S (EC)	1 1/2-2 pts.	0
	carbaryl (Sevin)	80 WP	1 1/4-2 1/2 1bs.	0
	endosulfan (Thiodan)	3 EC	1-1 1/3 qts.	1
	parathion	4 EC	1-2 pts.	10
	phosphamidon	8 EC	1/2 pt.	. 01
	pyrethrins + piperonyl butoxide (Pyrenone)	66% liquid (EC)	2-6 oz./100 gal.	0
thrips	azinphosmethyl (Guthion)	2 S (EC)	2-3 pts.	. 0
	lindane (Isotox-lindane)	25 WP	1 1b. D a a f	Do not apply after fruit starts to form.

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
thrips (cont.)	parathion	4 EC	1-2 qts.	10
tomato fruitworm	azinphosmethyl (Guthion)	2 S (EC)	3-6 pts.	14
(same specifics as corn earworm and	carbaryl (Sevin)	80 WP	1 1/4-2 1/2 1bs.	0
fruitworm)	cryolite (Kryocide)	36 WP	15-30 lbs.	wash fruit
	esfenvalerate (Asana)	1.9 EC	1.7-3.4 ozs.	1
	fenvalerate (Pydrin)	2.4 EC	5 1/3-10 2/3 ozs.	1
	methamidophos (Monitor)	4 EC	1 1/2-2 pts.	7
	methomyl (Lannate, Nudrin)	1.8 L	2-4 pts.	1
	naled (Dibrom)	8 EC	1 pt.	. 1
	Penncap-M	2 EC	4 pts.	15
	permethrin* (Ambush) (Pounce)	2 EC 3.2 EC	3.2-12.8 ozs. 2-8 ozs.	up to day of harvest
tuberworm	azinphosmethyl (Guthion)	2 S (EC)	2 1/4-3 pts.	0
weevils	allethrin (Pyrellin SCS)	1% liquid (EC)	1-1 1/2 pts.	see label.

INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN. DAYS TO HARVEST
whitefly	azinphosmethyl (Guthion)	2 S (EC)	1 1/2-2 pts.	0
	endosulfan (Thiodan)	3 EC	2/3 qt./100 gal.	1
	esfenvalerate (Asana)	1.9 EC	1.7-3.4 ozs.	1
	fenvalerate (Pydrin)	2.4 EC	5 1/3-10 2/3 ozs.	1
	parathion	4 EC	1-2 pts.	10
	phosphamidon	8 EC	1/2 pt.	10
white grubs	lindane (Isotox-lindane)	25 WP	1-2 lbs.	preplant (soil)
wireworms	diazinon	14 G	21-28 lbs.	preplant
	diazinon	2 B	50 lbs.	none listed
	diazinon	14 G	70 lbs.	preplant, broadcast
	diazinon	4 EC	10 qts.	preplant, broadcast
	fonofos (Dyfonate)	10 G	20 lbs.	preplant, broadcast
	lindane (Isotox-lindane)	25 WP	1-2 lbs.	preplant (soil)

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INSECT	INSECTICIDE	FORMULATION	RATE/ACRE	MIN, DAYS TO HARVEST
wireworms (cont.)	parathion	10 G	30-40 lbs.	preplant, broadcast & disc 3 wks, preplanting
	parathion	4 EC	5 qts.	apply to soil surface pre- planting & work 6-9" into soil

be applied by air or ground. Use sufficient water to obtain uniform coverage. Do not apply more than 1.2 lbs. active ingredient per acre per season which is equivalent to 76.8 ozs. of Ambush 2 EC or 48 ozs. of Pounce 3.2 EC. *Permethrin (Ambush, Pounce) only for Florida use where final market is for fresh tomatoes. Do not use on cherry tomatoes or any variety used to produce fruit less than 1" (one inch) in diameter. Permethrin can

THE 1986-87 TOMATO SEASON WAYNE HAWKINS MANAGER, FLORIDA TOMATO COMMITTEE ORLANDO, FLORIDA

The Organizational Meeting of the Florida Tomato Committee was held on September 5, 1986, at the Ritz Carlton Hotel, Naples, Florida. The initial regulations were the same as those in effect for the 1985-86 season except the minimum size was raised to 2-8/32 inches in diameter which eliminated the shipment of 7x7 tomatoes. This change was not approved until December 1, 1986.

Marketing Agreement No. 125 and Order No. 966 for Fresh Florida Tomatoes were amended in 1986 to provide for paid advertising and promotion, production research projects, and to allow any alternate within a district to serve on the Committee at a meeting if a member and his alternate from the same district are not present. The production research projects and the education and promotion programs funded by the Florida Tomato Exchange in the past were recommended to the Secretary of Agriculture as projects for the Florida Tomato Committee during the 1986-87 season. He approved the programs.

The Committee met again on March 26, 1987, at Port LaBelle, Florida, with the primary reason being to review the activities of the Education and Promotion Plan. Representatives from Lewis & Neale, Inc., and Communication Resources, Inc., outlined in detail the activities that had taken place during the course of the season and explained planned activities for the balance of the season. The Committee unanimously reaffirmed their position on amending the U. S. Grade Standards for Fresh Tomatoes. They also requested management to seek ways to stop the sale of 7x7 tomatoes within the production area.

Following the Committee meeting, a reception and dinner was held at the Port LaBelle Country Club honoring Bill Cleveland. After more than 20 years of service to the Florida Tomato Committee, Bill decided to retire following the 1986-87 season. This function sponsored by registered handlers was well attended. Bill and Blanche will continue to reside at Bal Harbour in the winter and Big Canoe, Georgia, during the summer months.

Last season's Annual Report of the Florida Tomato Committee gave a good review of the activities that occurred in the attempt to amend the Marketing Order for Florida Tomatoes; however, it went to press before the results of the referendum were known. The four amendments recommended by the Committee and Exchange passed by a huge margin. Likewise the two amendments recommended by the Department dealing with periodic referendum and tenure were defeated by a large margin.

The Committee's recommendation to eliminate small tomatoes was opposed by only a few shippers, but it received a lot of opposition from repackers in the northeastern part of the United States. The majority of this opposition came from the New York City area. Due to the nature of this request, it was not approved by the Secretary of Agriculture in time for the beginning of the season. It did, however, become effective on December 1, 1986, and continued for the balance of the season. This regulation also applied to imports into the United States. It did not apply to sales in the production area and this generated a lot of discussion within the industry. Ways to prevent the marketing of 7x7's in the production area are a major concern of the Florida Tomato Committee at this time.

Total acres planted in Mexico were reportedly up; however, Mexico had weather similar to Dade County and it took its toll on quality. Prices at Nogales, Arizona, were constantly cheaper than Florida prices which tended to depress the market, particularly in the west. In early February, March and part of April, Mexico flooded the United States with cheap tomatoes which severely affected prices in Florida. The same tactics were employed by the Mexicans last season, but efforts to get any relief from Washington failed. Meetings were held with the Commerce Department and the International Trade Commission to consider filing an anti-dumping suit against Mexico.

Total harvested acres in Florida were 50,908, compared to 45,530 the previous season and 44,729 in the 1984-85 season. Districts 2, 3 and 4 had increases of 450, 2,748 and 2,669 acres, respectively. District 1 was down 489 acres, giving a net increase of 5,378 acres. There were 778 acres less of ground tomatoes and 6,156 acres more of staked tomatoes planted this season. The ratio changed this season and is now about 1/4 ground and 3/4 staked. Total shipments were 56,366,486 25-lb. equivalents compared to 52,421,792 the previous season.

Total shipments were up 3,944,694 25-lb. equivalents from the previous season. Weather conditions that prevailed throughout most of the winter season and wet conditions in the spring prevented the shipments from being much higher. Fair crops were produced in the fall and spring, but January, February and March saw very erratic situations. Cold, windy weather caused bloom drop and a lot of misshapen fruit. Cold, wet conditions enhanced disease problems, making it nearly uncontrollable in some fields.

Harvesting of the fall crop began in Districts 3 and 4 in mid-October with District 2 starting one week later and District 1 starting about the first of December. Total shipments from all districts exceeded one million packages by the week ending November 8 and continued at this level for the next 12 weeks with two weeks showing more than 2.4 million packages. Shipments dropped to

to 997,015 for the week ending February 7, back to 1,289,914 the next week, then down to 860,805 for the week ending February 21. Shipments totalled 1,038,134, 545,773, 802,365, and 952,514 for the next four weeks and then exceeded one million per week for the balance of the season.

District 2 started harvesting the fourth week of October and continued shipping good volume through the third week of May. Acreage planted for harvest was up 11 percent over the previous season and total shipments were up about 14 percent. Weekly shipments from this district exceeded 100,000 25-1b. equivalents for 28 weeks during the season and 19 of these weeks had shipments that exceeded 200,000 25-1b. equivalents.

District 1 started picking the last week of November and for all practical purposes finished on April 25. Weekly volume remained steady throughout this period but in no way approached a normal season. Total acreage planted for harvest was down approximately four percent but shipments were up about eight percent. This is attributed to the fact that crops were not that good this season, but they were better than the previous season.

District 3 started shipping the middle of October and by November 1 weekly shipments totalled more than 200,000 packages per week. The volume increased slightly each week, reaching over one million packages by the week ending December 6. For the next eight weeks, they ranged from 617,543 to 1,271,612. Shipments for the balance of the season fluctuated up and down the scale between 185,000 and 1.3 million packages per week. Cold, windy, rainy weather caused grade outs to be high and reduced average yields on most farms. Total shipments were up nearly 14 percent over the previous season, but acreage harvested was up nearly 22 percent. Some of the shipments reported for District 3 were actually grown in District 4 and vice versa. The completion of Interstate 75 makes it easy to haul tomatoes from the field in one district to another district to be packed.

District 4 started harvesting in mid-October and reached shipments totalling more than 500,000 25-lb. equivalents by the fourth week. Fall acreage was up about 25 percent but shipments were up only four percent. About 5.7 million 25-lb. equivalents were shipped from District 4 during the fall season compared to 5.5 million the previous season. This points out how bad the growing conditions were and it also explains why prices were above normal. As mentioned earlier, some of the tomatoes packed and shipped in District 4 are actually grown in District 3 and vice versa so it is very difficult to document exact figures from one season to the next.

Harvest of the spring crop in District 4 started in early April. About 1,100 more acres were harvested this spring, but shipments were down nearly two percent. During the last 11 weeks of the season, District 4 shipped more than 14 million 25-lb. equivalents, but slightly more than 12.5 million of these were shipped in a seven-week period. Basic quality and size were good during most of this period. Prices were good for most of the spring season. Heavy rains in late March and frost in early April cut down on the total yield. Some fields, however, were picked four or five times due to price.

The total 56,366,486 25-lb. equivalents were shipped over a 35-week period. Twenty-seven of these weeks had shipments exceeding one million packages with nine weeks showing more than two million and one of these showing more than three million 25-lb. equivalents. The total shipments were up 3,944,694 25-lb. equivalents from the previous season.

The total value of the crop was about 410.1 million dollars, compared to 408.1 million the previous season. The average price was \$7.28 per 25-lb. equivalent for the entire season, compared to \$7.78 per 25-lb. equivalent for the 1985-86 season and \$5.99 for 1984-85. Evenly spaced supplies during the winter season and the lack of a freeze causing major replanting helped stabilize the season's average price.

During the 1986-87 season, there were about 11 different commercial varieties planted, compared to more than 15 the previous season. Sunny, Duke, F.T.E. No. 12, and BHN 26 accounted for slightly more than 94 percent of the total acreage. Some of the other varieties planted were Freedom, Castle 1035, Floradade, Floratom, Pacific, Hayslip and IFAS 7181. The Florida Tomato Exchange is continuing research efforts to find a new super variety for Florida and several seed companies are working toward the same objective.

The continuing regulations allowing commingling of only 5x6 and larger tomatoes, requiring all tomatoes shipped out of state to be in new boxes, requiring the tomatoes to be run over sizing equipment and be packed at the registered handler's facility, requiring the name and address of the registered handler on the carton coupled with washing and positive lot identification, went a long way toward solving the problems of theft and the shipment of cull tomatoes all over the United States.

The Committee's activities in controlling container weights and designated diameters of tomato sizes have been profitable for the Florida Tomato Industry. It is also doubtful that Mexican producers would impose restrictions on themselves voluntarily if the Florida Tomato Marketing Order was not in effect. The need for continued use of these controls plus consideration of addi-

tional regulations on domestic shipments during periods of market glut are essential if profitable returns are to be expected by the Florida Tomato Industry.

The producers of Florida tomatoes must continue to work together to provide the ultimate consumer with a more palatable product. New varieties will be developed and the consumer must be educated in the proper methods of ripening and preparation. Increased per capita consumption of fresh Florida tomatoes could cure many of the problems of overproduction. Joint efforts of the Florida Tomato Committee and the Florida Tomato Exchange are channeled in this direction.

